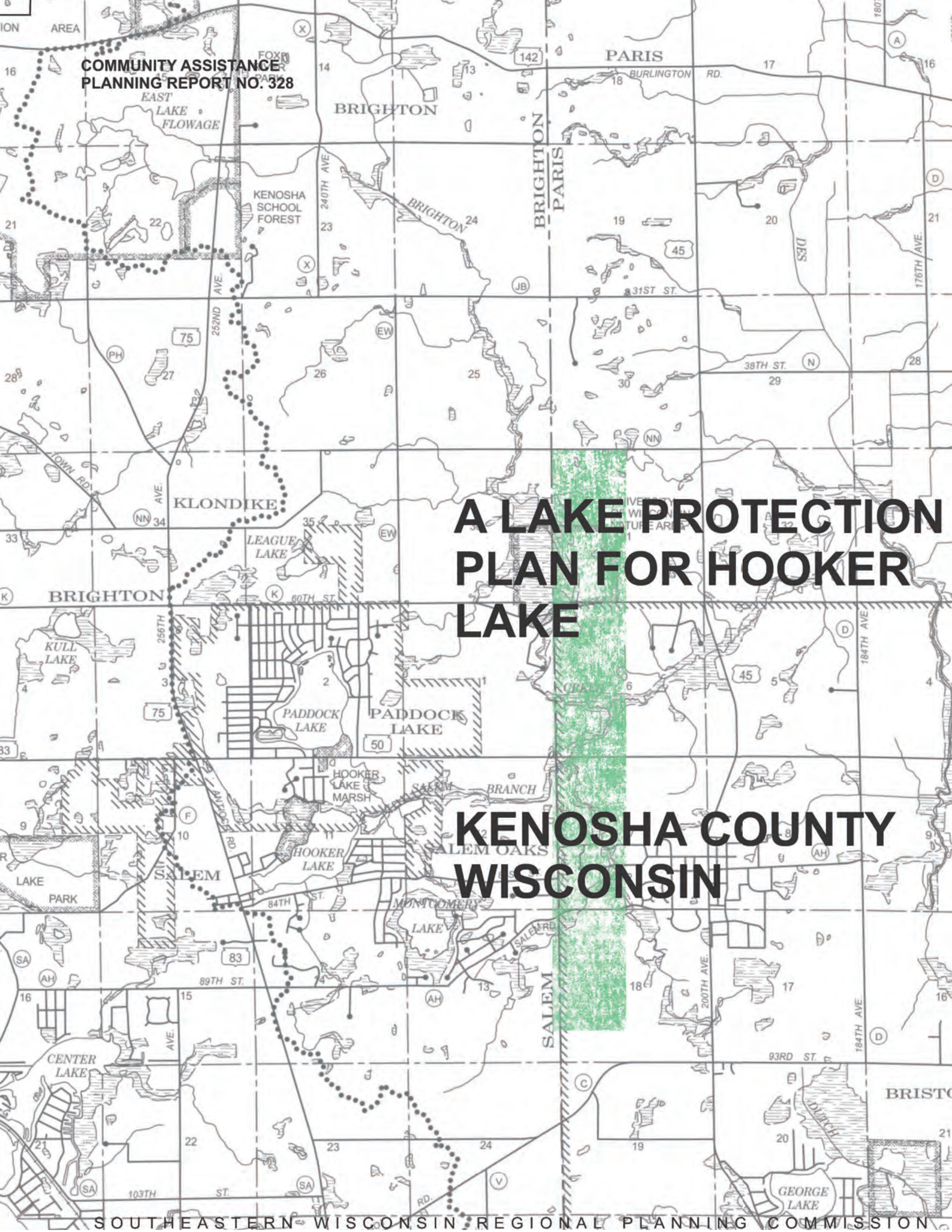
COMMUNITY ASSISTANCE
PLANNING REPORT NO. 328

A LAKE PROTECTION PLAN FOR HOOKER LAKE

KENOSHA COUNTY WISCONSIN



SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

Special acknowledgment is due Jim Grumbeck who gathered and reported lake and stream water quality information.

Special acknowledgment is due Dale J. Buser PE,PH, Principal Specialist, Beverly Saunders, Senior Specialist, Michael A. Borst, Research Analyst, Anna Cisar, Research Analyst, and Laura Fields Sommers, Research Analyst, for their contributions to the preparation of this report.

COMMUNITY ASSISTANCE PLANNING REPORT
NUMBER 328

A LAKE PROTECTION PLAN FOR HOOKER LAKE
KENOSHA COUNTY, WISCONSIN

Prepared by the

Southeastern Wisconsin Regional Planning Commission
W239 N1812 Rockwood Drive
P.O. Box 1607
Waukesha, Wisconsin 53187-1607
www.sewrpc.org

The preparation of this publication was financed in part through a grant from the Wisconsin Department of Natural Resources Lake Planning Grant Program.

March 2017

$20.00

(This page intentionally left blank)

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

Chapter III

LIST OF MAPS

Map | Page

Chapter I

Chapter II

Chapter III

Chapter I

INTRODUCTION

PURPOSE OF PLAN

The health of a lake or stream is usually a direct reflection of use and management of land within the lake's or stream's watershed. Hooker Lake, together with its watershed and associated wetlands, is a highly valued natural resource located within U.S. Public Land Survey Sections 10 and 11, Township 1 North, Range 20 East, in the Town of Salem, Kenosha County (see Map 1 and "Hooker Lake Characteristics and Assets" section below). The purpose of this plan is to provide a framework that helps maintain and enhance the land and water resources of Hooker Lake and its watershed with a focus on *protecting* this existing high-quality resource from human impacts and *preventing* future degradation. This report's recommendations are appropriate and feasible lake management measures. Actively following appropriate lake management measures can enhance and preserve Hooker Lake's native plant community and water quality while retaining and even enhancing opportunities for safe and enjoyable public recreation and beneficial use of lands within the Lake's watershed.

This plan complements other existing plans,[1] programs, and ongoing management actions in the Hooker Lake watershed. It is important to note that it relies upon the continuing commitment of government agencies, municipalities, and citizens to diligent lake planning and natural resource protection. Additionally, this plan assists State agencies, local units of government, nongovernmental organizations, businesses, and citizens in developing strategies benefitting the natural assets of Hooker Lake. By using the strategies outlined in this plan, the natural environment will be enriched and preserved.

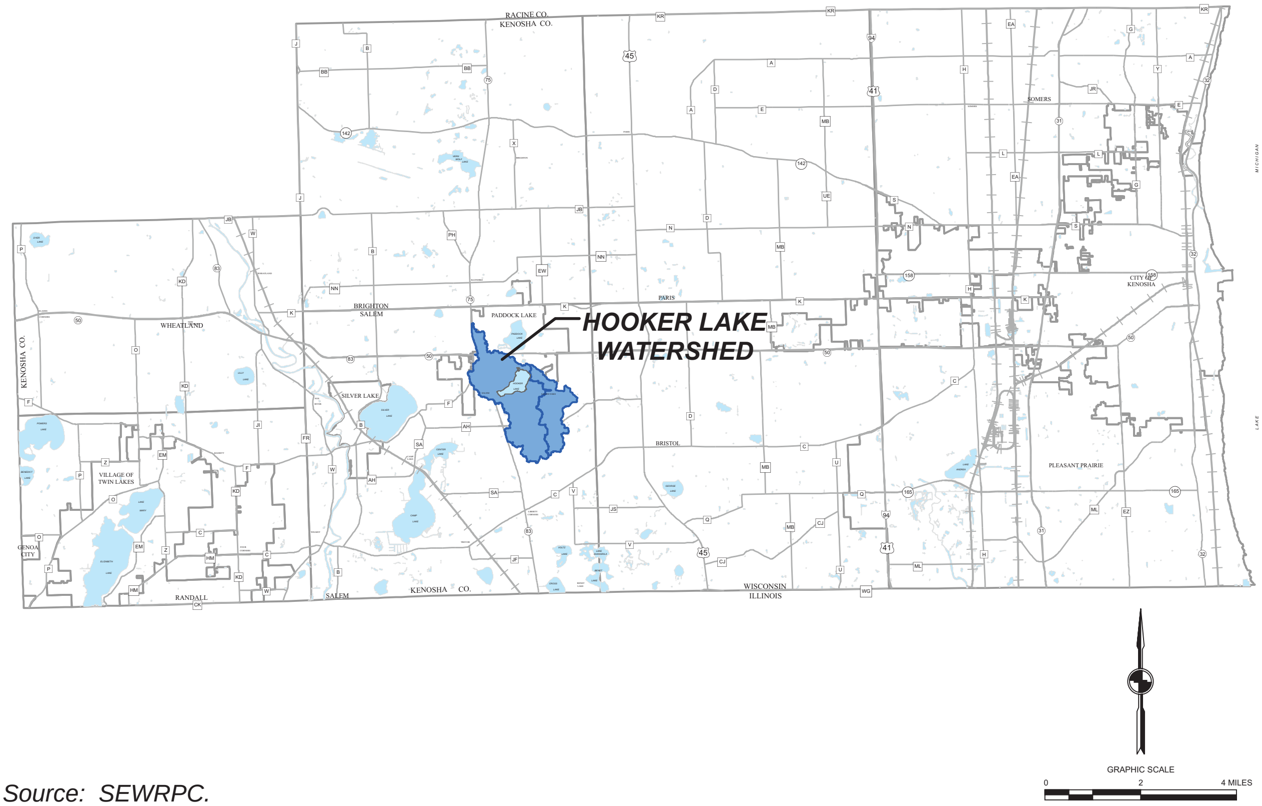
This planning program was funded, in part, by the Hooker Lake Management District (HLMD), and in part, through a Chapter NR 190 Lake Management Planning Grant awarded to the HLMD and administered by the Wisconsin

---

[1]*SEWRPC Planning Report No. 44,* A Comprehensive Plan for the Des Plaines River Watershed, Part One, Chapters 1-10, *June 2003; SEWRPC Planning Report No. 44,* A Comprehensive Plan for the Des Plaines River Watershed, Part Two, Chapters 11-17, *June 2003; Town of Salem, Storm Water Management Plan, September 2009; SEWRPC Community Assistance Planning Report No. 275,* A Park and Open Space Plan for the Town of Salem: 2020, Kenosha County Wisconsin, *2005; and SEWRPC Community Assistance Planning Report No. 306,* A Comprehensive Plan for the Town of Salem: 2035, Kenosha County Wisconsin, *2010.*

Map 1

LOCATION OF THE HOOKER LAKE WATERSHED



Source: SEWRPC.

Department of Natural Resources (WDNR). The inventory and aquatic plant management plan elements presented in this report conform to the requirements and standards set forth in relevant *Wisconsin Administrative Codes*.[2]

HOOKER LAKE CHARACTERISTICS AND ASSETS

Based upon interpretation of the Hooker Lake shoreline on the 2010 aerial photography, the Lake has a surface area of 111 acres.[3] Assuming the current dam has increased water depth by one foot, Hooker Lake has a maximum water depth of 28 feet (see Map 2 for the Lake's bathymetry). The Lake's water elevation is controlled by a small

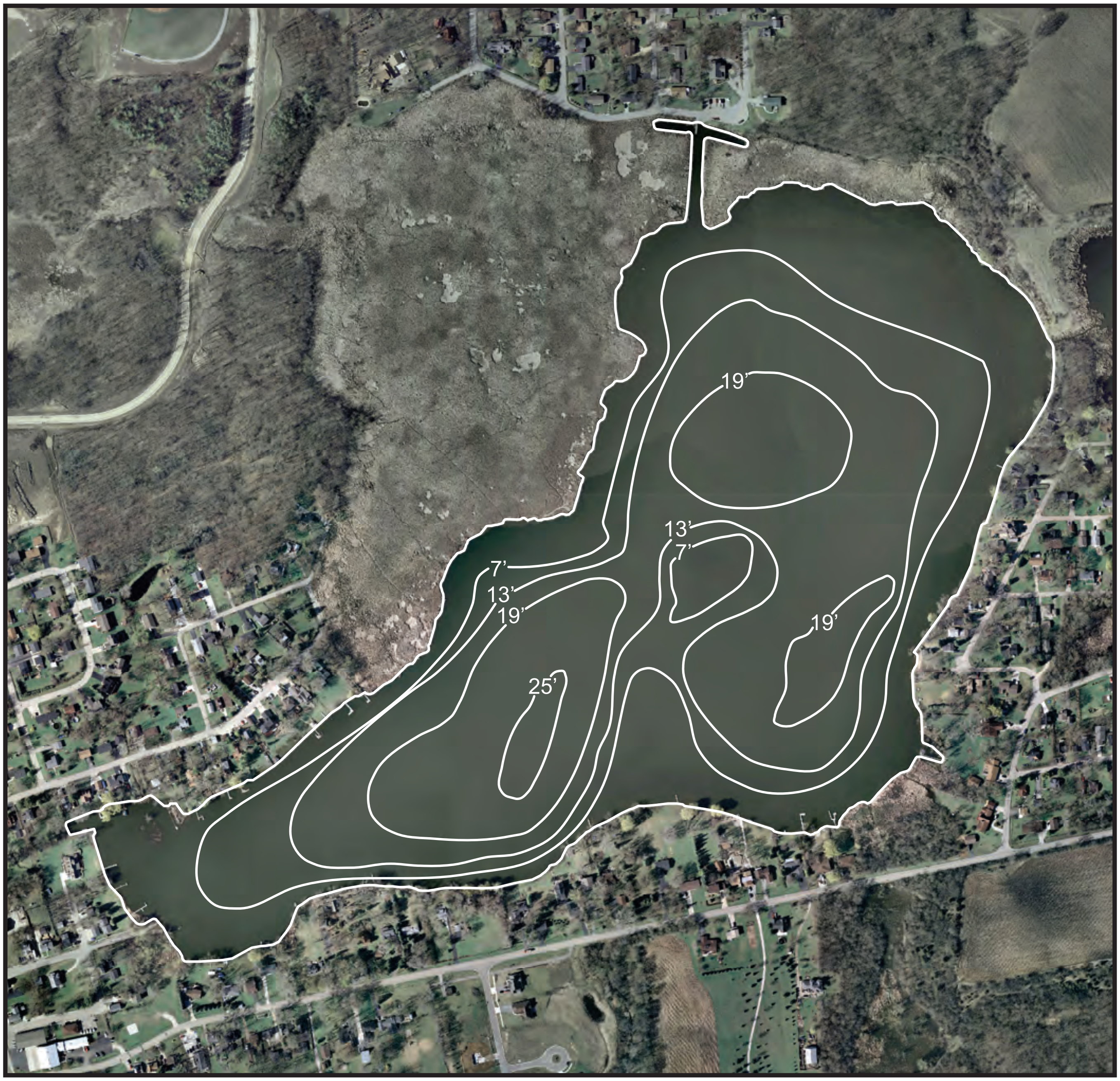
---

[2] *This plan has been prepared pursuant to the standards and requirements set forth in the following chapters of the* Wisconsin Administrative Code: *Chapter NR 1, "Public Access Policy for Waterways;" Chapter NR 40, "Invasive Species Identification, Classification and Control;" Chapter NR 103, "Water Quality Standards for Wetlands;" Chapter NR 107, "Aquatic Plant Management;" and Chapter NR 109, "Aquatic Plants Introduction, Manual Removal and Mechanical Control Regulations."*

[3] *The surface area of Hooker Lake has been variously reported as 87 acres in WDNR publication PUB-FH-800 2005, 102 acres on the 1952 bathymetric map produced by the Wisconsin Conservation Department, and 103 acres on the WDNR web site.*

Map 2

HOOKER LAKE BATHYMETRY



DATE OF PHOTOGRAPHY: APRIL 2010

—20'— WATER DEPTH CONTOUR IN FEET

Note: Bathymetric contour lines were defined by the
Wisconsin Department of Natural Resources in 1952.
One foot was added to lake depth to account for the lake
elevation increase following the 2002 Bryzek Dam reconstruction.

GRAPHIC SCALE
0 300 600 FEET

Source: Wisconsin Department of Naural Resources and SEWRPC.

privately-owned dam located at the northeast corner of the Lake that raises water elevations approximately one to two feet.[4] The dam is located downstream of a small shallow lake just northeast of Hooker Lake. The dam controls the water elevation of both Hooker Lake and the small, shallow downstream lake. Hooker Lake forms the headwater of the Salem Branch of Brighton Creek, a second order stream. From its confluence with the Salem Branch, Brighton Creek, a fourth order stream, flows to the east approximately four miles to its confluence with the Des Plaines River.

The WDNR classifies Hooker Lake as a deep headwater lake. Deep headwater lakes are larger than 10 acres, are likely to thermally stratify during warm weather and have hydrologic characteristics consistent with the definition of a drainage lake. Hooker Lake's primary source of water is precipitation and direct drainage from the surrounding land, but it likely does receive some flow from groundwater. Table 1 further details the hydrologic and morphologic characteristics of the Lake. Chapter II provides more insight on the importance of these characteristics.

Table 1

HYDROLOGY AND MORPHOMETRY OF HOOKER LAKE

Parameter	Measurement
Size	
Surface Area of Lake	111 acres
Total Tributary Area[a]	1,269 acres
Lake Volume	1,365 acre-feet
Residence Time[b]	1.0 -1.3 years
Shape	
Length of Lake	0.8 mile
Width of Lake	0.3 mile
Length of Shoreline	2.5 miles
Shoreline Development Factor[c]	1.3
General Lake Orientation	SW-NE
Depth	
Maximum Depth	28 feet
Mean Depth	12.3 feet

[a]Total tributary area represents land contributing runoff to the lake, and specifically excludes the lake surface but may include localized internally drained basins.

[b]Residence time is the number of years required for natural water sources to fill a lake one time under typical weather conditions. Natural sources of water to lakes include runoff from areas surrounding the lake, precipitation falling directly upon the lake, water entering from tributary streams, and water contributed to a lake by groundwater.

[c]Shoreline development factor is the ratio of the shoreline length to the circumference of a circular lake of the same area.

Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, and SEWRPC.

Hooker Lake and its watershed have a wide range of assets. For example, Hooker Lake is able to support a variety of recreational opportunities as evidenced by the recreational survey completed by Southeastern Wisconsin Regional Planning Commission (SEWRPC) staff during the summer and winter of 2012 and 2013 (see Chapter II). This survey shows that lake users engage in full-body contact uses (such as swimming and paddle boarding) as well as high- and low-speed boating and fishing. The Lake enjoys a reputation for good fishing, especially for northern pike, largemouth bass and panfish. The Lake's watershed contains a variety of wetlands, uplands, and woodlands that help support a wide variety of wildlife. Moreover, as is further described in Chapter II, the Lake contains two WDNR-designated Sensitive Areas: Hooker Lake Marsh and a small wetland area in the southwest corner of the Lake. The Lake and its watershed likely support a variety of reptile and amphibian species that live in and around the Lake, as well as a number of bird species that inhabit the area year round or during migration.[5]

---

[4] *Information regarding the outlet dam is found on the WDNR's dam information database found at http://dnr.wi.gov/topic/dams/damSearch.html.*

[5] *Based on bird, amphibian, and reptile databases for the Region.*

LAKE PROTECTION PROGRAMS AND GOALS

General lake protection goals and objectives for Hooker Lake, aimed at maintaining and enhancing the Lake's many assets, were developed as a part of this planning process. These goals and objectives were developed in consultation with the HLMD and the general public. These objectives also directly address goals established in the Kenosha County multi-jurisdictional comprehensive plan[6] and the Town of Salem Comprehensive Plan,[7] and include:

1. Describe existing conditions in the Hooker Lake tributary area including identifying and quantifying potential point and nonpoint sources of pollution, nutrient and contaminant inputs, and nutrient and contaminant balances;

2. Document changes in lake surface area over time, as an indicator of changes in lake surface elevation;

3. Identify the extent of existing and potential future water quality problems likely to be experienced in the Lake, including an assessment of the Lake's water quality using water quality monitoring data being collected as part of ongoing programs and estimates of changes in these conditions in the future; and,

4. Formulate appropriate lake protection programs, including public information and education strategies and other possible actions necessary to address the identified problems and issues of concern.

This plan uses the information described above to develop a comprehensive set of specific lake protection recommendations to protect and enhance Hooker Lake, and provides recommendations related to the issues and concerns of Hooker Lake residents, including an aquatic plant management plan. Implementing the recommended actions set forth herein should serve as an important step in achieving Lake use/protection objectives over time.

---

[6] *SEWRPC Community Assistance Planning Report No. 299,* A Multi-Jurisdictional Comprehensive Plan for Kenosha County: 2035, *April 2010.*

[7] *SEWRPC Community Assistance Planning Report No. 306*, A Comprehensive Plan for the Town of Salem: 2035, *March 2010.*

(This page intentionally left blank)

Chapter II

ISSUES AND CONCERNS

INTRODUCTION

Despite being a valuable resource, as discussed in Chapter I of this report, Hooker Lake is subject to a number of existing and potential future problems and issues of concern. To better define and understand these issues, and to foster continued recreational use of the Lake, the Hooker Lake Management District (HLMD) executed an agreement with the Southeastern Wisconsin Regional Planning Commission (SEWRPC) to investigate causes of community concern and to develop a comprehensive lake protection plan to address those causes. Table 2 lists issues of concern identified through consultation with the HLMD.[1] This chapter summarizes each issue of concern and presents information relevant to understanding the recommendations provided in Chapter III of this report.

ISSUE 1: WATER QUALITY

Actual and perceived water quality conditions are important issues for many Hooker Lake residents who have expressed concerns about pollutants that could enter the Lake from various sources. These sources include: the Lake's several tributary streams; the nearby and recent resurfacing and reconstruction of STH 83 adjacent to the west end of the Lake; fertilizer and pesticide runoff from shoreline properties; fertilizer runoff from agricultural properties within the watershed; and, bacteria sources throughout the watershed (e.g., feces from birds and other animals that live in the watershed). Additionally, concerns about excessive aquatic plant growth further reinforce water quality as an issue of concern given the fact that water quality conditions (such as levels of phosphorus) greatly influence the ability of a lake to support excessive aquatic plant growth.

As part of the discussion of water quality in Hooker Lake, it is important to succinctly define what *water quality* means since individuals have varying interpretations and levels of understanding. Water quality is often discussed in terms of visual cues. Algal blooms or cloudy water, for example, can lead an observer to come to the conclusion that the water in a lake is "unclean." However, to quantify actual lake water quality, lake managers and residents need to look at specific chemical, physical, and biological parameters that influence, or are indicators of, water quality.

---

[1]*The issues of concern are organized so those most commonly referenced by stakeholders over the entire project duration are listed first. Attention directed at denser aquatic plant growth during recent years, and especially during 2015, suggests that aquatic plants concerns may now garner increasing relative importance.*

Table 2

ISSUES OF CONCERN

	Issues and Concerns
1	Water Quality
2	Water Quantity
3	Lake Outlet Dam
4	Aquatic Plant Growth
5	Cyanobacteria and Floating Algae
6	Recreational Use and Facilities
7	Shoreline Maintenance
8	Fish and Wildlife
9	Plan implementation

Source: SEWRPC.

The most commonly used parameters for assessing water quality include water clarity and the concentrations of phosphorus, chlorophyll-*a*, and dissolved oxygen (see Table 3 for descriptive details). These parameters interact with one another in a variety of ways. For example, nutrient pollution derived from phosphorus containing fertilizers can cause a lake's phosphorus levels to increase, its clarity to decrease (due to algal growth in the water column), and chlorophyll-*a* (a measure of algae content) to increase. To develop a meaningful water quality maintenance and improvement program, key water-quality indices must be regularly measured over extended periods of time. This allows lake managers to establish baseline levels and identify trends. [2]

Historic water quality measurement data for Hooker Lake includes several isolated samples taken by WDNR staff in the 1970s (see Appendix A); data collected during 1991 and 1992 by WDNR Self-Help Program volunteers and U.S. Geological Survey (USGS) staff (see Appendix A); data collected in 1998, 2001, and 2004 by WDNR staff; and, most recently, data collected in 2009, 2010, and 2012-2015 by volunteers enrolled in the University of Wisconsin-Extension (UWEX) Citizen Lake Monitoring Network (CLMN), formerly known as the WDNR Self-Help Monitoring Program. The primary water quality sampling station is located at the deepest portion of Hooker Lake's western basin, as shown on Map 3. In addition to the water quality samples collected at the deep hole in the western basin, additional tributaries were sampled at six different locations (Map 3). As part of the preparation for this lake protection plan, Commission staff reviewed available water quality data listed above as well as that which appeared in various existing reports on Hooker Lake.

In addition to water clarity, phosphorus, chlorophyll-*a*, and dissolved oxygen measurements, a number of other parameters can also be measured to determine the "general health" of a lake (see Appendix A). For example, measurements of the bacteria *E-coli* are frequently taken on some lakes to determine swimming safety and chloride concentrations can indicate pollution entering a lake.[3]

The basic factors that need to be considered when assessing water quality conditions in a lake include:

1. **General characteristics of a lake, including past and current water quality conditions**—It is important to establish and benchmark lake water quality. To do this, concentrations of the aforementioned parameters (phosphorus, water clarity, chlorophyll-*a*, dissolved oxygen) should be measured and compared to past levels to determine if water quality has changed over time. Parameters that have been getting progressively worse can help determine which pollutants should be targeted for reduction. This information can then be reviewed within the context of the general lake characteristics to determine the extent of water quality problems as well as the most practical methods for effectively dealing with them.

[2]*Throughout this report, the use of underlining denotes items having management implications.*

[3]*Chlorides are used as an indicator of human-sourced pollution because they are naturally present in low quantities in Southeastern Wisconsin. Often, abnormally high chloride levels can indicate malfunctioning residential septic systems in areas not served by public sanitary sewer systems or may be the result of road salt or excessive fertilizer applications.*

Table 3

WATER QUALITY PARAMETER DESCRIPTIONS, TYPICAL VALUES, AND REGULATORY LIMITS/GUIDELINES

Parameter	Description	Southeastern Wisconsin Values[a]		Regulatory Limit or Guideline	Hooker Lake Values	
		Median	Range		Median	Range
Chloride (mg/L)	Low concentrations (e.g. < 5 mg/L) naturally occur in lakes due to natural weathering of bedrock and soils. Human activities increase concentrations (e.g., road salts, wastewater, water softener regeneration) and can effect certain plants and animals. Chloride remains in solution once in the environment and **can serve as an excellent indicator of other pollutants.**	16	1-57	Acute toxicity[b,c] 757 Chronic toxicity[b,c] 395	105[d]	38-121
Chlorophyll-*a* (µg/L)	The major photosynthetic "green" pigment in algae. The amount of chlorophyll-*a* present in the water is an indicator of the biomass, or amount of algae, in the water. **Chlorophyll-*a* levels above 10 µg/L generally result in a green-colored water** that may be severe enough to impair recreational activities such as swimming or waterskiing and are commonly associated with eutrophic lake conditions	9.9	1.8-706.1	2.6[e]	9.8[f]	2.5-31.3[f]
Dissolved Oxygen (mg/L)	Dissolved oxygen levels are one of the most critical factors affecting the living organisms of a lake ecosystem. Generally, dissolved oxygen levels are higher at the surface of a lake, where there is an interchange between the water and atmosphere, stirring by wind action, and production of oxygen by plant photosynthesis. Dissolved oxygen levels are usually lowest near the bottom of a lake where decomposer organisms and chemical oxidation processes deplete oxygen during the decay process. **A concentration of 5.0 mg/L is considered the minimum level below which many oxygen-consuming organisms, such as fish, become stressed**. Many species of fish are unlikely to survive when dissolved oxygen concentrations drop below 2.0 mg/L.	- -	- -	≥5.0[g]	- -[h]	0.1-13.2
Growing Season Epilimnetic Total Phosphorus (µg/L)	Phosphorus enters a lake from natural and human-derived sources and is a fundamental building block for plant growth. Excessive phosphorus can lead to nuisance levels of plant growth, unsightly algal blooms, decreased water clarity, and oxygen depletion, all of which can stress or kill fish and other aquatic life**. A concentration of less than 30 µg/L is the concentration considered necessary in a drainage lake such as Hooker Lake** to limit algal and aquatic plant growth to levels consistent with recreational water use objectives. Phosphorus concentration exceeding 30 µg/L are considered to be indicative of eutrophic lake conditions	30	8-720	30[g]	29[f]	18-63[f]
Water Clarity (feet)	Measured with a Secchi disk (a ballasted black-and-white, eight-inch-diameter plate) which is lowered into the water until a depth is reached at which the disk is no longer visible. It can be affected by physical factors, such as suspended particles or water color, and by various biologic factors, including seasonal variations in planktonic algal populations living in a lake. **Measurements less than 5 feet are considered indicative of poor water clarity and eutrophic lake conditions**	4.6	3-12	10.9[e]	8.8[f]	2.0-15.3[f]
Water Temperature (°F)	Temperature increases above seasonal ranges are dangerous to fish and other aquatic life. Higher temperatures depress dissolved oxygen concentrations and often correlate with increases of other pollutants.	- -	- -	Ambient[g] 35-77 sub-lethal[g] 49-80 Acute[g] 77-87	- -[h]	33-86

[a]*Wisconsin Department of Natural Resources Technical Bulletin No. 138,* Limnological Characteristics of Wisconsin Lakes, *Richard A. Lillie and John W. Mason,* 1983.

[b]*Wisconsin Administration Code Chapter NR 105, Surface Water Quality Criteria and Secondary Values for Toxic Substances. July, 2010.*

[c]*Pollutants that will kill or adversely affect aquatic organisms after a short-term exposure are termed acutely toxic. Chronic toxicity relates to concentrations of pollutants that will kill or adversely affect aquatic organisms our long time periods (time periods that are a substantial portion of the natural life expectancy of an organism).*

[d]*A series of lake water chloride concentration data points was collected in between May and November 2014. The average value from 2014 data is presented as the "mediam" value. Chloride concentrations have been consistently increasing across the region, and current chloride concentrations are likely higher.*

[e]*U.S. Environmental Protection Agency,* Ambient Water Quality Criteria Recommendations: Information Supporting the Development of State and Tribal Nutrient Criteria: Lakes and Reservoirs in Nutrient Ecoregion VII, *EPA 822-B-00-009, December 2000.*

[f]*Values collected, during growing season (June 1 through August 31).*

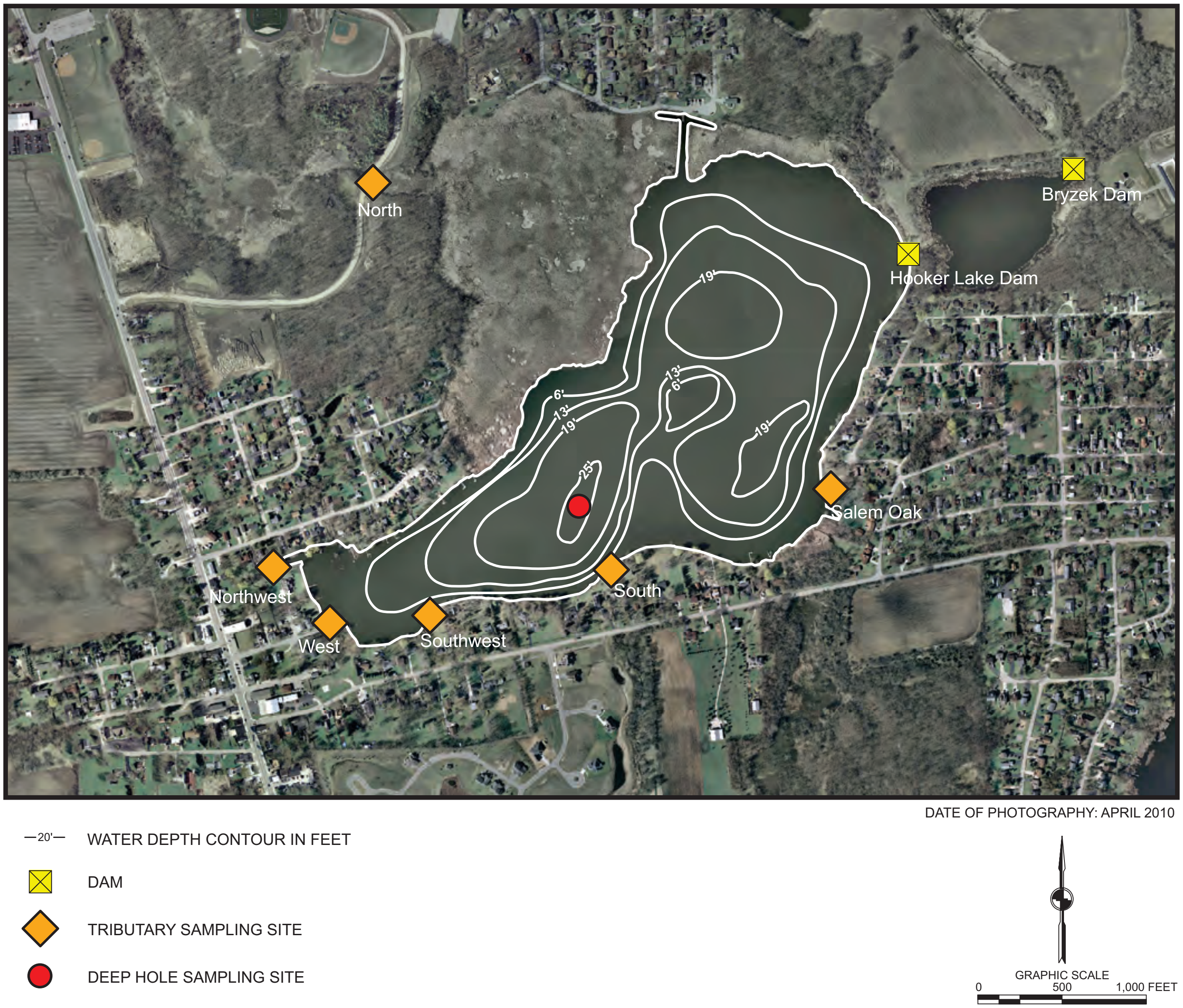
[g]*Wisconsin Administrative Code Chapter NR 102, Water Quality Standards for Wisconsin Surface Waters, November 2010.*

[h]*Oxygen concentrations and temperatures vary with depth and season. Median values provide little insight to understand lake conditions.*

Source: Wisconsin Department of Natural Resources, Wisconsin State Legislature, U.S. Environmental Protection Agency, and SEWRPC.

Map 3

HOOKER LAKE AND TRIBUTARY SAMPLING SITES: 2014



Source: Wisconsin Department of Natural Resources and SEWRPC.

2. **A lake's watershed characteristics, including land use and pollutant loadings**—Pollutants that enter a lake are highly dependent on the ways that the lands surrounding and draining to the lake (i.e., its *watershed*) are used. Different kinds of land use produce different kinds of pollutants (see Figure 1). For example, agricultural land can be a significant contributor of sediment (from soil erosion in fields) and nutrients (from fertilizers), depending on the type of agricultural practices that are used (e.g., tillage farming can loosen soils and make it easier for pollutants to enter the waterways). In contrast, urban land uses (e.g., residential, industrial, and commercial developments) can contribute a significant amount of heavy metals, oils, and nutrients. The amount and type of pollutants depend on actual use characteristics. For example, pollution related to human activities—oil leaked from cars onto pavement and fertilizers on lawns—may drain to a lake during rain events. Given this connection, it is important to understand the past, current, and planned land uses within the watershed. Based on these land use conditions, models can be applied to estimate the amount of pollution that is likely to be entering a lake. Knowing this can help identify areas that are more likely contributing to water quality deterioration, and can help determine where in the watershed to focus pollution reduction efforts.

Figure 1

ILLUSTRATIONS OF LAND USE AFFECTING WATERBODIES

NATURAL STREAM ECOSYSTEM

AGRICULTURAL STREAM ECOSYSTEM

URBAN STREAM ECOSYSTEM

Source: Illustration by Frank Ippolito, www.prolito, www.productionpost. com. Modified from D.M. Carlisle and others, The quality of our Nations's waters—Ecological heath in the Nations's streams, 1993-2005*, U.S. Geological Survey Circular 1391, 120p., http://pubs.usgs.gov/circ/1391/,2013, and SEWRPC.*

3. **The filtering ability of a lake's watershed and shorelines**—Various natural features can help filter pollutants which would otherwise enter a lake. These features, such as wetlands and vegetative buffers[4] can significantly decrease the amount of pollution that enters a lake either by absorbing and utilizing them (in the case of nutrients) and/or trapping pollutants (such as sediments) prior to their entering the lake. Certain wetland plants, such as cattails, are particularly effective in this capacity. Pollutants may be detained or retained within the watershed, with varying effects on the lake's water quality.

Each of these three factors is discussed below.

Lake Characteristics and Water Quality

As previously mentioned, the evaluation of water quality depends on monitoring (ideally over a protracted time period) the levels of various chemical and physical parameters of a lake's waters. In general, this monitoring data is used to determine the level and nature of pollution within a lake, the risks associated with that pollution, as well as the overall health of the lake. When evaluating water quality, it is important to know certain lake characteristics that provide context for evaluation. These lake characteristics include:

1. **Whether the lake stratifies, and, if it does, when the lake mixes**—*Stratification* refers to a condition in a lake in which the temperature difference (and associated density difference) between the surface waters (i.e., the epilimnion) and the deep waters (i.e. the hypolimnion) is great enough to form thermal layering that can prevent circulation and mixing between the two layers (see Figure 2).[5] If a lake stratifies, oxygen-rich surface waters in contact with the atmosphere do not freely mix with water in deeper portions of the lake. Therefore, the deeper hypolimnetic water cannot exchange gases with the atmosphere. Metabolic processes continue

---

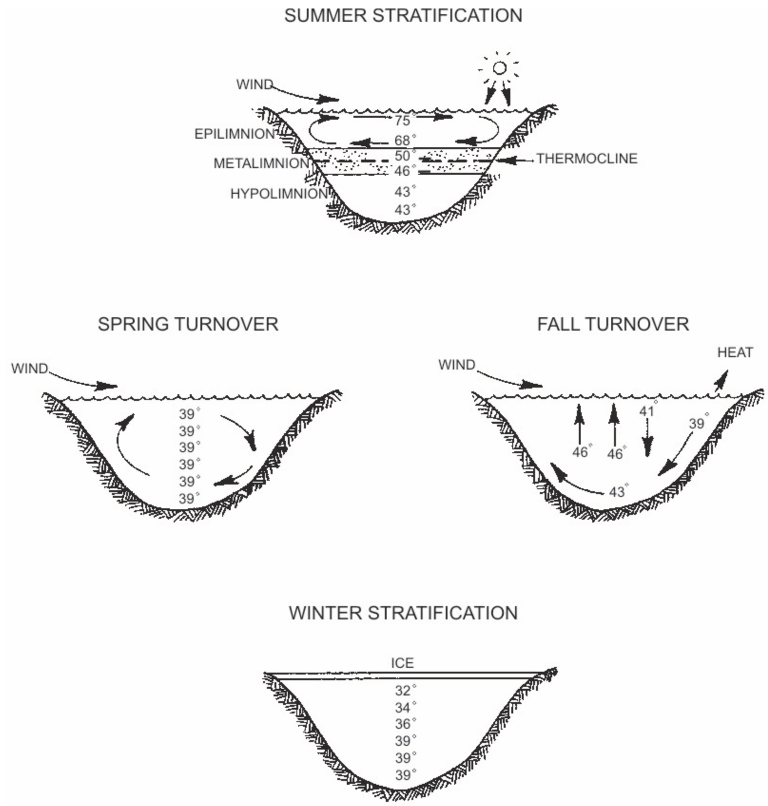
[4]*Vegetative buffers (e.g., forests, grassed waterways, and engineered vegetative strips) and wetlands each have the natural ability to slow down water. This encourages pollutants to settle out prior to their entering the lake.*

[5]*The thermocline (sometimes referred to as the metalimnion) is the thin layer of rapid temperature change that divides the epilimnion from the hypolimnion.*

to consume oxygen in the hypolimnion. If oxygen demands are high (such as in an enriched lake), or if the volume of deep isolated hypolimnetic water is small (limiting oxygen storage potential), water in deep portions of lakes can become extremely low in, or even completely void of, oxygen (anoxic) for a period of time. While some lakes remain permanently stratified, stratification in most Wisconsin lakes breaks down at least twice per year in response to changing seasons and ambient weather conditions.

Figure 2

LAKE THERMAL STRATIFICATION



Source: University of Wisconsin-Extension and SEWRPC.

A lake must be sufficiently deep to create sufficient temperature differences between surface and bottom waters for the lake to stratify. In general, lakes in Southeastern Wisconsin less than 15 feet deep are unlikely to stratify, whereas lakes with depths greater than 20 feet are likely to stratify. A lake's propensity to stratify is heavily influenced by the lake's shape, size, and orientation, landscape position, surrounding vegetation, through flow, water sources, and a host of other factors. Depth to the thermocline (the transition layer between the epilimnion and hypolimnion, sometimes also called the *metalimnion*) can range from less than 10 feet to well over 20 feet in typical Southeastern Wisconsin lakes. **The maximum depth of Hooker Lake is 28 feet, which is adequate depth for stratification to occur.**

For most stratifying lakes in the Region, the pattern is to become stratified sometime during mid- to late-spring, with a short-lived period (usually less than a week) of whole-lake mixing of water (called a "turnover") that takes place once during the spring and once again in the fall (see Figure 2). At turnover, the lake's temperature is uniform from the surface to the bottom. Lakes that stratify and turn over in the spring and fall are termed "dimictic." Mixing can also occur in response to windy conditions in some lakes. Lakes can also stratify in winter when warmer, denser water is found in the deeper portions of the lake. It is important to determine if stratification and subsequent turnovers occur because nutrients, low-oxygen water, and in some cases pollutants and sediment that have accumulated in the isolated bottom waters can suddenly mix into the entire water column during the turnover period, causing management problems. For example, excess nutrients can fuel nuisance-level algae and plant growth in a lake.

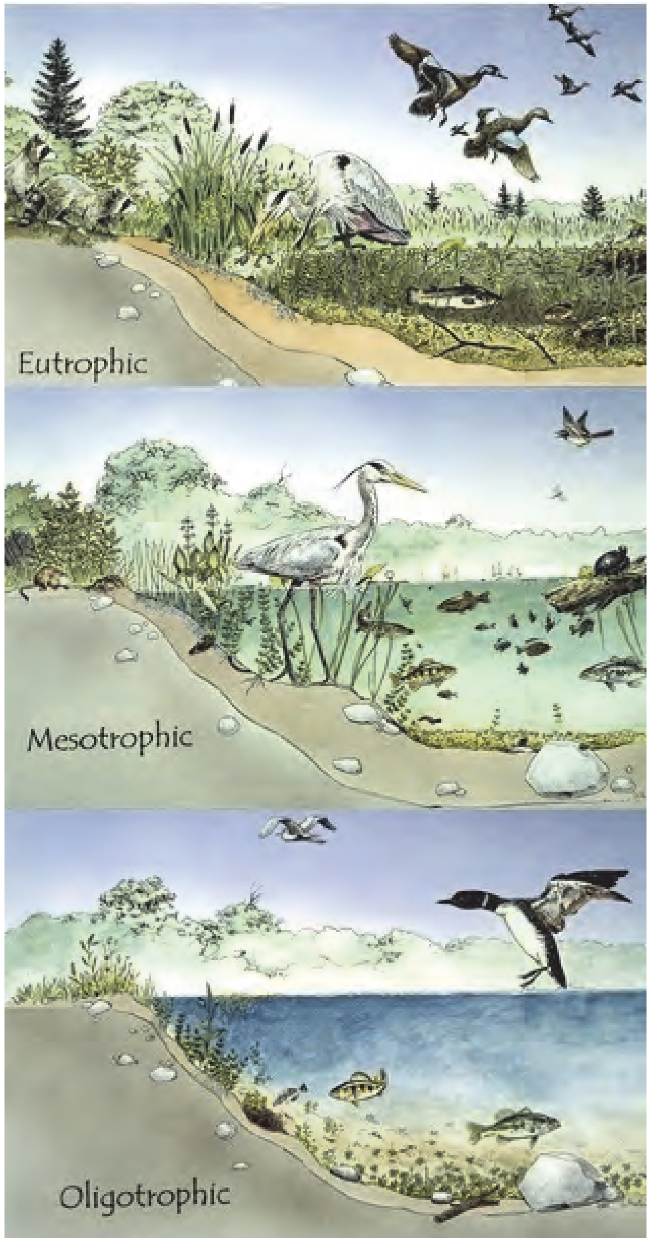
2. **Whether internal loading is occurring**—Internal loading refers to the release of accumulated phosphorus from a lake's bottom sediments that can occur under certain conditions associated with stratification. Phosphorus is typically not particularly soluble, and often adheres to particles that settle to the lake-bottom. When bottom waters become void of oxygen, the activities of decomposer bacteria in the bottom sediments, together with certain geochemical reactions that occur only in the complete absence of oxygen, can allow phosphorus in plant remains and lake-bottom sediment to dissolve into the water column. This allows phosphorus that is otherwise trapped in deep lake-bottom sediment to be released into lake water. Released phosphorus can mix into the water column during the next turnover period fueling plant and al-

gae growth. In most lakes, phosphorus is the nutrient controlling overall plant and algal growth, so additional phosphorus loading can lead to increased plant and algal growth. If this is occurring, a water quality management plan needs to focus on in-lake phosphorus management efforts in addition to pollution prevention. The shape of a lake's basin can influence the relative importance of this factor. Lakes with a large percentage of the surface area occupied by water just deep enough to stratify generally have more potential for significant internal phosphorus loading. **Three deeper regions of the Lake have adequate depth to stratify, making internal loading of phosphorus a potential concern.**

3. **A lake's current and past trophic states**—Lakes are commonly classified according to their degree of nutrient enrichment or t*rophic state*. The ability of lakes to support a variety of recreational activities and healthy fish and other aquatic life communities is often correlated with the degree of nutrient enrichment that has occurred. Three terms are generally used to describe the trophic state of a lake: *oligotrophic* (nutrient poor), mesotrophic (moderately fertile), and *eutrophic* (nutrient rich) (see Figure 3). Each of these states can happen naturally. Lakes tend to gradually shift from nutrient poor to nutrient rich as part of the natural lake aging process (see Figure 4); however, if a lake rapidly shifts to a more eutrophic state at a fast rate, pollution issues may be the cause. Another indication of pollution issues is when a lake enters the "hyper-eutrophic" level, which indicates highly enriched lakes (see Figure 5). Hyper-eutrophic lakes do not occur naturally (i.e., without contribution of human pollution).

Figure 3

ILLUSTRATIONS OF TROPHIC STATES

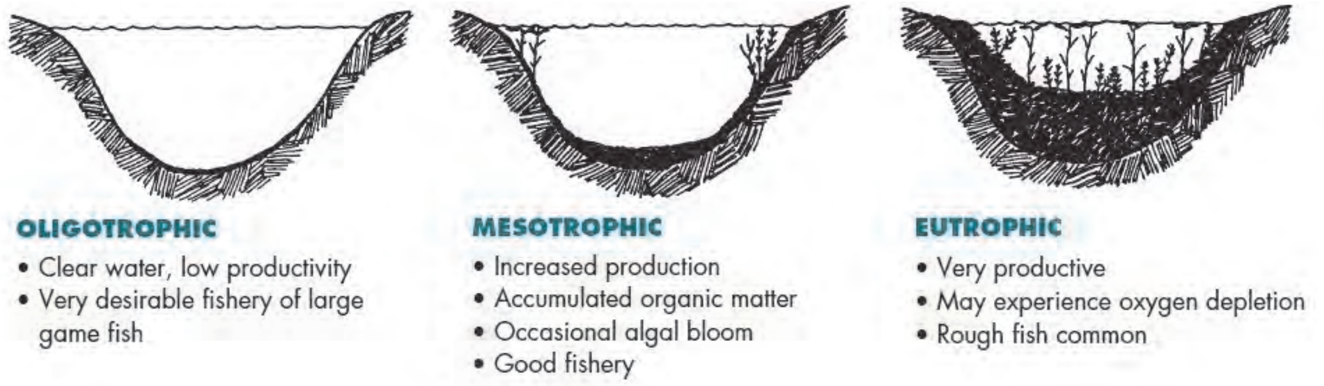


Source: DH Environmental Consulting, 1995.

4. **A lake's residence time**—*Residence time*, also known as retention time or flushing rate, refers to the average length of time a water molecule remains in a lake. The length of time water remains in a lake is significant because it can control how quickly pollution problems can be solved. For example, in lakes with short retention times, nutrients and pollutants are flushed out fairly quickly, meaning that management efforts could likely focus only on preventing pollution from the watershed. In contrast, lakes with long retention times tend to accumulate nutrients that can eventually become concentrated in bottom sediments, meaning that in addition to preventing pollution, it is also necessary to engage in in-lake water quality management efforts. The residence time of a lake is determined by comparing the volume of water in a lake to the amount of time it would take an equal volume of water to enter the lake; factors which influence the amount of water entering a lake include: the size of the lake's watershed, the average amount of precipitation and evaporation over the watershed, the average watershed runoff yield, and the surface area of the lake itself.

Figure 4

LAKE AGING AND TROPHIC STATES



Source: University of Wisconsin-Extension.

Figure 5

A HYPER-EUTROPHIC POND

Source: SEWRPC.

5. **Current and past water quality conditions of a lake and any tributaries**—The quality of water in a lake at any given time is determined by measuring an array of chemical and physical parameters, as described above. (See Appendix A for a comprehensive list of these parameters). Also, the water quality of a lake's tributary streams can greatly affect lake water quality, especially when the amount of in-flowing water from the tributary represents a significant percentage of total inflow to the lake. Other sources of water to a lake can include surface runoff, precipitation, and groundwater (seeps and springs).

General Surface-Water Hydrology

Water enters and leaves Hooker Lake. The relationship between inflow, storage, and outflow is examined in this section.

Lake Type, Water Sources, and Outflow

The WDNR classifies Hooker Lake as a deep headwater lake, a lake type that is deep enough to stratify and is largely fed by surface water. Deep headwater lakes are considered drainage lakes and have both an inlet and an outlet. The nutrient levels of drainage lakes tend to be higher than seepage or spring lakes due to their connection to streams and rivers and therefore greater surface runoff volumes enter such lakes. Hooker Lake is connected to the Salem Branch of Brighten Creek, which is a tributary to the Des Plaines River. Six tributary streams are mapped, entering the Lake from the north, northwest, west, southwest, south, and east. According to available records, the Lake's present outlet is Bryzek Dam located at the east end of the embayment.

Even though the lake is classified as a drainage lake, the inflow to the lake is modest, and **during dry weather, little to no water may enter or leave the Lake via streams.** At such times, the Lake's hydrology more closely resembles a seepage lake.

Residence Time

Based upon typical watershed yields within the Des Plaines River basin, **residence times for Hooker Lake range from 0.99 to 1.27 years, averaging 1.11 years.** During periods of heavy precipitation, the instantaneous residence time may be much shorter, while during drought, the instantaneous hydraulic detention time may be much longer. Long-term average pollutant loadings become more important considerations in assessing water quality in lakes with longer residence times. Therefore, the <u>degree of nutrient inflow is very important</u> in managing water quality conditions within a lake (since pollutants accumulate in a lake).

Water Quality

Hooker Lake has been studied for many years, with records extending back to the 1970s. Therefore, information is available to help quantify lake conditions and contrast changes over time. The available data is compiled in Appendix A and interpretations are presented in the following sections.

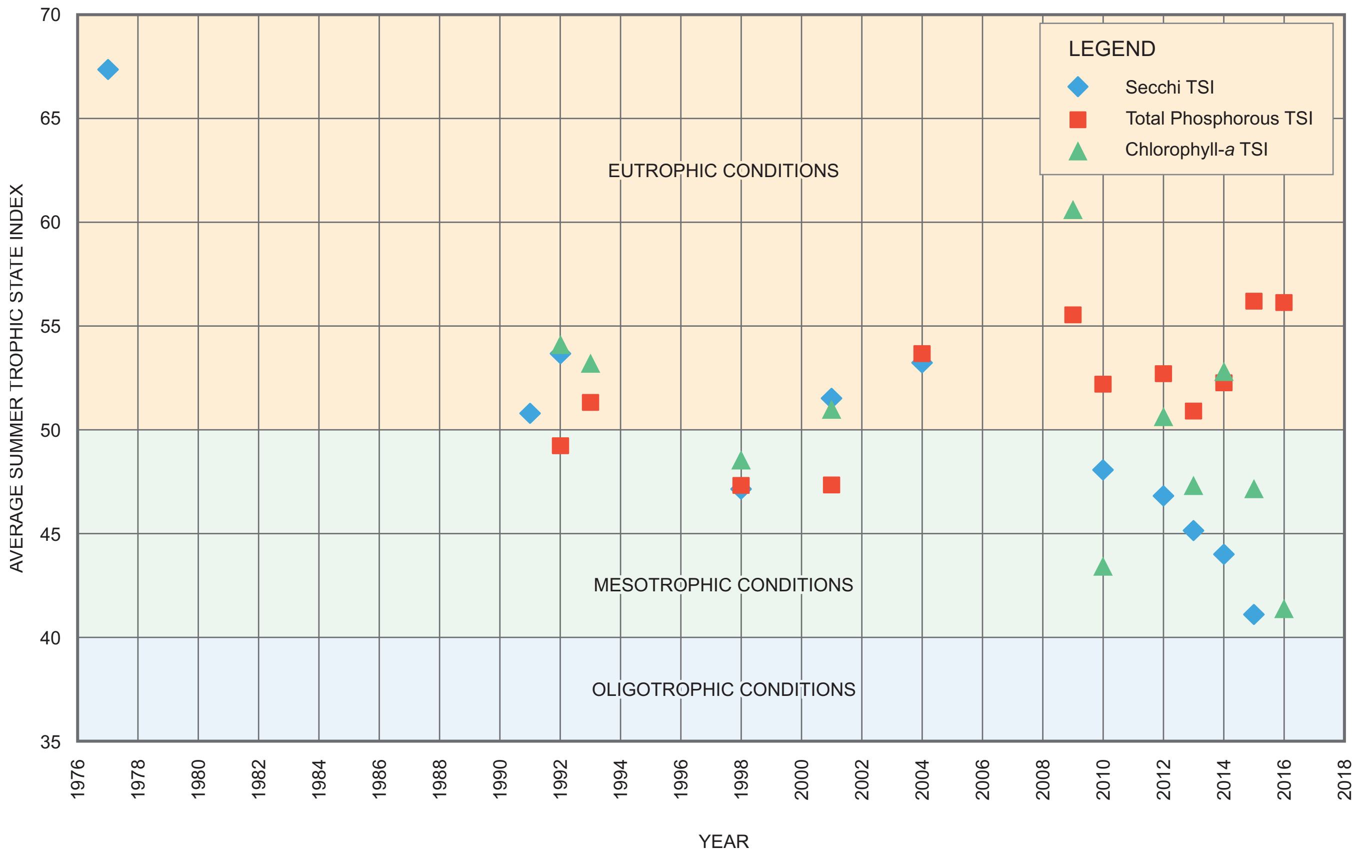
Trophic State and Nutrients

Like many lakes in southeastern Wisconsin, Hooker Lake is a fertile water body with abundant aquatic plants and green-colored water. Abundant aquatic plants impede some lake users from enjoying certain recreational pursuits and navigating portions of the Lake. Free-floating algae also has become overly abundant at times, reducing water clarity and causing recreational use problems. For this reason, the HLMD attempts to manage or reduce nuisance plant and algae growth (see Issues 4 and 5 of this chapter for additional detail). Several factors help describe and quantify the dynamic relationship between water clarity, nutrient levels, and plant and algae abundance. <u>Tracking and analyzing nutrient concentrations, water clarity, and chlorophyll-*a* concentration can help the HLMD develop and employ Lake management practices that more effectively and efficiently meet natural resource protection and lake user needs.</u>

Hooker Lake was historically eutrophic (see Figure 6). More recent water clarity and chlorophyll-*a* trophic state indices suggest that the Lake is becoming less eutrophic, and now easily meets values classifying it as a mesotrophic lake. However, the total phosphorus trophic state index has slowly risen, suggesting more eutrophic conditions. This apparently contradictory relationship is examined in the following paragraphs.

Figure 6

TROPHIC STATE OF HOOKER LAKE: 1991-2014



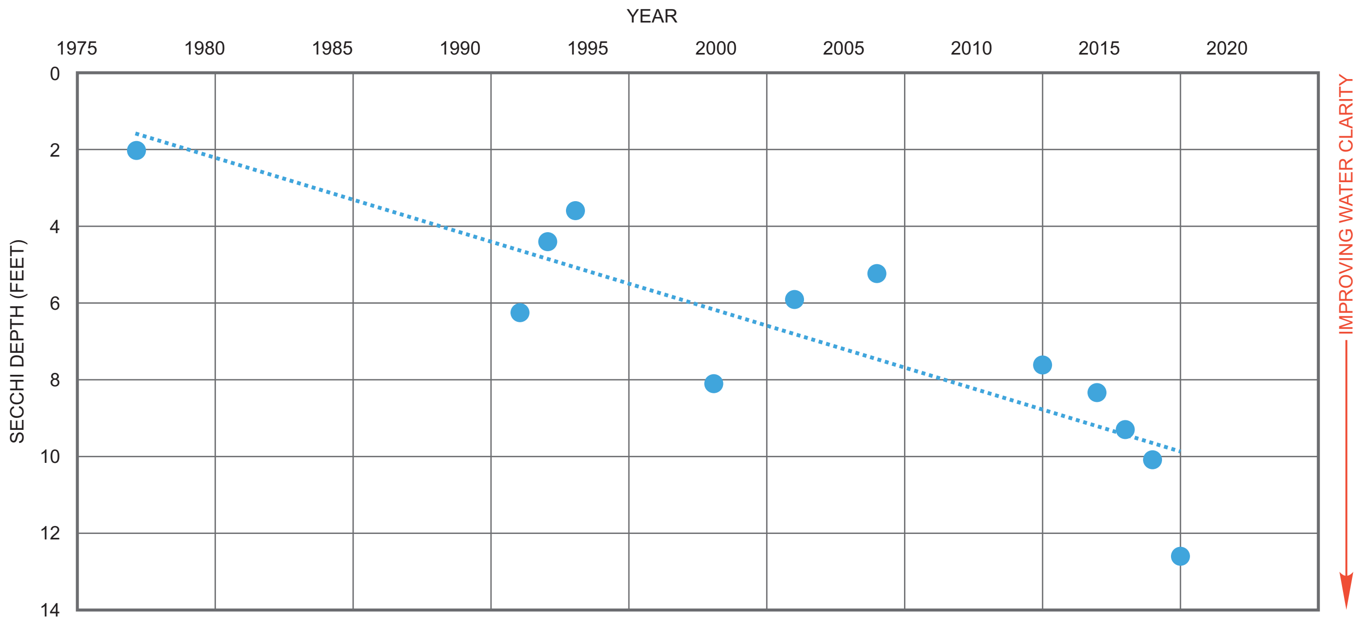
Source: U.S. Geological Survey, University of Wisconsin-Extension Citizen Monitoring Network, Wisconsin Department of Natural Resources Surface Water Information Management System, and SEWRPC.

In most lakes, changes in water clarity are controlled by free-floating algae abundance. Therefore, as free-floating algae populations decline, lake water becomes increasingly clear. Since algae and rooted plants compete for nutrients, increasingly abundant rooted aquatic plants require large amounts of the total phosphorus available in a lake. This decreases phosphorus available to algae, in turn reducing the abundance of free-floating algae which in turn causes lake water to clear. Similarly, when rooted aquatic plants senesce (or are digested or artificially killed), nutrients can return to the water column allowing algae populations to increase and water to become less clear. The increasingly clear water noted in Hooker Lake may be related to an increasingly abundant population of rooted aquatic plants in the Lake. Aquatic plant abundance has noticeably increased during recent years. Similarly, algae blooms may be related to time periods when large masses of aquatic plants are dying.

Hooker Lake's water clarity and free-floating algal abundance are plotted in Figures 7 and 8. Average summer water clarity has improved over the decades. In a similar fashion, chlorophyll-a concentrations have declined for at least 25 years. Most data conform to this long term declining trend. However, on four isolated recent occasions, chlorophyll-a concentrations were much higher than typical. During these periods, chlorophyll-*a* concentrations reached levels higher than any measured in the past. Interestingly, the high concentrations of chlorophyll-*a* noted on June 29, 2014 occurred around the same time as when the lake sampler entered the following notes: "lake sprayed for weeds" (June 7), "weeds dying" (June 18th), and "weeds dead" (June 29th). Similarly, the high concentrations of chlorophyll-*a* high noted on August 31, 2015 occurred several weeks after an herbicide application and during a time period when plants naturally senesce. **These data suggest that free-floating algal abundance increase when significant masses of aquatic plants die.**

Figure 7

MEAN SUMMER (JUNE THROUGH AUGUST)
SECCHI DISK MEASUREMENTS FOR HOOKER LAKE: 1977-2015

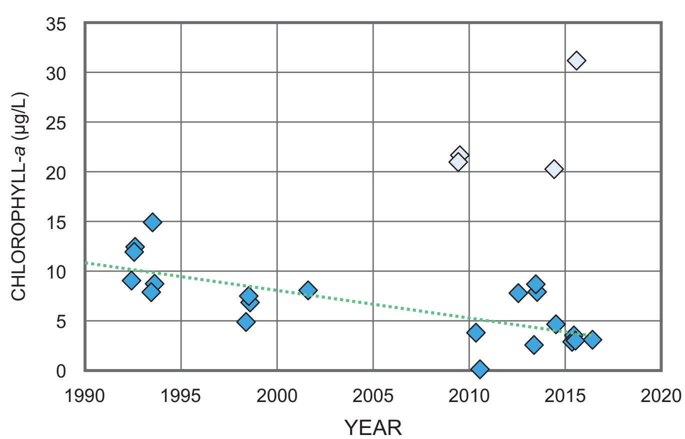


Source: U.S. Geological Survey, University of Wisconsin-Extension Citizen Monitoring Network, Wisconsin Department of Natural Resources Surface Water Information Management System, and SEWRPC.

The amount of phosphorus in the water column limits algal growth in most Wisconsin lakes. However, in some lakes, the amount of nitrogen limits algal growth. Awareness of the nutrient constraining algal growth is important when making management decisions that aim to control the growth of algae in a lake. In general, when the ratio of nitrogen (N) concentration to phosphorus (P) concentration is greater than 15:1, phosphorus limits algal growth. Conversely, when this proportion is less than 10:1, nitrogen availability limits plan growth. Ratios between 15:1 and 10:1 are transitional. Water quality data reveal that algal growth in Hooker Lake is limited by available phosphorus during all sampling periods (Table 4). This means that small additions of phosphorus can lead to large increases in algal growth. Therefore, **the Lake is prone to algae blooms when pulses of phosphorus enter the Lake.** Phosphorus pulses that affect Hooker Lake include:

Figure 8

GROWING SEASON CHLOROPHYLL-a
CONCENTRATIONS FOR HOOKER LAKE: 1990-2016



NOTE: The trendline does not consider four isolated high chlorophyll-*a* concentration values collected on June 30 and July 28, 2009, June 29, 2014, and August 31, 2015.

Source: U.S. Geological Survey, University of Wisconsin-Extension Citizen Monitoring Network, Wisconsin Department of Natural Resources Surface Water Information Management System, and SEWRPC.

- heavy runoff events (especially in spring and fall when tree pollen and leaf phosphorus increase phosphorus loads),
- turnover of the Lake's water column, enabling phosphorus from bottom sediment to reach the lake surface,
- time periods when large masses of rooted aquatic plants are in the process of dying or senescing.

Other factors can reduce free-floating algae abundance and increase lake water clarity without significantly changing phosphorus concentrations. For example, zooplankton feed upon free-floating algae. When zooplankton populations are high, heavy feeding pressure reduces the abundance of free-floating algae. Fish populations control zooplankton populations. Therefore, if few fish are present that feed on zooplankton, water can be clearer than in a situation where fish feed heavily on zooplankton, which in turn feed on free-floating algae. Similarly, filter feeders such as zebra mussels can also reduce the abundance of free-floating algae.

Table 4

HOOKER LAKE NITROGEN: PHOSPHORUS RATIOS 1977-2014

DATE	TOTAL NITROGEN (as N, mg/l)	TOTAL PHOSPHORUS (as P, mg/l)	N:P RATIO
11/23/2014	1.300	0.038	34.21053
10/27/2014	0.900	0.017	52.94118
9/4/2014	0.680	0.021	32.38095
6/11/2014	0.730	0.006	121.6667
5/13/2014	0.680	0.019	35.78947
8/17/2004	1.194	0.031	38.51613
8/28/2001	0.919	0.020	45.95000
4/2/1998	1.732	0.030	57.73333
4/22/1993	2.100	0.066	31.81818
4/2/1992	2.000	0.037	54.05405
4/13/1978	2.460	0.040	61.50000
2/2/1978	1.747	0.050	34.94000
11/3/1977	0.900	0.070	12.85714
7/14/1977	2.106	0.040	52.65000

Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, and SEWRPC.

Tributary Streams

In response to concerns about pollutants entering Hooker Lake from its watershed, water samples were collected in six tributary streams on six different dates between April and November 2014. The locations and general appearance of these sampling sites are shown on Map 3 and Figure 9. All water samples were collected by HLMD members using the University of Wisconsin – Stevens Point Water and Environmental Analysis Lab (WEAL) stream sampling protocol and analytical package. Resultant water quality data is tabulated in Appendix A (Tables A-7 through A-10).

Water collected from all six streams exceeded phosphorus standards at some point during the year and contained nitrogen concentrations in excess of guideline limits most of the time. However, the nitrogen concentration of water from several streams was less than that found in water samples drawn directly from Hooker Lake on the same date. Water from the Southwest Tributary (site number 4) and the West Tributary (site number 3) generally contained less or the same nitrogen concentration as Lake water, while the largely agricultural South Tributary (site number 5) contained nitrogen concentrations less than lake concentrations except during late spring. **The tributary streams do not generally have total suspended sediment concentrations in excess of typical guideline limits.** Even though no samples were collected during the winter deicing season, **water from certain streams regularly contained concentrations of chloride above chronic toxicity levels.** Water from Salem Oaks Tributary (site number 6) had chloride concentrations essentially at acute toxicity levels during one sampling period. The abundance and diversity of aquatic life likely suffers in the Salem Oaks tributary, due to excessively high chloride concentrations. Chloride concentrations in all streams are likely even higher during winter and early spring because of road deicing.

The concentrations of phosphorus, nitrogen, suspended solids, and chlorides varied significantly with time and place (see Figures 10 through 13). This can be related to many factors including precipitation and temperature patterns, the condition of the streams' channels and floodplains, vegetation, agricultural cropping and drainage practices, stormwater infrastructure, and street maintenance. For example, high intensity storms have the ability to generate intense runoff, increasing suspended solids and phosphorus concentrations in the receiving streams (see Figure 14 for nearby precipitation data collected during the sampling period). Similarly, freshly-plowed fields can release more sediment, nutrients, and water than a densely vegetated field. Such factors must be considered when evaluating changes in water quality over time. Examples of factors that may contribute to observed water quality conditions on the dates of sampling are summarized below.

- April 27, 2014: the Des Plaines River hydrograph suggests generally fair weather conditions after periods of rainfall, suggesting that little effective (runoff producing) precipitation fell during the previous week.[6]

[6]*United States Geological Survey Gaging Station 05527800, Des Plaines River at Russell, Illinois*

Figure 9

HOOKER LAKE TRIBUTARY STREAM SAMPLING SITES: 2014

Number 1 “North” (Looking Upstream)

Number 2 “Northwest” (Looking Downstream)

Number 3 “West” (Looking Upstream)

Number 4 “Southwest” (Looking Downstream)

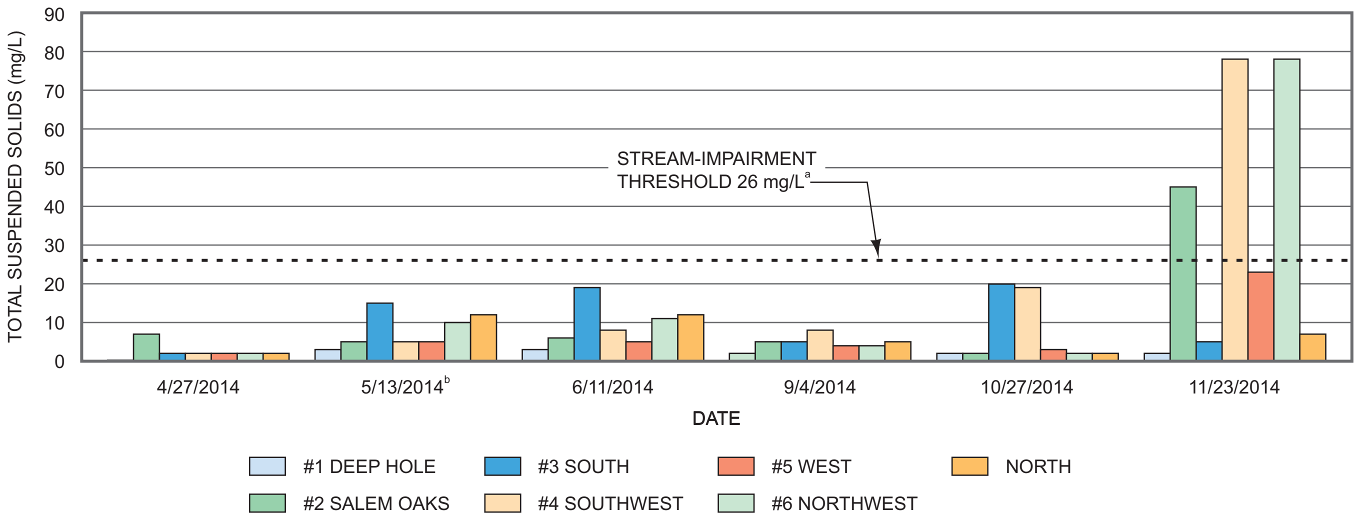
Number 5 “South” (Looking Downstream)

Number 6 Salem Oaks, (Looking Downstream)

Source: SEWRPC.

Figure 10

TOTAL SUSPENDED SOLIDS, HOOKER LAKE TRIBUTARIES 2014



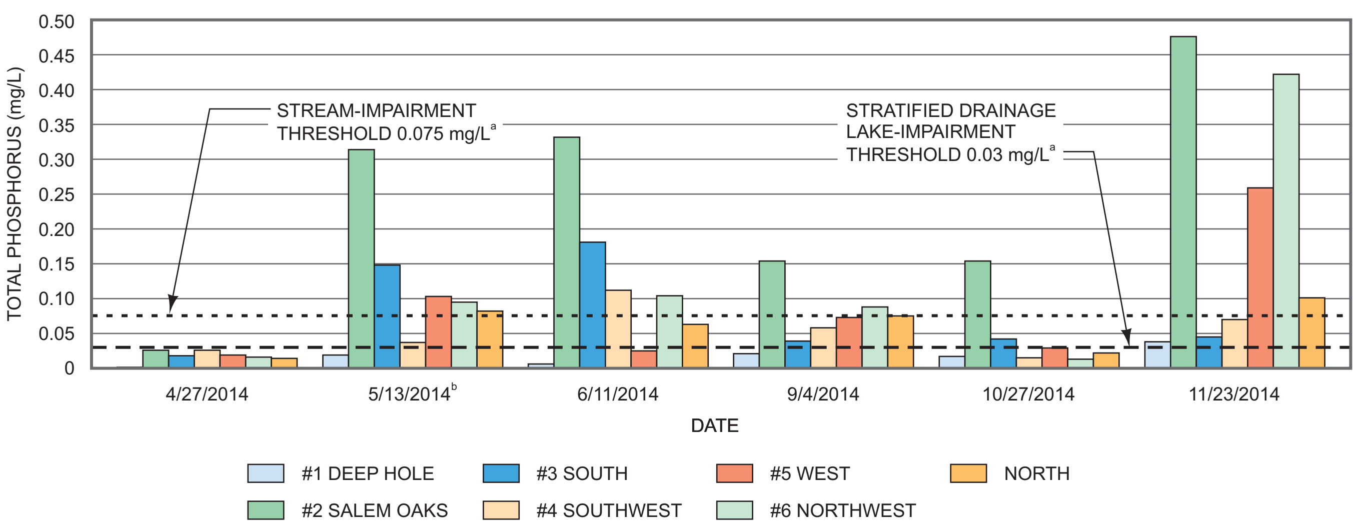
[a] *Value from Rock River Total Maximum Daily Load; U.S. Environmental Protection Agency and Wisconsin Department of Natural Resources, Total Maximum Daily Loads for Total Phosphorus and Total Suspended Solids in the Rock River Basin: Columbia, Dane, Dodge, Fond du Lac, Green, Green Lake, Jefferson, Rock, Walworth, Washington, and Waukesha Counties, Wisconsin, July 2011.*

[b] *Data Collected following a 3 inch rainfall.*

Source: University of Wisconsin-Extension Citizen Monitoring Network and SEWRPC.

Figure 11

TOTAL PHOSPHORUS, HOOKER LAKE TRIBUTARIES 2014



[a] *As set forth in Chapter 102.06(4) of the* Wisconsin Administrative Code*, November 2010.*

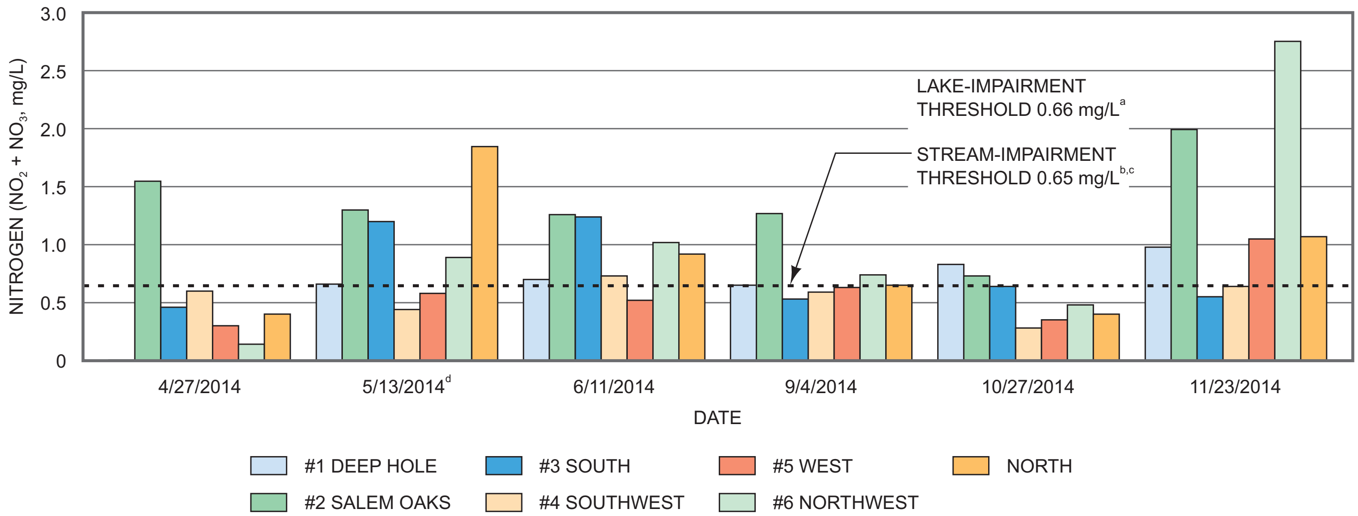
[b] *Data Collected following a 3 inch rainfall.*

Source: University of Wisconsin-Extension Citizen Monitoring Network and SEWRPC.

Kenosha precipitation records indicate light rain fell on four days the week before sampling (on the 21st 24th, 25th, and the 27th). Vegetation in the area was not likely well developed, decreasing the ability of run-off to be detained on the landscape. Fields may have been tilled, and some may have been freshly planted, potentially increasing nutrient availability.

Figure 12

TOTAL NITROGEN, HOOKER LAKE TRIBUTARIES 2014



[a]*U.S. Environmental Protection Agency,* Ambient Water Quality Criteria Recommendations: Information Supporting the Development of State and Tribal Nutrient Criteria: Lakes and Reservoirs in Nutrient Ecoregion VII, *EPA 822-B-00-009, December 2000.*

[b]*D.M. Robertson, D.J. Graczyk, L. Wang, G. LaLiberte, and R. Bannerman,* Nutrient Concentrations and their Relations to Biotic Integrity of Wadeable Streams in Wisconsin, *U.S. Geological Survey Professional Paper No. 1722, 2006.*

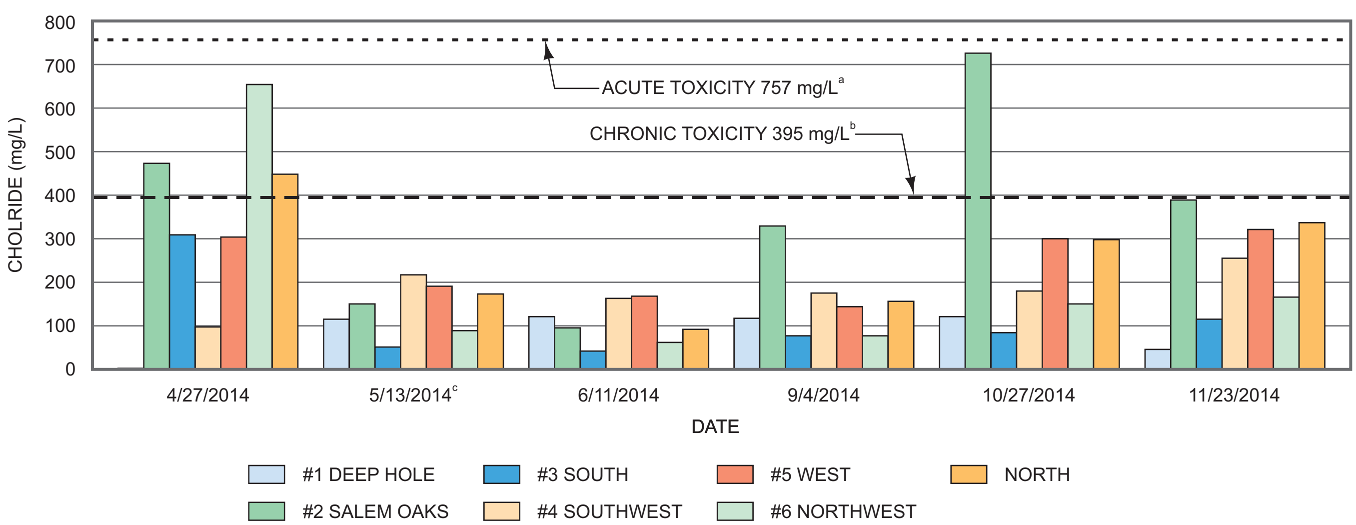
[c]*The reference value was developed by the U.S. Geological Survey and the Wisconsin Department of Natural Resources for southeastern Wisconsin. The U.S. Environmental Protection Agency has developed a similar reference value for southeastern Wisconsin till plains area of 1.30mg/L and a recommended criterion for Nutrient Ecoregion VII (mostly glaciated dairy region) of 0.54 mg/L.*

[d]*Data Collected following a 3 inch rainfall.*

Source: University of Wisconsin-Extension Citizen Monitoring Network and SEWRPC.

Figure 13

TOTAL CHLORIDE, HOOKER LAKE TRIBUTARIES 2014



[a]*As set forth in Chapter NR 105.05(2) of the* Wisconsin Administrative Code*, November 2010. Acute toxicity is the maximum daily concentration of substance which ensures protection of sensitive species.*

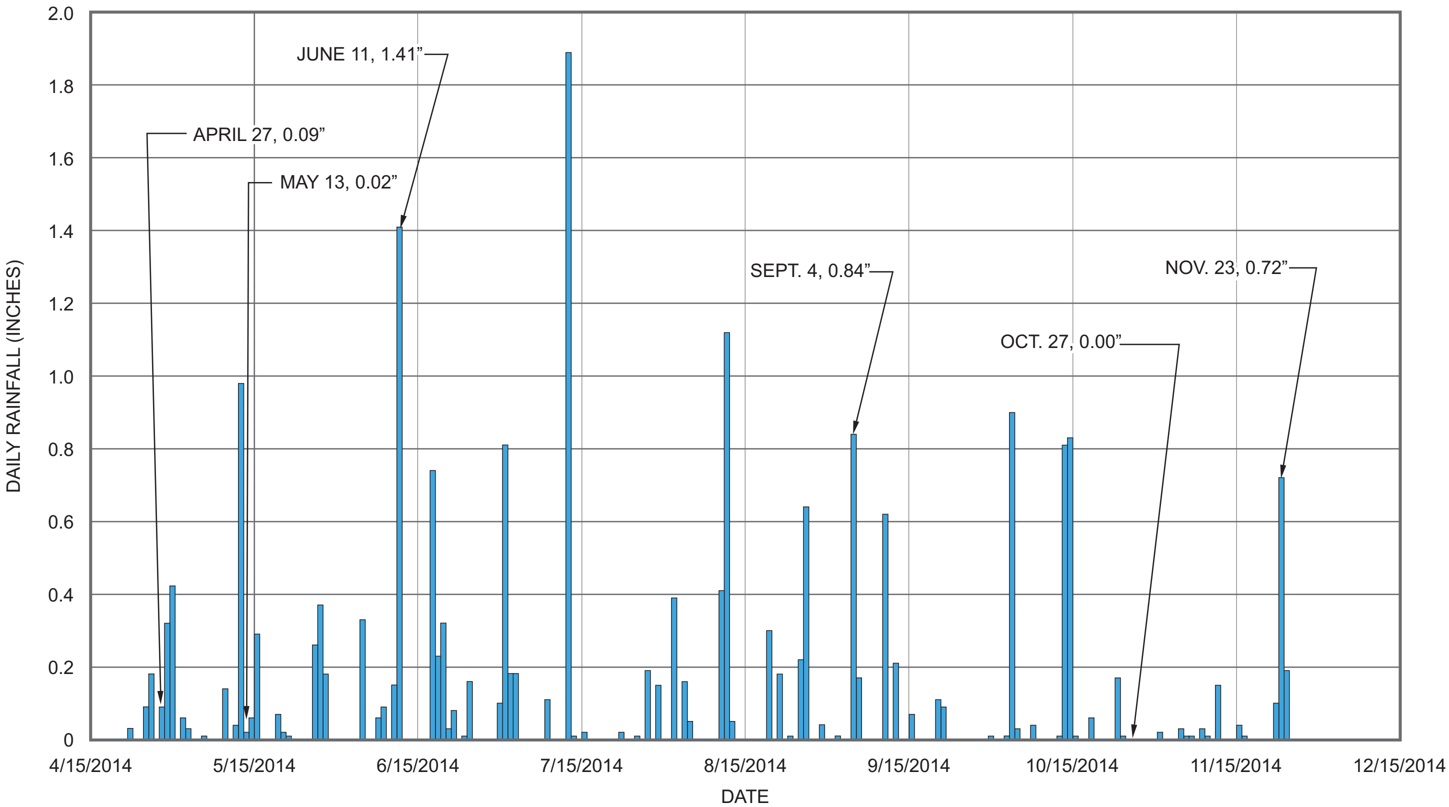
[b]*As set forth in Chapter NR 105.05(2) of the* Wisconsin Administrative Code*, November 2010. Chronic toxicity is the maximum four-day concentration of substance which ensures protection of sensitive species.*

[c]*Data Collected following a 3 inch rainfall.*

Source: University of Wisconsin-Extension Citizen Monitoring Network and SEWRPC.

Figure 14

DAILY RAINFALL AT THE KENOSHA REGIONAL AIRPORT COMPARED TO TRIBUTARY SAMPLING DATES: 2014



Source: The Weather Company and SEWRPC.

- May 13, 2014: The Des Plaines River hydrograph suggests that the previous week had been fair, with a large intense storm moving through the area shortly before sampling. Heavy rain did fall a day or two before sampling as confirmed by precipitation records (approximately one inch of rain fell on May 12 at the Kenosha Regional Airport). According to sampler notations, three inches of rain fell at Hooker Lake a short time before samples were collected. Heavy runoff would tend to increase sediment and nutrient loads. Vegetation in the area was likely still not well developed, decreasing the ability of the landscapes to detain runoff. Fields may have been tilled, and some may have been freshly planted and fertilized, potentially increasing sediment and nutrient availability.

- June 11, 2014: The Des Plaines River hydrograph suggests extended period of modest rainfall and runoff, interspersed with periods of heavy runoff. Heavy runoff would tend to increase sediment and nutrient loads. Rainfall records document heavy rain fell the day samples were collected. Pastures and natural areas were likely fully leafed out, increasing the ability of the landscape to detain stormwater. Crops were not likely yet well developed, decreasing the ability tilled agricultural parcels to detain runoff. Tilled fields may have been freshly dressed with nitrogen potentially increasing nutrient availability.

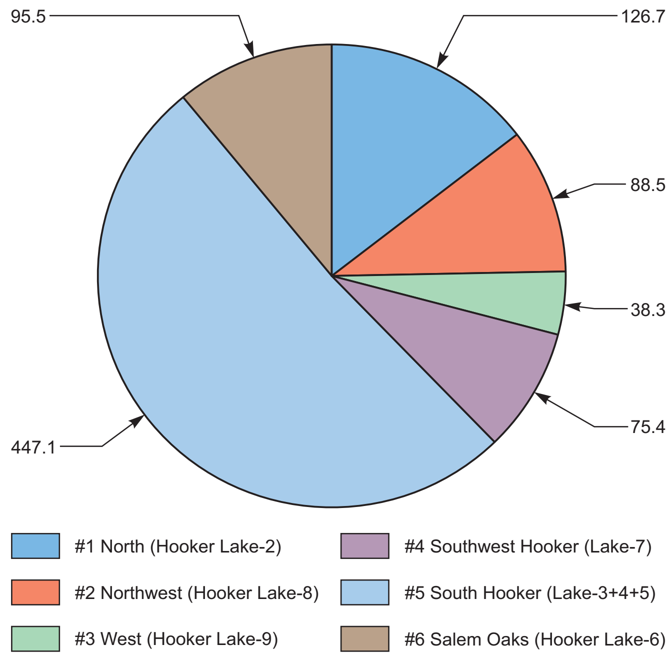
- September 4, 2014: The Des Plaines River hydrograph suggests an extended period of above average rainfall and runoff with occasional storms and periods of heavy runoff. Heavy runoff would tend to increase sediment and nutrient loads. Rainfall records document heavy rain fell the day the samples were collected. Pastures and natural areas were likely fully vegetated, increasing the ability of the landscape to detain stormwater. Crops were mature, increasing runoff detention on agricultural parcels. Some fields may have been harvested.

- October 27, 2014: The Des Plaines River hydrograph suggests wetter than normal conditions persisted through mid-October, but they were then followed by an extended period of fair weather. According to precipitation records, the October samples were collected during a period of little to no rainfall. Most vegetation was likely becoming dormant, decreasing the ability of the landscape to detain stormwater. Most crops had been harvested, decreasing runoff detention on agricultural parcels. Tree and shrub leaves, which can contribute significant nutrient pulses to surface water bodies, were falling, allowing them to be washed into streams when runoff producing storms occurred.

- November 23, 2014: The Des Plaines River hydrograph suggests a long period of fair weather ended on November 23 with a storm. Runoff rates increased, enhancing the potential for sediment and nutrient loading to streams. Precipitation records show that little effective rainfall fell for most of late October and early November and that the samples were collected during the first large rainfall after this extended dry period. Essentially all vegetation was likely dormant, decreasing the ability of the landscape to detain stormwater. Crops were harvested and many fields were likely tilled, decreasing the ability of runoff to be detained on agricultural parcels and increasing the potential yield of sediment and nutrients to streams. Trees had lost their leaves – the fair weather may have allowed fallen leaves to accumulate on streets and other uplands areas. However, when the November storm broke this drier weather period, the accumulated leaves may have been carried *en masse* to the Lake by the tributary stream.

Figure 15

HOOKER LAKE TRIBUTARY AREAS



Note: Values in acres.

Source: Town of Salem and SEWRPC.

Comparing these factors with the tributary water quality data, it becomes apparent that:

- The greatest pollutant concentrations are not correlated with the heaviest rainfall, a finding suggesting factors other than general soil erosion deliver sediment to the Lake.

- The highest pollutant concentrations were commonly found in streams draining developed watersheds.

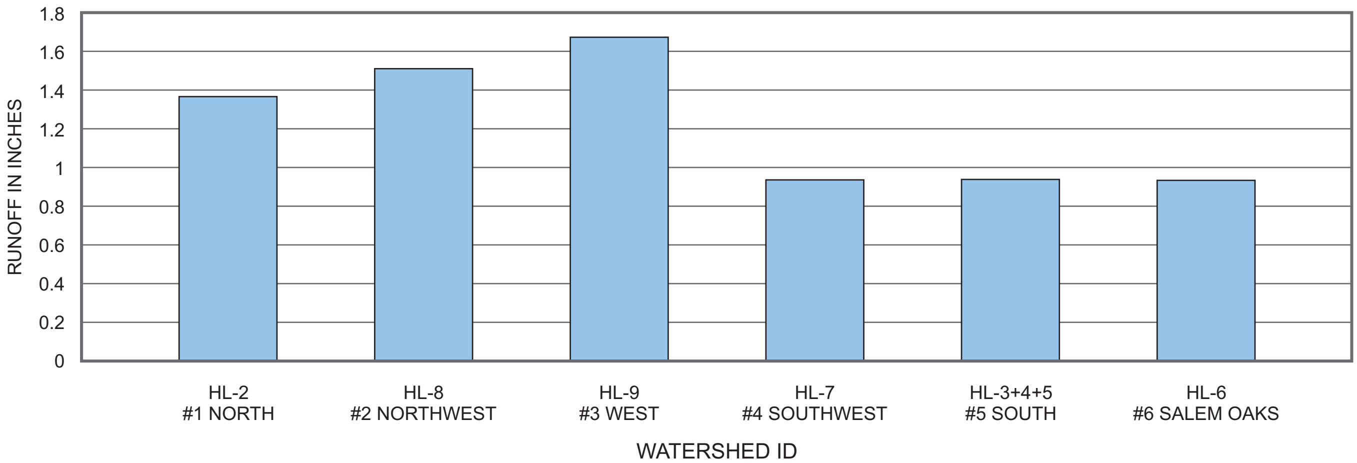
- The highest pollutant concentrations were detected after periods of dry weather and/or after leaf fall.

The concentrations of pollutants helps reveal which streams, events, and time periods yield the poorest quality water. While this is important to the stream itself, the impact of the stream on the Lake's water quality depends upon the mass of pollutant delivered to the Lake by that stream. The mass of pollutants entering the Lake is controlled by the concentration of a pollutant in water, and the overall volume of water delivered to the Lake by the stream in question. No flow information was collected as part of the tributary water sampling program. However, the relative sizes of the sampled watersheds and the simulated flows for various storm events have been estimated.[7] These estimates reveal significant differences in watershed characteristics. The South Tributary drains by far the largest area, with a watershed essentially the same size as the other five streams' watersheds combined (see Figure 15). In addition to varying in size, the watersheds vary in the volume of runoff produced by identical amounts of rainfall. This is related to many factors including topography, soils, the amount of impervious cover, the presence of engineered

[7]R. A. Smith National, Inc., Town of Salem – Storm Water Management Plan, December 2009. A copy of this document is available online at http://www.townofsalem.net/index.asp?SEC=ECC25DEF-D98F-4529-913D-713DF-6BAC4D0&Type=B_BASIC.

Figure 16

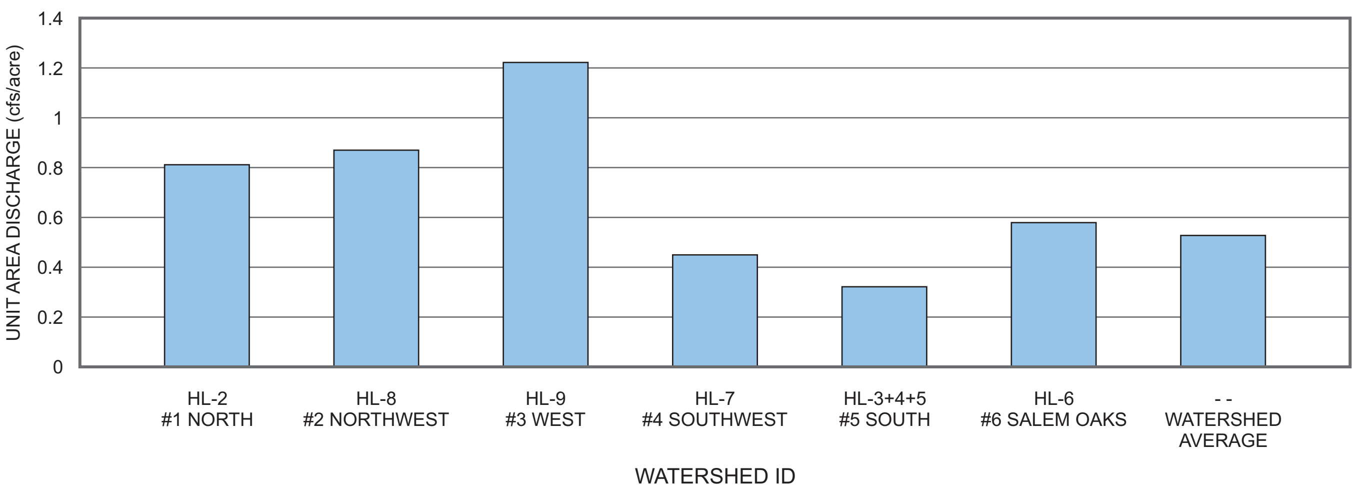
RUNOFF RESULTING FROM 50-PERCENT ANNUAL PROBABILITY (TWO-YEAR RECURRENCE INTERVAL) STORM



Source: Town of Salem and SEWRPC.

Figure 17

PEAK UNIT AREA DISCHARGE RESULTING FROM 50-PERCENT ANNUAL PROBABILITY (TWO-YEAR RECURRENCE INTERVAL) STORM



Source: Town of Salem and SEWRPC.

features that enhance runoff (e.g., ditches and storm sewers), and other factors. Using information from the Town of Salem's stormwater management plan, the volume of runoff and peak discharge rate generated by each acre of watershed from the 50-percent-annual probability (two-year recurrence interval) storm is compared (Figures 16 and 17).[8] The streams draining the comparatively more urbanized west and northwest areas yield greater runoff volumes and discharge rates per acre of watershed. Therefore, while the streams draining the more urbanized lands may not have the largest watersheds, they do provide the most runoff volume per acre of watershed area and do have higher potentials to erode banks and channels. <u>The North, Northwest, and West Watersheds likely provide opportunity to manage stormwater quantity and quality (see Chapter III for additional detail).</u>

[8]*Runoff volume per acre is expressed as an equivalent depth (e.g., inches) of runoff.*

As stated previously, the mass of pollutants reaching the Lake is more important than the concentrations detected in discrete water samples. A thorough sampling regimen would need to quantify the mass of pollutants reaching the Lake from each tributary stream watershed. However, a basic estimate of pollutant mass for a particular storm can be made using modelled flow volumes and the tributary water quality information already collected by the HLMD. Such information can be useful to compare the pollutant masses contributed by each tributary. For this exercise, the flow volume delivered by each tributary during the 50 percent annual recurrence interval storm was multiplied by the minimum, average, and maximum total phosphorus, total nitrogen, and total suspended solids concentrations detected in each tributary during 2014. This yields the mass of pollutants delivered by such a storm to the Lake by each stream (see Figure 18), allowing the relative contribution of each to be contrasted. This exercise reveals that, **even though the South Tributary is by far the largest tributary by watershed area, pollutant mass contributions from several of the much smaller but more highly developed watersheds rival the South Tributary's loads.**

The smaller watersheds high pollutant loads suggest much higher pollutant yields per acre of watershed. Figure 19 contrasts calculated pollutant mass contributed by each acre of each tributary's watershed. A watershed-average load helps illustrate those watersheds that are heavy contributors. As can be seen from that figure, **the Northwest tributary produces the most pollutant mass per acre,** <u>and may therefore be a watershed to focus additional attention on strategies to improve water quality.</u>

In summary, the available data clearly reveals that the **Salem Oaks Tributary has the poorest water quality.** However, the total mass of pollutants entering the Lake is highly dependent on the amount of water entering carried by each tributary. Flow rates were not quantified when the samples were taken and therefore the mass load contributed to the Lake from each tributary cannot currently be contrasted with available data. Flow estimates from stormwater management studies were used to estimate storm pollutant loading. Streams draining more highly developed areas yielded higher total pollutant mass and higher unit-area-pollutant mass loading. Since phosphorus is the pollutant most closely related to Lake management goals, <u>active management focused on the tributary streams exhibiting the highest unit area phosphorus loadings may provide the most benefit. These tributary streams include the North, Northwest, West, and Salem Oaks Tributaries. Future tributary sampling should include measurement of discharge and description of the physical characteristics of water quality and stream flow. Methods for measuring and estimating water flow are outlined in Chapter III.</u>

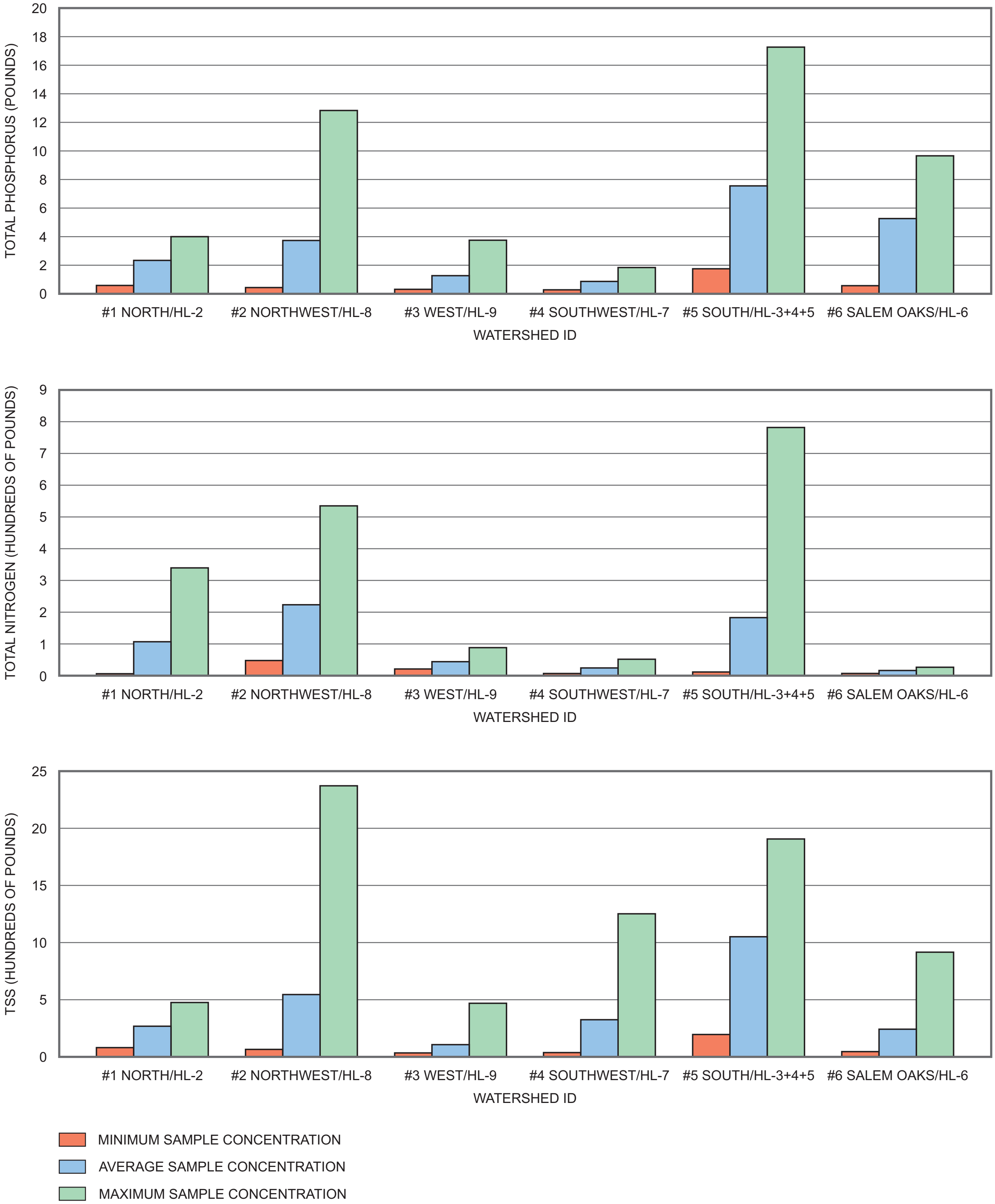
Temperature, Oxygen, and Stratification

When the Lake is stratified, shallow depths are considerably warmer, support abundant algae, and contain abundant oxygen. The thermocline is generally found somewhere between 12 and 24 feet below the surface, with the depth varying month-to-month and year-to-year. Water within the thermocline rapidly becomes colder with depth and contains less oxygen than the epilimnion. Water below the thermocline (the hypolimnion) is much colder than water at the Lake's surface and may not mix with the epilimnion until fall. Little sunlight penetrates past the thermocline; therefore, the deeper portions of the Lake do not host significant photosynthetic activity and hence do not receive oxygen from plants. However, oxygen continues to be consumed by decomposition and other processes in the deeper portions of the Lake. As a result, oxygen concentrations in the hypolimnion decline after the Lake stratifies and cannot be replenished until the Lake fully mixes during its fall turnover.

Water temperature profiles (Figure 20) suggest that Hooker Lake stratifies at about the 15 to 20 foot depth range. The development of a thermocline has far-reaching implications for the plant and animal life in the Lake, the general water quality of the Lake, and management decisions. Dissolved oxygen profiles (Figure 21) reveal extremely low oxygen levels in the deeper basins during late summer. Three separate deeper basins are found in Hooker Lake (Figure 22). The Lake's hypolimnion is confined to these deeper areas. The volume of the lake deep enough to be considered part of the hypolimnion and that commonly contains little to no oxygen during summer accounts for almost a quarter of the Lake's total water volume. The anoxic water found in the Lake's hypolimnion not only is uninhabitable for fish, but also reveals the likelihood of conditions that foster internal phosphorus loading in the Lake. Oxygen levels have not been measured at depths deeper than 10 feet since 2004. Measuring oxygen in the deep areas during the growing season will determine if the hypolimnion regularly becomes anoxic, allowing internal phosphorus loading to occur.

Figure 18

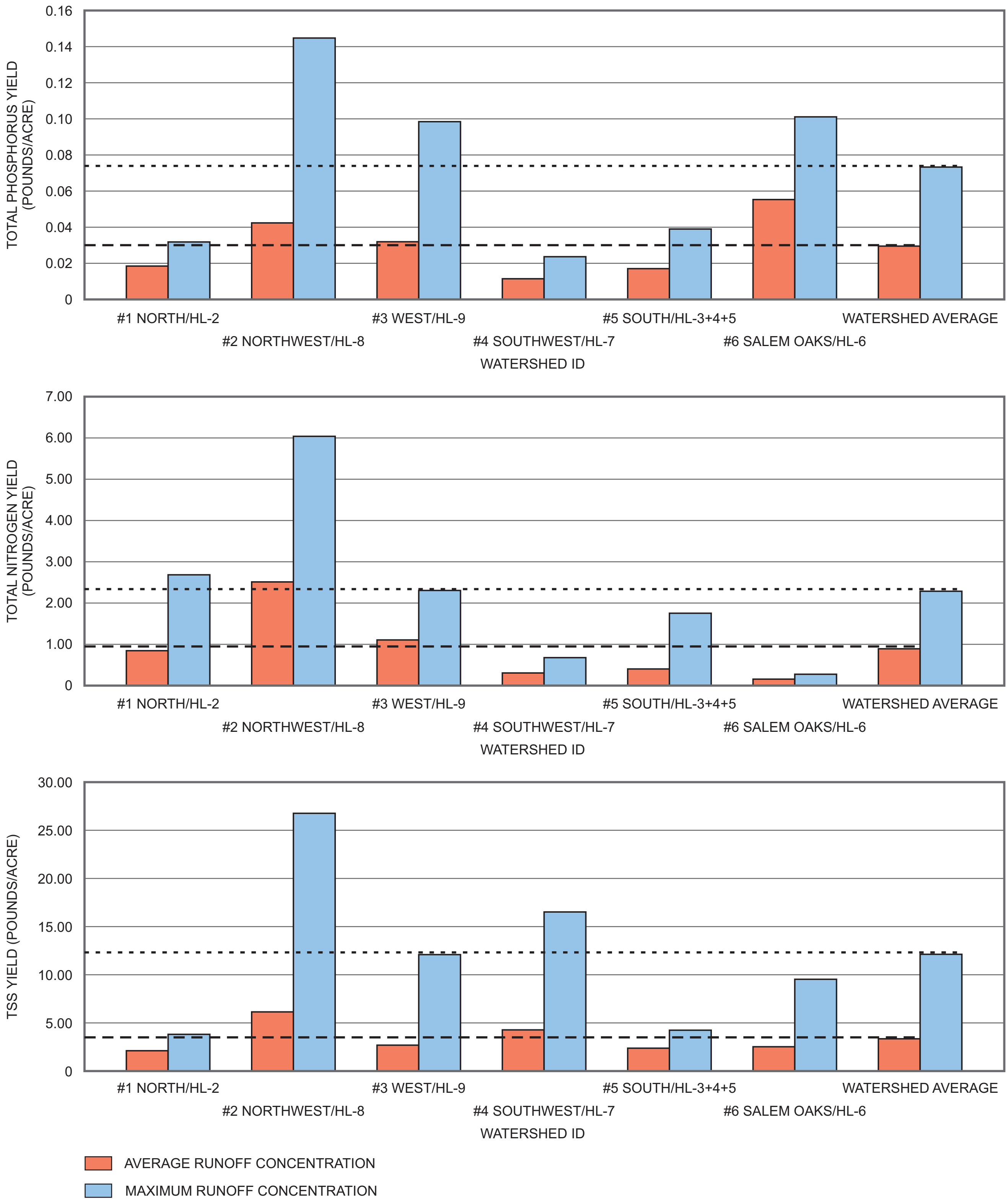
POLLUTANT MASS DELIVERED BY TRIBUTARY STREAMS BY 50-PERCENT ANNUAL PROBABILITY (TWO-YEAR RECURRENCE INTERVAL) STORMFLOW BASED UPON 2014 TRIBUTARY SAMPLING DATA



Source: The Wisconsin Department of Natural Resources, Town of Salem, and SEWRPC.

Figure 19

POLLUTANT UNIT AREA LOAD DELIVERED BY TRIBUTARY STREAMS BY 50-PERCENT ANNUAL PROBABILITY (TWO-YEAR RECURRENCE INTERVAL) STORMFLOW BASED UPON 2014 TRIBUTARY SAMPLING DATA

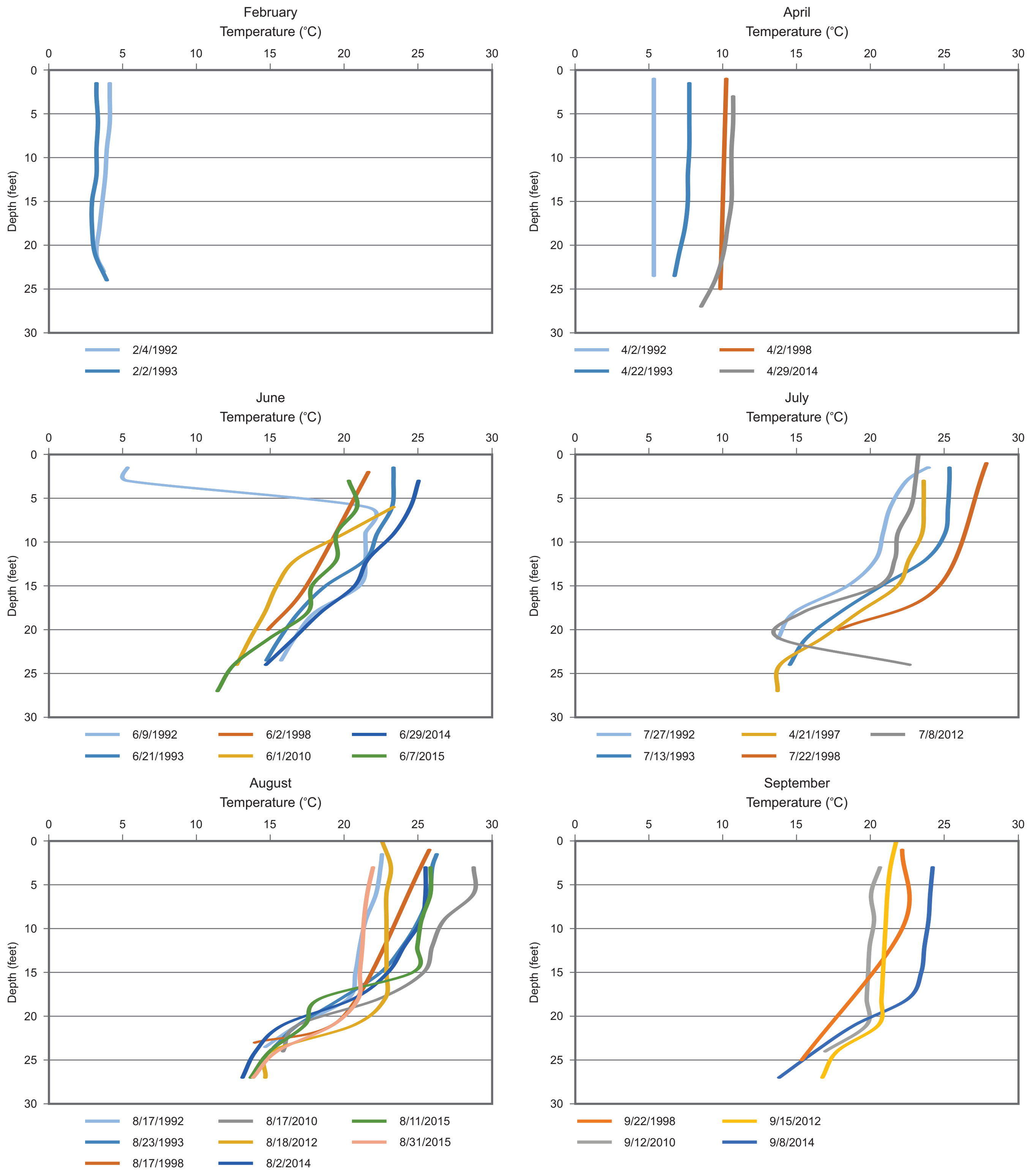


NOTE: THE HORIZONTAL LINES RESPRESENT WATERSHED-WIDE AVERAGES FOR AVERAGE AND MAXIMUM CONCENTRATIONS. BARS EXTENDING ABOVE THE LINE REPRESENT WATERSHEDS WITH HIGHER THAN AVERAGE UNIT AREA POLLUTANT LOADING.

Source: The Wisconsin Department of Natural Resources, Town of Salem, and SEWRPC.

Figure 20

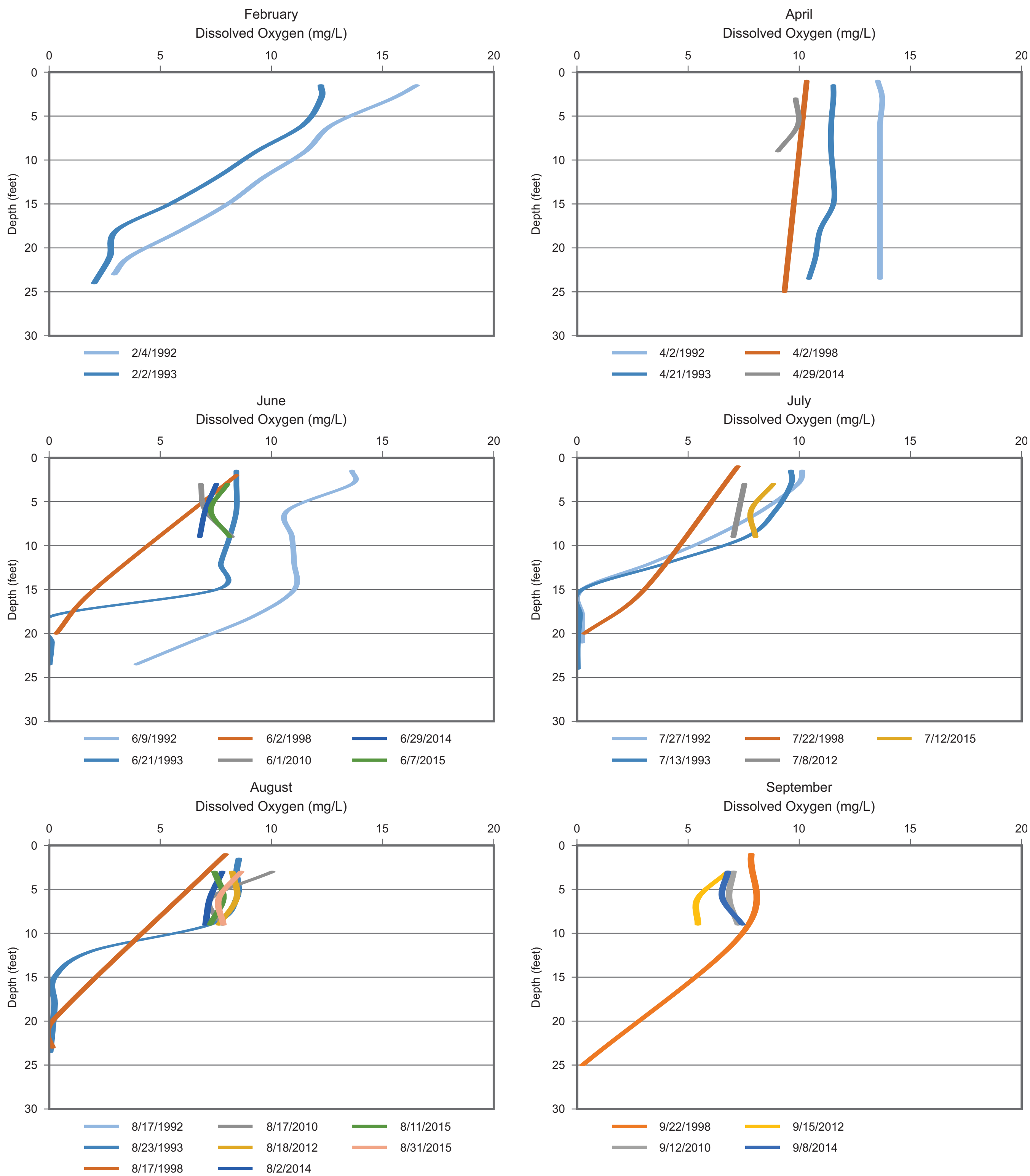
MONTH-BY-MONTH TEMPERATURE PROFILES, HOOKER LAKE



Source: The Wisconsin Department of Natural Resources, University of Wisconsin-Extension Citizen Monitoring Network, and SEWRPC.

Figure 21

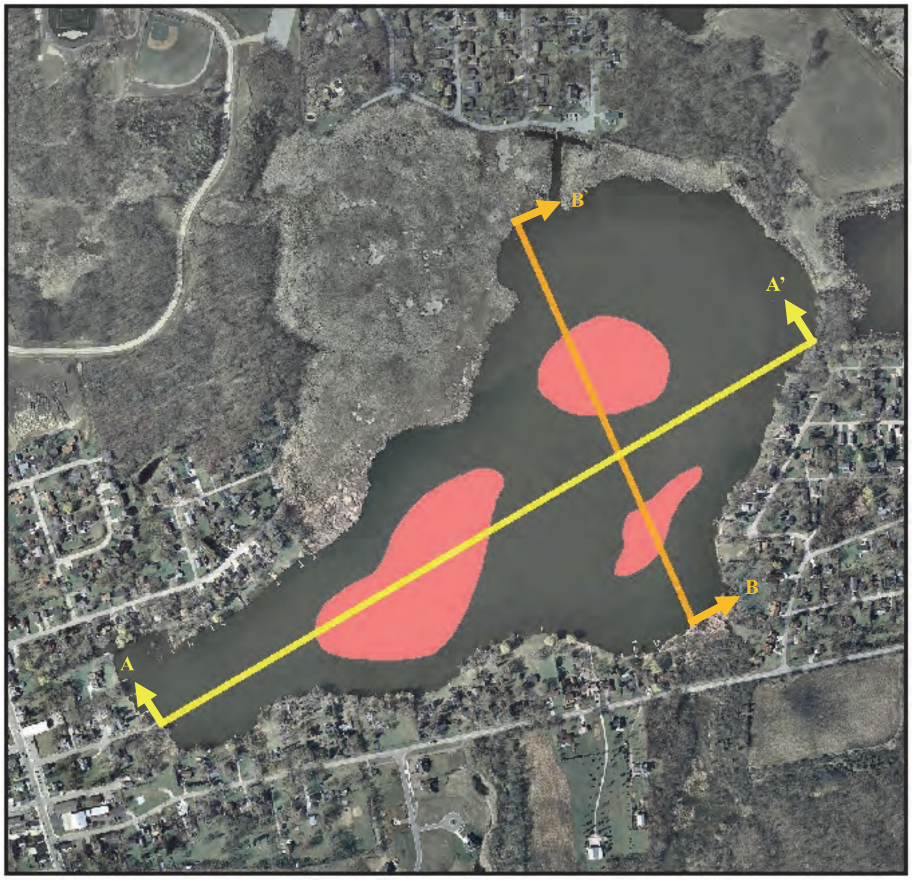
MONTH-BY-MONTH DISSOLVED OXYGEN CONCENTRATION PROFILES, HOOKER LAKE



Source: The Wisconsin Department of Natural Resources, University of Wisconsin-Extension Citizen Monitoring Network, and SEWRPC.

Figure 22

TYPICAL EXTENT OF BOTTOM SEDIMENT IN CONTACT WITH ANOXIC WATER DURING LATE SUMMER, HOOKER LAKE



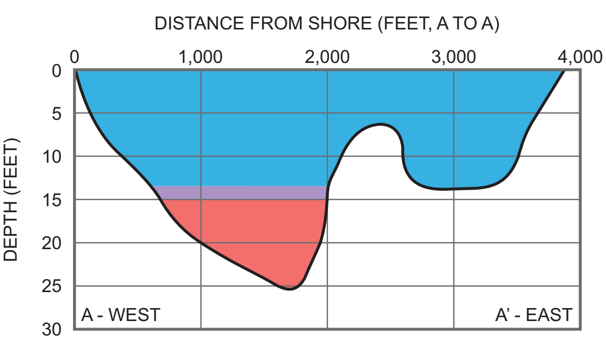
CROSS-SECTION B

CROSS-SECTION A

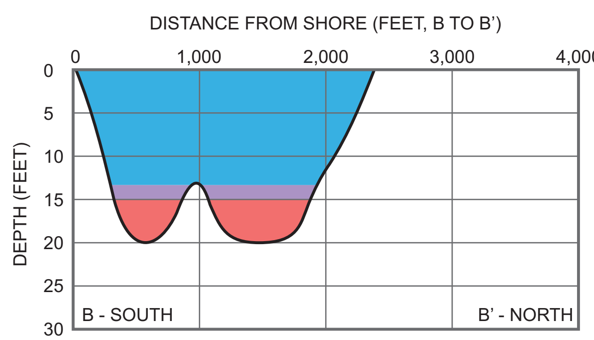
APPROXIMATE EXTENT OF BOTTOM SEDIMENT IN CONTACT WITH ANOXIC WATER

DATE OF PHOTOGRAPHY APRIL 2010

CROSS-SECTION A



CROSS-SECTION B



LAKE BOTTOM

OXYGENATED WATER

TRANSITION ZONE

ANOXIC WATER

Source: SEWRPC.

Phosphorus
When the Lake is fully mixed in the spring, phosphorus concentrations are similar throughout the Lake, with phosphorus concentrations averaging 30 µg/L over the period of record. Phosphorus concentrations vary widely within Hooker Lake when the Lake is stratified. Samples collected near the surface during the growing season range from 18 to 38 µg/L with an average of 28 µg/L. The average growing season phosphorus concentrations have remained well below the aquatic life impairment threshold of 60 µg/L for deep drainage lakes. However, the upper end of this range is close to the substantially lower recreational impairment threshold of 30 µg/L for such lakes,[9] and mandated by the *Wisconsin Administrative Code*.[10] The threshold standard is meant to represent an average of three monthly values collected from near-surface water between June 1 and September 15.

PHOSPHORUS SEQUESTRATION
In areas of mineral rich calcareous groundwater ("hardwater"), marl deposits often exist on the beds of lakes fed by groundwater seeps and springs. Marl is composed chiefly of calcium carbonate, clays and silts, and some organic detritus. The formation of marl can co-precipitate dissolved phosphorus which helps reduce phosphorus concentrations in the water of some lakes. In such instances, co-precipitated phosphorus is deposited as a stable mineral upon the lake bed. Over fifty percent of a lake's external phosphorus loading is typically retained in lake-bottom sediment. The actual amount retained in a lake varies widely with watershed and lake characteristics, but up to ninety percent can be retained in some instances.[11] Studies of Lake Nagawicka in Waukesha County have shown that 87 percent of the phosphorus contributed to the Lake is retained in lake-bottom sediment.[12] It is likely that marl formation actively occurs in the Lake, and that the Lake's phosphorus concentrations may be attenuated by phosphorus co-precipitation.

Marl is commonly formed as a byproduct of growth of certain algae species (e.g., muskgrass), accumulates on plant stems and leaves, and ultimately falls to the lake-bottom as the algae grows and dies. Photosynthesis increases water pH in the immediate vicinity of the plant, enhancing precipitation of calcite. Since enriched lakes generally support more algae, enriched lakes can have a self-reinforcing feedback loop to sequester more phosphorus. However, calcite/phosphorus minerals may become less stable at high pH ranges, potentially reducing the effect of this feedback loop.

Research in Europe has found that although marl lakes are resistant to phosphorus enrichment and eutrophication, the bottom-dwelling species of algae that promote marl production can be sensitive to long-term phosphorus enrichment. Decreased water clarity associated with higher phosphorus concentrations can decrease the depth to which bottom dwelling algae can grow, in turn decreasing the extent of marl-precipitating algae near the lake bottom. Less marl precipitation increases overall dissolved phosphorus in the lake, which fosters higher abundance of free-floating algal species. This further decreases water clarity, forming a self-reinforcing loop that eventually breaks down the marl formation process. Some formerly clear European marl lakes that had successfully buffered heavy, long-term external phosphorus loads went through rapid change after the lake's buffering capacity was exceeded and

[9] *Wisconsin Department of Natural Resources*, Wisconsin 2014 Consolidated Assessment and Listing Methodology (WisCALM) Clean Water Act Section 305(b), 314, and 303(d) Integrated Reporting

[10] *Wisconsin Administrative Code Chapter NR 102, op. cit.*

[11] *Lijklema L., "Phosphorus accumulation in sediments and internal loading," Hydrological Bulletin 20:213, 1986.*

[12] *U.S. Department of the Interior, Geological Survey Scientific Investigations Report 2006-5273*, Water Quality, Hydrology, and Response to Changes in Phosphorus Loading of Nagawicka Lake, a Calcareous Lake in Waukesha County, Wisconsin, *2006.*

are now eutrophic lakes with low water clarity.[13] This graphically illustrates how <u>the algae-based phosphorus sequestration process is vulnerable to excessive long-term high phosphorus loads, demonstrating the importance of reducing external phosphorus loads to lakes.</u>

Marl formation/phosphorus co-precipitation depends upon continued discharge of mineral-rich groundwater to springs and seeps on the lake-bottom. If the supply of groundwater is reduced, the vigor of hardwater discharge dependent algae is reduced, compromising the phosphorus sequestration cycle. Therefore, <u>the Lake's groundwater supply must be protected to ensure that phosphorus sequestration remains active.</u>

In Wisconsin, phosphorus is sequestered in lake-bottom sediment with calcite (as described above) or with iron. Unlike calcium minerals, iron-bound phosphorus is sensitive to the concentration of oxygen in adjacent water. Under low oxygen conditions, iron-bound phosphorus minerals dissolve and release plant-available phosphorus to the water column. This source of phosphorus, an important component of what is commonly referred to as internal loading, can be a significant contributor to the total phosphorus available to algae in lakes, especially in lakes that have fewer sources of external phosphorus during the growing season. For this reason, the presence of anoxic water can profoundly influence the nutrient dynamics of certain lakes.

INTERNAL LOADING

As mentioned earlier in this report, Hooker Lake's productivity is controlled by available phosphorus. Phosphorus, under oxygenated conditions, is tightly bound to solids and large amounts of phosphorus are commonly found in lake-bottom sediment. However, when oxygen is absent, geochemical reactions can take place that release phosphorus from the bottom sediment into the water column. The amount of sediment exposed to anoxic water is controlled by the shape of the lake basin. Even though two lakes may have equivalent maximum depths, a lake that has broad shallow areas and a small deep hole has less deep water bottom sediment area than an equal depth lake that is uniformly deep. Since sediment exposed to anoxic water can release phosphorus into the water column, lakes with more deep water sediment area are more susceptible to significant phosphorus internal loading. Moderate depth/size stratified lakes are among the most prone to internal phosphorus loading. Such lakes lack large water volumes, and, hence, have comparatively little stored oxygen in the hypolimnion, making them prone to anoxia.

It should be noted that phosphorus released to the hypolimnion is not directly available to most algae growing in the lake since little sunlight penetrates to these depths. Even though the thermocline is a barrier to circulation, it is imperfect and some phosphorus can migrate to shallower areas. For this reason, the highest levels of algal productivity are often found just above the thermocline in lakes with phosphorus internal loading. Mixing caused by wind and/or seasonal turnover can cause large concentrations of phosphorus from the hypolimnion to suddenly mix with surface water. This can lead to algal blooms.

Hooker Lake stratifies slowly in late summer and the stratification tends to be weak, potentially allowing some mixing to occur. In 1992, the Lake had not stratified by June and there was sufficient amount of oxygen present to support aquatic life all the way to the bottom of the Lake. However, anoxic conditions commonly develop in waters great than 15 feet below the surface by July. With the limited data, the bottom of the Lake appears to commonly experience oxygen deficiency and occasionally anoxia.

A phosphorus internal loading scenario was examined using dates with the highest phosphorus concentrations at the Lake bottom (Table 5). These concentrations occurred during August with anoxia occurring at a depth of approximately 15 feet. In this scenario, approximately 38 acres of the Lake's bottom sediment is in contact with anoxic

---

[13] *Wiik, Emma, Helen Bennion, Carl D. Sayer, Thomas A. Davidson, Suzanne McGowan, Ian R. Patmore, and Stewart J. Clarke,* "Ecological sensitivity of marl lakes to nutrient enrichment: evidence from Hawes Water, UK", *Freshwater Biology, Volume 60, Issue 11, November 2015, p. 2226-2247.*

Table 5

SURFACE AND BOTTOM WATER TOTAL PHOSPHORUS CONCENTRATIONS IN HOOKER LAKE: 1992-1998

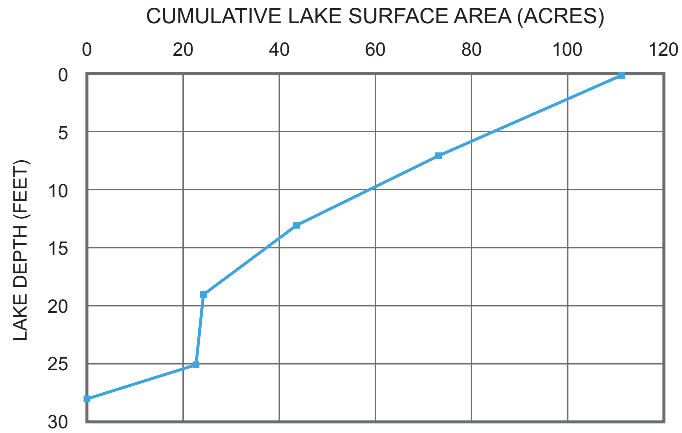
Date	Surface (μg/L)	Bottom (μg/L)
9/22/98	18	60
8/17/98	22	214
7/22/98	19	54
6/2/98	19	121
8/23/93	18	262
7/13/93	26	60
6/21/93	39	88
4/22/93	66	61
8/17/92	22	184
7/27/92	26	60
6/9/96	20	23
4/2/92	37	27

Source: SEWRPC.

water, and approximately 315 acre-feet of Hooker Lake's total water volume is anoxic (Figure 22, 23, and 24). This worst-case scenario suggests that up to 172 pounds of phosphorus could be released from lake-bottom sediment over the warm season. In such a case, the mass of phosphorus released from lake-bottom sediment would only be one-quarter the mass of phosphorus estimated by models to be contributed to the lake from its watershed (Table 6). Since anoxic water covers about 38 acres of the lake-bottom at its greatest extent, each acre of lake-bottom exposed to anoxic water contributes approximately 4.5 pounds of phosphorus to the water column over the summer season under this worst-case condition. Since Hooker Lake weakly stratifies, conditions necessary to support internal loading can break down fairly easily. Therefore, the actual average contribution of internal loading to the Lake's overall phosphorus budget is likely to be lower than this worst-case estimate. Therefore, **internal loading is not believed to be a dominant contributor to Hooker Lake's phosphorus budget, and effort to control phosphorus should remain primarily focused on the watershed. External loading must be minimized before any effort to reduce internal loading would be successful. Methods for reducing both internal and external loading are discussed in further detail in chapter III.**

Figure 23

LAKE DEPTH VERSUS SURFACE AREA, HOOKER LAKE

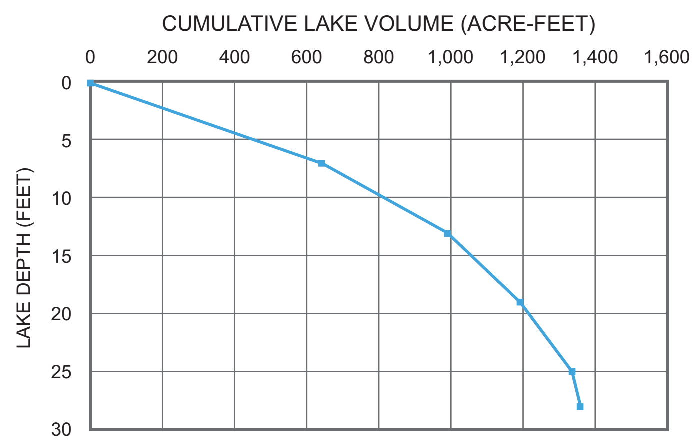


NOTE: THIS IS A CUMULATIVE PLOT OF THE TOTAL SURFACE AREA OF THE LAKE WITH WATER DEPTHS GREATER THAN OR EQUAL TO DEPICTED VALUES. FOR EXAMPLE, ROUGHLY 60 ACRES OF THE LAKE IS DEEPER THAN 10 FEET.

Source: The Wisconsin Department of Natural Resources and SEWRPC.

Figure 24

LAKE DEPTH VERSUS VOLUME, HOOKER LAKE



NOTE: THIS IS A CUMULATIVE PLOT OF THE TOTAL VOLUME OF THE LAKE CONTAINED IN DEPTHS LESS THAN OR EQUAL TO DEPICTED VALUES. FOR EXAMPLE, ROUGHLY 1,200 ACRE-FEET OF THE LAKE'S TOTAL VOLUME IS CONTAINED IN THE UPPER 20 FEET OF THE LAKE'S WATER COLUMN.

Source: The Wisconsin Department of Natural Resources and SEWRPC.

A corollary to the subject of tributary and lake nutrient levels is a study conducted in the Lake Wingra watershed in Dane County.[14] Over several years, researchers investigated sources of phosphorus in urban environments. Their

[14]*Roger Bannerman, of the USGS, has described the findings of the Lake Wingra study in his presentation entitled* "Urban Phosphorus Loads: Identifying Sources and Evaluating Controls.

Table 6

ESTIMATED ANNUAL POLLUTANT LOADINGS BY LAND USE CATEGORY WITHIN THE HOOKER LAKE TRIBUTARY

Land Use Category	Pollutant Loads: Circa 1835			
	Sediment (tons)	Phosphorus (pounds)	Copper (pounds)	Zinc (pounds)
Urban				
Residential	- -	- -	- -	- -
Commercial	- -	- -	- -	- -
Industrial	- -	- -	- -	- -
Governmental	- -	- -	- -	- -
Transportation	- -	- -	- -	- -
Recreational	- -	- -	- -	- -
Subtotal	- -	- -	- -	- -
Rural				
Agricultural	- -	- -	- -	- -
Wetlands	0.9	20.3	- -	- -
Woodlands	1.4	30.4	- -	- -
Water	2.4	3.3	- -	- -
Subtotal	4.7	54.0	- -	- -
Total	4.7	54.0	0	0

Land Use Category	Pollutant Loads: 2010			
	Sediment (tons)	Phosphorus (pounds)	Copper (pounds)	Zinc (pounds)
Urban				
Residential	10.0	61.5	4.1	29.2
Commercial	8.6	26.4	4.8	32.8
Industrial	1.5	4.7	0.9	6.0
Governmental	15.6	82.4	4.3	48.8
Transportation	4.6	9.2	20.2	72.2
Recreational	0.1	1.4	- -	- -
Subtotal	40.4	185.6	34.3	189.0
Rural				
Agricultural	110.0	497.9	- -	- -
Wetlands	0.3	5.8	- -	- -
Woodlands	0.3	5.5	- -	- -
Water	2.4	3.3	- -	- -
Subtotal	113	512.5	- -	- -
Total	153.2	698.1	34.3	189.0

Land Use Category	Pollutant Loads: 2035			
	Sediment (tons)	Phosphorus (pounds)	Copper (pounds)	Zinc (pounds)
Urban				
Residential	19.3	152.9	8.5	61.9
Commercial	46.3	141.6	26.0	175.8
Industrial	1.5	4.7	0.9	6.0
Governmental	20.7	109.4	5.7	64.8
Transportation	4.7	9.5	20.6	74.0
Recreational	0.7	16.2	- -	- -
Subtotal	93.2	434.3	61.7	382.5
Rural				
Agricultural	11.7	44.7	- -	- -
Wetlands	0.3	6.0	- -	- -
Woodlands	0.2	5.3	- -	- -
Water	2.4	3.4	- -	- -
Subtotal	14.6	59.4	- -	- -
Total	107.8	493.7	61.7	382.5

Note: Circa 1835 land cover values estimated from public land survey notes.

Source: SEWRPC.

findings reveal that, after lawn fertilizers, leaves left on streets in residential areas are the principle source of phosphorus in urban settings. Although the State of Wisconsin has passed legislation prohibiting use of lawn fertilizers containing phosphorus, little has been done in residential communities to address the issue of leaf litter and its role as a major contributor to phosphorus in lakes.

The Lake Wingra study has shown that of the various urban land uses, residential use contributes the greatest percentage of total phosphorus – nearly 60 percent. Furthermore, of the residential land uses, streets and lawns accounted for 65 percent of the total phosphorus loading. Residential streets yielded the largest total phosphorus loading, especially during autumn. On average, about 55 percent of the total annual residential loading of phosphorus in runoff occurs during autumn, and that percentage can be 70 percent or more. Phosphorus loading from streets was shown to be the result of curbside and street-area leaf litter. As traffic rolls over leaves, the crushed leaf structure accentuates phosphorus leaching during wet weather. Runoff then washes the leaf litter, and especially the released phosphorus from the crushed leaves, into the drainage system and eventually into lakes.

The Lake Wingra study underscores the importance of effectively managing leaves on residential streets during the fall, an action that can significantly reduce this large external phosphorus load. This would be especially important for Hooker Lake in residential areas on the north side of the Lake that are higher in elevation than the shoreland of the Lake and would, thus, drain toward it. A small portion of this area is serviced by the Village of Paddock Lake's leaf collection program. Residents of the Town of Salem currently decide how to dispose of their leaves individually, usually burning or composting. <u>Keeping leaves from collecting on residential streets through prompt leaf collection, and especially the timing of that collection from the streets, is a critical part of reducing phosphorus external loading from residential areas. Leaf burning is also a suitable method, as long as the leaves are not burned near the lakeshore, the shores and beds of tributary streams, or within intermittent ditches.</u>

Chloride

Under natural conditions, surface water in Southeastern Wisconsin contains very low chloride concentrations. Studies completed in Waukesha County lakes during the early 1900s report three to four mg/L of chloride. Most Wisconsin lakes saw little increase in chloride concentrations until the 1960s, but a rapid increase thereafter. Chloride in Hooker Lake was measured in the Lake once in 1998, with concentrations of 87 mg/L reported. This value is typical of present-day chloride levels in the lakes of Southeastern Wisconsin. Chloride concentrations in most lakes have been consistently increasing for decades.

Samples collected from tributaries feeding Hooker Lake contain much higher concentrations of chloride, and are an example of why chloride concentrations are increasing. Chloride concentrations were measured in the Hooker Lake tributaries during 2014 (Figure 13). Chloride concentrations in the summer months ranged between 41.8 and 726 mg/L, with an average of 209 mg/L. Concentrations above chronic toxicity occurred in the Salem Oaks, north, and northwest tributaries. Chloride concentrations were lower than typical during the estimated higher flows occurring on June 11 and November 23. Chloride concentrations are generally higher during cold weather months when road deicing chemicals are actively used. These measurements indicate that chloride concentrations in Hooker Lake have likely significantly increased since 1998. Chloride concentration should be regularly measured to evaluate if they are continuing to increase and if they are reaching harmful levels to aquatic life.

Chloride is considered a conservative pollutant, meaning that natural processes other than evaporation typically do not detain or remove it from water. Humans use chloride bearing materials for a multitude of purposes (e.g., road salt, water softening, industrial processes), and chloride concentrations are normally positively correlated with human-derived pollutant concentrations. Chloride is indicative of a suite of human-sourced and human enriched chemicals. These chemicals include agricultural nutrients and pesticides, pharmaceuticals, petroleum products, and a host of other substances in common use by modern society. For this reason, chloride concentrations are a good indicator of the overall level of human activity/potential impact and possibly the overall health of a water body. While the concentrations of chloride in Hooker Lake do not exceed current guidelines, rapidly increasing chloride concentrations attest to the fact that Hooker Lake is subject to a great deal of cultural pressure and the Lake has a propensity to accumulate human-introduced substances, a condition that could reduce water quality and overall ecosystem function over time. Management efforts to reduce chloride loading to Hooker Lake and other waterbodies throughout the Region are an important issue of concern. Winter road deicing practices are one related issue.

Although lake water chloride concentrations are within current guidelines, different species of plants and animals have varying abilities to survive or thrive in saltier environments. For example, reed canary grass, a common invasive plant species in wetland and riparian settings, is much better adapted to salty water environments. Similarly, Eurasian water milfoil (EWM) can survive levels of industrial and salt pollution that eliminates native aquatic plants. At least a few invasive animal species also are more tolerant of saltier water than native fish species. For example, invasive round goby (*Neogobius melanostomus*), a fish introduced from brackish water areas of Eurasia, grows better in higher salt environments and tolerates concentrations lethal to native fish species. Therefore, higher chloride concentrations may progressively favor undesirable changes to the flora and fauna of the lake and its watershed.

Available chloride concentration data reflect actual concentrations at set positions during discrete points in time, and are not necessarily representative of the range of values actually present over longer periods or over larger areas. For example, the chloride concentrations found in a tributary stream that drains a large roadway segment will likely have higher concentrations during periods of active de-icing or snow melt than during late summer. Similarly, such a tributary will likely have higher chloride concentrations than a similar tributary draining an undeveloped, unpopulated watershed. Therefore, chloride concentrations can vary over time and over short distances. Some streams in Southeastern Wisconsin have been found to contain chloride concentrations far above guideline standards for discrete periods of time but have acceptable concentrations during other periods of time. Episodic high chloride concentrations can dramatically alter the types and numbers of plants and animals living in a stream, even though "average" concentrations appear acceptable.

Chloride concentrations provide an excellent low-cost mechanism to monitor overall human influence on the Lake and can induce change to plant and animal communities. Therefore, chloride concentrations should be determined as part of regular water quality monitoring. Chloride reduction best management practices should be implemented. More details are provided in Chapter III.

Watershed Characteristics and Water Quality

Research shows that the health of a lake or stream is usually a direct reflection of the use and management of the land within its watershed. Research also shows that interventions are often necessary to maintain or improve the conditions of these resources. As mentioned earlier, different land uses can contribute different types of pollution to a lake. Though it is normal for some sediments and nutrients to enter a lake from the surrounding lands (contributing to the natural lake aging process), it becomes an issue of concern when people introduce pollutants (such as heavy metals, fertilizers, and oils) which would not have otherwise entered the system and/or accelerate natural erosion and sediment/nutrient delivery processes. Issues commonly arise when land use changes and when land is disturbed through tilling and construction. Such activity causes soils to loosen, erode, and eventually enter streams and lakes.

Given these connections between the practices around a lake and lake water quality, it is important to characterize the area that drains to a lake—its watershed—to determine potential pollution sources and risks to the lake's water quality. Several items need to be examined to complete this characterization, including:

1. **The location and extent of a lake's watershed**—Before characterizing a watershed, it is first necessary to delineate that watershed. The process of watershed delineation essentially involves analyzing elevation data of the surrounding locale to determine the area draining towards the lake. Completing this analysis provides the basis for determining whether potential pollutant sources are threats to the lake. For example, if a nonpoint source is near a lake but outside of its watershed, surface runoff from that source would not reach the lake, and, therefore, is not an issue of concern in terms of that lake's water quality.

2. **Ratio of watershed size to lake surface size**—Lakes with a high watershed area to lake surface area ratio can be more prone to water quality problems. As will be discussed below, the ways that the lands in a lake's watershed are used (e.g., agriculture, residential development, industrial) can greatly influence the types

and amounts of pollutants that wash into a lake as a result of precipitation events. The greater the amount of land surface draining to the lake, the greater is the likelihood that pollutants will be washed into the lake. Lakes with a watershed to lake surface ratio in excess of 10:1 often experience some type of water quality problems.[15]

3. **The type and location of existing land uses within the watershed**—The extent and location of current land uses within the watershed can help determine the potential causes of pollution to a lake. Land use conditions can be represented in models to estimate total pollutant loads that could enter a lake. Once these loads are determined, it is then possible to determine where to focus management efforts (e.g., if agriculture is the primary source of phosphorus, this may be an effective place to begin pollution reduction efforts).

4. **The type and location of past land use changes within the watershed**—Being aware of past land use changes can provide a context for understanding what caused past issues within a lake, particularly when considered with water quality monitoring data or well-known historical issues. If a long-term lake property owner, for example, remembers or has record of the years of high aquatic plant growth, large algal blooms, or low or high lake levels, those conditions can be assessed in terms of the historical land use changes to determine whether something happened within the watershed to cause that issue (such as an increase in cropping practices or development). This information can be helpful to future planning, because it offers insight into how the lake might react to similar situations.

5. **The nature and location of planned land use within the watershed**—In addition to current land use in the watershed, it is also possible to estimate land use changes that will occur in the future. Applying this information is important, as it helps determine the areas that may need to be targeted for management efforts in the future, as well as the potential extent of future pollution issues.

6. **The location of septic systems in the watershed (if applicable)**—Private onsite wastewater treatments systems (POWTS) or septic systems can be a significant source of phosphorus pollution when not properly maintained. Consequently, it is important to investigate whether such systems exist within the watershed.

The Hooker Lake watershed boundary was delineated using two-foot interval elevation contours developed from a 2003 digital terrain model. Actual land use within the watershed in 2010 and planned year 2035 land use were quantified by urban and rural categories, and that land use information was used with two models that calculate pollutant loadings.[16] Pollutant loading characteristics are discussed below.

Summary of Hooker Lake Watershed Characteristics and Water Quality

Hooker Lake's watershed, shown on Map 4, is situated within the Town of Salem and the Village of Paddock Lake, both in Kenosha County.[17] The **total land area that drains into Hooker Lake is approximately 1,269 acres,** or about two square miles. Hooker Lake has a **watershed to lake surface ratio of 11:1;** such a large ratio increases the likelihood of the Lake experiencing **some water quality issues.** According to 2010 land use statistics, **approximately two-thirds of Hooker Lakes watershed is used for rural land use purposes** (see Map 5 and Table 7). Currently, the Hooker Lake watershed has a distinctly agricultural tone: **agricultural and other open land uses represent the single largest land use in any category**—rural or urban—comprising about 45 percent of the total

---

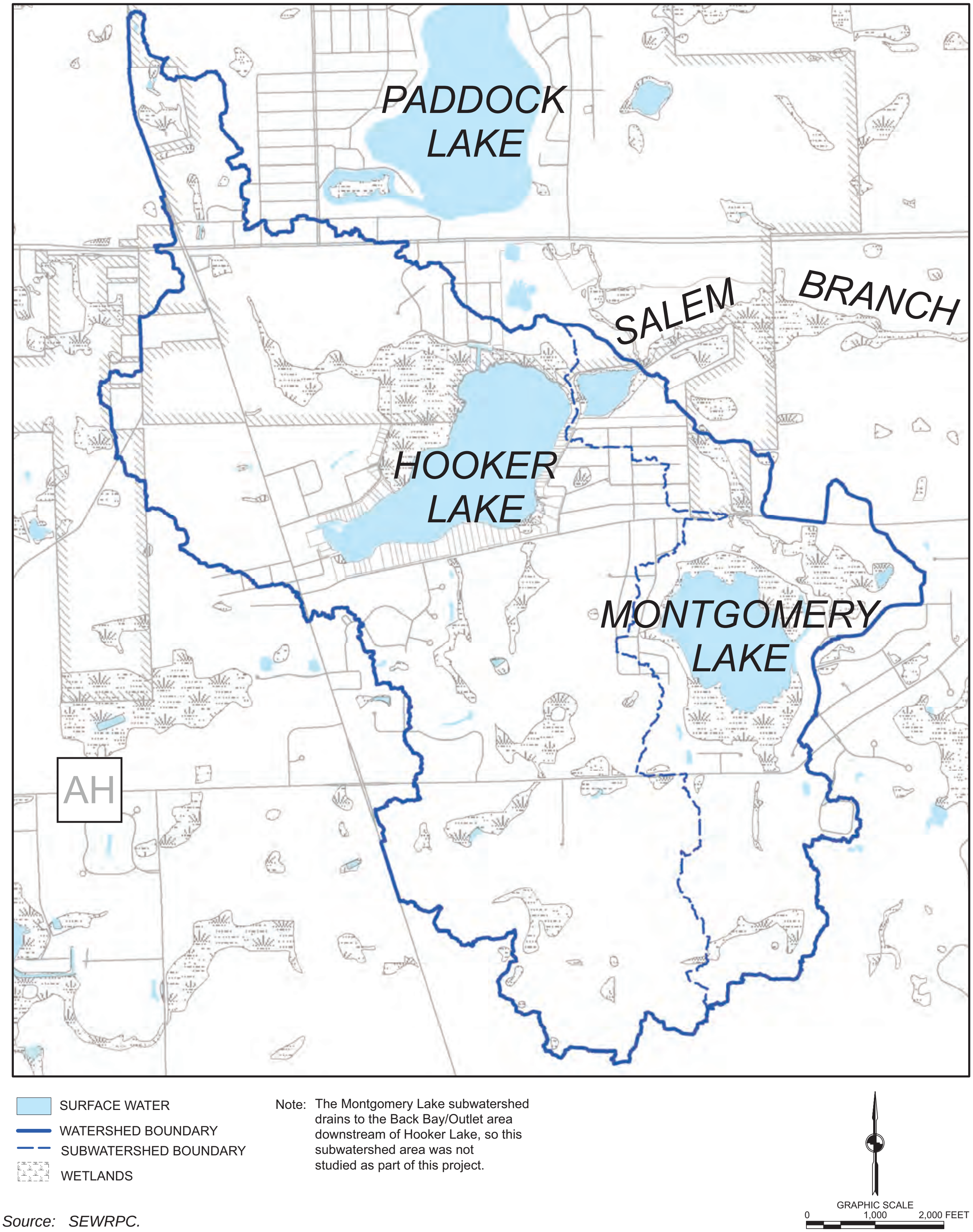
[15]*Aron and Associates,* Hooker Lake, Aquatic Plant Management Plan, *May 2009.*

[16]*Wisconsin Lake Model Spreadsheet (WiLMS version 3.0) and the unit area load-based (UAL) models.*

[17]*As shown on the watershed map for Hooker Lake, the Montgomery Lake subwatershed area drains to the back outlet bay of Hooker Lake downstream of the main Hooker Lake body. Since any inflow from the Montgomery subwatershed would, therefore, have negligible effect on the water quality of the main Hooker Lake body, this subwatershed area was not included as part of this report.*

Map 4

HOOKER LAKE WATERSHED



Note: The Montgomery Lake subwatershed drains to the Back Bay/Outlet area downstream of Hooker Lake, so this subwatershed area was not studied as part of this project.

Source: SEWRPC.

watershed. About 11 percent of the total watershed area is wetland (namely Hooker Lake Marsh as well as a number of smaller areas located along with the tributary streams located northwest and south of the Lake). Woodland covers about 10 percent of the watershed.

Based on current, predicted, and pre-settlement land use data estimated from public land survey notes, a model was used to estimate pollutant loadings that could potentially enter Hooker Lake,[18] as summarized in Table 6. These estimates could not, however, be contrasted to current in-lake data due to the absence of recent comprehensive water chemistry measurements. Consequently, they should only be used as guidance for where to target watershed management efforts when data is obtained. These calculations suggest that post-settlement land uses significantly increased sediment and phosphorus loads to the Lake. The Lake is estimated to now receive 30 times as much sediment and nearly 13 times as much phosphorus as it did before 1835 (i.e., before European settlement). As of 2010, over 70 percent of the sediment and phosphorus was contributed by rural land use. In 2035, with the forecast urbanization of rural lands, a decrease in sediment and phosphorus contribution is predicted. However, contributions will remain many times higher than pre-settlement conditions. Methods to decrease sediment and phosphorus loading should be implemented in both rural and urban areas. Urban land use is the only significant source of heavy metals. Urban areas should be targeted if heavy metals are found to be an issue within the Lake after further monitoring.

Past land use in a watershed can, to some degree, be reflected by the amount of historical urban growth in the area, and by historical changes in populations and number of households. Historical urban growth patterns for the Hooker Lake watershed are shown on Map 6 and represented in Table 8. Historical changes in population and households are shown in Table 9. An example of these changes can be seen by comparing aerial photographs representing conditions in 1970 and 2010 (Figure 25). As indicated in Tables 8 and 9, urban development was particularly intense between 1950 and 1980. Unfortunately, historical water quality data for Hooker Lake during this same time is not comprehensive enough to determine correlations with changes in the Lake's water quality, although it is probably a safe assumption that the urban development occurring in the watershed during and since that time likely has had some effect on the Lake.

Year 2035 planned land use for the Hooker Lake watershed is shown on Map 7.[19] It is evident that a significant amount of open and agricultural land is planned to be developed, mostly for residential and commercial uses. This pattern is more clearly shown in Map 8, which identifies those parts of the watershed that are in agricultural and open land use in 2010, but are forecast to be changed to urban uses by 2035. As can be seen from Map 8, the majority of the forecasted development is going to occur in the southern part of the watershed as single-family residential uses, and west of STH 83 where the development will be mostly single-family residential and commercial. The northern tip of the watershed (north of STH 50) will experience development mainly in the form of single-family and multi-family residential uses, although some amount of commercial development is also expected to occur. As summarized in Table 7, **agricultural land uses are expected to decrease significantly from about 42 percent of the land area in 2010, to about only 4 percent of the land area in 2035.** In addition to changing the nature of the pollutants in stormwater runoff, as can be seen from a comparison of the 2010 and 2035 pollution loading estimates in Table 6, this change also poses an **issue in terms of risk for pollution from areas where construction will take place.** Construction and grading associated with development pose a transient, although serious, pollution risk. **If not properly managed, construction sites can release large pulses of sediment and entrained nutrients**

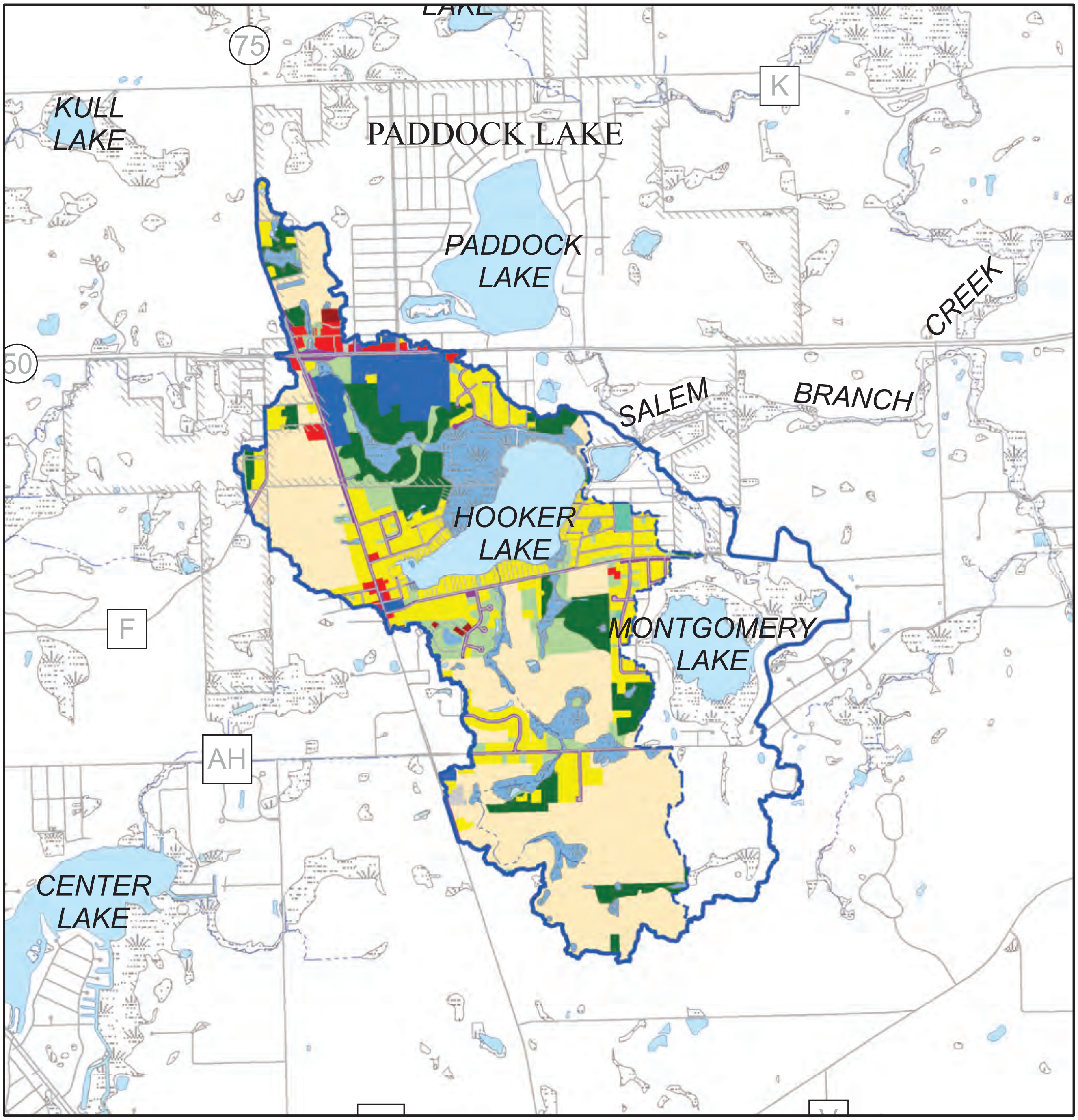
---

[18]*The calculations for nonpoint source phosphorus, suspended solids, and urban-derived metal inputs to Hooker Lake were estimated using either the Wisconsin Lake Model Spreadsheet (WiLMS version 3.0), or the unit area load-based (UAL) model developed for use within the Southeastern Wisconsin Region. These two models operate on the general principal that a given land use will produce a typical mass of pollutants on an annual basis.*

[19]*See SEWRPC Planning Report No. 48,* A Regional Land Use Plan for Southeastern Wisconsin: 2035, *June 2006.*

Map 5

LAND USES IN THE HOOKER LAKE WATERSHED: 2010



SINGLE-FAMILY RESIDENTIAL
MULTI-FAMILY RESIDENTIAL
COMMERCIAL
INDUSTRIAL
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES
GOVERNMENT AND INSTITUTIONAL

AGRICULTURAL
OTHER OPEN LANDS
RECREATION
WETLANDS
WOODLANDS
EXTRACTIVE AND LANDFILL
SURFACE WATER

WATERSHED BOUNDARY
SUBWATERSHED BOUNDARY
WETLANDS

Note: The Montgomery Lake subwatershed drains to the Back Bay/Outlet area downstream of Hooker Lake, so this subwatershed area was not studied as part of this project.

GRAPHIC SCALE
0 1,500 3,000 FEET

Source: SEWRPC.

Table 7

EXISTING AND PLANNED LAND USE WITHIN THE TOTAL DRAINAGE AREA TRIBUTARAY TO HOOKER LAKE: 2010 AND 2035

Land Use Categories[a]	2010 Acres	2010 Percent of Total Tributary Drainage Area	2035 Acres	2035 Percent of Total Tributary Drainage Area
Urban				
Residential				
Single-Family, Suburban Density	- -	- -	- -	- -
Single-Family, Low Density	45	3.5	292	22.6
Single-Family, Medium Density	182	14.1	265	20.5
Single-Family, High Density	- -	- -	- -	- -
Multi-Family	4	0.3	27	2.1
Commercial	22	1.7	118	9.1
Industrial	4	0.3	4	0.3
Governmental and Institutional	61	4.7	81	6.3
Transportation, Communication, and Utilities	84	6.5	86	6.7
Recreational	5	0.4	60	4.6
Subtotal	407	31.5	933	72.2
Rural				
Agricultural and Other Open Lands	579	44.8	52	4.0
Wetlands	145	11.2	149	11.5
Woodlands	137	10.6	133	10.3
Water[b]	25	1.9	26	2.0
Extractive	- -	- -	- -	- -
Landfill	- -	- -	- -	- -
Subtotal	886	68	360	27.8
Total	1293	100.0	1293	100.0

[a]*Parking included in associated use.*

[b]*25 acres of open water exist within the upland area draining to Hooker Lake. Hooker Lake occupies an additional 111 acres.*

Source: SEWRPC.

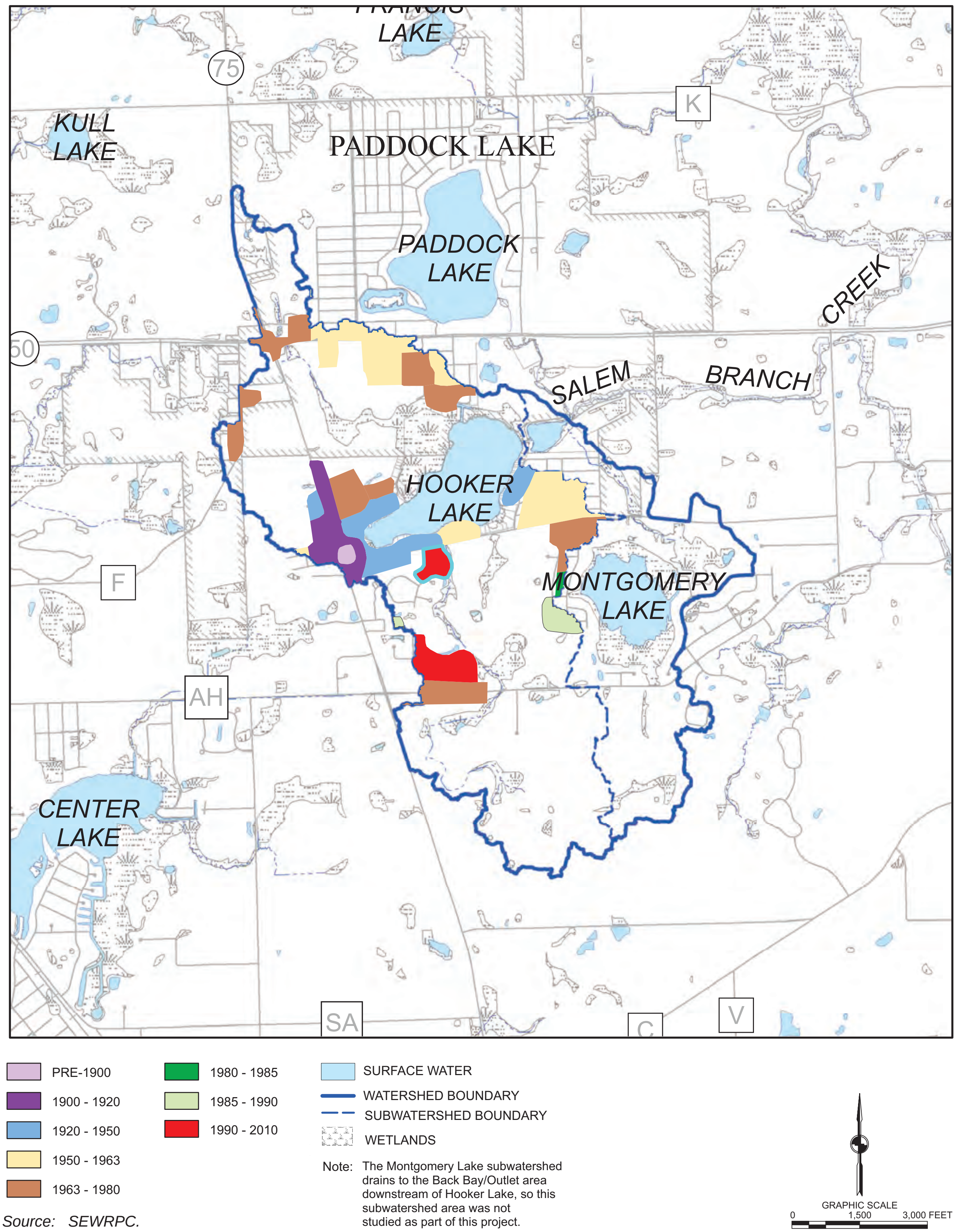
into water courses. Dissolved and floating pollutants and fine-grained sediment may be delivered to the Lake very quickly, while larger-grained sediment transported near and along the bed of streams may require considerable time to reach the Lake. Consequently, recommendations to mitigate this risk and ensure the continued health of the Lake are included in Chapter III of this report.

Finally, **nearly the entire Hooker Lake watershed is served or is planned to be served by either the Village of Paddock Lake or the Town of Salem sanitary sewer systems** (Map 9).[20] Some areas in the extreme southern portion of the watershed continue to be served by privately owned septic systems. Management of private onsite waste treatment systems is not a critical issue of concern in the Hooker Lake watershed.

[20]*It is important to note that the Town of Salem and Village of Silver Lake merger was approved by the Wisconsin Department of Administration in November 2016. It is anticipated that these two municipalities will officially become the new "Village of Salem Lakes" in February 2017.*

Map 6

HISTORIC URBAN GROWTH IN THE HOOKER LAKE WATERSHED



Note: The Montgomery Lake subwatershed drains to the Back Bay/Outlet area downstream of Hooker Lake, so this subwatershed area was not studied as part of this project.

Source: SEWRPC.

Since there has not been a recent comprehensive analysis of water quality in Hooker Lake, the conditions responsible for some of the perceived management problems are somewhat challenging to determine. However, the models suggest that agricultural land uses contribute about two-thirds of the sediment and phosphorus entering the Lake. Since many of the concerns center on water quality, and since phosphorus is the nutrient limiting aquatic plant growth in the Lake, actions to reduce phosphorus delivery from agricultural lands are important components of the effort to reduce concentrations of this limiting aquatic plant nutrient. Therefore, agriculture is currently land use targeted for management efforts. Attention should also be given to the channels draining rural lands. All size stream channels commonly exhibit unstable beds and banks fostered by artificially enhanced drainage. Bed and bank erosion can be major contributors to a stream's load of sediment and nutrients. Finally, the impending conversion of agricultural lands to urban use should be considered, especially in light of the potential to reduce runoff intensity and pollutant loadings through modern stormwater management practices, and the potential for heavy loads to be generated during construction. Chapter III includes a protocol that should be followed and amended as more data is obtained. Consideration should be given to enhance the existing or latent pollution mitigation ability of the watershed (e.g., through maintenance and expansion of riparian buffers), since this will prevent many types of pollution from many different sources rather than just from one land use.

Table 8

HISTORIC URBAN GROWTH IN THE HOOKER LAKE WATERSHED

Time Period	Land Developed During Time Period (acres)	Annual Increase in Land in Urban Use (Percent of watershed land area per year)
Pre-1900	3	- -
1900-1920	33	0.1
1920-1950	46	0.1
1950-1963	89	0.5
1963-1970	33	0.4
1970-1975	26	0.4
1975-1980	41	0.6
1980-1985	2	0.3
1985-1990	11	0.2
1990-2010	31	0.2

Source: SEWRPC.

How Watershed and Shoreland Filtering and Storage Affect Water Quality

Sediment deposition within a lake can result from erosion of the shoreline, watershed or aquatic plant death and biomass accumulation, and transport of sediment from the lake's watershed. Sediments can bury natural sand and gravel bottom substrate, degrading fish habitat and causing a loss of aquatic organisms. Species such as sunfish (e.g., largemouth bass, bluegill, and green sunfish), and darters and minnows (e.g., common shiner, sand shiner, and

Table 9

POPULATION AND HOUSEHOLDS IN THE HOOKER LAKE WATERSHED: 1960-2035

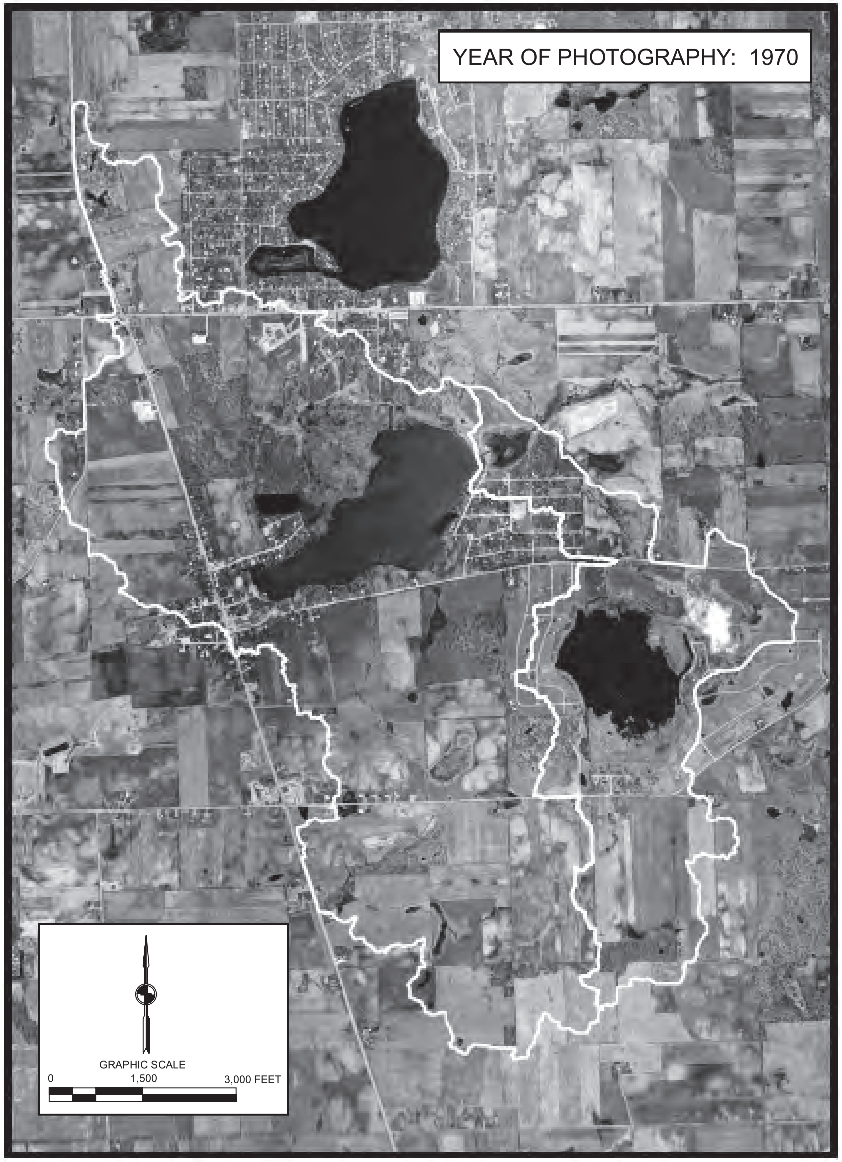
Year	Population	Change from Previous Decade		Households	Change from Previous Decade	
		Number	Percent		Number	Percent
1960	495	- -	- -	170	- -	- -
1970	861	366	74	257	87	51
1980	1,306	445	52	408	151	59
1990	1,293	-13	-1	452	44	11
2000	1,590	297	23	551	99	22
2010	1,731	141	9	643	92	17
2035	2,899	1,168	67	1,091	448	70

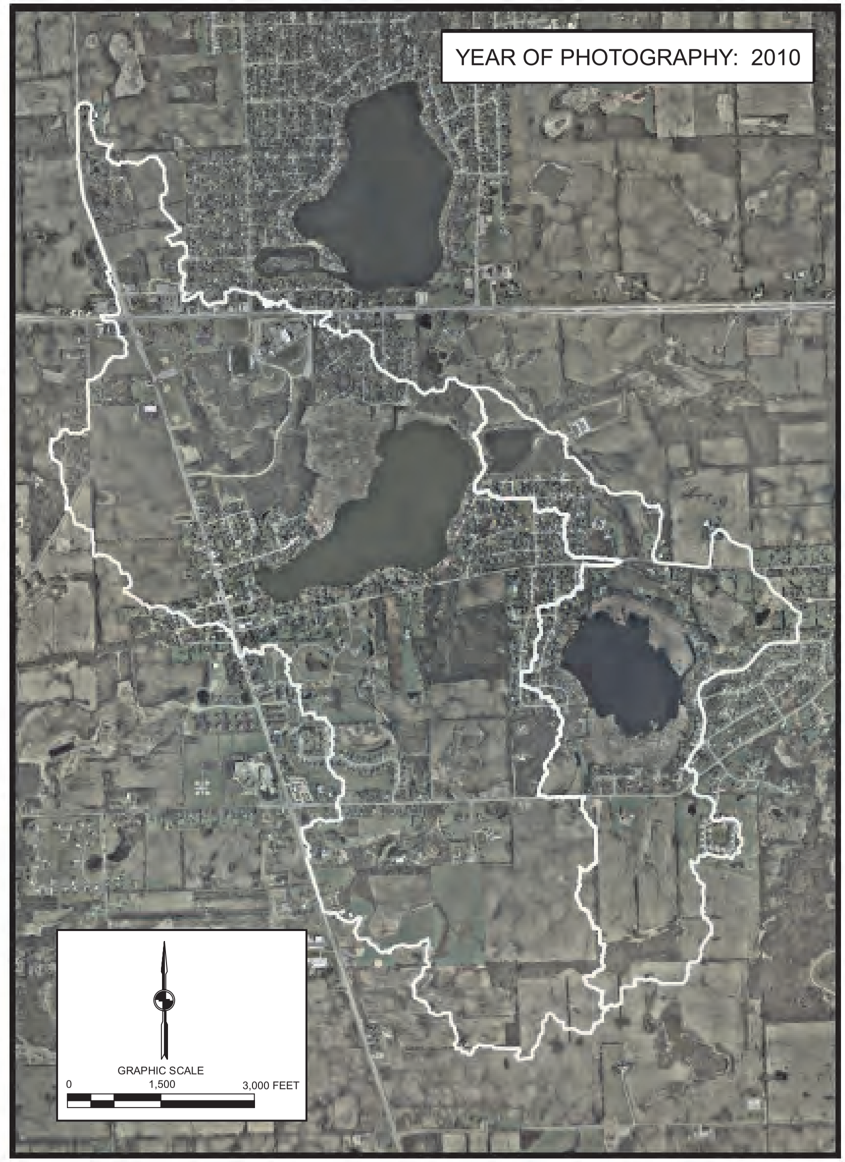
NOTE: Planned 2035 data based on 2000 census data and does not reflect change which may have occurred between 2000 and 2010.

Source: SEWRPC.

Figure 25

HISTORIC AERIAL PHOTOGRAPHS OF HOOKER LAKE: 1970 AND 2010

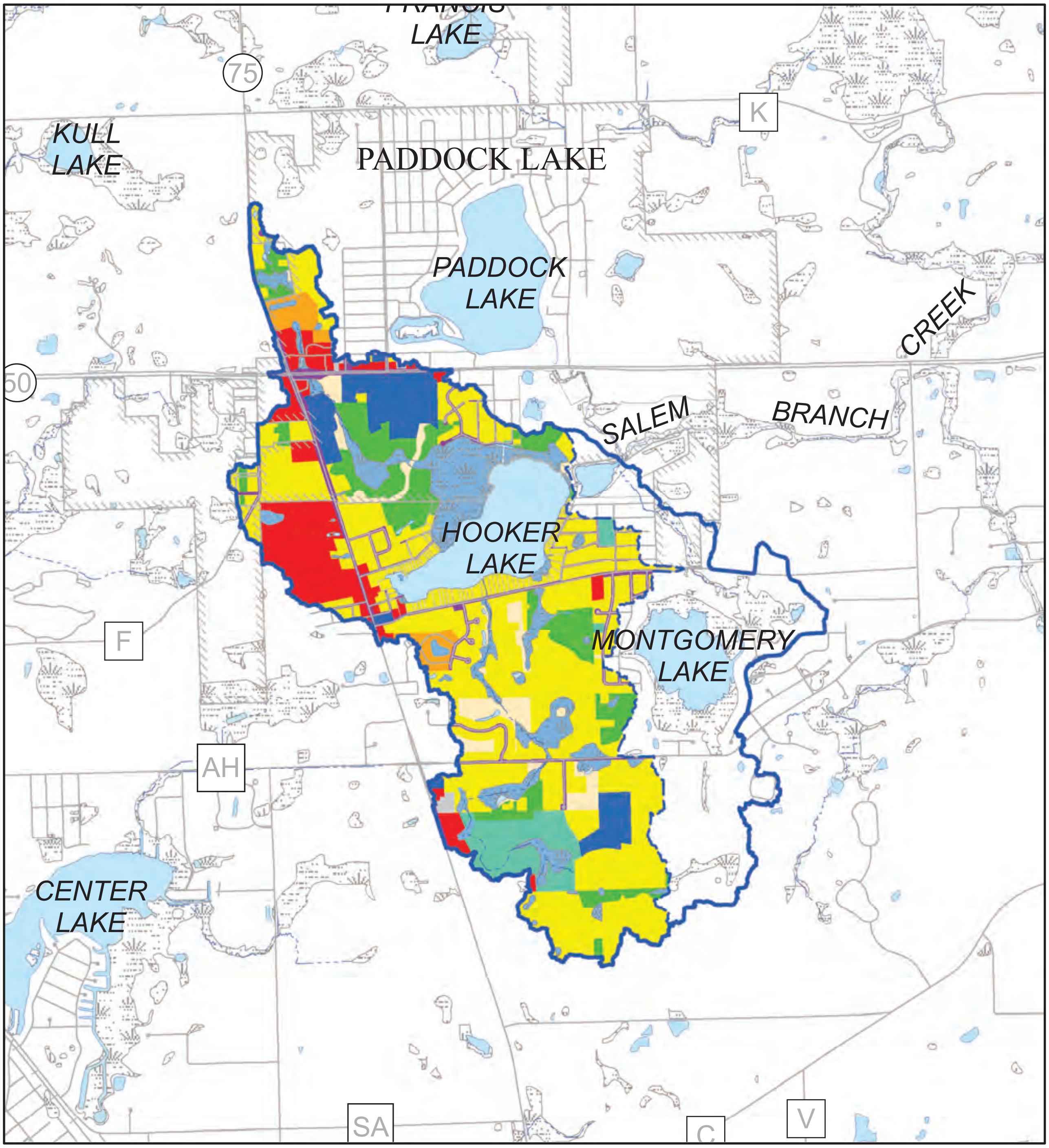




Source: SEWRPC.

Map 7

PLANNED LAND USES IN THE HOOKER LAKE WATERSHED: 2035



SINGLE-FAMILY RESIDENTIAL
MULTI-FAMILY RESIDENTIAL
COMMERCIAL
INDUSTRIAL
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES
GOVERNMENT AND INSTITUTIONAL
AGRICULTURAL AND OTHER OPEN LANDS
RECREATION
WETLANDS
WOODLANDS
EXTRACTIVE AND LANDFILL
SURFACE WATER
WATERSHED BOUNDARY
SUBWATERSHED BOUNDARY
WETLANDS

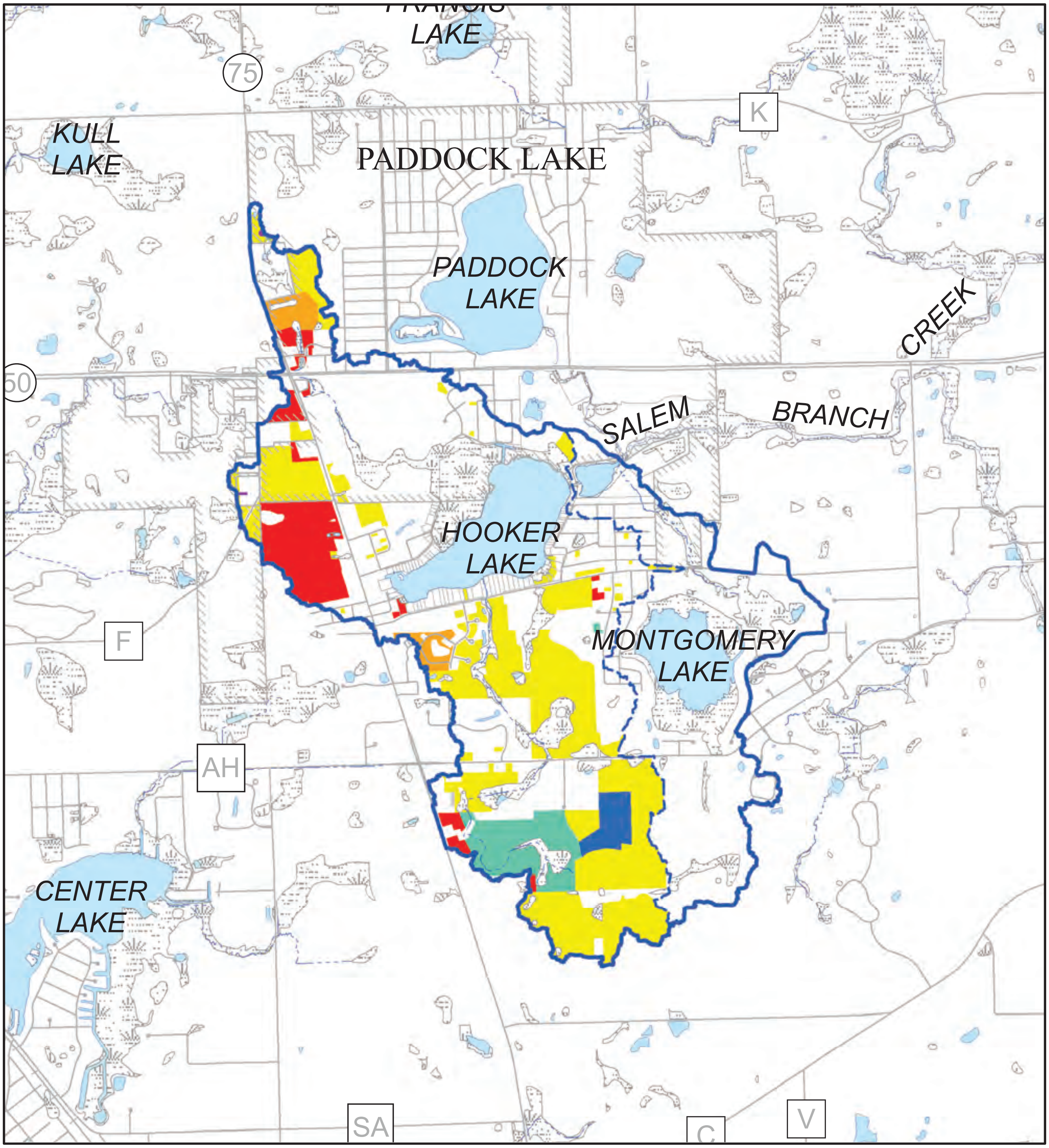
Note: The Montgomery Lake subwatershed drains to the Back Bay/Outlet area downstream of Hooker Lake, so this subwatershed area was not studied as part of this project.

GRAPHIC SCALE
0 1,500 3,000 FEET

Source: SEWRPC.

Map 8

2010 AGRICULTURAL AND OPEN LANDS CONVERTED TO URBAN DEVELOPMENT UNDER PLANNED 2035 LAND USE CONDITIONS WITHIN THE HOOKER LAKE WATERSHED



SINGLE-FAMILY RESIDENTIAL
MULTI-FAMILY RESIDENTIAL
COMMERCIAL
INDUSTRIAL
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES
GOVERNMENT AND INSTITUTIONAL
RECREATION
SURFACE WATER
WATERSHED BOUNDARY
SUBWATERSHED BOUNDARY
WETLANDS

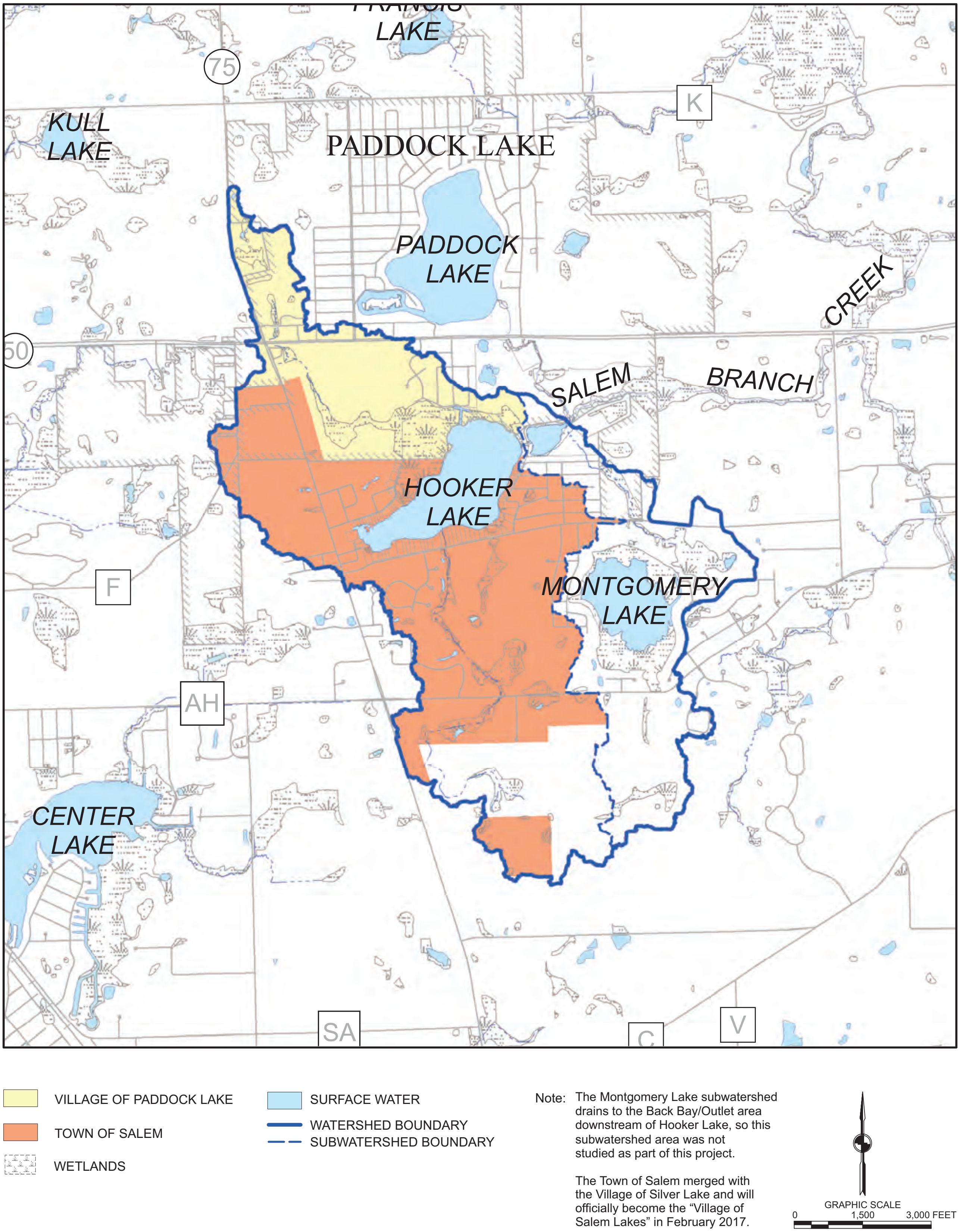
Note: The Montgomery Lake subwatershed drains to the Back Bay/Outlet area downstream of Hooker Lake, so this subwatershed area was not studied as part of this project.

GRAPHIC SCALE
0 1,500 3,000 FEET

Source: SEWRPC.

Map 9

PLANNED SANITARY SEWER SERVICE AREAS IN THE HOOKER LAKE WATERSHED: 2035



Note: The Montgomery Lake subwatershed drains to the Back Bay/Outlet area downstream of Hooker Lake, so this subwatershed area was not studied as part of this project.

The Town of Salem merged with the Village of Silver Lake and will officially become the "Village of Salem Lakes" in February 2017.

Source: SEWRPC.

spotfin shiner) are dependent upon sand and gravel substrates for feeding, nesting, and rearing of juveniles.[21] The loss of water volume associated with sedimentation can limit recreational opportunities, the total population of fish able to reside in a lake, and the quality of deep-water habitat in a lake. Finally, sediment may act as a reservoir for nutrients, and have the potential to re-enter the water column given the right conditions (e.g., agitation, dissolution under anoxic conditions).

It is important to note, however, that some sedimentation happens naturally when lakes "age," (Figure 4). Though this process normally occurs naturally over centuries, **sedimentation can be accelerated to unnaturally high levels when land use practices in the watershed limit natural attenuation (e.g., filtering provided by streamside vegetation) and instead favor erosion, heavy runoff, and artificial pollutant loading.**

Since certain types of land use features can serve to filter or remove pollutants prior to the pollutants entering a lake system, it is important to evaluate where such features exist within the Hooker Lake watershed. It should be noted that these features can overlap and may provide multiple benefits. Examples of these features include:

1. **Stormwater detention or retention ponds**—Stormwater management ponds, when properly maintained, can capture and store runoff water during rainfall events, slowing the flow of water and allowing many pollutants (such as sediment and heavy metals) to settle out before reaching downstream waterbodies. Since phosphorus is tightly bound to sediment, trapping sediment also reduces phosphorus loads passed downstream. These ponds need to be periodically dredged and may require other maintenance to ensure they function properly. <u>Stormwater detention or retention ponds in a lake's watershed are a useful means of protecting, or improving, lake water quality by significantly reducing pollution loads to the lake.</u> Stormwater ponds are normally designed to decrease peak flows by storing water during the heaviest runoff period and releasing stored water at a controlled rate over an extended period of time. On account of this, stormwater management ponds may also help mitigate downstream bed and bank erosion problems, extend the period when intermittent streams actively flow, and contribute to the value of riparian and in-stream habitat. However, they may also warm water, can sometimes attract nuisance species, and can be barriers to aquatic organism migration.

2. **Wetlands**—Wetlands, which are generally characterized by wet soils and wetland-based plants, are beneficial to the health of a lake, particularly when located at or near a lake's inlet and along the course of tributary streams. These areas slow the flow of water moving toward the lake, causing sediment, bound phosphorus, and heavy metals to settle in a similar fashion to stormwater management ponds. Additionally, **the plant life located in wetlands is able to absorb pollutants such as phosphorus and incorporate them into biomass,** thereby preventing the pollutant from entering the lake. These natural features are invaluable ecosystems, are well known as "nature's pollution filtration system", and are integral to the life histories of a large number of familiar fish, amphibians, birds, and other animals. Knowing where wetlands are located can help determine if a pollution source is a high risk to waters downstream from the wetlands or can provide significant ecological value to lake residents such as northern pike, a fish that spawns in wetlands.

3. **Natural terrestrial buffers (e.g., forests or prairies with extensive natural vegetation)**—Natural buffers primarily refer to natural terrestrial vegetative features such as forests or prairies. These areas, like wetlands, are densely vegetated and can slow the flow of water and incorporate pollutants into biomass. Consequently, **these areas, if located in an area that intercepts water flowing toward the lake, can help lower pollution risks to the lake.** Additionally, enhancing these features, particularly in areas adjacent to a waterbody, can help assure that the watershed can naturally reduce the amount of pollution entering that waterbody. Like wetlands, buffers are critical to the life cycle of many herptiles (amphibians and turtles) and birds.

[21]*Despite the potential for the sedimentation process to adversely affect fish populations, a number of projects can be put into place to encourage healthy fish populations, even if sandy and rocky sediments are buried. These projects are further described in the "Shoreline Maintenance" and "Wildlife" sections of this chapter.*

4. **Floodlands**—are areas inundated during periods of heavy runoff. Such areas may be directly adjacent to streams and convey floodwater (floodways) spreading the energy of the flowing water over a broader area or can store water in a relatively quiescent fashion (floodplains) helping reduce downstream flood elevations. Floodlands can reduce stream power and thereby reduce erosion and pollutant mobilization. Additionally, floodplains can act as sediment, nutrient, and pollutant traps, and provide refuge to aquatic life, providing similar ecological services as wetlands. Floodlands provide the broadest value in their natural state, but can still provide valuable service when developed in compatible open spaces uses. Floodland can be restored along manipulated drainageways as part of projects that help stabilize eroding beds and banks.

5. **Constructed terrestrial buffers (e.g., grassed waterways, vegetative strips)—Constructed** buffers can take a number of forms including grassed waterways, vegetative strips, and rain gardens located along the shoreline. Such buffers are generally constructed to intercept the flow of water toward a river or lake. They function in a similar way to natural buffers (i.e., slowing the flow of water); however, they do need to be carefully designed and should use native plants to ensure that they function well. **Constructing buffers can enhance the water quality of a lake without negatively affecting residential or agricultural land use.** Further details on buffers and their efficacy are included in Appendix B.

6. **Nearshore aquatic (In-Lake) habitat**—Lake vegetation in the shoreline areas, such as bulrushes and cattails, can filter and assimilate nutrients and sediment to some degree. Such areas also help protect vulnerable shorelines from erosion and provide valuable aquatic habitat. Consequently, encouraging their survival and enhancement can help improve lake water quality.

To locate examples of the features described above, SEWRPC staff completed an inventory of detention basins, wetlands, woodlands within the Hooker Lake watershed using existing databases, mapping software, field inspections, and aerial imagery. Additionally, to identify the extent of shoreline terrestrial buffers and in-lake vegetative buffers, SEWRPC staff completed a field assessment of the Hooker Lake shoreline in the summer of 2014. These inventories are discussed below.

Summary of How Watershed and Shoreland Filtering Affect the Water Quality of Hooker Lake

Several stormwater basins are located within the Hooker Lake watershed. If they are being properly maintained, these basins help limit the amount of pollution entering Hooker Lake from the residential areas draining to these basins. Consequently, maintaining these ponds should be a <u>high priority</u>. Recommendations related to this topic are provided in Chapter III of this report.

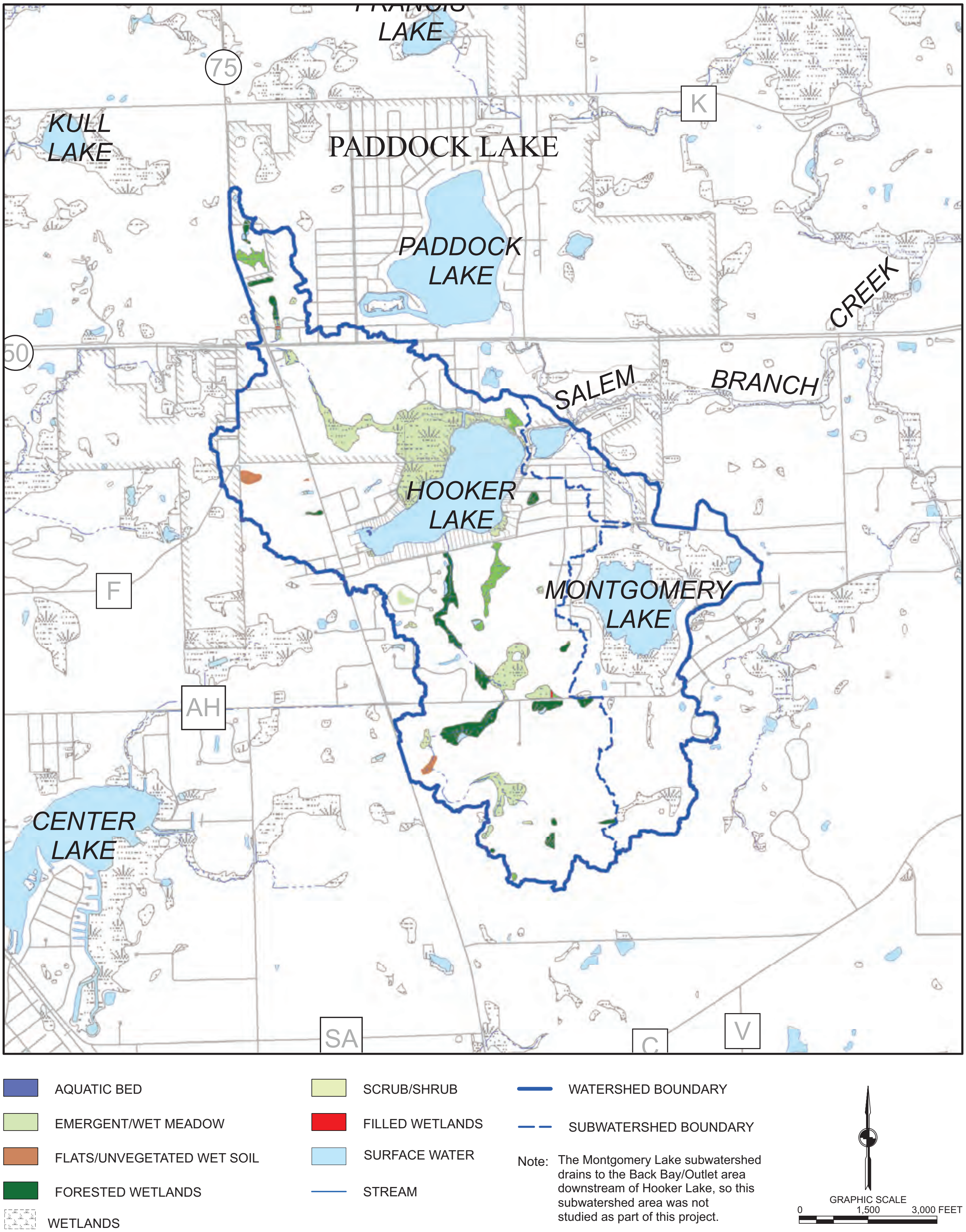
As of 2010, eleven percent of the Hooker Lake watershed in 2010 was comprised of wetlands. Wetlands are located primarily at the northwest end of the Lake and along the stream that enters the Lake from the south (see Map 10). These wetland areas help protect the Lake from pollution and sediment from those areas of the watershed and provide valuable and diverse habitat function for aquatic, terrestrial and avian life. The potential to naturally remove pollutants, in combination with the many other benefits provided by wetlands, illustrates how <u>crucial maintenance of wetlands is for Hooker Lake</u>. Consequently, recommendations related to maintaining and enhancing wetland functions are also included in Chapter III of this report.

About 10 percent of the Hooker Lake watershed is composed of woodlands. Woodlands and other natural areas are particularly valuable when located in areas adjacent to the Lake or its tributaries (see Map 11). Consequently, <u>these areas should be protected to the greatest extent practical to protect water quality and the overall environmental integrity of the Lake</u> (see Chapter III for recommendations).

The locations of constructed terrestrial buffers along the shoreline of Hooker Lake, and other shoreline protection measures (e.g., seawalls), are shown on Map 12. **There are very few existing terrestrial buffers,** primarily small gardens along the shoreline. Such buffers can provide the Lake with protection from the pollution that could otherwise enter the Lake (e.g., lawn clippings, fertilizers, and oil from cars). Consequently, <u>installation and enhancement</u>

Map 10

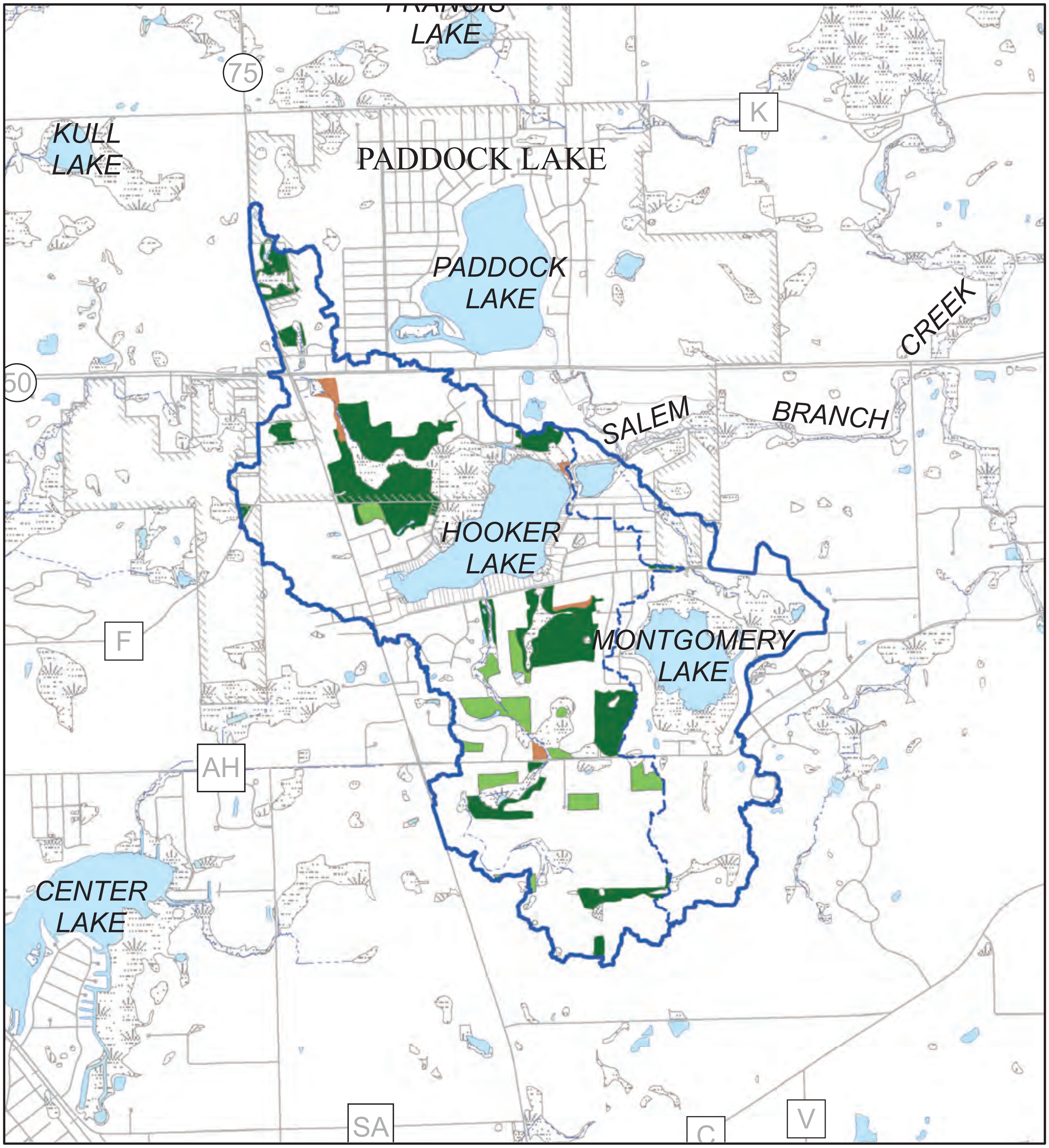
WETLAND COVER TYPES IN THE HOOKER LAKE WATERSHED: 2010



Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 11

UPLAND COVER TYPES IN THE HOOKER LAKE WATERSHED: 2010



UPLAND BRUSH

DECIDUOUS FOREST

GRASSLAND

WETLANDS

SURFACE WATER

WATERSHED BOUNDARY

SUBWATERSHED BOUNDARY

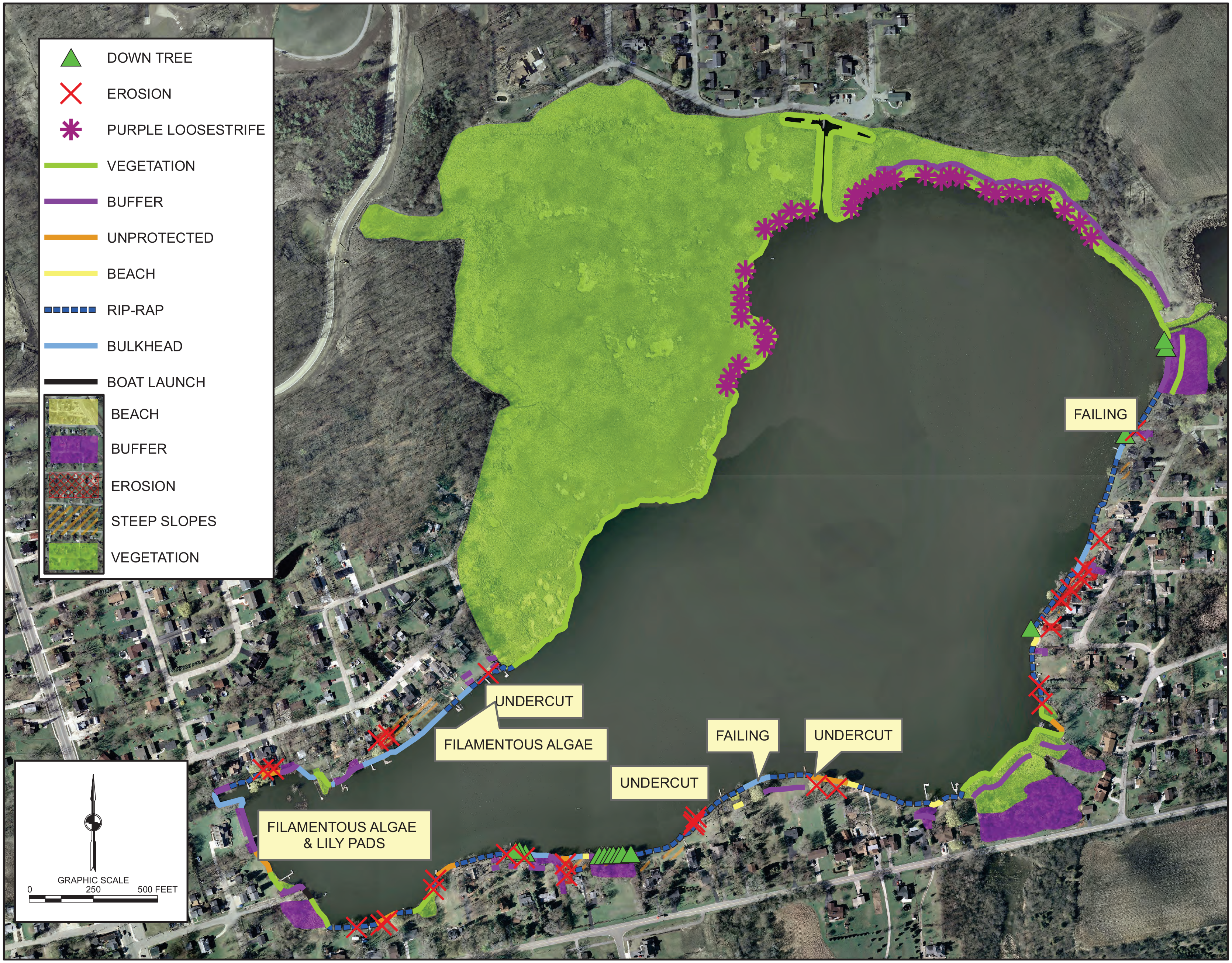
Note: The Montgomery Lake subwatershed drains to the Back Bay/Outlet area downstream of Hooker Lake, so this subwatershed area was not studied as part of this project.

GRAPHIC SCALE
0 1,500 3,000 FEET

Source: SEWRPC.

Map 12

SHORELINE PROTECTION AND BUFFERS ON HOOKER LAKE: 2014



Source: SEWRPC.

of terrestrial buffers along the shoreline of Hooker Lake should be considered a high priority. Recommendations related to terrestrial buffers, as well as in-lake vegetative buffers, are further discussed in Chapter III of this report.

Buffer creation and enhancement of existing buffers/wetlands should be crucial aspects of protecting the water quality of Hooker Lake. Buffer and wetland maintenance and development should likely target strategic areas in the watershed, that produce runoff which does not filter through existing buffers or wetland systems prior to entering the Lake or a tributary stream. Some of these areas were identified by comparing the flow pathways within the watershed to the locations of the natural and constructed features discussed above.[22] Map 13 shows identified flow pathways. Referring to this map, surface water in the southern part of the watershed drains mostly from single-family residential areas and is collected by the tributary stream that enters the lake along its southern shore (tributary site 5-south- in Map 3). This tributary is currently buffered by small natural wetlands that should help filter and reduce the pollutant load coming from future residential areas. Therefore, it is important that these small wetlands, and the stream itself, be protected, left intact, and/or be naturalized and enhanced during construction of these residential areas.

The flow pathways in the northern part of the Lake's watershed cross an area of woodlands and wetlands (see Map 13). The wetlands and woodlands, if protected from development and adverse manipulation, should act as a buffer to protect the Lake from pollutant load coming from the planned residential and commercial lands in that part of the watershed. However, it has been reported that certain portions of the tributaries draining this area are actively eroding. The lands to the west of STH 83 present a challenge. Runoff from much of these lands does not currently drain through any natural buffer areas and portions of the channels are actively eroding. Indeed, most of the southern part of this area, which would be commercial under planned land use conditions drains directly into the Lake at the west end (site 3, Map 3). Thus, it is important to target this area for pollution reduction efforts (strict enforcement of stormwater management and construction site erosion control ordinances), buffer enhancement projects, streambed and bank erosion control and enhancement, and initiation of programs to deal with phosphorus loading from residential and urban areas (proper street leaf litter disposal, no-phosphorus lawn fertilizers). Recommendations related to water quality enhancement within Chapter III will focus on these areas.

ISSUE 2: WATER QUANTITY

This section examines factors that influence the supply of water to Hooker Lake. The initial portion of this section examines three separate, yet related, variables that are of particular concern to Lake residents. These factors include the extent of open water and contiguous marshland, the amount of water reaching the Lake from the western portions of the Lake's watershed, and the water surface elevation of the Lake over time.

Surface Area of Hooker Lake and Contiguous Marshlands

Hooker Lake's water levels have been noted to fluctuate since at least the 1970s.[23] Fluctuating water levels can change the acreage of the Lake and the extent of and elevation of floodplain areas. Information was gathered from a variety of sources to help quantify changes over time. Aerial photographs of Hooker Lake were collected and the apparent area of open water, adjacent marshland, and the small lake/wetland just downstream of Hooker Lake were contrasted. The earliest aerial photograph located as part of this analysis was 1937 while 2015 was the most recent. Copies of these aerial photographs are included in Appendix C. The apparent areas of the Lake and adjacent wetlands for each aerial photograph are summarized in Table 10. As can be seen from these values, the Lake

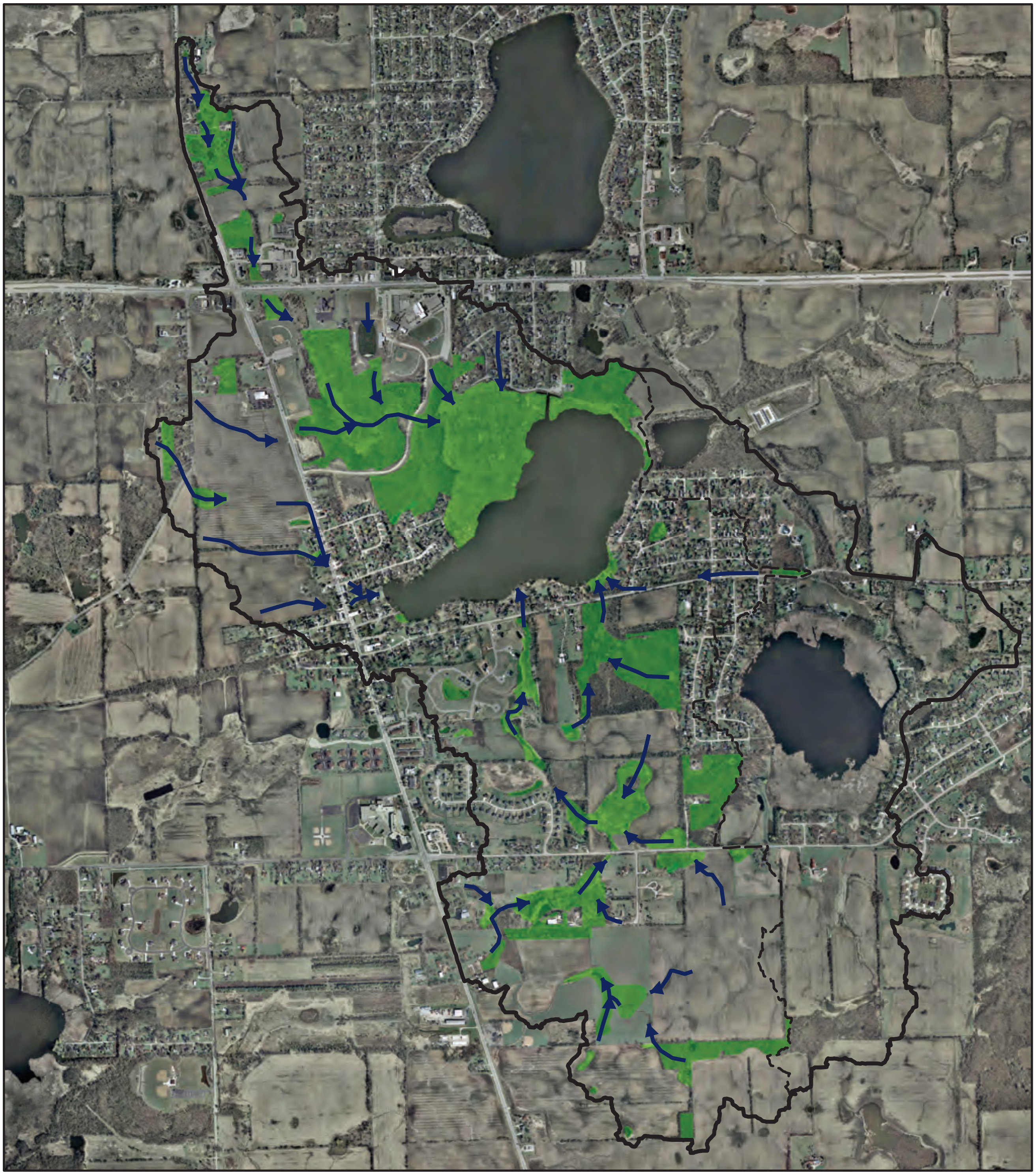
---

[22] *Flow pathways within the Hooker Lake watershed were determined using elevation data and field investigations.*

[23] *Plening, Ronald R., Surface Water Resources of Kenosha County, Wisconsin Department of Natural Resources, 1982.*

Map 13

EXISTING BUFFERS AND WATER FLOW PATHWAYS IN THE HOOKER LAKE WATERSHED



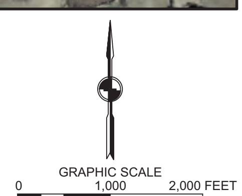
BUFFER

FLOW PATHWAY

WATERSHED BOUNDARY

SUBWATERSHED BOUNDARY

Note: The Montgomery Lake subwatershed drains to the Back Bay/Outlet area downstream of Hooker Lake, so this subwatershed area was not studied as part of this project.



Source: SEWRPC.

Table 10

SURFACE AREA FLUCTUATIONS OF HOOKER LAKE AND ADJOINING WATER BODY: 1937-2015

Year	Hooker Lake	Waterbody immediately downstream of former Hooker Lake Dam
	Surface Area (Acres)	
Open Water		
1937	97	0
1963	107	4
1970	109	5
1980	109	4
1990	110	6
2000	110	8
2010	112	9
2015	112	9
Mean	108	6
Contiguous Marsh		
1937	51	7
1963	54	6
1970	52	6
1980	55	8
1990	55	6
2000	53	4
2010	53	4
2015	54	4
Mean	53	6
Open Water + Contiguous Marsh		
1937	148	7
1963	161	10
1970	161	11
1980	164	12
1990	165	12
2000	163	12
2010	165	13
2015	166	13
Mean	162	11

Note: Each surface area value is based upon average of three independent measurements.

Source: Kenosha County Interactive Mapping and SEWRPC.

surface area appears to have slowly but consistently increased since 1937. Since the open water acreage is determined through interpretation of aerial photographs, the increased open water area may be related to changes in vegetation around the periphery of the Lake. For example, manicured residential landscaping allows the water/land interface to be seen much more plainly than natural shorelines. The apparent open water acreage of Hooker Lake has increased about five acres (approximately five percent) during the past 53 years, two acres (about two percent) of the total being noted since 2002.

Western Watershed Runoff Volume and Flow Rates

Portions of Hooker Lake's watershed lie to the west of, and must drain under, State Trunk Highway (STH) 83. The Wisconsin Department of Transportation (WisDOT) reconstructed STH 83 during 2006, a project which included changing and adding stormwater management infrastructure. During the same approximate time period, Lake residents began noticing that heavy precipitation correlated with abnormally high Lake water-surface elevations and abnormally long periods of high water in the Lake. Based upon their intimate knowledge of the local watershed, the HLMD suggested two potential reasons for changed water levels: reconstruction of the Lake's outlet dam and reconstruction of STH 83. Dam reconstruction was found to have increased the crest elevation of the outlet and reduced the width of the spillway, conditions that cause higher water levels and prolonged flooding during periods of heavy runoff (see the "Issue 3: Lake Outlet Dam" section of this chapter for more information). HLMD was further concerned that changes in the stormwater drainage system associated with STH 83 reconstruction increased runoff volume and intensity. This section evaluates potential changes to runoff volume and intensity from portions of the watershed draining under STH 83.

Members of the HLMD believe that local runoff patterns have changed over the past 10 to 15 years. Evidence of this included less widespread incidental ponding in the area directly west of the Lake and intense runoff in the newly created open drainageway immediately adjacent to and paralleling 83rd Street.[24] Lake residents reported these observations to the WDNR and the WisDOT, noting that they believed STH 83 reconstruction was at least partially respon-

[24]*This new drainageway merged runoff from several smaller drainage systems which were not as readily apparent to casual observation. Increased flow in this new channel is largely attributable to the increased number of acres served by this single discharge point, and not large increases in the total volume of runoff reaching the Lake.*

sible for these changes. In response to these concerns, the WisDOT reviewed the HLMD's concerns and commissioned a hydrology and drainage study.[25] Copies of several maps, tables, and correspondence related to this study are included in Appendix D.[26]

As part of their study, the WisDOT examined five subwatersheds situated west of STH 83 near the extreme western end of Hooker Lake. The study labelled these subwatersheds from north to south:

- North Non-Contributing Subwatershed (35.2 acres). This area is a closed depression meaning that surface water accumulates in low spots with no surface outlet. Water leaves closed depressions by evaporation, by seeping into the soil and becoming part of groundwater flow, and/or by agricultural drainage tiles.

- North Subwatershed (20.7 acres)

- Central Subwatershed (22.1 acres)

- 83rd Street Subwatershed (22.7 acres)

- 85th Street Subwatershed (8.38 acres).

Water from the North and Central Subwatersheds drains under STH 83 a short distance northwest of the intersection of STH 83 and 82nd Street (see Map 14). Although the North Non-Contributing Subwatershed does not provide direct surface-water runoff to Hooker Lake, it could contribute surface-water flow through agricultural drainage tile outlets.[27] The actual presence of tile outlets will need to be investigated in the field. After passing under STH 83, water from the combined area drains toward the Lake in an open channel, enters a pipe about 150 feet north of 83rd Street near 249th Avenue, and then discharges underwater in Hooker Lake. The inlet of this pipe reportedly clogs and the resultant flooding detains stormwater.[28] The drainage network east of STH 83 serving the North Non-Contributing, North, and Central Subwatersheds was not modified as part of the highway reconstruction project. Therefore, assuming all other factors remained the same, the stormwater conveyance system downstream of STH 83 that serves the North Non-Contributing, North, and Central Subwatersheds delivers water to the Lake in the same fashion as before construction, and is not a significant source of higher water levels or increased pollutant loads

Highway reconstruction did substantially change the drainage system serving the North and Central Subwatersheds upstream (west) of STH 83. Portions of open ditch were replaced with buried storm sewers, a change that could slightly speed runoff. Wider roads and sidewalks contributed to slightly more impervious area in the watershed, slightly increasing runoff speed and volume Pre-existing buried storm sewers pipes paralleling STH 83 were replaced, but the pipe size (36-inch diameter) remained the same as that present before road reconstruction.[29] A

---

[25]Kapur and Associates, Inc., STH 83 (1322-00-70) Hydrology Evaluation, Memorandum dated May 2, 2009.

[26]*Additional information regarding the Town of Salem's stormwater management plans may be found at the following website: http://www.townofsalem.net/index.asp?SEC=ECC25DEF-D98F-4529-913D-713DF6BAC4D0&Type=B_BASIC*

[27]*Based upon soil coloration patterns evident in historical aerial photographs, the North Non- Contributing Subwatershed is likely tiled. Agricultural drainage tiles may divert water from this closed drainage basin to discharge points adding to the overall overland flow volume reaching Hooker Lake.*

[28]*Flierl, Kurt (Project Manager, Wisconsin Department of Transportation Southeast Region). Hooker Lake Drainage Meeting Minutes, December 12, 2008, December 18, 2008.*

[29]*Flierl, Kurt (Project Manager, Wisconsin Department of Transportation Southeast Region), op. cit.*

Map 14

GENERALIZED PRE AND POST 2006 RECONSTRUCTION OF STH 83

Source: Kapur and Associates and SEWRPC.

stormwater detention pond was constructed immediately northwest of the intersection of STH 83 and 81st Street as part of the highway reconstruction project (see Map 14). The stormwater detention swale reduces peak runoff flow rates by storing and gradually releasing water draining from the North Subwatershed, and probably water stored in the depression in the North Non-Contributing Subwatershed and then conveyed in an agricultural drain tile. The stormwater detention swale enhances the potential for groundwater infiltration and reduces sediment and pollutant loads reaching the Lake. The WisDOT information reports that the time needed for runoff to reach the Lake from the North Non-Contributing, North, and Central Subwatersheds is essentially unchanged, while peak runoff flowrates were substantially reduced.[30]

The changes made to the stormwater conveyance network servicing the North and Central Watersheds as part of the STH 83 reconstruction project do not appear to significantly affect the overall intensity, quality, or quantity of stormwater reaching Hooker Lake. Therefore, <u>changes made to the stormwater conveyance system in the North and Central Subwatersheds as part of STH 83 reconstruction are not significant contributors to recent flooding and water quality concerns in Hooker Lake</u>. Furthermore, the WisDOT information suggests that water quality from this area may be marginally improved and the erosive potential of the stream in the unmodified channel reach downstream of STH 83 is should be reduced.

Before highway reconstruction, the 83rd Street Subwatershed drained under STH 83 at more than one location. Ditches and a partial storm sewer system discharged to a two-foot by two-foot box culvert that passed under STH 83 and directed runoff to a steep ravine-like drainage ditch roughly midway between 83rd and 82nd Streets (see Map 14). Water from this area then joined runoff from the North and Central Subwatersheds before entering the pipe which carried the combined flow to an underwater discharge in Hooker Lake. Other partially buried culverts reportedly drained under STH 83 near 83rd place.[31]

According to the HLMD, incidental ponding occurred in some areas in response to flows greater than the capacity of the existing pipes, inlet elevations, and clogging. Some buildings occasionally experienced flooding problems,[32] a condition likely attributable to incidental ponding. Based upon pre-construction photographs (see Figure 26), there was very little treatment or storage of runoff draining from the developed areas immediately adjacent to STH 83. The water from the 83rd Street Subwatershed entered a very steep and reportedly eroding ravine-like drainageway,[33] a fea

---

[30]*The WisDOT's consultant used the U.S. Army Corps of Engineers Hydrologic Engineering Center's Hydrologic Modelling System (HEC-HMS) software to simulate pre-construction and post-construction conditions. This model was applied in a design storm mode that evaluates the runoff from a single event of a given frequency. The modeling approach considers antecedent soil moisture conditions, interception storage by vegetation, and infiltration into the soil. The model has a limited pollutant load estimation capability which was not available at the time of the WisDOT study. However, an alternative approach to load estimation, based in part on application of pollutant concentrations measured by the HLMD, was applied for the study documented herein. The HLMD has stated that a dynamic runoff model such as the U.S. Environmental Protection Agency's Storm Water Management Model (SWMM) would be appropriate to apply for estimating runoff from the watershed. If SWMM were run in continuous simulation mode under which a longer time series of meteorological data were used as input, rather than in a design storm mode, it would yield different runoff information than would HEC-HMS applied in a design storm mode. However, the information generated using SWMM would not necessarily lead to different conclusions than were reached based on the analysis with HEC-HMS. HLMD could hire a consultant to perform a SWMM evaluation of the watershed runoff characteristics if desired.*

[31]*Ibid.*

[32]*Telephone conversation, Kurt Flierl (WisDOT) with Dale Buser (SEWRPC), February 17, 2017.*

[33]*Ibid.*

ture that would not contribute to water detention or water quality improvement. The new ditch and culvert serving the 83rd Street Subwatershed were needed to address property flooding and assure a reliable route to convey water to the Lake, and were not installed to eliminate areas of known natural ponding.[34] In summary, **while STH 83 reconstruction could theoretically slightly speed runoff to the Lake and could slightly increase runoff volume contributed by the 83rd Street Subwatershed, the small changes in runoff volume or speed would not tangibly change Lake elevations.** If the HLMD desires, stormwater detention ponds could be located, designed, and permitted to intercept runoff from the area upstream of STH 83 with the intent of improving water quality and reducing runoff intensity from the 83rd Street Subwatershed before it enters Hooker Lake. The most practical location for a detention pond would be just west of the developed area paralleling STH 83.

Figure 26

EXAMPLES OF STATE HIGHWAY 83 CORRIDOR STORMWATER INFRASTRUCTURE BEFORE THE 2006 HIGHWAY RECONSTRUCTION PROJECT

Source: Wisconsin Department of Transportation.

Runoff from the 85th Street Subwatershed formerly followed a diffuse overland conveyance route directly east of STH 83 (see Map 14). Also, topographic maps reveal at least one closed depression in the area east of STH 83. Both the diffuse overland conveyance route and the closed depression intercepted and detained stormwater, slowing runoff. It is not possible to predict the actual amount of water detained in the depression without detailed study. However, changes to runoff patterns made as part of highway reconstruction would tend to increase the volume of runoff reaching the Lake. These changes bypassed storage in closed depressions and the formally diffuse conveyance route; and, in turn, reduced groundwater recharge and evapotranspiration. Based upon personal observations before and after road reconstruction, HLMD members believe that water and sediment reach the Lake more quickly after highway reconstruction. The 85th Street Subwatershed area was also enlarged by about 10 percent, much of which is impervious surface. The somewhat diffuse conveyance and ponded areas that existed before reconstruction were replaced with a single discharge point that quickly conveys water directly to the Lake in a straight, steep open channel paralleling 83rd Street (see Map 14).

Given the information available at the time of this study, the changes made to the 83rd and 85th Street Subwatersheds as part of STH 83 reconstruction would slightly increase the volume of water delivered to the Lake, would slightly increase peak flow rates, and would slightly decrease the amount of time needed for stormwater to reach the Lake. Nevertheless, the runoff volume from the 83rd and 85th Street Subwatersheds are only a small fraction of the Lake's total

[34]*Ibid.*

watershed area (about 3.4 percent), and, assuming all other factors remaining unchanged, **increased runoff from this small area would not measurably increase Lake elevations on its own, and, therefore, is not the primary reason for noticeably higher water elevations in Hooker Lake.** Given the information now available, **the most probable reason for increased Lake water elevation is reconstruction of the Lake outlet dam,** as discussed in the "Issue 3: Lake Outlet Dam" section of this chapter. However, the changes to the 85th Street Subwatershed enhance the ability of stormwater to carry sediment and other pollutants to Hooker Lake.

Although STH 83 reconstruction is not the most probable cause of higher Lake elevations, steps can be taken that can tangibly enhance the timing and quality of water reaching Hooker Lake. The stormwater detention swale immediately northwest of the intersection of STH 83 and 81st Street was designed to modulate runoff volumes to better match downstream infrastructure. While the design should incidentally benefit the Lake, runoff volume reduction and water quality enhancement were not primary factors guiding design.[35] Steps could be taken to increase stormwater retention (through groundwater infiltration and evapotranspiration), increase the ability of the detention pond to remove sediment and other pollutants from runoff, and provide extended baseflow to downstream stream reaches. Examples include enlarging the detention swale or providing supplemental upstream water storage,[36] examining and potentially modifying vegetation in and around the swale, providing quiescent floodplain areas along conveyance routes, and potentially reconfiguring the detention swale's inlet and outlet configuration. Similar techniques should be employed in the 83rd and 85th Street Subwatersheds to replace and increase stormwater storage and treatment features lost as part of STH 83 reconstruction.

Highway reconstruction was not the only recent change in the 109 acres of the Hooker Lake watershed to the west of STH 83. For example, a network of newly excavated ditches is visible in the western portion of the watershed on recent aerial photography (see Map 14). The new ditches are found in actively cropped areas and were likely constructed to enhance or maintain efficient drainage of wet areas in cropped areas. The ditches may have been dug to supplant failing agricultural tile lines or breach topographic highs that cause water to accumulate in portions of the fields. A particularly relevant example of recent ditch expansion is detailed in Figure 27. This ditch extends toward an extensive area of wet soil,[37] and may intercept failing agricultural tile lines originating in the closed depression in the North Non-Contributing Subwatershed and/or promotes more efficient drainage in the immediate area. **This ditch may increase the effective watershed area contributing to Hooker Lake, increasing flow volumes and pollutant loads.** Therefore, this new ditch could increase water, sediment, and other pollutant loads delivered to the Lake. The pollutant load increase would be most pronounced if there is surface water directly entering the tile line. Furthermore, diverted water may decrease the effectiveness of the WisDOT stormwater detention swale. As suggested in Chapter III, the presence and purpose of this ditch should be examined, and the potential effect on runoff further investigated.

Lake Surface Elevation

Water elevations have been measured on Hooker Lake since at least the early 1990s. Unfortunately, the reference elevations of the measuring points differ and/or have apparently changed in response to damage, replacement, and other factors. Detailed review of lake levels, downstream gaging station data, and the records themselves allowed us to estimate mean sea level (NDVD 29 datum) lake surface elevations for a 24-year period of record. Some years included one point of measurement, while many measurements were collected during most years. High, average, and low water elevations for the available period of record are graphed in Figure 28. In addition to water levels, the

---

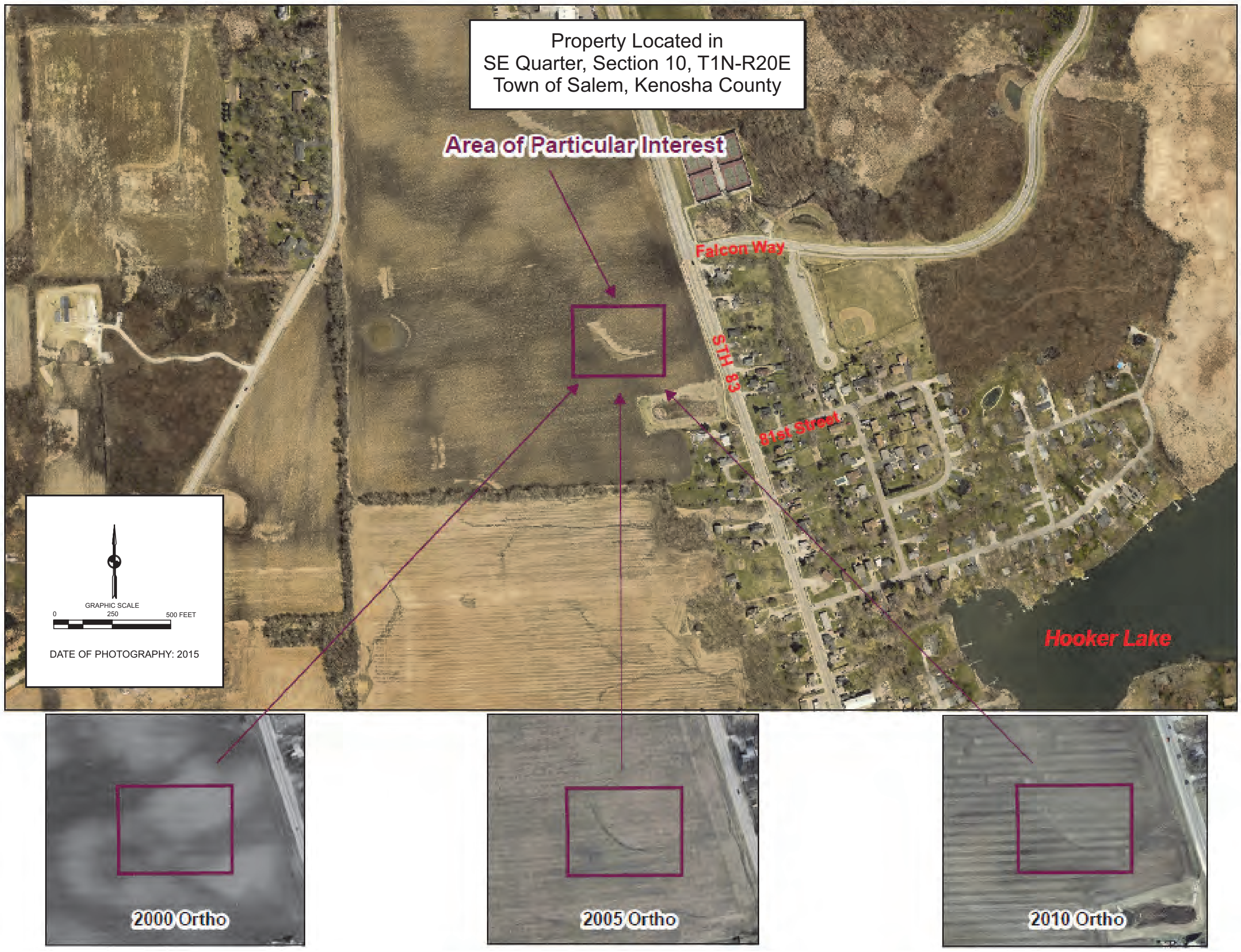
[35]*Flierl, Kurt (Project Manager, Wisconsin Department of Transportation Southeast Region), op. cit.*

[36]*Excellent opportunities to enhance stormwater storage appear to be present in the areas draining to the existing detention pond. An example is discussed at the end of this section.*

[37]*Wet soils often appear darker in color on spring aerial photography.*

Figure 27

INDICATIONS OF RECENT DITCHING IN THE HOOKER LAKE WATERSHED



Source: SEWRPC.

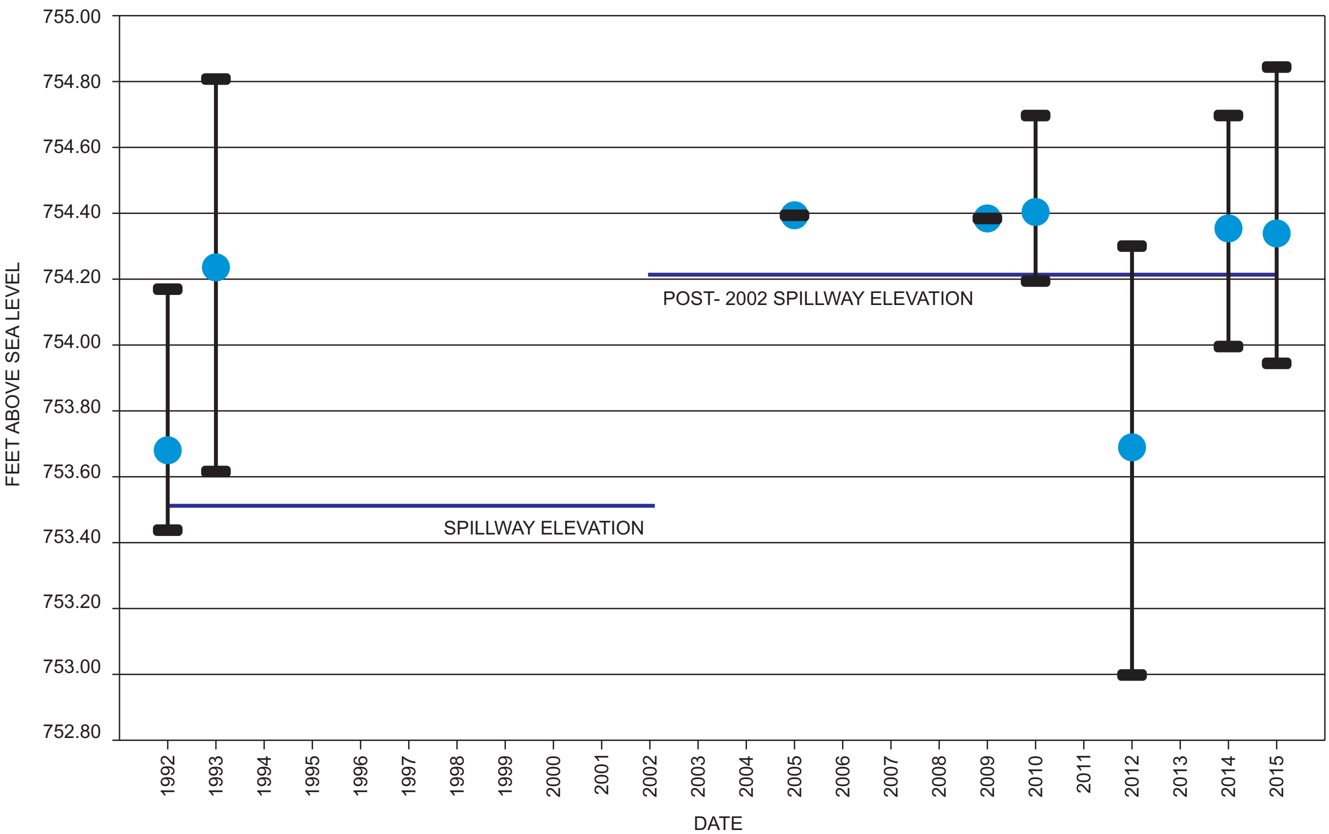
elevation of the outlet dam spillway is illustrated. Since the outlet dam was rebuilt in 2002 at a different elevation, both the original and post-2002 dam reconstruction spillway elevations are illustrated.

Water elevation data reveal that the absolute range of water-surface elevation has remained essentially unchanged over the period of available record. The lowest water level was recorded during a drought when the new and higher outlet dam spillway was dry. Conversely, the highest water levels occurred both before and after dam reconstruction. However, the high water level measured before dam reconstruction is associated with a period of extreme precipitation, whereas the post-dam reconstruction high water level is associated with less remarkable precipitation events. These facts underscore the profound effect of precipitation on lake elevation and the possible influence of the higher dam spillway. Aside from the year-to-year precipitation changes, the extremely limited data set generally suggests that Hooker Lake water levels have marginally increased since dam reconstruction

Although very limited data is available, the fair and wet-weather water elevations of Hooker Lake appear to have been increased after the Bryzek Dam was reconstructed in 2002. Since the dam's spillway capacity was likely reduced, extreme runoff events could generate higher than typical water elevations and may take a longer than typical length of time to return to normal. <u>The potential for this situation can be quantified by carefully measuring the dam's spillway configuration and contrasting it to current floodplain model values, and, if necessary, modifying the model</u>

Figure 28

APPROXIMATE LAKE LEVEL ELEVATION OF HOOKER LAKE: 1992-2015



NOTE: The blue circles represent annual average lake levels and the black bars represent the maximum and minimum elevations. Only a single measurement was available for 2005 and 2009.

Source: Wisconsin Department of Natural Resources, U.S. Geological Survey, and SEWRPC.

to account for the actual spillway capacity. Moreover, given that climate patterns are changing within Wisconsin,[38] **lake levels could potentially be susceptible to variability in the future.** The extent and nature of these changes are difficult to predict on a local level without a comprehensive local climate analysis, which is beyond the scope of this study. In general, some climate models predict that certain future climate changes could alter hydrologic budgets, leading to changes in water levels or flows, and cause water levels to change due to changes in the precipitation regime and in evapotranspiration.

Lake elevations are vulnerable to change if surface water and/or groundwater inflow are manipulated, inconsistent or lost over a season. For the long-term health of the Lake, it is important to focus on projects that can be undertaken to protect sources of water for the Lake. These types of projects generally address the two primary factors that influence water supply to a lake during both periods of adequate rainfall and periods of drought. These factors are:

A) The ability of the watershed to store and gradually release surface water runoff (i.e., surface water detention) and

B) The recharge rates of aquifers (i.e., groundwater systems) that supply the baseflow of water to the Lake and withdrawals from the contributing groundwater flow system.

---

[38] *Wisconsin Initiative on Climate Change Impacts (WICCI),* Wisconsin's Changing Climate—Impacts and Adaptation, *2011*.

Both of these factors are discussed below.

Surface Water Runoff Management
The speed at which incident precipitation or snowmelt leaves the land surface is dependent on many variables. These variables include the nature of soils, the slope of the land surface, vegetation, and the amount of storage available in a watershed. Storage in a watershed can detain runoff and slow the speed at which stormwater leaves the landscape. Storage can be provided by stormwater detention basins, buffers, or wetlands which slow the water velocity, temporarily storing and gradually releasing it, and, in some instances, allowing the water to soak deep into the ground. Some of the water that infiltrates into the ground becomes part of the local surface water system. This water moves slowly toward a lake or stream, maintaining baseflow over a period well beyond the day of the rain event. If buffers and wetlands do not exist to store and gradually release the runoff, the runoff could more rapidly enter a lake and, depending on the lake size and outlet characteristics, quickly flow out of the lake. In this case, a smaller volume of water is kept within the watershed to gradually supply the lake over time. This rapid flow often results in higher erosion and greater concentrations of sediment and nutrients reaching lakes and streams.

Impervious surfaces greatly increase the volume and velocity of runoff after a rainfall (see Figure 29).[39] Many studies directly link increases in impervious land surface to decreases in habitat quality and ecological integrity. For example, a 2003 study of 47 southeastern Wisconsin streams reported that fish and insect populations dramatically decline when impervious surfaces cover more than about 8 to 10 percent of the watershed, and streams with more than 12 percent watershed impervious surface consistently have poor fish communities.[40] Consequently, <u>reducing or preventing impervious cover, or installing measures that reduce the direct runoff from impervious cover (such as rain gardens or buffers), are crucial components in ensuring consistent high quality water supply to a lake.</u> The effect of impervious surfaces can be reduced in many ways, including the following examples:

- Limit the size of hard surfaces
  - Limit driveway width or share between neighbors
  - Minimize building footprints (i.e., build tall instead of wide, consistent with local zoning ordinances)
  - Remove unneeded sidewalks and parking spots

- Opt for pervious materials
  - Green roads (e.g., incorporate bioswales, grassed ditches)
  - Mulch walkways
  - Permeable pavers for walkways and driveways

- Capture or infiltrate runoff
  - Use rain barrels
  - Plant rain gardens
  - Channel gutters and downspouts to rain barrels, rain gardens, or places where they can infiltrate
  - Assure that the soil in lawn areas is not compacted

- Maintain and restore shoreline buffers (discussed further under Issue 5)

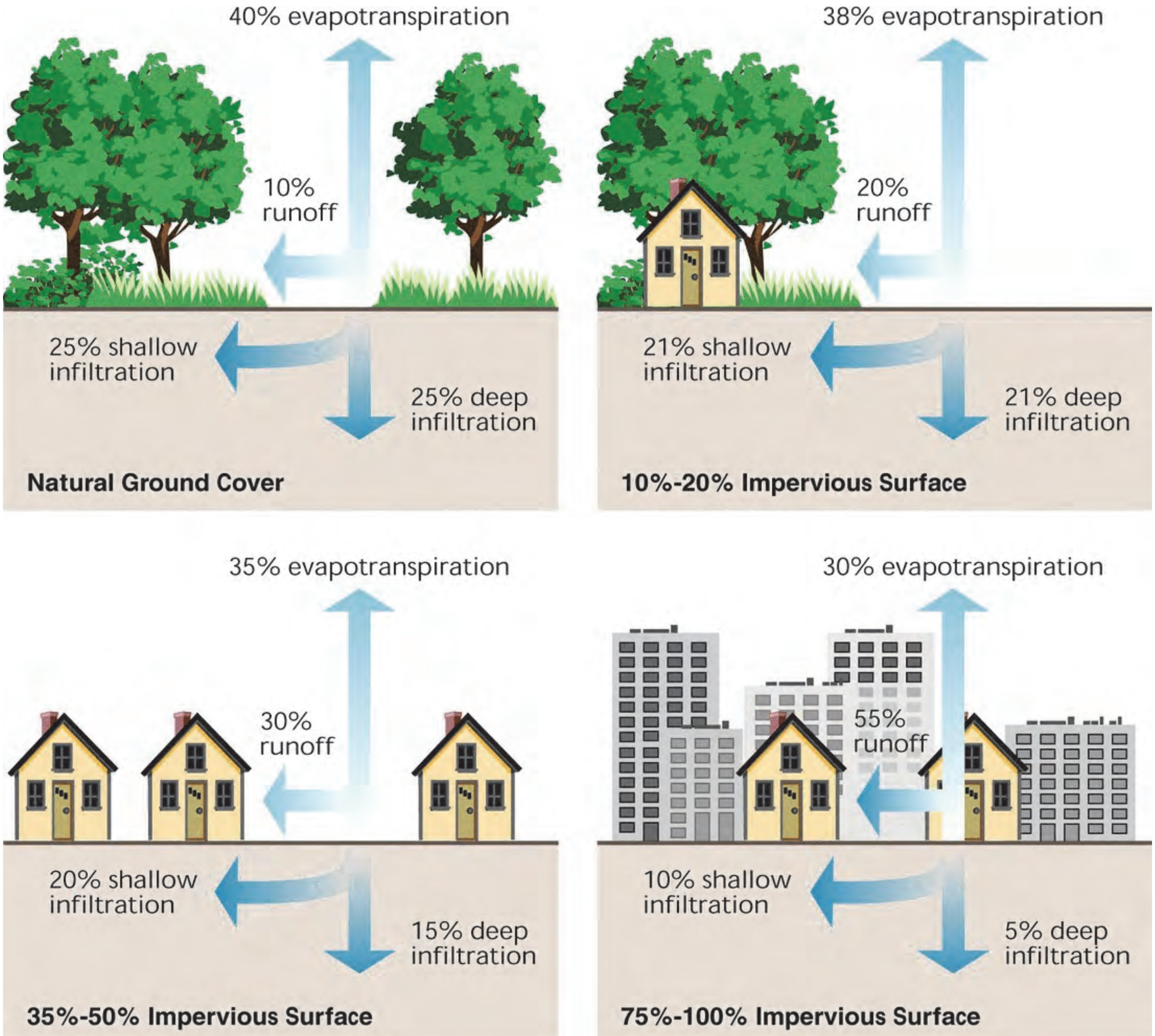
---

[39]*Impervious surfaces are those that resist or prevent absorption or transmission of water (e.g., asphalt or concrete driveways or sidewalks and roads, buildings).*

[40]*Center for Land Use Education. Page 13,* www.uwsp.edu/cnr/landcenter/pdffiles/Imp_Surf_Shoreland_Dev_Density.pdf. *Research studies: Wang, L., J. Lyons, P. Kanehl, R. Bannerman, and E. Emmons 2000.* Watershed Urbanization and Changes in Fish Communities in Southeastern Wisconsin Streams. *Journal of the American Water Resources Association. 36:5(1173-1187); Wang, L., J. Lyons, and P. Kanehl 2001.* Impacts of Urbanization on Stream Habitat and Fish Across Multiple Spatial Scales. *Environmental Management. 28(2):255-266.*

Figure 29

SCHEMATIC OF THE EFFECTS OF IMPERVIOUS SURFACES ON RUNOFF AND GROUNDWATER RECHARGE



Source: Federal Interagency Stream Restoration Working Group and SEWRPC.

To determine where improvements can be made to maintain and extend the volume of water supplied to Hooker Lake, several factors need to be assessed. These include:

1. **The location and extent of current urban land use within the watershed**—Urban land uses generally have a much higher percentage of impervious cover than rural land uses. Consequently, to assess where management efforts can be made to reduce the amount of impervious cover (or where efforts can be made to slow the speed and/or reduce the volume of runoff leaving these areas) it is necessary to identify where urban land use exists.

2. **The location and extent of planned land use changes within the watershed**—Since urban land use has a higher percentage of impervious cover, it is important to know where rural land is expected to be converted to urban land in the future. In such cases, extra precautions can be taken to implement management efforts

that reduce runoff velocity and/or volume when the development occurs. During development, efforts can be made to enhance infiltration and runoff characteristics beyond those of the undeveloped land cover. Such measures can help mitigate the effects of impervious surfaces in other historical developments that did not consider stormwater management.

3. **The location and extent of natural areas and stormwater management structures**—Stormwater retention and detention basins and natural areas (e.g., buffers, grassed waterways, floodlands, wetlands, and woodlands) can slow flowing surface water, in some cases can store and gradually release water, and can promote infiltration of water into the groundwater flow system. Consequently, if runoff passes through these kinds of areas, it can moderate runoff peaks and lengthen the time during which water is supplied to a lake.

To help target water volume management efforts, the SEWRPC staff inventoried the three preceding factors for the Hooker Lake watershed using geographic information system techniques and 2010 color digital orthophotography collected under a Regional orthophotography program administered by the Commission. Current and planned land use data are shown on Maps 5 and 7. **Urban land use currently occupies about 30 percent of the watershed.** Additionally, by comparing the 2010 and 2035 land use data, it can be seen that **an extensive portion of the watershed which is currently used for agriculture is anticipated to be converted to residential uses under planned year 2035 conditions** (see Map 8). Though much of the land in the southern and northern parts of the watershed that is planned for conversion from agricultural to residential uses is currently well buffered (see Map 12), the proximity of these development areas to the Lake and tributary streams may be a cause for concern if infiltration practices, stormwater management, and buffer enhancement are not considered high priorities in these new developments, especially in those areas of residential and commercial development to the west of STH 83. Consequently, recommendations for stormwater management related to this new planned development, as well as general recommendations for slowing, storing, and infiltrating runoff, are included in Chapter III of this report.

Map 13 also indicates, as was discussed in the "Water Quality" section, that, **with the exception of the majority of the shoreline properties, most runoff within the watershed enters a natural feature that could aid with infiltration and/or filtering.** Consequently, recommendations to increase water infiltration and filtering on shoreline properties are also included in Chapter III of this report.

Baseflow Recharge Rate Management

Baseflow refers to water that reaches the Lake from groundwater. This groundwater is replenished through recharge (precipitation that soaks deeply into the ground and enters local aquifers). **Baseflow is crucial to Hooker Lake because it supplies water to the Lake during times when surface runoff is scarce** (e.g., during droughts). Groundwater typically contains little to no sediment and phosphorus, has a more stable temperature regimen, and commonly contains a lower overall pollutant load when compared to surface-water runoff – all of which are favorable to aquatic life and the ecology of waterbodies. Groundwater-derived baseflow sustains many wetlands and creeks during drier periods, enabling these features to maintain a diverse assemblage or plants and animals and provide unique ecological functions. Consequently, it is important to maintain recharge to local aquifers that supply Hooker Lake and streams and wetlands within the watershed.

Generally, groundwater supplies can be depleted by two reasons: 1) pumping from the aquifer that supplies the baseflow, thereby reducing, or in extreme cases, eliminating, flow from springs and seeps and 2) reducing aquifer recharge through land use changes that increase impervious cover and speed runoff. The first of these most commonly occurs when a high-capacity well, or multiple wells, are installed in the groundwatershed of a waterbody without proper consideration for the effect pumping may have on the aquifer's naturally occurring groundwater discharge areas. Since water levels in Hooker Lake have not decreased, sufficient quantities of groundwater reach the Lake to maintain its normal elevation. This does not mean that flow volumes have not been affected, but it is beyond the scope of this study to quantify change in groundwater flux to the Lake over time. Since sufficient groundwater discharges to the Lake during dry periods to maintain its elevation, groundwater depletion is not considered a priority issue of concern at the present time. However, if high capacity or numerous additional wells are proposed in the Lake's groundwatershed in the future, their effect on Lake levels should be carefully investigated, and, if those effects were found to be significant, they should be mitigated.[41] Whatever the case, actions that lessen consumptive use of groundwater in the Lake's groundwatershed should help maintain or enhance groundwater flux to the Lake.

The second common cause of groundwater depletion is reduced recharge. Recharge to an aquifer can be reduced in many ways. Hastening stormwater runoff, eliminating native vegetative cover, ditching and disconnecting floodplains from streams, and increasing the amount of impervious land surface can all reduce stormwater infiltration, increase runoff, and reduce groundwater recharge. Development and land management activities need to consider groundwater recharge,[42] and actions to protect and enhance recharge should be a priority. Consequently, to maintain groundwater-sourced baseflow to Hooker Lake, it is necessary to identify high priority groundwater recharge areas for protection and watershed-wide practices that enhance recharge in all areas. To help support this activity, two factors need to be analyzed, including:

1. **The direction of groundwater flow**—To understand groundwater contributions to a lake's water budget, it is important to know where groundwater recharge occurs and in what direction groundwater flows. Groundwater elevation is normally a subdued reflection of surface topography, and groundwater normally flows in directions perpendicular to groundwater elevation contours. Topographically higher areas are commonly recharge areas; while lakes, wetlands, and streams are commonly groundwater discharge areas. Groundwater recharge/discharge systems occur on many scales: long regional recharge/discharge relationships and short localized flow paths, both of which can be important contributors to a lake's overall water budget. While localized flow systems typically occur within the Lake's surface-water watershed, regional flow paths may move in directions and distances out of phase with surface water feeding a lake. Therefore, some groundwater feeding a lake may originate in areas distant from the lake and/or outside the lake's surface-water watershed boundary. The relationship between short-and-long distance groundwater flow paths is illustrated in Figure 30.

   Local groundwater flow paths are relatively easy to estimate from topographic maps. However, to approximate the flow direction of deeper, more regionally extensive systems, groundwater elevation measurements collected in water supply or monitoring wells need to be consulted. Since groundwater normally moves perpendicular to potentiometric contours, deep groundwater flow directions can be predicted. The locations of streams, ponds, and lakes can be used to predict if a surface water body is fed by groundwater, recharges groundwater, or has little interaction with groundwater. By combining these data, maps can be prepared identifying land areas that likely contribute recharge and are therefore sources of groundwater-sourced baseflow to a lake, and areas that convey groundwater to a lake.

2. **The groundwater recharge potential in the area that is likely contributing to the groundwater supply**—Groundwater recharge potential is based on the amount of impervious cover, topographic relief, and soil characteristics. A flat area with no impervious cover and highly permeable soils, for example, would be classified as having high or very high groundwater recharge potential, whereas sleepily sloping area with lower permeability (e.g., clay soils) would be classified as low potential. Identifying groundwater recharge potential enables the areas with the highest infiltration potential to be identified and protected (e.g., the areas where impervious surfaces should be avoided or where appropriate infiltration facilities should be constructed).

To determine where management efforts should be employed to protect groundwater recharge to Hooker Lake, SEWRPC staff analyzed groundwater elevation contours and the groundwater recharge potential in the areas surround

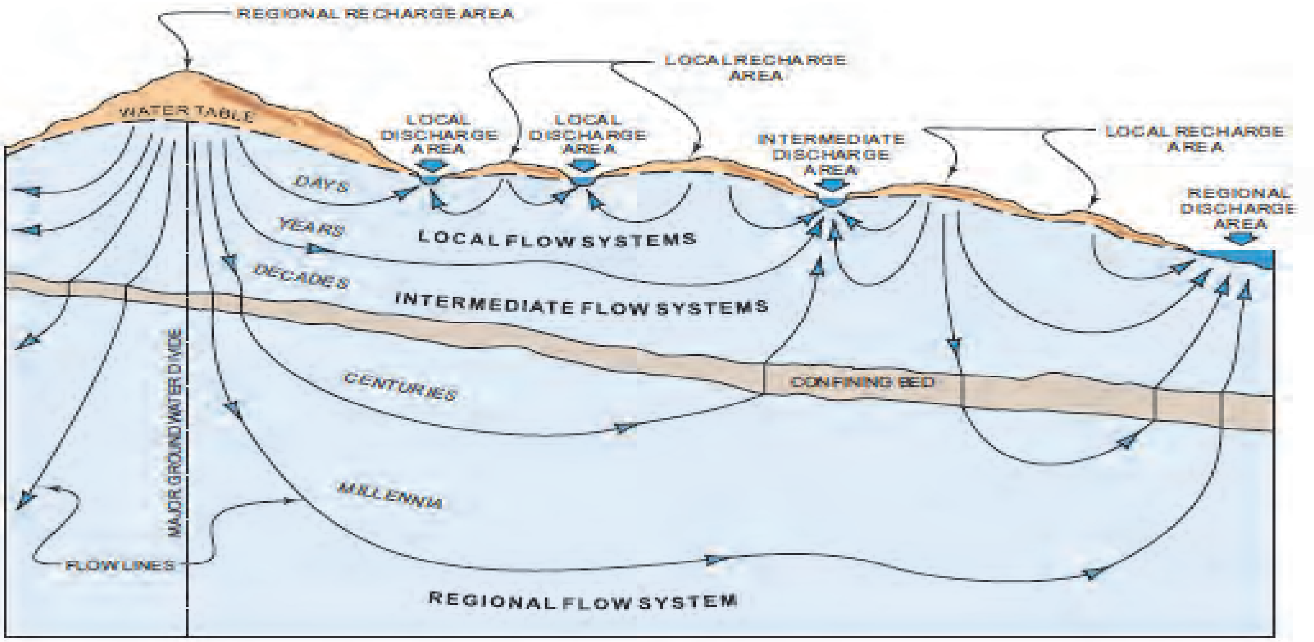
---

[41]*SEWRPC Planning Report No. 52,* A Regional Water Supply Plan for Southeastern Wisconsin, *December 2010.*

[42]*Ibid.*

Figure 30

CROSS SECTION DEPICTING LOCAL VERSUS REGIONAL GROUNDWATER FLOW PATHS



Source: A. Zaporozec in SEWRPC Technical Report Number 37, Groundwater Resources of Southeastern Wisconsin, 2002.

ing the Lake.[43] This inventory was not confined to the surface watershed, as was the case for the other inventories completed in this report, because the groundwater flow may be coming from outside of the watershed. The results of these inventories are described below.

Map 15 shows the general water table elevation contours, in feet above NGVD 29, in the immediate Hooker Lake area. In general, the shallow regional groundwatershed divide is located approximately three miles to the west-northwest. **Large portions of the recharge area for shallow regional groundwater may lie to the west outside the Lake's surface-water watershed.** Shallow groundwater in the regional system to the west of the groundwatershed divide flows to discharge points in the Fox River watershed. Near Hooker Lake, shallow regional groundwater flow is predominately to the southeast and flow is likely to the southeast in the southern portion of the Lake's watershed and to the northeast in northern portions of the Lake's watershed. Given the typical water elevation of Hooker Lake, the Lake may lose water to the groundwater flow system along its southern and eastern shorelines while the wetlands abutting the northwest shoreline may be fed by the regional shallow groundwater flow system. Localized flow systems likely contribute groundwater to the Lake in steeply sloping areas that essentially surround the Lake, while areas near the dam may lose water to localized flow systems connecting the Lake to the stream downstream of the dam. Water in the deeper aquifers is separated from the shallow aquifer by hundreds of feet of impermeable shale and exhibit a current potentiometric surface essentially equivalent to the Lake's elevation.[44] Little to no water exchange is anticipated between the Lake and deep aquifers under natural conditions and current pressure head distributions. Overall, it appears that the Lake is neither a strong groundwater discharge area nor a significant groundwater recharge area.

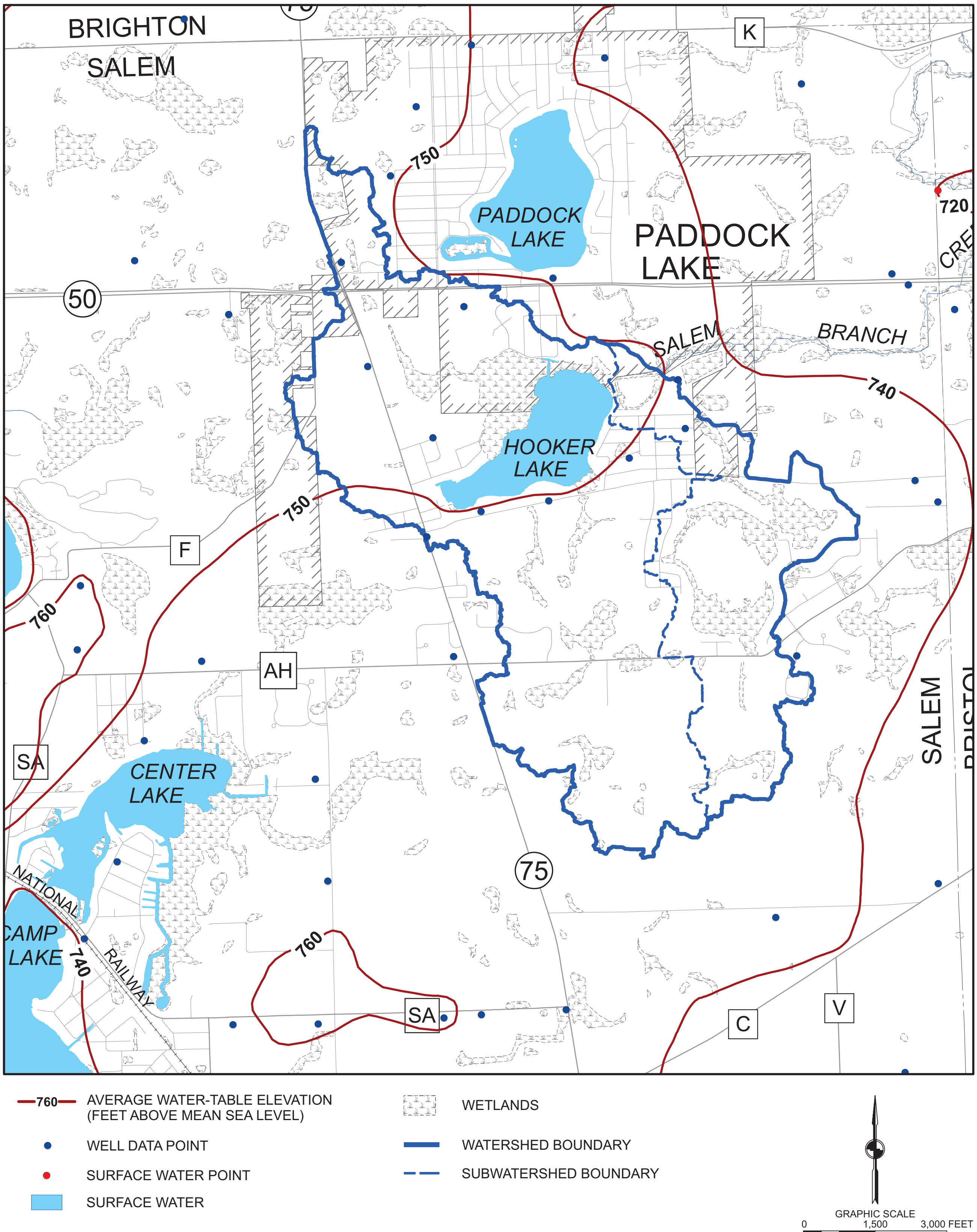
---

[43]*SEWRPC Planning Report No. 52, op. cit.*

[44]*Potentiometric surface is the elevation to which water will rise in a well penetrating an aquifer confined by impermeable rock layers.*

Map 15

GROUNDWATER TABLE ELEVATIONS BASED ON WELL ELEVATIONS WITHIN THE HOOKER LAKE WATERSHED



Source: Wisconsin Geological and Natural History Survey and SEWRPC.

Groundwater recharge potential of the lands near Hooker Lake is illustrated in Map 16. The areas with the highest groundwater recharge potential abut the south shore of the Lake and the large inlet wetland on the northwest side of the Lake. Both these areas are within the Lake's surface water watershed and very likely contribute water to the Lake's local groundwater flow system. Infiltration of precipitation into these areas enhances the amount of groundwater entering the Lake and reduces runoff volume. Reduced runoff volume usually correlates with lower erosion potential and decreased sediment and pollutant loading to downstream water bodies. The high recharge potential area located to the west of the inlet wetland is in an area where both local and regional flow paths contribute water to the Lake. This area may provide an excellent opportunity to protect and even enhance groundwater recharge. The high recharge potential area located to the south of the Lake probably does not contribute recharge to the regional shallow groundwater flow system. However, infiltrated water has a high likelihood of entering localized flow systems discharging to Hooker Lake and its tributary streams. Some of this area is used for residential purposes, and likely has a significant amount of impervious surface, a fact potentially decreasing the current groundwater recharge value of this area. Such an area is a prime target for stormwater management measures that enhance infiltration, helping offset the effect of impermeable surfaces. The groundwater recharge potential of most of the remaining groundwatershed is classified as moderate. Opportunities to enhance the proportion of precipitation infiltrated in such areas should be actively pursued in all areas to the northwest of the Lake, but their ability to directly impact groundwater flow to the Lake decreases with increasing distance from the Lake. <u>Recommendations related to investigating these recharge areas are also included in Chapter III.</u>

Some projects can be undertaken to improve the volume, timing, and quality of water delivered to the Lake without further study. In the interest of encouraging these kinds of actions, <u>Chapter III of this report describes recommendations focused on increasing infiltration, particularly in the moderate and high groundwater recharge potential areas in the Hooker Lake watershed and in areas to the west of the surfacewater watershed that may contribute to groundwater recharge and Hooker Lake's baseflow.</u> These recommendations should be implemented whenever and wherever practical. Consideration should be given to active promotion of stormwater infiltration practices. Examples of promotion includes providing incentives that encourage stormwater infiltration and/or promulgating ordinances that incorporate performance metrics that can be efficiently met using stormwater infiltration techniques.

ISSUE 3: LAKE OUTLET DAM

The water surface of Hooker Lake has been controlled by a dam since at least 1929.[45] At least 3 dams have controlled the Lake's water level over this period. The locations of these dams are illustrated on Map 3. The most upstream dam is located at the shoreline of the eastern-most area of Hooker Lake proper, and is generally referred to as "Hooker Lake Dam". At present, this dam is not known to be used and is largely submerged. Water levels within the Lake are now controlled by the "Bryzek Dam" located approximately 1,100 feet east-northeast of the Hooker Lake Dam (Figure 31). A culvert located a short distance downstream of the Bryzek Dam appears to backwater during intense runoff events (Figure 32).[46] Backwatering can diminish the ability of the Bryzek Dam to pass high flow events. The Bryzek Dam was reconstructed in 2002, and an after-the-fact permit was issued by the WDNR in 2005. Both dams are situated on private property and are privately owned. The dam owner has granted HMLD permission to operate the dam and clear debris.

In 2007 and 2008, residents of Hooker Lake contacted the WDNR with concerns regarding high water levels and flooding at Hooker Lake. In 2007, the WDNR reviewed survey data from SEWRPC Planning Report No. 44, *A*

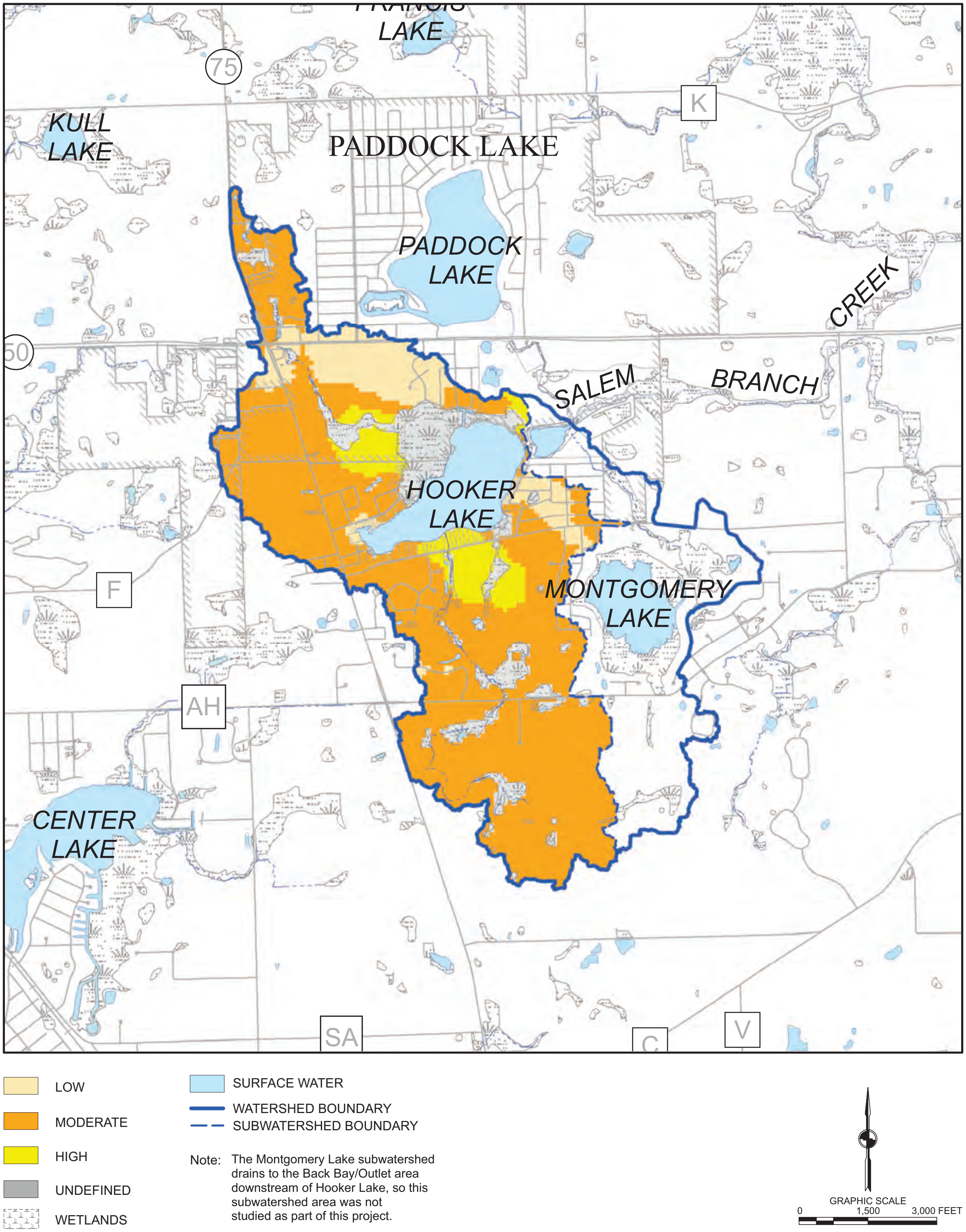
---

[45]*Wisconsin Department of Natural Resources,* Detailed Information for Dam HOOKER LAKE*, On-Line Dam Database, April 4, 2016.*

[46]*Southeastern Regional Planning Commission, Planning Report No. 44,* A Comprehensive Plan for the Des Plaines River Watershed, *June 2003.*

Map 16

ESTIMATES OF GROUNDWATER RECHARGE POTENTIAL WITHIN THE HOOKER LAKE WATERSHED



Source: Wisconsin Geological and Natural History Survey and SEWRPC.

Figure 31

BRYZEK DAM: 2014

Source: SEWRPC.

Figure 32

CULVERT DOWNSTREAM OF BRYZEK DAM: 2014

Source: SEWRPC.

Comprehensive Plan for the Des Plaines River Watershed, June 2003. This report provides drawings and elevations of the earlier Bryzek Dam as it existed before the 2002 reconstruction (Appendix E contains records and photos of the dam). Combining this data with field observations made by WDNR staff in 2009, it was ascertained that the reconstructed dam had a spillway elevation approximately 10 inches higher than the earlier dam. Additionally, the reconstructed dam had a spillway that was about 11 inches narrower than the original Bryzek Dam. **A higher spillway elevation and reduced spillway width could exacerbate the magnitude and duration of high lake water elevation periods** following large precipitation and snowmelt events. In exceptional high flow conditions, the amount of discharge may possibly overtop the dam's engineered spillway and embankment. Overtopping can destabilize a dam and is a condition prohibited by Chapter NR 333 of the *Wisconsin Administrative Code*. The WDNR dam database includes a notation that an order was issued by the WDNR on November 8, 2010 requiring that the dam be modified and easements procured, or the dam should be removed. **A time extension was issued by the WDNR on May 18, 2016 requiring the spillway elevation to be restored to the pre-2002 spillway elevation, 0.7 feet lower than the current elevation, between July 1, 2016 and August 1, 2016. In lieu of restoration, a petition to raise and enlarge the dam or a request for a permit to abandon the dam may be submitted to the WDNR by August**

Figure 33

ACCUMULATED DEBRIS AT CULVERT DOWNSTREAM OF BRYZEK DAM: 2016

Source: Village of Paddock Lake and SEWRPC.

1, 2016, with written notification submitted by July 1, 2016.[47] The HLMD should actively monitor progress and results of this negotiation and should actively assert itself in this matter. Consequently, recommendations related to dam design, inspection, operation, and ownership are made in Chapter III of this report.

The Bryzek Dam and the downstream culvert commonly become clogged with floating debris such as cattails and tree branches. The Village of Paddock Lake or the HLMD has cleared such flow obstructions in the past, which is important to maintaining proper water level, flow capacity, and safe operation. Some of these debris jams can be quite severe, appreciably restricting flow (see Figure 33). **Restricted outlet capacity could raise water levels to higher than expected water levels which in turn can lead to property damage.** For this reason, Chapter III includes recommendations that integrate the HLMD into dam operation and potentially ownership.

ISSUE 4: AQUATIC PLANT GROWTH

Aquatic plant management is a significant issue of concern to Hooker Lake stakeholders. Consequently, this section first discusses the general need for aquatic plant management by evaluating the current state of aquatic plants in Hooker Lake, compares the current state with past surveys, and then discusses management alternatives.

It is important to note that all lakes have plants. In fact, in a nutrient-rich lake such as Hooker Lake (nutrient-rich lakes are common in the Southeastern Wisconsin Region due to nutrient-rich soils), it is actually normal to have luxuriant aquatic plant growth in the shallow areas. Additionally, it is important to note that **native aquatic plants**

---

[47]*As of the writing of this report, we are not aware of any progress to resolve this issue.*

Table 11

AQUATIC PLANT SPECIES OBSERVED IN HOOKER LAKE: 1992, 2008, AND 2014

Aquatic Plant Species	Native (N) or Nonnative (I)	1992	2008	2014
Ceratophyllum demersum (coontail)	N	X	X	X
Chara spp. (muskgrass)	N	X	X	X
Elodea canadensis (waterweed)	N	X	X	X
Lemna minor (Duckweed)	N	X	X	- -
Myriophyllum spicatum (Eurasian water milfoil)	I	X	X	X
Myriophyllum verticillatum (native milfoil)	N	- -	X	- -
Najas flexilis (bushy, or slender, pondweed)	N	X	X	X
Najas marina (spiny, or brittle, naiad)	N	X	X	- -
Nitella spp. (stonewort)	N	X	- -	- -
Nuphar variegata (spatterdock)	N	X	X	X
Nymphaea odorata (white water lily)	N	X	X	X
Potamogeton crispus (curly-leaf pondweed)	I	X	X	- -
Potamogeton foliosis (leafy pondweed)	N	- -	X	- -
Potamogeton illinoensis (Illinois pondweed)	N	X	X	- -
Potamogeton praelongus (white-stem pondweed)	N	- -	X	- -
Potamogeton richardsonii (clasping-leaf pondweed)	N	X	X	- -
Potamogeton zosteriformis (flat-stem pondweed)	N	X	X	- -
Stuckenia pectinata (Sago pondweed)	N	X	X	X
Utricularia vulgaris (bladderwort)	N	X	X	- -
Vallisneria americana (eel-grass/wild celery)	N	X	X	X
Zosterella dubia (water stargrass)	N	- -	X	X
Total Number of Species	- -	17	20	10

Source: Aron and Associates and SEWRPC.

form an integral part of lake ecosystems. These plants serve a number of valuable functions including: improving water quality by using excess nutrients, providing habitat for invertebrates and fish, stabilizing lake bottom sediments, and supplying food and oxygen to the Lake through photosynthesis. It is also important to note that even though aquatic plants may hinder use of and/or access to a lake, aquatic plants should not necessarily be eliminated or even significantly reduced because they may serve other beneficial functions. For example, the white water lily (found only sparsely in Hooker Lake) plays a major role in providing shade, habitat, and food for fish and other important aquatic organisms. It also plays a significant role in preventing shoreline erosion, as it can dampen waves that would otherwise damage the shoreline. Additionally, the shade that this plant provides helps reduce the growth of other plants, such as Eurasian water milfoil (EWM) and coontail, because it limits the amount of sunlight reaching young plants on the lake bottom. Furthermore, aquatic plants compete with free floating algae for plant nutrients. Without aquatic plants, free floating algae may become extremely abundant, reducing water clarily. Given these benefits, removing native "nuisance" plants (especially white water lilies) beyond the need for gaining access to the lake should be avoided.

Aquatic Plants in Hooker Lake

To document the types, distribution, and relative abundance of aquatic macrophytes in Hooker Lake and, thus, to determine the need for aquatic plant management, aquatic plant surveys were conducted in 1992 and 2008 by Aron and Associates and by SEWRPC staff in 2014. Table 11 a lists the aquatic plant species observed in the 1992, 2008, and 2014 surveys.

Table 12

ABUNDANCE DATA FOR AQUATIC PLANT SPECIES IN HOOKER LAKE: 2014

Aquatic Plant Species	Native or Invasive	Number of Sites Found	Dominance Value[a]
Floating Plants			
Nuphar variegata (spatterdock)	Native	3	5.5
Nymphaea odorata (white water lily)	Native	4	5.5
Submerged Plants			
Ceratophyllum demersum (coontail)	Native	78	112.6
Chara spp. (muskgrass)	Native	40	68.5
Myriophyllum spicatum (Eurasian water milfoil)	Invasive	25	23.6
Elodea canadensis (waterweed)	Native	15	22.1
Zosterella dubia (water stargrass)	Native	14	15.8
Vallisneria americana (eel-grass/wild celery)	Native	4	3.2
Najas flexilis (bushy pondweed)	Native	3	2.4
Potamogeton pectinatus (Sago pondweed)	Native	3	1.6

NOTE: There are a total of 253 grid-point sampling sites on Hooker Lake; all 253 sites were visited during the survey. 138 of those sites were at, or shallower than, the 15-foot maximum depth at which plants grew; 127 of those sites actually had vegetation.

[a]*The* ***dominance value*** *of a species is derived from a combination of how often it was observed at sampling sites that had some kind of vegetation present and its relative density at those sites; it provides an indication of the relative importance and abundance of a species within a community.*

Source: SEWRPC.

The 2014 survey revealed that the five most dominant native plant species in Hooker Lake, in descending order of abundance were:

- coontail (*Ceratophylum demersum*),
- muskgrass (*Chara spp.*),
- elodea (*Elodea canadensis*),
- water stargrass (*Zosterella dubia*), and
- eel-grass/water celery (*Valesneria americana*).

See Table 12 for the list of aquatic plant species that were found and for detailed characterization of their abundance and dominance. Individual distribution maps for each species are included in Appendix F along with text explaining the ecological significance of each plant and guidance on their identification. It should be noted that muskgrass is the aquatic macrophyte largely responsible for marl formation. Marl formation reduces lake water phosphorus concentrations which helps improve water, demonstrating the valuable ecological service muskgrass provides the lake.

Data from the 2014 survey reveals that of the 138 sites having a water depth at or less than the 15-foot maximum depth of plant growth in Hooker Lake, 127 had moderate[48] amounts of vegetation and most of them **contained vegetation known to interfere with recreational use when found growing in abundance** (such as coontail). <u>These results indicate that the Lake has types of plants at levels of abundance that deters recreational use. Therefore, aquatic plant management is warranted.</u>

---

[48]*Moderate vegetation in this context refers to a rake fullness measurement of 2 on a scale of zero to three (see Appendix F for schematic of rake fullness ratings).*

Table 13

SUMMARY STATISTICS FOR ALL AQUATIC PLANT SPECIES IN HOOKER LAKE: 2008 AND 2014

Summary Statistics	2008	2014
Total number of survey sites visited/sampled	225.00	253.00
Total number of survey sites with vegetation	65.00	127.00
Total number of sites shallower than the maximum depth of plants	110.00	138.00
Frequency of occurrence at sites shallower that the maximum depth of plants	59.09	93.03
Simson Diversity Index	0.87	0.79
Maximum depth of plants (ft)	13.50	15.00
Number of sites sampled using rake on rope (R)	102.00	0
Number of sites sampled using rake on pole (P)	122.00	253.00
Average number of all species per site (shallower than max depth)	0.94	1.95
Average number of all species per site (veg. sites only)	1.72	2.17
Average number of native species per site (shallower than max depth)	0.83	1.77
Average number of native species per site (veg. sites only)	1.59	1.98
Species Richness	16.00	10.00
Species Richness (including visuals)	20.00	10.00

NOTE: The WDNR-generated map of grid points provides 238 sampling points. During the 2008 survey, 225 of those sites were visited; during the 2014 survey, SEWRPC field staff sampled an additional 15 sites to fill in apparent “blank spots” on the site map.

Source: Aron and Associates, Wisconsin Department of Natural Resourdes, and SEWRPC.

Since the 2008 and 2014 surveys were both conducted using the same point-intercept methodology,[49] comparing data from these two surveys should accurately reflect changes in the aquatic plant communities in Hooker Lake over the intervening six year period. It is worth noting that six years is more than enough time for a lake to undergo significant changes in its aquatic plant composition. *To accurately monitor plant populations and identify developing trends in plant communities, relatively frequent (three- to five-year intervals) point-intercept plant surveys should be conducted; more frequently if negative developments are observed, such as loss of native species or rapid increase of plants, especially nonnatives.*

Table 13 contrasts the results of the 2008 and 2014 aquatic plant surveys. Two things become immediately apparent. First, the number of species markedly decreased between from 2008 to 2014 (see Table 11 for species lists). In six years, the number of aquatic species decreased by 50 percent, with species richness falling from 20 to 10. This loss in species diversity has significantly affected the pondweed species – and has affected pondweeds that are both sensitive to water quality disturbances and those that are tolerant of eutrophic conditions and disturbance. This suggests that an external condition is affecting the health of the plant community. Aquatic herbicides such as chemical treatment 2,4-D and Endothall are likely the cause for the loss of bladderwort (*Utricularia vulgaris*) and white water crowfoot (*Ranunculus longirostrisis*). It is also notable that white water crowfoot was listed as a dominant

---

[49]*The point intercept method uses predetermined points arranged in a grid pattern across the entire lake surface as sampling sites. Each site is located using global positioning system (GPS) technology and a single rake haul is taken at that site. A quantitative assessment of the rake fullness, on a scale of zero to three, is then made for each species identified. Further details on the methodology can be found at Wisconsin Department of Natural Resources, Publication No. PUB-SS-1068 2010.*

species in the 2007 Hooker Lake Integrated Sensitive Area Report (Appendix J) yet was not found in the 2008 or 2014 survey. White water crowfoot is uncommon to this area and considered an ecologically important species as it supports ducks, upland game birds, invertebrates, and fish.[50]

Reviewing Table 14, it can be seen that the frequency of occurrence of nearly all native plants decreased between 2008 and 2014. Thirteen of the 15 submerged plants found in the Lake in 2008 were found at fewer locations or not at all in 2014. Again, aquatic plant management strategies have been noted to dramatically effect aquatic plants. For example, shoreline algal treatments can decimate muskgrass populations.[51] Muskgrass is a critical component of the Lake's phosphorus sequestration system, and reducing muskgrass populations can have a serious impact on a lake's trophic state, clarity, and free floating and toxic algae abundance.

In addition to the marked decrease in native species richness and frequency of occurrence, there was a concurrent significant increase in the occurrence of coontail (see Map 17). It should be noted that the significant increase in coontail does not correlate to an increase in other plant species. While there is no definitive hypothesis explaining the increase in coontail, it is known that coontail recovers more quickly following application of some aquatic herbicides, allowing coontail to grow more quickly than other native species. This allows coontial to suppress other native plants by shading.

Table 14

FREQUENCY OF OCCURRENCE OF SUBMERGED AQUATIC PLANT SPECIES IN HOOKER LAKE: 2008 AND 2014

Aquatic Plant Species	2008	2014
Ceratophyllum demersum (coontail)	23.1	61.4
Chara spp. (muskgrass)	46.2	31.5
Elodea canadensis (waterweed)	6.2	11.8
Myriophyllum spicatum (Eurasian water milfoil)	21.5	19.7
Myriophyllum verticillatum (native milfoil)	13.9	- -
Najas flexilis (bushy pondweed)	- -	2.4
Najas marina (spiny, or brittle, naiad)	7.7	- -
Potamogeton crispus (curly-leaf pondweed)	1.5	- -
Potamogeton illinoensis (Illinois pondweed)	1.5	- -
Potamogeton praelongus (white-stem pondweed)	1.5	- -
Potamogeton richardsonii (clasping-leaf pondweed	4.6	- -
Potamogeton zosteriformis (flat-stem pondweed)	15.4	- -
Stuckenia pectinata (Sago pondweed)	4.6	2.4
Utricularia vulgaris (bladderwort)	1.5	- -
Vallisneria americana (eel-grass/wild celery)	6.2	3.1
Zosterella dubia (water stargrass)	15.4	11.0

NOTE: The Frequency of Occurrence, expressed as a percent, is the number of occurrences of a species divided by the number of sampling sites with vegetation.

Source: Aron and Associates and SEWRPC.

A key aspect of the ability of an ecosystem, such as a lake, to maintain its ecological integrity is through biological diversity, or *species richness*. Conserving the biodiversity of an ecosystem helps not only to sustain the ecological integrity of the system, but preserves a spectrum of options for future decisions regarding the management of that system. With seven different native submerged species of aquatic plants, the 2014 survey indicated 1) that Hooker Lake contains only a **fair diversity of aquatic species, with only ten species,** for a lake of its size and 2) as indicated in Table 14 and Map 18, a decline in the number of native species. Native plant presence and diversity are crucial parts of the Lake's health. Therefore, the native plants should be protected to the greatest extent practical. By comparison, nearby Lake Mary has been reported to have 15 species;[52] Elizabeth Lake, 18 species;[53] Geneva Lake,

---

[50]*Heidi Bunk, Wisconsin Department of Natural Resources email to SEWRPC, Hooker Lake Lake Management Plan Comments, November 4, 2016 and follow up telephone conversations.*

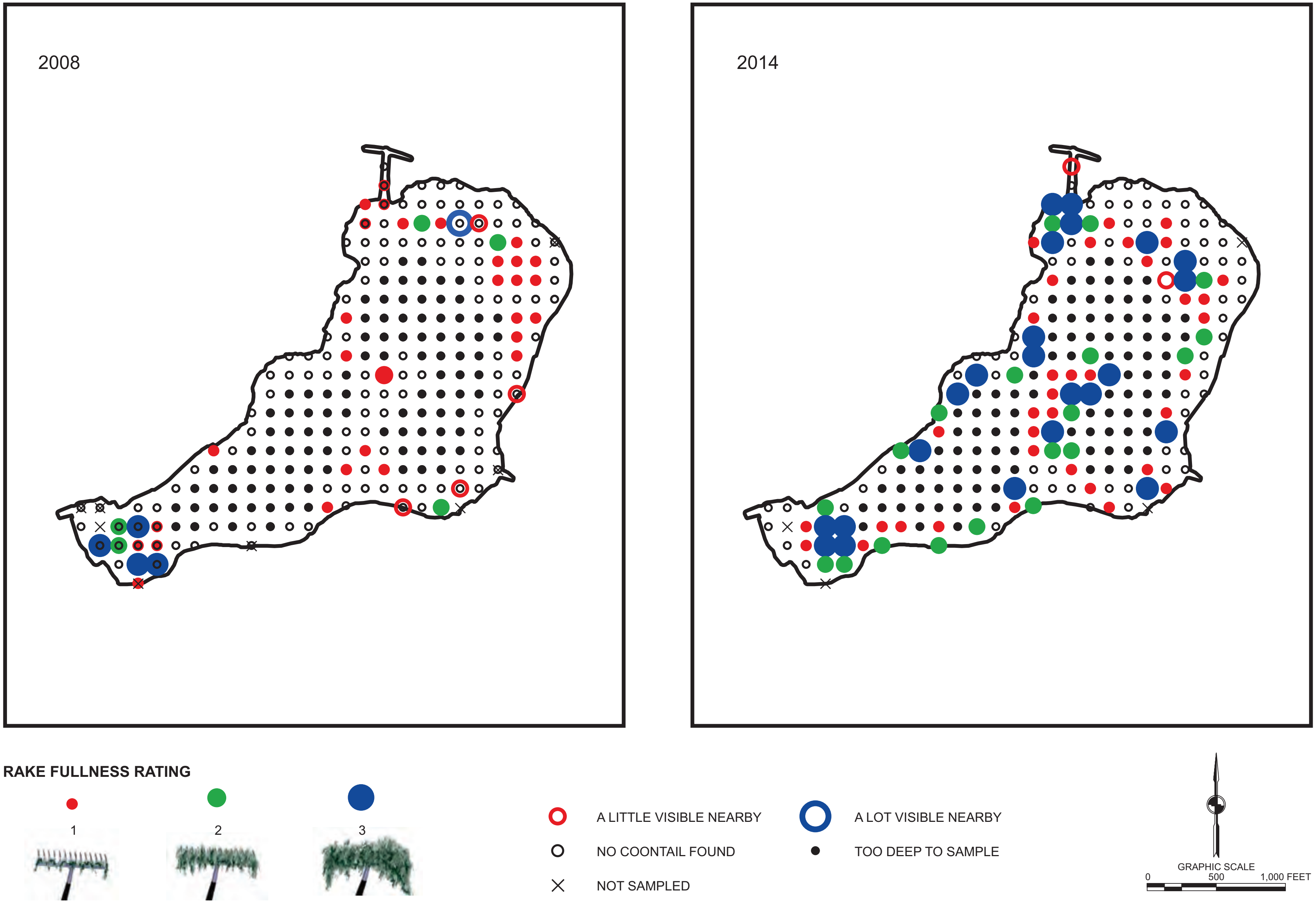
[51]*Ibid.*

[52]*SEWRPC Community Assistance Planning Report No. 302*, A Lake Management Plan For Elizabeth Lake And Lake Mary, Kenosha County, Wisconsin, *Volume One*, Inventory Findings, *July 2009*.

[53]*Ibid.*

Map 17

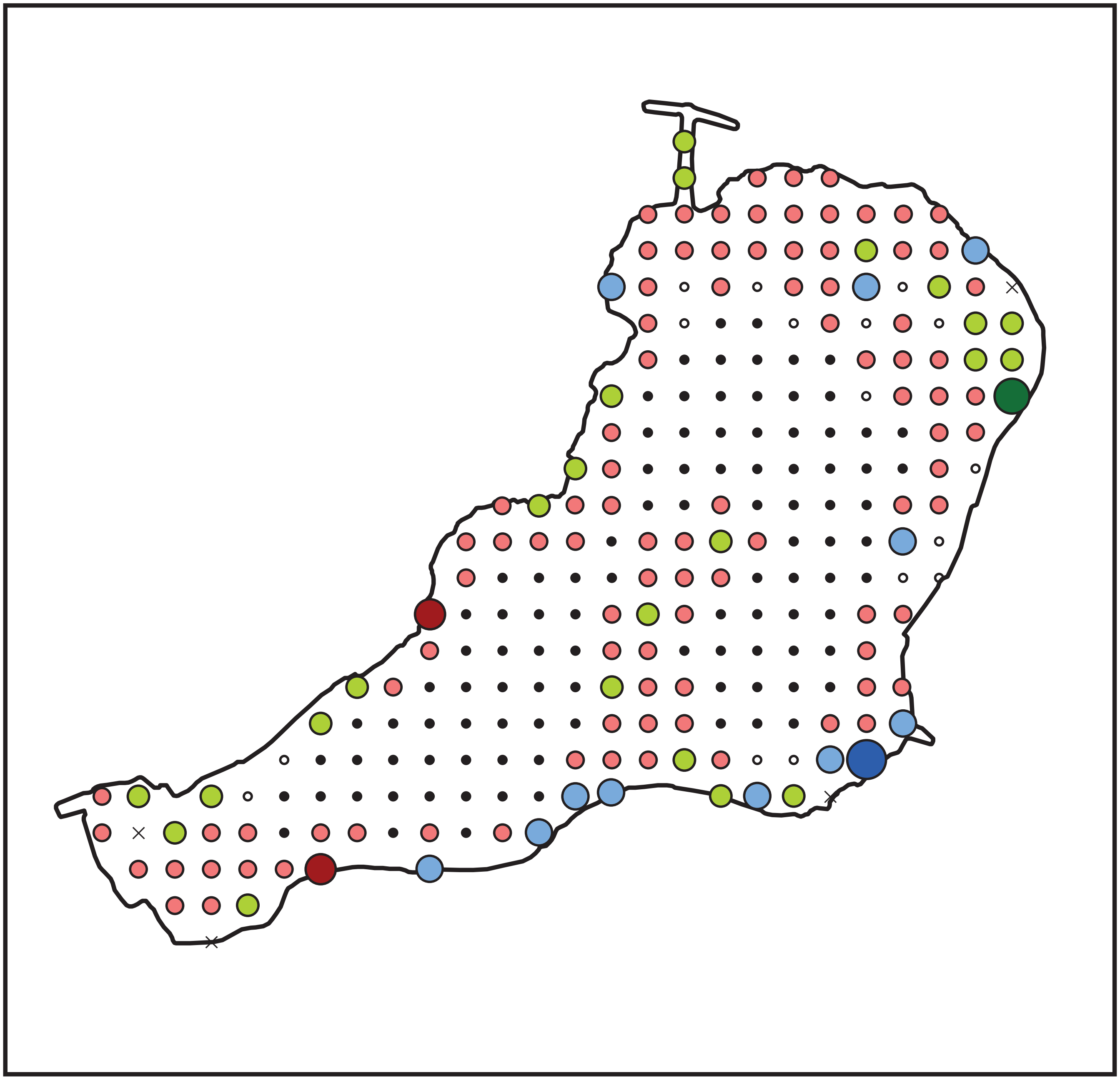
COONTAIL OCCURENCE IN HOOKER LAKE: 2008 VS 2014



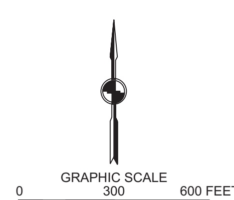
Source: SEWRPC.

Map 18

SPECIES RICHNESS AT SURVEY SITES IN HOOKER LAKE: 2014



NOTE: The above diagram presents the data for number of species observed in Hooker Lake at each sampling site during the 2014 aquatic plant survey; sampling occurred at 253 sampling sites, 127 had vegetation.



Source: Wisconsin Department of Natural Resources and SEWRPC.

20 species;[54] George Lake, 11 species;[55] and, Voltz Lake, ten species.[56] Future aquatic plant surveys will be needed to determine if there is an overall sustained downward trend in the number of native plant species.

The terms "nonnative" and "invasive" are often confused and incorrectly assumed to be synonymous. Nonnative is an overarching term describing living organisms introduced to new areas beyond their native range with intentional or unintentional human help. Nonnative species may not necessarily harm ecological function or human use values in their new environments. Invasive species are the subset of nonnative species that damage the ecological health of their new environments and/or are considered a nuisance to human use values. In summary, **invasive species are non-native but not all non-native species are invasive.**

Introducing invasive species, either plants or animals, can severely disrupt both terrestrial and aquatic natural systems. **Invasive species reproduce prolifically and often have no natural predators to control their growth, factors that combine to allow them to outcompete native species for space and other necessary resources. This can have devastating effects on native species that have well developed dependencies on the availability of native plants and animals.**

A list of common invasive wetland and aquatic plants of current concern in the Southeastern Wisconsin Region is found below. This list is based upon conversations with WDNR staff that took place during early 2016. A full list with photos may be found in Appendix G:

- Eurasian water milfoil (*Myriophyllum spicatum*),
- Curly-leaf pondweed (P*otamogeton crispus*),
- Non-native phragmities (*Phragmities australis subspecies australis*),
- Reed canary grass (*Phalaris arundinaceae*),
- Hybrid cattail (*Typha x glauca*), and
- Common buckthorn (*Rhamnus cathartica*).

The WDNR officially lists six invasive species in or near Hooker Lake (Figure 34):

- Eurasian water milfoil (*Myriophyllum spicatum*),
- Curly-leaf pondweed (*Potamogeton crispus*),
- Hybrid water milfoil (cross between EWM and the native Northern water milfoil),
- Reed canary grass (*Phalaris arundinaceae*),
- Purple Loosestrife (*Lythrum salicaria*), and
- Zebra mussel (*Dreissena polymorpha*).

EWM was found in about 20 percent of the vegetated sampling sites in Hooker Lake during the 2014 survey and was overall the third most dominant species. Table 15 and Map 19 show the distribution of EWM has increased between 2008 and 2014, but the density at the sites where it was found has decreased. As EWM has been

[54]SEWRPC Community Assistance Planning Report No. 60, 2nd Edition, A Lake Management Plan for Geneva Lake Walworth County, Wisconsin, May 2008.

[55]S*EWRPC Community Assistance Planning Report No. 300*, A Lake Management Plan for George Lake, Kenosha County, Wisconsin, *August 2007*.

[56]*SEWRPC Memorandum Report No. 159*, An Aquatic Plant Management Plan for Voltz Lake, Kenosha County, Wisconsin, *January 2005*.

known to cause severe recreational use problems in lakes within the Southeastern Wisconsin Region, and since EWM populations can displace native plant species and interfere with recreational use, the abundance of this species indicates the need to control its population. This further emphasizes the need to continue to actively employ a well thought out aquatic plant management effort.

The zebra mussel (*Dreissena polymorpha*) has been shown to affect lake water clarity. This nonnative species of shellfish rapidly colonizes nearly any clean, stable, flat underwater surface, artificial or natural, and this behavior has caused the zebra mussel to become a costly nuisance to humans as massive populations of the mollusk have clogged municipal water intake pipes and fouled underwater equipment. The animal also has been known to negatively impact native benthic organism populations, disrupting aquatic food chains by removing significant amounts of bacteria and smaller phytoplankton, which serve as food for a variety of other aquatic organisms, including larval and juvenile fishes and many forms of zooplankton. By removing desirable algal species from the water column, the competition for nutrients is reduced, which often can foster growth of undesirable filamentous algae and cyanobacteria which are not consumed by zebra mussels. Therefore, zebra mussels can cause desirable algae populations to decline and the abundance of undesirable algal species to concomitantly increase.

Figure 34

INVASIVE SPECIES IN HOOKER LAKE AND ITS WATERSHED

Zebra Mussel

Purple Loosestrife

Reed Canary Grass

Source: Wisconsin Department of Natural Resources, The Nature Conservancy and SEWRPC.

Table 15

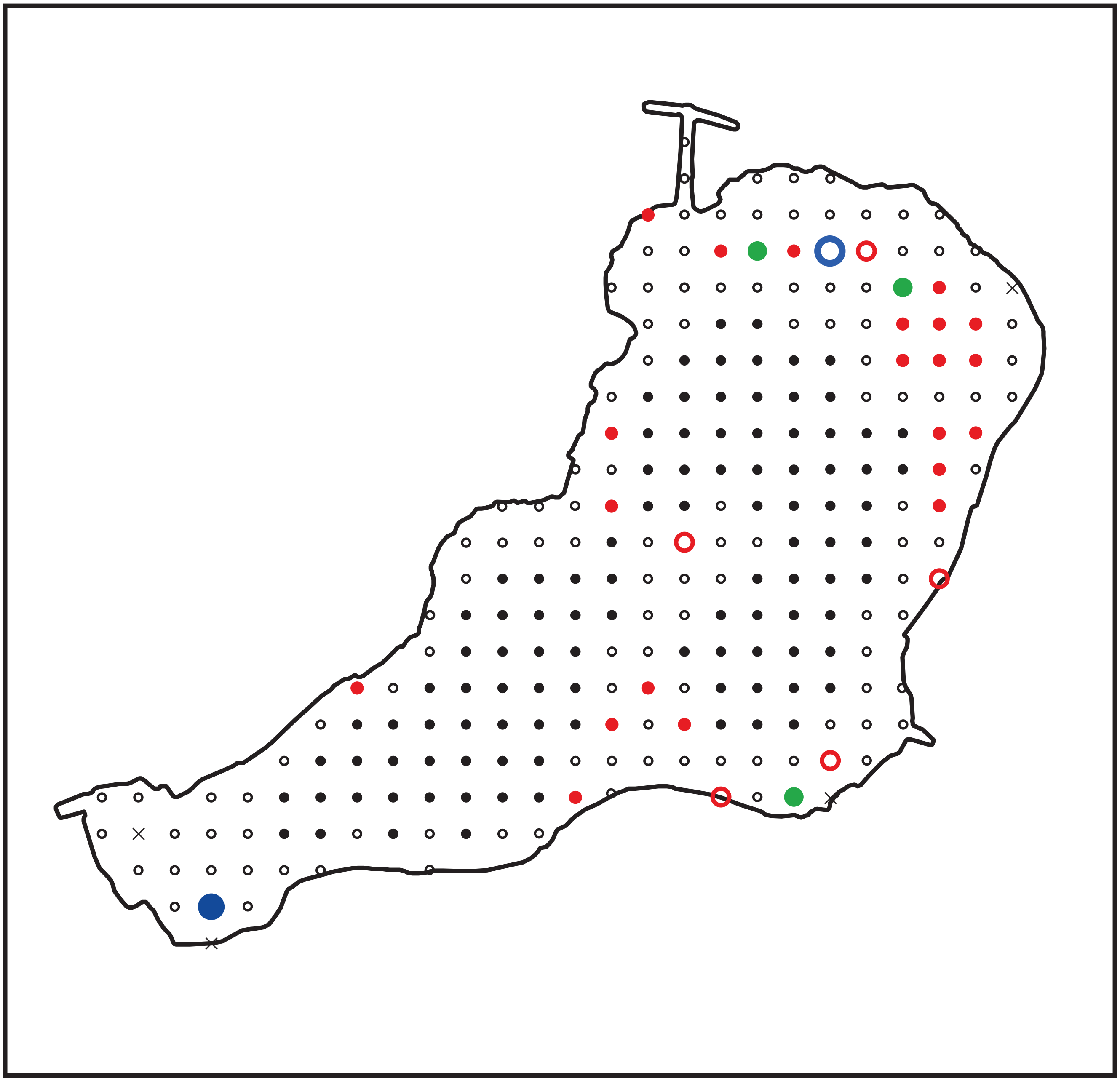
INDIVIDUAL SPECIES STATISTICS FOR KEY AQUATIC PLANT SPECIES IN HOOKER LAKE: 2008 AND 2014

Summary Statistics	EWM 2008	EWM 2014	Coontail 2008	Coontail 2014	Chara 2008	Chara 2014
Frequency of occurrence within vegetated area (percent)	21.50	19.70	23.10	61.40	46.20	31.50
Frequency of occurrence at sites shallower than maximum depth of plants	12.70	18.10	13.60	56.50	27.30	28.90
Relative Frequency (percent)	12.50	9.10	13.40	28.40	26.80	14.50
Relative Frequency (squared)	0.02	0.01	0.02	0.08	0.07	0.02
Number of sites where species found	14.00	25.00	15.00	78.00	30.00	40.00
Average rake fullness	1.00	1.20	2.00	1.80	1.00	2.20
Number of visual sightings	6.00	6.00	- -	2.00	2.00	1.00
Present (visual or collected)	present	present	present	present	present	present

Source: Aron and Associates and SEWRPC.

Map 19

EURASIAN WATER MILFOIL DISTRIBUTION IN HOOKER LAKE: 2014



RAKE FULLNESS RATING

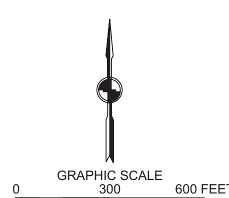
A LITTLE VISIBLE NEARBY

A LOT VISIBLE NEARBY

NO EURASIAN FOUND

TOO DEEP TO SAMPLE

NOT SAMPLED

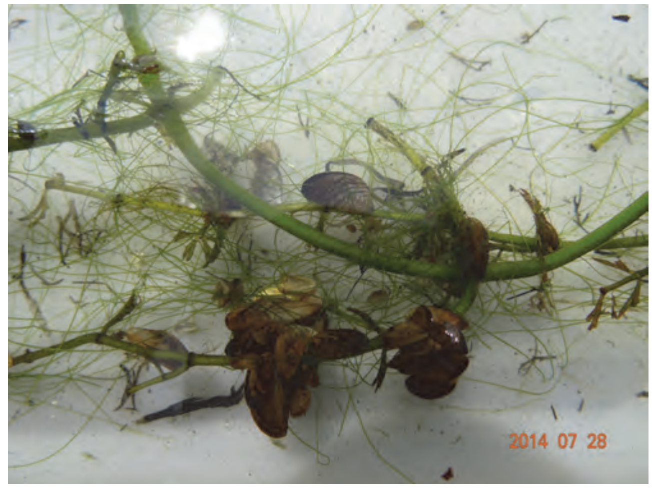


Source: SEWRPC.

As a result of the filter feeding proclivities of these animals, many lakes have experienced improved water clarity. Ironically, in some lakes, **improved water clarity has resulted in increased growth of rooted aquatic plants, including EWM. This may be what is being observed in Hooker Lake at the present time.** As described in the water quality discussion earlier in this report, water clarity in Hooker Lake has steadily improved since 2010. Hooker Lake residents reported the presence of zebra mussels since at least 2010, thereby lending support to the notion that increased clarity may be a reflection of the zebra mussel activity. Interestingly, aquatic plant survey data from 2014 indicates a substantial increase (nearly 100 percent) in the number of survey sites containing aquatic plants since the previous survey in 2008 as well as a substantial increase in the number of sites with EWM (see Table 15).

Figure 35

ZEBRA MUSSELS ATTACHED TO AQUATIC PLANTS DURING 2014 AQUATIC PLANTS SURVEY OF HOOKER LAKE



Source: SEWRPC.

A curious caveat to the interplay between zebra mussels, water clarity, EWM and native aquatic plants has been observed within the Southeastern Wisconsin Region. Zebra mussels have been noted to attach themselves to the stalks of the EWM plants (Figure 35). The weight of the attached mussels then acts as ballast, dragging the EWM stems deeper into the water column and below the zone of light penetration. This interferes with the competitive strategy of the EWM plants and in some cases has contributed to improved growth of beneficial native aquatic plants, while in other cases has led to nuisance growths of filamentous algae (which are too large to be ingested by the zebra mussels). Regardless of the seemingly beneficial impacts of these animals, the overall effect on a lake's aesthetics, ecology, and cost to lake uses are negative.

Zebra mussel abundance has been observed to fluctuate in Southeastern Wisconsin lakes over time. Populations have been noted to quickly build after introduction, peak, and then decline. It is not uncommon to note substantially reduced zebra mussel populations over periods of time of a year or more, a situation that correlates with the zebra mussels' life cycle (it lives for three to five years) and exhaustion of desirable food sources. However, once established in a lake, remaining zebra mussel populations can quickly re-establish a large year class of offspring when conditions improve, repopulating the lake to abundance levels similar to previous peak population densities.

Aquatic Plant Management Alternatives

Conflicting interests commonly occur when it comes to aquatic plant management, because pursuing one goal may interfere with the accomplishment of another. EWM eradication, for example, could be accomplished with heavy chemical treatment. However, given that EWM often coexists with native plants (including a very similar looking native milfoil plant), this technique would fail to accomplish the goal of conserving native plant populations. Consequently, the aquatic plant management alternatives described in this section take into consideration the sometimes conflicting goals of maintenance of access, control of EWM and other nonnative species, and protection of native species.

Aquatic plant management measures can be classified into five groups: 1) *physical measures*, which include lake-bottom coverings; 2) *biological measures*, which include the use of organisms, including herbivorous insects; 3) *manual measures*, which involve the manual removal of plants by individuals; 4) *mechanical measures*, which include simple cutting machines combined with hand-removal of cut plant material, harvesting with a machine that both cuts plants and collects the cuttings, or suction harvesting (described below); and 5) *chemical measures*, which include the use of aquatic herbicides to kill nuisance and nonnative aquatic plants. All of these control measures are stringently regulated. Additionally, most of the alternatives require a State of Wisconsin permit. Chemical controls, for example, require a permit and are regulated under Chapter NR 107 of the *Wisconsin Administrative Code*, while placement of bottom covers, a physical measure, requires a Wisconsin Department of Natural Resources (WDNR) permit under Chapter 30 of the *Wisconsin Statutes*. All other aquatic plant management practices are regulated under Chapter NR 109 of the *Wisconsin Administrative Code*.

The aquatic plant management elements presented in this section consider alternative management measures consistent with the provisions of Chapters NR 103, NR 107, and NR 109 of the *Wisconsin Administrative Code*. Further, the alternative aquatic plant management measures are consistent with the requirements of Chapter NR 7 of the *Wisconsin Administrative Code* and with the public recreational boating access requirements relating to eligibility under the State cost-share grant programs set forth in Chapter NR 1 of the *Wisconsin Administrative Code*.

Physical Measures

Lake-bottom covers and light screens provide limited control of rooted plants by creating a physical barrier that reduces or eliminates sunlight available to plants. They are often used to create swimming beaches on muddy shores, to improve the appearance of lakefront property, and to open channels for motorboats. Various materials can be used with varied success rates. For example, pea gravel, which is usually widely available and relatively inexpensive, is often used as a cover material despite the fact that plants readily recolonize areas where pea gravel is used. Other options include synthetic materials, such as polyethylene, polypropylene, fiberglass, and nylon, all of which can provide relief from rooted plants for several years. These synthetic materials, known as bottom screens or barriers, generally have to be placed and removed annually, as they are susceptible to disturbance by watercraft propellers and to the build-up of gasses from decaying plant biomass trapped under the barriers. In the case of Hooker Lake, the need to encourage native aquatic plant growth while simultaneously controlling the growth of exotic species, often in the same location, suggests that the placement of lake-bottom covers as a method to control for aquatic plant growth is not viable, as it is not consistent with the objective of encouraging native aquatic plant growth.

Biological Measures

Biological controls offer an alternative approach to controlling nuisance plants. Traditional biological control techniques use herbivorous insects to control nuisance plants and have been shown to be successful in some southeastern Wisconsin lakes.[57] However, given that heavy boat traffic is allowed on the Lake (a factor which often limits the efficacy of these programs), Hooker Lake would likely not be a valid candidate for this kind of project, specifically if *Eurhychiopsis lecontei*, an aquatic weevil species, is released for the purpose of controlling EWM. Thus, <u>the use of *Eurhychiopsis lecontei* as a means of aquatic plant management control is not considered a viable option for use on Hooker Lake.</u>

Manual Measures

Manual removal of specific types of vegetation provides a highly selective means of controlling the growth of nuisance aquatic plant species, including EWM. There are two common manual removal methods: raking and hand-pulling.

Raking is conducted in nearshore areas with specially designed rakes. This method provides an opportunity to remove nonnative plants in shallow nearshore areas and also provides a **safe and convenient method for controlling aquatic plants in deeper nearshore waters around piers and docks.** Advantages of using these rakes includes:

---

[57]*B. Moorman, "A Battle with Purple Loosestrife: A Beginner's Experience with Biological Control," Lake Line, Vol. 17, No. 3, September 1997, pp. 20-21, 34-3; see also, C.B. Huffacker, D.L. Dahlsen, D.H. Janzen, and G.G. Kennedy,* Insect Influences in the Regulation of Plant Population and Communities, *1984, pp. 659-696; and C.B. Huffacker and R.L. Rabb, editors,* Ecological Entomology, *John Wiley, New York, New York, USA.*

1) they are relatively inexpensive (costing between $100 and $150 each); 2) they are easy to use; 3) they produce immediate results; and 4) they immediately remove the plant material from a lake, thereby preventing nutrient release and sedimentation from decomposing plant material. Should Hooker Lake residents decide to implement this method of control, an interested party could acquire a number of these specially designed rakes for use by the riparian owners on a trial basis. Therefore, <u>to manage dense plant growth in areas where other control alternatives are not feasible, raking is considered a viable option.</u>

The second type of manual control—hand-pulling of stems where they occur in isolated stands—provides an alternative means of controlling plants such as EWM. **This method is particularly helpful when attempting to target nonnative plants in the high growth season, when native and nonnative species often coexist.** This method allows for higher selectivity than rakes, mechanical removal, and chemical treatments, and, therefore, results in less loss of native plants. Additionally, the physical removal of the plants also prevents sedimentation and nutrient release, which could help maintain water depths in the Lake and could incrementally help mitigate water quality concerns. Given these advantages, <u>manual removal of EWM through hand-pulling and removal from the Lake is considered a viable option in Hooker Lake where practical.</u> It could be employed by volunteers or homeowners, as long as they are trained to properly identify EWM. If hand removal of plants is contemplated within defined sensitive areas, a permit must be procured from the WDNR before any plants are removed.[58] The WDNR provides abundant guidance materials, including an instructional video, on the manual removal of plants.

Pursuant to Chapter NR 109 of the *Wisconsin Administrative Code*, **both raking and hand-pulling of aquatic plants in a 30 by 100 foot area (30 linear feet along the shoreline, including the "use" area, extending 100 feet out into a lake) is allowed without a WDNR permit, provided that the hand-pulled plant material is removed from the lake. Any other manual removal would require a State permit, unless employed to control designated nonnative invasive species,** such as EWM. In general, State permitting requirements for manual aquatic plant removal call for all hand-pulled material to be removed from the lake.

Mechanical Measures

Traditional Harvesting

Aquatic plants can be harvested mechanically with specialized equipment known as harvesters. This equipment consists of an apparatus that cuts up to a depth of five feet below the water surface and a collection system (e.g., a conveyor and a basket) that picks up the majority of the cut plants. Mechanical harvesting can be a practical and efficient means of controlling sedimentation, as well as plant growth, as it removes the plant biomass, which would otherwise decompose and release nutrients into a lake. Mechanical harvesting is particularly effective for large-scale plant growth problems.

An advantage of mechanical harvesting is that the harvester, when properly operated, typically **leaves enough plant material in a lake to provide shelter for aquatic wildlife and stabilize lake-bottom sediment, something that none of the other aquatic plant management methods accomplish.** Aquatic plant harvesting also has been shown to facilitate the growth of native aquatic plants by allowing light to penetrate to the lakebed. Finally, harvesting does not kill native plants in the way that other control methods do. Instead, this method simply trims them back.

A disadvantage of mechanical harvesting is that the harvesting operations may **fragment plants and, thus, unintentionally facilitate the spread of EWM,** which utilizes fragmentation as a means of propagation, particularly in areas where plant roots have been removed. This <u>further emphasizes the need to prevent harvesting that removes the roots of native plants.</u> Harvesting may also disturb bottom sediments in shallow areas, thereby increasing tur

[58]*Hand pulling of plants in sensitive areas is regulated under Wisconsin Administrative Code Chapter NR 109* Aquatic Plants: Introduction, Manual Removal and Mechanical Control Regulations, *March 2011.*

bidity and resulting in deleterious effects, including smothering fish breeding habitat and nesting sites. Disrupting lake-bottom sediments also could increase the risk of nonnative species recolonization, as these species tend to thrive under disturbed bottom conditions. To this end, **most WDNR-issued permits do not allow deep-cut harvesting in areas having a water depth of less than three feet,**[59] which would limit the utility of this alternative in some areas of Hooker Lake. Nevertheless, if done correctly and carefully and accomplished under suitable conditions, harvesting has been shown to be of benefit in maintaining navigation lanes and ultimately reducing the regrowth of nuisance plants while still maintaining native plant communities.

Another disadvantage of harvesting is that some cut **plant fragments can escape the collection system on the harvester.** This side effect occurs fairly frequently on lakes where harvesting is used. Generally, to compensate for this, most harvesting programs include a plant pickup program which includes using the harvester to pick up large amounts of floating plant material, as well as a program to pick up plants from lakefront property owners who have raked plant debris onto their docks. This kind of program, when completed systematically, can help alleviate the aesthetic consequences of plant debris which can accumulate on the lake shore.

Aquatic plant harvesters are commonly fairly large and are difficult to operate in shallow near shore areas containing numerous obstacles such as piers and rafts. However, smaller harvesters are now available, which make nearshore harvesting a practical option. These harvesters are designed to enable operation in shallow water, are shorter and narrower, and have stern mounted propulsion.[60] Small harvesters allow near-shore vegetation to be controlled, and are a practical alternative for Hooker Lake.

Given the costs of a harvesting program, residents of the HLMD would need to demonstrate a strong commitment to this approach of aquatic plant management. If the Lake community were willing to undergo the expense, <u>harvesting could be considered a viable option for Hooker Lake.</u> However, if this program is selected, <u>plant collection programs to prevent nuisance amounts of aquatic plant fragment accumulation and a training program for all operators must be employed.</u>[61]

Cutting

Smaller versions of weed harvesting machines (weed cutters) typically do not have means to retrieve plant cuttings from the water like larger harvesters. As a result, cut plants are generally left to be removed by hand raking – a labor intensive job. Although some cutters have been equipped with a basket arrangement to facilitate cut plant retrieval, the use of weed cutters is better suited to small areas in shallower water, such as around piers. Therefore, <u>weed cutters are not considered a viable option for Hooker Lake.</u>

Suction Harvesting

An emerging harvesting method called Diver Assisted Suction Harvesting (DASH) is now available in Wisconsin. First permitted in Wisconsin in 2014, DASH, also known as suction harvesting, is a mechanical process where divers identify and pull out aquatic plants by their roots at the bottom of the lake and then insert the entire plant into

[59]*Deep-cut harvesting is harvesting to a distance of only one foot from the lake bottom. This is not allowed in shallow areas because it is challenging to properly ensure that the harvester does not hit the lake bottom in these areas.*

[60]*An example of a small harvester is the Aquarius Systems FB-120 series skimmer/harvester. Reference to this product is not an endorsement, but rather gives the reader the ability to locate information to better envision such equipment.*

[61]*WDNR staff can host training sessions to ensure that all harvester operators are aware of the terms of a harvesting permit.*

a suction device which transports the plant to the surface for disposal. The process is essentially a more efficient method for hand-pulling plants. However, such a labor–intensive operation by skilled professional divers is, at present, a costly undertaking and long-term evaluations will need to take place to determine the efficacy of the technique. However, many technical advantages appear to be related to the method when performed in small, isolated spots, including: 1) **lower possibility of plant fragmentation** compared to harvesting and traditional hand-pulling, thereby reducing regrowth of invasive plants like EWM; 2) **increased selectivity of plant removal** compared to harvesting with a harvester, thereby reducing the loss of native plants, and 3) **lower frequency of fish habitat disturbances.** Despite these advantages, considering of the size of area needing treatment and the cost associated with this type of management, DASH is not presently considered a viable option for the HLMD to employ for large-scale application at Hooker Lake.

Even though DASH may not be a practical option for the HLMD to employ to control nuisance aquatic plants over large areas, it may be a convenient and practical method for individual landowners or groups of landowners to privately contract to control nuisance plants in critical areas. For example, this technique may be attractive to employ in portions of the Lake adjacent to their own piers and swimming areas. Although such work would be conducted at the landowners' expense, it may allow certain landowners to be more satisfied with the appearance and usability of their own Lake frontage.

Both mechanical harvesting and suction harvesting are regulated by WDNR and require a permit. Non-compliance with the permit requirements is legally enforceable with a fine or permit revocation. The information and recommendations provided in this report will help meet the requirements for these permits, which can be granted for up to a five-year period.[62] At the end of that period, a new plant management plan will need to be developed to determine the success of the management technique. This updated plan should be based on a new aquatic plant survey and should evaluate the harvesting activities that occurred in the Lake during the harvesting period.[63] Operation is overseen by the WDNR aquatic invasive species coordinator for the region.[64]

Chemical Measures

Use of chemical herbicides in aquatic environments is **stringently regulated and requires a WDNR permit and WDNR staff oversight during application.** Chemical treatment with herbicides is a short-term method for controlling heavy growths of nuisance aquatic plants. Chemicals are generally applied to growing plants in either liquid or granular form. Advantages of using chemical herbicides to control aquatic plant growth include relatively low cost, as well as the ease, speed, and convenience of application. The disadvantages associated with chemical control include:

1. **Unknown and/or conflicting evidence about long-term effects of chemicals on fish, fish food sources, and humans**—Chemicals approved by the U.S. Environmental Protection Agency to treat aquatic plants have been studied to rule out short-term negative (acute) effects on humans and wildlife. Additionally, some studies also determine the long-term negative (chronic) effects of the chemical on animals (e.g., the effects of being exposed to these herbicides for long periods of time). However, it is often impossible to conclu

[62]*Five-year permits are granted so that a consistent aquatic plant management plan can be implemented over that time. This process allows the aquatic plant management measures that are undertaken to be evaluated at the end of the permit cycle.*

[63]*Aquatic plant harvesters must report harvesting activities as a part of the permit requirements.*

[64]*Information on the current aquatic invasive species coordinator can be found on the WDNR website.*

sively state that there will be no a long-term effects due to the constraints of animal testing, time, and other issues. Additionally, long-term studies have not been completed on all of the potentially affected species[65] and there are conflicting studies/opinions regarding the role of the chemical 2,4-D as a carcinogen in humans.[66] Please see Appendix H for further facts on 2,4-D. For some lake property owners, the risk of using this chemical may, therefore, be considered too great, despite the legality of use. Consequently, the concerns of lakefront owners should be taken into consideration whenever chemicals are used. Additionally, if chemicals are used, they should be used as early in the season as possible to allow sufficient time for them to decompose before swimmers and other lake users actively utilize the lake in the summer.[67]

Figure 36

NUISANCE ALGAE IN HOOKER LAKE: 2015

Source: Hooker Lake Resident and SEWRPC.

2. **A risk of increased algal blooms due to the eradication of macrophyte competitors**—Nutrients in lake water promotes plant and algae growth. Generally, if rooted plants are not the primary user of nutrients, algae has a tendency to increase in abundance, decreasing water clarity. Therefore native plants must be preserved whenever and wherever pracitcal, and excessive use of chemicals must therefore be avoided; particularly if fish populations are to be maintained at a healthy level (fish require aquatic plants for food, shelter, and oxygen). Further details on this topic are discussed in the "Cyanoboctena and Floating Algae" section of this chapter. Residents reported that 2015 was a particularly bad year for algae in Hooker Lake with algal blooms and filamentous algae (see Figure 36) presenting many problems for boaters and others recreating on the Lake. In view of the decline in the number of aquatic plant species from 20 species observed in 2008 to only ten species observed in 2014, the abundance of algae in 2015 is not a particular surprise. A balance between the rooted plants and algae must be promoted. When one of the two declines, the other increases in abundance. This may be the case in Hooker Lake in 2015 when fewer rooted aquatic plants resulting in increased algal abundance. Subsequent surveys, observations, and analyses will be needed to evaluate this potential linkage.

3. **A potential increase in organic sediments, as well as associated anoxic conditions that can cause fish kills**—When chemicals are used on large mats of aquatic plants, the dead plant material generally settles to the bottom of a lake and subsequently decomposes. This process leads to an accumulation of sediment. Additionally, this process can also lead to a loss of oxygen in the deep areas of a lake as bacteria use oxygen to decompose plant remains (particularly in stratified lakes like Hooker Lake). Extensive loss of oxygen can create conditions that inhibit a lake's ability to support fish, causing fish kills. This process emphasizes the need to limit chemical control to early spring, when EWM has yet to form dense mats.

---

[65]*U.S. Environmental Protection Agency, EPA-738-F-05-002, 2*,4-D RED Facts, *June 2005.*

[66]*M.A. Ibrahim, et al., "Weight of the Evidence on the Human Carcinogenicity of 2,4-D*", Environmental Health Perspectives, *Vol. 96, December 1991, p. 213-222.*

[67]*Though the labels allow swimming in 2,4-D-treated lakes after 24 hours, it is possible that some swimmers may want more of a wait time to ensure that they receive less exposure to the chemical. Consequently, allowing for extra time is recommended so that residents and Lake users can feel comfortable that they are not being unduly exposed.*

4. **Adverse effects on desirable aquatic organisms due to loss of native species**—Native plants, such as pondweeds, provide food and spawning habitat for fish and other wildlife. Consequently, if native plants are unintentionally lost due to inappropriate chemical application, fish and wildlife populations often suffer. Additionally, native plants may be replaced by more aggressive non-native nuisance plants. It should be noted that navigational treatments for Eurasian water milfoil can greatly diminish white water crowfoot and bladderwort populations, and shoreline treatments for algae can eliminate muskgrass. Consequently, great care and prudence must be exercised when electing to apply aquatic herbicides. In general, other aquatic plant control measures have less long-term potential to harm native plant communities, and should therefore be favored over chemical measures. Nevertheless, <u>if chemical application is truly needed to combat aggressive nuisance populations of EWM, only chemicals that specifically target EWM should be used, and these should be applied in the early spring when native plants have not yet emerged.</u>

5. **A need for repeated treatments due to existing seed banks and/or plant fragments**—Chemical treatment is not a one-time solution. The fact that the plants are not specifically removed from the lake increases the possibility for seeds/fragments to remain in a lake after treatment, thereby allowing for a resurgence of the species. Additionally, leaving large areas void of plants (both native and invasive) creates an area of disturbance (i.e., an area without an established plant community) which tends to be where EMW thrives. In short, chemically treating large areas can sometimes leave opportunities for reinfestation. Consequently, <u>repeated chemical treatment would likely be needed.</u>

6. **Hybrid water milfoils resistance to chemical treatments**—Hybrid water milfoil complicates management since research suggests that certain strains may have higher tolerance to commonly utilized aquatic herbicides such as 2,4-D and Endothall. Subsequently, <u>further research on the efficacy and impacts of herbicides on hybrid water milfoil is needed to better understand appropriate dosing.</u>

Certain factors complicate application of chemicals to lakes, namely the coincidence of EWM with native species, the physical similarities between Northern (native) and EWM, and the presence of hybrid Eurasian water milfoil (HWM). However, **due to EWM's tendency to grow very early in the season, early spring chemical treatment is an effective way to target the non-native plant while minimizing impact on native plants.** Early spring treatments have the advantage of being more effective due to the colder water temperatures, which enhance the herbicidal effects and reduce the concentrations needed. As discussed above, early spring treatment also reduces human exposure (swimming is not particularly popular in very early spring) and limit the potential for collateral damage to native species.

Another factor to consider is the way a lake has reacted to chemicals that were applied previously (see Table 16). Chemical controls have been documented since 1979 and have been fairly consistent for macrophyte treatment since 1990. Although there are no obvious correlations between aquatic plant surveys and chemical treatment applications, chemical treatment is likely a significant factor in the changes seen between 2008 and 2014 aquatic plant surveys.

According to WDNR staff, if chemicals are used to control EWM, <u>low volumes of chemicals should be used over the entire Lake in the *early spring*</u> (i.e., a whole lake treatment). <u>Spot treatments</u> are known to be less effective and more detrimental to native plant communities. However, the WDNR generally will not approve whole-lake chemical herbicide treatments without evidence of a significant infestation of EWM. To document the degree of infestation, a recent comprehensive, complete point-intercept survey is required and EWM amounts, as measured at each sampling site by rake fullness, need to average between two and three on the rake fullness scale (see Appendix F for schematic of rake fullness) in 35 to 75 percent of vegetated sampling sites.[68] The WDNR will also likely require

[68] *As per personal communication with Craig Helker and Heidi Bunk, WDNR.*

Table 16

HISTORICAL CHEMICAL TREATMENT ON HOOKER LAKE

Year	Algae Control			Macrophyte Control					
	Cutrine Plus (gallons)	Copper Sulfate (pounds)	Copper Ethanolamine (gallons)	2,4-D (gallons)	AM40-Amine Salt (gallons)	Diquat (gallons)	Habitat (Pints)	Triclopyr (quarts)	Endothall/ Aquathol (gallons)
1979	- -	- -	- -	35.0	- -	- -	- -	- -	- -
1990	6.0	- -	- -	37.0	- -	- -	- -	- -	- -
1992	12.5	- -	- -	40.0	- -	8.0	- -	- -	5.0
1993	- -	- -	- -	10.0	- -	- -	- -	- -	- -
1994	- -	- -	- -	82.5	- -	- -	- -	- -	- -
1995	- -	- -	- -	71.5	- -	- -	- -	- -	- -
1996	- -	- -	- -	45.0	- -	- -	- -	- -	- -
1997	- -	- -	- -	500 lbs.	- -	- -	- -	- -	- -
1998	- -	- -	- -	12.0 + 1,200 lbs.	- -	- -	- -	- -	- -
1999	- -	- -	- -	1,200 lbs.	- -	- -	- -	- -	- -
2000	- -	- -	- -	156.0	- -	- -	- -	- -	- -
2002	- -	- -	- -	781 lbs.	- -	- -	- -	- -	- -
2003	- -	- -	- -	515 lbs.	- -	- -	- -	- -	- -
2004	- -	- -	- -	1,600 lbs.	- -	- -	- -	- -	- -
2005	- -	- -	- -	650 lbs.	- -	- -	- -	- -	- -
2006	- -	- -	- -	910 lbs.	- -	- -	- -	- -	- -
2007	- -	- -	- -	1,115 lbs.	- -	- -	- -	- -	- -
2008	- -	5	- -	500 + 215 lbs.	- -	- -	- -	- -	- -
2011	- -	- -	- -	- -	49.5 +3	- -	1	- -	38 lbs.
2013	- -	- -	- -	259.5	- -	- -	- -	- -	1.5
2014	- -	- -	- -	180.5	- -	0.14	- -	0.28	120
2015	- -	- -	1	- -	- -	0.89	- -	3.56	- -
Total	18.5	5	1	917, 9,198 lbs.	52.5	9.03	1	3.84	126.5, 38 lbs.

NOTE: Gallons represent liquid forms of chemical; pounds represent granular forms.

Source: Wisconsin Department of Natural Resources and SEWRPC.

a treatment efficacy test to evaluate dosage and the sensitivity of the target plants to the proposed chemical mix. The 2014 point-intercept survey of Hooker Lake (the most recent available) found EWM at about 20 percent of the vegetated sampling sites and had a rake fullness average of 1.2 (see Table 15). Considering that the EWM population in Hooker Lake does not appear to satisfy the WDNR abundance requirements for whole-lake treatments, the apparent fragile nature of the native plant population in Hooker Lake, the lack of success of EWM spot treatments, and the probable need of a chemical efficacy test, a whole-lake chemical treatment for EWM does not appear to be a viable option in the immediate future.

Other Aquatic Plant Management Issues of Concern

The recommendations in this section call for monitoring and controlling aquatic plants that already grow in the Lake. However, many other activities contribute to *inhibiting or preventing* nuisance aquatic plant growth in the Lake (which helps avoid the adverse effects that result from many in-lake control alternatives). A number of factors create a lake environment conducive to "excessive" plant growth, both in terms of EWM and native plants. For example, poor water quality with high phosphorous content (which can be caused by polluted surface water runoff entering the Lake) provides the building blocks that all plants need to thrive and eventually reach what is perceived as a nuisance level. Consequently, implementing recommendations to improve water quality should to be an integral part of any comprehensive aquatic plant management plan. This is why many of the issues of concern discussed in the Water Quality section of this chapter are also considered priorities and why recommendations related to these factors are included in Chapter III of this report.

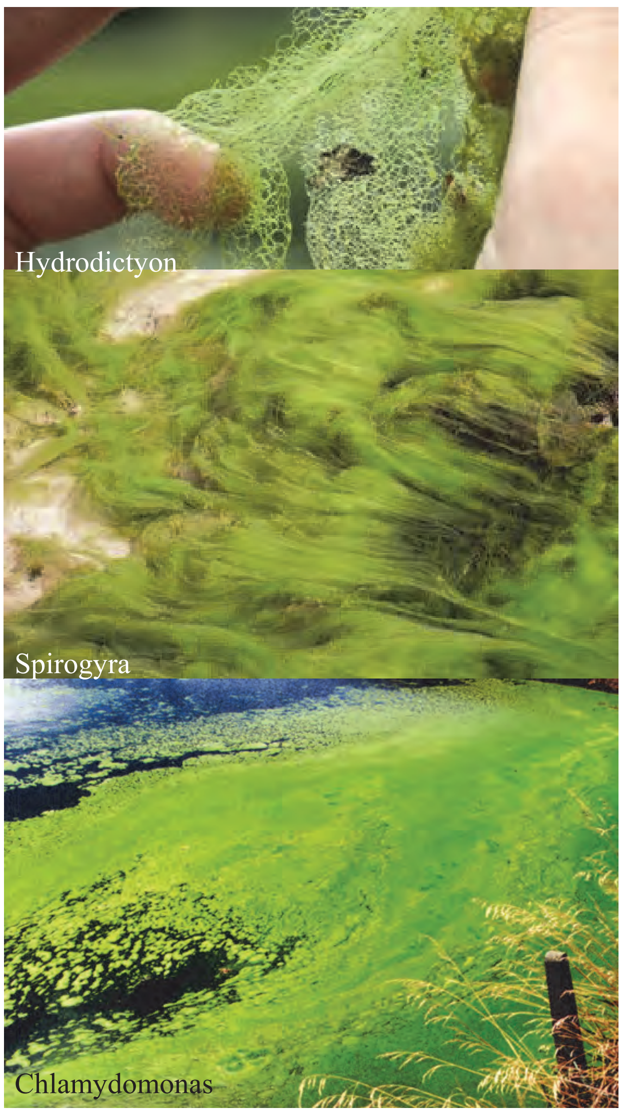
ISSUE 5: CYANOBACTERIA AND FLOATING ALGAE

Cyanobacteria and floating algae are ongoing issues of concern for Hooker Lake residents and users because periodic, relatively minor algal blooms have occurred in the spring and summer. As was discussed in earlier sections, Lake residents report that 2015 was a particularly bad year for algae in Hooker Lake with algae blooms and filamentous algae presenting many problems for boaters and others engaged in recreation on the Lake (Figure 36).

Before discussing excessive algae growth and management, it is important to note that the presence of **algae is generally a healthy component of any aquatic ecosystem.** Algae are primary building blocks of a lake food chain, and it can produce oxygen in the same way as rooted plants. Many forms of algae exist, from filamentous algae to cyanobacteria (formerly blue-green algae; see Figure 37). The majority of algae strains are beneficial to lakes in moderation. However, the presence of toxic strains (see Figure 38) as well as excessive growth patterns should be considered an issue of concern. As with aquatic plants, algae generally grow at faster rates in the presence of abundant dissolved phosphorus (particular-

Figure 37

DIFFERENT TYPES OF NON-TOXIC ALGAE



Source: Lewis Lab, University of New Mexico, and Landcare Research.

Figure 38

EXAMPLES OF TOXIC ALGAE

Source: National Oceanic and Atomspheric Administration and St. John's River Water Management District.

ly in stagnant areas). Consequently, when toxic or high volumes of algae begin to grow in a lake, it often indicates a problem with phosphorus enrichment/pollution.

In general, **the most permanent methods for preventing excessive and toxic algae growth are:**

1. **Manage water quality with a focus on phosphorus reduction**—Phosphorus pollution is often the cause of excessive algal growth. Consequently, the water quality recommendations discussed in Chapter III should be implemented.

2. **Maintain a healthy, diverse and active native aquatic plant community**—As mentioned in the "Aquatic Plant Growth" section of this chapter, maintaining a diverse, healthy, robust native plant community is tied to prevention of excessive algal blooms because aquatic plants and algae directly compete for phosphorus which inhibits either from dominating the lake. Consequently, careful implementation of the Aquatic Plant Management recommendations provided in Chapter III and communicating this nutrient-algae/plant growth relationship to residents (to encourage conservative hand-pulling of rooted vegetation) should be considered a priority.

In addition to these approaches, in-lake measures and manual removal methods could also be implemented including:

1. **Alum treatments** involve spreading a chemical (alum: hydrated potassium aluminum sulfate) over the surface of the lake. This chemical precipitates as a solid and carries algae and other solids to the bottom of the lake. Alum treatments can reduce phosphorus concentrations in the water column inhibiting regrowth of excess plants or algae. Nevertheless, this is a temporary solution and is often cost prohibitive. However, if algae become excessive, this method could be considered.

2. **Aeration** involves pumping air to a diffuser on the bottom of a lake that creates a rising column of small air bubbles. The rising bubbles create an upwelling current of lake water which circulates the water, preventing stratification and the accompanying anoxic conditions in deep water areas. This prevents internal loading (i.e., the release of phosphorus from deep sediments under anoxic conditions) and reduces the occurrence of algae blooms during the mixing (turnover) periods. This method is only necessary if internal loading is excessive. If poorly executed, aeration can exacerbate algal blooms.

3. **Manual removal**—Manual removal of algae using a suction device has recently been tested within the Region. This measure, though legal, is currently in the early stages of application. Additionally, "skimming" of algae has been tried by lake managers with little success. Consequently, it would be necessary to further investigate these kinds of measures prior to implementation.

All of the above measures are generally only implemented when algal blooms become so serious and long lasting that recreational use is impaired. This is often because each method is only temporarily effective, and repeated implementation of these measures can be cost prohibitive. Since Hooker Lake has had only relatively minor issues with algal blooms in the past, these methods are not recommended at this time. <u>The more permanent methods of algal control discussed above (i.e., pollution control and plant community maintenance) are considered most viable for Hooker Lake.</u>

As a final note about algae, though management for algae prevention is crucial, it may also be advantageous to actively monitor algae. Two primary methods are typically used to monitor algae levels. The first is to collect chlorophyll-*a* measurements, which quantify the concentration of suspended algae levels in the water column (i.e., the green color in water). The second is to collect algae samples to determine whether the algae species actually present are non-toxic. Neither of these monitoring efforts has occurred on Hooker Lake; however, if blooms become excessive and/or very common, monitoring should be considered.

ISSUE 6: RECREATIONAL USE AND FACILITIES

Essentially all Lake residents and users want to ensure that Hooker Lake continues to support conditions favoring recreation and, relatedly, property value. Therefore, maintaining or enhancing the Lake's ability to sustain recreational use is a primary driving force behind essentially all issues of concern. Many of the topics discussed in this report (e.g., aquatic plants, water quality, algal blooms, water quantity, and wildlife) are related because each one can affect various recreational uses.

Table 17

RECREATIONAL WATER CRAFT DOCKED ON HOOKER LAKE: Wednesday, July 30, 2014

Category	Observation	Docked Boats
Type of Watercraft	Power/ski boat	23
	Pontoon boat	27
	Fishing boat	10
	Personal watercraft	9
	Kayak	10
	Canoe	12
	Rowboat	14
	Sailboat	0
	Wind board/paddle board	2
	Paddleboat (pedalboat)	12
	Rafts	4
Total		123

Source: SEWRPC.

Boating

SEWRPC staff counted the number and type of watercraft docked on Hooker Lake during July 2014 (Table 17) and counted boats on the water during 2012 (Tables 18 and 19). These numbers provide insight into the intensity of watercraft use as well as the type of activities in which watercraft engage. From the 2012 data, it appears that weekday boat traffic is quite limited. The maximum number of boats on the water occurred during late morning and evenings, when four boats were counted. In contrast, many more boats were found to be actively in use on the Lake during weekends, when up to seven boats were on the water. Fishing was far and away the most popular boat use during weekdays, particularly throughout the morning and early afternoon. During weekends, fishing remains the most popular boating activity through mid-morning, but cruising/water skiing are more popular than fishing later in the day. Very little other boating activity was noted on Hooker Lake.

The type and intensity of boating taking place varies by the day of the week, time of day, season, and prevailing weather conditions. According to a statewide survey that subdivided results by region,[69] boaters in Southeastern Wisconsin took to the water in the greatest numbers during July, with slightly lower numbers of boaters found on the water during June and August (Table 20). These three months account for approximately two-thirds of the total number of boater-days logged in the Region for the entire year. About three to four times as many boaters use their boats on weekends than weekdays (Table 21). The weekday/weekend statistics compares favorably with SEWRPC 2012 Hooker Lake boat counts.

Fishing was by far the most popular activity in Southeastern Wisconsin in both spring and fall, and remains a leading reason for boat use throughout the summer (Table 20). Again, the data produced by the Commission's 2012 boat count corresponds quite well with regional averages, suggesting that Hooker Lake's boating activity is fairly represented by regional averages. The typical boat used on inland lakes in Southeastern Wisconsin is an open hulled vessel measuring approximately 18 feet long powered by a motor producing approximately 90 horsepower (Tables 22 and 23). Sailboats comprise approximately 24 percent of boat traffic (15 percent non-powered and 9 percent non-powered), while other nonpowered boats comprise only two percent of boats found on waterbodies in the region.

---

[69]*Penaloza, Linda J., "Boating Pressure on Wisconsin's Lakes and Rivers, Results of the 1989-1990 Wisconsin Recreational Boating Study, Phase 1,"Wisconsin Department of Natural Resources Technical Bulletin 174, 1991.*

Table 18

ACTIVE RECREATIONAL WATERCRAFT AND RELATED ACTIVITIES ON HOOKER LAKE—WEEKDAYS: SUMMER 2012

Category	Observation	Time and Date											
		6:00 to 8:00 a.m.		8:00 to 10:00 a.m.	10:00 a.m. to Noon			Noon to 2:00 p.m.		2:00 to 4:00 p.m.		4:00 to 6:00 p.m.	
		Wednesday June 20	Thursday June 28	Thursday June 21	Tuesday June 19	Tuesday June 26	Wednesday July 27	Friday July 27	Thursday August 30	Tuesday June 26	Wednesday June 27	Friday July 31	Wednesday August 15
Type of Watercraft (number in use)	Power/ski boat	0	0	0	0	0	1	0	0	1	1	1	1
	Pontoon boat	0	0	0	0	0	0	0	0	0	0	0	0
	Fishing boat	1	1	2	2	4	2	1	0	2	0	0	2
	Personal watercraft	0	0	0	0	0	0	0	0	0	0	0	0
	Kayak/canoe	0	0	0	0	0	0	0	0	0	0	0	1
	Rowboat	0	0	0	0	0	0	0	0	0	0	0	0
	Sailboat	0	0	0	0	0	0	0	0	0	0	0	0
	Wind board/paddle board	0	0	0	0	0	0	0	0	0	0	0	0
	Paddleboat (pedalboat)	0	0	0	0	0	0	0	0	0	0	0	0
	Other	0	0	0	0	0	0	0	0	0	0	0	0
Activity of Watercraft (number engaged)	Motorized cruise/pleasure												
	Low speed	0	0	0	0	0	0	0	0	0	0	0	0
	High speed	0	0	0	0	0	0	0	0	0	0	0	0
	Fishing	1	1	2	2	4	2	1	0	2	0	0	2
	Skiing/tubing	0	0	0	0	0	1	0	0	1	1	1	1
	Sailing/windsurfing	0	0	0	0	0	0	0	0	0	0	0	0
	Rowing/paddling/pedaling	0	0	0	0	0	0	0	0	0	0	0	1
	Other	0	0	0	0	0	0	0	0	0	0	0	0
Total	On water	1	1	2	2	4	3	1	0	3	1	1	4
	In high-speed use	0	0	0	0	0	1	0	0	1	1	1	1

NOTE: Shaded columns denotes local no-wake ordinance in effect from 6:00 p.m. to 10:00 a.m. on Hooker Lake.

Source: SEWRPC.

Table 19

ACTIVE RECREATIONAL WATERCRAFT AND RELATED ACTIVITIES ON HOOKER LAKE—WEEKENDS: SUMMER 2012

Category	Observation	Time and Date							
		6:00 to 8:00 a.m.	8:00 to 10:00 a.m.	10:00 a.m. to Noon	Noon to 2:00 p.m.			2:00 to 4:00 p.m.	4:00 to 6:00 p.m.
		Saturday July 21	Saturday August 11	Saturday August 25	Sunday August 19	Saturday August 25	Labor Day September 3	Saturday July 21	Saturday August 11
Type of Watercraft (number in use)	Power/ski boat	0	0	2	1	3	1	3	2
	Pontoon boat	0	0	1	1	3	1	2	2
	Fishing boat	4	6	2	0	0	1	2	1
	Personal watercraft	0	0	0	0	0	0	0	0
	Kayak/canoe	0	0	0	0	0	0	0	0
	Rowboat	0	0	0	0	0	0	0	0
	Sailboat	0	0	0	0	0	0	0	0
	Wind board/paddle board	0	0	1	0	0	0	0	0
	Paddleboat (pedalboat)	0	0	0	0	0	0	0	0
	Other	0	0	0	0	0	0	0	0
Activity of Watercraft (number engaged)	Motorized cruise/pleasure								
	Low speed	0	0	1	1	3	0	2	1
	High speed	0	0	0	0	0	1	0	1
	Fishing	4	6	1	0	0	1	2	2
	Skiing/tubing	0	0	2	0	3	0	3	1
	Sailing/windsurfing	0	0	0	0	0	0	0	0
	Rowing/paddling/pedaling	0	0	1	0	0	0	0	0
	Other	0	0	1	1	0	1	0	0
Total	On water	4	6	6	2	6	3	7	5
	In high-speed use	0	0	2	0	3	1	3	2

NOTE: Shaded columns denotes local no-wake ordinance in effect from 6:00 p.m. to 10:00 a.m. on Hooker Lake.

Source: SEWRPC.

Table 20

BOATING ACTIVITY IN SOUTHEASTERN WISCONSIN BY MONTH: 1989-1990

Activity	Percent Respondents Participating[a]						
	April	May	Jun	July	August	September	October
Fishing	68	57	49	41	44	42	49
Cruising	29	39	42	46	46	47	43
Water Skiing	3	9	20	27	19	16	8
Swimming	2	4	18	31	25	19	5
Average boating party size: 3.4 people							

[a]Repondents may have participated in more than one activity.

Source: Wisconsin Department of Natural Resources.

Table 21

DAILY DISTRIBUTION OF BOATING IN SOUTHEASTERN WISCONSIN BY MONTH: 1989-1990

Day of the Week	Percent Respondents Participating[a]
Sunday	46
Monday	16
Tuesday	14
Wednesday	16
Thursday	13
Friday	17
Saturday	46

[a]Repondents may have participated in more than one day.

Source: Wisconsin Department of Natural Resources.

Table 22

HULL TYPES IN SOUTHEASTERN WISCONSIN BY MONTH: 1989-1990

Day of the Week	Percent Respondents Participating[a]
Open	68
Cabin	17
Pontoon	9
Other	6
Average length: 18.4 ft Average beam width: 6.4 ft	

[a]Repondents may have participated in more than one day.

Source: Wisconsin Department of Natural Resources.

Only a few respondents to the WDNR boating survey felt that excessive boat traffic was present on Southeastern Wisconsin lakes.[70] Studies completed in Michigan attempt to quantify desirable levels of boat traffic on an array of lakes used for a variety of purposes. This study concluded that **10 to 15 acres of useable lake area**[71] **provides a reasonable and conservative average maximum desirable boating density,** and covers a wide variety of boat types, recreational uses, and lake characteristics.[72] **Use rates above this threshold are considered to negatively influence public safety, environmental conditions, and the ability of a lake to host a variety of recreational pursuits.** High-speed watercraft require more space, necessitating boat densities less than the low end of the range. The suggested density for a particular lake is:

Minimum desirable acreage per boat = 10 acres + (5 acres x (high-speed boat count/total boat count))

---

[70]*Ibid.*

[71]*"Useable lake area" is the size of the open water area that is at least 100 feet from the shoreline. However, local ordinances require slow/no-wake operation within 200 feet of the shoreline, further reducing useable lake area.*

[72]*Progressive AE, "Four Township Recreational Carrying Capacity Study, Pine Lake, Upper Crooked Lake, Gull Lake, Sherman Lake", Study prepared for Four Township Water Resources Council, Inc. and the Townships of Prairieville, Barry, Richland, and Ross, May 2001.*

Table 23

PROPULSION TYPES IN SOUTHEASTERN WISCONSIN BY MONTH: 1989-1990

Day of the Week	Percent Respondents Participating[a]
Outboard	53
Inboard/outboard	14
Inboard	6
Other (powered)	1
Sail	15
Sail with power	9
Other (nonpowered)	2
Average horse power: 86.5	

[a]*Repondents may have participated in more than one day.*

Source: Wisconsin Department of Natural Resources.

The 2012 SEWRPC boat count demonstrates that highest boat use occurs during weekends. Most boats in use during peak periods were capable of high-speed operation; however, less than half were actually being operated at high speed. If one assumes that half of the boats could potentially be operating at high speed during the day, the formula presented above suggests that 12.5 or more acres of useable open water should be available per boat. Given that roughly 60 useable acres are available for boating on Hooker Lake (using a 200 foot slow no wake shore zone), no more than four boats should be present on the lake at any one time to avoid use problems. If the more liberal 100 foot standard is used, the useable lake area increases to 80 acres, suggesting that no more than six boats should be on the lake at any one time to avoid use problems. During weekdays, the density of boats actually observed on Hooker Lake does not exceed suggested maximum boat densities. However, boat density appears to slightly exceed maximum densities during heavy use periods (weekends and holidays). This means that **the potential for use conflicts, safety concerns, and environmental degradation is slightly higher than desirable on Hooker Lake during peak use periods.** To help mitigate this concern, boating ordinances and regulations should be reviewed, and if necessary, modified. Such ordinances and regulations should be conscientiously enforced to help reduce the potential for problems related to boat overcrowding during periods of peak boat traffic. Additional details regarding this recommendation are presented in Chapter III.

One-hundred twenty-three watercraft were observed moored or on the shore around the Lake on July 30, 2014 (Table 17). Over half of all docked or moored boats were motorized, with fishing boats and pontoon boats comprising just over half the motorized boat total. Paddleboats and canoes are the most popular types of non-motorized watercraft. The total number of boats present around the Lake suggests that between two and six boats will be in active use on the Lake during peak use periods.[73]

Three boat launches provide public boating access to Hooker Lake. A paved single single-lane boat ramp operated by the Village of Paddock Lake is located at the extreme north end of the Lake. The boat launch is accessed by 78th Street. Dedicated parking for 6 to 10 vehicle/trailer combinations is available, handicap-accessible features and a boarding pier are available at this site, and portable restroom facilities are present. The Town of Salem operates the other two boat launches. A single-lane gravel boat launch is found on the east side of Hooker Lake at the terminus of 80th Street. This launch does not include dedicated parking or other supporting facilities. The other Town of Salem boat launch is found on the extreme west end of the Lake at the terminus of 83rd Street. Little additional information is presently available regarding this boat launch; however, aerial photographs suggest that it is a single lane gravel ramp with no supporting facilities.

The Village of Paddock Lake charges a fee to park at the Village boat launch between May 1 and October 31. A seasonal pass can be purchased for $35.00 (Wisconsin resident)/$40.00 (non-resident), or a daily parking pass may be purchased for $7.00. A seasonal pass allowing parking at both the Paddock Lake and Hooker Lake boat launches is available for $45.00 (Wisconsin resident)/$55.00 (non-resident). The Town of Salem does not charge a fee for use of its boat launches.

---

[73]*At any given time it is estimated that between about 2 percent and 5 percent of the total number of watercraft docked and moored will be active on the Lake.*

Given what is known about the Village of Paddock Lake launch site, **boat launch facilities and daily fees appear to conform to the minimum requirements set forth in Chapter NR 1 of the *Wisconsin Administrative Code*.** Compliance with this section is important, since certain grant and assistance funding is predicated by compliance with Chapter NR 1. It appears that daily launch fees could be increased by at least $1.00.[74] Launch fees can influence the intensity of use of the launch facility, and can be considered as part of a program to help avoid excess boat densities on the Lake. This is discussed in more detail in Chapter III.

Other Recreational Pursuits

Hooker Lake supports, or has the potential to support, a wide range of recreation beyond boating. The Lake is generally supportive of all common lake-based recreational activities. However, as pointed out in previous sections, some activities could be more fully realized through focused management. Some of the recreational activities supported by Hooker Lake are wholly reliant upon the presence of the Lake and shoreline areas. These activities include (but are not limited to) swimming, ice and open-water fishing (see "Issue 7: Fish and Wildlife" below for more detail regarding fish populations), ice skating, winter motorsports upon the ice, waterfowl hunting, and trapping. Local aesthetic appeal, property value, and many other recreational activities (e.g., nature study, bird and wildlife viewing, hunting, general outdoor relaxation) benefit from the presence of the Lake. While many recreational activities are relatively passive, intense active use (e.g., excessively heavy fishing pressure, motorsport racing on the ice, high speed boating) and/or out-of-place use (e.g., swimming in high-speed boating areas, high-speed boating near shorelines or shallow areas) can create use conflicts and compromise the overall recreational value of the Lake. The Village of Paddock Lake and the Town of Salem developed ordinances and regulations to regulate such issues (see Appendix I for copies of the lake use ordinances). <u>Relevant ordinances should be reviewed on a regular basis, amended to address current concerns, and conscientiously enforced.</u>

Hooker Lake's non-boating recreational benefits extend beyond the riparian community. The three boat launches provide access to the Lake. No swimming and very little practical access to shoreline fishing is available given the Lake's configuration and the locations of the boat launches. The State of Wisconsin owns approximately 42 acres of the marshland area located along the Lake's northwestern shoreline. This parcel is named the Hooker Lake Marsh Fishery Area. Its presence helps assure that the sensitive, large, and vital habitat area is protected into perpetuity. Hooker Lake Marsh Fishery Area abuts nearly 150 acres of publically-owned school property. Much of the school property remains undeveloped wetland and woodland. This property could be stewarded to protect natural resource functions that benefit the Lake, the adjacent state land, and which can serve as a vital component to conservation efforts. <u>The combined publically owned natural areas constitute the largest expanse and most diverse habitat area in the entire Hooker Lake watershed and form an ideal long-term conservation opportunity.</u>

ISSUE 7: SHORELINE MAINTENANCE

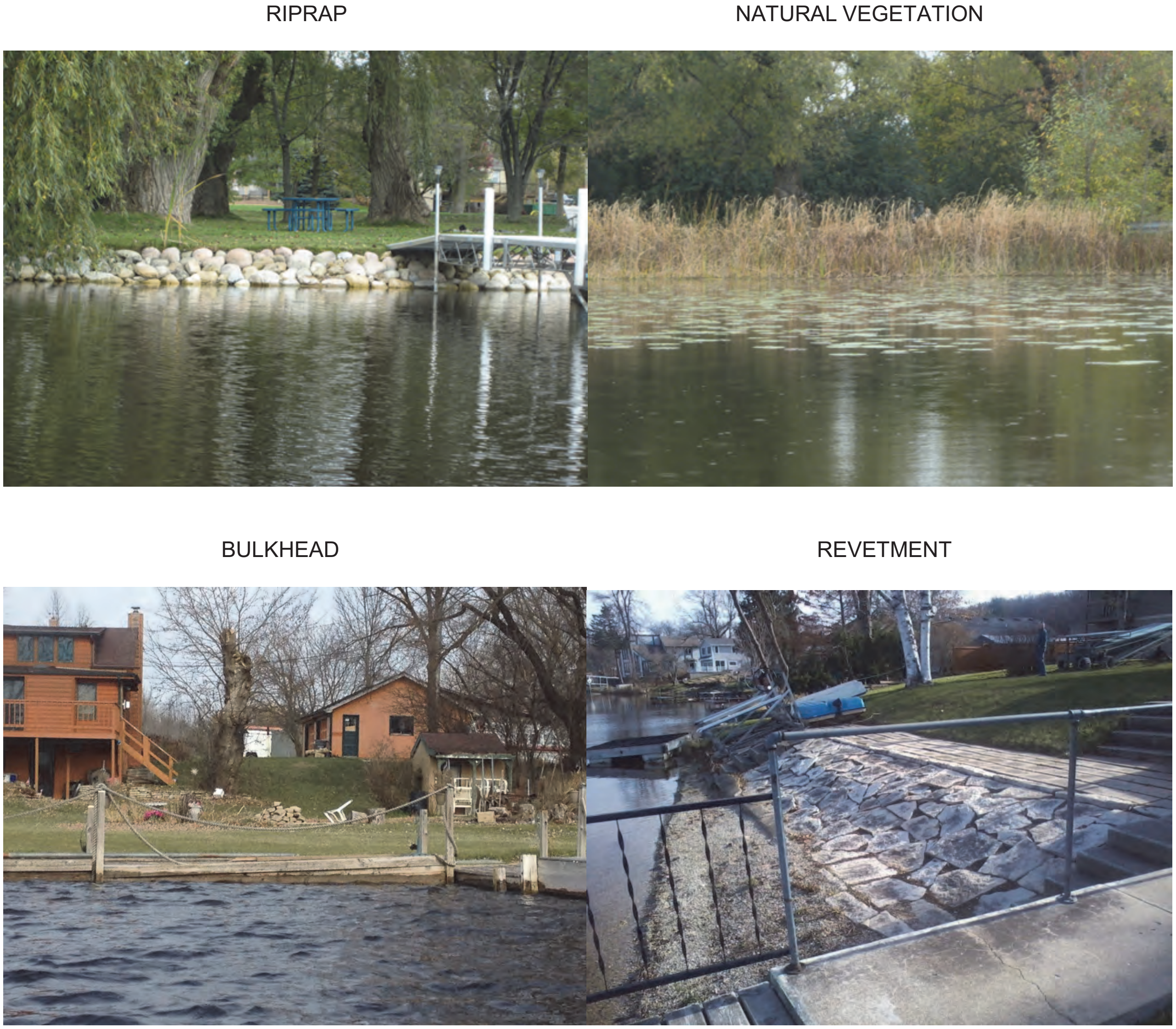
Many Hooker Lake shoreline property owners are concerned about maintaining the Lake's shorelines and the recreational and aesthetic use/appeal of the Lake without jeopardizing its health. This issue of concern is further emphasized by the fact that water quality, sedimentation, and aquatic plant growth can all be affected by shoreline maintenance practices.

---

[74]*NR 1.91(11)a encourages free boat launching but allows a maximum one-day base fee equivalent to the one-day fee for residents to enter state parks ($8.00 at the time of this report). NR1.91(11)b allows additional surcharges based upon the presence of an attendant (20 percent base fee surcharge), the size of boats served (30 percent base fee surcharge for boats between 20 and 26 feet in length and 60 percent base fee surcharge for boats greater than 26 feet in length), and the presence of on-site toilet facilities (20 percent base fee surcharge).*

Figure 39

TYPICAL SHORELINE PROTECTION TECHNIQUES



Source: SEWRPC.

Before discussing shoreline maintenance in Hooker Lake, it is important to understand the difference between two terms: *shoreline protection and buffers. Shoreline protection* encompasses those various measures—artificial or natural—that shield the immediate shoreline (water-land interface) against the erosive forces of wave action; buffers are those areas of plant growth—human-induced or natural—in the riparian zone (lands immediately back from the shoreline) that trap sediment and nutrients emanating from upland and nearshore erosion (buffers were described in detail earlier in this report).

When it comes to shoreline protection, several options exist for home owners. These options (see Figure 39), include: "bulkheads," where a solid, *vertical* wall of some material, such as poured concrete, steel, or timber, is erected; "revetments," where a solid, *sloping* wall, usually asphalt, as in the case of a roadway, or poured concrete, is used; and "riprap," where loose stone material is placed along the shoreline. All of the structures listed above require permits from WDNR.

It must be emphasized that **shoreline protection does not always need to rely on construction of engineered structures.** Many different kinds of natural shorelines offer substantial protection against erosive forces. The rock boulders and cliffs found along Lake Superior, for example, are natural barriers that serve to protect against shoreline erosion. Additionally, marshlands, such as those found in Hooker Lake Marsh and in the WDNR Sensitive Area at the southeast end of Hooker Lake, and areas of exposed cattail stalks and lily pads, such as those found around the Lake's shoreline, are effective mitigators of shoreline erosive forces, as the exposed plant stalks act to disperse and dampen waves by dissipating energy. (See the "Aquatic vegetative buffers" section earlier in this report.)

"Hard" artificially armored shoreline constructed of stone, riprap, concrete, timbers, and steel, once considered "state-of-the-art" in shoreline protection, are now recognized as only part of the solution in protecting and restoring a lake's water quality, wildlife, recreational opportunities, and scenic beauty. Indeed, evidence suggests that, in some cases, the inability of hard shorelines to absorb wave energy can increase wave energy in other portions of a lake since the wave energy is refracted back into the lake. More recently, "soft" shoreline protection techniques, referred to as "vegetative shoreline protection" (see Figure 40), involving a combination of materials, including native plantings, are increasingly required pursuant to Chapter NR 328 of the *Wisconsin Administrative Code*. Vegetative shoreline protection is becoming more popular as people living along lakes and streams have become aware of the value of protecting their shorelines, improving the viewshed, and providing natural habitat for wildlife. Additionally, **shorelines protected with vegetation help shield the Lake from both land-based and shoreline pollution and sediment deposition.**

Given the benefits of "soft" shoreline protection measures, the WDNR no longer permits construction of "hard" structures in lakes that do not have extensive wave action threatening the shorelines (although repair of existing structures is permitted). Consequently, this plan recommends that shoreline restoration focus on "soft" measures, including native planting, the maintenance of aquatic plants along the shorelines, and the use of "bio-logs" (see Figure 41). Artificial beach areas, which legally need to be made from pea gravel,[75] are considered as a separate category. The placement of pea gravel may be permitted; however, this would have to be evaluated by WDNR on a case-by-case basis.

Shorelines of Hooker Lake

To determine the shoreline restoration and maintenance needs of Hooker Lake, and to develop recommendations related to shoreline maintenance and pollution reduction, SEWRPC staff visited the Lake to assess Lake shoreline conditions during the summers of 2012 and 2014. The results of these surveys are shown on Map 12. As the map indicates, **there were few shoreline buffers along the developed residential properties** (a common condition for lakes in the Region). <u>Educating shoreline property owners regarding the importance of buffers, especially using native plants, to prevent pollution and shoreline erosion should be considered a priority</u>. Additionally, **several areas around the Lake have failing or inadequate shoreline protection and a number of sites exhibited eroded and/or undercut banks.** Given the desire of Lake users to promote long-term Lake health and the need to preserve recreational use and aesthetics of the Lake, <u>it should be considered a priority to repair existing shoreline structures where feasible, and to install "soft" shoreline protection, such as vegetative shoreline protection (i.e., the maintenance of near-shore native plants) whenever and wherever possible.</u>

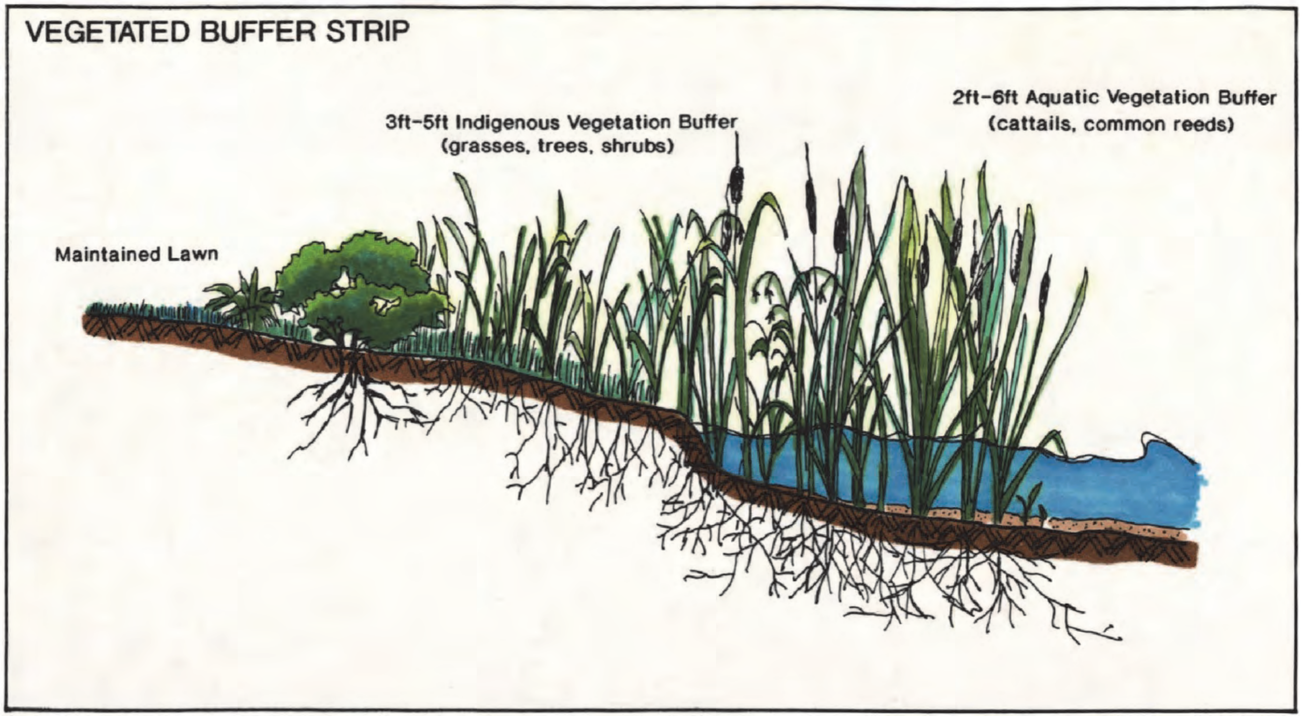
Further project recommendations for Hooker Lake's shoreline are included in Chapter III of this report.

---

[75]*WDNR does not permit the use of sand because these materials quickly flow into a waterbody and contribute to lake sedimentation.*

Figure 40

NATURAL SHORELINE BUFFER SCHEMATIC AND EXAMPLE



Source: Washington County Planning and Parks Department and SEWRPC.

Figure 41

"SOFT" SHORELINE PROTECTION TECHNIQUES

Natural Shoreline

Bio-logs

Buffers (Vegetative Strips)

Cattails

Source: SEWRPC.

ISSUE 8: FISH AND WILDLIFE

Protecting and enhancing lake-dependent aquatic and terrestrial wildlife populations is an important consideration of any lake protection plan. Based on field work and study of the Lake and its watershed, SEWRPC staff identified the following considerations related to aquatic and terrestrial wildlife:

1. Fishing was identified as an important recreational use of the Lake, as was verified by direct observations by Commission staff in 2012 and 2014 (see Tables 17 through 19);

2. Hooker Lake is reported to contain one critical fish species, the lake chubsucker (*Erimyzon sucetta*), a State Special concern species. Additionally, Salem Branch (the stream extending from Hooker Lake to the Des Plaines River) has been reported to contain State Special concern fish species, the pirate perch (*Aphredoderus sayanus*);

3. The WDNR manages Hooker Lake as a warmwater sport fishery;[76]

4. Two Natural Areas[77] are located within the Lake's watershed;

5. Hooker Lake contains two WDNR-designated Sensitive Areas;

6. About 12 species of amphibians and 13 species of reptiles are expected to be present in the Lake's watershed (amphibians and reptiles, including frogs, toads, salamanders, turtles, and snakes, are vital components of a lake ecosystem);

7. The Lake's watershed likely supports a significant population of waterfowl, including mallards, wood ducks, and blue-winged teal, particularly during the migration seasons; and

8. The Lake's watershed likely supports both small and large mammals, such as foxes and whitetail deer.

WDNR Sensitive Areas
Within or immediately adjacent to bodies of water, the WDNR, pursuant to authorities granted under Chapter 30 of the *Wisconsin Statutes* and Chapter NR 107 of the *Wisconsin Administrative Code*, can designate environmentally sensitive areas that have special biological, historical, geological, ecological, or archaeological significance, offer critical or unique fish and wildlife habitat including seasonal or life-stage requirements, or which offer water quality or erosion control benefits to the body of water.

Hooker Lake was surveyed by WDNR personnel utilizing sensitive area survey protocol in 2001 and again in 2007. As a result of these surveys, it was determined that two areas on Hooker Lake met the criteria for designation as sensitive areas (Map 20). The WDNR Sensitive Area report for Hooker Lake is presented in Appendix J.

WDNR-Designated Sensitive Area 1
Sensitive Area 1, locally known as Hooker Lake Marsh, abuts the northwest shoreline of Hooker Lake, and includes approximately 4,000 feet of lakeshore (see Map 20). About two-thirds of this shoreline is owned by the WDNR. The marshland has an average water depth of about two feet. This area was selected for its good quality wetland plants, its relatively large size, its location adjacent to the large undeveloped upland environmental corridor immediately to the west, and its important habitat for many wildlife species such as hawks, songbirds, waterfowl, and some kinds of reptiles and amphibians. This area also likely provides life-cycle critical spawning, nursery, refuge and feeding areas for several species of fish including northern pike.

Of the 16 native aquatic plant species observed in this area in 2007, the dominant emergent species was cattail and the dominant submerged species was muskgrass. Cattails provide a valuable mechanical barrier to natural wind-wave erosive forces acting against a lake's shoreline. The roots of such plants help stabilize lake-bottom sediment while the dense plant beds reduce the ability of nonnative invasive plant species to invade the Lake.

As part of the management of Sensitive Area 1, the WDNR recommends a variety of measures including maintaining the nearshore "Slow, No Wake" ordinance; minimizing disturbance of the stands of native aquatic vegetation; prohibiting mechanical aquatic plants harvesting; protecting seasonal fish spawning habitat; avoiding chemical

---

[76]*SEWRPC Memorandum Report No. 93*, A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report, *March 1995*.

[77]*Natural areas are those tracts of land so little modified by human activity, or which have recovered sufficiently from the effects of such activity, that they contain intact native plant and animal communities believed to be representative of the pre-European-settlement landscape.*

Map 20

WDNR-DESIGNATED SENSITIVE AREAS IN HOOKER LAKE

Source: Wisconsin Department of Natural Resources and SEWRPC.

treatment of EWM in areas adjacent to stands of susceptible aquatic plant species such as bladderwort or northern water milfoil; considering the use of mechanical or chemical treatments for reed canary grass and biological controls for purple loosestrife and milfoil where appropriate; and minimizing disturbance of herbs, trees, and shrubs along the shoreline to maintain wildlife habitat.

WDNR-Designated Sensitive Area 2

The shoreline and littoral zone along the southwest corner of the Lake compose up the bulk of Sensitive Area 2 (see Map 20). This site is approximately 1000 feet in length with an average water depth of about four and a half feet. Although the natural function and aesthetics of this area are disrupted (the shoreland area being comprised of about one-third wetland and two-thirds residential lawn), the site was chosen for the value of its aquatic plants to waterfowl, fish, and some amphibians and reptiles. The dominant submergent plants are coontail, white water crowfoot (*Ranunculus longirostris*), and nonnative EWM. Like Sensitive Area 1, the combination of emergent vegetation such as cattails with the silt/muck bottom substrate provide a high quality spawning habitat for northern pike and other species of fish that utilize aquatic vegetation for nursery, feeding, refuge, and resting sites.

Management recommendations for Sensitive Area 2 are similar to those for Area 1. An additional recommendation includes replacing existing shoreline stabilization practices with bioengineered practices such as vegetative shoreline protection or bio logs, and that buffer strips be installed along highly developed shoreline stretches. As was the case for Sensitive Area 1, protecting the native submergent and floating leaf aquatic plants in Sensitive Area 2 is considered critical to maintaining the fishery in Hooker Lake.

SEWRPC-Designated Natural Areas and Critical Species Habitat

As part of its regional planning program, and as a logical extension of its environmental corridor concept expounded through the regional, county-, and local-level land use plans for southeastern Wisconsin,[78] SEWRPC identified natural areas and critical species habitat areas within the Southeastern Wisconsin Region.[79] These areas reflect the attributes of the landscape that help: 1) protect and preserve the ambience, natural beauty, and biological diversity of southeastern Wisconsin and 2) maintain public health and welfare, support and sustain economic development, and provide continuing choices and opportunities for future generations. Areas identified as critical species habitat and/or natural areas were designated as being of local significance, regional significance, or state/national significance. Two such areas were identified in the Hooker Lake watershed. These areas are:

<u>Hooker Lake Marsh</u>: As described above as Sensitive Area 1, this WDNR-owned, forty-plus-acre, deep and shallow cattail marsh wetland complex is classified as NA-3, identifying it as a natural area of local significance.

<u>Hooker Lake</u>: A drainage lake with good water quality, wildlife habitat and other physical characteristics, classified as AQ-3, identifying it as a lake of local significance.

Aquatic and Terrestrial Habitat

Healthy fish, bird, amphibian, reptile, and mammal populations require: 1) good water quality, 2) sufficient water levels, 3) healthy aquatic plant populations, and 4) access to life-cycle critical habitat, and 5) well preserved or maintained aquatic and terrestrial habitat. Additionally, wildlife populations can also be enhanced by implementing “best management practices.” Since aquatic plant management, water quality, and water quantity have been dis

---

[78]*See SEWRPC Planning Report No. 7,* The Regional Land Use-Transportation Study, *1965, and subsequent editions; see also Bruce P. Rubin and Gerald H. Emmerich, Jr., “Refining the Delineation of Environmental Corridors in Southeastern Wisconsin,” SEWRPC Technical Record, Volume 4, Number 2, March 1981.*

[79]*SEWRPC Planning Report No. 42,* A Regional Natural Areas and Critical Species Habitat Protection and Management Plan for Southeastern Wisconsin, *September 1997.*

cussed previously in this chapter, this section will focus on maintaining and improving habitat conditions, and use of best management practices to enhance wildlife populations. The practices actually employed vary and are influenced by the type of wildlife. Therefore, this section first discusses aquatic wildlife enhancement and then addresses terrestrial wildlife enhancement.

Aquatic Wildlife Enhancement

Aquatic Best Management Practices

Aquatic best management practices can be implemented by landowners, recreationalists, and resource managers. Such activities include catch and release fishing and fish stocking, both of which help enhance a lake's overall fishery. To determine the most needed and effective practices, it is important to consider the following:

1. **The population and size structure of the fish species present in a lake**—Studies that examine the species, populations, and size structure of fish in a lake help managers understand issues that might face fish populations. For example, if low numbers of juvenile fish are found, this may indicate that the fish are not successfully reproducing, and, therefore, spawning and nursery, habitat may need to be improved. Similarly, if many juvenile fish are found with few large fish, over-fishing may be a factor limiting the growth of fish, thereby indicating that catch-and-release should be promoted in the lake. This type of information can therefore help lake managers efficiently and effectively refine fish population enhancement efforts.

2. **The history of fish stocking in a lake**—To evaluate fish population studies, it is important to understand how many fish of different sizes have been introduced through stocking. For example, if only large fish exist in a lake, it is possible that little to no natural spawning is taking place, which in turn could mean the lake's fishery is heavily dependent on fish stocking. This may suggest that enhanced or artificial spawning and rearing areas could add value to the lake's fishery.

Hooker Lake has been intermittently stocked by public agencies for over 100 years. For example, casual review of historical documents reveals that 374,000 walleyes and 275 white bass were planted into Hooker Lake during 1898.[80] More recently, the Lake has been stocked with northern pike, largemouth bass, and walleye since 1972 (see Table 24). The WDNR reports that largemouth bass are considered "abundant" in Hooker Lake, while panfish and northern pike are "common."[81] Additionally, a fish survey conducted in 2008 (see Table 25), by electrofishing[82] noted the presence of other fish in the Lake, including black crappie, warmouth, lake chubsucker, common carp, smallmouth bass, yellow bullhead, and bowfin. The WDNR plans to complete fish surveys in the fall of 2017 and spring 2018.

Overall, WDNR concludes that **Hooker Lake has a largemouth bass and panfish population with below average size.** In regards to the panfish population, this may be the result of high angler harvest concentrated on the biggest fish. As regards the bass population, the WDNR feels that having a top predator such as northern pike that can cull some of the smaller bass may result in improving both the size structure of the bass population as well as

[80]Biennial Report of the Commissioners of Fisheries of Wisconsin for the Years 1899 and 1900, *Democrat Printing Company, State Printer, 1901.*

[81]*Department of Natural Resources Lake Page:* http://dnr.wi.gov/lakes/LakePages/LakeDetail.aspx?wbic=746000.

[82]*Electrofishing is a process where an electrical pulse is placed in the water, causing fish to be temporarily stunned and float to the top of the lake. This process allows for fisheries biologists to record fish types, counts, and sizes without harming the fish populations.*

Table 24

FISH STOCKED INTO HOOKER LAKE

Year	Species Stocked	Age Class	Number Stocked	Average Length (inches)
1972	Walleye	Fry	1,000,000	1.00
1972	Northern Pike	Fry	400,000	1.00
1972	Largemouth Bass	Fry	40,000	1.00
1973	Walleye	Fry	1,300,000	1.00
1973	Northern Pike	Fry	577,500	1.00
1973	Walleye	Fingerling	19,190	3.00
1974	Walleye	Fingerling	18,250	3.00
1975	Walleye	Fingerling	7,500	5.00
1982	Northern Pike	Fingerling	180	7.00
1985	Northern Pike	Fingerling	180	8.00
1991	Northern Pike	Fingerling	550	8.00
1992	Northern Pike	Fingerling	170	8.00
1995	Northern Pike	Fingerling	174	8.50
2000	Northern Pike	Large fingerling	174	8.00
2006	Northern Pike	Large fingerling	175	9.20
2008	Northern Pike	Large fingerling	259	9.10
2010	Walleye	Small fingerling	3,614	1.70
2011	Walleye	Small fingerling	3,045	1.9
2012	Northern Pike	Large fingerling	207	7.5
2013	Walleye	Small fingerling	3,045	1.5
2014	Northern Pike	Large fingerling	174	9.1
2015	Walleye	Small fingerling	3,614	1.2

Source: Wisconsin Department of Natural Resources and SEWRPC.

improving the pike fishery. To this end, the WDNR has been putting small numbers of northern pike into the Lake over the years (Table 24). If approved by the WDNR fishery manager, additional northern pike could be stocked into the Lake by an association or similar entity to assist this management practice. Actions could be taken to promote northern pike access to preferred spawning areas (e.g., periodically flooded areas with firm-stemmed plants). Additionally, maintaining current practices and aquatic habitats (see "Aquatic Habitat" subsection below) within the Lake is crucial. Since stocking of walleye into Hooker Lake has not resulted in establishment of a reproducing population, the walleye population should probably be managed as a "put-grow-take" fishery with little expectation of natural reproduction.[83] Thus, periodic fish stocking should continue if the fishery is to remain viable. Recommendations related to these conclusions are included in Chapter III of this report.

Table 25

HOOKER LAKE FISH SURVEY SUMMARY: 2008

Species Collected	Average Length (inches)
Bluegill	5.5
Common Carp	- -[a]
Northern Pike	19.4
Warmouth	- -[a]
Lake Chubsucker	- -[a]
Largemouth Bass	10.8
Bowfin	- -[a]
Black crappie	7.5
Smallmouth bass	14.8

[a]*Species was found during WDNR fish survey but not sampled for size.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

[83]*E-mail communication from Luke S. Roffler, WDNR, May 18, 2015.*

Aquatic Habitat

Aquatic habitat enhancement generally refers to encouraging native aquatic plant (particularly pondweed) growth within a lake, as these plants provide food, shelter, and spawning areas for fish. Aquatic habitat enhancement also involves protecting wetlands (see “Terrestrial Habitat” section below), maintaining good ecological connectivity between the lake and its watershed, and encouraging the presence of woody debris along the shorelines. Woody debris is found in abundance in natural environments, provides shelter for fish populations, act as basking and rest areas for herptiles (e.g. frogs and turtles), may provide perch areas for important birds and insects, and can help protect shorelines from erosion in some instances.

To determine the status of aquatic habitat within the Lake beyond that identified as part of the summer 2014 aquatic plan survey (see “Issue 4: Aquatic Plant Growth” section), SEWRPC staff completed a shoreline assessment in the summer of 2014 (see “Issue 6: Shoreline Maintenance” section). The aquatic plant survey revealed that **Hooker Lake has only fair plant diversity, with only two different pondweed species,**[84] **while the shoreline assessment concluded that few areas along the Lake’s shoreline have significant woody debris** (see Map 12). <u>These conclusions suggest that the current aquatic native plant community should be maintained and enhanced, to the greatest extent practical, and that projects should be implemented to provide more woody debris along the shorelines.</u> Consequently, recommendations related to both are presented in Chapter III of this report.

Hooker Lake’s bottom is composed primarily of muck (i.e., silt and organic debris). Healthy aquatic ecosystems generally require a variety of habitat and substrate found in differing places within the Lake itself and tributary streams. For example, fish spawning, rearing, refuge, and feeding commonly take place in very different environments. Buffer installation, water quality management, removing fish passage impediments on perennial and intermittent streams, reconnecting floodplains to tributary streams, and maintaining nearshore vegetation and woody debris all promote healthy fish populations.

Terrestrial Wildlife

Two general practices can enhance terrestrial wildlife populations: application of best management practices and habitat enhancement. Each is described below.

Terrestrial Best Management Practices

The way people manage their individual plots of land and treat wild animals and plants has a significant impact on terrestrial wildlife populations. Turtles, for example, need to travel overland long distances from their home lake to lay their eggs. If pathways to acceptable habitats are not available, or are dangerous due to pets, fences, or traffic, turtle populations will decline. Many conservation organizations have developed “best management practices” (BMPs) or behaviors that homeowners and land managers can employ sustain or even increase wildlife populations.

Although some BMPs are species- or animal-type specific (e.g., spaying or neutering cats to limit reproduction and reduce their desire to kill birds), many are general practices that benefit all wildlife. In general, best management practices for wildlife enhancement primarily target agricultural and residential land uses. Agricultural measures tend to focus on encouraging land management that enhances habitat value, such as allowing fallen trees to naturally decompose where practical, or allowing for uneven topography which can create microhabitats needed by certain plants and animals. In contrast, residential measures tend to focus on practices that owners of smaller parcels can initiate on their own to provide or enhance habitat. Examples include installing a rain garden, avoiding heavy applications of fertilizers and herbicides, landscaping to provide food and cover, and preventing introduction of nonnative plants and insects. Other recommendations are generally applicable to all landowners. For example, careless, wanton, and/or indiscriminant killing of native wildlife, particularly amphibians, reptiles, and birds, is strongly discouraged and should be publicly censured.

---

[84]*Pondweed species are significant in a lake because they serve as excellent habitat for providing food and shelter to many aquatic organisms.*

Actively communicating best management practices to the public often provides an excellent means of encouraging healthy wildlife populations without major investment of public funds. Consequently, implementing and increasing the acceptance of best management practices is recommended in Chapter III of this report.

Terrestrial Habitat

Terrestrial wildlife needs large, well-connected areas of open natural or nature-like habitat. Consequently, protecting, connecting, and expanding natural habitat is crucial if wildlife populations are to be maintained or enhanced. Open space natural areas can generally be classified as either wetlands or uplands, as described below:

1. **Wetlands**—Wetlands are defined based on hydrology, hydric soils, and the presence of wetland plants. There are many types of wetlands (see Figure 42), from the familiar cattail and bulrush marsh to forested wetlands. Most aquatic and terrestrial wildlife relies upon, or is associated with, wetlands for at least a part of their lives. This includes crustaceans, mollusks, aquatic insects, fish, amphibians, reptiles, mammals (e.g., deer, muskrats, and beavers), and resident bird species, (e.g., turkey, songbirds and migrant species, such as sandhill and whooping cranes).

2. **Uplands**—Uplands are often characterized by the presence of drier, more stable soils. Like wetlands, natural uplands can also exist in many forms (e.g., prairies and woodlands) and also provide many critical functions for many upland game and nongame wildlife species through provision of critical breeding, nesting, resting, and feeding areas, as well as providing refuge from predators. However, unlike wetlands, the dry and stable soils make uplands more desirable for urban development and, therefore, such areas are more challenging to protect.

Figure 42

EXAMPLE WETLAND TYPES

MARSH WETLAND

Source: SEWRPC.

SCRUB/SHRUB WETLAND

Source: University of New Hampshire Cooperative Extension.

FORESTED WETLAND

Source: Prince William Conservation Alliance.

As mentioned above, **both wetlands and uplands are critical to wildlife populations. However, the dynamic interaction and movement between uplands and wetlands are also crucial** because many terrestrial organisms spend part of their time in the wetlands and the rest of their time in upland areas. For example, some amphibians live most of their lives in upland areas but depend on wetlands for breeding. Consequently, if the connections between uplands and wetlands are compromised (e.g., if a large road is placed between the two land types) it becomes dangerous, if not impossible, for amphibians to gain access to their breeding grounds, thereby reducing their ability to seasonally migrate or reproduce. In fact, habitat fragmentation (i.e., splitting up of large connected habitat areas) has been cited as the primary global cause of wildlife population decreases.[85] Therefore, protecting and expanding uplands and wetlands, as well as maintaining or enhancing their connectivity, will help maintain or enhance wildlife populations and diversity.

To determine the extent of the uplands and wetlands in the Hooker Lake watershed, and to gauge the state of the connections between these two areas, SEWRPC staff completed an inventory of the wetland and upland habitat within the Hooker Lake watershed. Wetland and woodland habitat areas are shown on Map 21. Most wetland acreage is located northwest of Hooker Lake in the form of emergent and wet meadow along the stream that enters the Lake in that area, as well as forested wetlands along the tributary stream south of the Lake. Upland habitat in the watershed includes deciduous woodlands and some grassland located northeast and south of the Lake. **These wetland and upland habitat complexes are likely ecologically connected.** Consequently, protecting and expanding these complexes as well as enhancing their connectivity should be made a priority to maintain and enhance wildlife populations. It is important to note, however, that wetland and upland protection and enhancement require a number of actions, including:

1. Preventing and/or limiting development within wetland and certain upland areas;

2. Taking steps to ensure new, rebuilt, or repaired infrastructure maintains or enhances environmental corridors and ecological connectivity between habitat areas;

3. Expanding uplands and/or wetlands where practical (e.g., reestablishing wetlands that are currently farmed, creating grasslands, or reforesting cleared areas); and

4. Ensuring that wetlands and uplands continue to function in a natural manner by controlling and/or removing invasive plant species introduced to those areas and avoiding activities that can disrupt habitat value (e.g., excessive use of motorsport vehicles).

A comprehensive plan must consider each of these elements individually and as a part of a larger habitat system. Consequently, recommendations related to each of these actions are included in Chapter III of this report. Additionally, implementation guidance is included in the "Issue 9: Implementation" section below and in Chapter III.

Other Wildlife Issues

The presence of aquatic birds (primarily geese) on the shorelines was also mentioned as an issue of concern. Though some management measures help control geese populations (e.g., oiling goose eggs to prevent hatching), the number of geese observed on Hooker Lake does not currently appear to warrant such action. Nevertheless, the presence of naturally vegetated buffers can discourage congregation of geese along shorelines. Geese prefer mowed shorelines. Consequently, a recommendation related to the installation of buffers is further emphasized in Chapter III of this plan as a part of the wildlife recommendations.

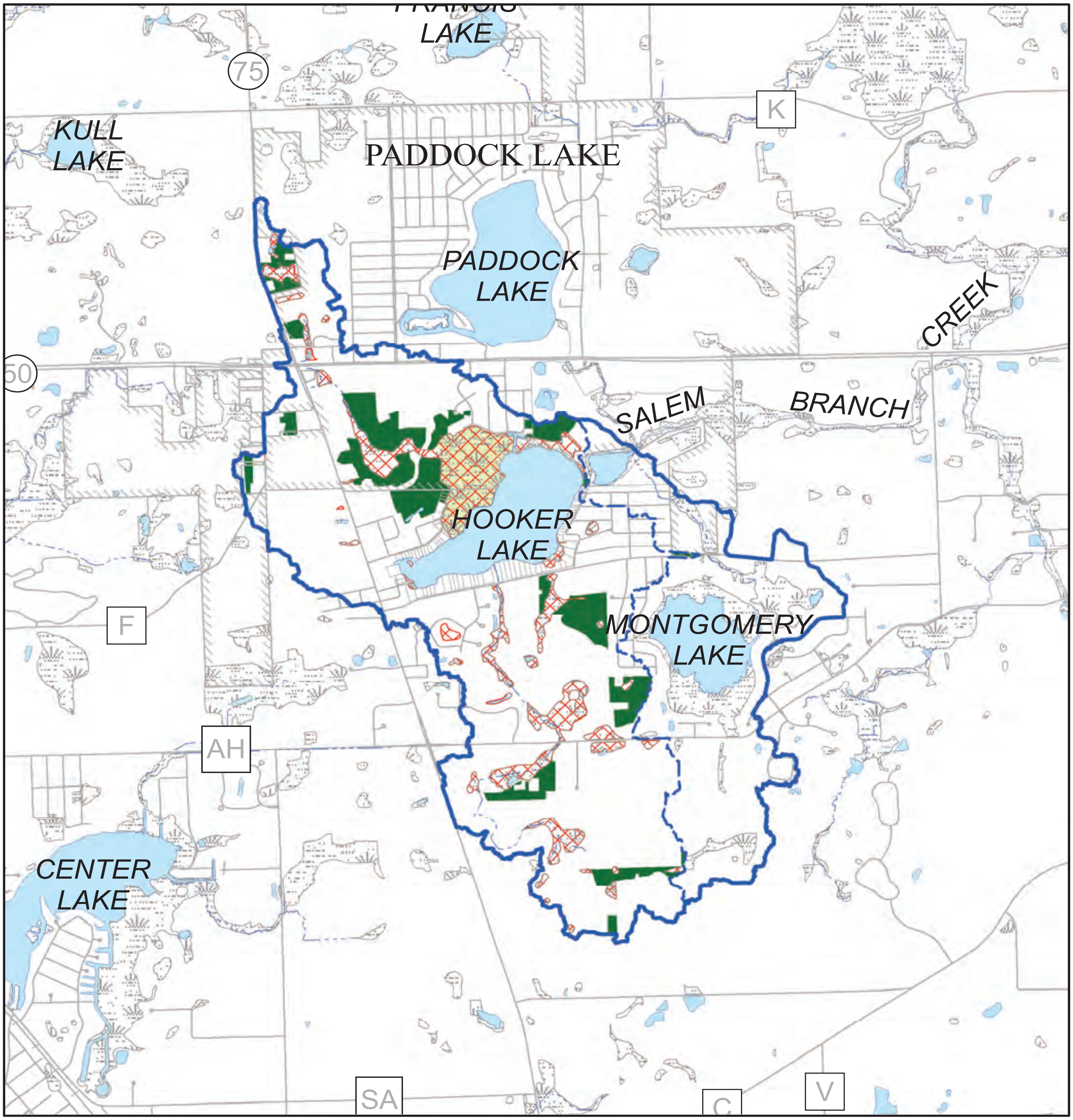
ISSUE 9: PLAN IMPLEMENTATION

A core issue for any lake protection plan is the need for guidance to implement plan recommendations. A significant step toward implementation of a plan is development of an action plan with timelines, goals, and identified responsible parties. These kinds of target metrics can help implementing agencies gauge progress over time and can help motivate participants, ensuring that the plan is carried through in the long term. When developing an action plan,

[85] *Lenore Fahrig, "Effects of Habitat Fragmentation on Biodiversity,"* Annual Review of Ecology, Evolution, and Systematics, *Vol. 34, 2003, pp. 487-515.*

Map 21

CRITICAL SPECIES SITES, WOODLANDS, AND WETLANDS WITHIN THE HOOKER LAKE WATERSHED



NATURAL AREAS

CRITICAL SPECIES HABITAT SITE (NONE)

WETLANDS: 2010

WOODLANDS: 2010

WETLANDS

SURFACE WATER

WATERSHED BOUNDARY

SUBWATERSHED BOUNDARY

Note: The Montgomery Lake subwatershed drains to the Back Bay/Outlet area downstream of Hooker Lake, so this subwatershed area was not studied as part of this project.

GRAPHIC SCALE

0 1,500 3,000 FEET

Source: SEWRPC.

it is important to know what on-the-ground implementation will involve. Consequently, some recommendations can be achieved using regulation while others involve proactively implementing new management efforts. Both are discussed below.

Regulatory Implementation

Regulatory implementation refers to the maintenance and improvement of water quality, water quantity, and wildlife populations through the use of local, State, and Federal rules and laws. A number of regulations relating to activities within the Hooker Lake watershed, such as zoning ordinances, boating and in-lake ordinances, and State regulations related to water quality, already help protect the Lake. These regulations help mitigate pollution, prevent or limit development, avoid activities that damage the resources base or intrinsic value, and encourage the use of best management practices.

Ordinances

Zoning ordinances dictate where development can take place, the types of development allowed, and the terms that need to be met for development to proceed. Consequently, **zoning can be a particularly effective tool for protecting buffers, wetlands, uplands, and shorelands when environmental considerations are taken into account during formulation of zoning districts.** A way for these environmental considerations to be taken in account is for the local zoning authorities and other regulatory agencies to use SEWRPC-designated environmental corridors (see Figure 43) in applying conservancy zoning district regulations to help determine where development is permitted and not permitted, and to determine the extent and intensity of development that is allowed.

In the Hooker Lake watershed, **three different units of government have different regulatory authorities** that apply to lake protection: Kenosha County, the Village of Paddock Lake, and the Town of Salem (see Table 26 and Map 22). **Kenosha County has zoning authority in most of the watershed.** This is advantageous because the general zoning ordinance for Kenosha County specifically states what development is constrained in environmental corridors. **Environmental corridor designations are used to set "no development" zones as well as "limited development" zones** depending on whether the area within the corridor is a lowland or upland, respectively. The fact that these corridors are used in zoning decisions means that the areas within the Hooker Lake watershed that are within environmental corridors (see Map 23) are well protected.

In addition to general zoning, shoreland zoning and **construction site erosion control and stormwater management ordinances also play a key part in protecting the resources within the watershed.** For example, shoreland zoning, which is administered by Kenosha County (except in the Village of Paddock Lake), follows statewide standards to create building setbacks around navigable waters.[86] Additionally, stormwater management and construction erosion control ordinances help minimize water pollution, flooding, and other negative impacts of urbanization on water resources (lakes, streams, wetlands, and groundwater) and property owners, both during and after construction activities.

---

[86]*The 2015-2017 State Budget (Act 55) changed State law relative to shoreland zoning. Under Act 55, a shoreland zoning ordinance may not regulate a matter more restrictively that it is regulated by a Sate shoreland-zoning standard unless the matter is not regulated by a standard in Chapter NR 115, "Wisconsin's Shoreland Protection Program," of the* Wisconsin Administrative Code*. Examples of unregulated matters may involve wetland setbacks, bluff setbacks, development density, and stormwater standards. In addition, under Act 55, a local shoreland zoning ordinance may not require establishment or expansion of a vegetative buffer on already developed land and may not establish standards for impervious surfaces unless those standards consider a surface to be pervious if its runoff is treated or is discharged to an internally drained pervious area. Additional legislation relative to shoreland zoning enacted after the 2015-2017 state budget legislation includes Act 41 which addresses town shoreland zoning authority relative to county authority (effective date: July 3, 2015) and Act 167 which codifies and revises current Wisconsin Department of Natural Resources shoreland standards.*

Figure 43

SYNOPSIS OF SEWRPC DESIGNATED ENVIRONMENTAL CORRIDORS

SEWRPC has embraced and applied the environmental corridor concept developed by Philip Lewis (Professor Emeritus of Landscape Architecture at the University of Wisconsin-Madison) since 1966 with the publication of its first regional land use plan. Since then, SEWRPC has refined and detailed the mapping of environmental corridors, enabling the corridors to be incorporated directly into regional, county, and community plans and to be reflected in regulatory measures. The preservation of environmental corridors remains one of the most important recommendations of the regional plan. Corridor preservation has now been embraced by numerous county and local units of government as well as by State and Federal agencies. The environmental corridor concept conceived by Lewis has become an important part of the planning and development culture in southeastern Wisconsin.

Environmental corridors are divided into the following three categories.

- **Primary environmental corridors** contain concentrations of our most significant natural resources. They are at least 400 acres in size, at least two miles long, and at least 200 feet wide.

- **Secondary environmental corridors** contain significant but smaller concentrations of natural resources. They are at least 100 acres in size and one mile long, unless they link primary corridors.

- **Isolated natural resource areas** contain significant remaining resources that are not connected to environmental corridors. They are at least five acres in size and at least 200 feet wide.

Key Features of Environmental Corridors

- Lakes, rivers, and streams
- Undeveloped shorelands and floodlands
- Wetlands
- Woodlands
- Prairie remnants
- Wildlife habitat
- Rugged terrain and steep slopes
- Unique landforms or geological formations
- Unfarmed poorly drained and organic soils
- Existing outdoor recreation sites
- Potential outdoor recreation sites
- Significant open spaces
- Historical sites and structures
- Outstanding scenic areas and vistas

Source: SEWRPC.

Table 26

LAND USE REGULATIONS WITHIN THE AREA TRIBUTARY TO HOOKER LAKE IN KENOSHA COUNTY BY CIVIL DIVISION: 2016

Community	Type of Ordinance				
	General Zoning	Floodplain Zoning	Shoreland Zoning	Subdivision Control	Construction Site Erosion Control and Stormwater Management
Kenosha County.....	Adopted	Adopted	Adopted	Adopted[a]	Adopted[a]
Town of Salem	Regulated under County ordinance	Regulated under County ordinance	Regulated under County ordinance	Adopted[a]	Adopted[a]
Village of Paddock Lake.....................	Adopted	Adopted	Adopted[b]	Adopted	Adopted

[a]*Both the Kenosha County and Town of Salem subdivision ordinances and erosion control and stormwater management ordinances apply within the Town of Salem. In the event of conflicting regulations, the more restrictive regulation applies.*

[b]*The Village of Paddock Lake has adopted a Shoreland-Wetland Overlay Zoning District to comply with the requirements of Chapter NR 117 of the* Wisconsin Administrative Code*. The Village has also adopted a Shoreland Overlay Zoning District that applies within 100 feet of the ordinary high water mark of navigable waters, which regulates building setbacks and removal of vegetative cover. These latter regulations are more restrictive than the State-mandated shoreland zoning regulations for cities and villages in NR 117.*

Source: SEWRPC.

Boating and In-Lake Ordinances

Boating and in-lake ordinances regulate the use of the Lake in general, and, when implemented properly, **can help prevent inadvertent damage to the Lake such as overfishing or severe shoreline erosion from excessive wave action reaching the shoreline.** The boating ordinance for the Town of Salem (including Hooker Lake) is provided in Appendix I. This ordinance is generally enforced by a warden or by the local law enforcement agency.

State Regulations

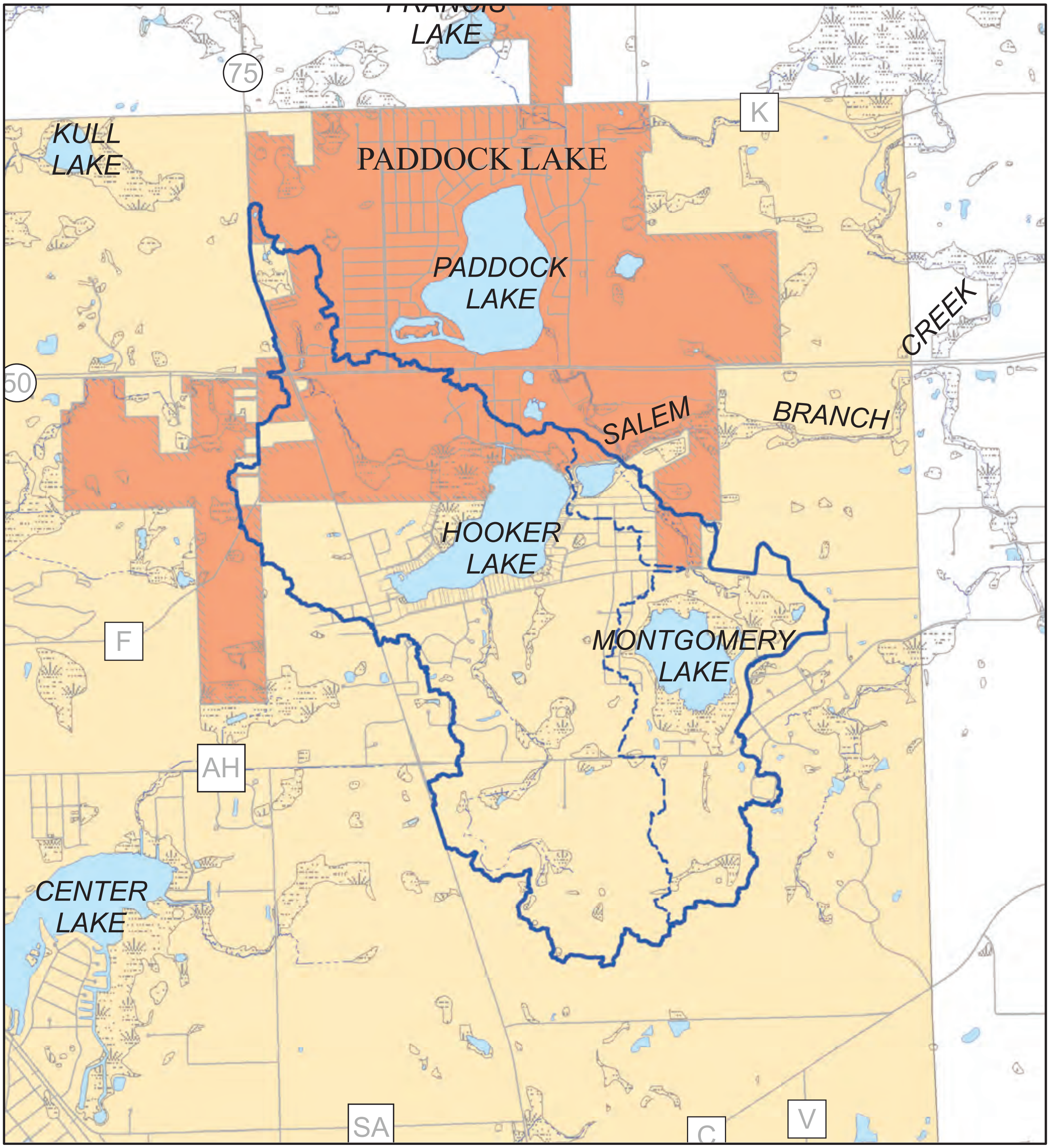
The State Legislature required the WDNR to develop performance standards for controlling nonpoint source pollution from agricultural and nonagricultural land and from transportation facilities.[87] The performance standards, which are set forth in Chapter NR 151 "Runoff Management" of the *Wisconsin Administrative Code*, set forth requirements for best management practices. Regulations also cover construction sites, wetland protective areas, and buffer standards.

---

[87]*The State performance standards are set forth in the Chapter NR 151, "Runoff Management," of the* Wisconsin Administrative Code. *Additional code chapters that are related to the State nonpoint source pollution control program include: Chapter NR 152 (This Chapter will be revised in response to the 2013 Wisconsin Act 20 as noted in WDNR Guidance #3800-2014-3, "Implementation of 2013 Wisconsin Act 20 for Construction Site Erosion Control and Stormwater Management," October 2014.), "Model Ordinances for Construction Site Erosion Control and Storm Water Management;" Chapter NR 153, "Runoff Management Grant Program;" Chapter NR 154, "Best Management Practices, Technical Standards and Cost-Share Conditions;" Chapter NR 155, "Urban Nonpoint Source Water Pollution Abatement and Storm Water Management Grant Program;" and Chapter ATCP 50, "Soil and Water Resource Management." Those chapters of the* Wisconsin Administrative Code *became effective in October 2002. Chapter NR 120, "Priority Watershed and Priority Lake Program," and Chapter NR 243, "Animal Feeding Operations," were repealed and recreated in October 2002.*

Map 22

CIVIL DIVISIONS WITHIN THE HOOKER LAKE WATERSHED



VILLAGE OF PADDOCK LAKE

TOWN OF SALEM

WETLANDS

SURFACE WATER

WATERSHED BOUNDARY

SUBWATERSHED BOUNDARY

Note: The Montgomery Lake subwatershed drains to the Back Bay/Outlet area downstream of Hooker Lake, so this subwatershed area was not studied as part of this project.

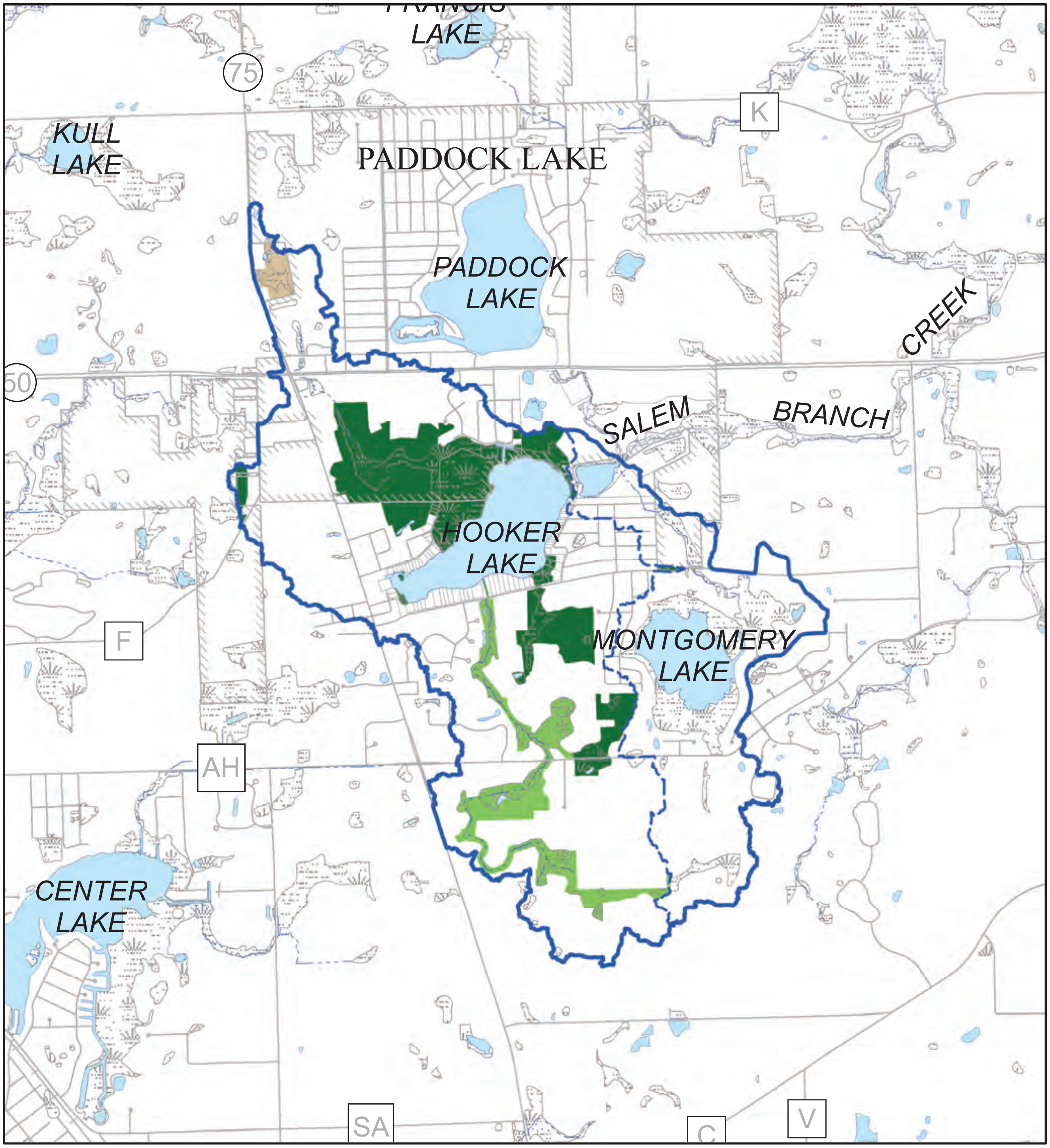
The Town of Salem merged with the Village of Silver Lake and will become the "Village of Salem Lakes" in February 2017.

GRAPHIC SCALE
0 1,500 3,000 FEET

Source: SEWRPC.

Map 23

ENVIRONMENTAL CORRIDORS WITHIN THE HOOKER LAKE WATERSHED



PRIMARY ENVIRONMENTAL CORRIDOR

SECONDARY ENVIRONMENTAL CORRIDOR

ISOLATED NATURAL RESOURCE ARA

WETLANDS

SURFACE WATER

WATERSHED BOUNDARY

SUBWATERSHED BOUNDARY

Note: The Montgomery Lake subwatershed drains to the Back Bay/Outlet area downstream of Hooker Lake, so this subwatershed area was not studied as part of this project.

GRAPHIC SCALE
0 1,500 3,000 FEET

Source: SEWRPC.

The regulations discussed above play a crucial role in maintaining the health of the Lake and of all the resources within the Hooker Lake watershed. However, even though developers, residents, and lake users are legally obligated to adhere to the ordinances, limited resources within the enforcement bodies at the State, County, and municipal levels can sometimes make the task of ensuring compliance difficult. <u>Consequently, Chapter III provides recommendations on the best ways for the HLMD to work with regulatory agencies to help them enforce the existing ordinances and regulations to the greatest extent practical.</u>

Proactive Management Efforts

In addition to continued and enhanced ordinance enforcement, a number of recommendations made under this plan also seek to proactively improve conditions within the Lake through voluntary efforts. Chapter III provides details on these recommendations and guidance on their implementation. However, several challenges can limit the ability of lake residents and the Management District to engage in certain management efforts recommended under this plan. Some of these challenges include:

1. **Lack of adequate funding**—The HLMD, as a taxing body, has authority to levy taxes within the District to secure funding necessary to manage the Lake. In addition, grant funds may be available to for larger, more extensive projects that would otherwise be beyond the financial capacity of the District.

2. **Institutional capacity**—Institutional capacity refers to the capacity that agencies within the watershed have to implement projects in terms of knowledge, staff, and other resources. Map 22 depicts the civil divisions within the watershed and Table 26 lists the land use regulations enforced by those civil divisions. Many resources are available to help residents and lake users implement management measures. Nevertheless, some guidance will likely be necessary to ensure that those attempting management projects are completing the projects in an effective and efficient fashion consistent with plan recommendations.

3. **Volunteer and Interest Base**—To increase the advocacy and volunteer base for labor intensive or broad-based projects like hand-pulling or wetland invasive species monitoring, it is desirable to reach a broader stakeholder group beyond lakeshore and near-lakeshore residents.

<u>Consequently, Chapter III provides recommendations and suggested actions that seek to ensure that the above capacity issues are addressed.</u>

In addition to capacity building, communicating the details of this plan will also be crucial to encouraging voluntary management efforts. For example, communicating the difference between native and nonnative plants and the fact that removing plants can spur algae growth, are important to ensure that homeowners understand why a “clean” shoreline is not always the best option for a lake, and to ensure that homeowners maintain a healthy plant community on the shoreline. <u>Consequently, another major recommendation in Chapter III is communicating the necessary and important components of this plan.</u>

SUMMARY

All issues of concern expressed by Hooker Lake residents during the development of this plan have merit. Additionally, as discussed in the “Aquatic Plant Growth” section of this report, addressing these issues will contribute to effectively managing the aquatic plant population within Hooker Lake and improving the general health of the Lake. Therefore, each issue has associated recommendations set forth in Chapter III. It is important to note that many opportunities exist to help ensure the sustainable use of Hooker Lake and its watershed. The implementation of the recommendations provided in Chapter III of this report will help capitalize on these opportunities.

Chapter III

LAKE MANAGEMENT RECOMMENDATIONS AND IMPLEMENTATION

INTRODUCTION

Hooker Lake is a valuable resource to lake residents and visitors, contributes to the economy and quality of living in the local area, and is important asset to the overall hydrology and ecology of the larger Des Plaines River watershed due to its role as a headwater lake. This chapter provides actionable suggestions that help maintain and enhance the health of the Lake and encourage its continued enjoyment. Recommendations provided in this chapter are based upon the data analyses and interpretations provided in Chapter II.

The recommendations made in this chapter cover a wide range of programs and seek to address every aspect that significantly influences the health and recreational use of Hooker Lake. Consequently, it may not be feasible to implement every recommendation immediately. To assist efficient plan implementation, the importance and significance of each recommendation is described lake managers to prioritize plan elements. Nevertheless, all recommendations should eventually be addressed, subject to possible modification based on analysis of data collected in the future (e.g., future aquatic plant surveys and water quality monitoring), project logistics, or changing conditions.

The measures discussed in this chapter are primarily focused on those that can be implemented through collaboration between the Hooker Lake Management District, the Town of Salem, the Village of Paddock Lake and Hooker Lake residents. However, partnerships with WDNR, developers, landowners, and other nearby municipalities are likely very important and necessary to ensure the long-term ecological health of Hooker Lake. Therefore, people engaging in Hooker Lake management efforts are encouraged to continuously seek out projects and partnerships that will aid in implementing the recommendations contained within the plan.

Though the logistics for implementing each recommendation may not be fully described, this chapter does suggest potential projects. It is important to note that these project suggestions do not necessarily constitute recommendations; they are presented to provide the implementing entities with ideas about the type and nature of projects to pursue. In summary, this chapter provides a context for understanding what needs to be done, as well as to help those implementing the plan picture what such efforts may look like and embrace the overall intent.

ISSUE 1: WATER QUALITY

As described in Chapter II, limited water quality data is available for Hooker Lake. The few available data sets suggest that Hooker Lake has historically been a eutrophic (high nutrient level) lake. Even though data sets suggest that the Lake is becoming a less fertile mesotrophic lake, many lake residents continue to express concern about various water-quality-related issues including sources of pollution in the watershed and overly abundant aquatic plant and algal growth. These factors suggest that water quality management is warranted on the Lake.

Management efforts to improve Hooker Lake water quality should focus primarily on the following strategies:

1. **Continue to actively track key water quality parameters.** Water quality monitoring is an important tool that allows the Lake's current condition to be quantified, longer-term changes to be understood, and the factors responsible for change to be identified. Monitoring is a key factor to maintaining and improving Lake health. Therefore, regularly recurring water quality monitoring should be a high priority. To allow comparison with previously collected data and, thereby, allow trends to be identified, sample collection should continue at the site identified as the "deep hole" (i.e., the point above the deepest part of the Lake). Laboratory samples should be collected in early spring shortly after ice out (e.g., early April) and at least once during mid-summer (e.g., late July). Collect field measurements (e.g., water clarity, temperature, and dissolved oxygen) much more frequently. At a minimum, these samples should be analyzed for the following parameters:

   a. Field measurements
      - Water clarity (i.e., Secchi depth in the Lake)
      - Temperature (profiled over the entire water depth range at the deepest portion of the Lake with more frequent readings near the thermocline)
      - Dissolved oxygen (profiled over the entire water depth range at the deepest portion of the Lake with more frequent readings near the thermocline)

   b. Laboratory samples
      - Total phosphorus (near-surface sample with supplemental samples collected near the deepest portions of the Lake)
      - Total nitrogen (near-surface sample)
      - Chlorophyll-*a* (near-surface sample)
      - Chloride (near-surface sample),

   The Clean Lakes Monitoring Network (CLMN) provides training and guidance on monitoring the health of lakes. Volunteers commonly monitor water clarity, temperature, and dissolved oxygen throughout the open water season (preferably every 10 to 14 days) and basic water chemistry (i.e., phosphorus and chlorophyll-*a* concentrations) four times per year (two weeks after ice off and during the last two weeks of June, July, and August).

   <u>Because of their simplicity, utility, and low cost, it is highly recommended that field measurements (water clarity, temperature profiles, oxygen profiles) be taken much more frequently</u> than the minimums described above. Lake conditions can change rapidly and frequently, and more frequent measurements can help lake managers identify and quantify important water quality issues. Supplemental temperature/oxygen profiles collected at other times of the year (e.g., other summer dates, fall, and winter) would be especially helpful to understand lake mixing. Additionally, oxygen profiles should be collected during midsummer in the nighttime hours just before sunrise to help evaluate diurnal oxygen saturation swings.

Laboratory tests quantify the amount of a substance within a sample under a specific condition at a particular moment in time, and are particularly valuable benchmark values. **Field measurements can often serve as reasonable surrogates for common laboratory tests.** For example, water clarity decreases when total suspended solids and/or chlorophyll-*a* concentrations are high, samples with high concentrations of total suspended solids commonly contain more phosphorus, and water with higher specific conductance commonly contains more salt and, therefore, more chloride. Periodically sampling water and running a targeted array of laboratory and field tests not only provides data for individual points in time, but can also allow laboratory/field test results to be compared. Once a relationship is established between laboratory and field values, this relationship can be used as an inexpensive means to estimate the concentrations of key water quality indicators normally quantified using laboratory data. Chloride concentrations should continue to be monitored to quantify the rate concentration increase over time, to gauge the overall impact of cultural influence on the Lake, and to evaluate if chloride concentrations are approaching levels that could damage the Lake's ecosystem.

In addition to the in-lake monitoring, **water quality should continue to be monitored at the six tributary streams (Map 3).** Since there is concern about external phosphorus loading potentially entering the Lake through the tributary streams, stream water quality sampling should be considered a high priority. Samples should be collected to represent a cross section of flow events (i.e. low, medium and high). Notations should be made by the sampler regarding current and recent weather conditions and qualitative description of flow and water quality (e.g., "creek is very high and muddy"), and the exact location, date and time where the sample was collected. Sampling parameters should include the following:

- Stream flow – methods in Appendix K
- Water clarity (transparency tubes, see below)
- Total phosphorus
- Total nitrogen
- Chloride
- Temperature
- Dissolved oxygen

Flow rate information allows the actual mass load of phosphorus contributed from the tributaries and the areas they drain to be estimated and compared. A field method to quantify actual flow in streams is included in Appendix K. The amount of water delivered from each tributary can also be estimated using empirical formulae (e.g., the Rational Method) and models (e.g., TR 55, SWMM). These flow estimates can be combined with water quality information collected in the tributary streams to estimate mass loadings from each stream. The Town of Salem has developed a stormwater management plan. As part of this effort, flows and water quality from various watersheds have been simulated.[1] These data may also be combined with future water quality results generated by the HLMD. Calculating mass loading using modeled flow rates should be considered a high priority. This information can then be used to target priority tributaries, seasons, and events for water quality analyses.

In addition to quantifying flow, general information should be collected regarding weather, stream water quality, and other factors. Creek depths typically make direct clarity measurement impossible; however

[1]*Information regarding the Town of Salem's stormwater management program may be found at the following website:http://www.townofsalem.net/index.asp?SEC=ECC25DEF-D98F-4529-913D-713DF6BAC4D0&Type=B_BASIC. The Village of Paddock Lake may have a similar document.*

transparency tubes (sometimes called turbidity tubes) provide a convenient way to quantify water clarity in shallow water. Transparency tubes are available from several vendors and cost well under $100. Water clarity information is simple and inexpensive to collect and can provide much insight into the day-to-day water quality of tributary streams.

<u>Parameters may be added or deleted or and sampling frequency may be increased or decreased to focus resources on the watersheds identified or suspected to have the greatest impact to the Lake's water quality</u>. For example, Salem Oaks tributary commonly produced samples with the highest concentrations of several pollutants, and could be a priority for future sampling and observation. Depending upon the watershed and sample results, action should be taken to help reduce pollutant loadings. For example, if phosphorus was detected in high concentrations in a tributary draining residential areas, efforts to communicate "best management practices" (BMP's) to homeowners should be reinforced, stormwater management infrastructure inspected, actions to protect and expand wetlands and buffers increased, and other factors considered. Intensified and/or expanded monitoring may help pinpoint source areas for particular attention.

Regular water quality monitoring helps Lake managers promptly identify variations in the Lake's water quality and improves the ability to understand problems and propose solutions. Given the rapidly changing landscape in which the Lake is situated, water quality and the conditions influencing water quality can rapidly change. <u>Regular review and revision of water quality monitoring recommendations should be considered a high priority</u>.

2. **Protect and enhance buffers, wetlands, and floodplains.** Protecting these features helps safeguard areas that already benefit the Lake and requires little to no additional input of money and labor. For this reason, protecting such areas should be considered <u>high priority</u>. **Enhancing these features is often a cost-efficient way of increasing the level of lake protection** and should be considered <u>a medium priority</u>. Efforts should begin by targeting direct residential inflow sources (i.e., the lake shoreline properties) and various sources from properties adjacent to the mapped tributary streams. Efforts may extend to adjacent properties as suitable. Implementation of this recommendation could involve:

    a. Continue to carefully control and limit development in SEWRPC-delineated primary environmental corridors (see Map 23 in Chapter II of this report) to protect existing natural buffers, floodplains, and wetlands systems. This may be accomplished through local zoning.

    b. Continue to enforce zoning standards set forth in Chapter NR115 of the *Wisconsin Administration Code* (Wisconsin's Shoreland Protection Program); i.e., 75 feet minimum setback from the ordinary high water mark along navigable waters in the watershed.[2]

---

[2] *The 2015-2017 State Budget (Act 55) changed State Law relative to shoreland zoning. Under Act 55 a shoreland zoning ordinance may not regulate a matter more restrictively than it is regulated by a State shoreland-zoning standard unless the matter is not regulated by a standard in Chapter NR 115, "Wisconsin's Shoreland Protection Program," of the* Wisconsin Administrative Code. *(Examples of unregulated matters may involve wetland setbacks, bluff setbacks, development density, and stormwater standards.) In addition, under Act 55, a local shoreland zoning ordinance may not require establishment or expansion of a vegetative buffer on already developed land and may not establish standards for impervious surfaces unless those standards consider a surface to be impervious if its runoff is treated or is discharged to an internally drained pervious areas. Additional legislation relative to shoreland zoning enacted after the 2015-2017 state budget legislation includes Act 41 which addresses town shoreland zoning authority relative to county authority (effective date: July 3, 2015) and Act 167which codifies and revises current Wisconsin Department of Natural Resources shoreland zoning standards.*

c. Provide information to shoreland property owners and landowners along mapped tributaries. This information should describe the benefits near-shore aquatic and terrestrial buffers provide to the Lake, and help encourage landowners to protect buffers where they still occur; and enhance, restore or create buffers in other favorable areas where none remain. This information could include installation instructions and typical costs. Such programs would be most productive if accompanied by an incentive program that helps share the cost of installation or provides tax incentives.

   Two examples of programs that could enhance buffers in the watershed include rain gardens in residential areas and Farm Service Agency programs such as the Conservation Reserve Program (CRP) and affiliated Conservation Reserve Enhancement Program (CREP) in agricultural areas. Both of these initiatives use vegetation to slow and filter stormwater runoff. If thoughtfully designed and located, groundwater recharge may also be enhanced. Grants may also be able to be procured for novel initiatives such as cropped buffers, where farmers receive a compensatory payment for growing crops that help filter runoff.

d. Consider a shoreline best management practice and shoreline buffer enhancement program. This program could encourage the development of rain gardens or buffers along the shoreline. Rain gardens can sometimes be combined with buffer strips for additive benefit. WDNR recently introduced a "Healthy Lakes" grant program that could help fund some of these efforts (Appendix L).

e. Consider obtaining conservation easements and purchasing wetlands, floodplains, and uplands in key areas. Buffers can be preserved indefinitely and can their ecological value enhanced to improve their habitat, filtering, and hydrologic functions. An example of such an approach is restoring runoff water storage capacity of the internally drained basins located to the west of the Lake. This would likely entail negotiating an agreement to compensate the owner for loss of agricultural value. Property leases, payments to supplant lost productivity, or property acquisition are examples of agreements that could enable such activities.

3. **Protect buffer, wetland, and floodplain function** by controlling invasive species that threaten ecological value. Additionally, relax human-imposed constraints placed upon watercourses. These efforts should be considered a medium priority. An example invasive species recommendation is to **monitor and control reed canary grass in wetlands and shorelands.** This species, a two- to nine-foot tall grass, spreads and quickly displaces native wetland plants that help treat polluted water before it reaches the Lake and which provide valuable wildlife habitat. Consequently, a visual survey of appropriate watershed and shoreline locations is recommended to determine whether reed canary grass is a problem. If it is found to be an issue, the infestation should be promptly eradicated.[3] Human-imposed constraints commonly manifest themselves as stream reaches that are ditched, aggressively eroding, and debris choked, incised, and or diked. Such reaches should be targeted for naturalization.

4. **Protect remaining woodlands.** Perhaps the largest threat posed to woodlands in Southeastern Wisconsin is the combined problem of diseases and insects that destroy the native tree canopy and invasive plants such as buckthorn (common buckthorn *Rhamnus cathartica* and glossy buckthorn *Frangula alnus*) that inhibit or prevent native tree regeneration. Introduced pests have attacked ash, elm, butternut, and oak species. New pests are on the horizon that target black walnut, beech, and other trees. Existing woodlands should be kept free of invasive plant species and actions can be taken to prepare the woodland for the arrival of pests. For

[3]*Reed canary grass can be controlled through burning, modifying hydrology (e.g., flooding), tilling, grazing, mulching, shading (with tree and shrub plantins, manual removal, mowing, and/or chemical treatment. These methods are commonly used in appropriate combination. More information can be found at the following website: http://dnr.wi.gov/topic/forestmanagement/documents/pub/FR-428.pdf*

example, increasing the diversity of tree species through careful stand management and or planting can help assure that complete canopy loss does not occur in the future. Actively employing these recommendations should be assigned a medium priority. State programs are available to assist woodland owners with stand management, understand tax implications, and obtain professional forestry advice.[4]

5. **Continue to maintain stormwater detention basins.** This should be considered a high priority, especially given the planned increase in urban land use. Maintenance of stormwater basins includes managing aquatic plants, removing and disposing of flotsam/jetsam, ensuring adequate water depth to settle and store pollutants, and actively and aggressively managing excess sediment. Specifications associated with the design of stormwater detention basins and maintenance requirements ensure that basins are functioning properly.[5] It is important to remember that stormwater detention ponds occasionally require dredging to maintain characteristics that protect the Lake. The frequency of dredging is highly variable and is dependent upon the design of the basin and the characteristics of the contributing watershed. Inspection of basins should be completed by the responsible regulatory entities in a manner consistent with current practices;[6] however, ensuring that owners of these ponds know the importance of meeting these requirements through educational outreach can help ensure continued proper function.

6. **Retrofitting existing and enhancing planned stormwater management infrastructure to benefit water quality** should be considered a high priority. Water quality can benefit by extending detention times, spreading floodwater, and using features such as grassed swales to convey stormwater. Implementing such work requires close coordination with the Town of Salem and the Village of Paddock Lake. Based on the analyses completed as part of this report, the North, Northwest, and West Tributaries are priority areas to consider stormwater management options.

7. **Collect leaves in urbanized areas.** This recommendation should be assigned a high priority. Leaves have been shown to be a very large contributor to total external phosphorus loading to lakes in urban settings. Data from the tributary sampling initiative suggests leaves may be an important contributor to phosphorus loads to Hooker Lake. Avoid stockpiling leaves in the street where they may be crushed and washed into the lake, or burning leaves in shoreline and ditch areas. These situations can create a strong pulse of phosphorus delivered to the Lake by late autumn rains.

8. **Stringent enforcement of construction site erosion control and stormwater management ordinances and creative employment of these practices** should be considered a high priority. Ordinances must be enforced by the responsible regulatory entities in a manner consistent with current practices;[7] however, local

---

[4]*The following website provides an overview of WDNR forestry information and programs: http://dnr.wi.gov/topic/ForestLandowners/*

[5]*Technical standards for design and maintenance of wet detention basins and other stormwater management practices can be found at http://dnr.wi.gov/topic/stormwater/standards/postconst_standards.html.*

[6]*Maintenance of stormwater detention basins was also included in the* Town of Salem – Stormwater Management Plan *adopted in March 2010. Consequently, implementation of this recommendation in a manner consistent with that plan should be prioritized by the Town.*

[7]*Enforcement of the construction site erosion control and stormwater management ordinances was also included in the* Town of Salem – Stormwater Management Plan *adopted in March 2010. Consequently, the implementation of this recommendation in a manner consistent with that plan should be prioritized by the Town. It is important to note that the recent merger between the Town of Salem and Village of Silver Lake was approved bythe Wisconsin Department of Administration. These two municipalities will officially become the new "Village of Salem Lakes" in February 2107. It is anticipated that there may be modifications to existing Town ordinances, permitting, and/or enforcement.*

citizens can help by reporting potential violations to the appropriate authorities (see “Issue 11: Implementation”).

An excellent opportunity to reduce lake sediment and nutrient loading will become available in the near future. Agricultural land use is forecast to transition to largely residential use. Whereas this may have been perceived as a negative to lake health in the past, stormwater management practices used in urbanizing landscapes can tangibly lessen pollutant loads and positively modulate runoff volumes when compared to existing agricultural land use. Therefore, if carefully and stringently enforced, modern stormwater management practices employed in the soon to be developed watershed areas may reduce the load of pollutants to the Lake and enhance dry weather baseflow. Moreover, future stormwater detention basins can be designed and located to enhance value beyond the requisite pollutant trapping and runoff detention value. If located properly, stormwater basins can provide valuable habitat functions (e.g., if a pond is located adjacent to a natural area). Similarly, stormwater detention basins can be located in areas prone to contribute to groundwater recharge, helping sustain valuable groundwater-derived baseflow to local lakes, streams and wetlands. Bioswales, unlined ditches, and a battery of other “green” stormwater management practices can add to the overall positive effect of modern stormwater management.

9. **Encouraging pollution source reduction efforts along the shorelines (best management practices)** is currently recommended as a high priority due to recent algal blooms. Pollution reduction measures include reducing fertilizer use to the maximum extent practical, ensuring cars are not leaking fluids on driveways, maintaining rain gardens to which runoff can drain, preventing soil erosion, **properly disposing of leaf litter and grass clippings (do not rake onto residential streets of assuring prompt pickup),** and properly storing salts and other chemicals so they do not drain to the Lake. Communicating these best management practices, and engaging in a campaign to encourage their use (e.g., offering to pick up grass clipping and leaves from homeowners) will likely yield a low-cost way to help improve water quality. Based upon the results of this study, these practices may be particularly valuable in the more urbanized areas such as the Salem Oaks, Northwest, and West Tributary watersheds.

10. **Managing in-lake phosphorus sources.** Although Hooker Lake is believed to receive more of its phosphorus loading from external sources, up to a forty percent of the Lake’s phosphorus may be contributed by internal loading. More data must be collected and analyzed to determine the relative importance of internal phosphorus loading. Collecting such data is considered a high priority. External loading currently contributes the largest quantities of this important plant nutrient, and all this additional phosphorus is new to the Lake. In-Lake phosphorus contributed by internal loading is “recycled” from that already in the Lake. While it can tangibly increase lake productivity, it is not as significant a factor as external phosphorus loads to the Lake. For this reason, managing external phosphorus loads should be considered a high priority, while managing in-Lake phosphorus loading should be considered a low priority. However, if external loading were significantly decreased and in-Lake phosphorus concentrations remained excessively high, managing internal phosphorus loads should be reassigned a high priority These actions help the Lake achieve less eutrophic conditions, lessen stress on the Lake’s fish and aquatic life community, help assure that natural plant-induced phosphorus sequestration processes continue, and sustain a high-quality ecosystem with more long-term resilience. Additional data needs to be collected to more fully evaluate internal loading dynamics, estimate dosing, and/or monitor treatment effectiveness. For example, additional water chemistry profiles and sediment samples from the deep portion of the Lake may need to be collected to better quantify internal loading rates.

    While a large variety of techniques can be used to reduce internal loading of phosphorus, two approaches appear to be the most promising for Hooker Lake. Additional details regarding each are provided below.

    a. **Chemical inactivation using alum.** Alum is used to purify drinking water and has been used for over four decades to improve lake water quality. Although all types of lakes have been treated with alum, lakes that lack significant external sources of phosphorus and owe much of their plant available phosphorus to internal loading are most amenable to this approach. Hooker Lake has the future potential to fit both criteria quite well, and may become well suited for alum treatment.

Alum treatments trap water-borne particles which in turn settle to the lake-bottom and form a layer of sediment that does not release phosphorus to overlying lake water under oxygenated or anoxic conditions. Water is much clearer and phosphorus concentrations are markedly lower immediately following an alum treatment. Improved water clarity catalyzes additional synergistic responses that further limit phosphorus concentrations in the Lake. Clearer water allows the plants that naturally produce marl to spread to greater depths, reinforcing the abundance of plant types that promote natural phosphorus sequestration. Lower phosphorus concentrations reduce the concentration of algae in open waters of the Lake, increasing water clarity and decreasing the load of organic matter decomposed in the hypolimnion. Decreased oxygen demand related to reduced algal decomposition allows oxygen concentrations in deeper areas to increase and/or the volume of anoxic water to decrease. Since oxygen deficient water is the catalyst for internal loading, reducing the volume (and hence extent) of anoxic water reduces the Lake's overall internal loading potential.

Care must be taken to achieve proper alum dosing. A dose should create a capping layer thick enough to form a nonreactive barrier above phosphorus bearing sediment. Since alum is acidic, buffering agents are commonly applied with the treatment. According to the WDNR, the cost for an alum treatment averaged less than $500 per acre of lake surface area in 2003 (Appendix M). Assuming average conditions and adjusting for inflation, the WDNR cost data suggests that an alum treatment for Hooker Lake may cost roughly $75,000. Others report significantly higher costs.[8] Most information sources state that benefits from alum treatments can tangibly improve water quality in stratified lakes for decades. Alum treatments on deep stratified lakes such as Hooker Lake typically benefit the Lake for 21 years. Alum treatments have reduced epilimnetic total phosphorus concentrations in some lakes as long as 45 years following treatment.[9]

b. **Hypolimnetic withdrawal and on-shore treatment** involves drawing water from deep areas of the Lake, piping it to a convenient location on the shoreline, and manipulating water chemistry using natural processes and/or induced physical and/or chemical means to cause phosphorus to come out of solution. On-shore treatment may also be employed to treat stormwater before it enters a lake.

Water can be treated in several ways after it is drawn from a lake, stream, or storm sewer, and several treatment processes can be combined for the desired result. The treatment process can rely on common municipal/industrial treatment practices, often employing prefabricated treatment system components. Alternatively, nature-like processes can be promoted in purpose built treatment cells to enhance water quality. Such treatment cells may take the appearance of ponds or wetlands. Examples of treatment processes that could benefit Hooker Lake include:

- **Aeration.** The simplest form of on-shore treatment is aeration. Air is pumped through water, increasing water oxygen concentration. The oxygenated water is then returned to deeper portions of the lake. This helps reduce the volume of anoxic water, reducing the areal extent of sediment/water conditions prone to release phosphorus to the water column, and thereby decreasing the amount of

[8]*Bassett Creek Watershed Management Commission, "Twin Lake Phosphorus Internal Loading Investigation", March, 2011.*

[9]*Huser, Brian, Sara Egemose, Harvey Harper, Michael Hupfer, Henning Jensen, Keith. M. Pilgrim, Kasper Reitzel, Emil Yydin, and Martyn Futter,* Longevity and effectiveness of aluminum addition to reduce phosphorus release and restore lake quality, *Water Research, in press.*

phosphorus released to the lake from bottom sediment. Aeration may produce phosphorus-bearing precipitates that can be captured on shore before the treated water is returned to the Lake (see below).

- **Dissolved phosphorus removal.** Dissolved phosphorus can be removed from the lake water by introducing certain compounds that combine with phosphorus forming a solid precipitate that is than collected and removed. Iron, alum, and lime can all be used to precipitate dissolved phosphorus under various pH and dissolved oxygen conditions. Since the treated water is in a controlled environment, water chemistry can be manipulated to allow any of these compounds to precipitate phosphorus.

- **Clarification.** Particles are removed from water by allowing the water to remain motionless for a period of time, by active filtration, or by centrifugal action. All of these clarification processes can be enhanced using flocculants such as alum.

- **Nature-like processes.** Water is allowed to flow, detained, and handled in ways that help remove pollutants. An example includes pumping deep lake water to a closed basin occupied by a manmade pond or wetland. Water is then aerated, comes in contact with plant material, filters through the underlying substrate, and is returned to the Lake or a tributary of the Lake through a diffuse path (e.g., created wetlands) or through the shallow groundwater system. This type of system would need to be built upon non-wetland soil areas. Significant open upland soil areas with good potential for such a treatment are found within a half mile of Hooker Lake.

On-shore treatment is currently used to improve water quality in many other lakes. For example, an active treatment system operating on Crystal Lake (a 79 acre, 35 foot deep lake in the Minneapolis metropolitan area) removed 200 pounds of phosphorus from stormwater and water drawn from the hypolimnion during its first full season of operation. This system is composed of a large vessel, operates between May and November, and can treat over one million gallons of water per day. This treatment volume equals about one-third of the Lake's entire volume over the period of operation.[10] Another community chose to polish wastewater to remove phosphorus using constructed wetlands and a carefully engineered groundwater recharge area to supplement flow in a high quality river.

The prevailing water elevation and lake outlet flow rate influences the method chosen to withdraw water. If the rate of withdrawal could be expected to exceed the lake outlet's discharge rate, the treated water should normally be returned to the lake to reduce the potential for lowered lake levels. In this case, lake water can be actively pumped to an area topographically higher than the lake, treated, and be allowed to return to the lake directly (via tributaries) or indirectly (via shallow groundwater). If lake elevations and outlet flow are moderate to high, water can be drawn from deep portions of the lake with little or no active pumping under favorable topographic conditions. Flashboards or gates can be used to prolong the period of time such a system could operate without reducing lake levels from normal elevation ranges. Water is treated prior to discharge.

The cost of on-shore treatment varies widely and depends upon the type and intensity of treatment desired. Custom-built on-shore treatment plants require significant capital investment to construct and continual input of labor, services, and consumable supplies over long periods of time. For example, the large system installed on Crystal Lake, Minnesota to resolve severe stormwater quality issues (see preceding paragraph) cost over one million dollars to build and $90,000 per year to operate. Equipment may sometimes be leased and delivered onto a site as a prefabricated package

---

[10]*Dullinger, Danielle, "Robbinsdale working to clean up Crystal Lake", StarTribune, March 11, 2014,http://www.startribune.com/robbinsdale-working-to-clean-up-crystal-lake/249536501/*

plant. In such a case, the risk of long-term commitment is reduced. Furthermore, smaller plants operating over extended periods of time can incrementally reduce the amount of phosphorus in a lake that does not suffer from ongoing heavy external loads. The cost of nature-like systems depends upon desired location and treatment capacity. In the right setting, little special investment may be needed aside from pumps, piping, and ongoing utility costs.

Implementation of these recommendations will significantly contribute to tracking and improving the water quality within Hooker Lake. However, since there is currently insufficient data to determine the level of need for these programs, **water quality management recommendations should be re-evaluated** and likely assigned a <u>medium priority</u> after additional water quality data become available (e.g., in three to five years) and trends are evaluated. This will help quantify how much water quality management effort should be undertaken as well as clarify the relative importance of internal loading to the Lake's overall phosphorus budget, and, relatedly, the need for in-lake phosphorus treatment.

ISSUE 2: WATER QUANTITY

Lake residents have expressed concern regarding several issues related to water quantity. Some of these issues focus on particular concerns (e.g., drainage from the the STH 83 area) while others are applicable to all portions of the watershed (e.g., maintaining groundwater supplies). As mentioned in the Chapter 2, maintaining water levels and flushing rates can be crucial to the health of the Lake. Slowing runoff and increasing baseflow are key principals to reduce extreme lake elevation fluctuation and maintain water quality. Consequently, the following recommendations are made to address monitoring and water quantity measurements:

1. **Lake elevation monitoring should be continued as a part of the regular CLMN data collection using the staff gauge already present in the Lake.** The reference point elevation must be related to a known datum to allow comparison to data collected in the past and the future. This is considered a <u>medium priority</u>. Continued monitoring is necessary, so that any issues can be detected early and a long-term Lake level record is obtained. Automated lake level systems are available and may be useful to link to public websites. Real time data may be useful to better enforce boating ordinances.

2. **Quantify the volume of water delivered to the Lake from the various subwatersheds.** At a minimum, stream flow should be quantified when water quality samples are collected, and is given a <u>high priority</u>. Additional measurements should be made to help quantify flow during fair weather, periods of heavy runoff, and dry weather. Runoff estimates can be made using empirical formulae or models. Additional measurements and modeling require substantial amounts of labor and/or cost. The HLMD should check with the Town of Salem and the Village of Paddock Lake to determine if these municipalities have collected useful flow and water quality data and/or have refined their runoff models (<u>high priority</u>).

3. **Upgrade or construct stormwater detention and treatment infrastructure to help reduce the quantity of sediment, nutrients and pollutants entering the lake, reduce peak flows in tributary streams, and reduce stream channel erosion.**This should be considered a <u>high priority</u> If properly designed and positioned, these practices can also reduce the volume of runoff and meaningfully contribute to groundwater recharge. Practices include detention/retention basins, swales, two-stage ditches, and on-line storage areas. Such practices are generally most practical and effective if dispersed in headwater areas. Such practices may be valuable to reduce water flow rates and sediment/pollutant loads in the western tributary area specifically mentioned by Lake residents, but are applicable throughout the Lake's watershed. Specific actions targeted at the western watershed area include the following:

    a. Investigate drainage from internally drained area at the extreme northwest corner of the Lake's watershed. Determine if water quantity and/or quality has been influence by recent ditching. Consider working with the land owner to improve the situation. Enhance water holding capacity, infiltration, and duration of ponded water in internally drained basins.

b. Upgrade the existing stormwater detention basin to improve water quality treatment performance. The current design was primarily intended to reduce flow rates, not improve water quality.

c. Identify opportunities for supplemental stormwater detention/retention basins. Most opportunities likely exist west of STH 83. Prioritize locations within the three identified watersheds immediately west of Hooker Lake that are not fitted with any stormwater quantity/quality infrastructure.

d. Naturalize conveyance channels. Encourage the use of swales as opposed to curb and gutter, piped, or paved channels. Incorporate or reconnect floodplains to slow water and decrease stream power.

e. Encourage application of best management practices, buffers, and lot-scale stormwater management. Examples include buffers along water course corridors in rural areas and rain gardens in urban areas.

4. **Developing a comprehensive water budget (and potentially a delineation of the area contributing groundwater to the Lake) should be considered** a medium priority if water levels change. A water budget will help better determine where groundwater supplied to Hooker Lake is coming from, and can help target management efforts to maintain or increase groundwater discharge. Additionally, if the water budget determines that groundwater flow is a significant contributor to the Lake, a delineation of the area contributing groundwater can be used to determine what areas need to be protected to ensure an adequate groundwater supply.

5. **Implementing measures to promote infiltration in near-shore residential areas** is a medium priority. Implementation of this recommendation could involve:

a. Improve infiltration of rainfall and snowmelt through installation of innovative BMPs associated with low-impact development, including rain garden projects (see Figure 44).[11] (Some of these projects can be partially funded through the WDNR “Healthy Lakes” initiative.); and

b. Retrofit current urban development (e.g., disconnect downspouts, install permeable pavement). This can be encouraged through educational outreach and by providing resources to lakeshore property owners.

6. **Reducing the impacts of future urban development** is a high priority. This recommendation can be implemented by:

a. Enforce the infiltration recommendations in the current Town of Salem Stormwater Management Plan, which sets infiltration requirement criteria;[12]

b. Protect high groundwater recharge potential areas. Consider local and more regional flow systems. Consider purchasing land or obtaining conservation easements on agricultural and other open lands with high groundwater recharge potential; and

---

[11] *Rain gardens are depressed basins that maintain native plants and help water infiltrate into the ground rather than entering the Lake through surface runoff. Rain gardens can help reduce the amount of erosion and unfiltered pollution entering the Lake and can stabilize baseflow to the Lake.*

[12] *R.A. Smith National Inc.,* Town of Salem - Stormwater Management Plant, *p. 2-8. This recommendation can be found at: http://www.townofsalem.net/vertical/sites/%7BFD43A93D-1DA7-4F52-8644-C09DA66C3401%7D/uploads/%7B9CAD9918-E8E5-4552-8FB9-EA052415CF0B%7D.PDF.*

c. Promote consideration of groundwater conditions when designing new developments. This could include encouraging developers to incorporate infiltration in site designs and local government consideration of groundwater recharge as an integral part of development proposals.[13]

7. **Continue to protect wetlands and uplands by enforcing County zoning ordinance** as discussed in the "Issue 2: Water Quality" section of this chapter. This is a medium priority.

As with the other recommendations made in this chapter, future changes in Lake elevation or outflow will spur the need to reevaluate the above recommendations. Plan reevaluation should be assigned a medium priority.

Figure 44

EXAMPLE OF A RAIN GARDEN

NOTE: Further details are provided on Natural Resources Conservation Service and Wisconsin Department of Natural Resources Websites at: http://www.nrcs.usda.gov/Omtermet/FSE_PLANTMATERIALS/publications/ndpmctn7278.pdf; and http://dnr.wi.gov/topic/Stormwater/raingarden/.

Source: U.S. Department of Agriculture, Natural Resources Conservation Service.

ISSUE 3: LAKE OUTLET DAM

As discussed in Chapter II, the dam that currently regulates the level and outflow of water from Hooker Lake is privately owned and was reconstructed in 2002. The owner of the dam permits HLMD personnel to periodically visit the dam to clear debris. Several recommendations are associated with the dam.

1. **The HLMD should continue to regularly monitor the spillway and downstream road crossing culvert for debris. Debris should be cleared to prevent it from restricting water outflow and unintended lake elevation changes.** This should be considered a high priority.

2. The **HLMD or another public entity should consider acquiring the dam.** This will help assure adequate maintenance and access to potential funding sources. This should be considered a medium priority, but may need to be elevated to high priority, if action is needed to correct dam deficiencies.

3. Complaints of flooding have occurred since the dam was reconstructed in 2002. **Available information suggests that the spillway capacity of the new dam may be less than the old dam and the spillway elevation is now about 10 inches higher than permitted.** This could create higher lake water levels during heavy runoff periods than would have occurred before reconstruction of the dam. As the regulatory agency for dam safety in the State, WDNR should evaluate the situation regarding the spillway capacity and take appropriate action. This should be considered a high priority. Depending on how the spillway issue is resolved, consideration may need to be given to revising the floodplain model and the floodplain maps for Hooker Lake.

---

[13] *Some Wisconsin communities have promulgated groundwater protection ordinances that require consideration of development's effect on groundwater supplies and surface-water/groundwater interactions. For example, the Village of Richfield in Washington County has passed such an ordinance. More information on the Richfield ordinance may be found at the following website: http://www.richfieldwi.gov/DocumentCenter/View/651*

4. **4.** Records now available suggest that the dam may not comply with regulatory agency standards. For example, **the dam's spillway may not be able to pass a sufficient amount of water to comply with WDNR regulation,** and could theoretically be unstable at high flow. The status of the dam should be reviewed, and action should be taken to correct deficiencies. This should be considered a <u>high priority</u>.

5. In conjunction with water elevation monitoring, **a rating curve should be developed relating water elevation with Lake outflow.** This may help with applications to apply aquatic chemicals and is useful to determine the Lake's water budget. This should be considered a <u>low priority</u>.

ISSUE 4: AQUATIC PLANT GROWTH

As discussed in Chapter 2, Hooker Lake historically contained a fairly diverse aquatic plant community capable of supporting a warm water fishery as well as a wide range of recreational uses. However, the 2014 survey (see Appendix F for distribution maps) also reveals three major reasons why revising the aquatic plant management activities and establishing a plan consistent with Lake conditions should be considered a <u>high priority</u>. These reasons include 1) high volumes of plants and algae that deter recreational use; 2) existence of invasive EWM, which could potentially threaten the long-term stability of the native aquatic plant community; and, 3) a potentially fragile and declining native plant community as evidenced by the relatively low numbers of native pondweeds in the Lake and the decline in plant species from 2008 to 2014.

This section describes a comprehensive aquatic plant management plan based on the preliminary recommendations provided in Chapter II. The recommendations presented below form the nucleus of an aquatic plant management plan for Hooker Lake and attempt to balance three major goals:

1. Promote that the current recreational use of the Lake (e.g., swimming, boating, and fishing) be maintained to the greatest extent practical,
2. Protect the native aquatic plant community, and
3. Effectively control invasive plants, especially EWM populations.

The conceptual plan described below relies upon common, State-approved, aquatic plant management alternatives listed in Chapter 2 including manual, biological, physical, chemical, and mechanical plant control measures.

Plant Management Recommendations

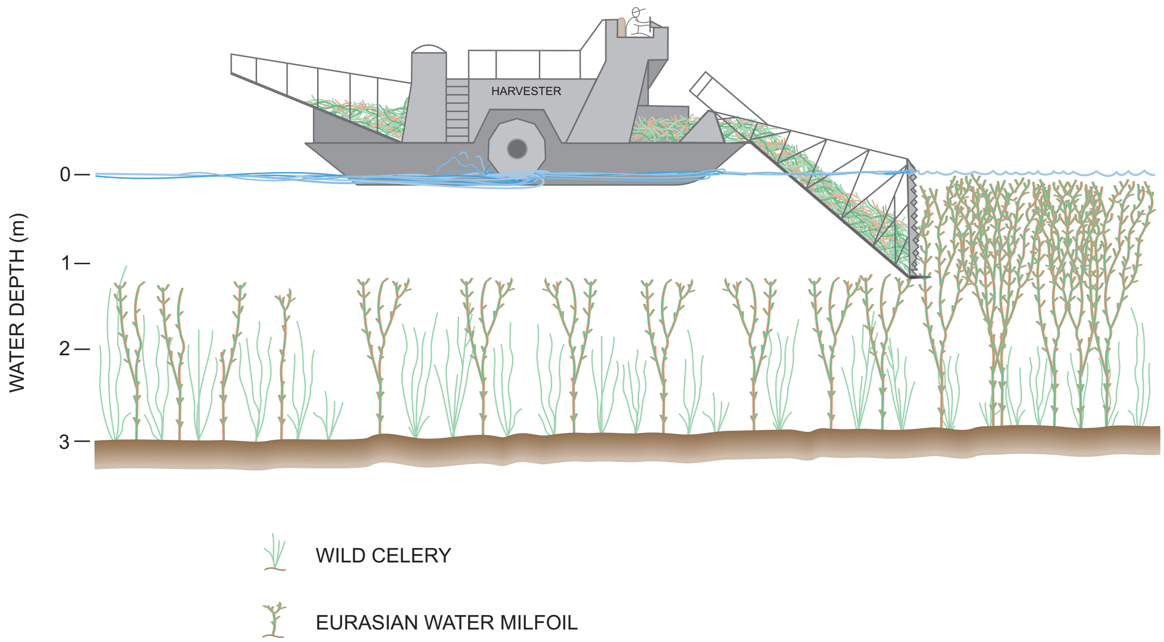
The most effective plans for managing nuisance and invasive aquatic plants combine several methods and techniques. A "silver bullet" single-focus strategy rarely produces the most efficient or best result. Therefore, to enhance access to Hooker Lake while maintaining Lake health, three aquatic plant management techniques are recommended under this plan, as described below:

1. **Create navigation lanes in high-traffic/critical access nearshore areas.** This should be considered a high priority. As can be seen on Map 24, *navigation lanes* are recommended for the portion of the Lake shoreline bordered by residential properties. Priority access lanes should be provided at the three public access sites, some of which also serve adjacent residential areas. To avoid further loss to the native aquatic plant community, plant harvesting is the preferred method to establish and maintain navigation lanes. Harvesting, as opposed to simple cutting, requires that several details be specified to ensure continued recreational use of the Lake and the health of the native plant community. These details include:

   a. **Leave at least one foot of uncut plant material rooted to the Lake bottom while harvesting.** This should be considered a <u>high priority</u> and is done to avoid agitating lake-bottom sediment and helps ensure native plants communities are maintained. Disturbing lake-bottom sediment can uproot native plants and promote colonization of new areas by EWM. Leaving one foot of uncut plant material is gen-

Figure 45

PLANT CANOPY REMOVAL OR "TOP CUTTING" WITH AN AQUATIC PLANT HARVESTER



NOTE: Selective cutting or seasonal harvesting can be done by aquatic plant harvesters. Removing the canopy of Eurasian water milfoil may allow native species to reemerge.

Source: U.S. Department of Natural Resources and SEWRPC..

erally easy to accomplish when water depths are three feet or greater. However, when water depths are less than three feet, special care should be employed. Consequently, all areas less than three feet deep are designated as "shallow-cut only" areas. This means that, in these areas, only the "top cut" technique (see Figure 45) should be used. Harvesting should not occur where the harvester is unable to leave one foot of plant material. Instead, raking and hand-pulling should be used in these areas. Likely areas for raking and hand-pulling are depicted in Map 24.

b. It should be a <u>high priority</u> to **inspect all cut plants for any live animals and immediately return such animals to the Lake.** Some animals get entangled in plants and caught in the harvester, particularly when cutting larger plant mats. Consequently, cut plants must be carefully examined to avoid inadvertent harvest of fish, crustaceans, amphibians, turtles, and other animals.

c. **Harvesting should not occur in the early spring** (<u>high priority</u>) to prevent disturbing spawning fish.

d. **All harvester operators must undergo WDNR training to help assure adherence to harvesting permit specifications and limitations** (<u>high priority</u>). Training should be provided by the regional WDNR aquatic invasive species coordinator and should cover, at a minimum 1) "deep-cut" versus "shallow-cut" techniques and when to employ each according to this plan; 2) review of the plan, associated permit, and review of the need to restrict cutting in shallow areas; and 3) plant identification to encourage conservation of native plant communities. Additionally, the training should ensure that all harvester personnel are aware that they must record their work for inclusion in permit-required annual harvesting reports.

e. Harvesting can fragment plants. Plant fragments may float in the Lake and accumulate on shorelines, creating aesthetic and recreational use problems. Harvesting can also help spread undesirable plants as some plants can reproduce themselves from fragments. **A harvesting program should include a**

Map 24

AQUATIC PLANT MANAGEMENT PLAN MAP FOR HOOKER LAKE: 2016

[a]Navigation lanes are drawn to scale.

Source: U.S. Department of Natural Resources and SEWRPC.

comprehensive plant pickup program that all residents can use (high priority). This helps assure that harvesting activities do not become a nuisance for lake residents. A plant pickup program typically includes residents raking plants and placing them on their pier for weekly pickup. This may be combined with a regular effort by harvester operators to pick up cut plant fragments. Efforts should be as collaborative as practical.

2. **Hand-pulling and/or raking for nuisance plant growth, including EWM, in the near-shore areas** should be considered a medium priority. A permit is not required for these activities for individual landowers employing this practice on a 30-foot width of their own shoreline (including the recreational use area such as a pier) that does not exceed a 100-foot distance into the Lake, as long as all the resulting plant materials are removed from the Lake. It is also recommended that, prior to the "hand-pulling" season, an educational campaign be promoted to assure that shoreline residents know the value of native plants, the relationship between algae and plants (i.e., fewer rooted plants is commonly related to more algae), the basics of plant identification, and the specifics about the actions they are allowed to legally take to "clean up" their shorelines.[14]

3. **Chemical treatment** has historically been the primary method used to manage aquatic plant in Hooker Lake. Recently, a **whole-lake chemical treatment strategy** has been suggested to manage EWM. The WDNR considers such treatments on a lake-by-lake basis, but, given the significant decrease in aquatic plant species diversity, the WDNR is unlikely to support a whole-lake chemical treatment at this time. Therefore, chemical treatment is given a low priority. **If the HLMD believes chemical treatment is needed in the future, it will need to contact the proposed chemical applicator to collect information needed to seriously consider this option.** The information that would need to be collected includes:

   a) A list of proposed alternatives for chemicals and or admixtures

   b) Target concentrations and treatment methodologies

   c) Probable cost and schedule

   d) The anticipated longevity of the treatment

   The WDNR considers the following elements when reviewing a whole-lake permit application:

   - Lake volume. The entire lake volume needs to be calculated. The volume of the epilimnion layer[15] needs to be broken out because the amount of chemical applied is based on the volume of water in the epilimnion alone.

   - Water temperature profile. Whole-lake treatments are most effective and typically required to be implemented in spring as soon as possible after the Lake stratifies. Lake temperature profiles should be monitored to ensure the whole lake is fully stratified. The temperature of the epilimnion needs to be monitored to ensure the minimum temperature requirements specified by use of directions of the chosen chemicals are met.

   - Target plant density and the thresholds for applying a whole lake treatment. A typical threshold is average Eurasian and hybrid water milfoil rake fullness rating of between two and three at a minimum of 35 percent of vegetated sampling sites, based on a recent comprehensive point-intercept aquatic plant survey;

---

[14]*SEWRPC and WDNR staff could help review this document.*

[15]*When completely stratified, the epilimnion layer is the top layer of the lake that is warmer and less dense. The chemicals will mix throughout that layer but are unable to break through the thermocline layer, which acts as a barrier.*

- Native Plants. The type and abundance of native plant populations and their sensitivity to chemical treatments.

- Distribution. Are native plant communities more monotypic or are they intermixed with EWM and natives.

  A whole-lake treatment may need to be followed later in the year by harvesting or chemical treatments to maintain navigation lanes.

  Care must be exercised to carefully choose herbicides that at least somewhat selectively control EWM, hybrid water milfoil (HWM), and curly-leaf pondweed to prevent unintentional loss of native aquatic species. A **WDNR permit and WDNR staff supervision are required to implement this alternative.** Additionally, lakeshore property owners need to be informed of the chemical treatment and permit conditions before applying chemicals. **Residual chemicals concentrations should be monitored** after application is complete. Generally, chemical residue monitoring is undertaken as a standard component of whole-lake treatments to determine if applied chemicals are well dispersed throughout the Lake.

  A further complication of the whole lake treatment scenario is the presence of **HWM,** which has been found in Hooker Lake. **Properly adjusting the treatment dosage can be a difficult task.** Too high a dosage can significantly damage the native plant population while too low a dosage could actually promote evolution of herbicide resistance HWM by killing the susceptible plants but leaving the heartier strains to propagate into an infestation that would be increasingly difficult to control with chemicals. Furthermore, accurate dosage relies on precise and current lake bathymetry, confirmed HWM identification (possibly through DNA analysis), and may require multiple samples of HWM be collected from the Lake and tolerance tested (through a process known as “challenge testing”) to accurately determine the plant’s susceptibility to various chemical mixes.

Map 24 locates elements of the proposed aquatic plant management plan and helps aquatic plant managers implement aquatic plant management plan recommendations. Nevertheless, aquatic plant management must react to what is actually occurring at the time of treatment. Consequently, this aquatic plant management plan must be reevaluated every three to five years (before the end of the five-year permitting cycle). Reevaluation is assigned a <u>high priority</u>. This effort should include a comprehensive point-intercept aquatic plant survey, a summary of aquatic plant management activities actually completed during the subject period, and an evaluation of plant community dynamics. This will help lake managers quantify and judge the effectiveness of the aquatic plant management plan described in this report and make appropriate adjustments.

Native Plant Community and Invasive Species Recommendations

1. Protect native aquatic plants to the highest degree feasible through careful application of aquatic plant management and water quality recommendations (<u>high priority</u>). Hooker Lake’s native plant community has been declining. Native plants provide wildlife habitat. **Muskgrass growth is particularly beneficial as it stimulates marl formation and phosphorous sequestration.**

2. Invasive species compromise the health and resilience of native plant and wildlife communities and are commonly a nuisance to lake recreation. Consequently, active invasive species management is recommended and is given <u>high priority</u>. **The most problematic invasive species currently in or around Hooker Lake are EWM, HWM, curly leaf pondweed and potentially reed canary grass.** All of these may be treated through manual or chemical methods. Mechanical and chemical aquatic plant control methods should follow best management practices to avoid spreading invasive plants and lower the stress imposed by invasive species on the native plant community.

3. Avoid disrupting bottom sediment or leaving large areas of bottom sediment devoid of vegetation to lower the risk of nonnative species recolonization (<u>high priority</u>). Invasive species tend to thrive under disturbed bottom conditions. EWM in particular thrives in such areas.

4. EWM, HWM, and curly leaf pondweed grow early in the season, earlier than many native aquatic plants. Executing control methods as early as practical in the spring can help minimize damage to native aquatic plant communities (high priority). Even though chemical treatment is not recommended at the present time, early spring chemical applications are more effective due to colder water temperatures, a condition enhancing the herbicidal effect and reducing the concentrations needed for effective treatment. Early spring chemical treatment also helps reduce human exposure through lower human contact with lake water when water temperatures are still cold. Lastly, early season eradication of curly leaf pondweed helps lower production of turions (a dormant plant propagule) that is the dominant preproduction method for this plant.

5. Introduction of new invasive species is a constant threat. **Preventing introduction and establishment of new invasive species** is crucial to maintaining healthy lakes. Starry stonewort – Figure 46, though not discussed in Chapter II, is a recently discovered invasive species posing a distinct risk to the Lake. To help decrease the chance of introduction, the following recommendations are given high priority:

   a. **Continue to educate residents and Lake users as to how they can help prevent invasive species from entering their lake** (Appendix N) and which species to look for, as new threats are continuously evolving;

   b. The HLMD should consider **enrolling in the Clean Boats Clean Waters program** (a State program targeting invasive species prevention) to proactively encourage lake users to clean boats and equipment before launching and using them in the Lake.[16] This will help lower the probability of invasive species entering Hooker Lake;

   c. Since boat launches are likely entry point for alien species, **boat launch sites should be targeted for focused aquatic plant control**; and

   d. If a new alien species infestation is found in the Lake, **efforts to eradicate the new species should immediately be evaluated and, if possible, be employed to help prevent establishment.** The WDNR offers funding that can aid early eradication efforts, particularly as it pertains to aquatic plants (Table 27). Therefore, citizen monitoring for new invasive species is recommended. The Wisconsin Citizen Lake Monitoring Network (CLMN) provides training to help local citizens engage in these efforts.

6. Chemical treatment has been the primary method of aquatic plant management in Hooker Lake. However, the spot treatment protocols used to date have shown to be largely ineffective. In fact, **the WDNR no longer recommends spot treatment as a viable method of aquatic plant management,** especially to address EWM. Therefore chemical treatment is assigned a low priority.

7. Given the loss of species diversity that has occurred in the Lake, at least some of which may be related to the use of aquatic herbicides, **the HLMD should consider aquatic plant harvesting to keep navigation lanes clear of vegetation (high priority).** Aquatic plant harvesters are used at many other lakes in the area, and several models are available. Harvesting can be completed by a contract service provider, or the HLMD can purchase and operate a harvester.

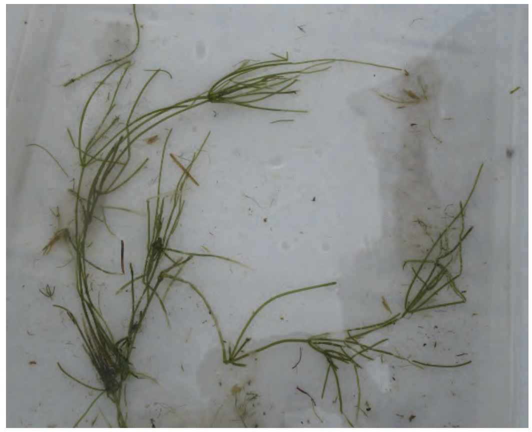
Map 24 is provided to help future aquatic plant managers implement the aquatic plant management plan recommendations. However, aquatic plant management must consider and react to what is actually occurring in the Lake at the time of treatment. Consequently, **this aquatic plant management plan should be reevaluated in three to five years** (at the end of the five-year permitting cycle). Periodic plan review and re-evaluation is assigned a high priority. This effort should include a comprehensive aquatic plant survey and an evaluation of the the relative effectiveness

---

[16]*Further information about Clean Boats Clean Waters can be found on the WDNR website at: http://dnr.wi.gov/lakes/cbcw/.*

Figure 46

AQUATIC INVASIVE SPECIES WATCHLIST



STARRY STONEWORT
(*Nitellopsis obtuse L.)*

- Distinctive star-shaped bulbils

- Side branches arranged in whorls or 4-6 branchlets; more robust than other members of family

Source: Paul Skawinski, Skawinski, P.M. (2014). Aquatic Plants of the Upper Midwest: A Photographic Field Guide to Our Underwater Forests. *Wausau, Wisconsin, USA: Self-Published., Wisconsin Department of Natural Resources, Vic Ramey, University of Florida, Minnesota Sea Grant, Ohio Sea Grant, and SEWRPC.*

of recent aquatic plant management activities. This will help lake managers evaluate the continued suitability of the aquatic plant management measures described in this report and make appropriate changes to the plan.

ISSUE 5: CYANOBACTERIA AND FLOATING ALGAE

Algal blooms have become a concern in Hooker Lake in recent years. Preventing excessive algal growth should be considered a medium to high priority. Four recommendations address this concern:

1. **Maintain and improve water quality** by implementing recommendations provided in the “Issue 1: Water Quality” section of this chapter. Initial efforts should be focused on reducing external phosphorus loading. Address internal phosphorus loading if excessive external loading is controlled water quality and algal blooms persist.

2. **Maintain a healthy aquatic plant community** (to compete with algal growth) by implementing recommendations provided in the “Issue 4: Aquatic Plant Growth” section of this chapter (high priority).

3. **Algae in the Lake should be monitored.** This effort should focus on monitoring chlorophyll-*a* (high priority), as was described in the water quality monitoring recommendation above. When large amounts of suspended algae grow, this monitoring could also include collecting and identifying algae to check whether a toxic strains are present (medium priority).

4. **Residents should be warned to not enter the water in the event of an excessive algal bloom.** This should be considered a high priority if algal blooms contain toxic strains. Therefore, a method to quickly communicate water conditions adverse to body contact should be developed.

Implementing the above recommendations will help assure that algae growth does not preclude or greatly inhibit Lake use.

ISSUE 6: RECREATIONAL USE AND FACILITIES

Hooker Lake is popular with boaters who live on the Lake and who trailer watercraft to the Lake. **The Village of Paddock Lake operates a public boat launch that meets the requirements necessary for the Lake to receive public funding.** Although little work is needed at the present time, maintaining this public boat launch should be

Table 27

EXAMPLE WDNR GRANT PROGRAMS SUPPORTING LAKE MANAGEMENT ACTIVITIES

Category	Program	Grant Program	Maximum Grant Award	Minimum Financial Match	Application Due Date	Examples of Potentially Eligible Issues
Water	Surface Water Grants	Aquatic Invasive Species (AIS) Prevention and Control	Education, Prevention, and Planning Projects: **$150,000**	25%	December 10	Issue 4
			Established Population Control Projects: **$200,000**	25%	February 1	
			Early Detection and Response Projects: **$20,000**	25%	Year-Round	
			Research and Development: annual funding limit: **$500,000**	25%	Year-Round	
			Maintenance and Containment: **permit fee reimbursement**	25%	Year-Round	
		Lake Classification and Ordinance Development	**$50,000**	25%	December 10	Issues 1, 2, 6, 7
		Lake Protection	**$200,000**	25%	February 1	All
		Lake Management Planning: Large and Small Scale	Small-Scale: **$3,000**	33%	December 10	
			Large Scale: **$25,000**	33%	December 10	
	Citizen-Based Monitoring Partnership Program		**$4,999**		Spring	Issues 1, 2
	Targeted Runoff Management	- -	Small-Scale: **$150,000**	30%	April 15	Issues 1, 4, 5
			Large-Scale: **$1,000,000**	30%	April 15	
	Urban Nonpoint Source & Stormwater Management	- -	Design/construction: **$150,000**	50%	April 15	
			Property Acquisition: **$50,000**	50%	April 15	
Conservation & Wildlife	Knowles-Nelson Stewardship Program	Acquisition of Development Rights		- -	May 1	Issues 1, 2, 4, 5, 6, 7
		Natural Areas		- -	February 1, August 1	
		Sport Fish Restoration	- -	50%	February 1	Issue 8
		Streambank Protection		- -	February 1, August 1	Issues 1, 2, 3, 4, 7
Boating	Boat Enforcement Patrol	- -	Up to **75% reimbursement**	None	Various	Issue 6
	Recreational Boating Facilities	- -	Up to **$100,000 per state**	50%	- -	
Recreation	Knowles-Nelson Stewardship Program	Acquisition and Development of Local Parks	- -	- -	- - May 1	Issues 7, 8
		Habitat Area	- -	- -	February 1, August 1	
		Urban Green Space	- -	- -	- - May 1	

NOTE: More information regarding these example grant programs may be found online at the following address: http://dnr.wi.gov/aid/grants.html. Additional federal, state, and local grant opportunities are available.

Source: Wisconsin Department of Natural Resources and SEWRPC.

considered a high priority. This could include elements that help reduce the chance of spreading invasive species such as deploying trained volunteers to inspect boats and distribute literature during high-use periods. The two Town of Salem boat launch sites should also be managed to help reduce the chance of spreading invasive species.

Boat counts suggest that Hooker Lake is subjected to boat densities at the upper end or slightly exceeding desirable levels during high-use periods. Excessive boat density decreases the ability of the Lake to safely, sustainably, and satisfactorily support a wide range of activities. This means that **the potential for use conflicts, safety concerns, and environmental degradation is slightly higher than desirable on Hooker Lake during weekends and holidays.** To help avoid such problems, existing boating regulations should be reviewed for compatibility with current conditions and expectations and the ordinances should be conscientiously enforced. Given the variability of boating density, this recommendation should be considered a low priority for week days, but a high priority for weekends and holidays.

Demand for power boating on Hooker is on the verge of exceeding desirable capacity during peak-use periods. Common economic theory suggests that demand can be reduced if cost increase. Cost can include the price paid to launch a boat or other factors such as convenience. Certain changes can be made that both benefit the long-term health of the Lake and may place negative pressure on demand. These changes include the following:

- Review water-based recreation ordinances and modify as necessary. Stringently enforce the regulations, especially during holidays and weekends. Consider a water patrol. Grants are available to assist with revision and development of ordinances and with water patrols.
- Increase the current base boat launch fees from $7.00 to $8.00 as allowed by State law.
- Consider surcharges, particularly on weekends and holidays, such as the following:
  - Twenty per cent surcharge for toilet facilities. Potentially also apply to weekday rates to enhance revenue available for weekend/holiday launch attendants.
  - Large boat surcharges on weekends. An attendant would need to be on site for effective application.
  - Have an attendant on duty during all summer weekends and holidays. The attendant’s primary duty would be to implement Clean Boats/Clean Waters watercraft inspections (Appendix N) and distribute literature to help lake users understand invasive species issues. A surcharge of 20 per cent may be charged when an attendant is on duty, and the attendant can also be responsible for launch surcharges for large boats.

Increasing launch fees is assigned an overall medium priority, the implementation of which is dictated by the needs and perceptions of Lake users. Nevertheless, an attendant trained in Clean Boats/Clean Waters inspection protocol should be considered even if no increase in launch fees is desired. Such an inspector can help reduce the probability of the spread of invasive species into the Lake and other lakes, and should be considered a high priority.

ISSUE 7: SHORELINE MAINTENANCE

Shoreline maintenance is assigned medium to high priority due to the results of the shoreline assessment conducted in 2014, which reveal areas of erosion, unprotected banks, a large portion of unbuffered shoreline, and failing shoreline protection. The major recommendations related to shoreline maintenance are:

1. **Encourage repair or removal of failing “hard” shoreline structures.** This should be considered a high priority and could be done by educating private landowners and donation-based cost-share programs. Removal may require technical expertise; consequently, it is also recommended that WDNR and shoreline restoration experts be consulted and integrated into the process.
2. **Educate residents and shoreline property owners on the importance of buffers and appropriate shoreline protection measures** consistent with lake use and guidelines presented in the Healthy Lakes Initiative Plan. This should be considered a high priority.

3. **Encourage installation of "soft" or "natural" shoreline protection** (e.g., bio-logs, buffers, native shoreline plantings, and native aquatic plantings) **whenever appropriate. Focus on areas where little to no shoreline protection exists or where erosion is currently taking place.** Natural shoreline protection has the additional benefit of deterring nuisance geese from congregating along shorelines. This action should be considered a medium priority. Should these shoreline protections take the form of shoreline buffers (as recommended in the "Issue 1: Water Quality" section of this chapter), funding would be available from WDNR through the "Healthy Lakes Initiative" that can be used for these types of projects.

4. **Ensure enforcement of shoreline setbacks/shoreland zoning** as discussed in the "Issue 2: Water Quality" section (high priority).

Implementing programs that encourage stable and ecologically friendly shorelines will greatly contribute to the health of the Lake in terms of wildlife populations, sedimentation, and water quality. To track success, **it is also recommended that shoreline restoration goals be established and that a new shoreline assessment be completed after a shoreline restoration program has been implemented** (medium priority). This will help document progress and may be useful in future reports and/or grant applications.

ISSUE 8: FISH AND WILDLIFE

Wildlife is reliant on Lake health. The presence of wildlife increases recreational use and enjoyment of the Lake and the functionality of the Lake as an ecosystem. To enhance wildlife within the Hooker Lake watershed, the following recommendations are made:

1. **Continue current fish stocking practices.** Stocking of northern pike may improve the largemouth bass population and community structure. This should be considered a medium priority. Stocking helps assure that the fishery is maintained while efforts to better support natural fish propagation are developed and implemented.

2. **Current fishing practices**[17] **and ordinances should continue to be enforced** because the current fishery appears to be healthy. This requires no direct change, and would therefore be a medium priority, unless current fishery characteristics or recreational uses tangibly change.

3. **Identify and remove fish passage barriers on streams.** Even ephemeral streams (streams which dry up seasonally) provide fish passage to spawning and nursery grounds. All four streams with mapped connections to the Lake run through wetlands, which are critical feeding, breeding, and spawning habitat for many fish species including northern pike. Fish passage barriers are often categorized by scale. Small scale barriers include debris jams, sediment and railroad ballast accumulations, and overgrowth of invasive plants. Such barriers are commonly not recognized as problems, but can significantly effect fishery vitality. Large scale barriers include dams and culverts that are perched, too narrow, or too long. These barriers vary greatly in their ease of removal. Best management practices include prioritization of barrier removal along a single stream, with highest habitat benefits and highest ease of removal given the highest rank for remediation. Ozaukee County's Fish Passage Program is highly developed and is a good information resource.[18] Removing fish passage barriers should be considered a medium priority. Fish passage projects often require frequent communication and active collaboration with private land owners, municipalities, and highway departments.

[17] *Should residents be interested in reducing carp populations, catching and removing carp and catching and releasing northern pike would be advantageous.*

[18] *See website at http://www.co.ozaukee.wi.us/619/Fish-Passage*

4. **Improve aquatic habitat in the Lake by maintaining or installing large woody debris and/or vegetative buffers along the Lake's edge.** The Lake's shorelines have been sanitized through traditional landscaping practices, a situation that reduces habitat value for aquatic organisms. Implementing this recommendation could take the form of educational or incentive-based programs to encourage riparian landowners to install "fish sticks"[19] (see Figure 47), to leave fallen trees in the water, and to develop buffer systems along the shoreline. This should be considered a <u>medium priority</u>. WDNR grant money is available through the "Healthy Lakes" program on a competitive basis for implementing "fish sticks" projects. Installing buffers will provide the added benefits of deterring geese populations from congregating on shoreline properties and promoting better water quality.

Figure 47

EXAMPLES OF COMPLETED "FISH STICKS" PROJECTS

Source: Wisconsin Department of Natural Resources.

5. **Encourage adoption of best management practices to improve wildlife populations.** This should be a <u>medium priority</u>, although this should increase to a higher priority if wildlife populations decline. The acceptance and employment of best management practices can be fostered through voluntary, educational, or incentive-based programs for properties adjacent to the shoreline, and by directly implementing these practices on public and protected lands. Special interest non-governmental organizations ("NGOs", e.g., Pheasants Forever, Ducks Unlimited, Trout Unlimited, etc.) exist to foster habitat improvement projects, some of which collaborate with land owners to install beneficial projects. The HLMD should actively communicate and collaborate with NGOs. If this recommendation is implemented, a complete list of best management practices and relevant NGOs should be compiled and provided to landowners.

6. **Ensure proper implementation of the aquatic plant management plan** described earlier in this chapter (see "Issue 4: Aquatic Plant Growth" section) specifically as it relates to avoiding inadvertent damage to native species (<u>high priority</u>).

7. **Preserve and expand wetland and terrestrial wildlife habitat, while making efforts to ensure connectivity between such areas (<u>high priority</u>).** This could be achieved by implementing of the buffer and wetland protection recommendations provided in the "Issue 1: Water Quality" section of this chapter.

---

[19]*Natural shorelines generally have hundreds of fallen trees per mile along the shoreline. "Fish sticks" is a term coined for engineered installation of woody debris (logs) along lake shorelines to mimic these natural conditions. Generally these projects involve anchoring logs into the shore so that the log is oriented perpendicular to the shoreline. See "Healthy Lakes Initiative" in Appendix L.*

8. **Follow WDNR guidelines for protecting WDNR-designated Sensitive Areas.** This should be a high priority endeavor. The WDNR established two Sensitive Areas on Hooker Lake reflecting the particularly valuable habitat they provide and the number and importance of plant and animal species depending on these areas for survival. The WDNR established guidelines regarding a number of issues that impact these areas including regulation of recreational traffic, permissible types of aquatic plant management, and the types of shoreline protection.

9. In general, keeping track of fish and wildlife populations will help Lake managers detect change. Consequently, **continued monitoring of fish populations and periodic recording of the types of animals found on the Lake and within its watershed is also recommended** as a medium priority.

ISSUE 9: IMPLEMENTATION

The methods to implement the plan vary with recommendation type. For example, several important recommendations relate to enforcing of current ordinances (e.g., shoreline setbacks, zoning, construction site erosion control, and boating). Public agencies often have limited resources available to monitor compliance and effect enforcement. Consequently, the following recommendations are aimed at local citizens and management groups and are made to enhance the ability of the responsible entities to monitor compliance and enforce regulations.

1. **Maintain active, open relationships with the County, municipal zoning administrators, directors of public works/ city engineers, as well as law enforcement officers.** This helps build solid working relationships with the responsible entities and facilitates efficient communication whenever needed (high priority).

2. **Keep actively abreast of activities within the watershed** (e.g., construction, filling, erosion) that appear to be affecting the Lake, **maintain good records (e.g., notes, photographs),** and judiciously notify relevant regulatory entities as appropriate (medium priority).

3. **Educate watershed residents about relevant ordinances and update ordinances as necessary to face evolving use problems and threats.** This will help ensure that residents know why these rules are important, that permits are required for almost all construction within the watershed, and that such permits offer opportunities to regulate activities that could harm the Lake (high priority).

In addition to regulatory enforcement, a number of voluntary and/or incentive-based programs should be considered. These require proactive efforts to protect and manage the Lake. A number of factors hinder the ability of local citizens and management groups to effectively execute lake management projects. Consequently, the following actions are suggested to enable tangible action:

1. **Encourage key players to attend meetings, conferences, and/or training programs to build their lake management knowledge** which will enhance institutional capacity (medium priority). Some examples of capacity-building events are the Wisconsin Lakes Conference (which targets local lake managers) and the "Lake Leaders" training program (which teaches the basics of lake management and provides ongoing resources to lake managers). Both are hosted by the University of Wisconsin - Extension. Additionally, courses, workshops, on-line training, regional summits, and general meetings can also be used for this purpose. Attendance at these events should include follow-up documents/meetings so that the lessons learned can be shared with the larger lake group.

2. **Continue to ensure inclusivity and transparency with respect to all Lake management activities.** If stakeholders do not fully understand the aims and goals of a project, or if they do not trust the process, excess energy can be devoted to conflict, a result that benefits no one. For this reason, this element is assigned

high priority. These efforts should be implemented through public meetings and consensus building so that conflicts can be discussed, addressed and mitigated prior to implementing projects.

3. **Foster and monitor management efforts to communicate actions and achievements to future lake managers.** Institutional knowledge is a powerful tool that should be preserved whenever possible. Actions associated with this are sometimes imbedded in organization bylaws (e.g., minutes) and are therefore assigned medium priority. Open communication helps increase the capacity of lake management entities. This may take the form of annual meetings, website, newsletters, emails, reports and any number of other means that help compile and report action, plans, successes, and lessons learned. These records should be kept for future generations.

4. **Apply for grants when available** to support implementation of programs recommended under this plan (high priority). Table 27 provides a sample of WDNR grant opportunities that can potentially be used to implement plan recommendations. **The HLMD should be aware that other local, State, and Federal agencies likely have grant opportunities that could assist with plan implementation.**

5. **Integrate lake users and residents in future management efforts** (medium priority). The aim of this effort is to add to the donor and volunteer base working toward improving the Lake. Private donations and volunteer time can be used as cost match for some grants.

Additionally, as discussed in Chapter 2, a major recommendation that should be considered a high priority is the **creation of an action plan/schedule which highlights goals, accomplishment, timelines, logistical needs, and responsible parties.** This document will help assure that plan recommendations are implemented in a timely, comprehensive, transparent, and effective manner. Additionally, an action plan can help ensure that all responsible parties are held accountable for their portions of the plan's implementation.

As a final note, a major recommendation to promote implementation of this plan is **education of lake residents, users, and governing bodies** regarding the content of this plan. A campaign to communicate relevant information should therefore be given a high priority.

SUMMARY AND CONCLUSIONS

Hooker Lake is a valuable and cherished natural resource. Those charged with the responsibility of protecting it need to consider not only the Lake's current conditions, but also its condition in the near and far future. Therefore, this plan has been developed, and is intended to be implemented, to address the needs of both the present and the future. Managing any issue or set of issues requires vision and the ability to see the lake system and stakeholder needs as a whole.

The future is expected to bring many changes to Hooker Lake's watershed. Projections suggest that the agriculture-dominated watershed of today is expected to give way to a watershed dominated by urban residential land use in the next two decades. **It is critical that proactive measures be executed that lay groundwork for effectively dealing with and benefiting from future change.** Excellent working relationships with appropriate local, county and state entities need to be nurtured right now to help protect critical features and areas in the watershed during development, to initiate actions (such as residential street leaf litter pickup and disposal), and to instill attitudes among current and future residents that will foster cooperation and coordination of effort on many levels.

To aid in the implementation of the plan recommendations, Table 28 highlights recommendations, as well as their priority level. Additionally, Maps 25 and 26, in combination with the aquatic plant management recommendation map (Map 24), identify where these recommendations should be implemented. These maps will provide current and future Hooker Lake managers with a visual representation of where to target management efforts.

Table 28

SUMMARY OF RECOMMENDATIONS FOR HOOKER LAKE: 2016

Number	Description	Suggested Priority Level
ISSUE 1: WATER QUALITY		
1	Actively track key water quality parameters for the long term. Frequently collect field measurements by taking readings with hand-held instruments, with full-depth profiles of temperature and dissolved oxygen concentrations. Actively participate in the Clean Lakes Monitoring Network programs.	HIGH
2	Track water quality and flow in tributary streams over a range of runoff conditions.	HIGH
3	Promote actions and enforce rules that that protect, preserve, and/or enhance shoreline buffers, environmental corridors, wetlands, water detention features, and floodplains, especially those near or adjacent to the Lake and tributary streams. Examples include application of best management practices, infrastructure construction, landowner education, and direct acquisition or acquiring easements on key parcels of real estate.	HIGH
4	Maintain ecological integrity and function of buffers, environmental corridors, wetlands, woodlands, stream corridors, and floodplains by controlling invasive species and relaxing human-imposed constraints.	MEDIUM
5	Monitor and maintain existing stormwater detention basins. Consider enhancing and supplementing stormwater detention infrastructure in highly developed watersheds, such located to the north and west of the Lake.	HIGH
6	Promptly collect leaves in urbanized watersheds.	HIGH
8	Stringently and thoughtfully enforce construction site erosion control and stormwater ordinances. Engage Lake users in monitoring violations. Remember that land-use conversion is an opportunity to reduce pollution loads to the Lake.	HIGH
10	Promote pollution source reduction practices, especially on riparian parcels.	HIGH
11	Manage in-Lake phosphorus sources.	LOW
12	Reevaluate the recommendations of this plan in three to five years, particularly if new data indicates unacceptable water quality or trends.	MEDIUM
ISSUE 2: WATER QUANTITY		
1	Regularly measure and record Lake water surface elevation.	MEDIUM
2	Quantify tributary stream flow volumes through direct measurement of flows under various weather and runoff conditions.	HIGH
3	Enhance stormwater detention and treatment. Opportunities to both create and restore detention and treatment exist in the watershed.	HIGH
4	Quantify groundwater contributions to the Lake and protect groundwater recharge areas.	MEDIUM
5	Implement measures that help protect the Lake’s groundwater supply. For example, promote infiltration in near-shore residential areas through land management practices, protect areas of high groundwater potential, promote groundwater recharge in new developments, and avoid overdrafting groundwater supplies.	MEDIUM
6	Reduce impacts of future urban development.	HIGH
7	Continue to protect wetlands and uplands through enforcement of County zoning ordinances.	MEDIUM
8	Periodically re-evaluate plan recommendations.	MEDIUM
ISSUE 3: LAKE OUTLET DAM		
1	Keep the spillway/dam clear of debris through regular inspections, especially after significant rainfall events.	HIGH
2	Consider acquisition of the Bryzek Dam by HLMD or another public entity.	HIGH
3	Evaluate current status of Bryzek Dam spillway controversy and actively promote actions that help correct regulatory and/or physical deficiencies.	HIGH
4	Develop a rating curve relating water elevation with Lake outflow.	LOW

Table 28 (continued)

Number	Description	Suggested Priority Level
	ISSUE 4: AQUATIC PLANT GROWTH	
1	Manage aquatic plant growth to favor recovery of desirable native plants and maintain or enhance navigation.	HIGH
2	Actively control aquatic invasive species such as Eurasian and hybrid water milfoil, curly leaf pondweed, and reed canary grass. Early spring control has the least potential to harm native plants.	HIGH
3	Create navigation lanes in high traffic, critical nearshore areas using plant harvesting. Implement a comprehensive and consistent plant pickup program.	HIGH
4	Hand pull or rake nuisance vegetation, especially invasive plant species, in nearshore areas.	MEDIUM
5	Avoid disrupting bottom sediment as part of plant management. Avoid indiscriminate spot application of aquatic herbicides.	HIGH
6	Focus efforts on prevention of new nonnative species: Educate residents; join Clean Boats Clean Waters program; target launch sites for aquatic plant management; citizen monitoring and immediate notification of WDNR if new species observed	HIGH
7	Reevaluate the aquatic plant management plan in three to five years, conducting a new complete point-intercept aquatic plant survey.	HIGH
8	Focus efforts on prevention of new nonnative species: Educate residents; join Clean Boats Clean Waters program; target launch sites for aquatic plant management; encourage citizen monitoring and immediate notification of WDNR if new species observed	HIGH
9	Implement “Issue 1: Water Quality” recommendations to reduce conditions that encourage nuisance aquatic plant growth.	HIGH
	ISSUE 5: CYANOBACTERIA AND FLOATING ALGAE	
1	Maintain or improve water quality (implement the actions listed under Issue 1: Water Quality). This action reduces the overall abundance or free-floating plants and algae.	HIGH
2	Maintain or enhance native aquatic plant community (implement the actions listed under Issue 4: Aquatic Plant Growth). This action suppresses algal growth by increasing competition for water-borne nutrients.	HIGH
3	Monitor algal population.	HIGH
4	Monitor for toxic algae during algal blooms.	MEDIUM
5	Educate Lake users about the hazards of toxic algae and develop a warning program if algal blooms and/or toxic strains are identified.	HIGH
	ISSUE 6: RECREATIONAL USE AND FACILITIES	
1	Maintain the public boat launch.	HIGH
2	Review and conscientiously enforce existing boating regulations. Review ordinances to ensure compatibility with current conditions and expectations on weekends, holidays, and weekdays.	HIGH for weekends and holidays, LOW for weekdays
3	Consider increasing launch fees.	MEDIUM
4	Establish a Clean Boats/Clean Waters cleaning station and education/inspection program	HIGH
	ISSUE 7: SHORELINE MAINTENANCE	
1	Repair or remove failing shoreline structures and replace with natural materials.	HIGH
2	Educate shoreline property owners on the importance of buffers and appropriate shoreline protection measures consistent with lake use guidelines presented in the Healthy Lakes Initiative plan.	HIGH
3	Install “natural” or “soft” infrastructure whenever artificial shoreline protection is desired or needed.	MEDIUM
4	Develop shoreline restoration goals with a follow-up survey to monitor progress.	MEDIUM
5	Enforce ordinances to ensure proper building setbacks and mitigation measures.	HIGH

Table 28 (continued)

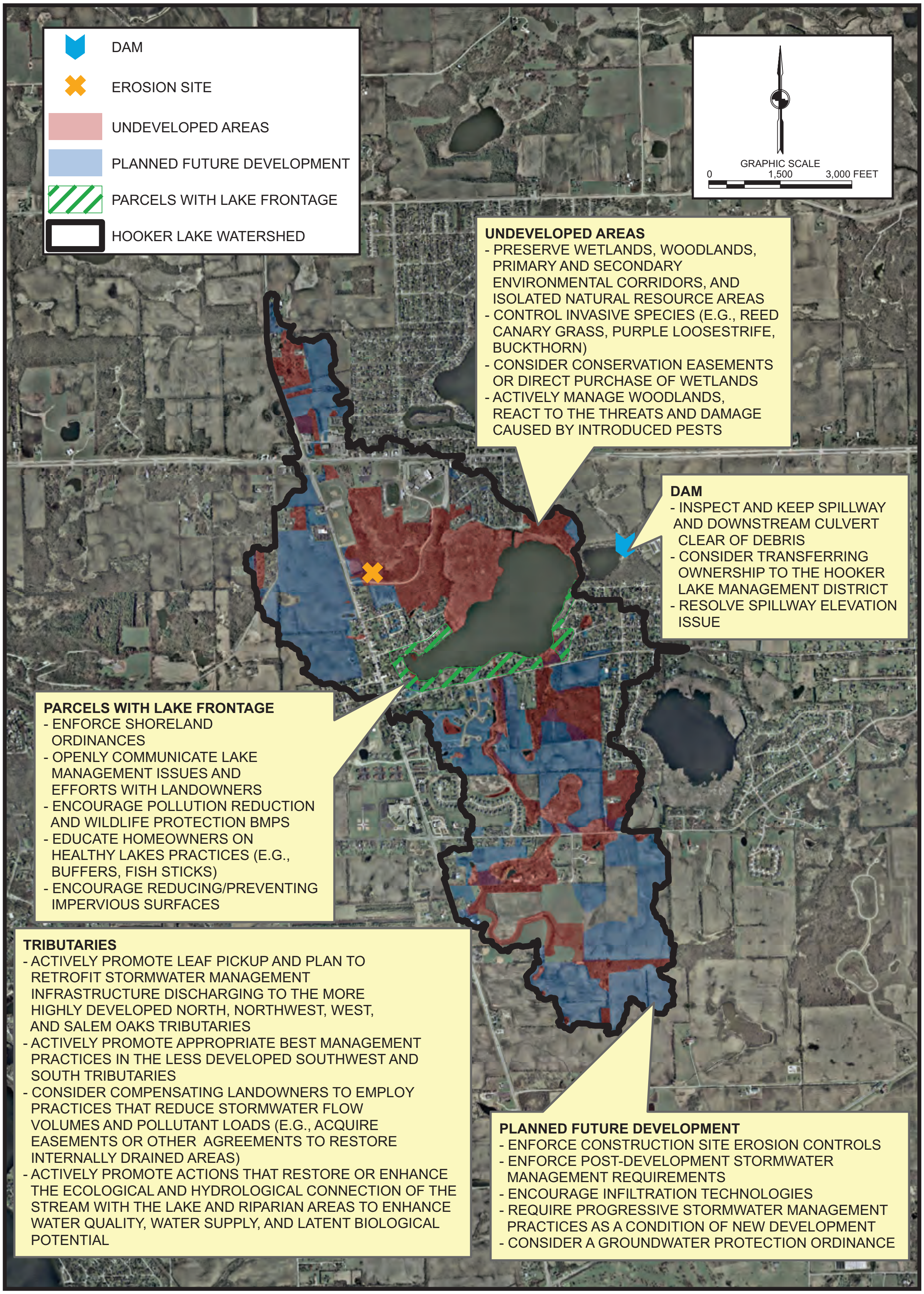
Number	Description	Suggested Priority Level
ISSUE 8: FISH AND WILDLIFE		
1	Continue fish stocking.	MEDIUM
2	Maintain current fishing practices and regulations.	MEDIUM
3	Identify and remove fish passage barriers on streams.	MEDIUM
4	Introduce woody debris (e.g., “fish sticks” or fallen trees) into the Lake’s shallow nearshore area and encourage vegetative buffers on the shorelines.	MEDIUM
5	Implement recommendations listed under Issue 4: Aquatic Plant Growth and Issue I: Water Quality to help assure a healthy foundation of aquatic plants to support fish and wildlife populations.	HIGH
6	Periodically monitor fish and wildlife populations.	MEDIUM
7	Communicate and encourage implementation of wildlife best management practices along shoreline and in other valuable habitat areas.	MEDIUM
8	Follow guidelines set by WDNR to protect WDNR Sensitive Areas: “Slow no-wake,” restrictions on mechanical and chemical treatment of aquatic plants, use of “soft” techniques for protecting shoreline in Sensitive Area #2	HIGH
ISSUE 9: IMPLEMENTATION		
1	Foster open relationships with potential project partners and collaborators	HIGH
2	Establish a written action plan that identifies action items, timelines, responsible parties, and potential funding sources.	HIGH
3	Actively remain abreast of changes and activities in the watershed. Communicate this information to other Lake users, regulators, and others interested in the health of the Lake.	MEDIUM
4	Educate watershed residents about relevant ordinances and update ordinances as necessary to face evolving use problems and threats.	HIGH
5	Encourage key players to attend meetings, conferences, and/or training programs to build their lake management knowledge.	MEDIUM
6	Continue to ensure inclusivity and transparency with respect to all Lake management activities.	HIGH
7	Foster and monitor management efforts to communicate actions and achievements to future Lake managers,	MEDIUM
8	Apply for grants.	HIGH
9	Encourage participation of Lake users and residents in management efforts to acquire a wider volunteer base. Record donated resources and Volunteer time.	MEDIUM
10	Actively monitor management efforts and their effects to develop and communicate lessons learned.	MEDIUM
11	Actively share this plan.	HIGH

Source: SEWRPC.

As stated in the introduction, this chapter is intended to stimulate ideas and action. The recommendations should, therefore, provide a starting point for addressing the issues that have been identified in Hooker Lake and its watershed. **Successful implementation of the plan requires vigilance, cooperation, diligence, and enthusiasm from local management groups, State and regional agencies, counties, municipalities, and lake residents.** The recommended measures will help provide the water quality and habitat protection necessary to maintain and establish conditions in the watershed suitable for retaining and improving the natural beauty, ecological value and ambience of Hooker Lake and its ecosystems. This in turns helps guarantee the enjoyment of the Lake by its human population today and in the future.

Map 25

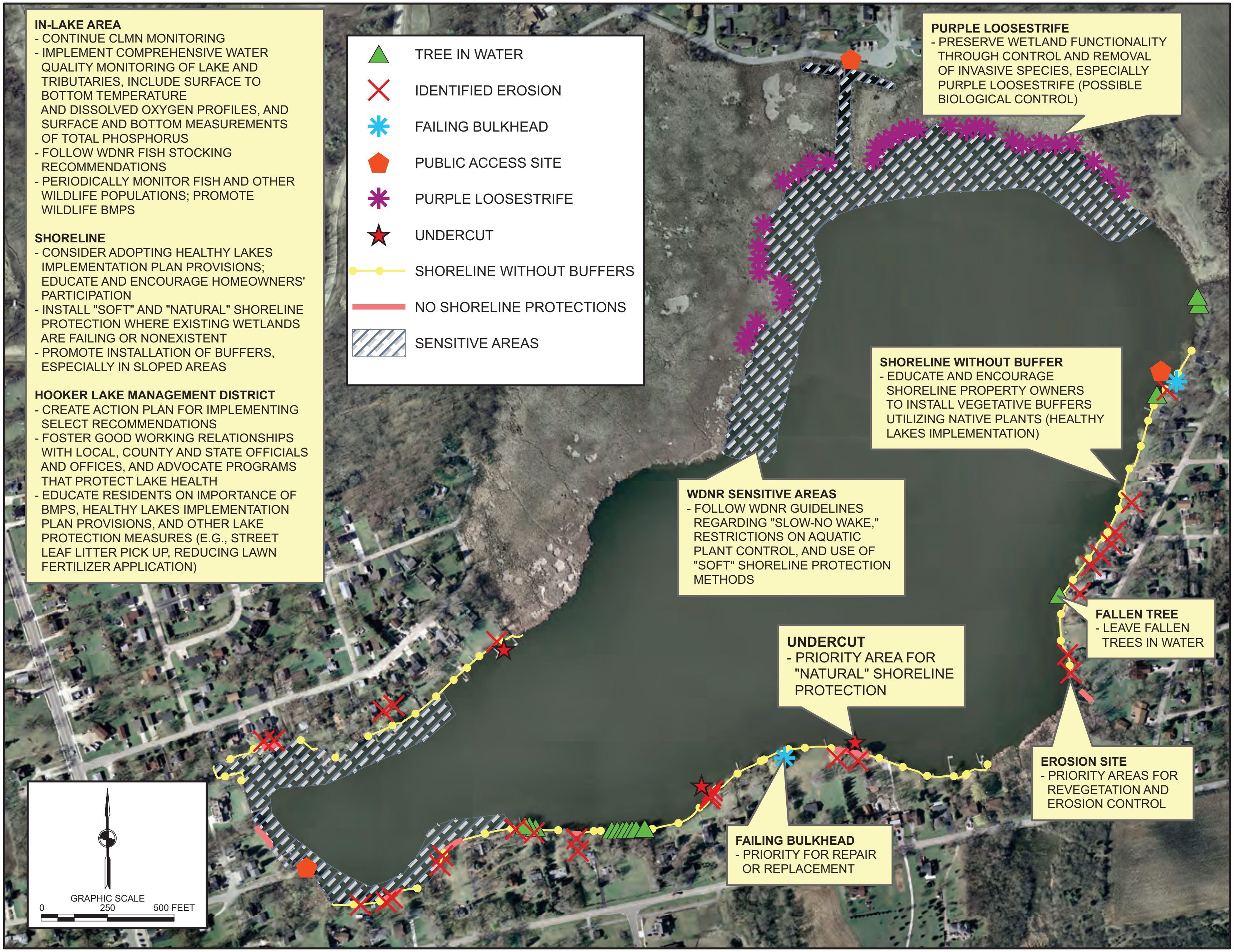
SELECTED RECOMMENDATIONS FOR THE HOOKER LAKE WATERSHED: 2016



Source: SEWRPC.

Map 26

IN-LAKE, SHORELINE, AND INSTITUTIONAL RECOMMENDATIONS FOR HOOKER LAKE: 2016



Source: SEWRPC.

APPENDICES

(This page intentionally left blank)

Appendix A

WATER QUALITY DATA

(This page intentionally left blank)

Table A-1

DESCRIPTION OF PRIMARY WATER QUALITY PARAMETERS AND THEIR REGIONAL AVERAGES

Parameter	Description	Regional Average[a]	Existing Standards
Primary Water Quality Parameters			
Chlorophyll-*a*	The major photosynthetic, "green," pigment in algae. The amount of chlorophyll-*a* present in the water is an indication of the biomass, or amount of algae, in the water. Chlorophyll-*a* levels above 0.10 mg/l generally result in a green coloration of the water that may be severe enough to impair recreational activities, such as swimming or waterskiing	43	- -
Total Phosphorus	Phosphorus, which can enter a lake from natural and manmade sources, is a fundamental building block for plant growth. However, excessive levels of phosphorus in lakes can lead to nuisance levels of plant growth, unsightly algal blooms, decreased water clarity, and oxygen depletion that can stress or kill fish and other aquatic life. Statewide standards exist for phosphorus concentrations in lakes (Rock Lake's phosphorus standard is 0.06 mg/l, meaning that if the Lake exceeded this concentration it would be considered impaired with respect to phosphorus). A concentration of less than 0.06 mg/l is the concentration considered necessary to limit algal and aquatic plant growths to levels consistent with recreational water use objectives	- -	0.06[b]
Dissolved Oxygen	Dissolved oxygen levels are one of the most critical factors affecting the living organisms of a lake ecosystem. Generally, dissolved oxygen levels are higher at the surface of a lake, where there is an interchange between the water and atmosphere, stirring by wind action, and production of oxygen by plant photosynthesis. Dissolved oxygen levels are usually lowest near the bottom of a lake, where decomposer organisms and chemical oxidation processes deplete oxygen during the decay process. A concentration of about 5.0 mg/l is considered the minimum level below which oxygen-consuming organisms, such as fish, become stressed, while fish are unlikely to survive when dissolved oxygen concentrations drop below 2.0 mg/l	10-12	- -
Water Clarity (feet)	Measured with a Secchi disk, a black-and-white, eight-inch-diameter disk, which is lowered into the water until a depth is reached at which the disk is no longer visible. It can be affected by physical factors, such as suspended particles, and by various biologic factors, including seasonal variations in planktonic algal populations living in a lake	5	- -
General Water Quality Parameters			
Alkalinity	The measure of the ability of a lake to absorb and neutralize acidic loadings, aka buffering; influenced by the soils and bedrock of the watershed due to any calcium carbonates ($CaCO_3$) – **higher levels of Ca CO_3 indicate a more alkaline lake with a higher buffering capacity**	173	- -
Calcium	Related to the growth of phytoplankton due to its reactive nature with phosphorus	36	
Chloride	Small quantities are normal in lakes due to natural weathering of bedrock and soils, while large concentrations (from road salts and effluents from wastewater treatment plants or septic systems) have an unknown impact on the ecosystem; however, **can serve as an indicator of increases in other pollutants**	19	- -
Color (Platinum units or "units")	Affects water transparency or water clarity; influenced by dissolved and suspended materials in the water, phytoplankton population levels, and various physical factors	46	
Conductivity (MicroSiemens per centimeter – μS/cm)	The measure of how much resistance to electrical flow exists in the water, thereby indirectly estimating the amount of dissolved ions in the water; **increased conductivity measurements can signal a potential pollution problem**	500-600	- -
Hardness	Measure of multivalent metallic ion concentrations such as calcium and magnesium in a lake; lakes with higher hardness levels tend to produce more fish and aquatic plants	- -	- -
Magnesium	A fundamental building block of chlorophyll and a vital nutrient to all green plants	32	- -
pH (Standard Units – S.U.)	Measures the hydrogen ion concentration on a scale from 0 (alkaline) to 14 (acidic); it influences how much nutrients (e.g., phosphorus, nitrogen) can be utilized and **can affect the solubility and toxicity of heavy metals** (e.g., lead, copper, cadmium), all of this affects the organisms living in a lake	7-8.5	- -

Table A-1 continued

Parameter	Description	Regional Average[a]	Existing Standards
General Water Quality Parameters (continued)			
pH (Standard Units – S.U.)	Measures the hydrogen ion concentration on a scale from 0 (alkaline) to 14 (acidic); it influences how much nutrients (e.g., phosphorus, nitrogen) can be utilized and **can affect the solubility and toxicity of heavy metals** (e.g., lead, copper, cadmium), all of this affects the organisms living in a lake	7-8.5	- -
Potassium	Linked to the growth of cyanobacteria (blue-green algae), which can sometimes contain toxic byproducts	- -	- -
Silica	Significant role in the production of many algae forms in freshwater lakes, especially diatoms; insufficient levels can shift algal population dominance from beneficial species (i.e., diatoms) to less desirable species (i.e., blue-green algae)	- -	- -
Sodium	Linked to the growth of cyanobacteria (i.e., blue-green algae), which can sometimes contain toxic byproducts	- -	- -
Sulfate	A form of sulfur that is an important nutrient for many aquatic organisms occurs in rocks and fertilizers, affecting the lake's eutrophication process. In high concentrations, especially in highly industrialized areas, can have a deleterious effect on some aquatic plants	20-40	- -
Total Dissolved Solids	An estimation of the total amount of inorganic solids dissolved in water due to the predominant bedrock, topography, climate, and land use in the watershed	- -	- -
Total Nitrogen	Essential to plant growth; natural sources include precipitation, nitrogen fixation in lake water and sediments, groundwater input, and surface runoff; manmade sources include livestock waste, fertilizers, and human sewage	1.43	- -
Total Suspended Solids	The soils and sands found suspended or floating within a sample of water; related to turbidity	- -	- -
Turbidity (Nephelometric Turbidity Units – N.T.U.)	Affects water transparency or water clarity due to suspended particles in the water, usually from runoff, soil erosion, and the disturbance or re-suspension of lake bottom sediments	6.7	- -

[a]*All measurements in milligrams per liter (mg/l) unless otherwise noted.*

[b]*Wisconsin Department of Natural Resources Technical Bulletin No. 138,* Limnological Characteristics of Wisconsin Lakes, *Richard A. Lillie and John W. Mason,* 1983.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table A-2

WATER QUALITY VALUES FOR HOOKER LAKE: 2004 & 2001

Water Quality Parameters	Aug. 17, 2004	Aug. 28, 2001
Depth of Sample (feet)	0-6	0-6
N, NO2 + NO3 (mg/L)	- -	0.015
N, NH3 (mg/L)	0.074	0.014
N, Kjeldahl Total (mg/L).	1.12	0.89
P, Total (mg/L)	0.031	0.020
Ca (mg/L)	42.7	39.6
Mg (mg/L)	26.8	24.8
Alkalinity (mg/L)	169	165
Conductivity (UMHOS-25ºC)	560	571

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table A-3

WATER QUALITY VALUES FOR HOOKER LAKE: 1977-1978

Water Quality Parameters	July 14, 1977		November 3, 1977		February 2, 1978		April 13, 1978	
	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep
Depth of Sample (feet)	0	23	0	23	0	10	0	24
N, NO2 + NO3 (mg/L)	0.056	0.049	0.040	0.476	0.167	0.133	1.073	1.200
N, NH3 (mg/L)	0.170	2.100	0.100	<0.030	0.430	0.360	0.340	0.180
N, Organic (mg/L).	1.880	1.740	0.760	0.990	1.150	0.930	1.050	1.000
N, Total (mg/L)	2.100	3.900	0.910	1.470	1.750	1.420	2.460	2.380
P, PO4 (mg/L)	0.026	0.040	0.010	0.015	0.021	0.012	0.018	0.011
P, Total (mg/L)	0.040	0.090	0.060	0.070	0.050	0.020	0.040	0.060
Ca (mg/L)	35	45	34	38	45	43	45	45
Mg (mg/L)	34	32	32	31	36	36	36	35
Na (mg/L)	21	20	17	17	23	22	19	20
K (mg/L)	2.4	3.3	3.0	3.6	2.4	3.5	3.3	3.3
Fe (mg/L)	0.18	0.29	<0.06	0.11	<0.06	<0.06	0.08	0.14
Mn (mg/L)	<0.03	0.15	<0.03	0.04	4.14	0.15	<0.03	<0.03
Conductivity (UMHOS/CM-25oC)	464	519	459	470	547	522	422	336
SO4 (mg/L)	50	68	- -	- -	- -	- -	- -	- -
Cl (mg/L)	41	38	40	41	48	47	45	49
pH	8.0	7.3	8.2	8.0	7.9	7.8	8.0	8.0
Alkalinity (mg/L)	154	205	150	154	180	178	154	154
Turbidity (mg/L)	6.4	3.0	2.8	16.0	2.6	1.5	3.2	3.0

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table A-4

WATER QUALITY VALUES FOR HOOKER LAKE: 1960

Water Quality Parameters	March 19, 1960
pH	7.4
Alkalinity (mg/L)	187
Conductivity (UMHOS-25ºC)	498

Source: Wisconsin Conservation Department

Table A-5

WATER QUALITY VALUES FOR HOOKER LAKE: 1993

Water Quality Parameters[a]	April 22, 1993		June 21, 1993	July 13, 1993	August 23, 1993
	Shallow	Deep	Shallow	Shallow	Shallow
Depth of Sample (feet)	1.5	23	1.5	1.5	1.5
Chlorophyll a (µg/L)	36.4	- -	7.82	14.9	8.66
Ca (mg/L)	51	51	- -	- -	- -
Fe (µg/L)	<50	<50	- -	- -	- -
SO4 (mg/L)	32	32	- -	- -	- -
Cl (mg/L)	61	61	- -	- -	- -

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table A-6

WATER QUALITY VALUES FOR HOOKER LAKE: 1992

Water Quality Parameters[a]	February 4		April 2		June 9		July 27		August 17	
	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep
Depth of Sample (feet)	1.5	23	1.5	24	1.5	23	1.5	23	1.5	23
N, NO2 + NO3 (mg/L)	- -	- -	0.012	0.012	- -	- -	- -	- -	- -	- -
N, NH3 (mg/L)	- -	- -	0.020	0.020	- -	- -	- -	- -	- -	- -
N, Organic. (mg/L)	- -	- -	0.78	0.98	- -	- -	- -	- -	- -	- -
N, Total (mg/L)	- -	- -	0.8	1.0	- -	- -	- -	- -	- -	- -
P, PO4 (mg/L)	- -	- -	0.002	0.003	- -	- -	- -	- -	- -	- -
P, Total (mg/L)	- -	- -	0.037	0.027	0.020	0.023	0.026	0.060	0.022	0.184
Ca (mg/L)	- -	- -	50	52	- -	- -	- -	- -	- -	- -
Mg (mg/L)	- -	- -	33	34	- -	- -	- -	- -	- -	- -
Na (mg/L)	- -	- -	32	32	- -	- -	- -	- -	- -	- -
K (mg/L)	- -	- -	3.0	3.0	- -	- -	- -	- -	- -	- -
Fe (mg/L)	- -	- -	<0.05	<0.05	- -	- -	- -	- -	- -	- -
Mn (mg/L)	- -	- -	<0.04	<0.04	- -	- -	- -	- -	- -	- -
Conductivity (UMHOS/CM-25ºC)	590	675	636	637	642	675	630	738	647	788
SO4 (mg/L)	- -	- -	45	45	- -	- -	- -	- -	- -	- -
Cl (mg/L)	- -	- -	72	71	- -	- -	- -	- -	- -	- -
pH	8.6	7.8	8.6	8.6	8.7	7.5	8.4	7.1	8.5	7.0
Alkalinity (mg/L)	- -	- -	180	180	- -	- -	- -	- -	- -	- -
Turbidity (mg/L)	- -	- -	1.6	1.8	- -	- -	- -	- -	- -	- -
Water Temperature (°C)	4.0	3.5	5.5	5.5	21.5	13.0	24.0	13.5	22.5	14.5
Color	- -	- -	15	15	- -	- -	- -	- -	- -	- -
Hardness, CaCO3 (mg/L)	- -	- -	260	270	- -	- -	- -	- -	- -	- -
Fluoride, Dissolved (mg/L)	- -	- -	0.1	0.1	- -	- -	- -	- -	- -	- -
Silica, Dissolved (mg/L)	- -	- -	1.1	1.1	- -	- -	- -	- -	- -	- -
Solids, Dissolved (mg/L)	- -	- -	386	386	- -	- -	- -	- -	- -	- -
Chlorophyll-*a* (*µg/L*)	- -	- -	19	- -	9	- -	12	- -	12	- -

Source: U.S. Geological Survey and SEWRPC.

Table A-7

TOTAL SUSPENDED SOLIDS CONCENTRATIONS AT INFLOW SITES TO HOOKER LAKE: 2014

(mg/l)

Date	Site 1 (north)	Site 2 (northwest)	Site 3 (west)	Site 4 (southwest)	Site 5 (south)	Site 6 (S. Oaks)
11/23/2014	7	78	23	78	5	45
10/27/2014	2	2	3	19	20	2
9/4/2014	5	4	4	8	5	5
6/11/2014	12	11	5	8	19	6
5/13/2014[a]	12	10	5	5	15	5
4/27/2014	2	2	2	2	2	7

[a]Data collected after a 3-inch rainfall on the night prior.

Source: Wisconsin Department of Natural Resources.

Table A-8

TOTAL PHOSPHORUS AT INFLOW SITES TO HOOKER LAKE: 2014

(mg/l)

Date	Site 1 (north)	Site 2 (northwest)	Site 3 (west)	Site 4 (southwest)	Site 5 (south)	Site 6 (S. Oaks)
11/23/2014	0.101	0.422	0.259	0.070	0.045	0.476
10/27/2014	0.022	0.013	0.029	0.015	0.042	0.154
9/4/2014	0.075	0.088	0.073	0.058	0.039	0.150
6/11/2014	0.063	0.104	0.025	0.112	0.181	0.332
5/13/2014[a]	0.082	0.095	0.103	0.037	0.148	0.314
4/27/2014	0.014	0.016	0.019	0.026	0.018	0.026

[a]Data collected after a 3-inch rainfall on the night prior.

Source: Wisconsin Department of Natural Resources.

Table A-9

TOTAL NITROGEN AT INFLOW SITES TO HOOKER LAKE: 2014

(mg/l)

Date	Site 1 (north)	Site 2 (northwest)	Site 3 (west)	Site 4 (southwest)	Site 5 (south)	Site 6 (S. Oaks)
11/23/2014	0.50	1.87	1.29	0.92	1.42	0.28
10/27/2014	0.10	6.30	2.40	0.50	0.20	0.10
9/4/2014	0.10	1.50	2.80	0.70	0.10	0.90
6/11/2014	8.60	17.60	3.00	3.10	0.80	0.50
5/13/2014[a]	6.50	12.30	6.10	3.00	0.70	1.00
4/27/2014	0.10	4.40	1.60	0.10	8.20	1.20

[a]Data collected after a 3-inch rainfall on the night prior.

Source: Wisconsin Department of Natural Resources.

Table A-10

TOTAL CHLORIDES AT INFLOW SITES TO HOOKER LAKE: 2014

(mg/l)

Date	Site 1 (north)	Site 2 (northwest)	Site 3 (west)	Site 4 (southwest)	Site 5 (south)	Site 6 (S. Oaks)
11/23/2014	337.0	166.0	321.0	255.0	115.0	389.0
10/27/2014	298.0	150.0	301.0	180.0	84.3	726.0
9/4/2014	156.0	76.8	144.0	175.0	77.2	329.0
6/11/2014	91.6	61.9	168.0	163.0	41.8	95.1
5/13/2014[a]	173.0	89.0	191.0	217.0	51.1	150.0
4/27/2014	448.0	654.0	304.0	97.3	309.0	473.0

[a]Data collected after a 3-inch rainfall on the night prior.

Source: Wisconsin Department of Natural Resources.

Appendix B

RIPARIAN BUFFER GUIDE
"MANAGING THE WATER'S EDGE"

(This page intentionally left blank)

Managing the Water's Edge

Making Natural Connections

Problem Statement:

Despite significant research related to buffers, there remains no consensus as to what constitutes optimal riparian buffer design or proper buffer width for effective pollutant removal, water quality protection, prevention of channel erosion, provision of fish and wildlife habitat, enhancement of environmental corridors, augmentation of stream baseflow, and water temperature moderation.

Southeastern Wisconsin Regional Planning Commission

Our purpose in this document is to help protect and restore water quality, wildlife, recreational opportunities, and scenic beauty.

This material was prepared in part with funding from the U.S. Environmental Protection Agency Great Lakes National Program Office provided through CMAP, the Chicago Metropolitan Agency for Planning.

Introduction

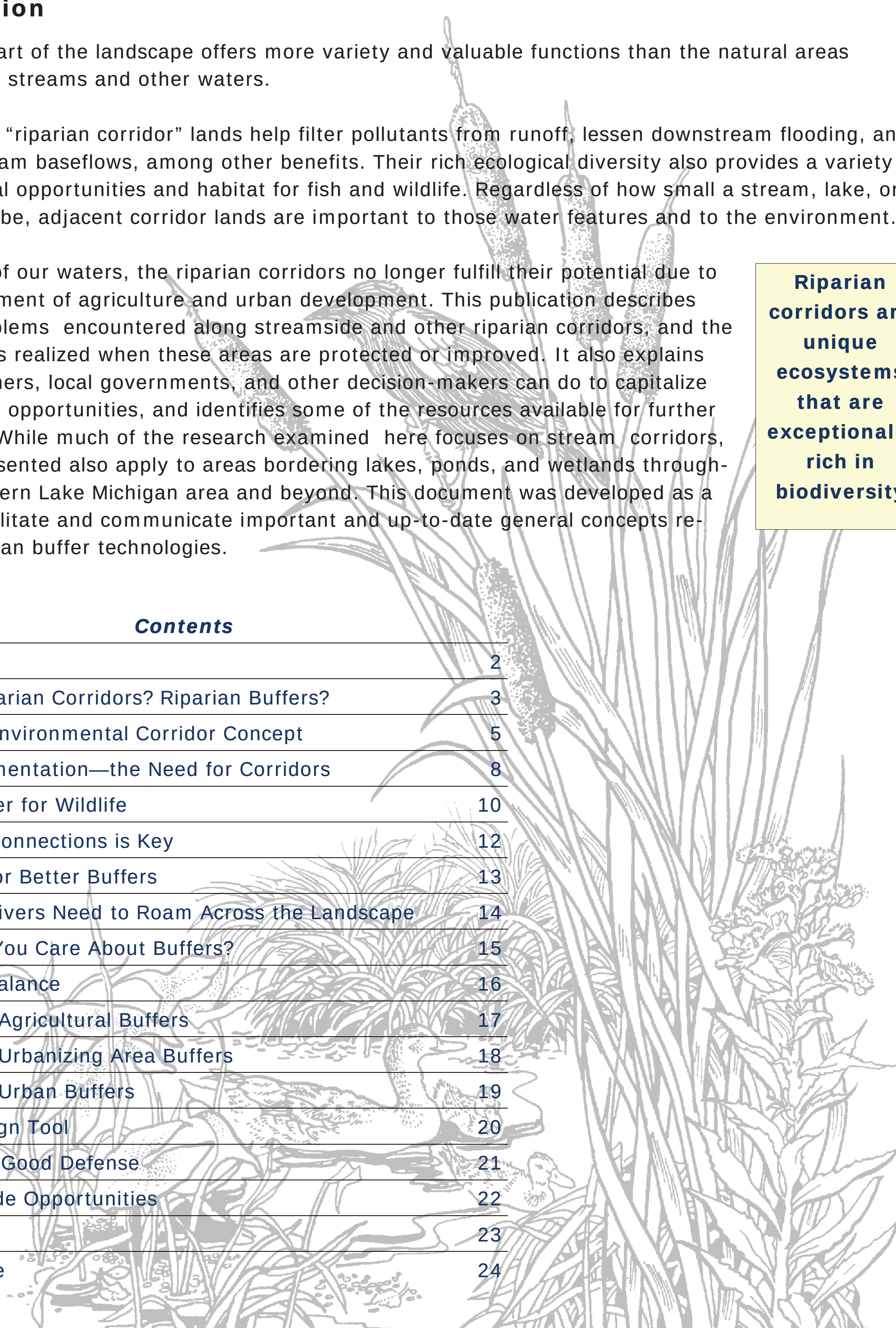
Perhaps no part of the landscape offers more variety and valuable functions than the natural areas bordering our streams and other waters.

These unique "riparian corridor" lands help filter pollutants from runoff, lessen downstream flooding, and maintain stream baseflows, among other benefits. Their rich ecological diversity also provides a variety of recreational opportunities and habitat for fish and wildlife. Regardless of how small a stream, lake, or wetland may be, adjacent corridor lands are important to those water features and to the environment.

Along many of our waters, the riparian corridors no longer fulfill their potential due to the encroachment of agriculture and urban development. This publication describes common problems encountered along streamside and other riparian corridors, and the many benefits realized when these areas are protected or improved. It also explains what landowners, local governments, and other decision-makers can do to capitalize on waterfront opportunities, and identifies some of the resources available for further information. While much of the research examined here focuses on stream corridors, the ideas presented also apply to areas bordering lakes, ponds, and wetlands throughout the southern Lake Michigan area and beyond. This document was developed as a means to facilitate and communicate important and up-to-date general concepts related to riparian buffer technologies.

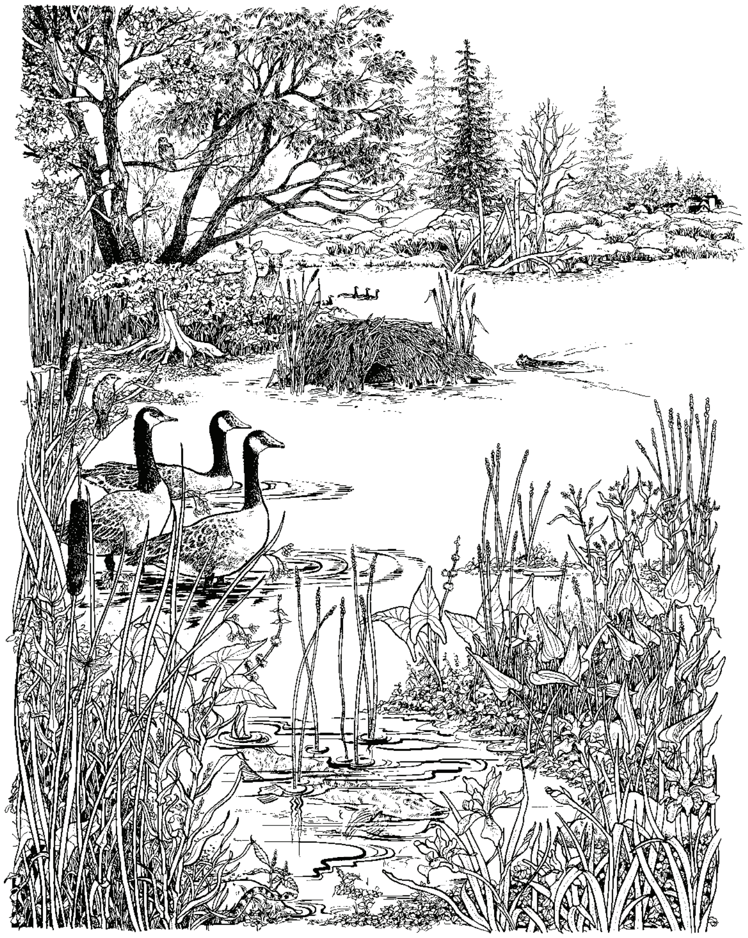
Riparian corridors are unique ecosystems that are exceptionally rich in biodiversity

Contents



What Are Riparian Corridors? Riparian Buffer Zones?

The word riparian comes from the Latin word *ripa*, which means bank. However, in this document we use riparian in a much broader sense and refer to land adjoining any water body including ponds, lakes, streams, and wetlands. This term has two additional distinct meanings that refer to 1) the "natural or relatively undisturbed" corridor lands adjacent to a water body inclusive of both wetland and upland flora and fauna and 2) a buffer zone or corridor lands in need of protection to "buffer" the effects of human impacts such as agriculture and residential development.



University of Wisconsin—Extension

The word buffer literally means something that cushions against the shock of something else (noun), or to lessen or cushion that shock (verb). Other useful definitions reveal that a buffer can be something that serves to separate features, or that is capable of neutralizing something, like filtering pollutants from stormwater runoff. Essentially, buffers and buffering help protect against adverse effects.

Riparian buffer zones function as core habitat as well as travel corridors for many wildlife species.

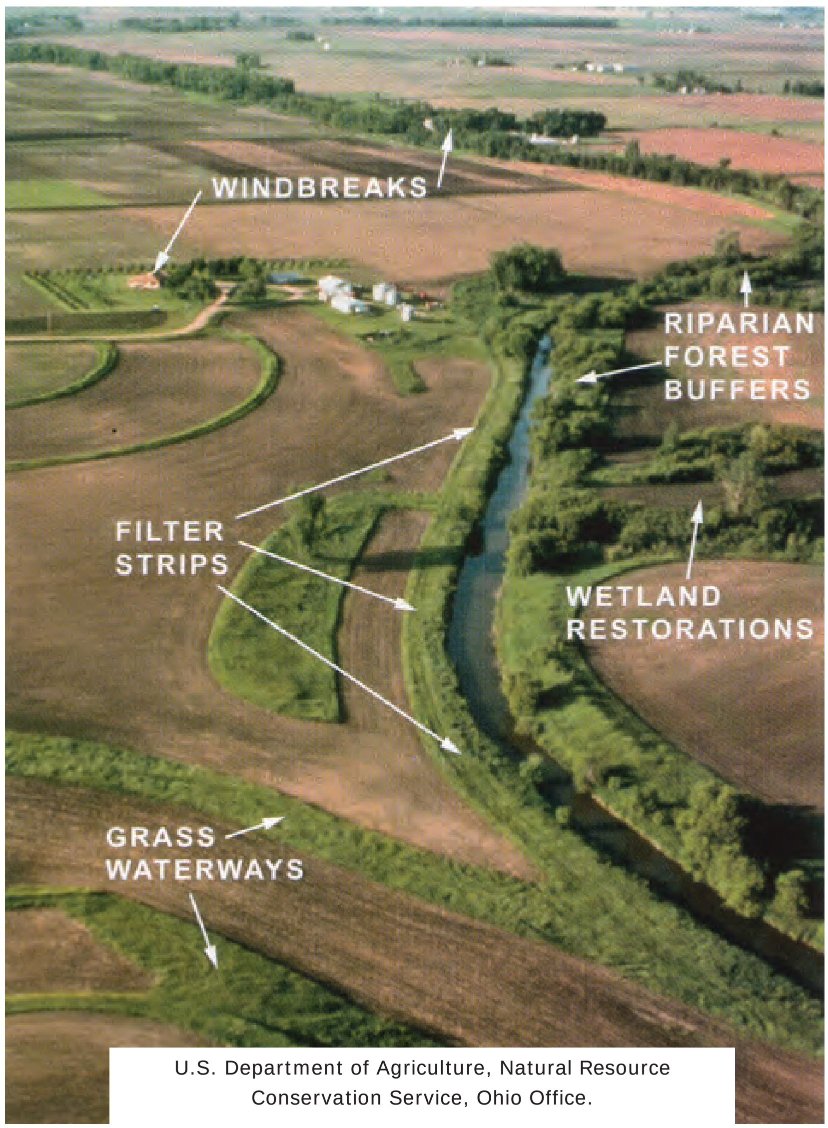
Riparian buffers are zones adjacent to waterbodies such as lakes, rivers, and wetlands that simultaneously protect water quality and wildlife, including both aquatic and terrestrial habitat. These zones minimize the impacts of human activities on the landscape and contribute to recreation, aesthetics, and quality of life. **This document summarizes how to maximize both water quality protection and conservation of aquatic and terrestrial wildlife populations using buffers.**

What Are Riparian Corridors? Riparian Buffer Zones?

Buffers **can** include a range of complex vegetation structure, soils, food sources, cover, and water features that offer a variety of habitats contributing to diversity and abundance of wildlife such as mammals, frogs, amphibians, insects, and birds. Buffers can consist of a variety of canopy layers and cover types including ephemeral (temporary-wet for only part of year) wetlands/seasonal ponds/spring pools, shallow marshes, deep marshes, wetland meadows, wetland mixed forests, grasslands, shrubs, forests, and/or prairies. Riparian zones are areas of transition between aquatic and terrestrial ecosystems, and they can potentially offer numerous benefits to wildlife and people such as pollution reduction and recreation.

In the water resources literature, riparian buffers are referred to in a number of different ways. Depending on the focus and the intended function of a buffer, or a buffer-related feature, buffers may be referred to as stream corridors, critical transition zones, riparian management areas, riparian management zones, floodplains, or green infrastructure.

It is important to note that within an agricultural context, the term buffer is used more generally to describe filtering best management practices most often at the water's edge. Other practices which can be interrelated may also sometimes be called buffers. These include grassed waterways, contour buffer strips, wind breaks, field border, shelterbelts, windbreaks, living snow fence, or filter strips. These practices may or may not be adjacent to a waterway as illustrated in the photo to the right. For example, a grassed waterway is designed to filter sediment and reduce erosion and may connect to a riparian buffer. These more limited-purpose practices may link to multipurpose buffers, but by themselves, they are not adequate to provide the multiple functions of a riparian buffer as defined here.



U.S. Department of Agriculture, Natural Resource Conservation Service, Ohio Office.

Beyond the Environmental Corridor Concept

The term "environmental corridors" (also known as "green infrastructure") refers to an inter-connected green space network of natural areas and features, public lands, and other open spaces that provide natural resource value. Environmental corridor planning is a process that promotes a systematic and strategic approach to land conservation and encourages land use planning and practices that are good for both nature and people. It provides a framework to guide future growth, land development, and land conservation decisions in appropriate areas to protect both community and natural resource assets.

Environmental corridors are an essential planning tool for protecting the most important remaining natural resource features in Southeastern Wisconsin and elsewhere. Since development of the environmental corridor concept, there have been significant advancements in landscape ecology that have furthered understanding of the spatial and habitat needs of multiple groups of organisms. In addition, advancements in pollutant removal practices, stormwater control, and agriculture have increased our understanding of the effectiveness and limitations of environmental corridors. In protecting water quality and providing aquatic and terrestrial habitat, there is a need to better integrate new technologies through their application within riparian buffers.

SEWRPC has embraced and applied the environmental corridor concept developed by Philip Lewis (Professor Emeritus of Landscape Architecture at the University of Wisconsin-Madison) since 1966 with the publication of its first regional land use plan. Since then, SEWRPC has refined and detailed the mapping of environmental corridors, enabling the corridors to be incorporated directly into regional, county, and community plans and to be reflected in regulatory measures. The preservation of environmental corridors remains one of the most important recommendations of the regional plan. Corridor preservation has now been embraced by numerous county and local units of government as well as by State and Federal agencies. The environmental corridor concept conceived by Lewis has become an important part of the planning and development culture in Southeastern Wisconsin.

Beyond the Environmental Corridor Concept

Environmental corridors are divided into the following three categories.

- **Primary environmental corridors** contain concentrations of our most significant natural resources. They are at least 400 acres in size, at least two miles long, and at least 200 feet wide.

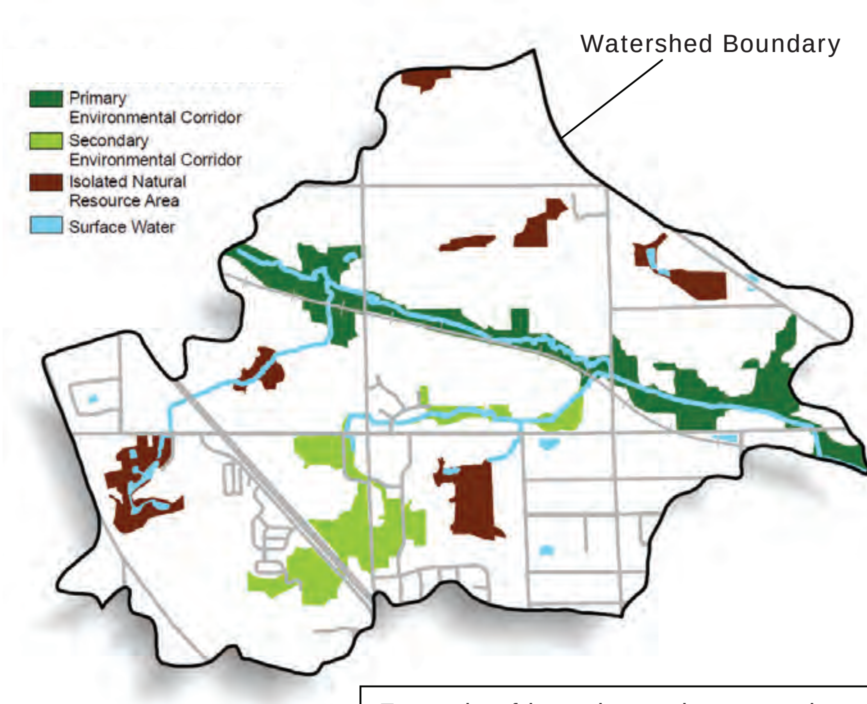
- **Secondary environmental corridors** contain significant but smaller concentrations of natural resources. They are at least 100 acres in size and at least one mile long, unless serving to link primary corridors.

- **Isolated natural resource areas** contain significant remaining resources that are not connected to environmental corridors. They are at least five acres in size and at least 200 feet wide.

Key Features of Environmental Corridors

- Lakes, rivers, and streams
- Undeveloped shorelands and floodlands
- Wetlands
- Woodlands
- Prairie remnants
- Wildlife habitat
- Rugged terrain and steep slopes
- Unique landforms or geological formations
- Unfarmed poorly drained and organic soils
- Existing outdoor recreation sites
- Potential outdoor recreation sites
- Significant open spaces
- Historical sites and structures
- Outstanding scenic areas and vistas

Beyond the Environmental Corridor Concept

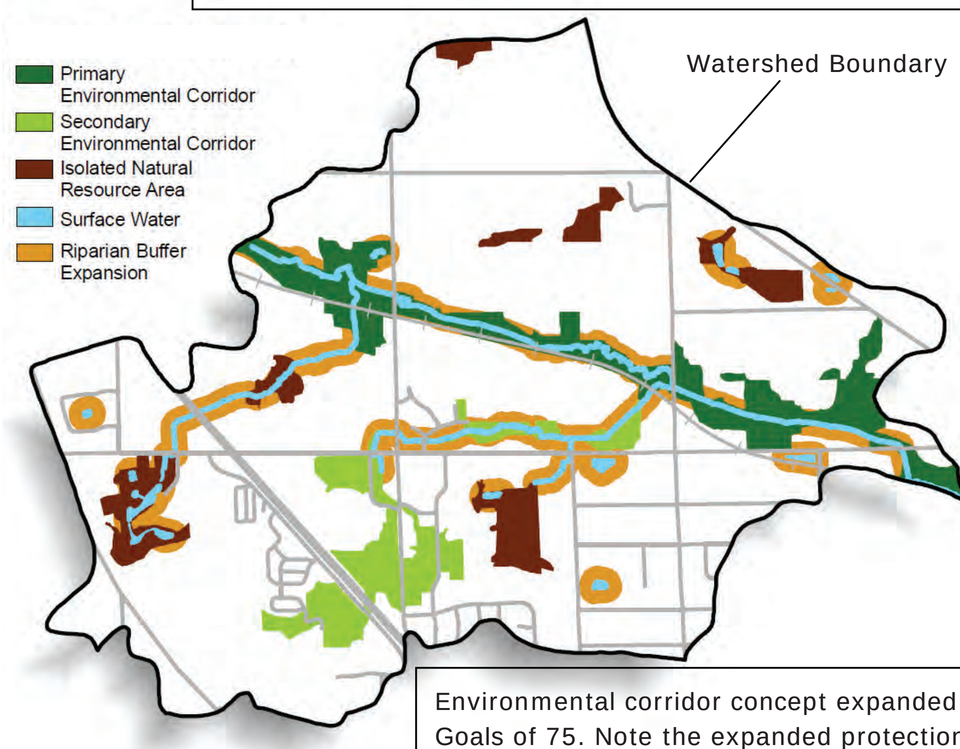


The Minimum Goals of **75** within a Watershed

75% minimum of total stream length should be naturally vegetated to protect the functional integrity of the water resources. (Environment Canada, How Much Habitat is Enough? A Framework for Guiding Habitat Rehabilitation in Great lakes Areas of Concern, Second Edition, 2004)

75 foot wide minimum riparian buffers from the top edge of each stream bank should be naturally vegetated to protect water quality and wildlife. (SEWRPC Planning Report No 50, A Regional Water Quality Management Plan for the Greater Milwaukee Watersheds, December 2007)

Example of how the environmental corridor concept is applied on the landscape. For more information see "Plan on It!" series **Environmental Corridors: Lifelines of the Natural Resource Base** at http://www.sewrpc.org/SEWRPC/LandUse/EnvironmentalCorridors.htm



Environmental corridor concept expanded to achieve the Goals of 75. Note the expanded protection in addition to the connection of other previously isolated areas.

Habitat Fragmentation—The Need for Corridors

Southeastern Wisconsin is a complex mosaic of agricultural and urban development. Agricultural lands originally dominated the landscape and remain a major land use. However, such lands continue to be converted to urban uses. Both of these dominant land uses fragment the landscape by creating islands or isolated pockets of wetland, woodland, and other natural lands available for wildlife preservation and recreation. By recognizing this fragmentation of the landscape, we can begin to mitigate these impacts.

New developments should incorporate water quality and wildlife enhancement or improvement objectives as design criteria by looking at the potential for creating linkages with adjoining lands and water features.

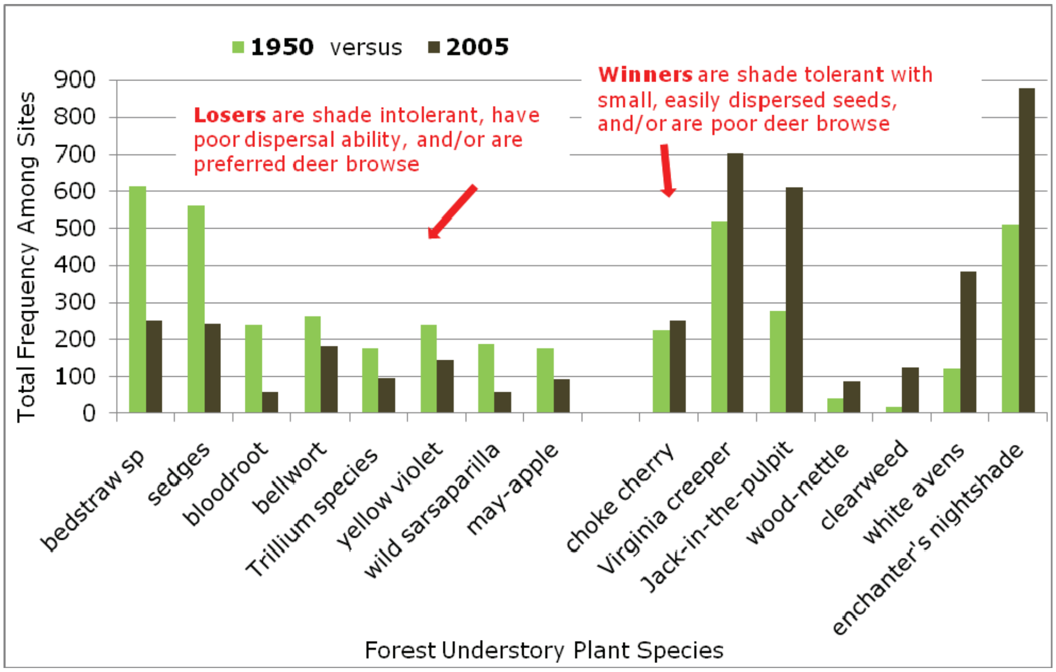
At the time of conversion of agricultural lands to urban uses, there are opportunities to re-create and expand riparian buffers and environmental corridors reconnecting uplands and waterways and restoring ecological integrity and scenic beauty locally and regionally. For example, placement of roads and other infrastructure across stream systems could be limited so as to maximize continuity of the riparian buffers. This can translate into significant cost savings in terms of reduced road maintenance, reduced salt application, and limited bridge or culvert maintenance and replacements. This simple practice not only saves the community significant amounts of money, but also improves and protects quality of life. Where necessary road crossings do occur, they can be designed to provide for safe fish and wildlife passage.

Overland travel routes for wildlife are often unavailable, discontinuous, or life endangering within the highly fragmented landscapes of Southeastern Wisconsin and elsewhere.

State Threatened Species: Blanding's turtle

Habitat Fragmentation—The Need for Corridors

Forest understory plant species abundance among stands throughout Southern Wisconsin



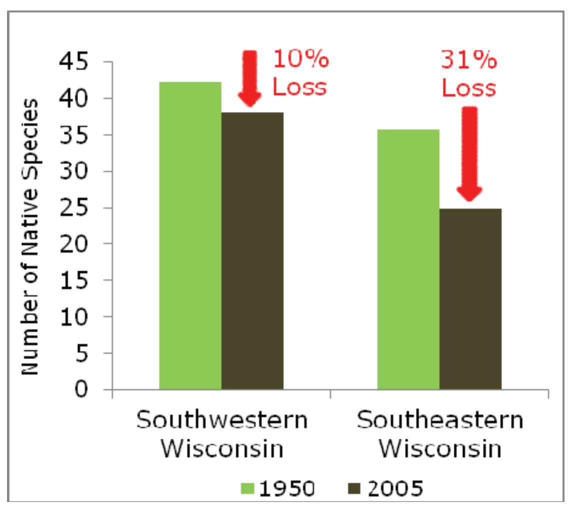
Forest fragmentation has led to significant plant species loss within Southern Wisconsin

(Adapted from David Rogers and others, 2008, Shifts in Southern Wisconsin Forest Canopy and Understory Richness, Composition, and Heterogeneity, Ecology, 89 (9): 2482-2492)

"...these results confirm the idea that large intact habitat patches and landscapes better sustain native species diversity. It also shows that people are a really important part of the system and their actions play an increasingly important role in shaping patterns of native species diversity and community composition. Put together, it is clear that one of the best and most cost effective actions we can take toward safeguarding native diversity of all types is to protect, enhance and create corridors that link patches of natural habitat."
Dr. David Rogers, Professor of Biology at the University of Wisconsin-Parkside

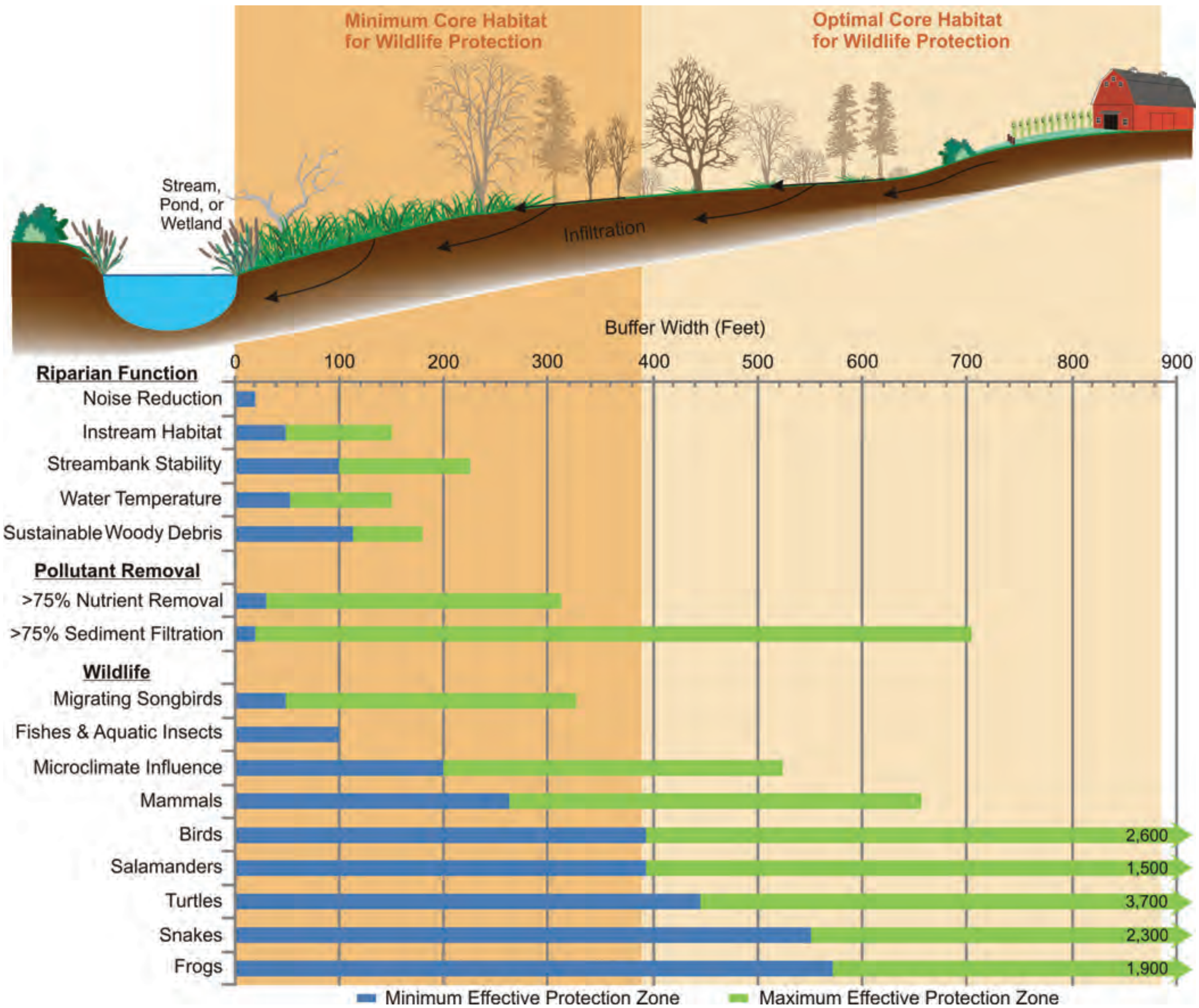
Since the 1950s, forests have increasingly become more fragmented by land development, both agricultural and urban, and associated roads and infrastructure, which have caused these forests to become isolated "islands of green" on the landscape. In particular, there has been significant loss of forest understory plant species over time (shrubs, grasses, and herbs covering the forest floor.) It is important to note that **these forests lost species diversity even when they were protected as parks or natural areas**.

One major factor responsible for this decline in forest plant diversity is that routes for native plants to re-colonize isolated forest islands are largely cut-off within fragmented landscapes. For example, the less fragmented landscapes in Southwestern Wisconsin lost fewer species than the more fragmented stands in Southeastern Wisconsin. In addition, the larger-sized forests and forests with greater connections to surrounding forest lands lost fewer species than smaller forests in fragmented landscapes.



Wider is Better for Wildlife

Why? Because buffer size is the engine that drives important natural functions like food availability and quality, access to water, habitat variety, protection from predators, reproductive or resting areas, corridors to safely move when necessary, and help in maintaining the health of species' gene pools to prevent isolation and perhaps extinction.



One riparian buffer size does not fit all conditions or needs. There are many riparian buffer functions and the ability to effectively fulfill those functions is largely dependent on width. Determining what buffer widths are needed should be based on what functions are desired as well as site conditions. For example, as shown above, water temperature protection generally does not require as wide a buffer as provision of habitat for wildlife. Based on the needs of wildlife species found in Wisconsin, the minimum core habitat buffer width is about 400 feet and the optimal width for sustaining the majority of wildlife species is about 900 feet. Hence, the value of large undisturbed parcels along waterways which are part of, and linked to, an environmental corridor system. The minimum effective buffer width distances are based on data reported in the scientific literature and the quality of available habitats within the context of those studies.

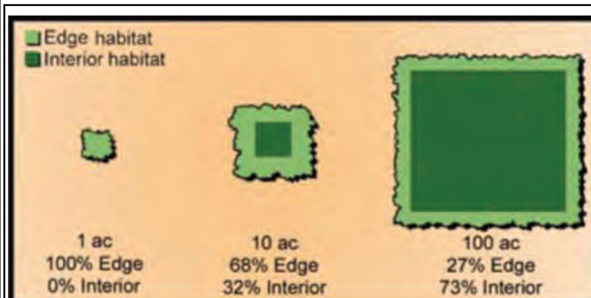
Wider is Better for Wildlife

Wildlife habitat needs change within and among species. **Minimum Core Habitat and Optimum Core Habitat distances were developed from numerous studies to help provide guidance for biologically meaningful buffers to conserve wildlife biodiversity.** These studies documented distances needed for a variety of biological (life history) needs to sustain healthy populations such as breeding, nesting, rearing young, foraging/feeding, perching (for birds), basking (for turtles), and overwintering/dormancy/hibernating. These life history needs require different types of habitat and distances from water, for example, one study found that Blanding's turtles needed approximately 60-foot-wide buffers for basking, 375 feet for overwintering, and up to 1,200 feet for nesting to bury their clutches of eggs. Some species of birds like the Blacked-capped chickadee or white breasted nuthatch only need about 50 feet of buffer, while others like the wood duck or great blue heron require 700-800 feet for nesting. Therefore, **understanding habitat needs for wildlife species is an important consideration in designing riparian buffers.**

Although *Ambystoma* salamanders require standing water for egg laying and juvenile development, most other times of the year they can be found more than 400 feet from water foraging for food.

Wisconsin Species	Mimimum Core Habitat (feet)	Optimum Core Habitat (feet)	Number of Studies
Frogs	571	1,043	9
Salamanders	394	705	14
Snakes	551	997	5
Turtles	446	889	27
Birds	394	787	45
Mammals	263	No data	11
Fishes and Aquatic Insects	100	No data	11
Mean	388	885	

This approach was adapted from *R.D. Semlitsch and J.R. Bodie, 2003, Biological Criteria for Buffer Zones around Wetlands and Riparian Habitats for Amphibian and Reptiles, Conservation Biology, 17(5):1219-1228.* These values are based upon studies examining species found in Wisconsin and represent mean linear distances extending outward from the edge of an aquatic habitat. The Minimum Core Habitat and Optimum Core Habitat reported values are based upon the mean minimum and mean maximum distances recorded, respectively. Due to a low number of studies for snake species, the recommended distances for snakes are based upon values reported by *Semlitsch and Bodie.*

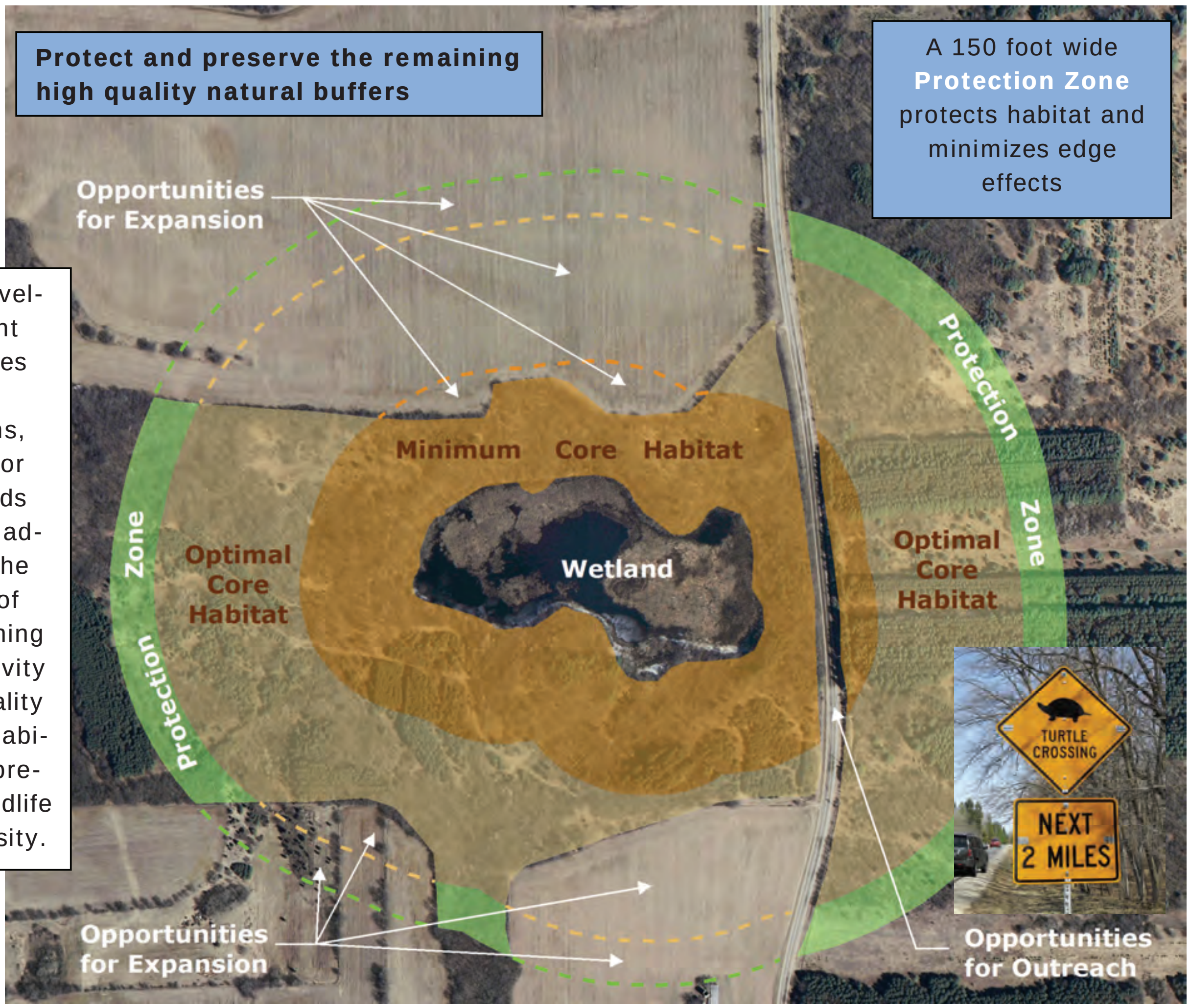


"***Large patches typically conserve a greater variety and quality of habitats, resulting in higher species diversity and abundance."*** *Larger patches contain greater amounts of interior habitat and less edge effects, which benefits interior species, by providing safety from parasitism, disease, and invasive species.*

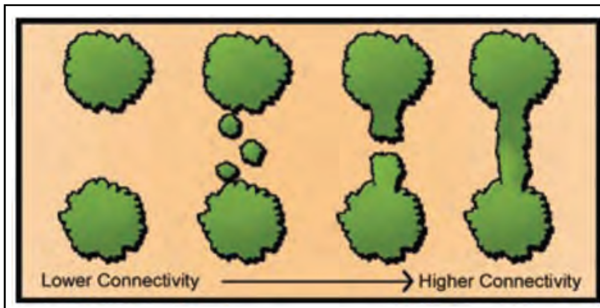
(Bentrup, G. 2008. Conservation buffers: design guidelines for buffers, corridors, and greenways. Gen. Tech. Rep. SRS-109. Asheville, NC: Department of Agriculture, Forest Service, Southern Research Station)

Maintaining Connections is Key

Like humans, all forms of wildlife require access to clean water. Emerging research has increasingly shown that, in addition to water, more and more species such as amphibians and reptiles cannot persist without landscape connectivity between quality wetland and upland habitats. Good connectivity to upland terrestrial habitats is essential for the persistence of healthy sustainable populations, because these areas provide vital feeding, overwintering, and nesting habitats found nowhere else. Therefore, both aquatic and terrestrial habitats are essential for the preservation of biodiversity and they should ideally be managed together as a unit.



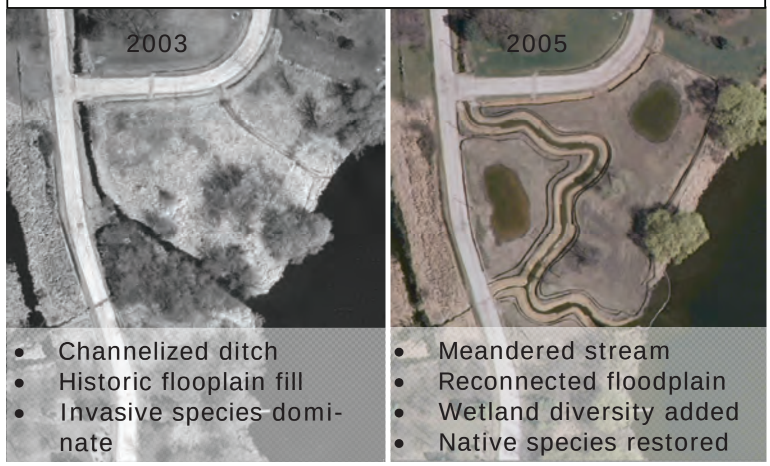
Land development practices near streams, lakes, or wetlands need to address the issue of maintaining connectivity with quality upland habitats to preserve wildlife biodiversity.



Increasing connectivity among quality natural landscapes (wetlands, woodlands, prairies) can benefit biodiversity by providing access to other areas of habitat, increasing gene flow and population viability, enabling recolonization of patches, and providing habitat (Bentrup 2008).

Basic Rules to Better Buffers

Protecting the integrity of native species in the region is an objective shared by many communities. The natural environment is an essential component of our existence and contributes to defining our communities and neighborhoods. Conservation design and open space development patterns in urbanizing areas and farm conservation programs in rural areas have begun to address the importance of maintaining and restoring riparian buffers and connectivity among corridors.



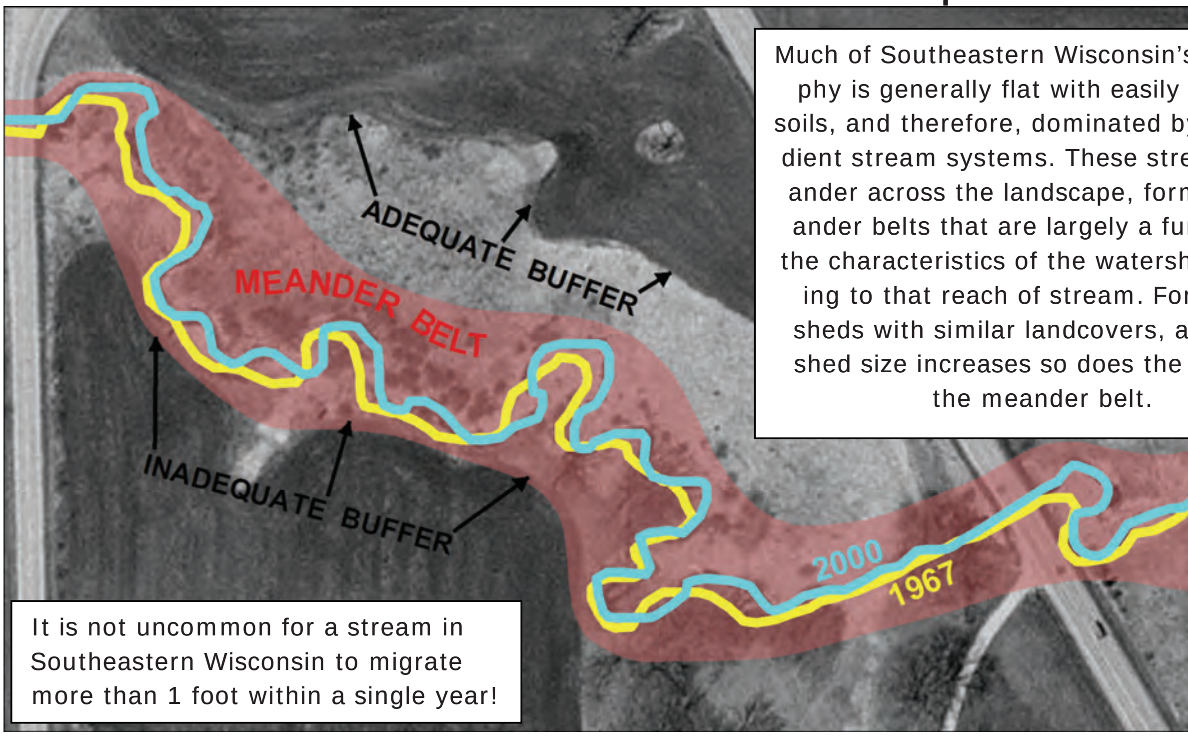
There are opportunities to improve buffer functions to improve water quality and wildlife habitat, even in urban situations

How wide should the buffer be? Unfortunately, there is no one-size-fits all buffer width adequate to protect water quality, wildlife habitat, and human needs. Therefore, the answer to this question depends upon the predetermined needs of the landowner and community objectives or goals.
As riparian corridors become very wide, their pollutant removal (buffering) effectiveness may reach a point of diminishing returns compared to the investment involved. However, the prospects for species diversity in the corridor keep increasing with buffer width. For a number of reasons, 400- to 800-foot-wide buffers are not practical along all lakes, streams, and wetlands within Southeastern Wisconsin. Therefore, communities should develop guidelines that remain flexible to site-specific needs to achieve the most benefits for water resources and wildlife as is practical.

Key considerations to better buffers / corridors:

- Wider buffers are better than narrow buffers for water quality and wildlife functions
- Continuous corridors are better than fragmented corridors for wildlife
- Natural linkages should be maintained or restored
- Linkages should not stop at political boundaries
- Two or more corridor linkages are better than one
- Structurally diverse corridors (e.g., diverse plant structure or community types, upland and wetland complexes, soil types, topography, and surficial geology) are better than corridors with simple structures
- Both local and regional spatial and temporal scales should be considered in establishing buffers
- Corridors should be located along dispersal and migration routes
- Corridors should be located and expanded around rare, threatened, or endangered species
- Quality habitat should be provided in a buffer whenever possible
- Disturbance (e.g. excavation or clear cutting vegetation) of corridors should be minimized during adjacent land use development
- Native species diversity should be promoted through plantings and active management
- Non-native species invasions should be actively managed by applying practices to preserve native species
- Fragmentation of corridors should be reduced by limiting the number of crossings of a creek or river where appropriate
- Restoration or rehabilitation of hydrological function, streambank stability, instream habitat, and/or floodplain connectivity should be considered within corridors.
- Restoration or retrofitting of road and railway crossings promotes passage of aquatic organisms

Creeks and Rivers Need to Roam Across the Landscape



Much of Southeastern Wisconsin's topography is generally flat with easily erodible soils, and therefore, dominated by low gradient stream systems. These streams meander across the landscape, forming meander belts that are largely a function of the characteristics of the watershed draining to that reach of stream. For watersheds with similar landcovers, as watershed size increases so does the width of the meander belt.

It is not uncommon for a stream in Southeastern Wisconsin to migrate more than 1 foot within a single year!

Healthy streams naturally meander or migrate across a landscape over time. Streams are transport systems for water and sediment and are continually eroding and depositing sediments, which causes the stream to migrate. When the amount of sediment load coming into a stream is equal to what is being transported downstream—and stream widths, depths, and length remain consistent over time—it is common to refer to that stream as being in a state of **"dynamic equilibrium."** In other words the stream retains its physical dimensions (equilibrium), but those physical features are shifted, or migrate, over time (dynamic).

Room to Roam

Riparian buffer widths should take into account the amount of area that a stream needs to be able to self-adjust and maintain itself in a state of dynamic equilibrium. ... These are generally greater than any minimum width needed to protect for pollutant removal alone.

Streams are highly sensitive, and they respond to changes in the amounts of water and sediment draining to them, which are affected by changing land use conditions. For example, streams can respond to increased discharges of water by increased scour (erosion) of bed and banks that leads to an increase in stream width and depth—or "degradation." Conversely, streams can respond to increased sedimentation (deposition) that leads to a decrease in channel width and depth—or "aggradation."

Why Should You Care About Buffers?

Economic Benefits:

- Increased value of riparian property
- Reduced lawn mowing time and expense
- Increased shade to reduce building cooling costs
- Natural flood mitigation protection for structures or crops
- Pollution mitigation (reduced nutrient and contaminant loading)
- Increased infiltration and groundwater recharge
- Prevented loss of property (land or structures) through erosion
- Greater human and ecological health through biodiversity

Recreational Benefits:

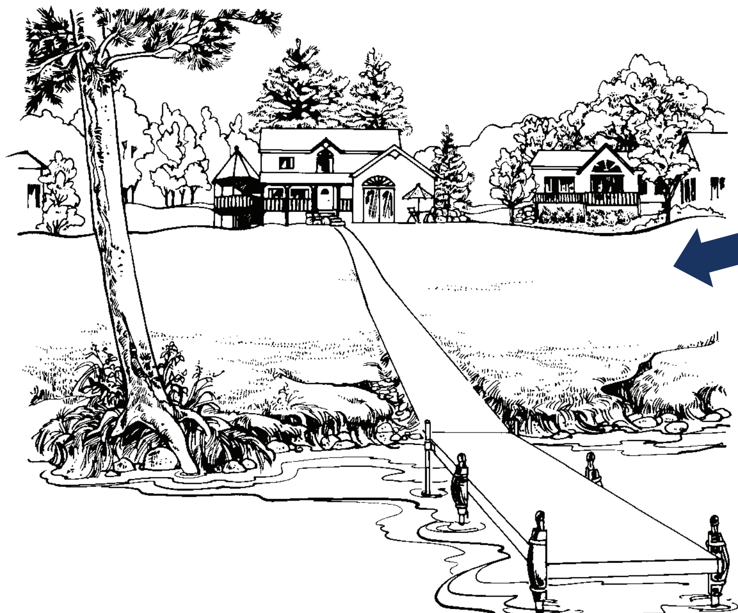
- Increased quality of the canoeing/kayaking experience
- Improved fishing and hunting quality by improving habitat
- Improved bird watching/wildlife viewing quality and opportunities
- Increased potential for expansion of trails for hiking and bicycling
- Opportunities made available for youth and others to locally reconnect with nature

Riparian buffers make sense and are profitable monetarily, recreationally, and aesthetically!

Social Benefits:

- Increased privacy
- Educational opportunities for outdoor awareness
- Improved quality of life at home and work
- Preserved open space/balanced character of a community
- Focal point for community pride and group activities
- Visual diversity
- Noise reduction

A Matter of Balance



University of Wisconsin—Extension

Although neatly trimmed grass lawns are popular, these offer limited benefits for water quality or wildlife habitat. A single house near a waterbody may not seem like a "big deal," but the cumulative effects of many houses can negatively impact streams, lakes, and wetlands.

All the lands within Southeastern Wisconsin ultimately flow into either the Mississippi River or the Great Lakes systems. The cumulative effects of agriculture and urban development in the absence of mitigative measures, ultimately affects water quality in those systems. Much of this development causes increases in water runoff from the land into wetlands, ponds, and streams. This runoff transports water, sediments, nutrients, and other pollutants into our waterways that can lead to a number of problems, including flooding that can cause crop loss or building damage; unsightly and/or toxic algae blooms; increased turbidity; damage to aquatic organisms from reduced dissolved oxygen, lethal temperatures, and/or concentrations of pollutants; and loss of habitat.

Riparian buffers are one of the most effective tools available for defending our waterways. Riparian buffers can be best thought of as forming a living, self-sustainable protective shield. This shield protects investments in the land and all things on it as well as our quality of life locally, regionally, and, ultimately, nationally. Combined with stormwater management, environmentally friendly yard care, effective wastewater treatment, conservation farming methods, and appropriate use of fertilizers and other agrichemicals, **riparian buffers complete the set of actions that we can take to minimize impacts to our shared water resources.**

Lakeshore buffers can take many forms, which require a balancing act between lake viewing, access, and scenic beauty. Lakeshore buffers can be integrated into a landscaping design that complements both the structural development and a lakeside lifestyle. Judicious placement of access ways and shoreline protection structures, and preservation or reestablishment of native vegetation, can enhance and sustain our use of the environment.

University of Wisconsin—Extension

Case Study—Agricultural Buffers

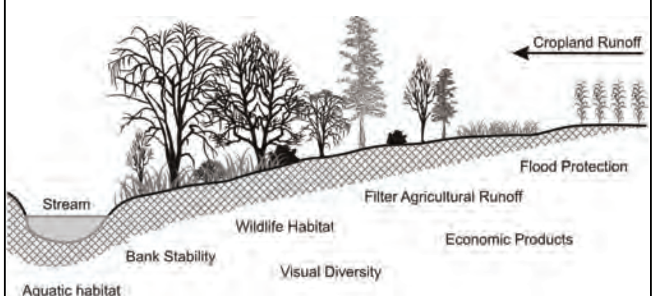
Agricultural nonpoint source pollution runoff continues to pose a threat to water quality and aquatic ecosystems within Wisconsin and elsewhere. In an effort to address this problem, the Wisconsin Buffer Initiative was formed with the goal of designing a buffer implementation program to achieve science-based, cost-effective, water quality improvements (report available online at http://www.soils.wisc.edu/extension/nonpoint/wbi.php).

While it is true that riparian buffers alone may not always be able to reduce nutrient and sediment loading from agricultural lands, WBI researchers found that "...***riparian buffers are capable of reducing large percentages of the phosphorus and sediment that are currently being carried by Wisconsin streams. Even in watersheds with extremely high loads (top 10%), an average of about 70% of the sediment and phosphorus can be reduced through buffer implementation***." (*Diebel, M.J. and others, 2009, Landscape planning for agricultural nonpoint source pollution reduction III: Assessing Phosphorus and sediment reduction potential, Environmental Management, 43:69-83.*).

Challenge:
Buffers may take land out of cultivated crop production and require additional cost to install and maintain. Cost sharing, paid easements, and purchase of easements or development rights may sometimes be available to offset costs.
Benefits:
Buffers may offset costs by producing perennial crops such as hay, lumber, fiber, nuts, fruits, and berries. In addition, they provide visual diversity on the landscape, help maintain long-term crop productivity, and help support healthier fish populations for local enjoyment.

Federal and state natural resource agencies have long recognized the need to apply a wide range of Best Management Practices on agricultural lands to improve stream water quality. Although there are many tools available in the toolbox to reduce pollutant runoff from agricultural lands, such as crop rotations, nutrient and manure management, conservation tillage, and contour plowing, riparian buffers are one of the most effective tools to accomplish this task. Their multiple benefits and inter-connectedness from upstream to downstream make riparian buffers a choice with watershed-wide benefits.

Determine what benefits are needed.



The USDA in *Agroforestry Notes* (AF Note-4, January 1997) outlines a four step process for designing riparian buffers for Agricultural lands:

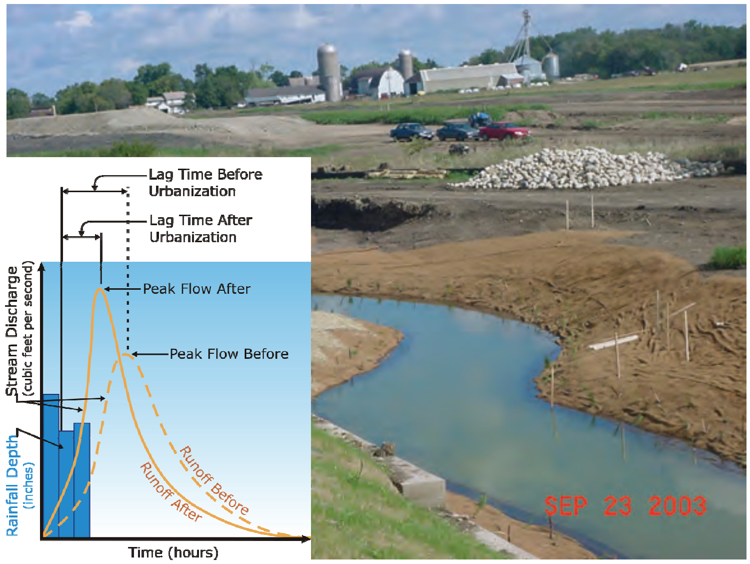
1-Determine what buffers functions are needed
2-Identify the best types of vegetation to provide the needed benefits
3-Determine the minimum acceptable buffer width to achieve desired benefits
4-Develop an installation and maintenance plan

Drain tiles can bypass infiltration and filtration of pollutants by providing a direct pathway to the water and "around" a buffer. This is important to consider in design of a buffer system which integrates with other agricultural practices.

Case Study—Urbanizing Area Buffers

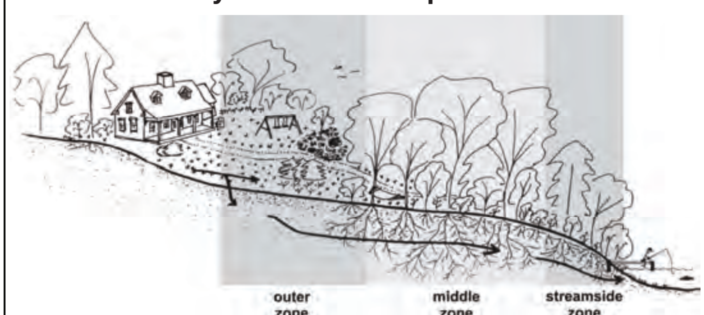
When development occurs near a waterbody, the area in driveways, rooftops, sidewalks, and lawns increases, while native plants and undisturbed soils decrease. As a result, the ability of the shoreland area to perform its natural functions (flood control, pollutant removal, wildlife habitat, and aesthetic beauty) is decreased. In the absence of mitigating measures, one the consequences of urban development is an increase in the amount of stormwater, which runs off the land instead of infiltrating into the ground. Therefore, **urbanization impacts the watershed, not only by reducing groundwater recharge, but also by changing stream hydrology** through increased stormwater runoff volumes and peak flows. This means less water is available to sustain the baseflow regime. The urban environment also contains increased numbers of pollutants and generates greater pollutant concentrations and loads than any other land use. This reflects the higher density of the human population and associated activities, which demand measures to protect the urban water system.

Mitigation of urban impacts may be as simple as not mowing along a stream corridor or changing land management and yard care practices, or as complex as changing zoning ordinances or widening riparian corridors through buyouts.



Comparison of hydrographs before and after urbanization. Note the rapid runoff and greater peak streamflow tied to watershed development. (Adapted from Federal Interagency Stream Restoration Working Group (FISRWG), Stream Corridor Restoration: Principles, Processes, and Practices, October 1998)

Anatomy of an urban riparian buffer



The most effective urban buffers have three zones:

Outer Zone-Transition area between the intact buffer and nearest permanent structure to capture sediment and absorb runoff.

Middle Zone-Area from top of bank to edge of lawn that is composed of natural vegetation that provides wildlife habitat as well as improved filtration and infiltration of pollutants.

Streamside Zone-Area from the water's edge to the top of the bank or uplands that provides critical connection between water, wetland, and upland habitats for wildlife as well as protect streams from bank erosion

(Fact sheet No. 6 Urban Buffer in the series Riparian Buffers for Northern New Jersey)

Challenge:

Urban development requires balancing flood protection, water quality protection, and the economic viability of the development.

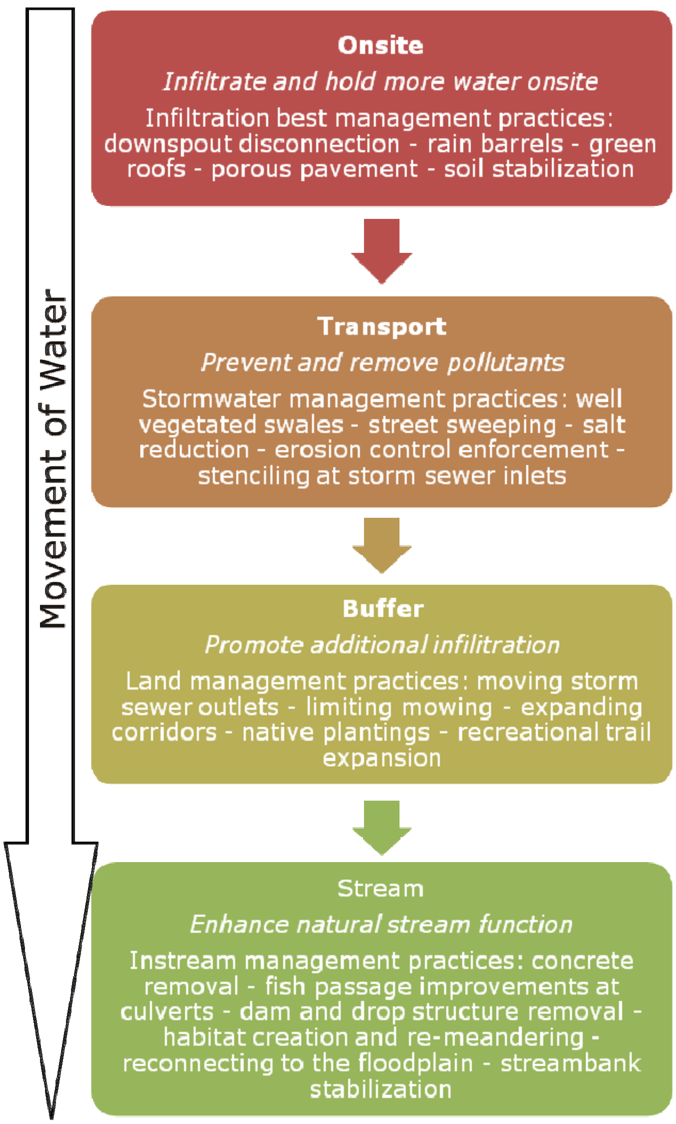
Opportunities:

Buffers may offset costs by providing adequate space for providing long-term water quantity and water quality protection. In addition, they provide visual diversity on the landscape, wildlife habitat and connectedness, and help maintain property values.

Case Study—Urban Buffers

Placement of riparian buffers in established urban areas is a challenge that requires new and innovative approaches. In these areas, historical development along water courses limits options and requires balancing flood management protection versus water quality and environmental protection needs. Consequently, some municipalities have begun to recognize the connections between these objectives and are introducing programs to remove flood-prone structures and culverts from the stream corridors and allow recreation of the stream, restoring floodplains, and improving both the quality of life and the environment.

In urban settings it may be necessary to limit pollution and water runoff before it reaches the buffer.



Challenge:
There are many potential constraints to establishing, expanding, and/or managing riparian buffers within an urban landscape. Two major constraints to establishment of urban buffers include:

1) **Limited or confined space to establish buffers** due to encroachment by structures such as buildings, roadways, and/or sewer infrastructure;
2) **Fragmentation of the landscape** by road and railway crossings of creeks and rivers that disrupt the linear connectedness of buffers, limiting their ability to provide quality wildlife habitat.

Much traditional stormwater infrastructure intercepts runoff and diverts it directly into creeks and rivers, bypassing any benefits of buffers to infiltrate or filter pollutants. This is important to consider in design of a buffer system for urban waterways, which begin in yards, curbsides, and construction sites, that are figuratively as close to streams as the nearest storm sewer inlet.

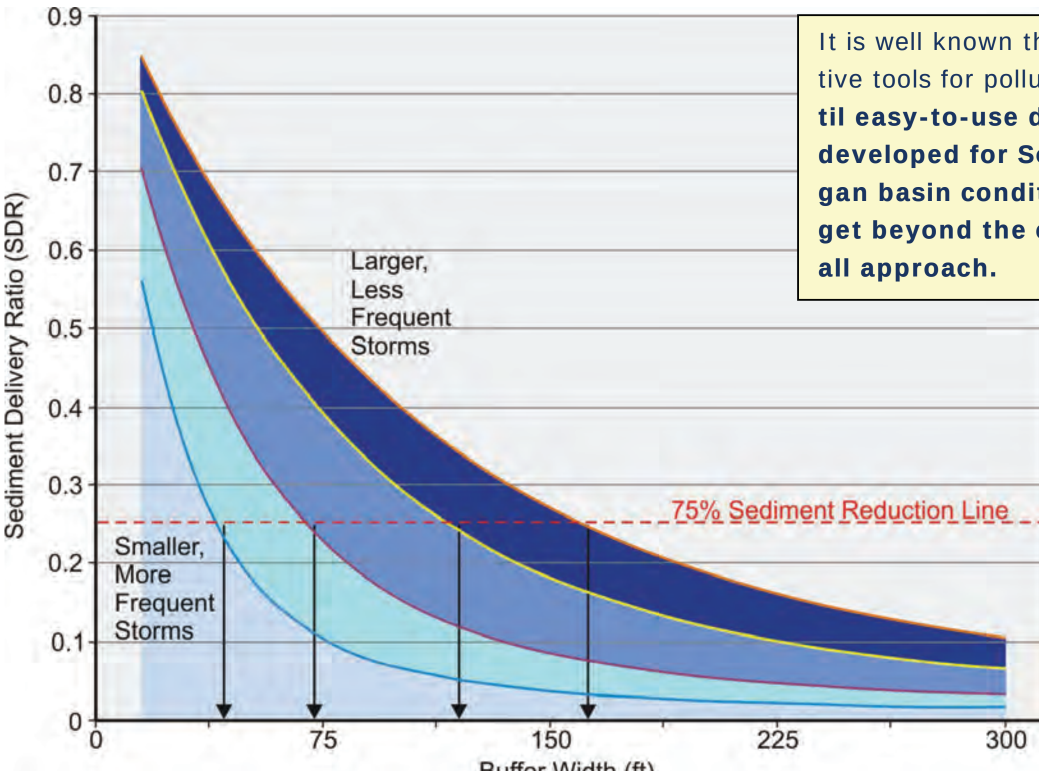
A Buffer Design Tool

Design aids are needed to help municipalities, property owners, and others take the "guesswork" out of determining adequate buffer widths for the purpose of water resource quality protection. While there are various complex mathematical models that can be used to estimate sediment and nutrient removal efficiencies, they are not easily applied by the people who need them including homeowners, farmers, businesses and developers.

To fill this gap, design aid tools are being developed using factors such as slope, soils, field length, incoming pollutant concentrations, and vegetation to allow the user to identify and test realistic buffer widths with respect to the desired percent pollutant load reduction and storm characteristics. By developing a set of relationships among factors that determine buffer effectiveness, the width of buffer needed to meet specific goals can be identified.

In the example below, 50-foot-wide buffers are necessary to achieve 75 % sediment removal during small, low intensity storms, while buffers more than 150 feet wide are necessary to achieve the same sediment reduction during more severe storms. Based on this information, decision-makers have the option of fitting a desired level of sediment removal into the context of their specific conditions. Under most conditions, a 75-foot width will provide a minimum level of protection for a variety of needs (SEWRPC PR No. 50, Appendix O.)

It is well known that buffers are effective tools for pollutant removal, but **until easy-to-use design aid tools are developed for Southern Lake Michigan basin conditions, we can never get beyond the current one size fits all approach.**



This generalized graph depicts an example of model output for an optimal buffer width to achieve a 75% sediment reduction for a range of soil and slope, vegetation, and storm conditions characteristic of North Carolina. *(Adapted from Muñoz-Carpena R., Parsons J.E.. 2005. VFSMOD-W: Vegetative Filter Strips Hydrology and Sediment Transport Modeling System v.2.x. Homestead, FL: University of Florida. http://carpena.ifas.ufl.edu/vfsmod/citations.shtml)*

Buffers Are A Good Defense

> ***"Riparian ecosystems are naturally resilient,*** *provide linear habitat connectivity, link aquatic and terrestrial ecosystems, and create thermal refugia for wildlife: all characteristics that can contribute to ecological adaptation to climate change."*
>
> *(N. E. Seavy and others, Why Climate Change Makes Riparian Restoration More Important Than Ever: Recommendations for Practice and Research, 2009, Ecological Restoration 27(3):330-338)*

Today's natural resources are under threat. These threats are immediate as in the case of chemical accidents or manure spills, and chronic as in the case of stormwater pollution carrying everything from eroded soil, to fertilizer nutrients, to millions of drips from automobiles and other sources across the landscape. Non-native species have invaded, and continue to invade, key ecosystems and have caused the loss of native species and degradation of their habitats to the detriment of our use of important resources.

A more subtle, but growing, concern is the case of stresses on the environment resulting from climate change. Buffers present an opportunity for natural systems to adapt to such changes by providing the space to implement protective measures while also serving human needs. **Because riparian buffers maintain an important part of the landscape in a natural condition, they offer opportunities for communities to adjust to our changing world.**

Well-managed riparian buffers are a good defense against these threats. In combination with environmental corridors, buffers maintain a sustainable reserve and diversity of habitats, plant and animal populations, and genetic diversity of organisms, all of which contribute to the long-term preservation of the landscape. Where they are of sufficient size and connectivity, riparian buffers act as reservoirs of resources that resist the changes that could lead to loss of species.

Refuge or protection from increased water temperatures as provided by natural buffers is important for the preservation of native cold-water, cool-water, and warm-water fishes and their associated communities.

Buffers Provide Opportunities

River, lake, and wetland systems and their associated riparian lands form an important element of the natural resource base, create opportunities for recreation, and contribute to attractive and well-balanced communities. These resources can provide an essential avenue for relief of stress among the population and improve quality of life in both urban and rural areas. Such uses also sustain industries associated with outfitting and supporting recreational and other uses of the natural environment, providing economic opportunities. Increasing access and assuring safe use of these areas enhances public awareness and commitment to natural resources. Research has shown that property values are higher adjoining riparian corridors, and that such natural features are among the most appreciated and well-supported parts of the landscape for protection.

We demand a lot from our riparian buffers!

Sustaining this range of uses requires our commitment to protect and maintain them.

Summary

The following guidance suggestions highlight key points to improve riparian corridor management and create a more sustainable environment.

Riparian corridors or buffers along our waters may contain varied features, but all are best preserved or designed to perform multiple important functions.

Care about buffers because of their many benefits. Riparian buffers make sense and are profitable monetarily, recreationally, aesthetically, as well as environmentally.

Enhance the environmental corridor concept. Environmental corridors are special resources which deserve protection. They serve many key riparian corridor functions, but in some cases, could also benefit from additional buffering.

Avoid habitat fragmentation of riparian corridors. It is important to preserve and link key resource areas, making natural connections and avoiding habitat gaps.

Employ the adage "wider is better" for buffer protection. While relatively narrow riparian buffers may be effective as filters for certain pollutants, that water quality function along with infiltration of precipitation and runoff and the provision of habitat for a host of species will be improved by expanding buffer width where feasible.

Allow creeks and rivers room to roam across the landscape. Streams are dynamic and should be buffered adequately to allow for natural movement over time while avoiding problems associated with such movement.

Consider and evaluate buffers as a matter of balance. Riparian buffers are a living, self-sustainable shield that can help balance active use of water and adjoining resources with environmental protection.

Agricultural buffers can provide many benefits. Riparian buffers in agricultural settings generally work well, are cost-effective, and can provide multiple benefits, including possibly serving as areas to raise certain crops.

Urban buffers should be preserved and properly managed. Though often space-constrained and fragmented, urban buffers are important remnants of the natural system. Opportunities to establish or expand buffers should be considered, where feasible, complemented by good stormwater management, landscaping, and local ordinances, including erosion controls.

A buffer design tool is needed and should be developed. Southeastern Wisconsin and the Southern Lake Michigan Basin would benefit from development of a specific design tool to address the water quality function of buffers. Such a tool would improve on the currently available general guidance on dimensions and species composition.

Buffers are a good defense. Combined with environmental corridors, riparian buffers offer a good line of defense against changes which can negatively impact natural resources and the landscape.

Managing the Water's Edge

MORE TO COME

Future editions in a riparian buffer planning series are being explored with the intent of focusing on key elements of this critical land and water interface. Topics may include:

- Information sharing and development of ordinances to integrate riparian buffers into existing land management plans and programs
- Integration of stormwater management practices and riparian buffer best management practices
- Application of buffers within highly constrained urban corridors with and without brownfield development
- Installation of buffers within rural or agricultural lands being converted to urban uses
- Utilization of buffers in agricultural areas and associated drainage systems
- Integration of riparian buffers into environmental corridors to support resources preservation, recreation and aesthetic uses
- Preservation of stream courses and drainageways to minimize maintenance and promote protection of infrastructure
- Guidance for retrofitting, replacement, or removal of infrastructure such as dams and road crossings, to balance transportation, recreation, aesthetic, property value, and environmental considerations.
- Protection of groundwater recharge and discharge areas
- Protection of high quality, sensitive coastal areas, including preservation of recreational potential

MORE INFORMATION

This booklet can be found at http://www.sewrpc.org/RBMG-no1 . Please visit the website for more information, periodic updates, and a list of complementary publications.

* * *

W239 N1812 Rockwood Drive, Waukesha, WI, 53187-1607
262-547-6721.

Staff Acknowledgements:

Principal Author: Tom Slawski, PhD, Principal Planner

Michael Hahn, P.E., P.H., Chief Environmental Engineer
Laura Kletti, P.E., Principal Engineer
Gary Korb, Regional Planning Educator, UW-Extension/SEWRPC
Ed Schmidt, GIS Planning Specialist
Mike Scott, GIS Application Specialist
Sara Teske, Research Analyst
Jeff Thornton, PhD, Principal Planner

www.sewrpc.org

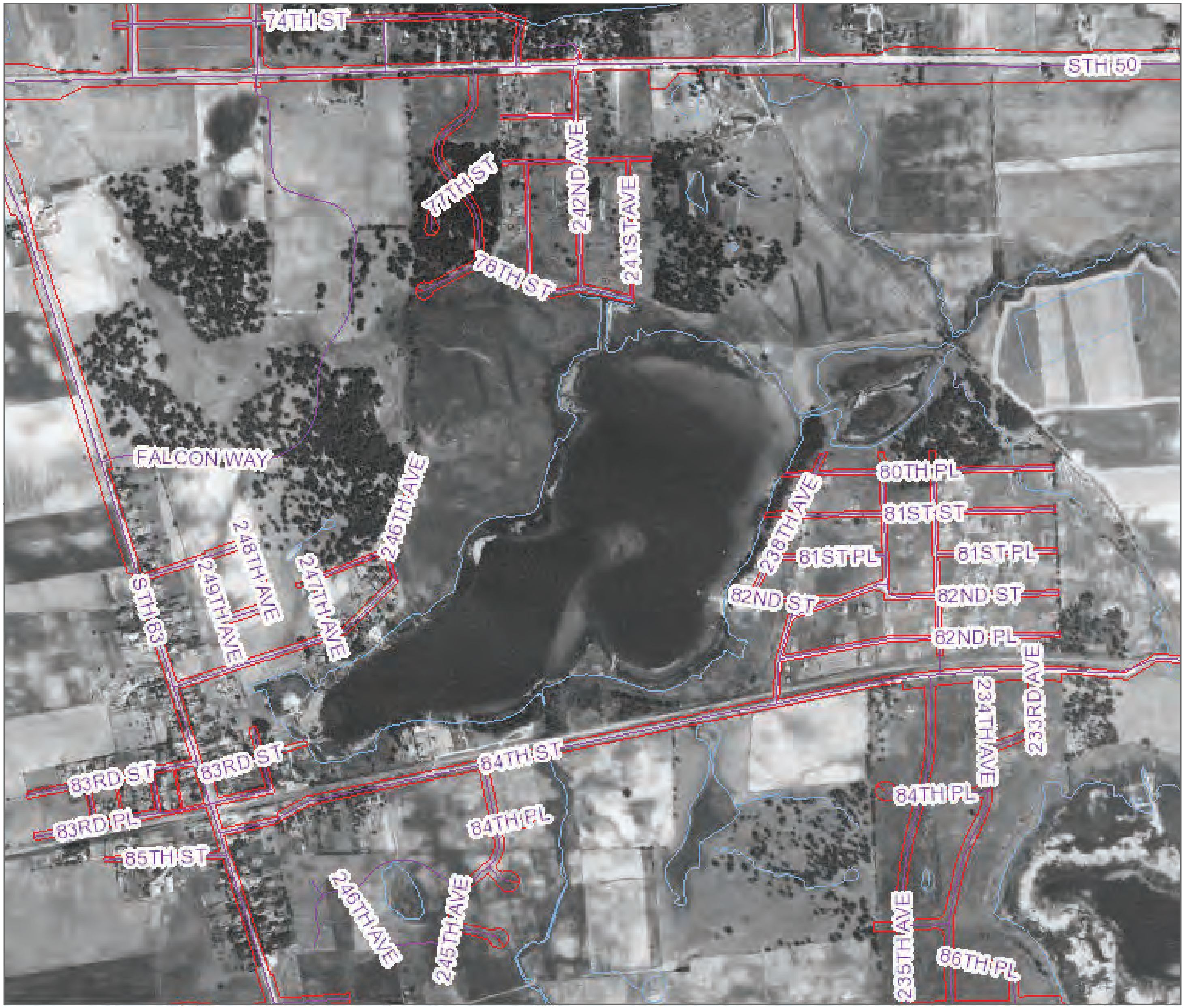
May 7, 2010

Appendix C

AERIAL PHOTOS OF HOOKER LAKE 1937-2015

(This page intentionally left blank)

1937



KENOSHA COUNTY
INTERACTIVE MAPPING

Legend

Water Features

N
S

1 inch = 1,000 feet

DISCLAIMER This map is neither a legally recorded map nor a survey and is not intended to be used as one. This drawing is a compilation of records, data and information located in various state, county and municipal offices and other sources affecting the area shown and is to be used for reference purposes only. Kenosha County is not responsible for any inaccuracies herein contained. If discrepancies are found, please contact Kenosha County.

Date Printed: 3/31/2016

1963

KENOSHA COUNTY
INTERACTIVE MAPPING

Legend

Water Features

N
S

1 inch = 1,000 feet

Date Printed: 3/31/2016

1970

KENOSHA COUNTY
INTERACTIVE MAPPING

Legend

Water Features

N
S

1 inch = 1,000 feet

Date Printed: 3/31/2016

1980

KENOSHA COUNTY
INTERACTIVE MAPPING

Legend

Water Features

1 inch = 1,000 feet

DISCLAIMER This map is neither a legally recorded map nor a survey and is not intended to be used as one. This drawing is a compilation of records, data and information located in various state, county and municipal offices and other sources affecting the area shown and is to be used for reference purposes only. Kenosha County is not responsible for any inaccuracies herein contained. If discrepancies are found, please contact Kenosha County.

Date Printed: 3/31/2016

1990

KENOSHA COUNTY
INTERACTIVE MAPPING

Legend

Water Features

N
S

1 inch = 1,000 feet

DISCLAIMER This map is neither a legally recorded map nor a survey and is not intended to be used as one. This drawing is a compilation of records, data and information located in various state, county and municipal offices and other sources affecting the area shown and is to be used for reference purposes only. Kenosha County is not responsible for any inaccuracies herein contained. If discrepancies are found, please contact Kenosha County.

Date Printed: 3/31/2016

2000

KENOSHA COUNTY INTERACTIVE MAPPING

Legend

Water Features

N

S

1 inch = 1,000 feet

Date Printed: 3/31/2016

2010

KENOSHA COUNTY
INTERACTIVE MAPPING

Legend

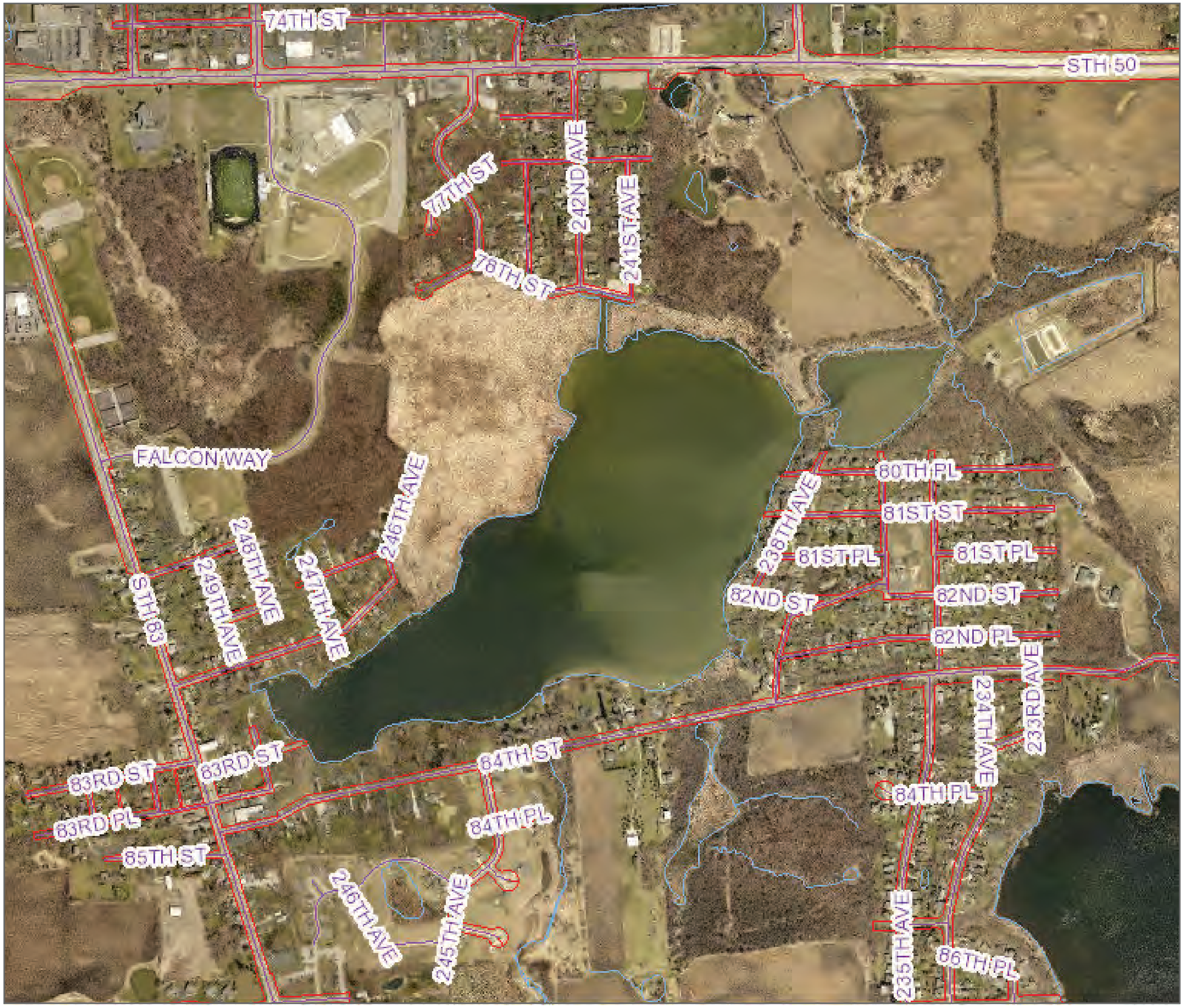
Water Features

N
S

1 inch = 1,000 feet

Date Printed: 3/31/2016

2015



KENOSHA COUNTY
INTERACTIVE MAPPING

Legend

Water Features

N
S

1 inch = 1,000 feet

Date Printed: 3/31/2016

Appendix D

HYDROLOGY AND DRAINAGE

(This page intentionally left blank)

Division of Transportation
System Development
Southeast Regional Office
935 South 60th Street
West Allis, WI 53214

Jim Doyle, Governor
Frank J. Busalacchi, Secretary
Internet: www.dot.wisconsin.gov

Telephone: (414) 266-1167
Facsimile (FAX): (414) 266-1152
E-Mail: waukesha.dtd@dot.state.wi.us

Hooker Lake Drainage Meeting
MEETING MINUTES
DECEMBER 12, 2008

DATE: 12/18/08
Location: Town of Salem, Town Hall
FROM: Kurt Flierl, WisDOT SE Region, Project Manager

ATTENDEES:

WisDOT SE Region – Anita Pusch, Kurt Flierl, Dawn Marshall, Reem Shana

WDNR – Tanya Meyer, Michael Luba

Town of Salem – Brad Zautcke

Residents – Tim/Barb Vanderhoef, Michael Rombalski, William/Virginia Winter, Rob Pizzalu, Robert Harris, Frank/Carol Bell, Tom Hinze, John McEntegart, Tim Malecki, Jamie Rook, Richard Rukstales, Marion Schmidt, Greg Kruchko

Representatives from the WisDOT, and WDNR met with residents affected by higher than historic Hooker Lake levels. Tim Vanderhoef, a resident since 2005 that has been impacted by lake levels, shared background and pictures from 2006-2008 identifying flooding, runoff water, and debris carried by runoff water. Primary concern from residents was a perceived increase in the amount of water entering Hooker Lake, how much faster water is entering Hooker Lake, water levels remaining higher than historic for longer periods of time, and runoff affecting Hooker Lake water quality. Additional comments and concerns included: perceived increases in the volume of runoff for drainage areas east of STH 83 which were not impacted with STH 83 construction, and the inability to mow lake frontage due to higher than historic lake levels. Residents have correlated the 2006 STH 83 construction as one of the root causes of increases in Hooker Lake water levels – ie. “there must be some connection”. Other potential contributing factors that were identified included reconstruction of a dam on private property in 2002, adjacent development around Montgomery Lake, development within the Hooker Lake watershed, and record precipitation/hydrologic events (eg. rain, snow melt, frozen ground).

WISDOT
WisDOT staff provided background and handouts on two storm sewer systems constructed in 2006, and shared a plan view of the entire 1330 acre Hooker Lake watershed and the approximate 115 acres of that watershed that pass through department constructed storm sewer system.

North Storm Sewer System
- Approx. 950ft. in length from 82nd Street to 81st Street
- Drains 85 acres
- Includes detention swale

The department constructed a detention swale on the west side of STH 83, just north of existing residential development, to control peak discharges from a 56 acre drainage area feeding into department storm sewer. Peak discharge for a 50 year rainfall event were reduced from 80 cfs (cubic feet per

Transportation District 2
141 N.W. Barstow Street
P.O. Box 798
Waukesha, WI 53187-0798

Jim Doyle, Governor
Frank J. Busalacchi, Secretary
Internet: www.dot.wisconsin.gov

Telephone: (262) 548-5903
Facsimile (FAX): (262) 521-5357
E-Mail: Waukesha.dtd@dot.state.wi.uS

second) to 30 cfs. The detention swale was constructed to primarily reduce the size of storm sewers along STH 83. Secondary benefits include some storm water retention and treatment. The 56 acre area, combined with an adjacent 29 acre area, provide 90% of the storm water input into the department constructed north storm sewer system which discharges approximately 200 ft. east of STH 83 on 82nd Street. The size of the pipe discharging at 82nd Street (36-inch) has not changed. Contrary to discussion that the Town of Salem had no input into the design of the storm sewer, WisDOT staff shared that the Town of Salem reviewed the storm sewer design and also paid for 90% of the costs of the north storm sewer system based on contributing flows from outside of the highway right of way. WisDOT staff identified that the 85 acres that drain overland and eventually drain through the north storm sewer system had previously drained overland and then through culverts, ditches, and a partial storm sewer system. WisDOT identified that the time for water to travel overland and then through the detention swale, storm sewers, and eventually reach Hooker Lake, has minimally changed (minutes, not hours) - and in peak events the time has increased due to the detention that is taking place in the newly constructed swale. WisDOT tried to convey that by the time water from adjoining large tracts of land reached the previous system of culverts and storm sewer, that it was either a shallow concentrated flow, or open channel flow and that little, if any, infiltration was taking place during peak events. WisDOT staff did identify an increase in impervious area due to a slightly wider paved roadway where infiltration is not taking place across those now paved areas of roadway/sidewalk, which creates more runoff volume. The increase in impervious area for the areas feeding the north storm system is approximately 0.4 acres (18,000 SF) – of which 47% is due to Town of Salem requested sidewalk. The bottom 0.8 ft. of the detention swale detains approximately 3500 cubic feet of water for longer periods of time due to swale discharge being located 0.8 ft. above the bottom of the swale – offsetting the runoff volume created by an approximate 2.5” event.

South Storm Sewer System

- Approx. 1600 ft. in length (along STH 83) – South of 85th Street to 82nd Street
- Discharges east of STH 83 on 83rd Street
- Drains 29 acres

Although not described in full detail at the meeting, WisDOT constructed a storm sewer system that carries storm water from the STH 83 roadway from 400 ft. south of 85th Street up to 82nd Street. This storm system also carries stormwater runoff from an adjacent approximately 28 acres. It was relayed to residents that a partial storm sewer system from west 83rd Street up to 82nd Street was in place prior to construction, and that cross culverts – some buried over time – also carried storm water from the west side of STH 83 to the east side of STH 83 near 83rd place. The discharge of the previous storm system, a 2 ft. by 2 ft. box culvert, was located about 400 ft. south of 82nd Street between Gus’s Garage and a carryout pizza restaurant and eventually combined with the discharge from 82nd Street(above) and entered a 36-inch concrete pipe located approx 250 ft east of STH 83 which crosses private property (Rook property) and enters Hooker Lake under water. The discharge for the south sewer system was moved to 83rd Street as part of 2006 roadway construction due to the inadequate size of the pipe crossing private property. The department shared that the average travel time for water to travel overland and then travel through the newly constructed storm system has increased, however that average increase is not creating a measurable increase in Hooker Lake water levels. Prior to construction, some stormwater detention was likely taking place at the confluence of the two storm sewer systems due to the inadequate sizing of the 36-inch pipe crossing private property – but again, this water would have created localized flooding west of the Rook property and subsided in a matter of hours – not days. WisDOT staff shared photos of the entrance to the 36-inch pipe in which runoff debris had blocked the entrance – creating the situation described. Similar to the north storm sewer system, the Town of Salem reviewed our construction plans and participated in the construction cost of the south system based on contributing flows from outside of the highway right of way.

Transportation District 2
141 N.W. Barstow Street
P.O. Box 798
Waukesha, WI 53187-0798

Jim Doyle, Governor
Frank J. Busalacchi, Secretary
Internet: www.dot.wisconsin.gov

Telephone: (262) 548-5903
Facsimile (FAX): (262) 521-5357
E-Mail: Waukesha.dtd@dot.state.wi.uS

WDNR
WDNR staff provided background and information on a private dam on Hooker Lake. The dam is privately owned by Mr. Michael Bryzek and was reconstructed without a permit in 2002. Information obtained by WDNR staff appears to indicate that the dam spillway was reconstructed 0.7 ft. higher than previous and also 0.9 feet less in width. Inability to access the Bryzek Dam has precluded WDNR from obtaining and verifying as-built information. WDNR has been coordinating with Mr. Bryzek's attorney regarding survey of his dam, as well as the Hooker Lake Dam.

WDNR staff also shared information on floodplain mapping. Floodplain mapping of Hooker Lake was complete, relatively speaking, in recent years. Mr. Vanderhoef's house is located within the 100 year flood plain.

Town of Salem
Town staff indicated that a storm water district has recently been created which could undertake a study to evaluate the Hooker Lake watershed and actions that could mitigate flooding.

General Discussion
Residents discussed other potential causes that may have resulted in increased level of Hooker Lake. Discussion indicated that development and flooding of area around Montgomery Lake has contributed to Hooker Lake water levels.

Historic nature of precipitation events was also discussed. WDNR identified that Hooker Lake flooding this past June was not unique and that flooding took place at lakes across the southern half of the state. Flooding this past June resulted in closing of IH 94 in Jefferson County and also STH 50 in Kenosha County.

WisDOT staff inquired if Mr. Vanderhoef could identify that dates in which flooding events had taken place for a historical perspective. The dates currently identified include August and December of 2006, August of 2007, and April and June of 2008. Although not shared at the meeting, these dates correlate with recorded historic events in the Kenosha Area, including:

- Four of the top six historic crests of the Fox River near New Muenster
    1. 15.18 ft. on **6/15/2008**
    2. 14.98 ft. on **8/24/2007**
    3. 14.10 ft. on 2/21/1994
    4. 13.73 ft. on **5/24/2004**
    5. 12.68 ft. on 6/15/1999
    6. 12.14 ft. on **4/12/2008**

- Record of near record rainfall August 11, 2004

- Two of the top four historic crests of the Des Plaines River at Russel IL (State Line)
    1. 11.09 ft. on **5/23/2004**
    2. 10.75 ft. on 3/6/1976
    3. 10.75 ft. on 9/27/1986
    4. 10.51 ft. on **8/24/2007**

- State of Emergency in Kenosha County in August 2007 due to "worst flooding in more than 30 years"
- Flash Flooding as a result of August 24, 2006 storm following saturated conditions

- Flash Flooding in Kenosha area, September 12, 2006
- Blizzard of December 1, 2006 - in which 17 inches of snow were recorded at Kenosha U.S. Coast Guard station – followed by snow melt and rain the third week of December
- Flash Flooding of June 18, 2007, with 2.6 inches of rain reported in Bristol
- Heavy Rain from June 7-9th, 2008

ACTION ITEMS

- WisDOT staff will provide response to Mr. Vanderhoef in late January/early February that will summarize storm sewer design and any changes in volume of water reaching Hooker Lake, the time for water to get to Hooker Lake, and impacts on Hooker Lake water levels. *Since meeting with residents on December 12, the department will hire a consultant to do an independent review of the department designed roadway drainage and quantify changes in runoff affecting Hooker Lake water levels. Copy of that report will be provided to Mr. Vanderhoef, the Hooker Lake District, and the Town of Salem.*
- WisDOT staff will pursue as-built survey of Bryzek Dam using WisDOT survey crews and include information in response to Mr. Vanderhoef and Hooker Lake District.

APPENDIX N
TOWN OF SALEM DRAINAGE AND FLOODING COMPLAINT INVENTORY
December 2009

Map ID	Tax Key	Address	Owner Name	Complaint	Date	Inspection Date	ERU Fee	Field Observations	Town Issue	State or County Issue	Private Property Issue	Located in Regulatory Flood Plain Limits	Problem Affecting Multiple Homes (#)	Only Floods in Large Storm Events	Recommendations	Estimated Cost ($ in 2009)	Priority Ranking
1	65-4-120-073-0781	31017 82nd Street	William Schreier	Backyard flooding after farm developed	3/4/2009	07/09/09 9:00am	1	Large drainage area coming from the South; Across the street from the Fox River/floodplain; No one was home during inspection.	N	N	Y	N	N	Y	Does not appear to be an issue that the Town can solve beyond property acquisition.	$171,200*	Low
2	65-4-120-073-0155	8122 Shorewood Dr	Kenneth Morrison	Fix Fox River	3/13/2009	---	1	Located in a flood plain. Phone number has been disconnected, and based on the County's website, ownership has changed.	N	N	Y	Y	Y	Y	Located in a flood plain directly along the Fox River. Phone number has been disconnected, and based on the County's website, ownership has changed. Does not appear to be an issue the Town can solve beyond property acquisition.	$112,400*	Low
3	65-4-120-183-0516	31020 93rd Street (CTH F)	Marcia Lee	Neighbor modified flow run off	4/1/2009	07/09/09 1:00pm	2	Downstream property does not have a driveway culvert causing water to pond on her property; Neighbor also constructed a berm on his lot line which also causes ponding on her property.	N	Y	Y	N	N	N	Sent the property owner the contact information for the County Highway department to try and get a driveway culvert installed on neighboring property.	< $2,500	Low
4	67-4-120-312-0480	11807 306th Court	Charles Vance	Flooding	7/13/2009	7/17/2009 and 11/18/2009	1	No one was home during either inspection; Mike Murdock and his crew completed work to relieve a clogged ditch and SS inlet down the road from this property in mid-July. 3/4 of the property is within a floodplain.	N	N	Y	Y	N	Y	Could not find any contact information for this owner, but two seperate site visits were conducted. Not sure what exact complaint is but the garage is lower than the roadway elevation and land surrounding the house is in a floodplain. It was determined that this is not an issue that the Town can resolve at this time beyond property acquisition.	$276,500*	Low
5	66-4-120-294-1365	28628 115th Place	Sandra Burritt	Driveway floods when it rains because of road	4/14/2009	7/17/2009	1	Complained of driveway flooding. Located on top of a hill with a low area at the end of the driveway.	N	N	Y	N	N	Y	Appears to be a private property issue that could be solved by repaving the driveway to drain towards the road.	< $10,000	Low
6	66-4-120-291-0285	10420 286th Avenue	Amanda Schuett	Flooding, drainage pipe to small	7/14/2009	7/17/2009	1	Claims that the culvert beneath 286th Street is too small and causes entire property to flood.	Y	N	N	N	Y (3)	Y	Look into possible upgrades in size of this culvert or add additional culverts beneath road.	< $10,000	Medium
7	66-4-120-212-1410	9700 276th Avenue	David Gilbertsen	Broken field tiles to lake	5/20/2009	7/31/2009 9:30am	1	Broken drain tile that runs from a wetland behind his property across Camp Lake Road to an apartment complex property and discharges to Center Lake. They think the tile is broken somewhere near the lake and are looking for some legal advice on how to go about fixing and getting an agreement in place for maintenance.	N	N	Y	N	Y (2)	Y	Check with Town Attorney to see if there are any sample agreements they can use. Mr. Gilbertson and the neighbor are both willing to fix the issue themselves but would like some input on the legal obligations/agreements for future maintenance.	< $2,500	Low
8	66-4-120-212-0425	27601 95th Street	Thaddeus Mazuchowski	Water coming from every direction	7/14/2009	11/18/2009	1	House located at the bottom of a hill; adjacent to a floodplain; no formal ditches/conveyance systems in this neighborhood. Water ponds in the low area on his property near the road. Property owner has to pump water to the other side of his home to the channel behind him.	N	N	Y	Y	Y (3)	N	Homeowner could regrade the open areas of the lot to provide positive drainage toward the channel. Another possible solution would be to construct a ditch conveyance system to direct runoff away from this home during average, more frequent rain events.	< $10,000	Low
9	66-4-120-212-0125	27544 94th Street	Michelle Verran	Only one on street that floods	9/21/2009	10/2/2009 anytime	1	Runoff is ponding above the foundation walls on the west side of the house; Owners recently installed a drain tile/pea gravel in this area but no sealant or clay dyke was installed. Claims that the driveway culvert has woodchucks nesting inside.	N	N	Y	N	N	Y	Property owner wants to build a retaining wall above the foundation wall to avoid this issue. Advised them to extend the drain tile to the roadway ditch to give relief. Town televised the driveway culvert the week of October 12th and did not find any blockage in the culvert. Work to be completed by homeowner, but time may be needed to provide guidance.	< $2,500	Low
10	65-4-120-161-0300	27101 85th Street	James Hauri	Stagnant water on property	6/29/2009	11/18/2009	1	85th Street roadway culvert is directed towards his property and runoff from Silver Lake Park sits in a low area on his property because there are no formal ditches on the south side of the road.	Y	N	Y	N	N	N	A possible solution is to construct a berm/ditch at the discharge point of culvert to direct runoff to the wetland complex to the east, or reposition the culvert at an angle further east to promote runoff to drain toward this wetland and not this property.	< $10,000	Low
11	66-4-120-283-0700	27531 113th Street	Pamela Doyle	Flooding in neighborhood	3/2/2009	7/17/2009	1	Very flat neighborhood in a floodplain. Mike Murdock indicated that survey shots in the past proved that the elevations of Camp Lake, surrounding wetlands and most roadway ditches in this neighborhood were the same.	Y	N	N	Y	Y (14)	Y	Property acquisition appears to be the only feasible solution for this neighborhood. Same neighborhood as complaint #12. Cost includes purchase of all lots in the floodplain with homes built on them in this neighborhood.	$2,131,300* (Cost includes solution to complaint #12)	Medium
12	66-4-120-283-0580	27414 113th Street	John Van Den Berge	Flooding	7/13/2009	7/17/2009	1	Claims that the CTH C culvert upstream of his property was upsized about 10 years ago and causes additional flooding on his property. Mike Murdock has talked to the County and they claim that this culvert was collapsed for many years before they replaced it in kind. All of his property is within a floodplain.	Y	Y	N	Y	Y (14)	Y	Does not appear to be an issue that the Town can solve at this time beyond property acquisition. Same neighborhood as complaint #11. Cost includes purchase of all lots in the floodplain with homes built on them in this neighborhood.	$2,131,300* (Cost includes solution to complaint #11)	Medium
13	66-4-120-281-1466	10714 269th Avenue	Leah Wheeler	Flood Damage	7/14/2009	07/31/09 1:00pm	1	Property sustained substantial flood damage during the June storm, but never usually had any flooding issues in the home in past. Lake area behind house is in a flood plain and always has drainage issues.	N	N	Y	Y	N	Y	Does not appear to be an issue that the Town can solve at this time beyond property acquisition.	$359,800*	Low

* Property Acquisition values are based on the 2009 Assessed Value of the property(s).

APPENDIX N
TOWN OF SALEM DRAINAGE AND FLOODING COMPLAINT INVENTORY
December 2009

Map ID	Tax Key	Address	Owner Name	Complaint	Date	Inspection Date	ERU Fee	Field Observations	Town Issue	State or County Issue	Private Property Issue	Located in Regulatory Flood Plain Limits	Problem Affecting Multiple Homes (#)	Only Floods in Large Storm Events	Recommendations	Estimated Cost ($ in 2009)	Priority Ranking
14	66-4-120-281-1502	10615 269th Avenue	Brian Spiegelhoff	Flooding	6/19/2009	7/17/2009	1	Resident was very upset and did not provide much information other than his basement has been flooded and he had a sewer back-up the past two June rainfall events. Brad mentioned the possibility of him being on the sanitary sewer overflow complaint list.	N	N	Y	N	N	Y	Verify if owner is supposed to be on the sanitary sewer back-up list instead. Other possible solution is property acquisition.	$174,900*	Medium
15	66-4-120-281-0845	26831 105th Street	Charles Tess	Water has flooded home multiple times during heavy rains		7/17/2009	1	Property owner was hauling out flood damaged property when we walked by. He mentioned that his property floods during the major storm events.	N	N	Y	N	N	Y	Does not appear to be an issue that the Town can solve at this time beyond property acquisition.	$100,400*	Low
16	66-4-120-281-1155	26623 106th Street	Reported by Mike Murdock	Low area with constant drainage issues. Roadway cross culvert is directed towards house.	11/4/2009	11/4/2009 2:00pm		Kettle area just upstream of Shoreview Subdivision. A roadway cross culvert is directed towards this home. A Town owned Park is in this neighborhood, but appears to be a bit higher than the low area of the neighborhood.	Y	N	N	N	Y (13)	N	Determine if drainage from this low area can be directed toward the drainage canal through the Town owned Park property without increasing flooding to the Shoreview Subdivision downstream. Investigate if a water quality pond could be installed to help slow down flows and provide a water quality benefit.	< $300,000	High
17	66-4-120-214-0670	10326 268th Avenue	John Kraus	Lot retaining water	4/20/2009	7/17/2009	1	Property sits in a low spot between the 268th Ave and the railroad tracks. Property owner was not home, but saw that a sump pump was hooked up in the back yard with a dewatering hose in the backyard. Assumed that when backyard gets flooded, the dewatering hose directs water to the other side of the RR tracks. The drainage from Brad Kaminscky's neighborhood and a culvert beneath the RR tracks eventually drains to this area as well.	Y	N	N	N	Y (15)	N	Determine if drainage in the rear of the lot could be sent to the front of the house, under the roadway, to Camp Lake or if there is a more efficient drainage solution for this drainage area to get to Camp Lake without ponding by the RR tracks. Town owned Park is two lots to the east. Possible water quality pond could be designed if there is enough elevation drop.	< $250,000 (Cost includes solution for complaint #18)	High
18	66-4-120-214-0480	26501 103rd Place	Brad Kaminscky	Flooding	5/14/2009	7/31/2009 9:00am	1	Neighborhood flooding / ditches are undersized. The Town has tried to address the issue of excessive runoff from the field to the east by installing a berm in the ditch of 264th Street to split the flow between 103rd Place and 104th Street. In large storms the berm is ineffective. Driveway culverts along 103rd place are of varying sizes/conditions which may also contribute to these issues if they are undersized/clogged. Upstream of John Kraus drainage complaint.	Y	N	N	N	Y (15)	Y	Reassess the berm that was installed to see if a more permanent solution is possible. Evaluate culvert sizes and conditions along 103rd Place. Try to tie the solution to this problem with the drainage complaint from John Kraus.	< $250,000 (Cost includes solution for complaint #17)	High
19	66-4-120-214-1617	9924 270th Court	Patrick Mulvey	Flooding	7/13/2009	11/4/09 1:00pm	1	1 - Worried about the capacity of the private drain tile once the 27 or so lots to the south of the railroad get developed. Thinks the Town should take the responsibility to replace and upsize this tile. 2 - Very indirect drainage pattern on the north side of his block before it discharges into the neighboring wetland and eventually to the privately owned drain tile.	Y	N	N	N	Y (20)	N	1 - Property owners adjacent to this drain tile have collaboratively decided to pay a contractor to fix tile. Therefore nothing is recommended at this time. 2 - Reevaluate the existing drainage route to see if there is a more direct solution.	1 = $0 2 = < $10,000	1 = Low 2 = Medium
20	66-4-120-214-0770	27090 99th Street	Mary Kamin	Property Floods (house below road elevation)	9/1/2009	10/2/2009 9:30am	1	Basement flooding occurs regularly as house was built 1 foot below the adjacent roadway elevation. Property owner wants to put in a drain tile west of the house to get water to drain away from house but there is not a roadway ditch/conveyance system to tie into.	N	N	Y	N	N	N	Does not appear to be enough grade to bring the drain tile to the front of the house, the homeowner should look into bringing it behind house (near RR ditch) along with a small berm for overland flow. Also recommended that homeowner investigate the soils near his basement since the drainage area does not appear to be very large and water is somehow seeping in from the basement floor. Maybe there is a large sand seam that is bringing additional water toward the house? Homeowner to complete work, but some time may be needed to provide guidance.	< $2,500	Low
21	66-4-120-211-0281	26805 96th Place	Herbert Frank	Flooding	3/20/2009	07/31/09 1:30pm	1	Located in a flood plain. Resident is frustrated that he can't raise his house and we can't fix his problem.	Y	N	N	Y	Y (16)	N	Property acquisition appears to be the only feasible solution for this neighborhood. Cost includes purchase of all lots in the floodplain with homes built on them in this neighborhood.	$2,748,700*	Medium
22	65-4-120-164-0360	9025 269th Avenue	Cynthia Pastick	Backyard flooding because of new house	5/22/2009	7/17/2009	1	Talked to someone from this household while walking the site for complaint #24. Addressed the same concerns related to the Timber Lane Subdivision Flooding.	Y	N	N	Y	Y (12)	N	Address this issue as part of the Timber Lane Subdivision Conveyance System & Storage Project.	$659,500	High
23	65-4-120-164-0230	26711 89th Street	Ann Newcome	Flooding	6/30/2009	07/09/09 12:30pm	1	Looks like culverts beneath the driveway and 268th Ave along CTH AH are in very poor condition. Yard floods in almost all storm events.	N	Y	Y	N	N	N	Send the property owner the Kenosha County Highway Department contact information to begin the process of replacing this driveway culvert.	< $10,000	Low
24	65-4-120-161-0100	26400 89th Street	Ronald Schaetten	Field Flooding	4/28/2009	7/17/2009	4	Complaint related to the Timber Lane Subdivision Flooding Issues. Claims that a roadway culvert was removed near the newly constructed home that has caused ponding water in his agricultural fields. Completed a second field visit on 10/2/2009 to discuss the same issues.	Y	N	Y	N	N	Y	Address this issue as part of the Timber Lane Subdivision Conveyance System & Storage Project. On second site visit reiterated to the property owner that he could combine lots or move lot lines to try and maximize the amount of impervious area to one lot (maximum of 5 ERU's per parcel).	$659,500	High

* Property Acquisition values are based on the 2009 Assessed Value of the property(s).

APPENDIX N
TOWN OF SALEM DRAINAGE AND FLOODING COMPLAINT INVENTORY
December 2009

Map ID	Tax Key	Address	Owner Name	Complaint	Date	Inspection Date	ERU Fee	Field Observations	Town Issue	State or County Issue	Private Property Issue	Located in Regulatory Flood Plain Limits	Problem Affecting Multiple Homes (#)	Only Floods in Large Storm Events	Recommendations	Estimated Cost ($ in 2009)	Priority Ranking
25	65-4-120-153-0261	25720 93rd Street	Terry Skweres	Flooding from neighbors	3/5/2009	07/09/09 9:30am	1	1 - New Home east of this property has caused flooding of the adjacent Town owned property (french drain system) and this water encroaches onto their driveway/garage. 2 - Overall drainage issues on this street; it appears that there are multiple damaged or undersized culverts causing drainage issues; property owner has multiple ideas on how to fix neighborhood drainage.	Y	N	N	N	Y (17)	N	1 - Maintenance of the Town-owned french drain system should be looked into; 2 - Town televised the existing storm sewer on south side of road to confirm connections but ran into a blockage early on; Further surveying should be completed to determine alternate drainage solutions for this neighborhood.	1 = < $10,000 2 = < $100,000	High
26	65-4-120-154-0311	25501 89th Street	Gloria Albor	Flooding	7/13/2009	7/17/2009	1	Reiterated the repeated flooding issues his property has experienced every spring; Related to the Albor high water relief project.	Y	N	N	N	Y (2 + road)	N	Address this issue as part of the Albor High Water Relief Conveyance System Project.	$111,875	High
27	65-4-120-154-0320	25425 89th Street	John McLeran	Flooding	7/13/2009	7/17/2009	1	Reiterated the repeated flooding issues his property has experienced every spring; Related to the Albor high water relief project.	Y	N	N	N	Y (2 + road)	N	Address this issue as part of the Albor High Water Relief Conveyance System Project	$111,875	High
28	65-4-120-154-0130	24847 89th Street	James Beinecke	Flooding	5/8/2009	7/17/2009	1	No one was home during inspection, but later talked to him on the phone. Expressed that poor drainage from the 83/AH intersection floods the downstream properties on AH.	Y	Y	N	N	Y (5)	Y	Investigate whether the low area west of the intersection is a wetland to determine if it is possible to regrade this area to help drainage. Since this drainage is connected with CTH AH, coordinate solution with the County.	< $100,000	Medium
29	65-4-120-142-0271	8731 Antioch Road	Walter Langner	Flooding & Freezing in Entrance of Apartment Building	3/31/2009	07/09/09 11:00am	4	1 - Roof Drain problems; 2 - Drainage from STH 83 runs down driveway onto property (freezes in winter); 3 - Claims to have more runoff coming from the east since the Salem Streams Subdivision was developed.	N	N	Y	N	N	N	Review plans for Salem Streams Subdivision to ensure drainage was installed as approved. Other issues appear to be strictly private property issues.	< $2,500	Low
30	65-4-120-104-0595	24915 82nd Street	Lawrence & Mary Cukla	Heavy Flooding, property damage from STH 83	8/24/2009	10/2/2009 10:30am	1	Gravel is being washed down the channel that goes across the low section of their property ever since STH 83 was redone.	Y	Y	N	N	N	Y	Rip rap or large stone is recommended to be installed down the steep slope from 82nd Street to the channel (State responsibility?) to slow the velocity of the flows and minimize erosion.	< $10,000	Low
31	65-4-120-113-0870	24200 84th Street	Lorraine Paul	Meadow of Mills Pond needs dredging; STH 83 causing additional runoff to property	6/19/2009	11/18/2009		Lorraine not available to meet, but met with neighbor Frank Bell. Concerned about the available depth left in the wet detention pond; property owner claims that many areas of the pond has less than 3 foot depth.	N	N	N	Y	Y	Y	Review the maintenance agreement for this development to see if we can find language that requires the "owner" (developer at this point), to dredge pond as it gets filled with sediment.	< $10,000	Low
32	65-4-120-031-0211	25401 60th Street	William Holter	Farm field flooding her lot (Never in past)	7/2/2009	07/31/09 10:00am	1	Rear of property had standing water after the last two June storms from flooding on the neighboring ag field.	N	N	Y	N	N	Y	Private property issue; does not appear to be an issue that the Town can solve at this time.	---	---
33		near 26407 122nd Street	Reported by Mike Murdock	Frequent roadway flooding in this area	11/18/2009	11/18/2009		Appears to be a broken drain tile in this kettle area that causes water to pond and in larger rainfall events cause flooding on 122nd Street.	Y	N	Y	N	N	Y	Possible solution is to construct a high water relief conveyance system for this kettled area in the roadway right-of-way that allows water to drain to the east into the larger wetland complex.	< $100,000	Medium
34	67-4-120-344-0567	25020 Runyard Way E	Walter Losianowycz	Flooding	5/5/2009	07/09/09 10:00am	1	Stagnant water issues in the rear of his lot. Neighbor claims a storm sewer system was supposed to be installed for this area as part of the development.	Y	N	Y	N	N	Y	Check plans for Subdivision to confirm his claims. Send information on rain gardens to homeowner.	< $2,500	Low
35	67-4-120-344-0539	12720 249th Avenue	John Ciesla	Flooding	7/13/2009	11/4/2009 11:30am	1	Claims that neighboring property (67-4-120-353-0303 - extremely large parcel) previously hauled in tons of dirt and caused a dam in the existing drainage patterns which causes water to backflow onto the road in front of their house. They previously contacted the County, but they apparently went to the wrong side of the property.	Y	Y	N	N	Y (3)	Y	Follow up with the County to see what they found when they visited this site previously.	< $10,000	Low
36	67-4-120-344-0546	12755 249th Avenue	Jeff Malueg	Neighbor pumping water/Icing problems	3/2/2009	11/4/09 11:00am	1	Neighboring property's sump pump is directed along the property line and his lawn is constantly wet because of the clayey soils. Especially a problem in the winter with sheets of ice over his driveway. Nieghbor has dug a pit at the outfall point and filled with gravel to try to get water to seep into the ground better. Has improved since this work was done but still very soggy after rainfall events. Water does not appear to make it over the curb.	N	N	Y	N	Y (2)	N	This appears to be a private property issue between two neighbors. A curb cut could be installed at this location in the Town right-of-way to help the water get onto the road quicker, but will not solve the amount of water being pumped from his sump pump and eventually running across the driveway approach.	< $10,000	Low
37	66-4-120-264-0301	11534 Antioch Rd	Anna Kenjar	Flooding because of new development	7/13/2009	11/18/2009 11:30am	1	Complaining that groundwater is getting into her basement due to excessive ponding at the field inlet adjacent to her home. Claiming that the Heritage Estates development is causing excessive runoff or the field inlet is sized too small.	N	N	Y	N	N	Y	Recommended that the homeowner investigate options to protect the foundation of the home or install a french drain around the home to direct subsurface water away from the basement foundation. Work to be completed by homeowner, but some time may be needed to provide guidance.	< $2,500	Low
38		23908 116th Place	STH 83 culvert from Heritage Estates to Hickory Hollows Subdivision.	STH 83 culvert was upsized when roadway was reconstructed and it's causing erosion on property.		07/09/09 11:30am	1	Rip rap downstream of STH 83 Culvert has been blown out; causing downstream erosion problems for field inlet within this subdivision. Christine Gustafson has also complained about this in the past.	Y	Y	N	N	N	Y	On 11/04/2009 it appeared that additional rip rap had been placed at this outlet. Mike Murdock confirmed that this work was completed by the Town. Continue to keep an eye on this culvert and fix/maintain the rip rap as needed.	< $10,000	Low

* Property Acquisition values are based on the 2009 Assessed Value of the property(s).

APPENDIX N
TOWN OF SALEM DRAINAGE AND FLOODING COMPLAINT INVENTORY
December 2009

Map ID	Tax Key	Address	Owner Name	Complaint	Date	Inspection Date	ERU Fee	Field Observations	Town Issue	State or County Issue	Private Property Issue	Located in Regulatory Flood Plain Limits	Problem Affecting Multiple Homes (#)	Only Floods in Large Storm Events	Recommendations	Estimated Cost ($ in 2009)	Priority Ranking
39	67-4-120-354-1397	23502 125th Street	Theresa Jennings	Her and neighbors flood	9/16/2009	10/2/2009 8:30am	1	Catch basin and storm sewer installed in low area to handle drainage from 124th St, 124th Pl and 125th St. Appears to be a capacity issue.	Y	N	N	N	Y (25)	N	Look into size/capacity of existing storm sewer/drain tile and possibility of adding conveyance systems to 124th Street and 124th Place to avoid bringing all drainage to 125th Street.	< $300,000	High
40		122nd Street east of 224th Ave	reported by Mike Murdock	Constant drainage issues	8/28/2009	10/2/2009		According to Jason/Mike an existing drain tile runs along 122nd Street that discharges down 220th Avenue to Lake Shangrila. Town has installed a few french drain systems in the past in this area to alleviate drainage concerns.	Y	N	N	N	Y (13)	N	Investigate the possibility of running a storm sewer system down 122nd street that would discharge to a Town owned easement before draining to Lake Shangrila. Would likely be a deep sewer, but appears that it could work.	$205,175	High
41	67-4-120-361-2220	22033 117th Street	Scott & Gary Robb	His vacant lot next to house floods	4/29/2009	07/31/09 2:00pm	1	Erosion of shoulder of road occuring at the T-intersection with 221st Ave. Culvert beneath 117th Street and driveway culverts from the west join into a catch basin and discharge through a storm pipe to the lake. Looked like the pipe draining to the lake may be undersized.	Y	N	N	N	N	Y	Regrade and stabilize the eroded shoulder at the intersection. Investigate the sizes and capacity of the storm sewer system.	< $10,000	Low
42	66-4-120-243-0202	22725 98th Street	Dennis Sheen	Neighboring farm installed tile 06/2009	7/15/2009	07/31/09 12:00pm	1	Neighbor's drain tile being redirected to culvert under road onto his property and he is worried this will flood his crops further. The Town has installed an 18" drain tile system with catch basins west of his property on 98th 5-10 years ago.	N	N	N	N	N	N	Follow up with the Town attorney to see if there is any legal course of action or rights for the property owner in this situation.	< $2,500	Low
43	65-4-120-131-0705	8630 223rd Avenue	John Foglio	Flooding	7/13/2009	07/31/09 10:30am	1	Repeat flooding issues. It appears that the culvert in front of the home that crosses 223rd Ave to the wetland is pitched the wrong way / flat? Also the downstream culvert crossing Salem Road is smaller than the upstream culverts at 223rd and 86th Place. The Town put in two sock drains in their ditch/driveway culvert last summer to help aleviate this issue, but it seemed to make it worse.	Y	N	N	N	N	N	Investigate the culvert elevations/sizes. It appears that some rework would help aleviate the flooding issues for this property and the road.	< $100,000	High
44	65-4-120-132-0215	22505 85th Place	Deana Day	Backyard & Neighbors Flood	4/29/2009	07/31/09 11:00am	1	Back yard is constantly wet as well as surrounding neighbors. Neighborhood appears to be internally drained with no outlets. After looking at a map, identified this rear yard area as mapped wetland.	N	N	Y	N	Y (5)	N	Since this is a wetland there is not much the Town can do. Could look into a high water relief mechanism, but won't solve the "wetness" issue since this is a wetland.	---	---
															APPROXIMATE TOTAL	**$8,451,750**	

Source: Town of Salem, Wisconsin

* Property Acquisition values are based on the 2009 Assessed Value of the property(s).

KAPUR & ASSOCIATES, INC.
CONSULTING ENGINEERS

7711 N. Port Washington Road
Milwaukee, WI 53217
Ph: (414) 351-6668
Fax: (414) 351-4117

Memo

Date: **May 2, 2009**

To: **Anita Pusch – WisDOT SER**

Kurt Flierl – WisDOT SER

Cc:

From: **Elizabeth S. Klemann, P.E.**

RE: **STH 83 (1332-00-70) Hydrology Evaluation**

The Wisconsin Department of Transportation (WisDOT) reconstructed STH 83 in the Village of Salem in Kenosha County in 2006. There have been comments from the public to the WisDOT questioning whether the reconstruction of STH 83 to the west of Hooker Lake has contributed to recent flooding events on Hooker Lake. WisDOT asked Kapur & Associates, Inc. to do an independent review of the hydrology of the Hooker Lake watershed that crosses STH 83 in the portion that now has storm sewer, as requested by the Village of Salem. This memo summarizes that evaluation.

The hydrologic evaluation was conducted in HEC-HMS (the hydrology modeling software created by the U.S. Army Corps of Engineers) using TR-55 (UDSA, 1986) methodologies. TR-55 is a method for evaluating small watersheds that uses curve numbers (CN) to evaluate runoff. A CN is the percentage of rainfall that is converted to runoff. Higher CN values mean an area generates more runoff. Parking lots have a curve number of 99 (99% of rainfall becomes runoff) and wooded areas can have a curve number as low as 35 (35% of rainfall becomes runoff) depending on the soils.

DRAINAGE SUB-BASINS

Drainage basins were determined utilizing 2-foot contour mapping. 5 drainage basins are associated with the STH 83 storm sewer, although one basin has closed contours and does not contribute runoff in rainfalls up to the 2% probability event (50-year storm). See Figure 1.

- 85th Street (Blue)

This drainage area is 8.38 acres east of 85th Street that drains to the south. In the existing condition it crosses STH 83 near 85th Street and eventually drains to Hooker Lake. The entire sub-basin is developed, primarily as residential.

In the post-construction model, 650 feet of STH 83 to the south were added to the sub-basin because the storm sewer extends to the south. The runoff from this sub-basin joins with the runoff from 83rd Street basin before being discharged east of STH 83 along 83rd Street.

- 83rd Street (Orange)

This approximately 22.7-acre sub-basin between 83rd Street and 82nd Street on the west side of STH 83 extends approximately 1400 feet to the west. The pre-construction runoff crossed STH 83 east of 83rd Street in a cross-culvert and flowed into Hooker Lake. The land use in this sub-basin includes residential, forest, and agricultural fields.

After construction, the runoff from this area was carried in storm sewer to the south to 83rd Street and joins the runoff from the 85th Street sub-basin before flowing in storm sewer pipe to the east where it discharges near Hooker Lake.

- Central (Green)

This sub-basin is approximately 22.1 acres on the west side of STH 83 between roughly 82nd Street and 81st Street. The majority of the sub-basin is agricultural fields, but there is a residential area adjacent to STH 83 and some forested areas. The pipe connecting this sub-basin to the discharge near Hooker Lake was lengthened, but the longest flow path within the basin was not altered.

- North (Red)

The 20.7-acre sub-basin adjacent to STH 83 is agricultural fields. In the pre-construction condition, the sub-basin drains toward STH 83 and then flows along the west side of STH 83 through the ditch in the Central sub-basin where the flows from both Central and North cross the road in a cross-culvert.

A detention pond was constructed with the roadway project and the runoff from the north sub-basin flows into this pond prior to being discharged into the storm sewer which then flows to the south before merging with the flows from the central sub-basin.

- North (non-contributing)

There is an approximately 35.2-acre sub-basin to the west of the north basin that has a depressed area that intercepts runoff. Runoff does not leave this sub-basin in rainfall events of 2-percent probability (50-year average occurrence interval). Some runoff does leave this sub-basin in the 1-percent probability event (100-year average occurrence interval). The runoff flows across the north basin following the same flow path as the north sub-basin,

After several days of rain, the area was ponded as shown in this picture taken on April 28, 2009

HYDROLOGIC EVALUATION METHODOLOGY

Both pre-construction and post-construction conditions were modeled using HEC-HMS. Drainage basins included all tributary areas to the west of STH 83 and to the ultimate location of the back of the walk (considered residential in the pre-construction condition) on the east side of STH 83.

The connectivity of the storm sewer was included, but because the storm sewer is a rapid conduit with minimal time lag is it not included explicitly in the model. The water is assumed to pass through the storm sewer instantaneously.

The area of interest was Hooker Lake and any impacts to the amount of runoff on the 102-acre lake.

The following changes were made to the post-construction conditions:

- The 85th St sub-basin was enlarged for the additional roadway to the south that was connected to the storm sewer
- The 85th St sub-basin no longer drains to Hooker Lake via overland flow and instead merges with the 83rd sub-basin before both drain to Hooker Lake.
- The detention basin west of STH 83 was added in the North sub-basin
- The area of the roadway in all sub-basins was increased from 40’ wide to 60’ wide to account for addition of impervious surface in paved shoulder and sidewalk
- The North sub-basin no longer flows in a ditch to the Central sub-basin. The model was modified to change the connection to a pipe, which allows the water to move more quickly.
- The length of the channel that carries the south outfall, which carries the runoff from the 85th Street and 83rd Street sub-basins to Hooker Lake, was reduced to reflect the relocation of the outfall.

RAINFALL

Rainfall Depths used Bulletin 71 of USGS (Huff, 1992), which is a peer-reviewed estimate of rainfall in Illinois and Wisconsin that is widely accepted for use in modeling activities, such as this one.

Probability	Recurrence Interval (average frequency)	24-hour storm rainfall
4-percent	25-year	4.66
2-percent	50-year	5.38
1-percent	100-year	6.24

Rainfalls events are categorized by the probability of them being exceeded. A 4-percent probability storm is a rainfall event that will be smaller than only 4 percent of storms (i.e., greater than 96 percent of storms). In 100 years, the 4-percent probability event is expected to be seen only 4 times, which would be an average of every 25 years. However, the intervals can be much shorter. It is only over a long period of time these distribution patterns average out.

CONSERVATIVE ASSUMPTIONS

Several of the assumptions made in the model are conservative and will yield a change in runoff volumes that may be high.

- Rainfall depths used (Bulletin 71) are higher than other depths also published by the Southeast Wisconsin Regional Planning Commission. Higher rainfall amounts result in higher runoff amounts.

- No outlet was modeled on Hooker Lake for two reasons: a lack of information about the outfall and the modeled drainage area is not the complete Hooker Lake watershed. Including an outlet on Hooker Lake might offset some of the water added to the lake.

- In the pre-construction condition, the ditches adjacent to the roadway were assumed to be grass, but they were often paved. Pre-construction runoff may be slightly underestimated. In the post-construction condition, the terrace area (grass between the curb and sidewalk) was included in the impervious roadway area. Post-construction runoff may be slightly overestimated. Therefore, the change in runoff between the pre-construction and post-construction conditions may be slightly overestimated.

CONCLUSIONS

Figure 1 shows the drainage sub-basins and the discharge locations.

	Pre-construction – 1-percent Probability		Post-construction 1-percent Probability	
Discharge Location	Contributing Sub-basins	Peak Flow (cfs)	Contributing Sub-basins	Peak Flow (cfs)
84th Street	85th Street	33	None	0
83rd Street	None	0	85th Street and 83rd Street	124
Adjacent to BUILDING	Central	81	None	0
82nd Street	North (and North non-contributing)	171	Central and North (and North non-contributing)	117

The total peak flow discharge is reduced in the post-construction condition due to the addition of the storm water detention pond. Water is stored in the pond and discharged at a slower rate, which reduces the peak flow rate from the North and North non-contributing sub-basins.

The total amount of runoff was increased slightly due to the addition of paved shoulders and side walks, which are impervious areas.

The increase in the total amount of runoff would result in a very small increase (0.01 feet) over the entire surface of Hooker Lake. Please note, however, that this increase assumes there is no outlet from Hooker Lake, which is not the case. The actual amount of increase would be lower due to water exiting the lake. [See Table 1 for additional detail]

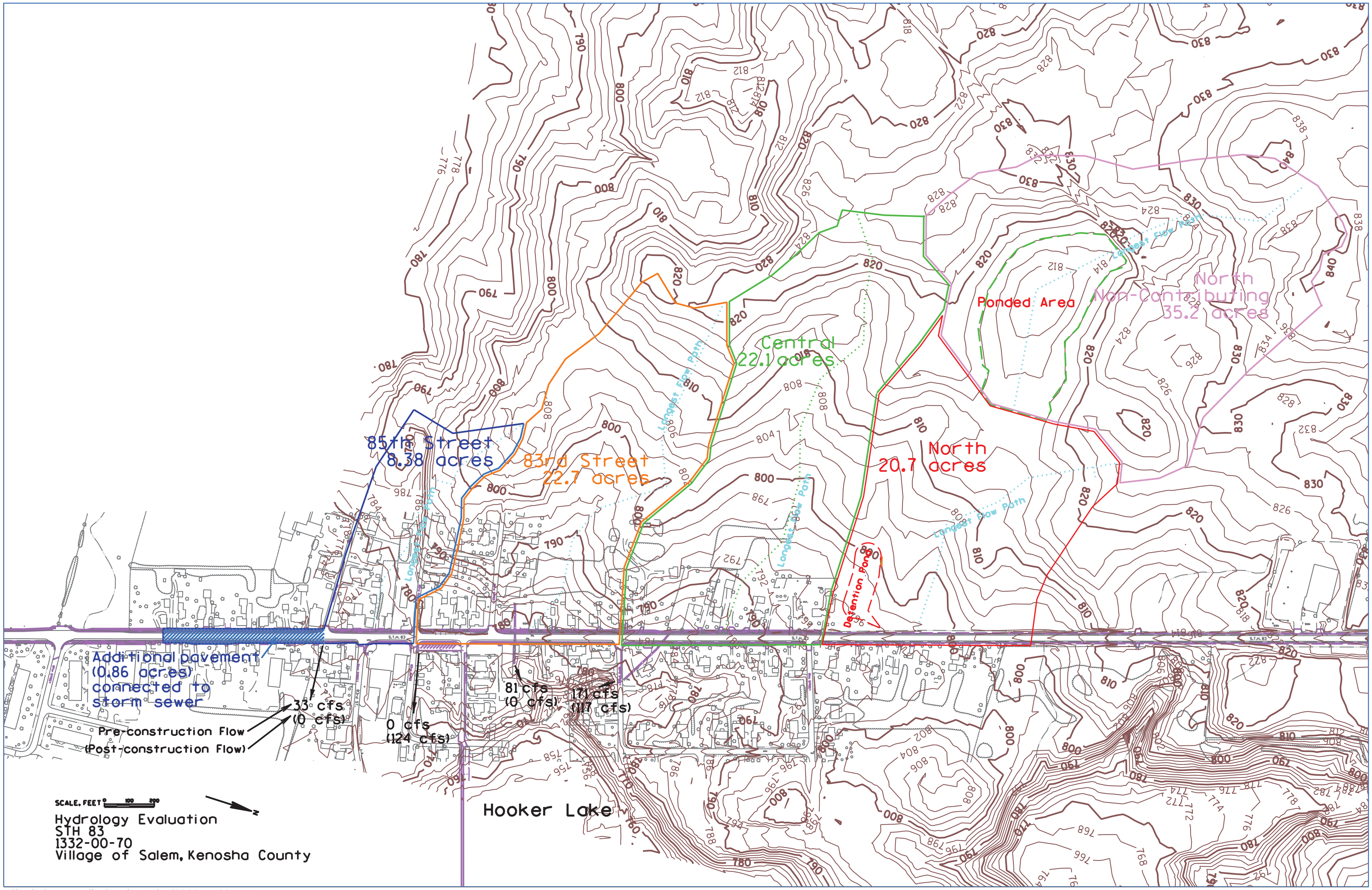
Any increases in water level seen on Hooker Lake are not due to changes associated with the reconstruction of STH 83.

TABLE 1 – Summary of results of modeling of STH 83 runoff.

Hooker Lake [Area=102 acres]	100-year Interval			50-year Interval			25-year Interval		
	Pre-Const'n	Post-Const'n	Difference	Pre-Const'n	Post-Const'n	Difference	Pre-Const'n	Post-Const'n	Difference
Peak Flow (cfs)	282.3	232.1	**-50.2**	229.9	191.4	**-38.5**	186.7	156.9	**-29.7**
Total Volume of Runoff (ac-ft)	31.38	32.73	1.35	23.85	25.03	1.18	18.42	19.45	1.03
Depth of Total Runoff over Hooker Lake FT	0.31	0.32	0.013	0.23	0.25	0.012	0.18	0.19	0.010
Depth of Total Runoff over Hooker Lake IN	3.7	3.9	0.16	2.8	2.9	0.14	2.2	2.3	0.12

New Detention Pond*	100-year Interval			50-year Interval			25-year Interval		
	Pre-Const'n	Post-Const'n	Difference	Pre-Const'n	Post-Const'n	Difference	Pre-Const'n	Post-Const'n	Difference
Peak Flow (cfs)	86.8	28.5	**-58.2**	71.0	25.3	**-45.7**	57.9	22.2	**-35.7**
Total Volume of Runoff (ac-ft)	10.8	10.8	0.1	7.1	7.2	0.1	4.9	4.9	0.1

*The new detention pond is located at the outlet of the North sub-basin. This table compares the pre-construction and post-construction runoff from the North and North Non-contributing sub-basins.



...\hydrology-rpt display.dgn 5/15/2009 11:22:55 AM

CHAPTER 4 - REVISED
STORM WATER QUANTITY ANALYSIS

INTRODUCTION

This chapter describes the approach used to determine flows and runoff volumes. The method and computer program are described, and the parameters used in the computations are discussed. Results from the analyses are presented.

The hydrologic analysis determined peak flows and runoff volumes for all the subbasins throughout the Town of Salem. Existing land use conditions in the watershed were analyzed using the year 2000 land use files for the Town developed by the Southeastern Wisconsin Regional Planning Commission (SEWRPC). The proposed 2020 land uses for the Town have been developed through the overall Town Neighborhoods planning process completed in 2007. The land use data provides information on the degree of imperviousness in the subbasin. Peak discharge flow rates and runoff volumes for the 2-, 10-, 25-, and 100-year recurrence interval storm events for the 24-hour storm duration have been developed for all the subbasins in the Town under existing and proposed land uses.

The Town of Salem Storm Water Ordinance includes two standards for stormwater management relating to water quantity. The Fox River runs along the western Town boundary, and the majority of the Town is located in the Fox River watershed. For the lands within the Fox River watershed, the standards require controls such that the post-construction peak storm water discharge rates shall not exceed the pre-construction peak discharge rates for the 2-year, 10-year, and 100-year, 24-hour design storms.

The eastern portion of the Town is within the Des Plaines River Watershed. For lands within the Des Plaines River Watershed, standards require controls to meet the post-construction 2-year storm peak discharge rate of 0.04 cubic feet per second per acre of new development and the 100-year peak discharge rate of 0.30 cubic feet per second per acre of new development. These release rates should be considered as maximums.

HYDROLOGIC METHODS

The rainfall/runoff relationships for all subbasins and major outfalls were developed using the hydrologic computer program PondPack, Urban Hydrology and Detention Pond Modeling Software, Version 10.1. PondPack is widely used for hydrologic analysis of urban and rural watersheds. The primary function of the PondPack model is to develop surface runoff hydrographs for each subbasin. The PondPack models evaluated each subbasin in the Town. Flow hydrographs for storm events with recurrence intervals of 2-, 10-, 25-, and 100-years were computed.

The Villages of Paddock Lake and Silver Lake are within the Salem Township boundary, but are separate municipalities and not part of the Town of Salem. Some of the subbasins are partially within the Town and one of the villages. If the portion of subbasin within the Town was less than 20 acres, the subbasin runoff was not evaluated. For partial subbasins that were evaluated, the subbasin included only the area within the Town.

Hydrologic Parameters

The data parameters required for the hydrologic analysis include precipitation, subbasin area, runoff curve numbers based on soil type and land use, and the timing associated with surface runoff reaching the stream system. The hydrologic parameters necessary for the analysis are described below.

Precipitation

The hydrologic analysis evaluated the 50%, 10%, 4%, and 1% annual chance probability of occurrence events, or the 2-, 10-, 25- and 100-year recurrence interval events, respectively. The peak discharges and runoff volumes were developed for a 24-hour storm using the SCS Type II rainfall distribution and 24-hour rainfall depths of 2.57, 3.62, 4.41, and 5.88 inches, respectively, obtained from the SEWRPC Technical Report #40, Rainfall Frequency in the Southeastern Wisconsin Region, April 2000.

Subbasin Area

The Town of Salem is divided into two major watersheds, the Fox River and the Des Plaines River. These two watersheds were divided into 14 sub-watersheds, and then further divided into 91 subbasins based on the topography, location of the tributary streams, location of major outfalls, and visual observations during field reconnaissance. The sub-watershed boundaries are shown in Figure 4-1, while the subbasin boundaries are illustrated in Figure 4-2. The subbasins ranged from 20 acres to 1,543 acres in size.

Soil Type

The hydrologic soil groups (HSG) in the Town of Salem were determined using the Natural Resources Conservation Service Soil Survey of Kenosha and Racine Counties, Wisconsin, 2003, and are shown on Figure 3-3. Soils are classified into four HSGs (A, B, C, and D) according to their minimum infiltration rate. The soils range from Group A, which has high permeability in well-drained soils, which produces less runoff, to Group D which has low permeability and more anticipated runoff. The predominant soils in the Town of Salem are Group C, which are primarily clay and have low infiltration rates, poor drainage, and high runoff potential. The HSG is used in determining the runoff curve number.

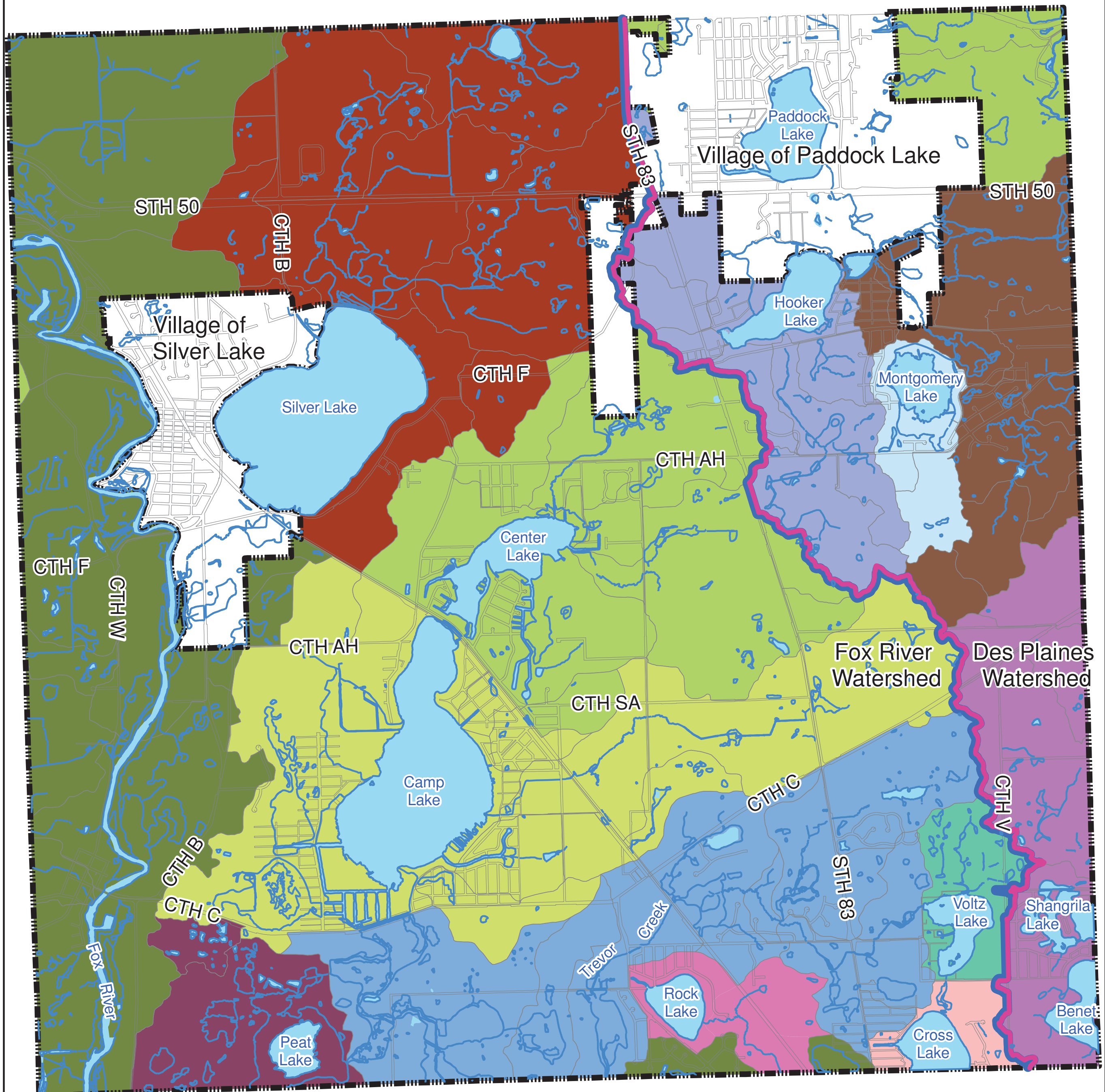
Runoff Curve Number

An area-weighted average curve number was computed for each subbasin based on land use and corresponding HSG determined using Geographic Information System (GIS). Existing year 2000 digital land use mapping was prepared by SEWRPC. Proposed 2020 land cover was determined from the proposed land use maps generated during the Neighborhood Planning process. The year 2000 land use was used for the two areas assumed to be annexed in the future and not included in the Neighborhood Planning process (shown on Figure 3-2). The runoff curve numbers assigned to each SEWRPC land cover classification are provided in Appendix B. The Neighborhood Planning process developed a different set of land use types and the curve numbers for those land covers are also provided in Appendix C.

Time of Concentration

The Time of Concentration (T_C) is defined as the time it takes for the surface water runoff to travel from the hydraulically most distant point of the subbasin to the discharge location. The T_C was calculated based on a combination of sheet flow, shallow concentrated flow, and open channel flow. The existing condition travel paths were determined from the available topographic mapping. The same times of concentration were used for the future 2020 condition. Generally, the T_C would be expected to be shorter for future conditions due to more impervious area and storm sewers, but insufficient data is available to estimate the future T_C.

These parameters were developed for existing 2000 and proposed 2020 land use conditions in each subbasin. Appendix D summarizes the subbasin parameter values used in the hydrologic analysis.



DRAFT

FIGURE 4-1
TOWN OF SALEM
SUBWATERSHED BOUNDARIES EXHIBIT

Legend

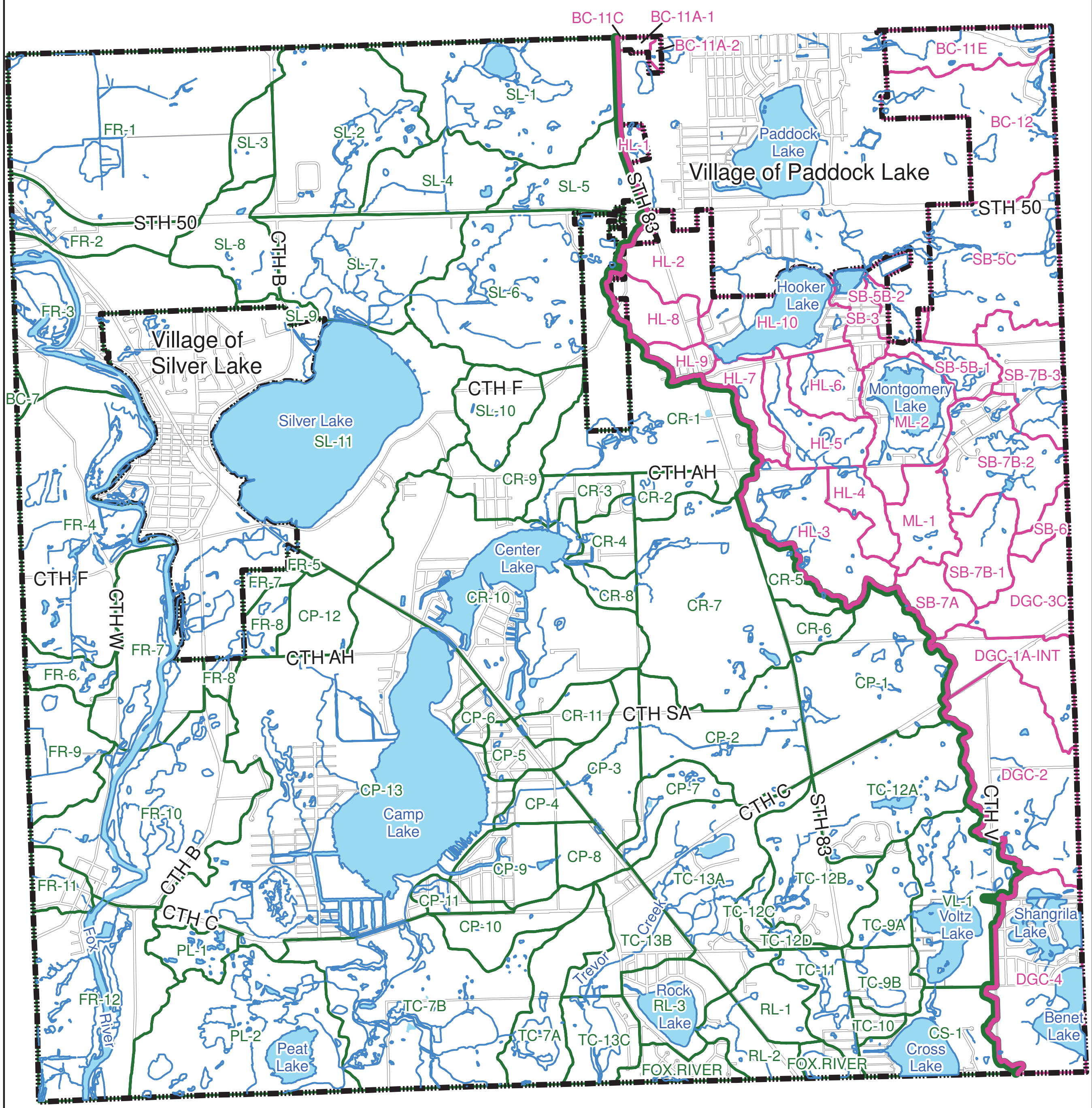
- MunicipalBoundary
- Major Watershed Division
- Subwatersheds
- Fox River (FR)
- Silver Lake (SL)
- Camp Lake (CP)
- Center Lake (CR)
- Peat Lake (PL)
- Brighton Creek (BC)
- Trevor Creek (TC)
- Dutch Gap Canal (DGC)
- Rock Lake (RL)
- Cross Lake (CS)
- Voltz Lake (VL)
- Salem Branch (SB)
- Montgomery Lake (ML)
- Hooker Lake (HL)

R.A. Smith National
Beyond Surveying and Engineering

N W E S

NTS

September 2009



DRAFT

FIGURE 4-2
TOWN OF SALEM
SUBBASIN BOUNDARIES EXHIBIT

Legend

- MunicipalBoundary
- Major Watershed Division
- Des Plaines Watershed
- Fox River Watershed
- SL-1 Subbasin ID

N
W E
S

NTS

September 2009

R.A. Smith National
Beyond Surveying and Engineering

Lakes in Town of Salem

Lakes of various sizes are scattered throughout the Town of Salem. A number of them have dam outlets, as identified by the Wisconsin Department of Natural Resources (WDNR). Some of the lakes provide substantial storage during storm events. Survey and analysis of the lake outlet structures was not part of this study, so the lake storage was not included in the hydrologic analysis. Some of the lakes have been evaluated in other studies. The lakes are shown on Figure 4-3 and available information on the lakes is provided in Table 4-1.

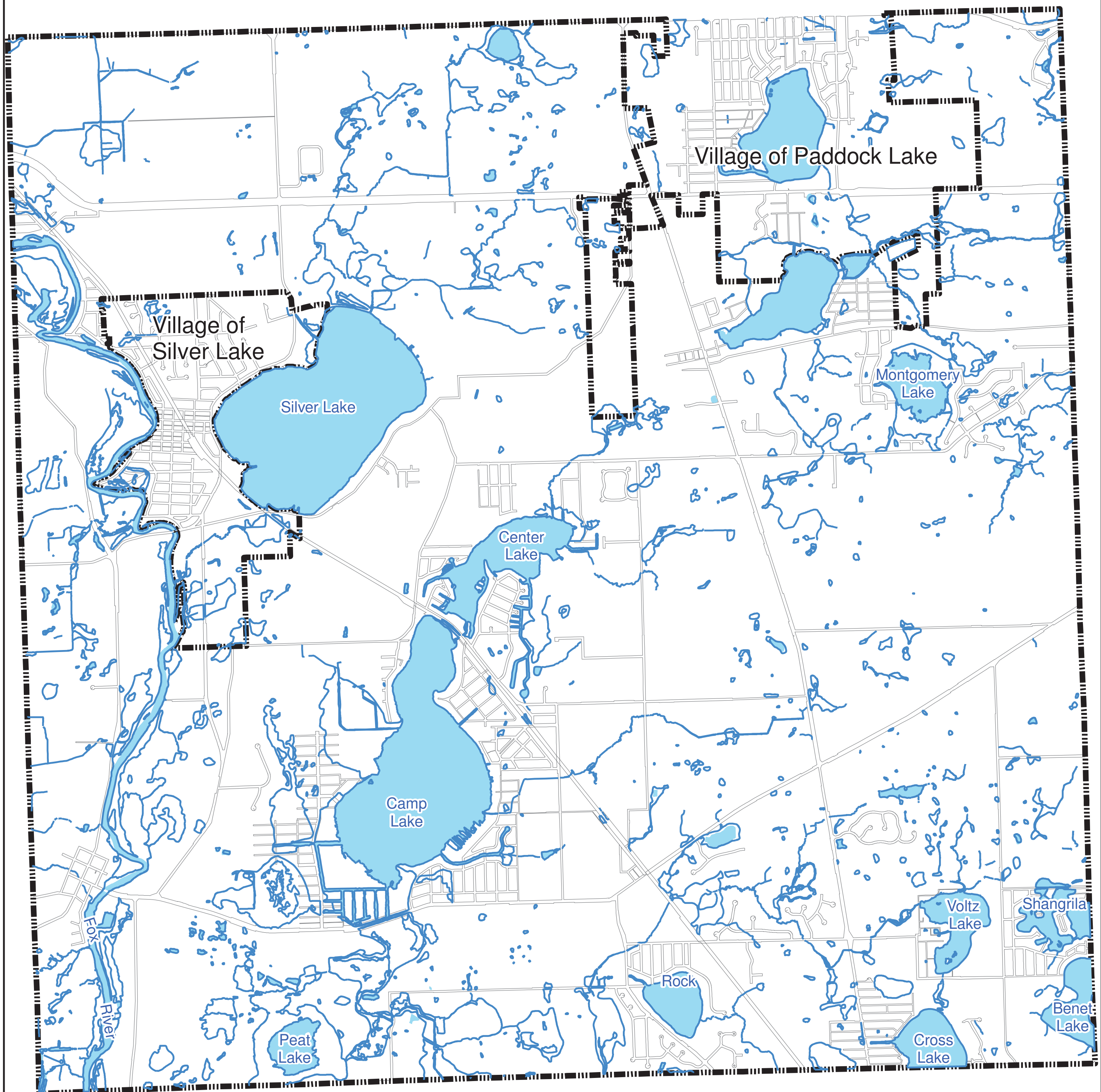
Table 4-1
Lakes in the Town of Salem

Lake Name	Official Dam Name[1]	Surface Area[2] (Ac)	Volume[2] (ac-ft)	Lake Association[3]	1% Annual Chance (100-year) Elevation[4] (ft, NGVD-29)
Camp Lake	Camp Lake	461	2,328	Camp/Center Lake Rehab District	742.7
Center Lake	Center Lake 2	129	1,136	Camp/Center Lake Rehab District	744.4
Cross Lake	Cross Lake	87	1,027	Cross Lake Improvement Association	N/A
Hooker Lake	Hooker Lake	87	983	Hooker Lake Management District	756.2
Montgomery Lake	N/A	N/A	N/A	N/A	800.9
Rock Lake	Rock Lake	44[1]	350[1]	Rock Lake Highlands Association	N/A
Benet/Shangrila Lake	Lake Shangrila	186[5]	874	N/A	N/A
Silver Lake	Silver Lake	464	4,819	N/A	749.4
Voltz Lake	Voltz Lake	52	362	Voltz Lake Management District	N/A

N/A Not Available
[1] WDNR website
[2] SEWRPC Memorandum Report No.93
[3] UW Extension Lakes
[4] SEWRPC correspondence dated July 31, 2009
[5] Includes six acres in Illinois

RESULTS OF HYDROLOGIC ANALYSIS

The peak flows for the 2000 and 2020 land use conditions were determined using PondPack for the 2-, 10-, 25-, and 100-year storm events for the Town subbasins illustrated in Figure 4-2. The results are summarized and compared in Appendix E. The existing 2000 analysis did not include existing detention facilities and natural floodwater storage areas and the 2020 land use analysis did not include any required post-construction stormwater controls. The comparison shows that in most cases, the proposed development would increase peak flows and the volume of runoff.


Village of Paddock Lake
Village of Silver Lake
Silver Lake
Montgomery Lake
Center Lake
Camp Lake
Voltz Lake
Shangrila
Rock
Benet Lake
Cross Lake
Peat Lake
Fox River

IDENTIFIED DRAINAGE PROBLEM AREAS

Early development in the Town was built without the benefit of planning for surface water drainage. This has created ongoing problems in a number of areas of the Town. The seven locations shown on Figure 4-4 have been identified as priority drainage problem areas due to the frequency and severity of flooding in these areas over time. Further details regarding the priority drainage problem areas are included below.

A - Salem Oaks Subdivision

Description

The drainage problems are mainly along 81st Street, 81st Place, and 82nd Street east of 235th Avenue. The existing storm water drainage patterns in this area can be characterized by a system of grass swales and culverts that drain from south to north through private properties and beneath Town roads. In general, the existing storm water drainage patterns do not allow for the efficient conveyance of storm water flows due to improvements on private properties and the lack of drainage easements and corridors.

Proposed Alternative

The proposed project includes a storm sewer conveyance system to capture runoff in Town right-of-ways and convey it underground to a stormwater management wet detention pond located on Town property south of 81st Street between 235th and 236th Avenues. The proposed drainage improvement plan is shown on Figure 4-5.

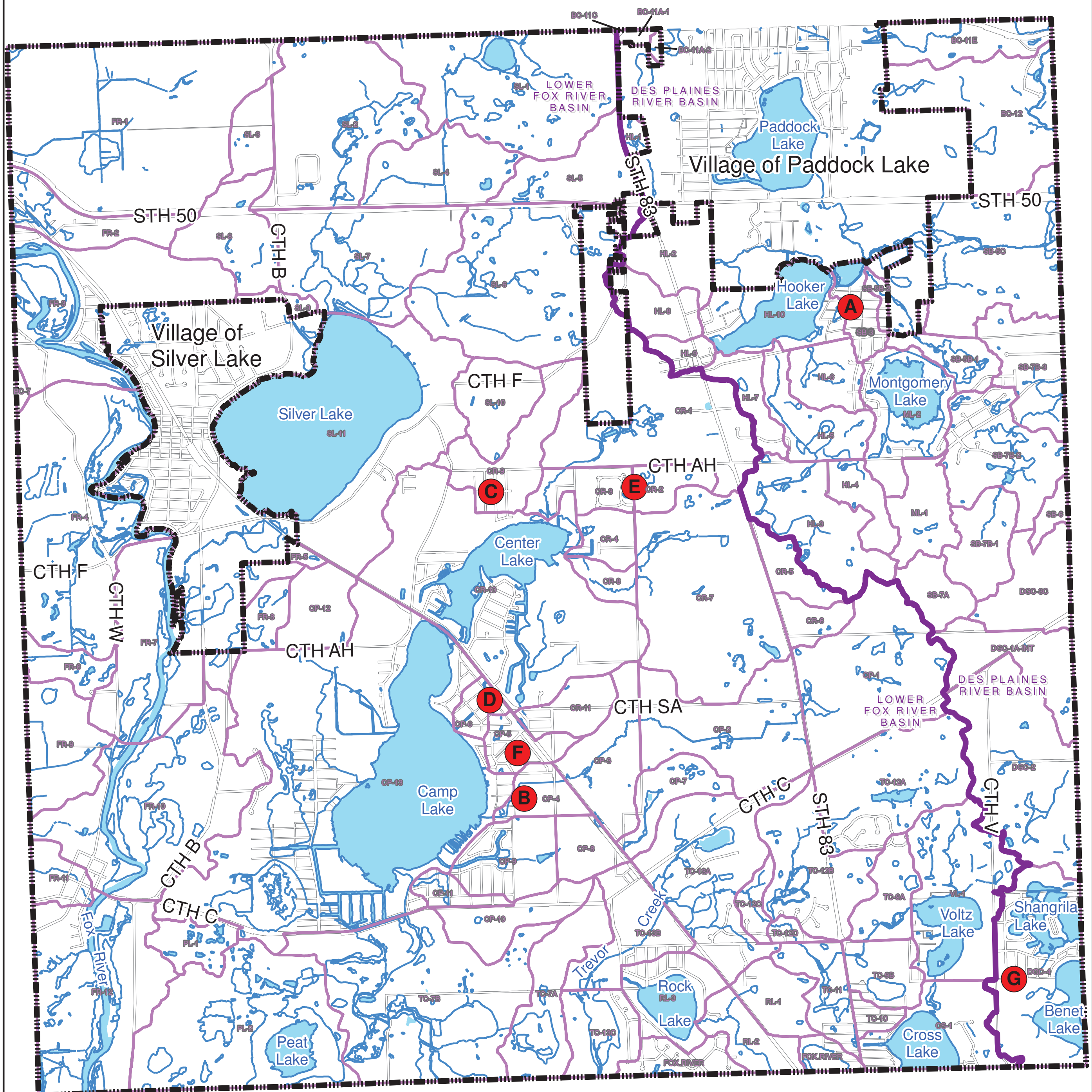
Benefits

The proposed project would reduce storm water flows through private properties in Salem Oaks east of 235th Avenue and provide water quality benefits to the Hooker Lake drainage basin via treatment of the storm water in the proposed wet detention pond.

Cost Estimate

Preliminary project costs have been estimated using Town mapping records, a site visit and the history of the drainage problems in this area of the Salem Oaks neighborhood.

Item	Quantity	Units	Unit Cost	Cost
Inlet	13	EA	$2,000	$ 26,000
Manhole	8	EA	$3,500	$ 28,000
Storm Sewer	2320	LF	$75.00	$174,000
Detention Pond	1	LS	$140,000	$140,000
			Subtotal	$368,000
			Contingencies	$ 74,000
			Engineering & Administration	$110,000
			Probable Construction Cost	**$552,000**



DRAFT

FIGURE 4-4
TOWN OF SALEM
PRIORITY DRAINAGE PROBLEM AREAS

Legend

- Priority Drainage Problem Areas
- MunicipalBoundary
- Subbasin Boundaries

R.A. Smith National
Beyond Surveying and Engineering

NTS
December 2009

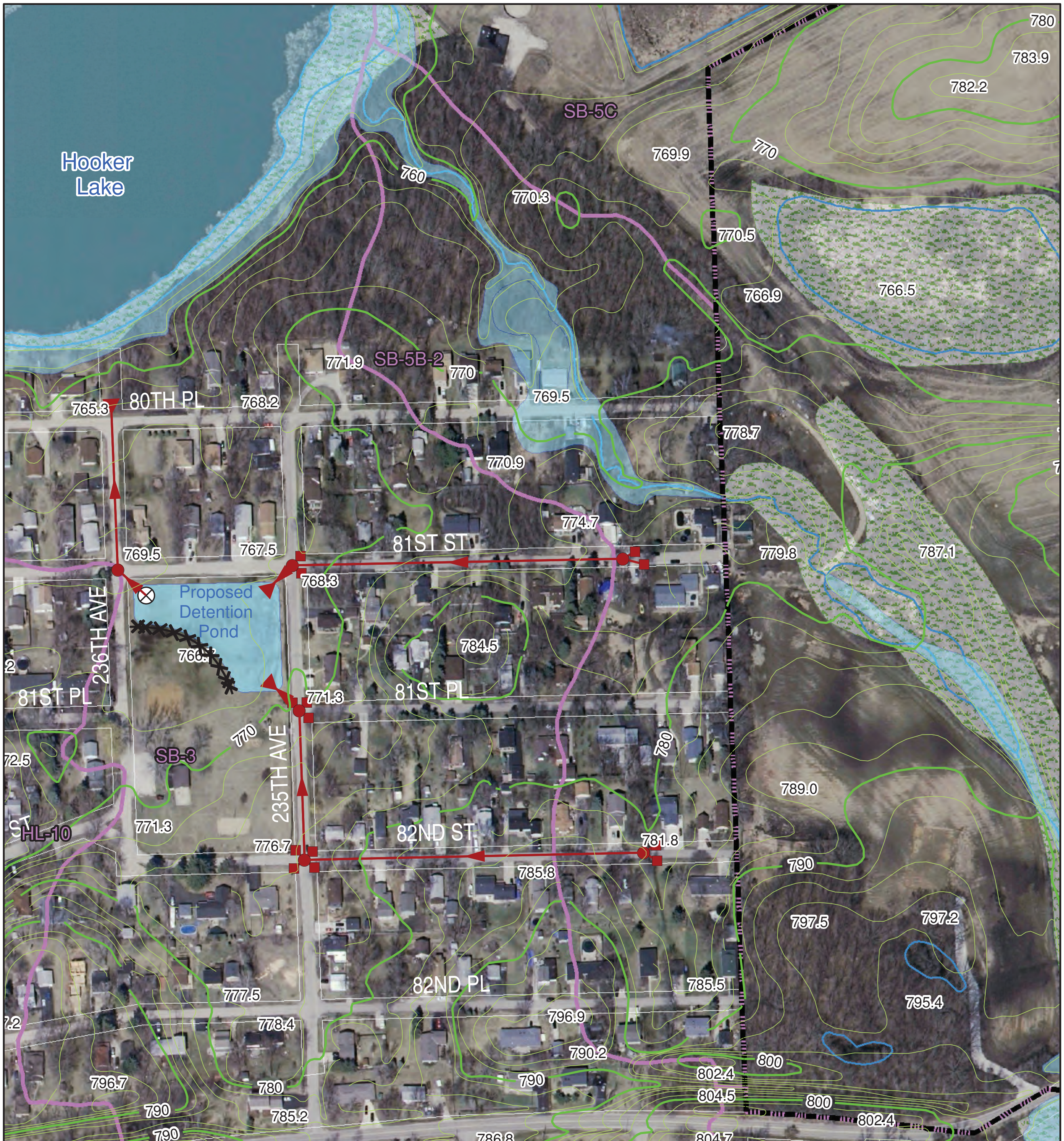


FIGURE 4-5
TOWN OF SALEM
SALEM OAKS SUBDIVISION

DRAFT

Legend

- Proposed Storm Sewer
- Proposed Catchbasin
- Proposed Manhole
- Proposed Outfall
- Proposed Outlet Control Structure
- Contours
- Proposed Fence
- Floodplain
- SEWRPC Wetlands
- Subbasin Boundaries
- MunicipalBoundary

N S W E

0 125 250
Feet

September 2009

R.A. Smith National
Beyond Surveying and Engineering

B - Shoreview Subdivision

Description

The Shoreview Subdivision is on the east side of Camp Lake north of 110th Street and west of 267th Avenue. The navigable stream that flows through the subdivision drains a primarily agricultural area of about 950 acres to the east (see Figure 4-6). The existing condition 100-year discharge through the subdivision developed during the hydrologic analysis is 875 cubic feet per second (cfs). The subdivision experiences overbank flooding and sediment deposition from the stream during heavy rainfall events.

Proposed Alternative

The proposed future land use map (Figure 3-2) shows the majority of the agricultural land in the drainage area will be developed as residential, with smaller areas converted to business and industrial land uses. The current storm water ordinance for this portion of the Town, which is within the Fox River Watershed, calls for the future 2-, 10-, and 100-year recurrence interval event runoff to be controlled to predevelopment levels. To lessen flooding in this neighborhood, we recommend that the more restrictive runoff regulations of 0.04 cfs/acre for the 2-year event and 0.30 cfs/acre for the 100-year event, as required in the Des Plaines Watershed, be applied to this drainage basin. The more restrictive runoff rates would help to reduce the flooding at no cost to the Town, but only as upstream development occurs.

To reduce flooding in the near future prior to new upstream development, one or more detention basins upstream of 267th Avenue could be constructed to reduce peak flood flows. The basins locations could be selected to be consistent with future land use plans and provide the flow reduction in advance of land development. Any detention basins located near the stream channel would need approval from the WDNR.

The channel through the subdivision is a navigable stream, which makes it difficult to obtain WDNR approval to enlarge or change the channel significantly to reduce flooding in this area. Flooding may be alleviated by removing the flood-prone homes or by creating a flood conveyance route outside the stream channel. Constructing an overbank conveyance area may involve removal of homes or garages, replacing culverts, and altering street grades. A WDNR permit would also be required.

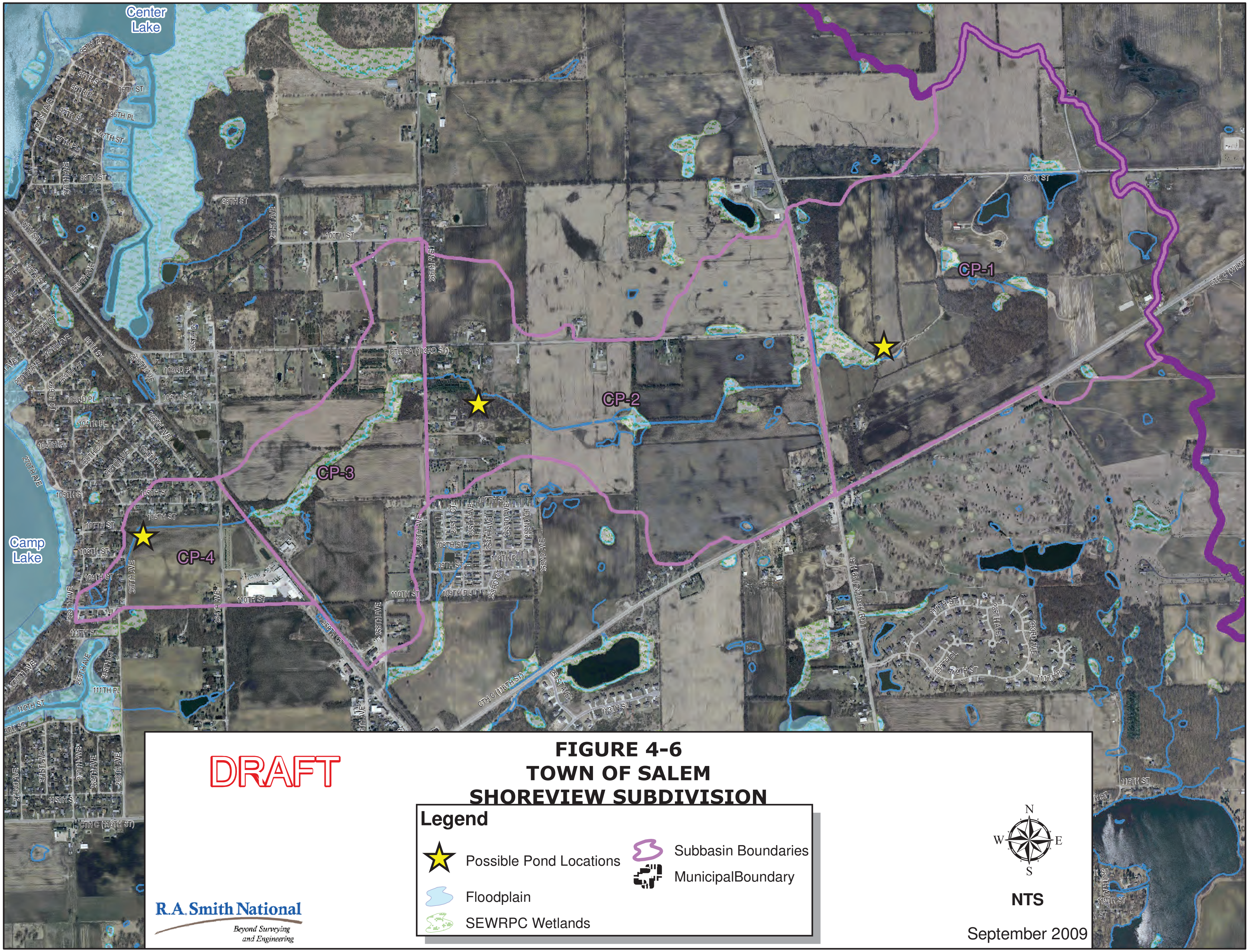
Further study of alternatives to address the flooding problem in this area is recommended. The study would include survey of home elevations, determining the capacity of the channel and culverts, identification of possible detention sites and overbank flood conveyance routes, and evaluation of land acquisition, structure removal, grading, and street crossing modifications necessary for each alternative. From this analysis and evaluation, the most effective solution to the flooding problem would be identified.

Benefits

Requiring future development to meet the more restrictive runoff requirements will decrease the future flood flows through the subdivision at no cost to the Town. Evaluating alternative solutions to the flooding and identifying an effective approach will provide the Town with a plan that can be implemented to resolve the flooding problems in Shoreview subdivision.

Cost Estimate

Due to the large amount of drainage area and the complexity involved with the navigable waterway flowing through this subdivision, extensive hydraulic and hydrologic modeling and analysis will be required. The cost of design, land acquisition and construction for this proposed project is estimated to be



DRAFT
FIGURE 4-6
TOWN OF SALEM
SHOREVIEW SUBDIVISION
Legend
Possible Pond Locations
Subbasin Boundaries
MunicipalBoundary
Floodplain
SEWRPC Wetlands
R.A. Smith National
Beyond Surveying and Engineering
N
S
E
W
NTS
September 2009
Center Lake
Camp Lake
CP-1
CP-2
CP-3
CP-4

approximately \$800,000. Implementing more restrictive runoff rates in the tributary drainage area will have no direct cost to the Town.

C - Timber Lane Subdivision

Description

The Timber Lane Subdivision is south of 89th Street between 268th and 271st Avenues. This subdivision has a multitude of drainage problems due to the lack of a planned drainage system. The storm water flow is generally through private properties, and there is currently no adequate route conveying the runoff south to Center Lake. Multiple homeowners on the block east of 270th Avenue and north of 90th Street have had damage to their homes during large rain events because it is a natural low area, and the ditches do not have the capacity to handle the amount of storm water draining to this area. The block west of 268th Avenue and north of 91st Place also has many drainage issues because it is also a natural low area that is nearly the same elevation as Center Lake. This area has had a history of drainage problems, possibly stemming from the addition of fill to the natural low lying detention areas with the construction of new homes. The landowner east of 268th Avenue also complains that he has standing water on his agricultural field after storm events due to possible damage or elimination of a previous downstream culvert or drain tile system many years ago.

Proposed Alternative

The proposed alternative includes a conveyance system and small wet detention pond. The conveyance system would include approximately 1,800 feet of storm sewer beginning on 270th Avenue north of 90th Street south to a constructed wet detention pond on the Town owned property on the northeast corner of 91st Street and 270th Avenue. This wet detention pond will provide water quality treatment for small rain events before discharging to the open ditch that flows to Center Lake. See Figure 4-7 for the proposed storm sewer and detention basin locations.

For the problems on the eastern portion of the subdivision, a conveyance system is proposed beginning on 268th Avenue north of 91st Place and west on 91st Place to the ditch that flows to Center Lake. See Figure 4-7 for the proposed storm sewer location. Another possible solution would be to restore the low lying areas that have been filled in west of 268th Avenue. Specifically, the Town could purchase the two partially developed properties on the west side of 268th Avenue, just south of 90th Street and re-establish these lots as a low area to provide storage for some of the drainage areas in this neighborhood. Because the surrounding lots are relatively low compared to the lake level, a wet detention basin in this area is not feasible.

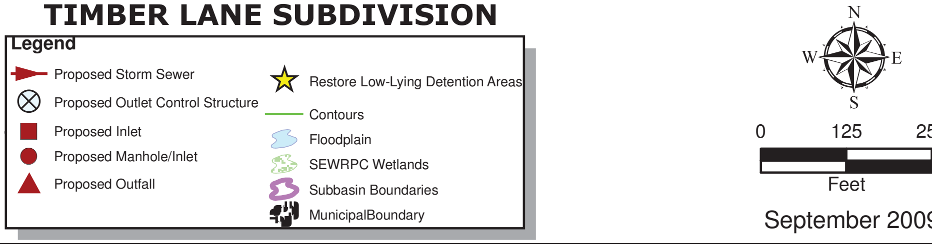
The tributary drainage area is anticipated to become residential land use in the future. Since the predevelopment runoff is causing considerable flooding, the more restrictive regulations of 0.04 cfs/acre for the 2-year event and 0.30 cfs/acre for the 100-year event required in the Des Plaines Watershed portion of the Town are recommended to be required for this drainage area. As development occurs, the runoff restrictions would reduce the flooding problem at no direct cost to the Town.

Benefit

The proposed storm sewer will provide a conveyance system that will at a minimum reduce nuisance flooding for smaller events and to a lesser extent for larger events. The wet pond will provide water quality treatment for smaller rain events prior to discharge into Center Lake. Restoring the low lying detention areas would not provide any water quality benefits, but would help relieve flooding in this neighborhood during the smaller more frequent rainfall events. Requiring future development to meet the more restrictive runoff requirements will decrease the future flood flows through the subdivision.

DRAFT

FIGURE 4-7
TOWN OF SALEM
TIMBER LANE SUBDIVISION



R.A. Smith National
Beyond Surveying and Engineering

September 2009

Cost Estimate

Preliminary project costs have been estimated using Town mapping records, a site visit and the history of the drainage problems in this area of the Timber Lane subdivision.

Item	Quantity	Units	Unit Cost	Cost
Inlet	10	EA	$2,000	$ 20,000
Manhole	7	EA	$3,500	$ 24,500
Storm Sewer	2000	LF	$75.00	$ 150,000
Detention Pond	1	LS	$85,000	$ 85,000
Land Acquisition	2	EA	$60,000.00	$ 120,000
Demolition & Grading	1	LS	$40,000.00	$ 40,000
			Subtotal	$ 439,500
			Contingencies	$ 88,000
			Engineering & Administration	$ 132,000
			Probable Construction Cost	**$ 659,500**

D - 99th Street and 270th Avenue

Description

The area southwest of the Wisconsin Central Railroad right-of-way between 270th Avenue and 271st Street is drained by an 8-inch drain tile in the backyards between 270th Avenue and 270th Court northeast of 100th Street. This tile frequently gets clogged with sediment and debris and the Town has routinely had to clean it out to help prevent flooding of this area.

The Town has recently become aware that the property owners adjacent to the private drain tile have collaboratively decided to fix the broken drain tile as a group of private property owners. Therefore, this project will remain in this report for future reference, but will not be recommended to be completed at this time.

Proposed Alternative

The proposed project includes a high water relief storm sewer in 270th Avenue between 99th and 100th Streets to capture storm water in this low area and convey it underground to the open channel southwest of 100th Street as shown on Figure 4-8.

Benefit

The storm sewer will alleviate flooding problems and remove the drainage facility from private property to Town right-of-way for easier access and a more efficient conveyance system.

Cost Estimate

This project is expected to be a fairly simple design, and therefore the design and construction of this proposed project is estimated as follows:

Item	Quantity	Units	Unit Cost	Cost
Inlet	2	EA	$2,000	$ 4,000
Manhole	2	EA	$3,500	$ 7,000
Storm Sewer	620	LF	$65.00	$ 40,300
			Subtotal	$ 51,300

DRAFT

FIGURE 4-8
TOWN OF SALEM
99TH ST. & 270TH AVE.

Legend

- Proposed Storm Sewer
- Proposed Inlet
- Proposed Manhole/Inlet
- Proposed Outfall
- Contours
- Floodplain
- SEWRPC Wetlands
- Subbasin Boundaries
- MunicipalBoundary

N S E W

0 75 150
Feet

September 2009

R.A. Smith National
Beyond Surveying and Engineering

Contingencies	$ 10,000
Engineering & Administration	$ 15,000
Probable Construction Cost	**$ 76,300**

E - 256th Avenue and CTH AH (89th Street)

Description

There is wetland on the east and west sides of 256th Avenue about 700 feet south of CTH AH. During storm events, water collects in the wetlands and ponds to high levels, overflowing the bicycle path and road and causing flooding issues for area residents on the east side 256th Avenue. The downstream west wetland has no designated overflow route. As water rises in the east wetland, it overflows to the northeast toward the intersection of 256th Avenue and CTH AH and frequently causes flooding problems for the Albor and McLeran properties.

Proposed Alternative

The proposed alternative includes a high-flow relief storm sewer on 256th Avenue that would convey excess stormwater from the wetlands on both sides of the road northerly to the southwest corner of the intersection of 256th Avenue and CTH AH as shown in Figure 4-9. The storm sewer would be directed to the existing ditch flowing west from the intersection. The storm sewer would be designed to function only during wet weather periods that would cause high water problems for neighboring residents. This design would not drain or cause any detrimental impacts to the wetlands. A storm sewer is proposed in lieu of ditched flow in this location because there is a hill rising and falling about 8 feet between the wetlands and the intersection, which would not be conducive to a ditch design.

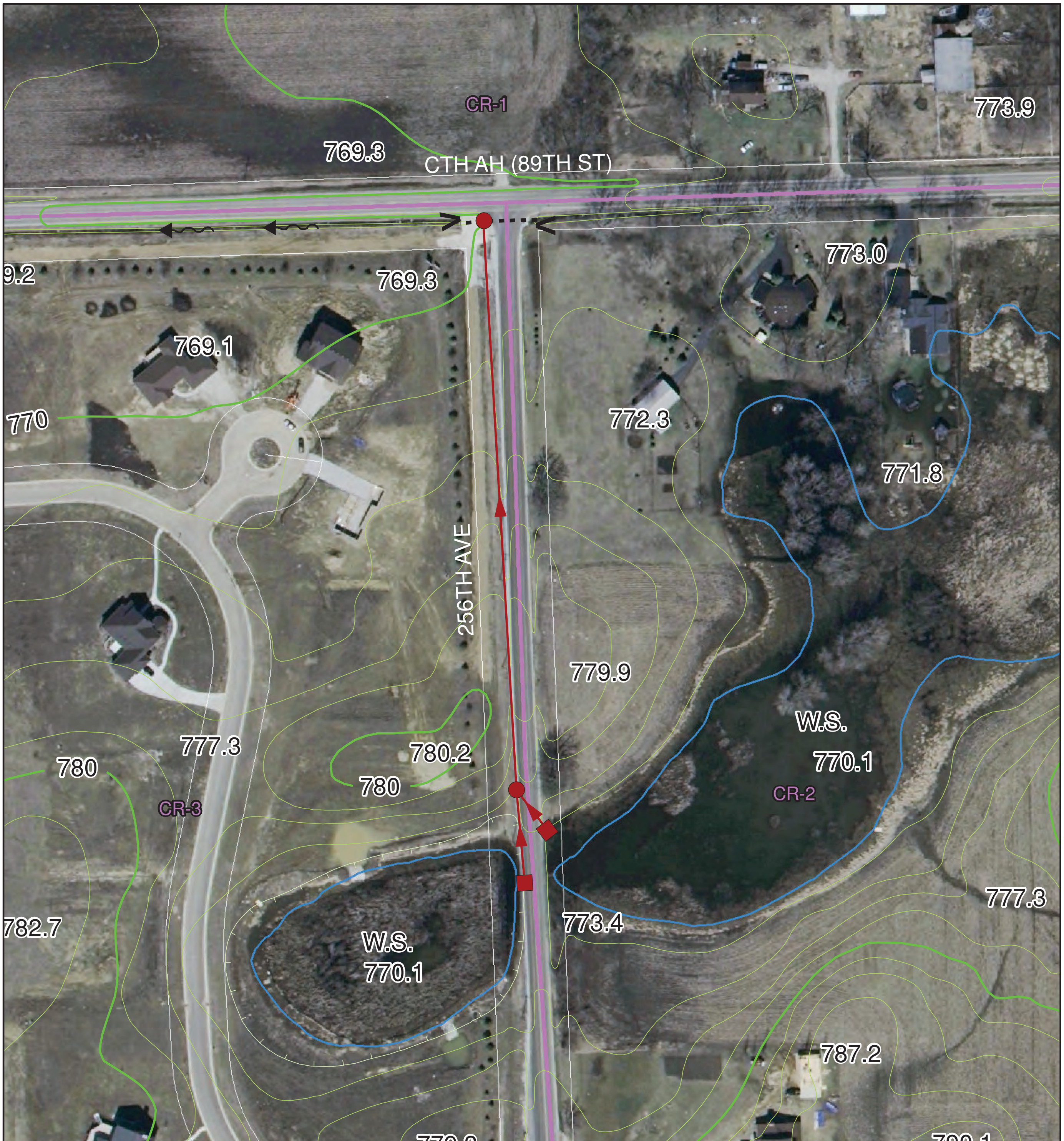
Benefits

This high-flow relief storm sewer will eliminate the chronic flooding problems that threaten adjacent properties. Once this storm water is discharged from the storm sewer, it will flow through approximately 1,800 feet of grassed ditch along CTH AH before entering the tributary to Center Lake, which would provide some water quality benefits. This ditch could also be redesigned to maximize the pollution reduction capacity as part of this project.

Cost Estimate

Preliminary project costs have been estimated as follows:

Item	Quantity	Units	Unit Cost	Cost
Special Manhole	1	EA	$6,500	$ 6,500
Manhole	1	EA	$3,500	$ 3,500
Storm Sewer	865	LF	$75.00	$ 64,875
			Subtotal	$ 74,875
			Contingencies	$ 15,000
			Engineering & Administration	$ 22,000
			Probable Construction Cost	**$ 111,875**



DRAFT

FIGURE 4-9
TOWN OF SALEM
256TH AVE. & CTH AH (89TH ST.)

Legend

- Proposed Storm Sewer
- Existing Culvert
- Proposed Inlet
- Proposed Manhole/Inlet
- Subbasin Boundaries
- Contours
- Floodplain
- SEWRPC Wetlands
- MunicipalBoundary

N W E S

0 75 150
Feet

September 2009

R.A. Smith National
Beyond Surveying and Engineering

F - Sunset Oaks Subdivision

Description

This area is southwest of the Wisconsin Central Railroad right-of-way between 268th Court and 105th Street. The drainage in this area is through private properties with no well-defined route. Flow comes to the area from a 48" culvert under the railroad right-of-way. The Town owns a small detention pond upstream of the railroad that has a 12" outlet pipe that was constructed to help slow down the runoff that discharges to the railroad culvert and alleviate flooding in this neighborhood. However, during large storm events it appears that some of the runoff north of 104th Street and east of the railroad tracks that would normally go north to Center Lake, instead flows south to the railroad right-of-way and through the private properties causing additional flooding issues.

Proposed Alternative

The proposed project includes a storm sewer conveyance system in the Town right-of-way to carry flow from the railroad culvert to the outlet at Camp Lake, as shown on Figure 4-10. The project would also include retrofitting the Town-owned wet detention pond upstream of the railroad to provide additional water quantity and quality control to the maximum extent possible.

Benefits

A storm water conveyance system would be created and, therefore, drainage would be moved from private property as it exists today, to the Town right-of-way. This project would also provide reduced flooding problems and possibly some additional water quality management with updates to the Town pond outlet pipe.

Cost Estimate

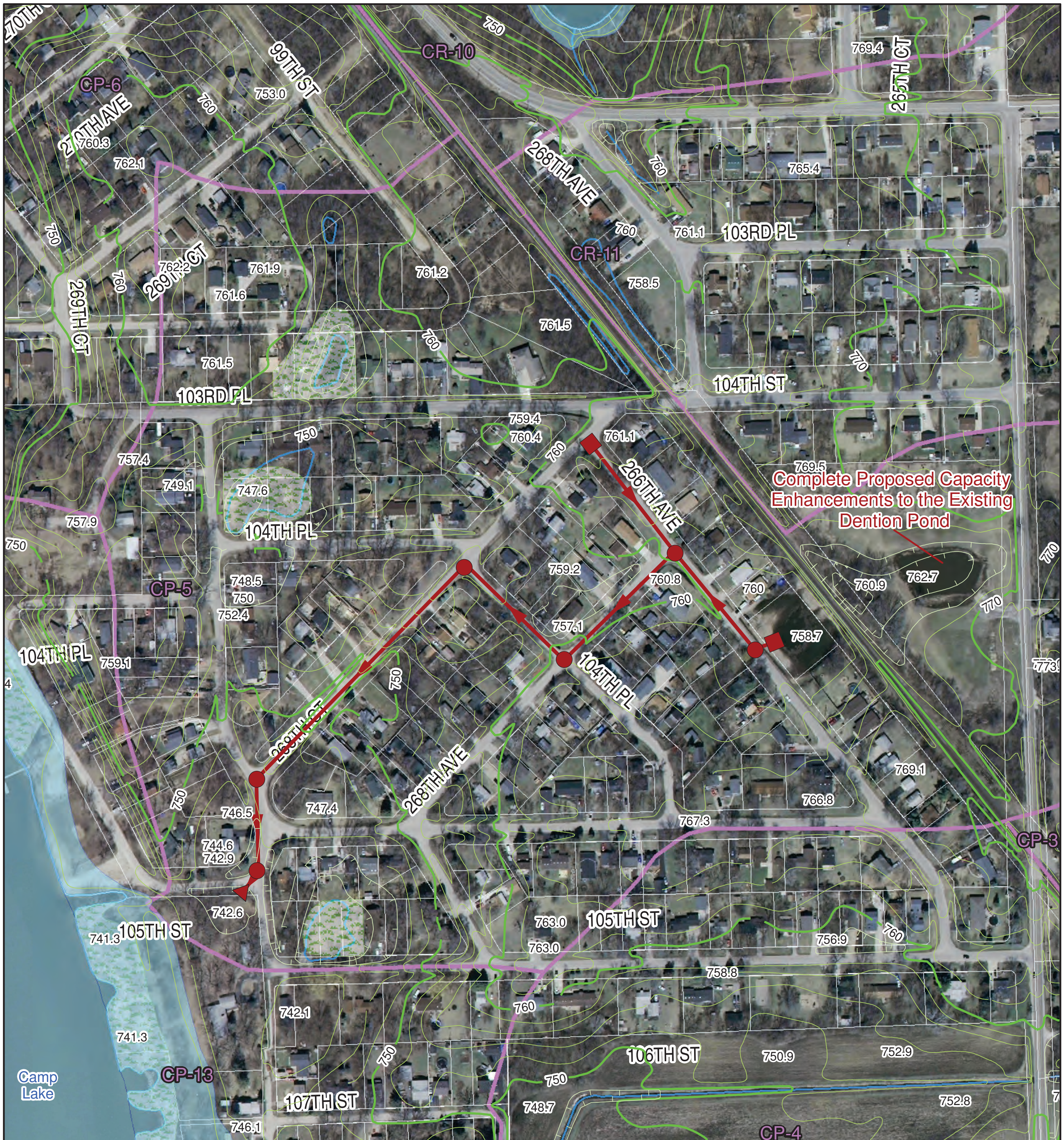
Preliminary project costs have been estimated using Town mapping records, a site visit and the history of the drainage problems in this area of the Sunset Oaks subdivision.

Item	Quantity	Units	Unit Cost	Cost
Inlet	13	EA	$2,000	$ 26,000
Manhole	8	EA	$3,500	$ 28,000
Storm Sewer	2500	LF	$75.00	$ 187,500
Detention Pond	1	LS	$200,000	$ 200,000
			Subtotal	$ 441,500
			Contingencies	$ 88,000
			Engineering & Administration	$ 132,000
			Probable Construction Cost	**$ 661,500**

G - 122nd Street & 224th Avenue

Description

The drainage problems are mainly along 122nd Street east of 224th Avenue. The existing storm water drainage patterns in this area can be characterized by a system of french drain inlets that are directed to an old drain tile running down the middle of 122nd Street. At the intersection of 220th Avenue, this drain tile heads north and eventually discharges into Lake Shangri-La. In general, this system is very inefficient and



DRAFT

FIGURE 4-10
TOWN OF SALEM
SUNSET OAKS SUBDIVISION

Legend

- Proposed Storm Sewer
- Proposed Inlet
- Proposed Manhole/Inlet
- Proposed Outfall
- Contours
- Floodplain
- SEWRPC Wetlands
- Subbasin Boundaries
- MunicipalBoundary

N S W E

0 150 300

Feet

September 2009

R.A. Smith National
Beyond Surveying and Engineering

does not seem to have enough capacity for this drainage area, which causes water to constantly pond on the adjacent properties and on the roadway.

Proposed Alternative

The proposed project includes a storm sewer conveyance system to capture runoff in Town right-of-ways and convey it more efficiently to Lake Shangri-La. This system should alleviate the nuisance drainage patterns that exist currently. The proposed drainage improvement plan is shown on Figure 4-11.

Benefits

The storm sewer conveyance system will alleviate nuisance flooding problems and provide a more efficient drainage route for runoff.

Cost Estimate

Preliminary project costs have been estimated using Town mapping records, a site visit and the history of the drainage problems in this area.

Item	Quantity	Units	Unit Cost	Cost
Inlet	8	EA	$2,000	$ 16,000
Manhole	8	EA	$3,500	$ 28,000
Storm Sewer	1,500	LF	$65.00	$ 97,500
			Subtotal	$141,500
			Contingencies	$ 28,300
			Engineering & Administration	$ 35,375
			Probable Construction Cost	**$205,175**

Additional Drainage and Flooding Complaints

In addition to these seven priority drainage problem areas, the Town has also received a large number of reports of other nuisance drainage and/or flooding complaints that are shown on Figure 4-12. The majority of these flooding complaints are either during large storm events, which unfortunately have occurred more frequently over the last few years, or are chronic wetness complaints during all types of rainfall events. R.A. Smith National has been assisting the Town in documenting all of these complaints in a database and following up with site visits to discuss the issue in detail with the resident who filed the complaint.

Within this database of drainage complaints, detailed information was compiled for each complaint including general field observations, whether it is a private property issue or a public concern, if the complaint is located within a floodplain, the approximate number of homes being affected, and the frequency and severity of the drainage complaint. An approximate cost to resolve the problem has also been assigned to each complaint. Due to elevation constraints, in many cases, the only feasible solution is for the Town to acquire the property and raze any of the buildings on the property for additional flood storage. In this case, the cost is shown as the 2009 assessed value of the property. Finally, each complaint was prioritized for Town action (ie. high, medium, low) to be addressed on an ongoing basis as funding is available through the existing storm water utility. The complete drainage complaint database for 2009 is included in Appendix N.

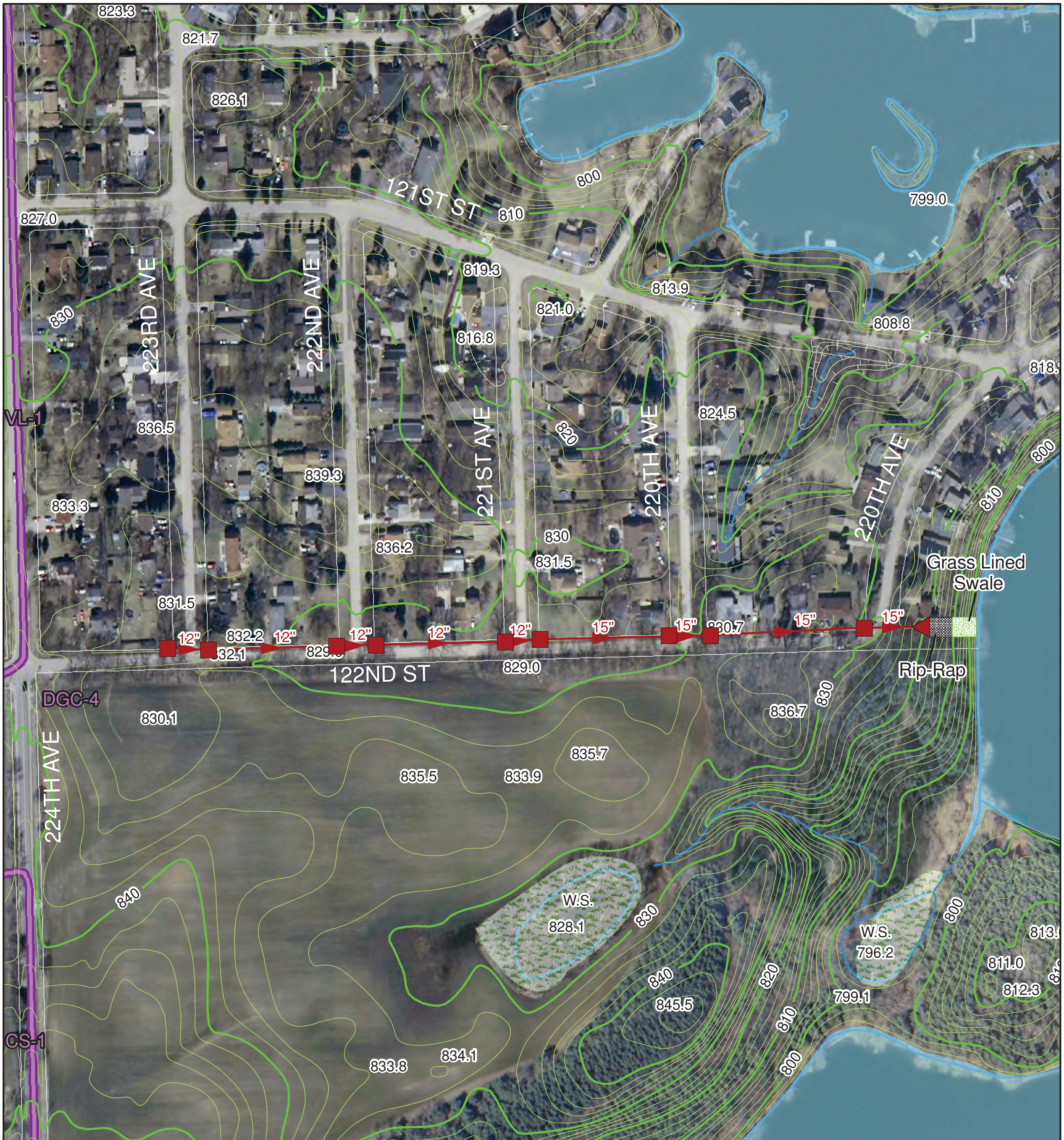


FIGURE 4-11
TOWN OF SALEM
122ND STREET & 224TH AVENUE

DRAFT

Legend

Proposed Storm Sewer	Contours
Proposed Outfall	Floodplain
Proposed Inlet	SEWRPC Wetlands
Subbasin Boundaries	MunicipalBoundary

N
W E
S

0 125 250
Feet

December 2009

R.A. Smith National
Beyond Surveying and Engineering

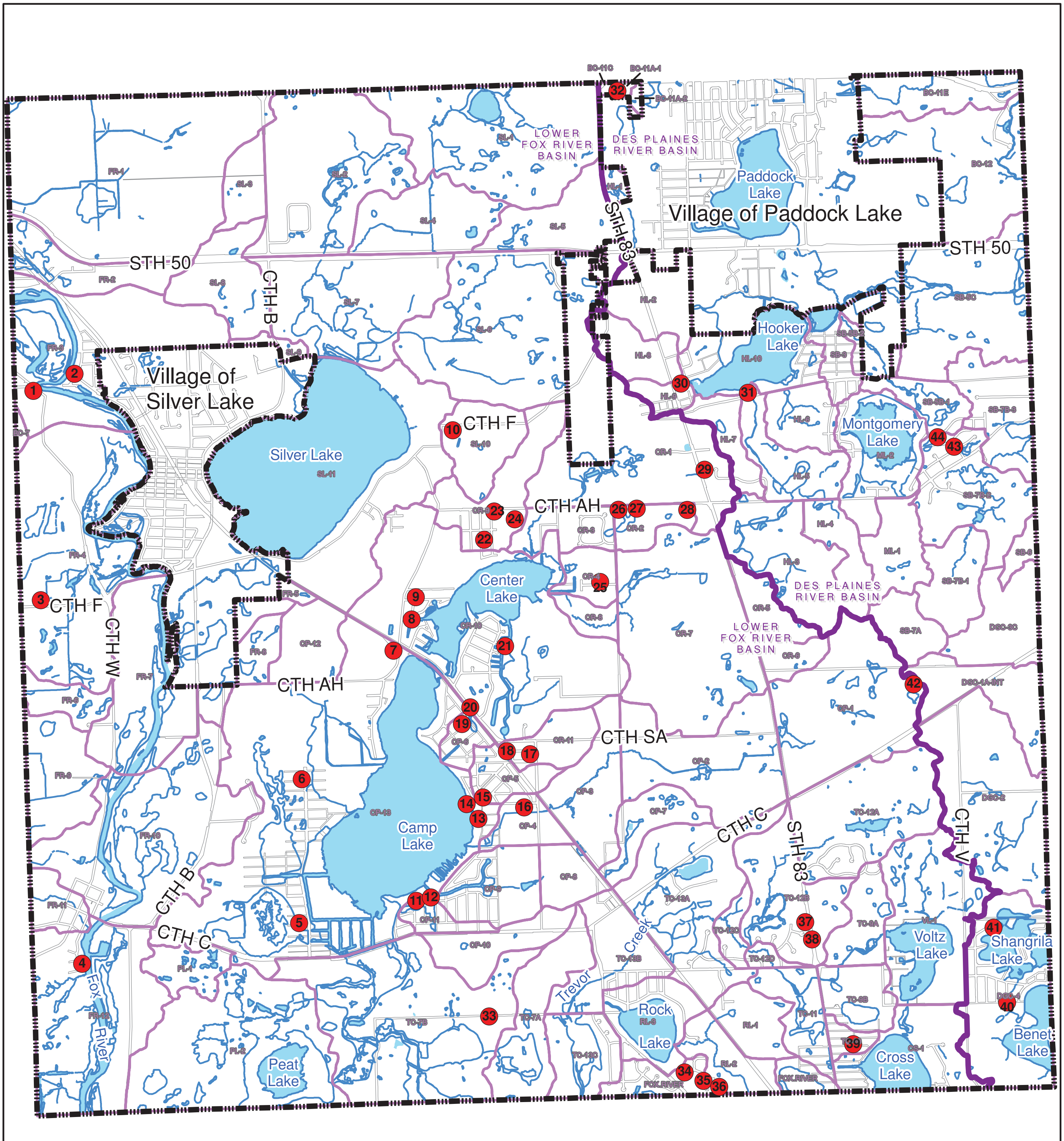


FIGURE 4-12
TOWN OF SALEM
DRAINAGE COMPLAINT INVENTORY

DRAFT

Legend

- **Drainage Complaints**
- **MunicipalBoundary**
- **Subbasin Boundaries**

R.A. Smith National
Beyond Surveying and Engineering

N E S W

NTS
December 2009

(This page intentionally left blank)

Appendix E

LAKE OUTLET DAM

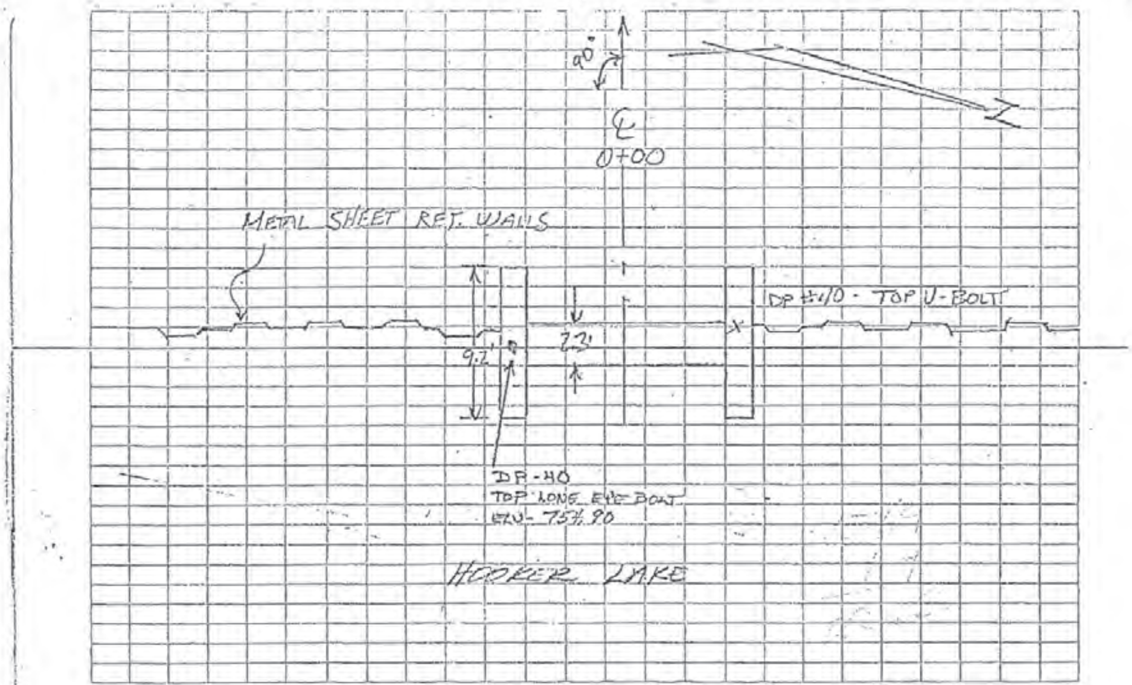
(This page intentionally left blank)

STRUCTURE NO. L7
HOOKER LAKE OUTLET

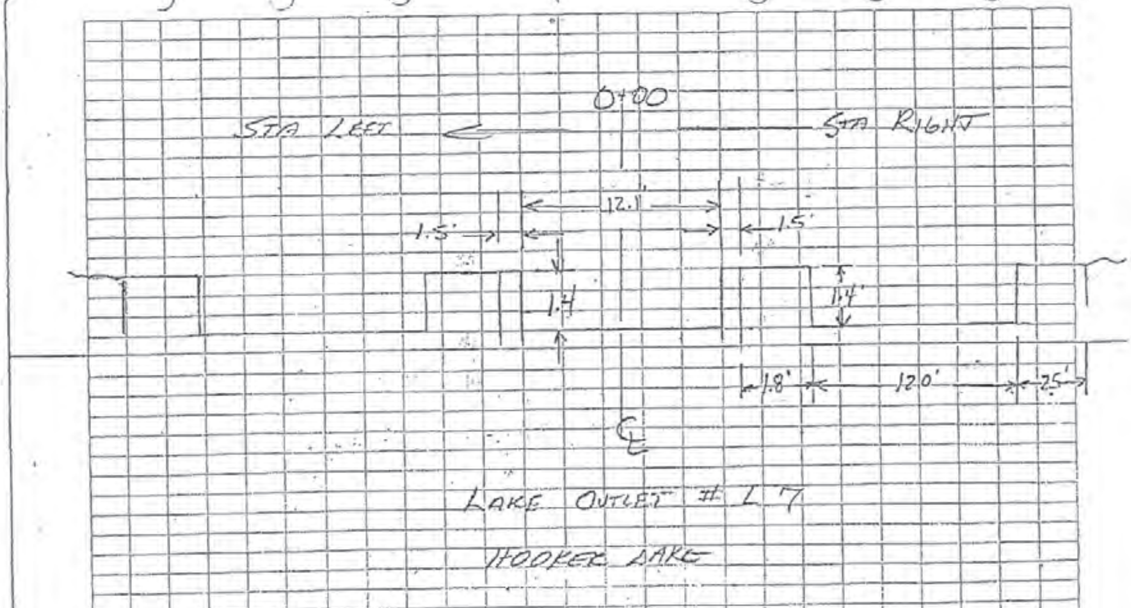
LAKE OUTLET - L-7

JAN 25, 1977

T - M. SCHMITZ



90°
℄
0+00
METAL SHEET RET. WALLS
DP #40 - TOP U-BOLT
9.2'
7.3'
DP-40
TOP LONG EYE BOLT
ELV- 75% 90
HOOKER LAKE



0+00
STA LEFT
STA RIGHT
12.1'
1.5'
1.5'
1.4
1.4'
1.8'
12.0'
2.5'
℄
LAKE OUTLET # L7
HOOKER LAKE

LAKE OUTLET - L-7

STA	B.S.	H.I.	F.S.	ELV		
BM	3.23	758.13				DP #40 EL=754.90
0+00			4.7	753.4		TOP CONC SPILLWAY
0+06 L			4.7	753.4		"
0+06 L			3.4	754.7		TOP HEADWALL
0+09.3L			3.4	754.7		TOP SHEET METAL
0+09.3L			4.7	753.4		" " @ OPENING
0+21.3L			4.7	753.4		" " " "
0+21.3L			3.2	754.9		TOP SHEET METAL
0+23.8L			3.2	754.9		" "
0+23.8L			4.1	754.0		GROUND
1+00L			3.23	754.90	754.91	"
	5.34	760.25				
TP			3.89	756.35	756.37	
	6.53	762.90				
2+00L			4.2	758.70		TOP HILL
2+40 TL			9.41	753.47	753.50	EDGE MARSH
	11.83	765.33				
3+00			12.7	752.6		MARSH
3+65			11.3	754.0		EDGE MARSH
3+85			9.7	755.6		BANK
4+00			8.7	756.6		FIELD
5+00			2.5	762.8		"

Source: SEWRPC.

LAKE OUTLET - L.7

STA	B.S.	H.I.	F.S.	ELV.		
		765.33				
TP	7.19	760.70	11.80	753.50	753.53	
BM			5.83	754.86	754.90	RP #40 EL=754.90
	6.10	761.00				
0+06R			7.5	753.5		TOP RET. WALL
0+66R			6.2	754.8		TOP HEAD WALL
0+09.3R			6.2	754.8		TOP SHEET METAL ~~@ OPENING~~
0+09.3R			7.5	753.5		" " @ OPENING
0+21.3R			7.5	753.5		" " "
0+21.3R			6.1	754.9		TOP SHEET METAL
0+23.8R			6.1	754.9		" "
0+23.8R			6.7	754.3		GROUND
1+00R			6.2	754.8		FIELD
2+00R			6.63	754.37	754.39	"
	15.66	770.05				
3+00R			13.6	756.5		"
3+32R			11.0	759.0		SLOPE
3+72R			7.5	762.6		"
4+00R			4.6	765.5		FIELD
4+75R			7.3	762.8		SLOPE
5+00R			11.4	758.7		FIELD
BM			14.04	755.99	756.04	RP #40 EL= 756.04

(This page intentionally left blank)

AYRES ASSOCIATES

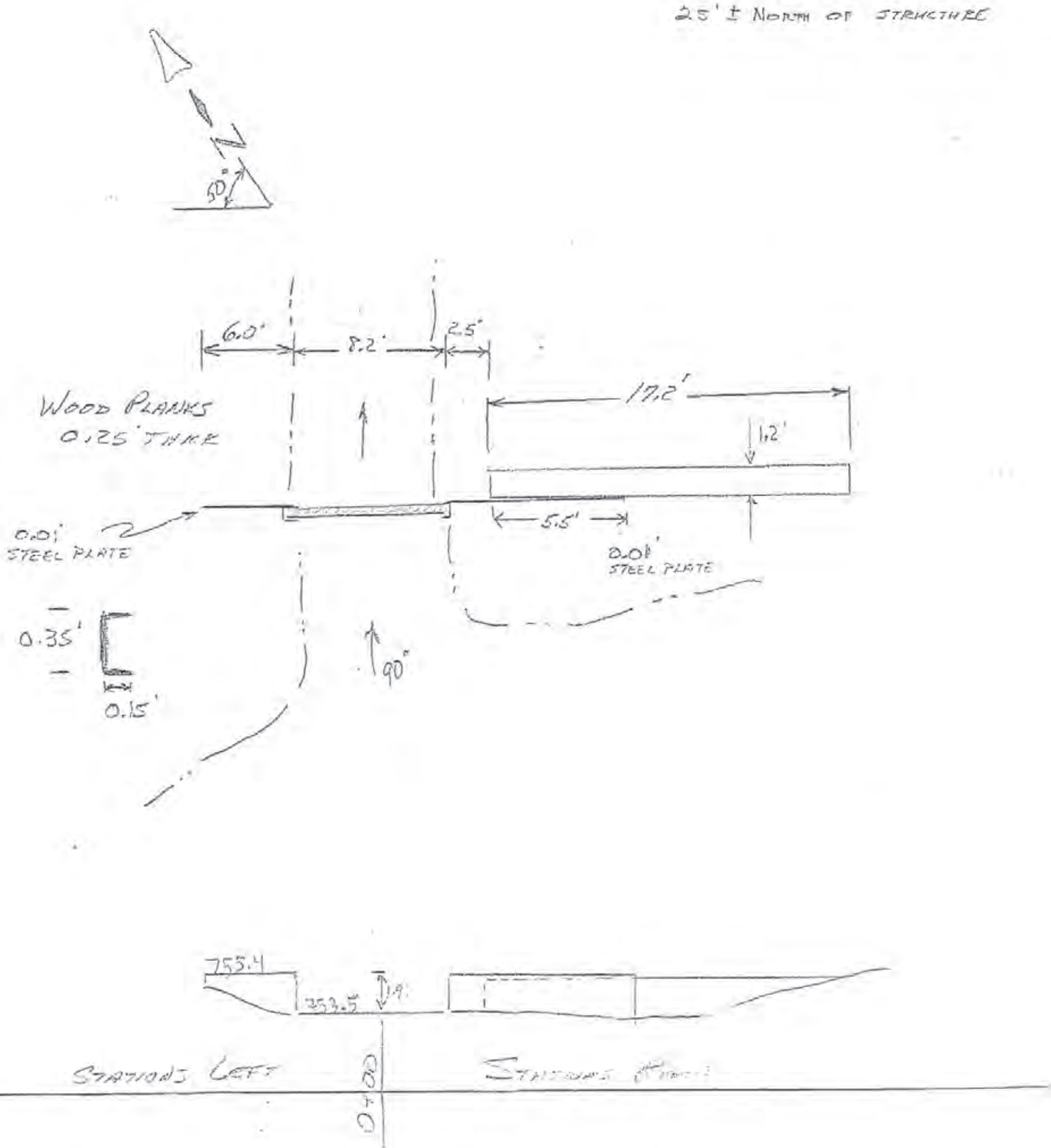
Page ______ of ______

FIELD REPORT DATE: 23 MAY 94 JN: 23-0135.00 INITIALS LC

STRUCTURE # 1000A

SALEM BRANCH OF BRIGHTON CREEK

DP-1000A IS IN A TREE
25' ± NORTH OF STRUCTURE



STRUCTURE 1000 A

Station	+	HI	−	Elev.	1000 A
BP 41	5.50	762.92			BP 41 757.42
0+00			9.50	753.42	Top of Wood overflow Plank
0+00			9.75	753.2	Ground @ Inlet side of Plank
0+00			11.40	751.5	" " Outlet " " "
0+04.2L			9.40	753.5	Plank
0+04.2L			7.50	~~775.4~~ 755.4 ESS	Top of Steel Plate
0+07.2L			8.20	754.7	Ground
0+10.2L			7.60	755.3	Plate @ Ground
0+20 L			7.30	755.6	Ground
0+30L			6.45	756.5	
0+40L			6.35	756.6	
0+50L			6.10	756.8	
0+04.1R			9.40	753.5	Wood Beam
0+04.1R			7.60	755.3	Top of Steel Plate
0+06.6R			10.10	752.8	Ground @ Concrete Headwall
0+06.6R			8.00	754.9	Top of Concrete Headwall
0+12.1R			7.75	755.2	Top End of Steel Plate
0+12.1R			8.90	754.0	Ground End
0+23.8R			7.90	755.0	End of Concrete Headwall @ Ground
0+34R			6.80	756.1	100° Azimuth Up Bank To
0+44R			5.40	757.5	Gravel Road + Ground Shots
0+54R			4.30	758.6	
0+64R			4.30	758.6	
			9.28	753.6	Water Surface

1000 A

143

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
RECORD OF VERTICAL CONTROL STATION

SECTION 11, TOWNSHIP 1 N, RANGE 20

KENOSHA COUNTY

BENCH MARK NO. DP-1000A ELEVATION 757.299'

REFERENCE BENCH MARK NO. REF-1000A ELEVATION 758.616

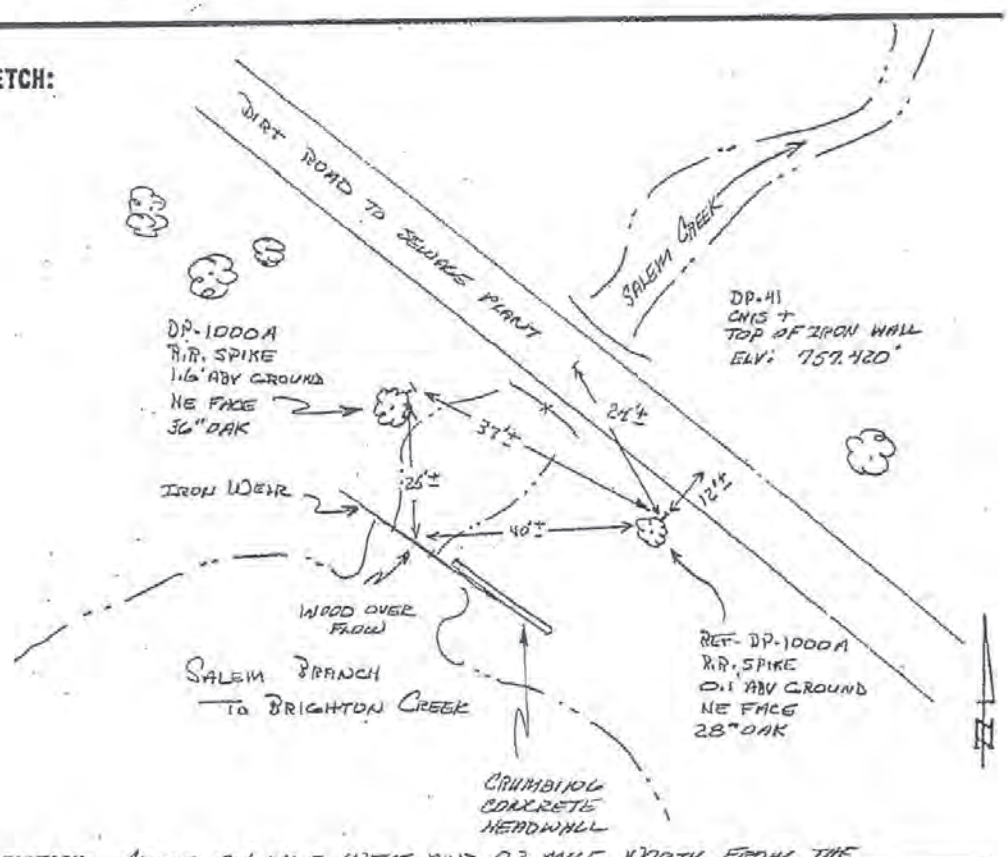
SET BY: OWEN AYRES & ASSOCIATES, ENGINEERS, MADISON, WISCONSIN

VERTICAL DATUM: MEAN SEA LEVEL, 1929 ADJUSTMENT

VERTICAL CONTROL ACCURACY: THIRD ORDER

DATE OF SURVEY: MARCH 1994 STRUCTURE #1000A

LOCATION SKETCH:



DETAILED DESCRIPTION: ABOUT 0.1 MILE WEST AND 0.2 MILE NORTH FROM THE EAST 1/4 CORNER OF SECTION 11, T1N, R20E. ABOUT 300' NW FROM THE OLD SEWAGE PLANT.

BOOK 1 – Pg 28

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
RECORD OF VERTICAL CONTROL STATION

SECTION 11, TOWNSHIP 1 N, RANGE 20 E

Kenosha COUNTY

BENCH MARK NO. D.P. 41 ELEVATION 757.420'

REFERENCE BENCH MARK NO. R.P. 41 ELEVATION 758.174'

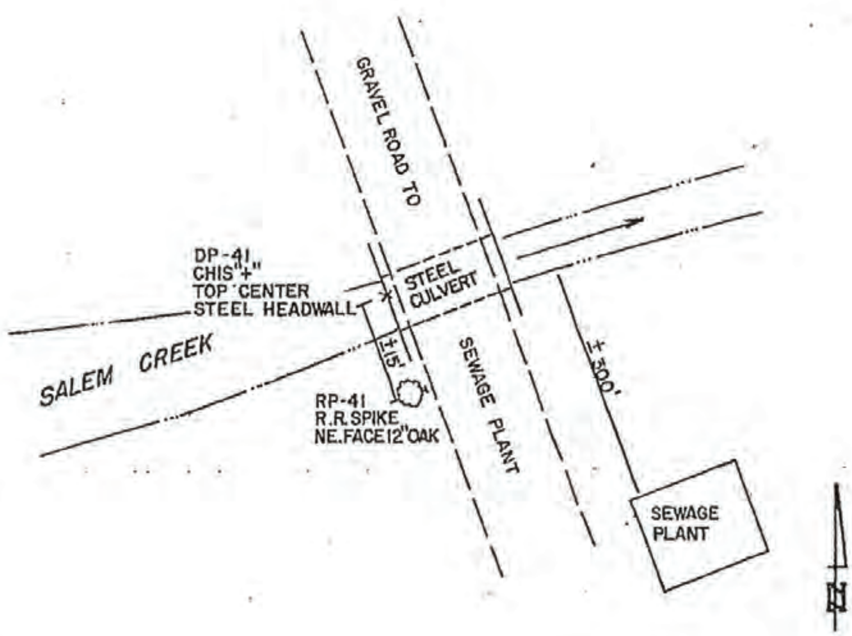
SET BY: ALSTER & ASSOCIATES, INC., ENGINEERS, MADISON, WISCONSIN

VERTICAL DATUM: MEAN SEA LEVEL, 1929 ADJUSTMENT

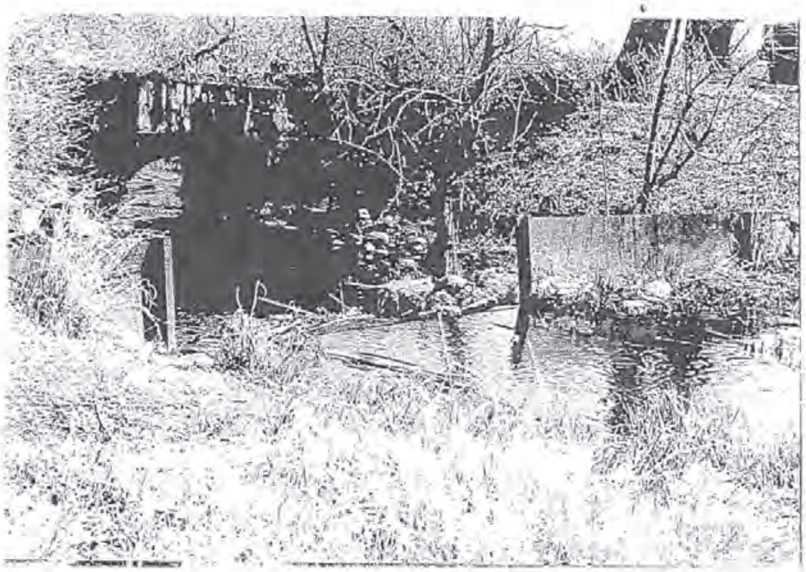
VERTICAL CONTROL ACCURACY:

DATE OF SURVEY: January 1977

LOCATION SKETCH:



DETAILED DESCRIPTION: About 0.1 mile west and 0.2 mile north of the east one quarter corner of section 11, T 1 N, R 20 E; on structure #1000.



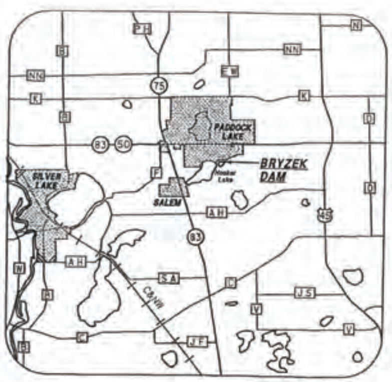
#1000 A

(This page intentionally left blank)

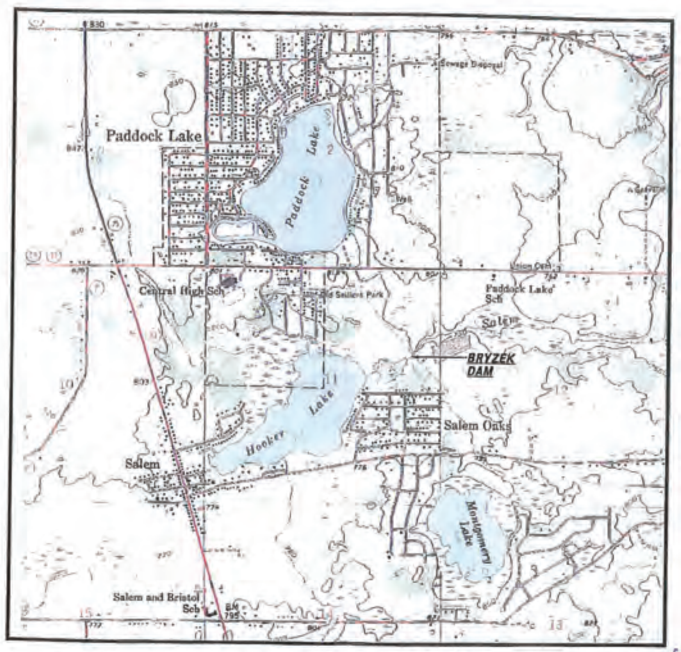
BRYZEK DAM – RECORD DOCUMENTS

HOOKER LAKE
KENOSHA COUNTY, WISCONSIN
TOWNSHIP 1 NORTH – RANGE 20 EAST

WISCONSIN MAP



PROJECT LOCATION MAP



U.S.G.S. QUADRANGLE MAP

DRAWING INDEX:

10331-T1 Title Sheet, Drawing Index and Notes

10331-01 Project Site Plan

10331-02 Profile, Plan and Section of Dam

BENCHMARK INFORMATION:

MEANDER CORNER EAST OF CENTER OF SECTION 11, T1N, R20E, KENOSHA COUNTY, WISCONSIN. MEANDER CORNER IS A CONCRETE MONUMENT WITH A BRASS CAP, 0.1'BELOW GROUND LEVEL, LOCATED AT SOUTH SIDE OF 6" FENCE POST BRACED TO THE EAST. POINT FALLS ON THE NORTH LINE OF LOT 2, BLOCK 16 OF SALEM OAKS SUBDIVISION. ELEVATION OF CAP IS 754.96 FEET REFERENCED TO NGVD 1929.

EAST QUARTER CORNER OF SECTION 11, T1N, R20E, KENOSHA COUNTY, WISCONSIN. QUARTER CORNER IS A CONCRETE MONUMENT WITH A BRASS CAP, 0.5'BELOW GROUND LEVEL, LOCATED AT THE NE CORNER OF THE SALEM OAKS SUBDIVISION. ELEVATION OF CAP IS 767.67 FEET REFERENCED TO NGVD 1929.

RAILROAD SPIKE SET IN 36" DIAMETER OAK LOCATED EAST OF EAST END OF BRYZEK DAM AND WEST OF DIRT ROAD. ELEVATION OF TOP OF SPIKE IS 759.64 FEET REFERENCED TO NGVD 1929.

P.K. NAIL SET IN TOP OF EAST ABUTMENT OF BRYZEK DAM. ELEVATION OF POINT IS 755.29 FEET REFERENCED TO NGVD 1929.

P.K. NAIL SET IN TOP OF WEST ABUTMENT OF BRYZEK DAM. ELEVATION OF POINT IS 755.26 FEET REFERENCED TO NGVD 1929.

WISCONSIN
WARREN S. HAYDEN
31978
Madison, WI
PROFESSIONAL ENGINEER
Warren S. Hayden
5/27/05

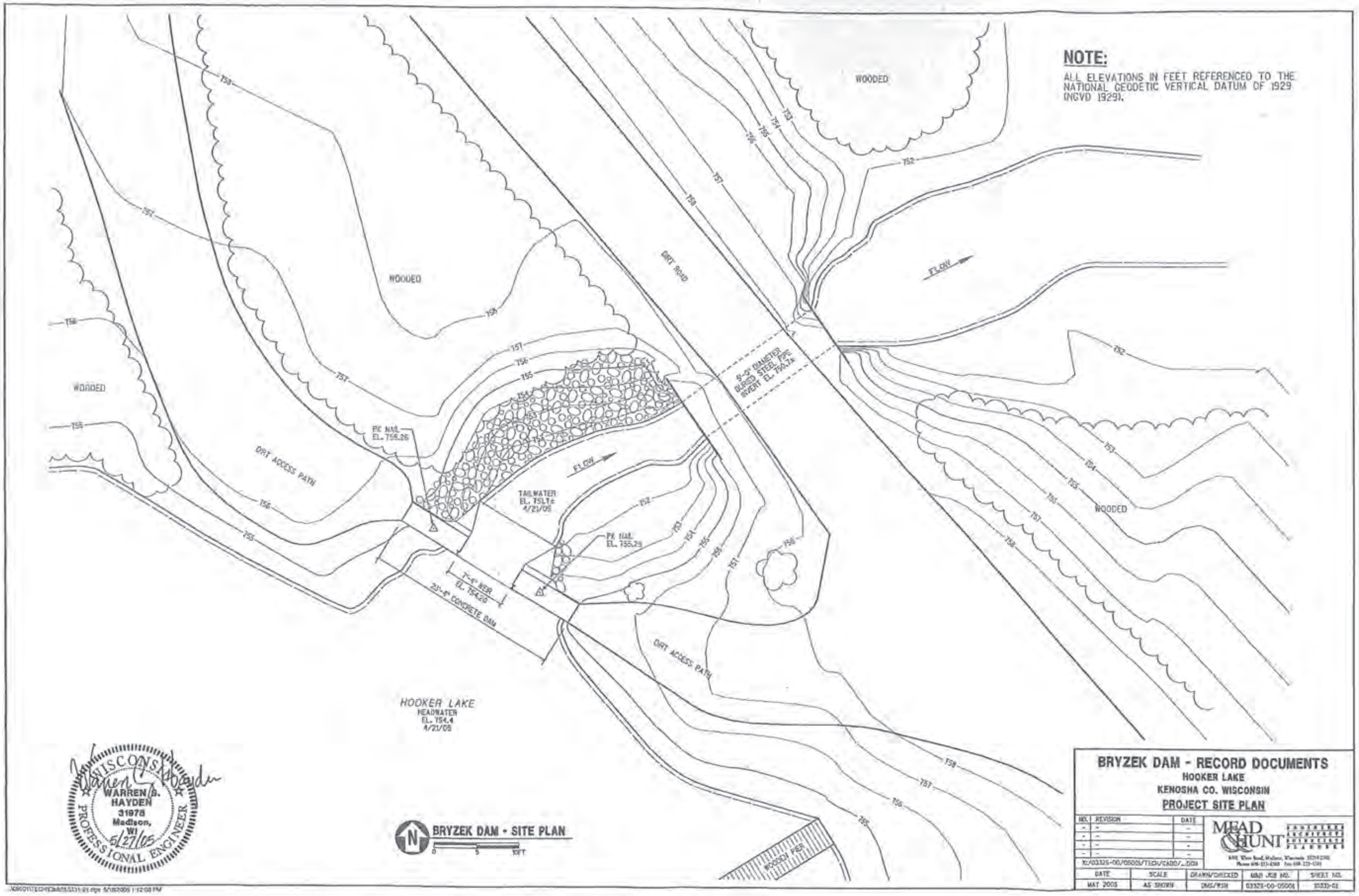
BRYZEK DAM - RECORD DOCUMENTS
HOOKER LAKE
KENOSHA CO. WISCONSIN
TITLE SHEET, DRAWING INDEX AND NOTES

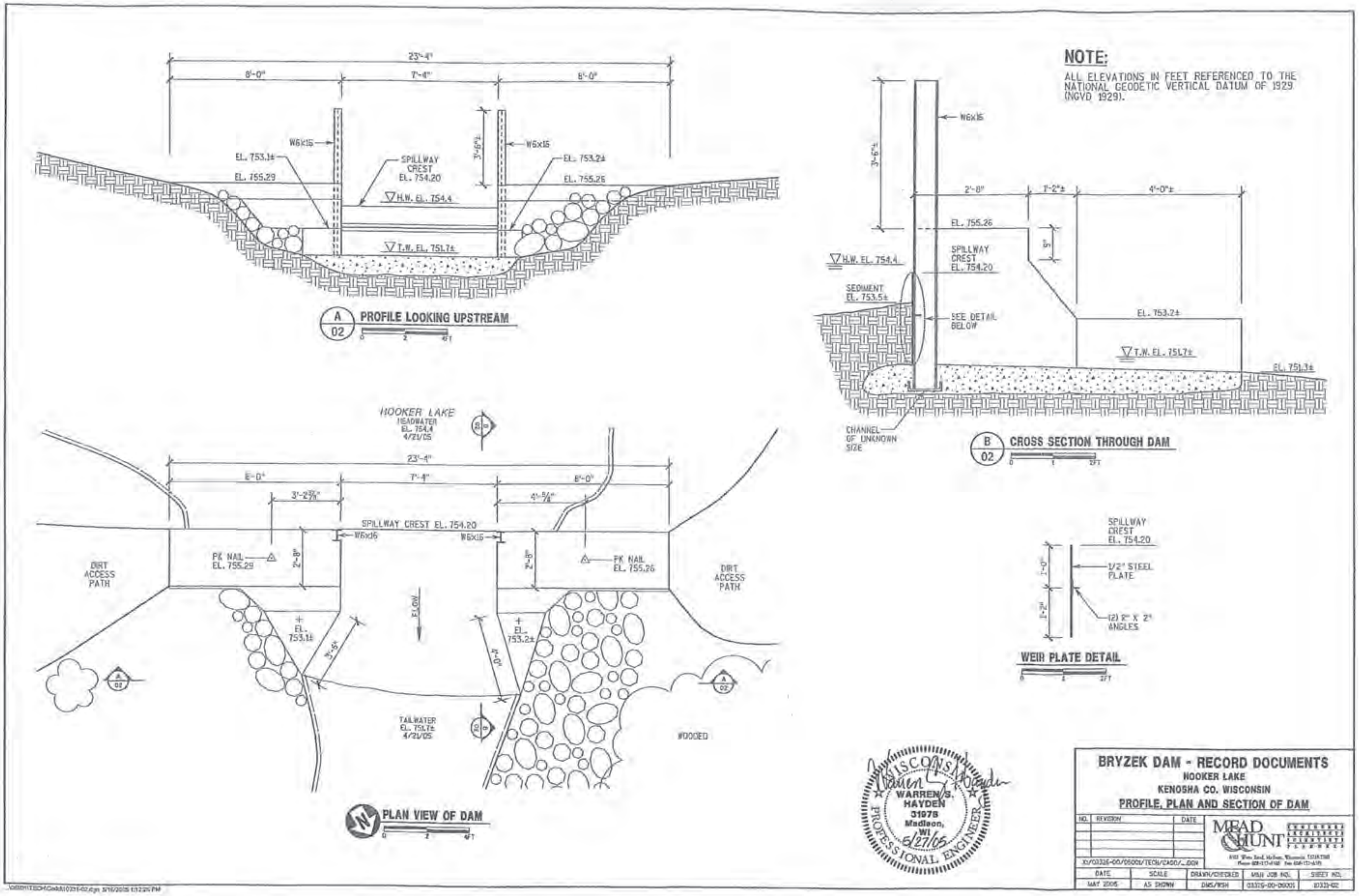
NO.	REVISION	DATE
-	-	-
-	-	-
-	-	-
-	-	-

X:/03326-00/05001/TECH/CADD/...DGN

MEAD & HUNT

DATE	SCALE	DRAWN/CHECKED	M&H JOB NO.	SHEET NO.
MAY 2005	AS SHOWN	DMS/WSH	03326-00-05001	10331-T1


NOTE:
ALL ELEVATIONS IN FEET REFERENCED TO THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD 1929).
WOODED
WOODED
WOODED
WOODED
DIRT ROAD
FLOW
FLOW
5'-0" DIAMETER BURIED STEEL PIPE INVERT EL. 750.7±
PK NAIL EL. 755.26
PK NAIL EL. 755.29
TAILWATER EL. 751.1± 4/21/05
DIRT ACCESS PATH
DIRT ACCESS PATH
7'-4" WEIR EL. 754.20
23'-4" CONCRETE DAM
HOOKER LAKE
HEADWATER EL. 754.4 4/21/05
WOODEN PIER
WISCONSIN
WARREN B. HAYDEN
31978
Madison, WI
6/27/05
PROFESSIONAL ENGINEER
BRYZEK DAM - SITE PLAN
BRYZEK DAM - RECORD DOCUMENTS
HOOKER LAKE
KENOSHA CO. WISCONSIN
PROJECT SITE PLAN
NO. REVISION DATE
MEAD & HUNT
DATE: MAY 2005
SCALE: AS SHOWN
DRAWN/CHECKED: DMS/WSH
M&H JOB NO.: 03329-00-05001
SHEET NO.: 10331-01


NOTE:
ALL ELEVATIONS IN FEET REFERENCED TO THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD 1929).
23'-4"
8'-0"
7'-4"
8'-0"
W6x16
EL. 753.1±
EL. 755.29
SPILLWAY CREST EL. 754.20
H.W. EL. 754.4
T.W. EL. 751.7±
EL. 753.2±
EL. 755.26
A 02 PROFILE LOOKING UPSTREAM
HOOKER LAKE
HEADWATER EL. 754.4 4/21/05
3'-2"
4'-5/8"
SPILLWAY CREST EL. 754.20
PK NAIL EL. 755.29
PK NAIL EL. 755.26
DIRT ACCESS PATH
2'-8"
FLOW
EL. 753.1±
EL. 753.2±
TAILWATER EL. 751.7± 4/21/05
WOODED
PLAN VIEW OF DAM
3'-6"±
2'-8"
1'-2"±
4'-0"±
EL. 755.26
SPILLWAY CREST EL. 754.20
H.W. EL. 754.4
SEDIMENT EL. 753.5±
SEE DETAIL BELOW
EL. 753.2±
T.W. EL. 751.7±
EL. 751.3±
CHANNEL OF UNKNOWN SIZE
B 02 CROSS SECTION THROUGH DAM
SPILLWAY CREST EL. 754.20
1/2" STEEL PLATE
(2) 2" X 2" ANGLES
WEIR PLATE DETAIL
WISCONSIN WARREN S. HAYDEN 31978 Madison, WI 5/27/05 PROFESSIONAL ENGINEER
BRYZEK DAM - RECORD DOCUMENTS
HOOKER LAKE
KENOSHA CO. WISCONSIN
PROFILE, PLAN AND SECTION OF DAM
MEAD & HUNT
DATE MAY 2005
SCALE AS SHOWN
DRAWN/CHECKED DMS/WSH
M&H JOB NO. 03326-00-05001

Detailed Information for Dam HOOKER LAKE

Dam Key Seq No	1269	Field File No	30.02
Size	SMALL	NID	10259
Popular Name	CARL BRYZEK	Former Name	

Location

County	Kenosha		
Latitude	42.561602	Longitude	-88.095638

Permitted TRS
QQQ:NE QQ:SW Q:NE - Sec:11 T:01N R:20

Located TRS
QQ:SW Q:NE - Sec:11 T:1N R:20

Contacts

Owner		**Alternate**	
Organization	Carl Bryzek Farm, LLC	Organization	BS Machine
Name	Frank Bryzek	Name	Steve Bryzek

Waterbody

Drainage Basin (sq mi) 2.00

Stream		**Impoundment**	
Local Name	OUTLET HOOKER LAKE	Local Name	HOOKER LAKE
Row and Official Name		Row and Official Name	
Navigable?	non-navigable	Size (acres)	87.00
When was navigability determined?		Maximum Depth (ft)	24.00

Regulatory / Inspection

NR 333 Years	EAP: IOM: HYD: STAB:2005 ZONE:		
Auth. Approval Desc	WP 413	Regulatory Agency	WIDNR
Hazard Rating	None	Estimated Hazard Rating	Low
Ferc. No		Exempt Issue Date	
Ferc. Inspection Year		License Expiration Year	

Construction Characteristics

Normal Storage (acre-ft)	90.00	Max Storage (acre-ft)	180.00
Structural Height (ft)	3.00	Hydraulic Height (ft)	1.00
Crest Length (ft)	0.00	Spillway Type	
Discharge Through Principal Spillway (cfs)	40.00	Width/Diameter of Principal Spillway (ft)	12.00
Total Discharge Through All Spillways (cfs)	40.00	Total Width/Diameter of All Spillways (ft)	
Core Type		Position	
Foundation Type		Foundation Certainty	
Purposes		Structural Types	

Detailed Information for Dam HOOKER LAKE

Water Levels

	Normal		Winter	
	MSL	Datum	MSL	Datum
Minimum				
Normal				
Maximum				

Construction History

Designer	Construction Firm	Complete Year
		1931
		2002

Outlet Gates

No data found.

Inspection History

Inspection Date	Inspection Report Date	DNR Engineer Initials	Inspection Type
5/20/2009			LEVEL
8/23/2007	8/23/2007	TLM	CHECK
1/20/2003		MJB	OTHER
7/21/1969			
7/21/1969	8/6/1969	XXX	LEVEL
4/2/1965	4/6/1965	XXX	LEVEL
6/14/1961		XXX	GEN
6/14/1961	6/27/1961	XXX	LEVEL
6/2/1947		XXX	GEN
6/2/1947	6/4/1947	XXX	LEVEL
7/9/1941	4/16/1942	XXX	LEVEL
6/29/1931	6/30/1931	XXX	LEVEL
9/13/1929	9/23/1929	XXX	GEN
8/28/1929		XXX	OTHER

Followups

Type of Followup	Due Date	Extension Date	Completion Date
OTHER	12/15/2009		10/28/2009
OTHER	3/1/2009		
OTHER	3/1/2009		5/20/2009

Approvals

Approval Month	Approval Year	Docket ID	Approval Type	DNR Engineer Initials
0	2005	IP-SE-2005-30-730RP	PERMIT TO CONSTRUCT-NAV STREAM; STAT 31.06	WDS
9	2005	IP-SE-2005-30-730RP	STABILITY ANALYSIS	WDS
1	1931	WP-413	LEVELS; STAT 31.02	XXX

Orders

Issue Date	Complied On Date	Docket ID	Order Description
11/8/2010		IP-SE-2010-30-04701	Modify dam, obtain easements, or remove

Inspection Schedule

No data found.

Source: Wisconsin Department of Natural Resources.

Survey Results
Bryzek and Hooker Lake Dams (Field File # 30.02)

Date of Survey: May 20, 2009

Dennis Siegrist - WDOT Surveyor Senior
Kurt Immler – WDOT Engineering Technician Transportation
Brent Binder, PE - WDNR Water Management Engineer
Tanya Meyer - WDNR Water Management Engineer

Background

The purpose of the survey was to assess potential discrepancies between the former and reconstructed Bryzek Dam. Our records indicate it was reconstructed in December, 2002. Over the past two years, residents have contacted the Department regarding high water levels and flooding at Hooker Lake. The Bryzek Dam could contribute to higher water levels on lakefront properties if it was not reconstructed to match historic dimensions.

The Department reviewed and approved Mr. Bryzek's after-the-fact application on September 30, 2005. During the plan approval process, it was indicated the dam was reconstructed in-kind. This means the spillway of the dam should have been built to the same width, elevation, and capacity as the former structure. The new dam would have maintained historical water levels on the impoundment because the spillway dimensions were unchanged. However, it appears the spillway dimensions are not the same.

The Department acquired additional data that puts into question information provided during the permit process. The Department acquired survey data for the former dam and compared it to dimensions for the reconstructed dam. From the comparison, it appears the reconstructed dam has a decreased spillway capacity. A decreased spillway capacity would allow less flow to pass through the dam during flood events, causing an increase in lake levels.

Summary of Findings

Bryzek Dam

Benchmarks were recorded in 2005, 1994, and 1977. Dimensions and elevations for the reconstructed dam were recorded in 2005. Dimensions and elevations for the former dam were recorded on May 23, 1994.

All benchmark and dam elevations surveyed on May 20, 2009 correlate to these recorded elevations. **Results indicate that the Bryzek Dam was reconstructed with smaller spillway dimensions:**

Survey Results
Bryzek and Hooker Lake Dams (Field File # 30.02)

Summary of Findings (continued)

Bryzek Dam

	Reconstructed Bryzek Dam [1]	Former Bryzek Dam [2]
Width (feet)	7.3	8.2
Elevation (feet) [3]	754.2	753.5

Hooker Lake Dam

The reconstructed Bryzek Dam has a higher spillway elevation than the Hooker Lake Dam:

	Reconstructed Bryzek Dam	Hooker Lake Dam
Elevation (feet) [3]	754.2	753.4

Removing some cattails might provide relief from higher lake levels during small storm events. However, a SEWRPC report [4] indicates the Hooker Lake Dam is not the controlling structure during the 10, 50, and 100-year flood events. Instead, it indicates that the Bryzek Dam creates the backwater effect.

Corrective Action for the Bryzek Dam

Permits and plan approvals under Chapter 31, Wisconsin Statutes, require flowage easements or appropriate legal arrangements from all property owners affected by increases in flood elevations up to the 100-year flood. In lieu of flowage easements, another option would be to modify the dam to achieve former spillway dimensions and to restore historic water levels. The Department would need to issue a plan approval prior to any modifications or design changes.

Survey Results
Bryzek and Hooker Lake Dams (Field File # 30.02)

Survey Data

Benchmarks

Benchmark	Description	Recorded Elevation [3]	Surveyed Elevation [3] (05/20/09)	Comparison
DP-1000A [5]	Railroad spike 1.6 ft above ground; NE face of 36" dia oak	757.299	757.30	Reference Point
REF DP-1000A [5]	Railroad spike 0.1 ft above ground; NE face of 28" dia oak	758.616	758.58	-0.04
#1 PK nail [1]	PK nail on left abutment of Bryzek Dam	755.26	755.265	0.00
#2 PK nail [1]	PK nail on right abutment of Bryzek Dam	755.29	755.29	0.00
DP-41 [6]	Chiseled + located on top of iron wall	757.420	757.41	-0.01

Bryzek Dam

Station	Elevation [3]	Description [7]
1	755.28	Right Concrete Abutment (Right)
2	755.30	Right Concrete Abutment (Left)
3	754.22 [8]	Spillway Crest (Right)
4	753.25	Flange (Right)
5	752.03	Downstream Concrete Sill (Right)
6	754.39	Water Level (Pier)
7	755.20	Left Concrete Abutment (Left)
8	755.28	Left Concrete Abutment (Right)
9	754.24 [8]	Spillway Crest (Left)
10	753.28	Flange (Left)
11	751.99	Downstream Concrete Sill (Left)
12	749.38	Culvert Invert (Upstream)
13	751.97	Water Level (Upstream of Road Culvert)
14	750.40	Creekbed (Upstream of Road Culvert)
15	749.58	Culvert Invert (Downstream)
16	751.90	Water Level (Downstream of Road Culvert)
17	751.08	Creekbed (Downstream of Road Culvert)

Survey Results
Bryzek and Hooker Lake Dams (Field File # 30.02)

Hooker Lake Dam

Station	Elevation [3]	Description [7]
1	754.95	Left Abutment
2	755.06	Top of Sheet Piling (Left)
3	753.39	Concrete Spillway (Left)
4	753.22	Concrete Spillway (Center)
5	753.44	Concrete Spillway (Right)
6	754.51	Right Abutment
7	754.80	Top of Sheet Piling (Right)
8	754.80	Water Level
9	752.64	Center Channel Shot (Bed) - approx 10 ft d/s of dam
10	752.27	Center Channel Shot (Bed)
11	754.40	Center Channel Shot (Water Level)
12	755.24	Embankment (Edge of Cattails)
13	756.11	Embankment Edge

1 Elevations, dimensions, and benchmarks obtained from *Evaluation Report - Bryzek Dam*, Mead & Hunt, May 2005.

2 Elevations and dimensions obtained from May 23, 1994 survey used in preparing the Southeastern Wisconsin Regional Planning Commission (SEWRPC) Planning Report No. 44, *A Comprehensive Plan for the Des Plaines River Watershed*, June 2003.

3 All elevations in feet referenced to the National Geodetic Vertical Datum of 1929 (NGVD29)

4 Table F-18, Southeastern Wisconsin Regional Planning Commission (SEWRPC) Planning Report No. 44, *A Comprehensive Plan for the Des Plaines River Watershed*, June 2003.

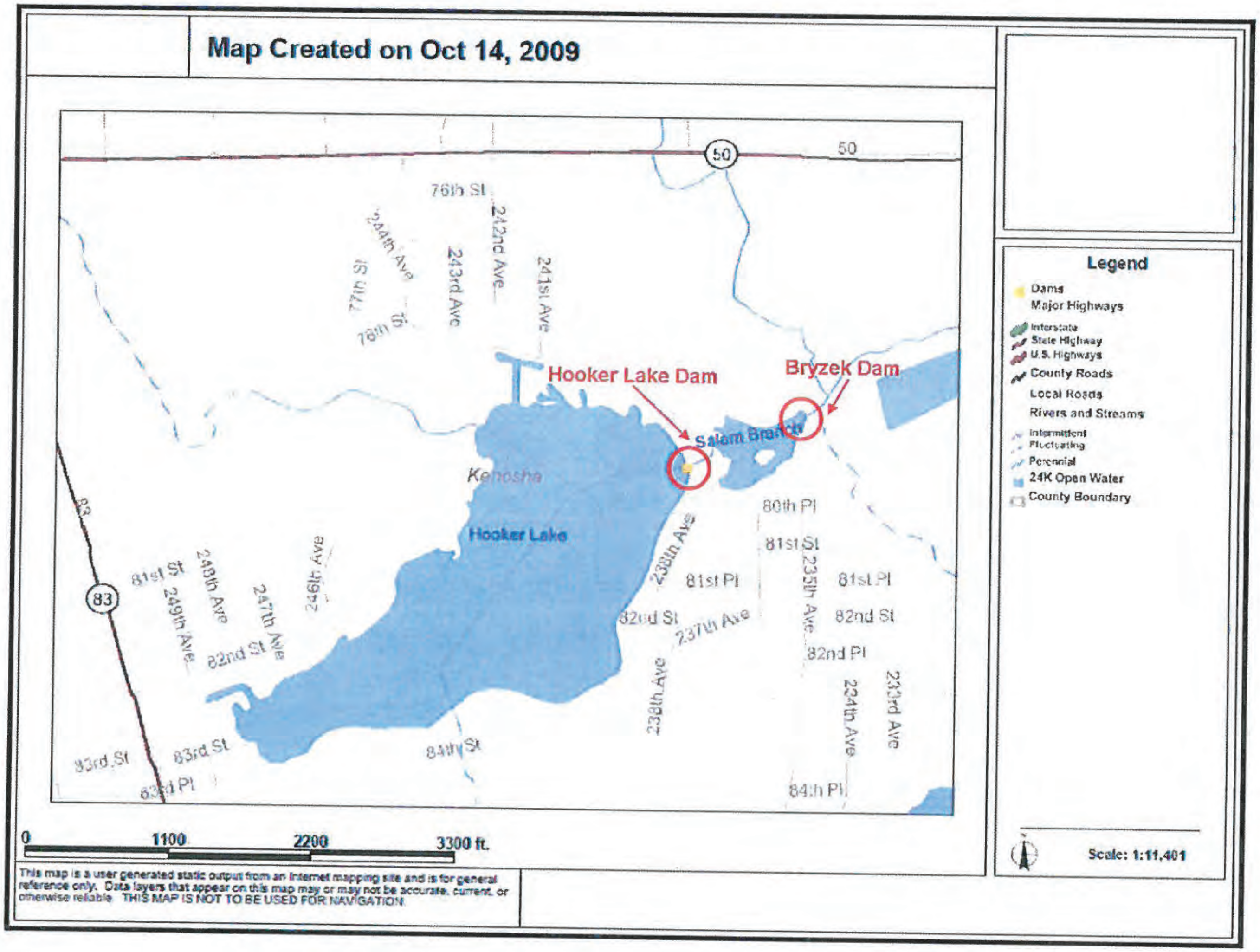
5 Southeastern Wisconsin Regional Planning Commission Record of Vertical Control Station, Structure #1000A, March 1994

6 Southeastern Wisconsin Regional Planning Commission Record of Vertical Control Station, Structure #1000, January 1977

7 Note that right and left are referenced while looking downstream

8 Elevation correlates with record documents in 2005 Mead and Hunt Evaluation Report

Survey Results
Bryzek and Hooker Lake Dams (Field File # 30.02)



Survey Results - Photo Log
Bryzek and Hooker Lake Dams (Field File # 30.02)

Photo #1 – Bryzek Dam
(May 20, 2009)

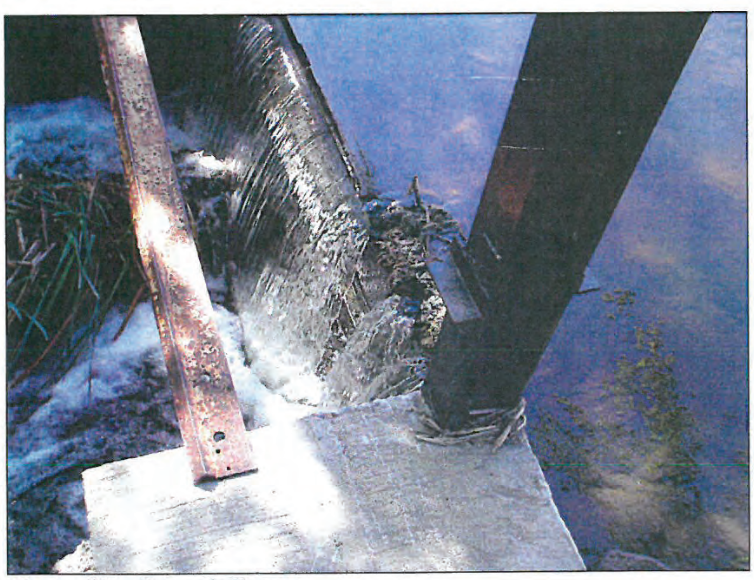


Photo #2 – Bryzek Dam
(May 20, 2009)

Survey Results - Photo Log
Bryzek and Hooker Lake Dams (Field File # 30.02)

Photo #3 – Benchmark REF DP-1000A (railroad spike)
(May 20, 2009)

Photo #4 – Benchmark REF DP-1000A (railroad spike)
(May 20, 2009)

Photo #5 – Benchmark DP-41 (iron wall)
(May 20, 2009)

Survey Results - Photo Log
Bryzek and Hooker Lake Dams (Field File # 30.02)

Photo #6 – Benchmark DP-1000A (railroad spike)
(May 20, 2009)

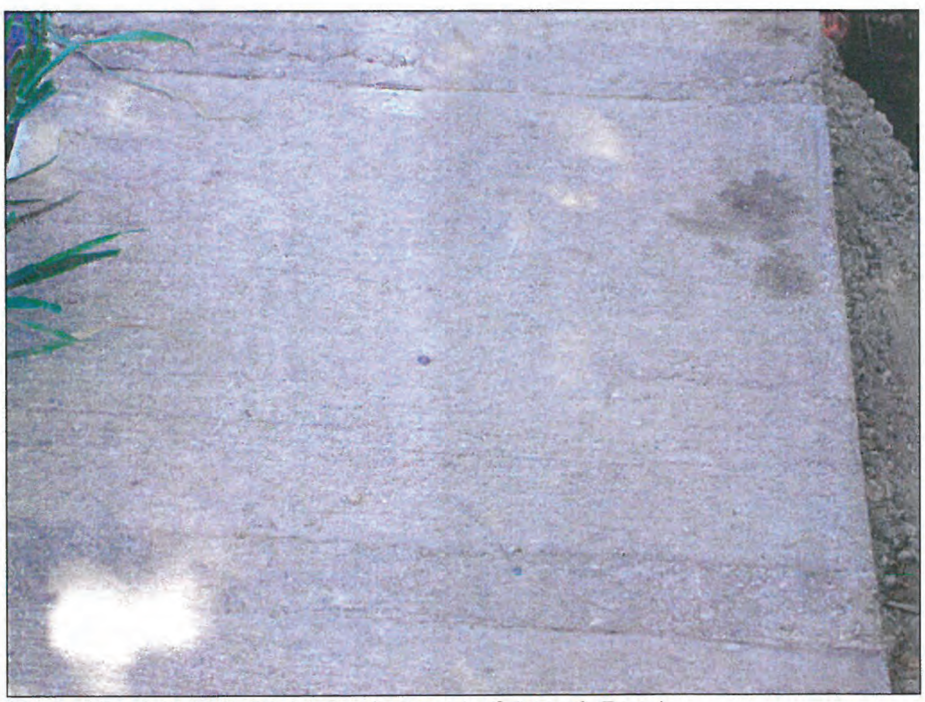


Photo #7 – PK Nail #2 (right abutment of Bryzek Dam)
(May 20, 2009)

Survey Results - Photo Log
Bryzek and Hooker Lake Dams (Field File # 30.02)

Photo #8 – Hooker Lake Dam
(May 20, 2009)

Photo #9 – Hooker Lake Dam (deteriorated left abutment)
(May 20, 2009)

Survey Results - Photo Log
Bryzek and Hooker Lake Dams (Field File # 30.02)

Photo #10 – Hooker Lake Dam (deteriorated spillway)
(May 20, 2009)

Photo #11 – Hooker Lake Dam (deteriorated spillway)
(May 20, 2009)

Photo #12 – Cattails (at dam looking downstream)
(May 20, 2009)

Photo #13 – Cattails
(May 20, 2009)

State of Wisconsin
DEPARTMENT OF NATURAL RESOURCES
Southeast Region
141 NW BARSTOW
Waukesha WI 53188

Scott Walker, Governor
Cathy Stepp, Secretary
Telephone 262-574-2188
Toll Free 1-888-936-7463
TTY Access via relay - 711

IP-SE-2010-30-04701

Certified Mail, Return Receipt Requested

May 18, 2016

Frank Bryzek
Family Agent (President)
Carl Bryzek Farm, LLC
8011 288th Avenue Lot W
Salem WI 53168

Expedited delivery via email: paladin09@peoplepc.com

Subject: Time Extension - Order to Reconstruct or Abandon Hooker Lake (Bryzek) Dam, Field File 30.02, Kenosha County

Dear Mr. Bryzek:

On November 8, 2010, the Department sent Carl Bryzek Farm, LLC an Administrative Order to Reconstruct or Abandon Hooker Lake (Bryzek) Dam. The Order was required to protect health, safety and property concerns, and to ensure the dam meets acceptable design standards. The Order established a deadline for restoring the historic spillway elevation for the dam. It also provided an option for obtaining flowage easements or abandoning/removing the dam in lieu of restoring the spillway elevation. A copy of the Order is attached for your reference.

It appears there was a misunderstanding and it was thought that the matter had been resolved after a portion of the steel weir was removed from the spillway. With your permission, the Department conducted a survey on April 6, 2016 to verify the steel weir spillway elevations of the dam. Note that elevations are in feet using National Geodetic Vertical Datum of 1929.

<u>2016 Top of steel weir spillway</u>	754.2 ft.
<u>2009 Top of steel weir spillway</u>	754.2 ft.
<u>1994 Top of steel weir spillway</u>	753.5 ft.
<u>1977 Top of concrete spillway</u>	753.4 ft.

Even with the adjustment made to the steel weir, elevations are still higher than the historic spillway elevation. To account for this the Department is extending the deadlines for the Hooker Lake (Bryzek) Dam Administrative Order, as follows:

1. The owner and/or agent of the Hooker Lake Dam shall restore the historic spillway elevation for Hooker Lake Dam no sooner than July 1, 2016 and no later August 1, 2016, by removing 0.7 feet from the top of the steel weir.

2. The owner and/or agent shall schedule a site visit with the Department to confirm the planned modifications have been made and to verify elevations. The site visit should be scheduled by August 1, 2016 and occur by September 1, 2016.

3. In lieu of provision #1, the owner and/or agent of the Hooker Lake Dam shall petition to raise and enlarge the dam by submitting an application to the Department by August 1, 2016. Flowage easements or appropriate legal arrangements are required from all property owners with lands that are affected by increases in water levels.

4. In lieu of provisions #1 and #3, the owner and/or agent of the Hooker Lake Dam shall submit an application for a permit to abandon the dam pursuant to section 31.185, Wisconsin Statutes, by August 1, 2016. If an application is submitted, the owner and/or agent of the Hooker Lake Dam shall remain responsible for the dam until a permit to abandon the dam is issued and all the conditions of that permit have been met.

5. The owner of the Hooker Lake Dam shall provide the Department written notification of its intent to modify, raise and enlarge, or abandon the dam, by **July 1, 2016**.

S. 710.11, Wis. Stats. states that dam owners may not accept transfer of ownership of a specific piece of land on which a dam is physically located unless they comply with S. 31.14(4), Wis. Stats. which requires proof of financial responsibility to repair, operate and maintain a dam for at least a 10 year period. S. 31.185, Wis. Stats. requires dam owners to get a permit from the Department before they transfer a dam to a new owner.

The transfer process requires an inspection by a professional engineer, a plan to complete any necessary repairs and proof of financial responsibility as mentioned above. Proof of ownership for all portions of the dam or access easements need to be included in the transfer of dam ownership application. Once the transfer is approved, the permit needs to be recorded with the Register of Deeds. The conditions of the Order for Hooker Lake (Bryzek) Dam would also need to be met as part of a transfer of dam ownership.

If you have any questions regarding these time extensions to the Order, please call me at (262) 574-2188, or email Nathan.Zoch@wisconsin.gov, or write to the address above. Thank you for your cooperation.

Sincerely,

Nathan Zoch
Water Management Engineer

cc: Bill Sturtevant, P.E., WDNR, State Dam Safety Engineer – GEFII, WT/3 (email)
Meg Galloway, P.E., WDNR, Dam Safety & Floodplain Section Chief, WDNR – GEF II, WT/3 (email)
Michelle Scott, WDNR, Waterway & Wetlands Field Supervisor (email)
John McEntegarts, Hooker Lake Management District (email)

(This page intentionally left blank)

Appendix F

HOOKER LAKE
AQUATIC PLANT SPECIES DETAILS

(This page intentionally left blank)

Figure A-1

RAKE FULLNESS RATINGS

Source: Wisconsin Department of Natural Resources and SEWRPC.

SOURCES OF INFORMATION:

Borman, S., Korth, R., & Temte, J. (2014). *Through the Looking Glass: A Field Guide to Aquatic Plants, Second Edition.* Stevens Point, WI, USA: Wisconsin Lakes Partnership.

Robert W. Freckman Herbarium: *http://wisplants.uwsp.edu*

Skawinski, P. M. (2014). *Aquatic Plants of the Upper Midwest: A Photographic Field Guide to Our Underwater Forests, Second Edition*. Wausau, Wisconsin, USA: Self-Published.

University of Michigan Herbarium: *http://www.michiganflora.net/home.aspx*

Ceratophyllum demersum — Coontail

Native

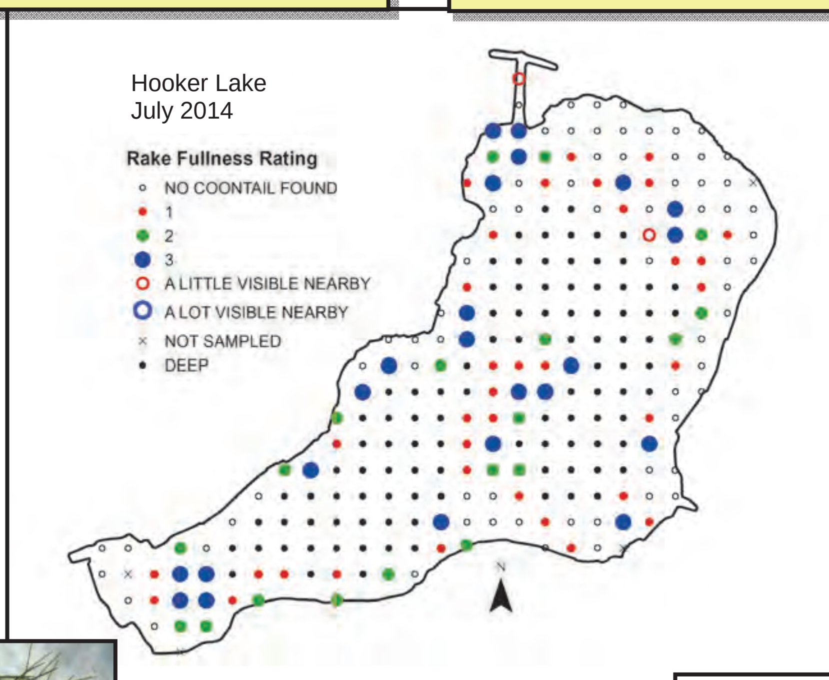
Identifying Features

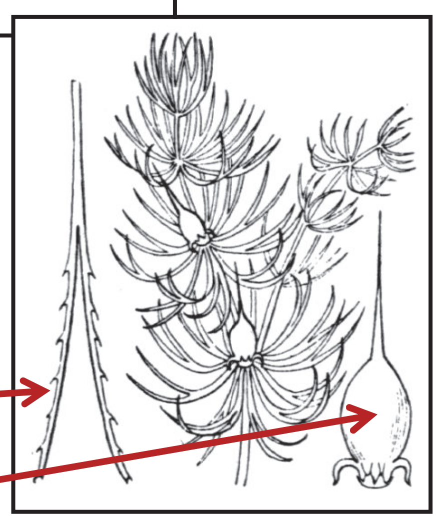
- Often bushy near tips of branches, giving the raccoon tail-like appearance ("coontail")
- Whorled leaves with one to two orders of branching and small teeth on their margins
- Flowers (rare) small and produced in leaf axils

Coontail is similar to spiny hornwort (*C. echinatum*) and muskgrass (*Chara* spp.), but spiny hornwort has some leaves with three to four orders of branching, and coontail does not produce the distinct garlic-like odor of muskgrass when crushed

Ecology

- Common in lakes and streams, both shallow and deep
- Tolerates poor water quality (high nutrients, chemical pollutants) and disturbed conditions
- Stores energy as oils, which can produce slicks on the water surface when plants decay
- Anchors to the substrate with pale, modified leaves rather than roots
- Eaten by waterfowl, turtles, carp, and muskrat





Second-Order Leaf Branching

First-Order Leaf Branching

Toothed Leaf Margins

Fruit (rare)

Chara spp. — Muskgrasses

Native

Algae (not vascular plants)

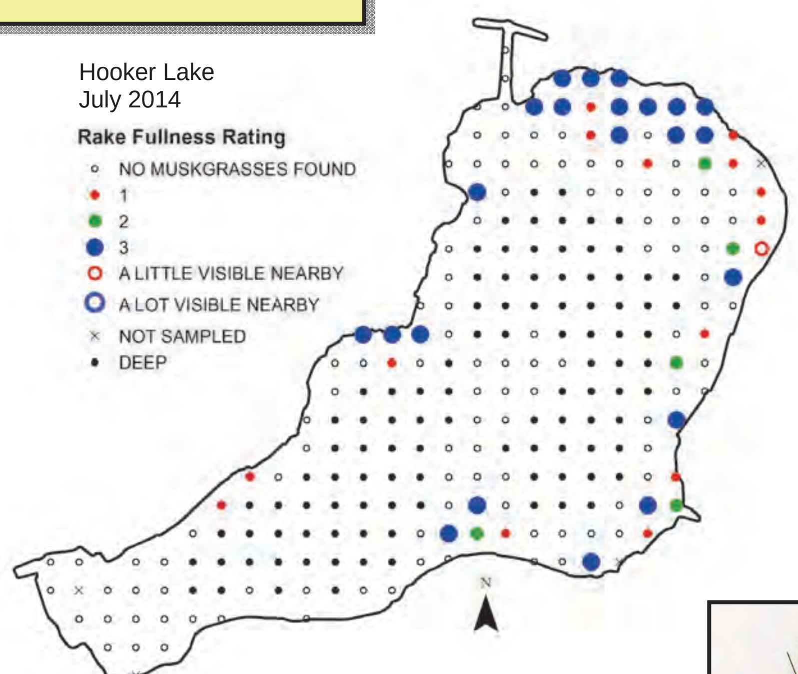
Identifying Features

- Leaf-like, ridged side branches develop in whorls of six or more
- Often encrusted with calcium carbonate, which appears white upon drying (see photo on left, below)
- Yellow reproductive structures develop along the whorled branches in summer
- Emits a garlic-like odor when crushed

Stoneworts (*Nitella* spp.) are similar large algae, but their branches are smooth rather than ridged and more delicate

Ecology

- Found in shallow or deep water over marl or silt, often growing in large colonies in hard water
- Overwinters as rhizoids (cells modified to act as roots) or fragments
- Stabilizes bottom sediments, often among the first species to colonize open areas
- Food for waterfowl and excellent habitat for small fish



Elodea canadensis — Common Waterweed

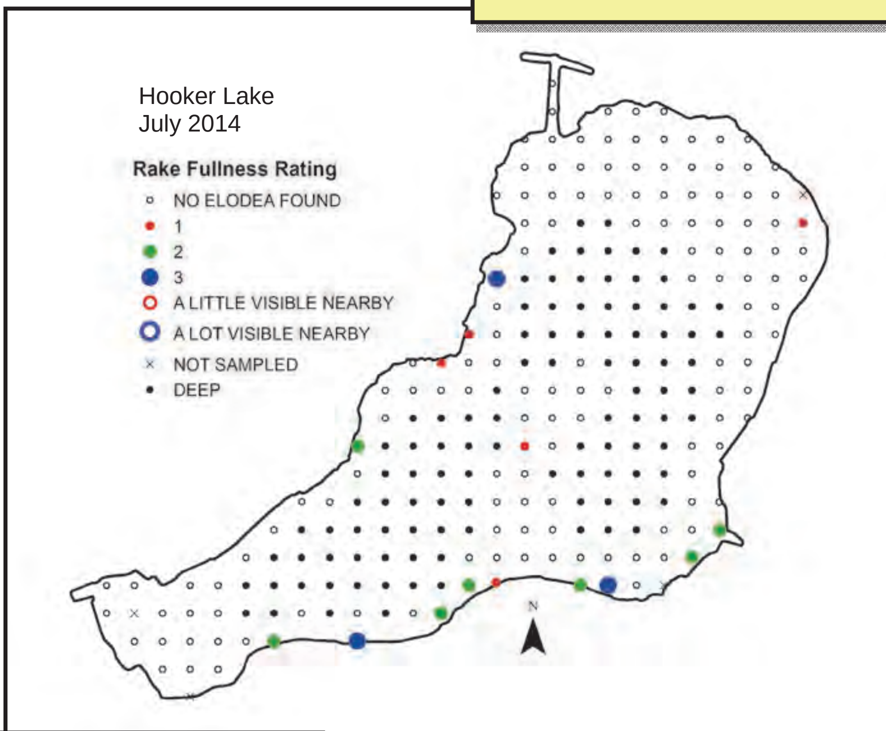
Native

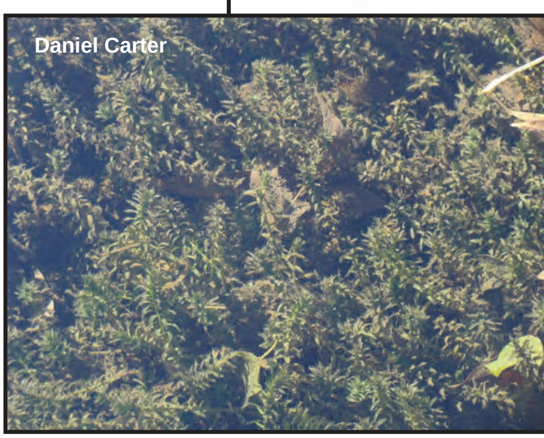
Identifying Features

- Slender stems, occasionally rooting
- Leaves lance-shaped, in whorls of three (rarely two or four), 6.0 to 17 mm long and averaging 2.0 mm wide
- When present, tiny male and female flowers on separate plants (females more common), raised to the surface on thread-like stalks

Ecology

- Found in lakes and streams over soft substrates tolerating pollution, eutrophication and disturbed conditions
- Often overwinters under the ice
- Produces seeds only rarely, spreading primarily via stem fragments
- Provides food for muskrat and waterfowl
- Habitat for fish or invertebrates, although dense stands can obstruct fish movement





Myriophyllum spicatum — Eurasian Water Milfoil

Nonnative/Exotic

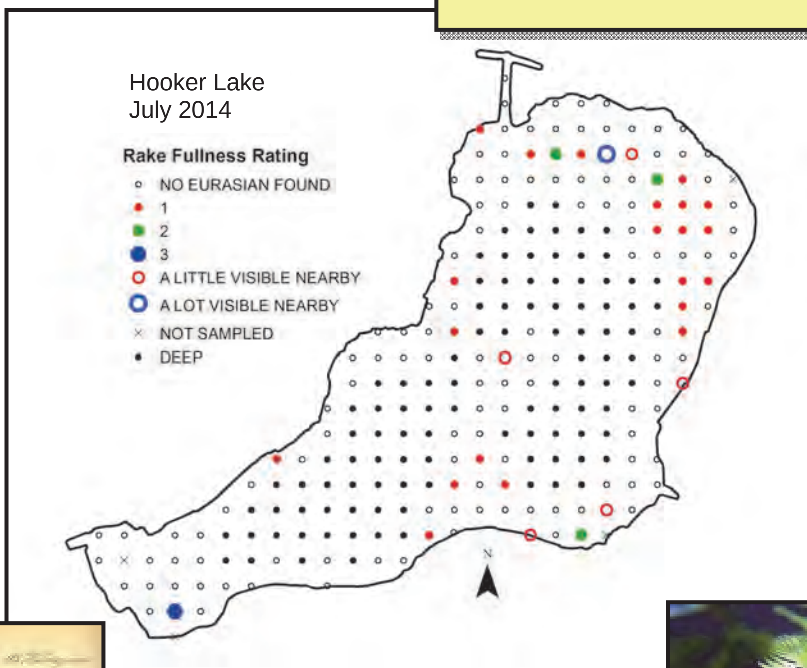
Identifying Features

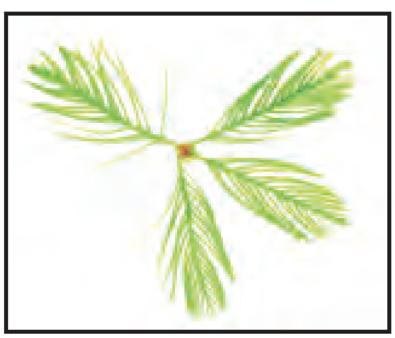
- Stems spaghetti-like, often pinkish, growing long with many branches near the water surface
- Leaves with 12 to 21 pairs of leaflets
- Produces no winter buds (turions)

Eurasian water milfoil is similar to northern water milfoil (*M. sibiricum*). However, northern water milfoil has five to 12 pairs of leaflets per leaf and stouter white or pale brown stems

Ecology

- Hybridizes with northern (native) water milfoil, resulting in plants with intermediate characteristics
- Invasive, growing quickly, forming canopies, and getting a head-start in spring due to an ability to grow in cool water
- Grows from root stalks and stem fragments in both lakes and streams, shallow and deep; tolerates disturbed conditions
- Provides some forage to waterfowl, but supports fewer aquatic invertebrates than mixed stands of aquatic vegetation





Najas flexilis — Bushy Pondweed or Slender Naiad

Native

Identifying Features

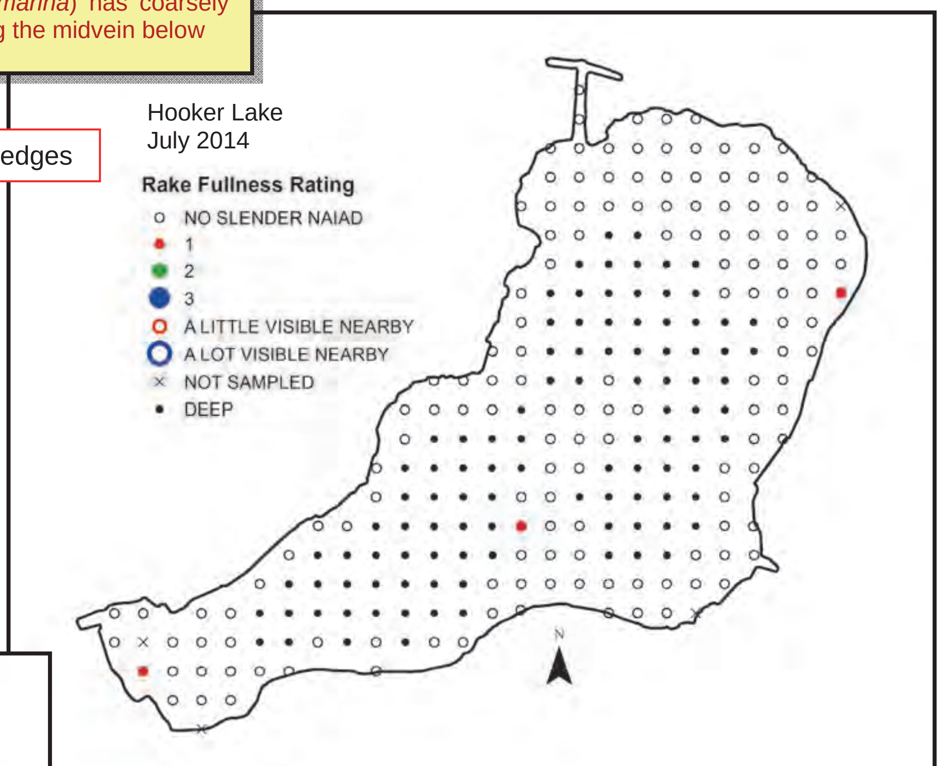
- Leaves narrow (0.4 to 1.0 mm) and pointed with broader bases where they attach to the stem and finely serrated margins
- Flowers, when present, tiny and located in leaf axils
- Variable size and spacing of leaves, as well as compactness of plant, depending on growing conditions

Two other *Najas* occur in southeastern Wisconsin. Southern naiad (*N. guadalupensis*) has wider leaves (to 2.0 mm). Spiny naiad (*N. marina*) has coarsely toothed leaves with spines along the midvein below

Ecology

- In lakes and streams, shallow and deep, often in association with wild celery
- *One of the most important forages of waterfowl*
- An annual plant that completely dies back in fall and regenerates from seeds each spring; also spreading by stem fragments during the growing season

Leaves narrow with serrated edges



Nuphar variegata
Native

Spatterdock

Identifying Features

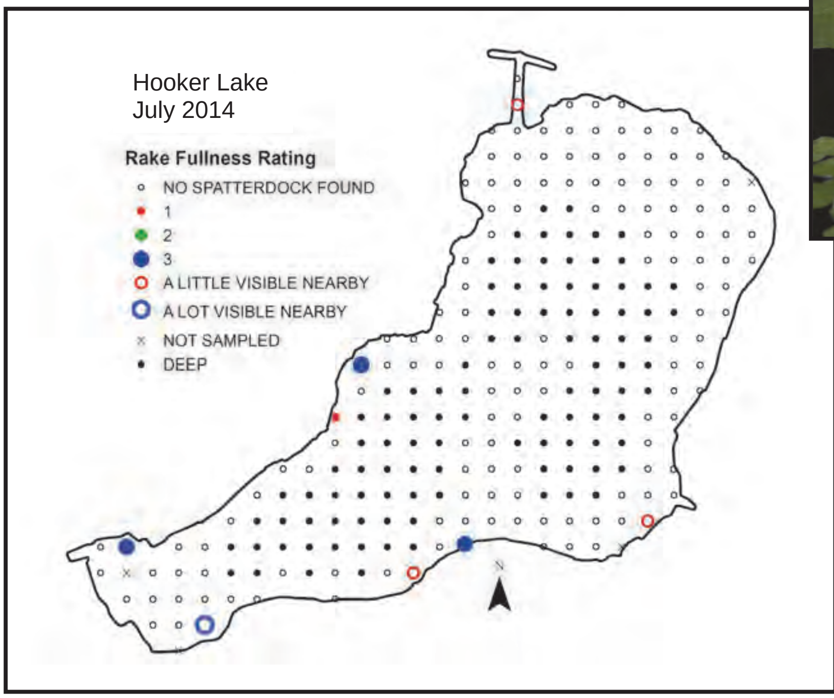
- Leaf stalks winged in cross-section
- Most leaves floating on the water surface, heart-shaped, and notched, with rounded lobes at the base
- Yellow flowers, 2.5 to 5.0 cm wide, often with maroon patches at the bases of the sepals (petal-like structures) when viewed from above

Unlike spatterdock, the similar yellow pond lily (*Nuphar advena*) has leaf stalks that are not winged in cross-section, leaves that more often emerge above the water surface, and leaf lobes that are more pointed. Spatterdock is superficially similar to water lilies (*Nymphea* spp.), but it has yellow versus white flowers and leaves somewhat heart-shaped versus round. American lotus (*Nelumbo lutea*) is also similar, but its leaves are round and un-notched, and its flowers are much larger

Ecology

- In sun or shade and mucky sediments in shallows and along the margins of ponds, lakes, and slow-moving streams
- Overwinters as a perennial rhizome
- Flowers opening during the day, closing at night, and with the odor of fermented fruit
- Buffers shorelines
- Provides food for waterfowl (seeds), deer (leaves and flowers), and muskrat, beaver, and porcupine (rhizomes)
- Habitat for fish and aquatic invertebrates


Ron Edwards




Jason Hollinger

Nymphaea odorata — White Water Lily

Native

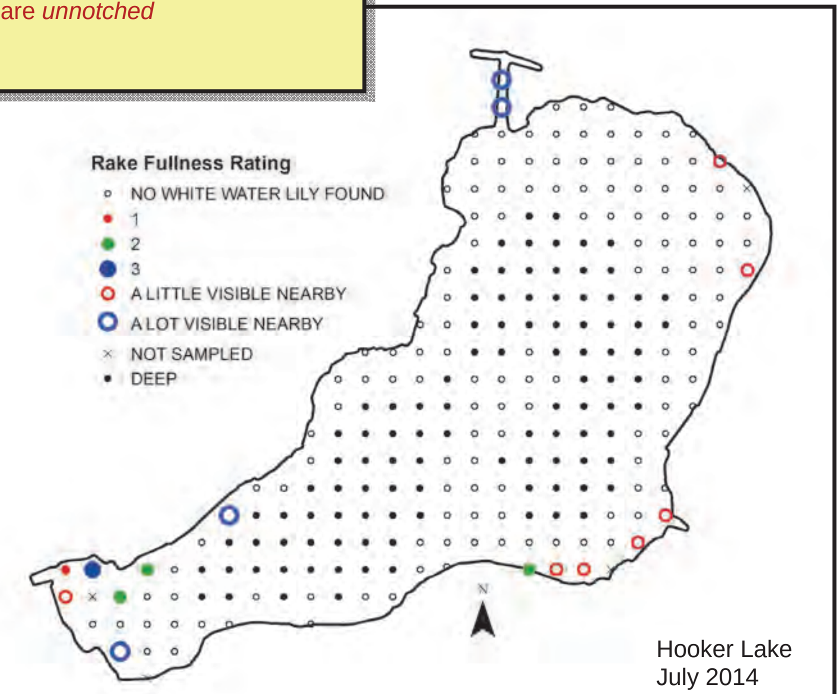
Identifying Features

- Leaf stalks round in cross-section with four large air passages
- Floating leaves round (four to 12 inches wide under favorable conditions), *with a notch* from the outside to the center, and reddish-purple underneath
- Flowers white with a yellow center, three to nine inches wide

Pond lilies (*Nuphar* spp.) are superficially similar, but have yellow flowers and leaves somewhat heart-shaped. American lotus (*Nelumbo lutea*) is also similar, but its leaves are *unnotched*

Ecology

- Found in shallow waters over soft sediments
- Leaves and flowers emerge from rhizomes
- Flowers opening during the day, closing at night
- Seeds consumed by waterfowl, rhizomes consumed by mammals



Hooker Lake
July 2014

Stuckenia pectinata — Sago Pondweed

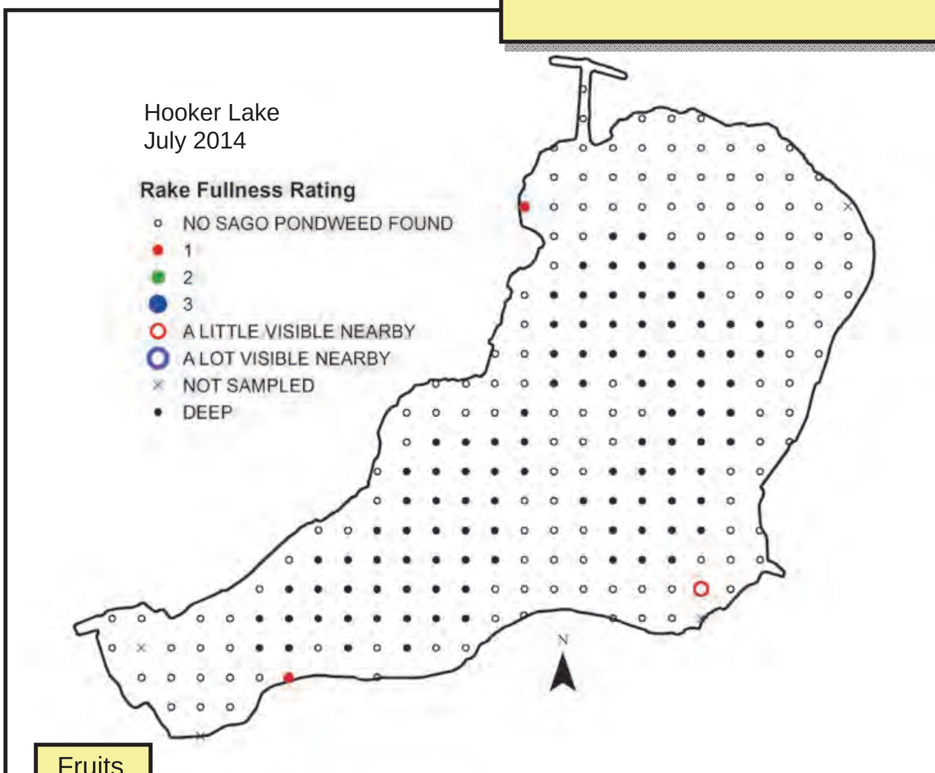
Native

Identifying Features

- Stems often *slightly zig-zagged* and forked multiple times, yielding a fan-like form
- Leaves one to four inches long, very thin, and ending in a sharp point
- Whorls of fruits spaced along the stem may appear as beads on a string

Ecology

- Lakes and streams
- Overwinters as rhizomes and starchy tubers
- Tolerates murky water and disturbed conditions
- Provides abundant fruits and tubers, which are an *important food for waterfowl*
- Provides habitat for juvenile fish



Fruits

Vallisneria americana — Eelgrass

Native

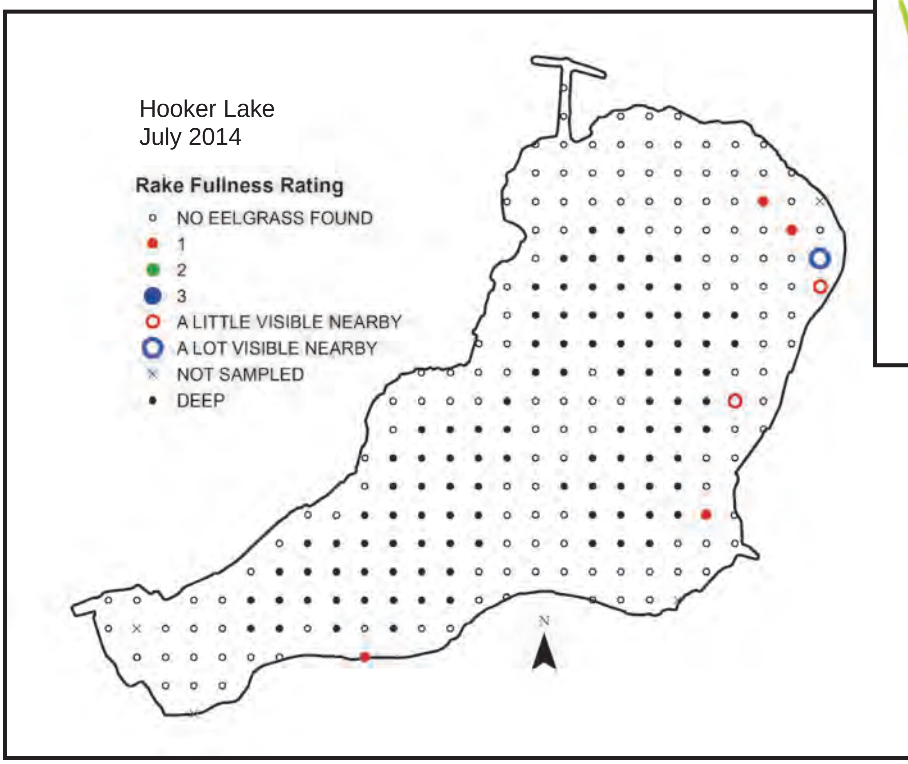
Identifying Features

- Leaves ribbon-like, up to two meters long, with a prominent stripe down the middle, and emerging in clusters along creeping rhizomes
- Male and female flowers on separate plants, female flowers raised to the surface on spiral-coiled stalks

The foliage of eelgrass could be confused with the submersed leaves of bur-reeds (*Sparganium* spp.) or arrowheads (*Sagittaria* spp.), but the leaves of eelgrass are distinguished by their prominent middle stripe. The leaves of ribbon-leaf pondweed (*Potamogeton epihydrus*) are also similar to those of eelgrass, but the leaves of the former are alternately arranged along a stem rather than arising from the plant base

Ecology

- Firm substrates, shallow or deep, in lakes and streams
- Spreads by seed, by creeping rhizomes, and by offsets that break off and float to new locations in the fall
- All portions of the plant consumed by waterfowl; an especially important food source for Canvasback ducks
- Provides habitat for invertebrates and fish



Zosterella dubia — Water Stargrass

Native

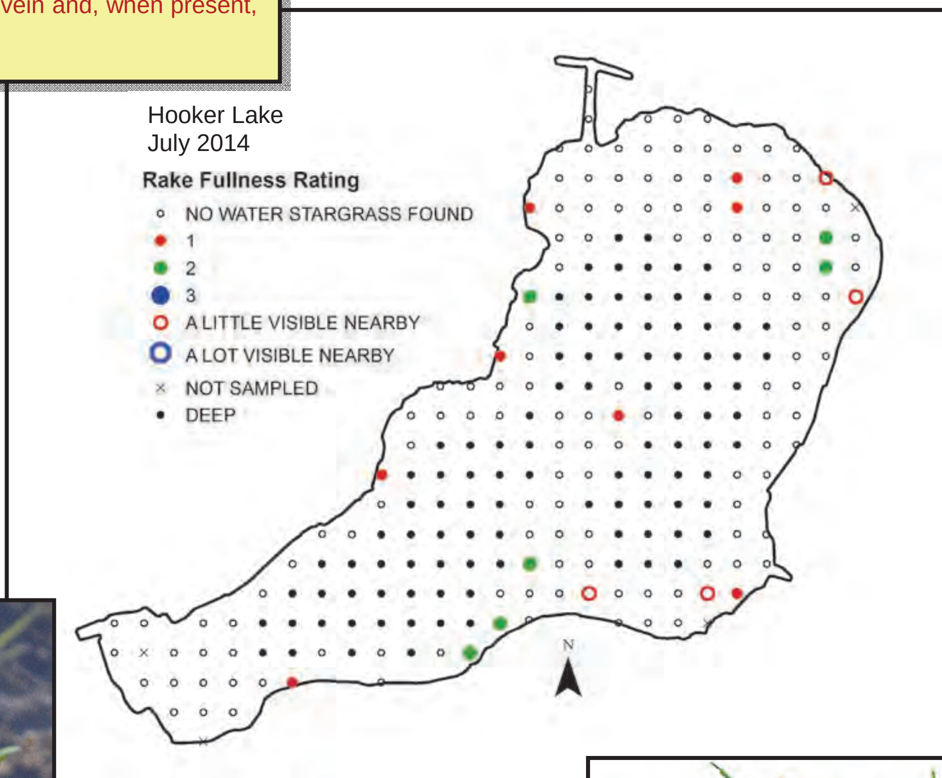
Identifying Features

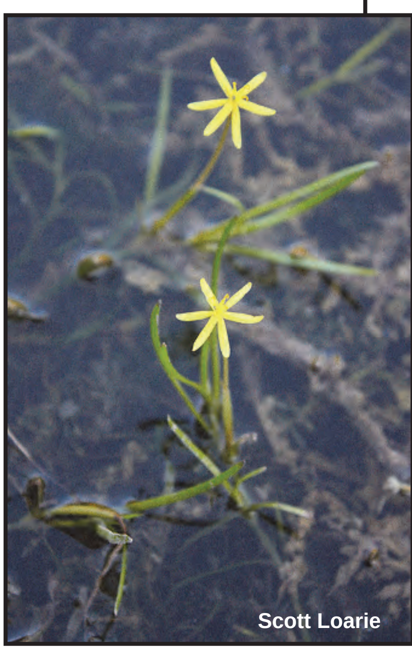
- Stems slender, slightly flattened, and branching
- Leaves narrow, alternate, with no stalk, and lacking a prominent midvein
- When produced, flowers conspicuous, yellow, and star-shaped (usually in shallow water) or inconspicuous and hidden in the bases of submersed leaves (in deeper water)

Yellow stargrass may be confused with pondweeds that have narrow leaves, but it is easily distinguished by its lack of a prominent midvein and, when present, yellow blossoms

Ecology

- Found in lakes and streams, shallow and deep
- Tolerates somewhat turbid waters
- Overwinters as perennial rhizomes
- Limited reproduction by seed
- Provides food for waterfowl and habitat for fish





(This page intentionally left blank)

Appendix G

INVASIVE AQUATIC AND WETLAND SPECIES

(This page intentionally left blank)

Regulated Aquatic Invasive Plants in WI

Please report any **prohibited** species (as indicated by the red frame box) to the WDNR.

Report by email to: Invasive.Species@wi.gov or **by phone at: (608) 266-6437**

OR to find out more information, for information on reporting restricted species and whom to contact go to:

http://dnr.wi.gov/invasives/aquatic/whattodo/

Flowering rush
(Butomus umbellatus)

Purple loosestrife
(Lythrum salicaria)

Curly-leaf pondweed
(Potamogeton crispus)

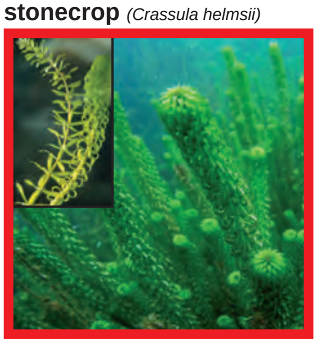
Eurasian water milfoil
(Myriophyllum spicatum)

Australian swamp stonecrop *(Crassula helmsii)*

Brazilian waterweed
(Egeria densa)

Hydrilla
(Hydrilla verticillata)

European frog-bit
(Hydrocharis morsus-ranae)



African elodea
(Lagarosiphon major)

Parrot feather
(Myriophyllum aquaticum)

Brittle waternymph
(Najas minor)

Yellow floating heart
(Nymphoides peltata)

Water chestnut
(Trapa natans)

Fanwort
(Cabomba caroliniana)

Didymo or rock snot (alga)
(Didymosphenia geminata)

Starry stonewort (alga)
(Nitellopsis obtusa)

Restricted Species | Prohibited Species

For more information about NR 40 (WI's Invasive Species Rule), Restricted, or Prohibited species please visit: www.dnr.wi.gov/invasives/classification

Bureau of Watershed Management
Wisconsin Department of Natural Resources
Box 7921
Madison, WI 53707-7921

DNR PUB-WT-960-2011

PRINTED ON RECYCLED PAPER

WISCONSIN DEPT. OF NATURAL RESOURCES

Design and Layout by Bonnie Reichert

Chapter NR 40:
Invasive Species Identification Classification and Control
Aquatic Invasive Plants Summary

The Invasive Species Rule (Chapter NR 40) went into effect on September 1, 2009. The rule establishes a comprehensive, science-based way to classify and regulate invasive species in Wisconsin. The rule divides species into 2 categories, "Prohibited" and "Restricted," with different regulations and control requirements. The rule also establishes "Preventative Measures" to show what actions we can take to slow the spread of invasive species. Chapter NR 40 covers over 128 species, including plants, animals, and microorganisms.

WI Statute 23.22 defines **Invasive Species** as "nonindigenous species whose introduction causes or is likely to cause economic or environmental harm or harm to human health." Not all nonnative plants are harmful, so NR 40 helps us determine which ones are invasive.

Prohibited Invasive Plants *

- These species are not yet in the state or only in a few places
- These species are likely to cause environmental and/or economic harm
- It is still possible to eradicate these species and prevent their spread statewide

Regulations: **Cannot transport, possess, transfer (buy or sell), or introduce without a permit**
Control Authority: Control is required. DNR may order or conduct a control effort

Restricted Invasive Plants *

- These species are already widely established in the state
- High environmental and/or economic impacts are evident with these species
- Complete eradication of these species is unlikely

Regulations: **Cannot transport, transfer (buy or sell), or introduce without a permit**
Control Authority: Control is encouraged but not required
*All viable part of the species (including seeds) are covered by these regulations.

What This Means for You

The primary goal of NR 40 is to slow the spread of invasive species in Wisconsin. The Department is using a "stepped enforcement" protocol, which emphasizes education and voluntary compliance. However, citations may be issued for aquatic invasive species violations. Remember:

- **It is illegal to buy, sell, give away, or barter any species listed under Chapter NR 40.**
- **Please become familiar with the listed plants and their regulated status for your county.**
- **You are responsible to comply with all elements of Chapter NR 40.**

Regulations differ slightly for certain species. Please go to the WDNR website to see listed exemptions for NR40, as well as the rule's implications for aquatic invertebrates, fish, and terrestrial species:

www.dnr.wi.gov/invasives/classification

For more information contact the WDNR
Invasive Species Project Coordinator at:
Email: Invasive.Species@wi.gov
Phone: (608) 266-6437

CS.v.8/30/11

Common Wetland Invasive Plants in WI

Please report **prohibited** species (as indicated by red on the maps) and all other species marked with an asterisk(*) when found in or near wetlands or shores. Provide the following data: exact location, land ownership (if known), population size, a photo or voucher specimen, and your contact information.

To report a sighting: send an email to: Invasive.Species@wi.gov or CALL 608-267-5066

Common buckthorn
(Rhamnus cathartica)

Glossy buckthorn
(Frangula alnus = Rhamnus frangula)

Non-native bush honeysuckles
(Lonicera spp.)

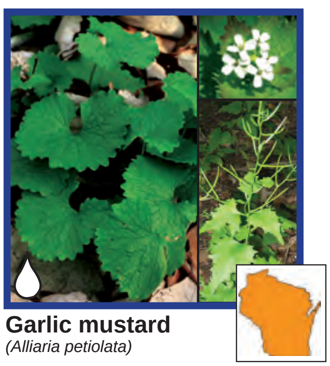
Canada thistle
(Cirsium arvense)

Common forget-me-not
(Myosotis scorpioides)

Dame's rocket
(Hesperis matronalis)

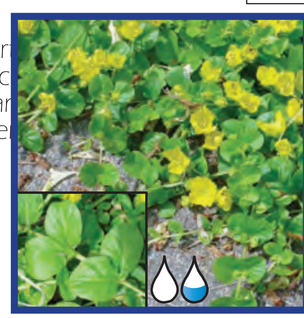
***Flowering rush**
(Butomus umbellatus)

***Garden valerian or heliotrope** *(Valeriana officinalis)*



Garlic mustard
(Alliaria petiolata)

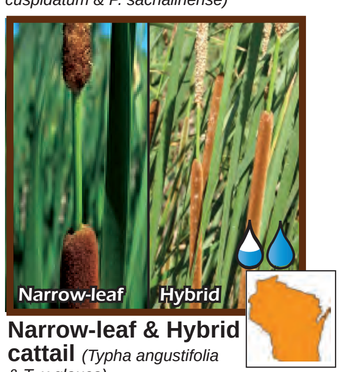
***Japanese & Giant knotweed** *(Polygonum cuspidatum & P. sachalinense)*



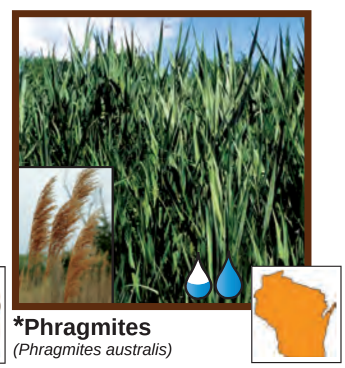
Moneywort
(Lysimachia nummularia)

***Purple loosestrife**
(Lythrum salicaria)

Watercress
(Nasturtium officinale)



Narrow-leaf & Hybrid cattail *(Typha angustifolia & T. x glauca)*



***Phragmites**
(Phragmites australis)

Reed canary grass
(Phalaris arundinacea)

Restricted Species | Prohibited/Restricted Species | Prohibited Species

Species without a map are not regulated by NR 40 (WI's Invasive Species Rule)

Tree | Vine | Grass | Shrub | Forb

SOMEWHAT WET (Floodplain forests, Seasonally flooded basins)

WET (Wet meadows, Shrub swamps, Wooded swamps)

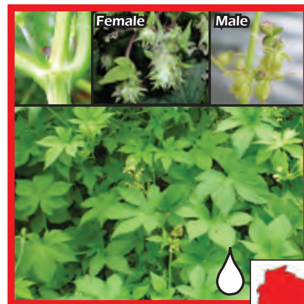
VERY WET (Deep marsh, Shallow marsh)

Early Detection Wetland Invasive Plants in WI

Early detection plants are either not yet present in WI or not widespread but have the potential to become widespread.

European high-bush cranberry *(Viburnum opulus* L. *subsp. opulus)*

***Chinese yam** *(Dioscorea oppositifolia)*



***Japanese hops** *(Humulus japonicus)*

Annual salt marsh aster *(Symphyotrichum subulatum)*

Cut-leaved teasel *(Dipsacus laciniatus)*

***European marsh thistle** *(Cirsium palustre)*

False spirea *(Sorbaria sorbifolia)*

***Giant hogweed** *(Heracleum mantegazzianum)*

***Hairy willow herb** *(Epilobium hirsutum)*

***Poison hemlock** *(Conium maculatum)*

Queen-of-the-meadow *(Filipendula ulmaria)*

Seaside goldenrod *(Solidago sempervirens)*

Yellow garden loosestrife *(Lysimachia vulgaris)*

***Yellow iris** *(Iris pseudacorus)*

***Japanese stilt grass** *(Microstegium vimineum)*

***Tall or Reed manna grass** *(Glyceria maxima)*

For more information about NR 40 (WI's Invasive Species Rule), Restricted, or Prohibited species please visit:
www.dnr.wi.gov/invasives/classification
For more information about the plant species please visit: http://dnr.wi.gov/wetlands/invasive.html

Bureau of Endangered Resources
and Division of Forestry
Wisconsin Department of Natural Resources
Box 7921
Madison, WI 53707-7921

PRINTED ON RECYCLED PAPER

DNR PUB-WT-930-2010

Design and Layout by Bonnie Reichert

Appendix H

2,4-D CHEMICAL FACT SHEET

(This page intentionally left blank)

January 2012

2,4-D Chemical Fact Sheet

Formulations

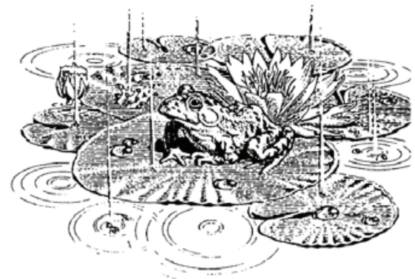
2,4-D is an herbicide that is widely used as a household weed-killer, agricultural herbicide, and aquatic herbicide. It has been in use since 1946, and was registered with the EPA in 1986 and re-reviewed in 2005. The active ingredient is 2,4-dichloro-phenoxyacetic acid. There are two types of 2,4-D used as aquatic herbicides: dimethyl amine salt and butoxyethyl ester. Both liquid and slow-release granular formulations are available. 2,4-D is sold under the trade names Aqua-Kleen, Weedar 64 and Navigate (product names are provided solely for your reference and should not be considered endorsements nor exhaustive).

Aquatic Use and Considerations

2,4-D is a widely-used herbicide that affects plant cell growth and division. It affects primarily broad-leaf plants. When the treatment occurs, the 2,4-D is absorbed into the plant and moved to the roots, stems, and leaves. Plants begin to die in a few days to a week following treatment, but can take several weeks to decompose. Treatments should be made when plants are growing.

For many years, 2,4-D has been used primarily in small-scale spot treatments. Recently, some studies have found that 2,4-D moves quickly through the water and mixes throughout the waterbody, regardless of where it is applied. Accordingly, 2,4-D has been used in Wisconsin experimentally for whole-lake treatments.

2,4-D is effective at treating the invasive Eurasian watermilfoil (*Myriophyllum spicatum*). Desirable native species that may be affected include native milfoils, coontail (*Ceratophyllum demersum*), naiads (*Najas* spp.), elodea (*Elodea canadensis*) and duckweeds (*Lemna* spp.). Lilies (*Nymphaea* spp. and *Nuphar* spp.) and bladderworts (Utricularia spp.) also can be affected.



Post-Treatment Water Use Restrictions

There are no restrictions on eating fish from treated water bodies, human drinking water or pet/livestock drinking water. Following the last registration review in 2005, the ester products require a 24-hour waiting period for swimming. Depending on the type of waterbody treated and the type of plant being watered, irrigation restrictions may apply for up to 30 days. Certain plants, such as tomatoes and peppers and newly seeded lawn, should not be watered with treated water until the concentration is less than 5 parts per billion (ppb).

Herbicide Degradation, Persistence and Trace Contaminants

The half-life of 2,4-D (the time it takes for half of the active ingredient to degrade) ranges from 12.9 to 40 days depending on water conditions. In anaerobic lab conditions, the half-life has been measured up to 333 days. After treatment, the 2,4-D concentration in the water is reduced primarily through microbial activity, off-site movement by water, or adsorption to small particles in silty water. It is slower to degrade in cold or acidic water, and appears to be slower to degrade in lakes that have not been treated with 2,4-D previously.

There are several degradation products from 2,4-D: 1,2,4-benzenetriol, 2,4-dichlorophenol, 2,4-dichloroanisole, chlorohydroquinone (CHQ), 4-chlorophenol and volatile organics.

Impacts on Fish and Other Aquatic Organisms

Toxicity of aquatic 2,4-D products vary depending on whether the formulation is an amine or an ester 2,4-D. The ester formulations are toxic to fish and some important invertebrates such as water fleas (*Daphnia*) and midges at application rates; the amine formulations are not toxic to fish or invertebrates at application rates. Loss of habitat following treatment may cause reductions in populations of invertebrates with either formulation, as with any herbicide treatment. These organisms only recolonize the treated areas as vegetation becomes re-established.

Available data indicate 2,4-D does not accumulate at significant levels in the bodies of fish that have been tested. Although fish that are exposed to 2,4-D will take up some of the chemical, the small amounts that accumulate are eliminated after exposure to 2,4-D ceases.

On an acute basis, 2,4-D is considered moderately to practically nontoxic to birds. 2,4-D is not toxic to amphibians at application rates; effects on reptiles are unknown. Studies have shown some endocrine disruption in amphibians at rates used in lake applications, and DNR is currently funding a study to investigate endocrine disruption in fish at application rates.

As with all chemical herbicide applications it is very important to read and follow all label instructions to prevent adverse environmental impacts.

Human Health

Adverse health effects can be produced by acute and chronic exposure to 2,4-D. Those who mix or apply 2,4-D need to protect their skin and eyes from contact with 2,4-D products to minimize irritation, and avoid inhaling the spray. In its consideration of exposure risks, the EPA believes no significant risks will occur to recreational users of water treated with 2,4-D.

Concerns have been raised about exposure to 2,4-D and elevated cancer risk. Some (but not all) epidemiological studies have found 2,4-D associated with a slight increase in risk of non-Hodgkin's lymphoma in high exposure populations (farmers and herbicide applicators). The studies show only a possible association that may be caused by other factors, and do not show that 2,4-D causes cancer. The EPA determined in 2005 that there is not sufficient evidence to classify 2,4-D as a human carcinogen.

The other chronic health concern with 2,4-D is the potential for endocrine disruption. There is some evidence that 2,4-D may have estrogenic activities, and that two of the break-down products of 2,4-D (4-chlorophenol and 2,4-dichloroanisole) may affect male reproductive development. The extent and implications of this are not clear and it is an area of ongoing research.

For Additional Information

Environmental Protection Agency
Office of Pesticide Programs
www.epa.gov/pesticides

Wisconsin Department of Agriculture, Trade, and Consumer Protection
http://datcp.wi.gov/Plants/Pesticides/

Wisconsin Department of Natural Resources
608-266-2621
http://dnr.wi.gov/lakes/plants/

Wisconsin Department of Health Services
http://www.dhs.wisconsin.gov/

National Pesticide Information Center
1-800-858-7378
http://npic.orst.edu/

Wisconsin Department of Natural Resources
Box 7921
Madison, WI 53707-7921

DNR PUB-WT-964 2012

Appendix I

LOCAL ORDINANCES RELATING TO HOOKER LAKE

Chapter 330. Lakes and Beaches

§ 330-1. Intent.

The intent of this chapter is to provide safe and healthful conditions for the enjoyment of aquatic recreation consistent with public needs and the capacity of the water resource.

§ 330-2. Applicability.

[Amended 4-10-2000 by Ord. No. 00-04-10] The provisions of this chapter shall apply to the lakes within the jurisdiction of the Town and to the rivers within the Town wherever the provisions of this chapter would be applicable to river traffic, except to the waters of Silver Lake, which shall be enforced exclusively by the Village of Silver Lake.

§ 330-3. Incorporation of state statutes.

A.

[HISTORY: Adopted by the Town Board of the Town of Salem 7-18-1991 by Ord. No. 91-07-18 (Ch. 20 of the 1991 Code). Amendments noted where applicable.] **GENERAL REFERENCES** Public Safety Department — See Ch. 119. Fees — See Ch. 272. Parks and recreation — See Ch. 396.

The following sections of the Wisconsin Statutes and any subsequent amendments thereto are hereby adopted and by reference made a part of this section as though fully set forth herein: [Amended 6-13-2011 by Ord. No. 11-06-13] **Wis. Stats. SectionTitle** 30.50Definitions 30.51Certificate of number and registration; requirements; exemptions 30.52Certificate of number and registration; application; certification and registration period; fees; issuance 30.53Certificate of origin; requirements; contents 30.531Certificate of title; requirements; exemptions 30.54(2)Lost, stolen or mutilated certificates 30.55Notice of abandonment or destruction of boat or change of address 30.60Classification of motorboats 30.61Lighting equipment 30.62Other equipment 30.635Motorboat prohibition 30.64Patrol boats

B.

Wis. Stats. Section 30.65 30.66 30.67 30.675 30.68 30.681 30.682 30.683 30.684 30.686 30.687 30.69 30.70 30.71 Any act required to be performed or prohibited by the provisions of any of the above-referenced statutory sections incorporated herein is required or prohibited by this section.

§ 330-4. Definitions.

Title

Traffic rules Speed restrictions Accidents and accident reports Distress signal flag Prohibited operation Intoxicated boating Preliminary breath screening test Implied consent Chemical tests Report arrest to department Officers action after arrest for violating intoxicated boating law Water skiing Skin diving Disposal of waste from boats equipped with toilets

As used in this chapter, the following terms shall have the meanings indicated: **MOORAGE** An area where continuous mooring of boats for more than 24 hours is permitted. **PUBLIC ACCESS** A marina or landing facility and the adjoining public shoreline under the ownership of the state, county or other municipality. **SHORE ZONE** The water area within 200 feet of any lakeshore within the Town of Salem, except: [Amended 6-13-2011 by Ord. No. 11-06-13C] A. On Silver Lake, where the shore zone shall mean the water area from the shore to five-foot depth as shown on the hydrographic map bearing legend DNR 1968. B. On Lake Shangri-La, where the shore zone shall mean the water area within 100 feet of any lakeshore. **SLOW NO-WAKE BENCHMARK** The elevation of the surface of inland waters within the Town of Salem at which operation of motorboats on such waters at a speed in excess of slow no-wake speed tends to create or cause property damage or abnormal shore erosion due to excessive wake or wash. The slow no-wake benchmark shall be the surface elevation of such inland waters as indicated by markers established for that purpose, the locations of which are depicted on the attached Marker Maps A and B. [1] The slow no-wake benchmarks for inland waters within the Town shall be as follows: [Added 4-17-2008 by Ord. No. 08-04-17; amended 6-13-2011 by Ord. No. 11-06-13C] **Body of WaterMarker LocationMarker Level** Cross LakeN42° 29" 53.0', W88° 05" 39.3'4.00

Voltz Lake

Body of Water

Camp Lake

Center Lake

Lake Shangri-La

Hooker Lake

Marker Location Cross Lake Gauging Station No. 1 is located on the west side of Cross Lake approximately 160 feet north of the intersection of S.T.H. "83" and 127th Place. The datum elevation for Cross Lake Gauging Station No. 1 is 810.00. Cross Lake Gauging Station No. 1 is scaled from 3.33 to 6.67 feet. N42° 30" 32.8', W88° 08" 51.9' Camp Lake Gauging Station No. 1 is located on the south side of Camp Lake north of C.T.H. "C" approximately 800 feet southwest of 277th Avenue. The gauging station is located approximately 40 feet north of the center line of C.T.H. "C" and approximately 30 feet west of the dam. The datum elevation for Camp Lake Gauging Station No. 1 is 730.00. Camp Lake Gauging Station No. 1 is scaled from 10.00 to 16.67 feet. N42° 31" 56.7', W88° 08" 18.7' Center Lake Gauging Station No. 1 is located on the south side of Center Lake adjacent to Camp Lake Road (C.T.H. "SA") in the waterway that connects Center Lake and Camp Lake. The gauging station is located north of C.T.H. "SA" approximately 400 feet northwest of 271st Avenue. The gauging station is located approximately 60 feet north of the center line of C.T.H. "SA" and approximately 10 feet northwest of a small dam in the waterway. The datum elevation for Center Lake Gauging Station No. 1 is 730.00. Center Lake Gauging Station No. 1 is scaled from 10.00 to 16.67 feet. N42° 30" 31.7', W88° 04" 16.6' Lake Shangrila Gauging Station No. 1 is located on the north side of Lake Shangrila adjacent of 118th Street. The gauging station is located southeast of 118th Street approximately 800 feet southwest of 117th Street. The gauging station is located approximately 30 feet southeast of the center line of 118th Street and approximately 10 feet northeast of the culvert under 118th Street. The datum elevation for Lake Shangrila Gauging Station No. 1 is 790.00. Lake Shangrila Gauging Station No. 1 is scaled from 3.33 to 6.67 feet. N42° 33" 21.9', W88° 06" 26.9' Hooker Lake Gauging Station No. 1 is located on the southwest side of Hooker Lake approximately 300 feet east of the intersection of 83rd Street and 249th Avenue. The gauging station is located approximately 30 feet east of the east end of 83rd Street. The datum elevation for Hooker Lake Gauging Station No. 1 is 745.00. Hooker Lake Gauging Station No. 1 is scaled from 8.50 to 13.33 feet. N42° 30" 32.9', W88° 05" 17.1'

Marker Level

11.50

12.00

5.85

9.80

8.25

A.

Body of Water

§ 330-5. Speed restrictions.

Marker Location Voltz Lake Gauging Station No. 1 is located on the northwest side of Voltz Lake adjacent to 231st Court. The gauging station is located east of 231st Court approximately 250 feet south of 117th Street. The gauging station is located approximately 25 feet east of the center line of 231st Court and approximately 30 feet south of Trevor Creek. The datum elevation for Voltz Lake Gauging Station No. 1 is 805.00. Voltz Lake Gauging Station No. 1 is scaled from 6.67 to 10.00 feet.

Marker Level

SLOW NO-WAKE SPEED That speed at which a boat moves as slowly as possible while still maintaining steerage control. **SWIMMING ZONE** An authorized area marked by official buoys to designate a swimming area. [1]*Editor's Note: The maps are on file at the office of the Town Clerk.*

In addition to the speed restrictions set forth in § 330-3 of this chapter, adopting § 30.66, Wis. Stats., no person shall operate a boat in excess of the slow no-wake speed: [Amended 6-14-1993 by Ord. No. 93-06-14D; 6-19-1995 by Ord. No. 95-06-19; 3-9-1998 by Ord. No. 98-03-09B; 4-11-2005 by Ord. No. 05-04-11A] (1) On any lake within a defined shore zone. (2) Except as otherwise provided in this section, on any lake between the hours of 7:00 p.m. and 10:00 a.m. on either the shore zone or the traffic lane. [Amended 12-14-2009 by Ord. No. 09-12-14] (3) On that part of the Fox River bounded on the north by the Highway C bridge and on the south by the Wisconsin-Illinois border. (4) On that part of the Fox River bounded on the south by the south face of the bridge on CTH F and on the north by a slow no-wake regulatory buoy placed at 42.32768 north latitude, 88.10749 west longitude. Additional slow no-wake buoys shall be placed to implement the speed restriction as follows: 1 buoy at 42.32517 north latitude and 88.10305 west longitude 1 buoy at 42.32495 north latitude and 88.10413 west longitude 1 buoy at 42.32553 north latitude and 88.10492 west longitude 1 buoy at 42.32675 north latitude and 88.10492 west longitude 1 buoy at 42.32675 north latitude and 88.10509 west longitude 1 buoy at 42.32674 north latitude and 88.10730 west longitude 1 buoy at 42.32701 north latitude and 88.10761 west longitude (5) On Lake Shangri-La in the area of the lake known as "the narrows." Slow no-wake buoys shall be placed to implement the speed restrictions as follows: 1 buoy 140 feet from the shore of the property identified as 12026 214th Avenue. 1 buoy 140 feet from the shore of the property identified as 21401 121st Street (6)

On Camp Lake within the shore zone. Slow no-wake buoys shall be placed in the following locations to implement the restrictions: [Added 9-10-2007 by Ord. No. 07-09-10B; amended 4-5-2010 by Ord. No. 10-04-05] 1 buoy at 42.31749 north latitude and 88.08702 west longitude 1 buoy at 42.31914 north latitude and 88.08609 west longitude 1 buoy at 42.31990 north latitude and 88.08583 west longitude 1 buoy at 42.31958 north latitude and 88.08466 west longitude 1 buoy at 42.31811 north latitude and 88.08421 west longitude 1 buoy at 42.31697 north latitude and 88.08499 west longitude 1 buoy at 42.31544 north latitude and 88.08435 west longitude 1 buoy at 42.31691 north latitude and 88.08547 west longitude 1 buoy at 42.31467 north latitude and 88.08397 west longitude 1 buoy at 42.31472 north latitude and 88.08385 west longitude 1 buoy at 42.31545 north latitude and 88.08475 west longitude 1 buoy at 42.31401 north latitude and 88.08308 west longitude 1 buoy at 42.31296 north latitude and 88.08231 west longitude 1 buoy at 42.31196 north latitude and 88.08193 west longitude 1 buoy at 42.31132 north latitude and 88.08206 west longitude 1 buoy at 42.31005 north latitude and 88.08353 west longitude 1 buoy at 42.30942 north latitude and 88.08468 west longitude 1 buoy at 42.30870 north latitude and 88.08575 west longitude 1 buoy at 42.30833 north latitude and 88.08691 west longitude 1 buoy at 42.31211 north latitude and 88.08966 west longitude 1 buoy at 42.31501 north latitude and 88.08692 west longitude 1 buoy at 42.31601 north latitude and 88.08723 west longitude 1 buoy at 42.31699 north latitude and 88.08749 west longitude On Hooker Lake between the hours of sunset and 10:00 a.m. either in the shore zone or the traffic lane. [Added 12-14-2009 by Ord. No. 09-12-14; amended 10-14-2013 by Ord. No. 13-10-14] On Lake Shangri-La/Benet between the hours of sunset and 10:00 a.m. either in the shore zone or the traffic lane during the months of July and August. [Added 6-13-2011 by Ord. No. 11-06-13C] (9) On Camp Lake between the hours of sunset and 10:00 a.m. either in the shore zone or the traffic lane. [Added 6-13-2011 by Ord. No. 11-06-13C; amended 3-12-2012 by Ord. No. 12-03-12A] (10) On Center Lake within the restricted areas marked by buoys placed at the following locations: [Added 5-14-2012 by Ord. No. 12-05-14A; amended 11-12-2013 by Ord. No. 13-11-12] **LocationBuoy TypeLatitudeLongitude** Center Lake Woods Swim area42° 32' 16.04" N88° 8' 1.12" W Beach Center Lake Woods Swim area42° 32' 16.64" N88° 8' 0.82" W Beach Center Lake Woods Swim area42° 32' 16.80" N88° 7' 59.14" W Beach Center Lake Woods Swim area42° 32' 16.32" N88° 7' 58.62" W Beach Swim area42° 32' 15.78" N88° 7' 58.25" W

(7)

(8)

B.

C.

A.

B.

C.

Location Center Lake Woods Beach Boat launch channel Center Lake Beach Center Lake Beach Camp Wonderland Camp Wonderland Center Lake Beach Pursuant to § 30.635, Wis. Stats., no person shall operate a motorboat on Rock Lake in excess of the slow no-wake speed. No person shall operate a motorboat on any inland waters subject to the jurisdiction of the Town of Salem at a speed in excess of slow no-wake speed when the surface water level of such inland bodies of water exceeds the slow no-wake benchmark as indicated by markers placed and maintained by the Town for that purpose. [Added 4-17-2008 by Ord. No. 08-04-17]

No wake Swim area Swim area No wake No wake Swim area

Buoy Type

§ 330-6. Capacity restrictions.

§ 330-7. Buoys, piers and rafts.

Latitude

42° 32' 14.63" N 42° 32' 19.24" N 42° 32' 19.67" N 42° 32' 24.77" N 42° 32' 26.99" N 42° 32' 28.13" N

Longitude

88° 8' 20.60" W 88° 8' 15.21" W 88° 8' 15.01" W 88° 8' 6.58" W 88° 8' 3.86" W 88° 8' 1.81" W

No person shall operate or loan, rent or permit a boat to leave the place where it is customarily kept for operation on the waters covered by this chapter with more passengers or cargo than shall be stated on the capacity information plate as required by § 30.501, Wis. Stats.

Removal. The Town may remove or cause to be removed all buoys, markers, piers and their supports, privately owned or placed, which are not removed by December 1 of each year and charge the cost and expense of such removal to the riparian owner. If such charge is not paid within 30 days after request therefor, a penalty of 10% shall be added to such charge, and the same shall constitute a lien on the property of the riparian owner and be inserted on the Town tax roll by the Town Clerk upon order of the Town Board and after notice to the riparian owner. [Amended 4-10-2000 by Ord. No. 00-04-10] Compliance. All buoys and aids to navigation must comply with § 30.74(2), Wis. Stats., and administrative regulations and shall have affixed thereto such numbers as assigned to them by the permit. Such numbers shall be located at least 12 inches above the waterline and shall be not less than three inches in height. Wharves and piers. [Amended 4-10-2000 by Ord. No. 00-04-10; 11-13-2001 by Ord. No. 01-11-13C] (1) No person shall erect or maintain any wharf or pier contrary to the statutes and regulations of the state or extending more than 100 feet from the shore, unless prior written approval is obtained from the Town, on all lakes and waters within the Town's jurisdiction. (2) No person may erect, place or maintain a wharf or pier on waters within the Town's jurisdiction which is so old, dilapidated or out of repair as to be dangerous, unsafe or otherwise unfit for normal use. (3)

D.

E.

F.

G.

A.

B.

If a water patrol officer or public safety officer shall determine that a violation of this section exists within the Town, the officer shall serve notice on the owner or occupant of the premises where such violation exists, either by personal delivery thereof to such person or by posting a copy of said notice in a conspicuous location on the premises. Such notice shall direct the owner or occupant of the premises to abate or remove such violation within 10 days. The notice shall also state that, unless such violation is so abated, the Town will cause the same to be abated and will charge the cost thereof to the owner or occupant of the premises where such violation exists. Pier or mooring buoy. No pier or mooring buoy shall be placed in the waters located within the boundary of a designated fire lane (extended into the water) unless so authorized, in writing, by the Town Board as to all waters under the jurisdiction of the Town Board, including those waters of Silver Lake into which designated Town fire lanes are extended. [Amended 4-10-2000 by Ord. No. 00-04-10] Rafts and platforms. (1) No person shall place or maintain any raft or platform more than 100 feet from shore. (2) Each raft or platform must: (a) Be firmly anchored with at least 18 inches of freeboard above the waterline; (b) Be painted white; and (c) Have attached thereto, not more than 12 inches from each corner or projection, a red reflector of not less than three inches in diameter. [Amended 3-11-1996 by Ord. No. 96-03-11] Buoy permits. (1) No bathing beach marker, speed zone marker, information marker, mooring buoy, fishing buoy or other marker shall be anchored or placed on any of the waters under the jurisdiction of the Town unless a written application therefor is made to and approved by the Town Board. The Town shall issue numbers for buoys as required in Subsection B above. [Amended 4-10-2000 by Ord. No. 00-04-10] (2) Permit fee established. Any person making application for the placement of a mooring buoy or other approved marker in the waters of any lake within the Town of Salem in accordance with the above section shall pay to the Clerk a permit fee as provided in Chapter 272, Fees, § 272-6. Such permit shall remain in effect so long as the applicant owns or rents the property for which such permit is granted. The permits granted hereunder shall automatically expire when an applicant sells or no longer occupies the premises for which the permit has been granted. Placement of authorized markers. The Chief of the Water Safety Patrol is authorized and directed to place authorized markers, navigation aids and signs in such water areas as shall be appropriate to advise the public of the provisions of this chapter and to post and maintain a copy of this chapter at all public access points within the jurisdiction of the Town.

§ 330-8. Swimming regulations.

Swimming from boats prohibited. No person shall swim from any unmanned boat unless such boat is anchored.

C.

A.

B.

Distance from shore or boats. No person shall swim beyond the shore zone or more than 50 feet from any pier unless within marked or authorized areas or more than 25 feet from anchored rafts or boats unless accompanied by a boat manned by a competent person and having readily available a ring buoy. Such boat shall stay reasonably close to and guard such swimmer; not less than one boat for each two swimmers. Hours limited. No person shall swim more than 200 feet from the shoreline between the hours of 7:00 p.m. and 10:00 a.m.

§ 330-9. Waterskiing regulations.

[Amended 12-14-2009 by Ord. No. 09-12-14; 6-11-2012 by Ord. No. 12-06-11] A. Hours. No person shall operate a boat for the purposes of towing a water skier, aquaplane or similar device or engage in waterskiing during those hours within which operation in excess of slow no wake is prohibited by § 330-5A. B. Traffic lane. Any boat engaged in towing a person on water skis, aquaplane or similar device must conform to all sections of this chapter and, in addition, must operate in a counterclockwise pattern on the lake in the traffic lane. There shall be no waterskiing, aquaplaning or similar activity within the shore zone. C. Water ski towing. (1) There shall not be more than two persons on water skis being towed by one boat at any one time, and each shall have an individual tow line. (2) Persons being towed must wear personal flotation devices as defined in § 30.62(3), Wis. Stats. (3) Persons being towed behind a vessel on water skis or similar device or engaged in a similar activity may not come or allow the tow rope to come within 100 feet of a personal watercraft. D. Towing of water tubes. (1) There shall not be more than two towing lines per boat. (2) The human capacity of each water tube shall not exceed that recommended by the manufacturer. (3) No vessel towing a person or persons on a water tube may come within 100 feet of other occupied anchored vessels, a personal watercraft, a buoy-marked swimming area or a public boat landing.
E. Exceptions. The limitations of this section shall not apply to participants in ski meets or exhibitions authorized and conducted as provided in § 330-11 of this chapter.

§ 330-10. Houseboats; littering prohibited.

Any boat or craft which is designed for persons to use for living, sleeping or camping activities, commonly referred to as a "houseboat," shall be equipped with suitable sanitation facilities and comply with § 330-3 of this chapter, adopting § 30.71, Wis. Stats. No person shall leave, deposit, place or throw on the waterways, ice, shores of waterways or upon any other public or private property adjacent to waterways any cans, bottles, debris, refuse or other solid waste material of any kind or any liquid waste, gasoline, oil or similar pollutant.

A.

B.

C.

D.

A.

B.

C.

D.

[Amended 11-13-2001 by Ord. No. 01-11-13D]

§ 330-11. Races, regattas, sporting events and exhibitions.

Permit required. No person shall direct or participate in any boat race, regatta, water-ski meet or other water sporting event or exhibition on Silver Lake unless such event has been authorized jointly by the Village Board of Silver Lake and the Town Board. On all other waters under the jurisdiction of the Town, such permit shall be authorized by the Town Board. Permit. A permit issued under this section shall specify the course or area of water to be used by participants in such event, and the permittee shall be required to place markers, flags or buoys approved by the Chief of the Water Safety Patrol designating the specified area. Permits shall be issued only when the proposed use of the water can be carried out safely and without danger to or substantial obstruction of other watercraft or persons using the lake. Right-of-way of participants. Boats and participants in any such permitted event shall have the right-of-way on the marked area, and no other persons shall obstruct such area during the race or event or interfere therewith. Permit fee required. Upon making application for a special event permit, the applicant shall pay a permit fee as provided in Chapter 272, Fees, § 272-6, to the Town Clerk.

§ 330-12. Driving of motor-driven vehicles on ice.

Speed. No person shall use or operate any automobile at a speed in excess of 10 mph on the ice of any lake or waterway within the Town of Salem. Hours. No person shall use or operate any automobile on the ice of any lake or other waterway within the Town of Salem after 9:00 p.m. Definition. The word "automobile," as used in this chapter, shall be construed to mean all motor vehicles of the type and kind permitted to be operated on the highways in the state. Risk and liability. All traffic on the icebound waters within the Town of Salem shall be at the risk of the traveler as set forth in § 30.81(3), Wis. Stats. Nothing in this chapter shall be construed as rendering the Town liable for any accident to those engaged in permitted traffic while this chapter is in effect.

§ 330-13. Joint jurisdiction over Silver Lake.

Recognizing the joint jurisdiction of the Village of Silver Lake and the Town over the waters of Silver Lake, it is the intent of this chapter that the Village of Silver Lake and the Town shall cooperate and coordinate ordinances, rules and regulations and shall have joint jurisdiction for enforcement purposes, except that violations occurring in the Town shall be brought before the Municipal Court of the Town, and those violations under the jurisdiction of the Village of Silver Lake shall be brought before the Municipal Court of the Village of Silver Lake.

§ 330-14. Water patrol officers; public safety officers.

[Added 4-13-1992 by Ord. No. 92-04-13B; amended 4-12-1993 by Ord. No. 93-04-12]

A.

B.

C.

Qualifications. The Town Board of the Town of Salem may appoint one or more water patrol officers who shall be adults of good moral character with no prior criminal record. A water patrol officer shall be a certified law enforcement officer. Authority. Water patrol officers of the Town of Salem shall have the authority to make arrests in the course of duty enforcing the provisions of this chapter, including those provisions of the Wisconsin Statutes incorporated by reference. Water patrol officers shall have the authority to carry firearms in the course of duty, subject to the restrictions and policies established by the Town Board from time to time. [Amended 2-13-1995 by Ord. No. 95-02-13B] Public safety officers. Town of Salem public safety officers may perform the additional duties of water patrol officers and shall have the power of arrest and may issue citations for violations of this chapter, including those provisions of the Wisconsin Statutes incorporated by reference. Town of Salem public safety officers shall have the authority to carry firearms in the course of duty, subject to the restrictions and policies established by the Town Board from time to time. [Amended 11-13-2001 by Ord. No. 01-11-13D]

§ 330-15. Boats in marked swim areas prohibited; exceptions.

[Added 11-13-2001 by Ord. No. 01-11-13B] No boat of any type is permitted within a water area which has been clearly marked by buoys or some other distinguishing device as a bathing or swimming area. This section does not apply in the case of emergency or to patrol or rescue craft.

§ 330-16. Fertilizer applications.

[Added 6-12-2006 by Ord. No. 06-06-12B] A. Definitions. As used in this section, the following terms shall have the meanings indicated: **FERTILIZER** Has the meaning specified under § 94.64(1)(e), Wis. Stats. **IMPERVIOUS SURFACE** A highway, street, sidewalk, parking lot, driveway, or other material that prevents infiltration of water into the soil. **LAWN AND TURF FERTILIZER** Has the meaning specified under § 94.64(1)(e), Wis. Stats., except the manufacturer has designated the product to be used for the promotion of lawn and turf growth. B. It shall be unlawful for any person to apply within the Town any lawn and turf fertilizer, liquid or granular, that contains more than a trace of phosphorus or other compound containing phosphorus, such as phosphate. C. It shall be unlawful for any person to apply or deposit any fertilizer on an impervious surface. If such application occurs, the fertilizer must be immediately contained and either legally applied to turf or any other lawful site or returned to the original or other appropriate container. D. Time of application. It shall be unlawful for a person to apply lawn and turf fertilizer when the ground is frozen or when conditions exist which promote or create runoff.

E.

A.

B.

C.

D.

E.

Exceptions. (1) Subsection B shall not apply when: (a) A tissue, soil or other test by UW-Extension Laboratory, or another state-certified soil-testing laboratory, and performed within the last three years indicates that the level of available phosphorus in the soil is insufficient to support healthy turf growth, as determined by the University of Wisconsin Extension Service, provided that the proposed lawn and turf fertilizer application shall not contain an amount of phosphorus exceeding the amount and rate of application recommended in the soil test evaluation. (b) The property owner or an agent of the property owner is first establishing or reestablishing turf via seed or sod procedures, and only during the first growing season. (2) Subsection B shall not apply to fertilizers used in any agricultural use as defined in § 91.01(2), Wis. Stats., to promote crop or product growth. (3) Any person who applies a lawn and turf fertilizer containing phosphorus pursuant to the aforementioned exception shall, consistent with the product label instructions, water such lawn and turf fertilizer into the soil where it is immobilized and generally protected from loss by runoff.

§ 330-17. Operation of aircraft on water prohibited; exceptions.

[Added 9-10-2007 by Ord. No. 07-09-10A] No person, firm or corporation shall operate or authorize the operation of any aircraft capable of landing on water on any river or lake within the jurisdiction of the Town of Salem, with the exception of Camp Lake. For purposes of this section, the term "operation" shall include but not be limited to landing or takeoff and any contact of any portion of such aircraft with the surface of any affected body of water. This section shall not apply to any operation on such bodies of water by duly authorized government or law enforcement officials or any operation necessitated by an emergency situation outside of the control of the operator of such aircraft.

§ 330-18. Violations and penalties.

Unless otherwise provided herein, any person violating any provisions of this chapter shall, upon conviction, be subject to the penalty provided in § 1-4 of this Code. [Amended 6-13-2011 by Ord. No. 11-06-13] Any person violating the provisions of § 330-3 of this chapter, incorporating § 30.681 or 30.684, Wis. Stats., shall, upon conviction, be subject to a forfeiture of not less than $150 nor more than $300. Any person violating any provision of the Wisconsin Statutes incorporated herein, which violation is punishable by the imposition of a fine or imprisonment, or both, shall be referred to state authorities for prosecution. Citations for violations of this chapter shall be issued on forms prepared by the Department of Natural Resources, and the Uniform Wisconsin Schedule, adopted pursuant to § 23.66, Wis. Stats., shall be effective for the posting of bonds for violations under this chapter.

The provisions relating to citations, arrests, questioning, releases, searches, deposits and stipulations of no contest in §§ 23.51(1m), (3) and (8); 23.53; 23.54; 23.56 to 23.64; 23.66; and 23.67, Wis. Stats., shall apply to violations of this chapter. [Added 1-12-2004 by Ord. No. 04-01-12C]

§ 330-19. Operation of motorboats on Rock Lake.

[Added 8-13-2012 by Ord. No. 12-08-13; amended 12-10-2012 by Ord. No. 12-12-10A] The propulsion of boats on Rock Lake shall be limited to the use of oars, paddles, sails or electric motors. This section shall not apply to: A. Any operation by duly authorized government or law enforcement officials in the course of the performance of their duties. B. Any operation necessitated by an emergency situation outside of the control of the operator of the motor boat. C. Any operation necessary for the mechanical or chemical management of weeds or other aquatic growth or shoreline restoration on Rock Lake by the holder of a permit issued by the Wisconsin Department of Natural Resources. D. Any operation necessary to complete a salvage operation on Rock Lake.

§ 330-20. Boat launch fees.

[Added 10-14-2013 by Ord. No. 13-10-14A] A. Any person, firm or corporation launching a boat at any public boat launch on Camp Lake or Center Lake shall pay a fee, as established below: (1) Daily fee: Town of Salem resident (single boat/single day launches): $3. (2) Dally fee: nonresident (single boat/single day launches): $4.50. (3) Daily launch fee for senior citizens over the age of 65 years: $0. (4) Annual launch fee: Town of Salem resident (unlimited launches in calendar year): $20. (5) Annual launch fee: nonresident (unlimited launches in calendar year): $30. B. The Town shall install and maintain a secured collection box at the public launches to accept the daily fees, shall post notice of the fee requirement in a prominent place at the public launches, and shall provide envelopes for payment with a receipt. In addition, the Town shall make annual fee launch stickers available for purchase at the Town Hall during the Town's normal business hours. C. All persons launching a boat at a public boat launch on Camp Lake or Center Lake shall display, at the request of any water patrol or public safety officer, a receipt for payment of the daily fee. D. Any person launching a boat at the public launch on Camp Lake or Center Lake in violation of the provisions of this section shall be subject to forfeiture as provided in § 330-18 of this Code.

Chapter 16

REGULATION OF HOOKER LAKE

16.01 INTENT.

The intent of this Chapter is to provide safe and healthful conditions for the enjoyment of aquatic recreation consistent with public needs on the waters of Hooker Lake.

16.02 APPLICABILITY AND ENFORCEMENT.

The provisions of this Chapter shall apply to Hooker Lake and shall be compatible with Chapter 29 of the Ordinances of the Town of Salem, passed the 13th day of July, 1978, as said Town Ordinances relates to the waters of Hooker Lake. This Chapter shall be enforced jointly by the Water Patrol officers of the Town of Salem and the Village of Paddock Lake.

16.03 STATE BOATING AND WATER SAFETY LAWS ADOPTED.

The statutory provisions describing and defining regulations with respect to water traffic, boats, boating and related water activities in the following enumerated sections of the Wisconsin Statutes, exclusive of any provisions therein relating to the penalties to be imposed or the punishment for violation of said Statutes, are hereby adopted by reference and made a part of this Chapter:

30.50 Definitions.

30.51 Operation of unnumbered boats prohibited; exemptions.

30.52 Certificates of number; applications; issuance; renewals; fees.

30.53 Identification number to be displayed on boats; certificate to be carried.

30.54 Transfer of ownership of numbered boat.

30.55 Notice of abandonment or destruction of boat or change of address.

30.60 Classification of motorboats.

30.61 Lighting equipment.

30.62 Other equipment.

30.635 Motorboat prohibition.

30.64 Patrol boats exempt from certain traffic regulations.

16.04 DEFINITIONS.

(a) "Shore Zone" shall mean the water area within 200 feet of the lake shore.

(b) "Swimming Zone" shall mean an authorized area marked by official buoys to designate a swimming area.

(c) "Moorage" shall mean an area where continuous mooring of boats for more than twenty-four (24) hours is permitted.

(d) "Public Access" shall mean a marina or landing facility and the adjoining public shoreline under the ownership of the state, county or municipality.

(e) "Slow No Wake Speed" shall mean the slowest possible speed needed to maintain steerage.

(f) "Traffic Lane" shall mean the area beyond two hundred feet (200') of the shoreline.

16.05 SPEED RESTRICTIONS.

In addition to speed restrictions set forth in Sec. 16.03 of this Chapter adopting Sec. 30.66, Wis. Stats., no person shall operate in excess of the "slow no wake speed":

(a) Within a defined shoreline zone, or

(b) Between sunset and 10:00 a.m. in either the shore zone or the traffic lane.

(c) In the event that the Village Board declares a state of emergency because of high water or other reason, such speed limit to remain in effect until such time as the emergency situation no longer exists as determined by the Board of Trustees.

16.06 CAPACITY RESTRICTIONS.

No person shall operate, loan, rent or permit a boat to leave the place where it is customarily kept for operation on the waters covered by this Chapter with more passengers or cargo than shall be stated on the Capacity Information Plate as required by Sec. 30.501, Wis. Stats.

16.07 BUOYS, PIERS, AND RAFTS.

(a) The Village of Paddock Lake or the Town of Salem may remove all buoys, markers, piers and their supports, privately owned or placed, which are not removed by December 1st of each year, and charge the cost and expense of such removal to the riparian owner. If such charge is not paid within thirty (30) days after request therefore, a penalty of ten percent (10%) shall be added to such charge and the same shall constitute a lien on the property of the riparian owner and be inserted on the Village of Paddock Lake tax roll by the Village Clerk/Treasurer upon order of the Village Board and after notice to the riparian owner.

(b) All navigation aids must comply to Sec. 30.74(2), Wis. Stats., and shall also have affixed to them any numbers issued by their permit pursuant to subsection (f) below. Such number shall be located at least twelve inches (12") above the water line, and shall not be less than three inches (3") in height.

(c) No person shall erect nor maintain any wharf or pier contrary to the Statutes and regulations of the State of Wisconsin, nor which extends more than one hundred (100') from the shore unless prior written approval is obtained from the Village of Paddock Lake and the Town of Salem.

(d) No pier or mooring buoy shall be placed in the waters located within the boundary of a designated fire lane (extended into the water) unless so authorized in writing by the Village Board of the Village of Paddock Lake and by the Town Board of the Town of Salem.

(e) Rafts and Platforms. No person shall place or maintain any raft or platform more than one hundred feet (100') from the shore. Rafts and platforms shall be anchored, have at least eighteen inches (18") of free board above the water line, be painted white, and have attached thereto, not more than twelve inches (12") from each corner or projection a red reflector at least three inches (3") in diameter.

(f) Buoy Permits. No bathing beach marker, speed zone marker, information marker, mooring buoy, fishing buoy or other marker shall be anchored or placed on Hooker Lake, unless a written application is approved by both the Village Board of the Village of Paddock Lake and the Town Board of the Town of Salem. As to such markers and buoys located on Hooker Lake, an application must be made jointly to the Village of Paddock Lake and to the Town of Salem and approved by both bodies. The Town of Salem shall issue numbers for such markers and buoys.

(g) Placement of Authorized Markers. The Chief of Water Safety Patrol is authorized and directed to place authorized markers, navigation aids and signs in such water areas as shall be appropriate to advise the public of the provisions of this Chapter and to post and maintain a copy of this Chapter at all public access points within the jurisdiction of the Village of Paddock Lake.

16.08 SWIMMING REGULATIONS.

(a) Swimming from Boats Prohibited. No person shall swim from any unmanned boat unless such boat is anchored.

(b) Distance from Shore or Boats. No person shall swim beyond the shore zone or more than fifty feet (50') from any pier (unless within marked authorized areas) or more than twenty-five feet (25') from anchored rafts or boats unless he is accompanied by a boat manned by a competent person and having readily available a ring buoy. Such boat shall stay reasonably close to and guard such swimmer, and there must be at least one (1) boat for each two (2) swimmers.

(c) Hours Limited. No person shall swim more than two hundred feet (200') from the shoreline between the hours of 7:00 p.m. and 10:00 a.m.

16.09 WATER SKIING.

(a) Hours. No person shall operate a boat for the purpose of towing a water skier, aquaplane or similar device between the hours of 7:00 p.m. and 10:00 a.m. tats.

(b) Traffic Lane. Any boat engaged in towing a person on water skis, aquaplane or similar device must conform to all sections of this Chapter and in addition, must operate in a counter-clockwise pattern on the lake in the traffic lane. There shall be no water skiing, aquaplaning or similar activity within the shore zone.

(c) Towing. There shall be not more than two (2) persons being towed by one (1) boat and each shall have an individual tow line. Persons being towed must wear personal flotation devices as defined in Sec. 30.62(3), Wis. Stats.

(d) Exceptions. The limitations of this section shall not apply to participants in ski meets or exhibitions authorized and conducted as provided in Section 16.11 of this Code.

16.10 LITTERING WATERWAYS PROHIBITED.

(a) Any boat or craft which is designed for living, sleeping or camping activities (commonly referred to as a "House Boat") shall be equipped with suitable sanitation facilities and comply with Sec. 30.71, Wis. Stats.

(b) No person shall leave, deposit, place or throw on the waterways, ice, shores or waterways or upon any other public or private property adjacent to waterways, any cans, bottles, debris, refuse or other solid waste materials of any kind.

16.11 RACES, REGATTAS, SPORTING EVENTS AND EXHIBITIONS.

(a) Permit Required. No person shall direct or participate in any boat race, regatta, waterski meet or other water sporting event or exhibitions on Hooker Lake unless such event has been authorized by the Village Board of the Village of Paddock Lake and the Town Board of the Town of Salem.

(b) Permit. A permit issued under this section shall specify the course or area of water to be used by participants and require the permittee to place markers, flags or buoys approved by the Chief of the Water Safety Patrol designating the specified area. Permits shall be issued only when the proposed use of the water can be carried out safely and without danger to or substantial obstruction of other watercraft or persons using the lake.

(c) Right-of-way of Participants. Boats and participants in any such permitted event shall have the right-of-way on the marked area and no other persons shall obstruct such area during the race or event or interfere therewith.

16.12 DRIVING AUTOMOBILES OR OTHER VEHICLES ON THE ICE.

(a) Speed. No person shall use or operate any automobile at a speed in excess of ten (10) miles per hour on the ice.

(b) Hours. No person shall use or operate any automobile on the ice after 9:00 p.m.

(c) Definitions.

(1) "Automobile" as used in this Chapter shall be construed to mean all motor vehicles of the type and kind permitted to be operated on the highways in the State of Wisconsin.

(2) "Other Vehicles" includes, but is not limited to, snowmobiles, go-carts, bicycles and motorcycles not permitted on state highways.

(d) Risk and Liability. All traffic on the icebound waters shall be at the risk of the travelers as set forth in Section 30.18(3) of the Wisconsin Statutes. Nothing in this Chapter shall be construed as rendering the Village of Paddock Lake or the Town of Salem liable for any accident to those engaged in permitted traffic.

16.13 PENALTIES.

Any person violating any provision of this Chapter shall, upon conviction, be subject to a forfeiture of not more than Fifty Dollars ($50.00) for the first offense, and not more than One Hundred Dollars ($100.00), for each subsequent offense with one (1) year. Any person violating Section 30.67(1) or (2), Wis. Stats., or 30.68(1) or (2), Wis. Stats., shall be referred to State authorities for prosecution.

Citations for violations of this Chapter shall be drafted on forms prepared by the Department of Natural Resources. Bonds may be posted for violations pursuant to Section 23.66, Wis. Stats.

16.14 JURISDICTION.

Recognizing the joint jurisdiction of the Village of Paddock Lake and the Town of Salem over the waters of Hooker Lake, it is the intent of this Chapter that the Village of Paddock Lake and the Town of Salem shall cooperate and coordinate ordinances, rules and regulations and shall have joint jurisdiction for enforcement purposes. However, violations occurring in the jurisdiction of the Town of Salem shall be brought before the Municipal Court of the Town of Salem and those violations under the jurisdiction of the Village of Paddock Lake shall be brought in the Municipal Court of the Village of Paddock Lake.

16.15 USE OF HOOKER LAKE BOAT LAUNCH.

(a) Policy. It is the declared policy of the Village to encourage the use of the facilities constructed by the Village for access to Hooker Lake in a fashion so as to allow equal access to all who wish to use this facility.

(b) Prohibitions. No operator of any vehicle shall park or stop or leave standing such vehicle on any street or highway or public way or in any parking space at or adjacent to the Hooker Lake boat launch, except in conformance with the permitting provisions of this ordinance. For purposes of this ordinance, vehicles shall include all motor vehicles as well as trailers, boats, motor homes or any other device which is defined as a vehicle under the Wisconsin Statutes, which are incorporated herein by reference.

(1) Presumption. Ownership of a vehicle is sufficiently related to causing, allowing, permitting or suffering a vehicle parked so as to require the owner to be responsible for the parking of said vehicle. It shall be presumed, upon a showing by the Village, that a parking violation occurred and upon a showing that the party charged pursuant to this ordinance, was the registered owner of the unlawfully parked vehicle on the date of the violation that said registered owner is responsible for and guilty of the violation charged.

(2) Overcoming Presumption. The presumption stated in the preceding subparagraph, when established as therein specified, shall constitute a prima facie case and a basis for judgment, except where the person or other legal entity to which the vehicle is registered overcomes said presumption by the submission of proof of any of the following:

(a) The vehicle is stolen at the time the violation occurred, and reported as such to law enforcement authorities within a reasonable time thereafter.

(b) The vehicle was lawfully parked.

(c) The ownership of the vehicle was lawfully transferred to another prior to the violation.

(c) Parking Passes. Parking passes are printed passes issued by the Village for a designated period of time, to an individual for the purpose of allowing such individual to legally park in a properly marked parking stall at the Hooker Lake boat launch for the period of time specified on the pass. Parking passes shall be of two (2) types as follows: Daily and seasonal.

(d) Fees. Fees for parking passes shall be as follows:

(1) Seasonal (May 1 through October 31)

(a) Wisconsin resident - $35.00

(b) Non-resident - $40.00

(2) Daily - $7.00

(3) Seasonal (May 1 through October 31) good for both Paddock Lake and Hooker Lake

(a) Wisconsin resident - $45.00

(b) Non-resident - $55.00

(e) Properly Displayed Passes. A properly displayed parking pass means that the parking pass must be displayed in the inside lower left hand corner of the front windshield. Operators of vehicles lawfully possessing and displaying valid parking passes, shall be permitted the privilege of parking in a lawful and orderly manner in a properly marked parking stall at the Hooker Lake boat launch without incurring the issuance of legal process and the imposition of forfeiture or penalty for failure to pay said fee.

(f) Form. Parking passes shall be obtained from the office of the Village Clerk/Treasurer and shall contain the date(s) for which the pass is valid and the name and address of the parking pass holder.

(g) Fine. Violation of this section shall result in the imposition of a fine of Twenty-five ($25.00) Dollars for a first offense and Fifty ($50.00) Dollars for a second and any subsequent offense.

Source: Village of Paddock Lake.

(This page intentionally left blank)

Appendix J

WDNR SENSITIVE AREA REPORT FOR HOOKER LAKE

(This page intentionally left blank)

Hooker Lake (Kenosha County, Wisconsin) Integrated Sensitive Area Report

Date of Original Assessment:	September 4, 2001
Date of Reassessment:	June 12th, 2007

Number of Sensitive Areas Surveyed: 2

Site Evaluators:	Doug Welch, Fisheries Biologist Heidi Bunk, Lakes Biologist Marty Johnson, Wildlife Biologist Heidi Hopkins, Water Management Specialist Craig Helker, Water Quality Biologist
Authors:	Gabriel Powers, Water Resource Specialist Heidi Bunk, Lakes Biologist

General Lake Information

Hooker Lake is an 87-acre lake with a maximum depth of 24 feet. The lake is located in south central Kenosha County, Township 1 North, Range 20 East, Section 11. Hooker Lake is characterized as a drainage lake. The lake receives its water from two tributaries, groundwater seepage, precipitation, and runoff. An outlet connects the lake to Salem Brook which ultimately discharges to the Des Plaines River.

Two public boating access sites are located on Hooker Lake. One access meets the requirements of "adequate public access" as defined by NR 1.91(11), Wis. Adm. Code. Hooker Lake is host to a variety of recreational uses including, but not limited to fishing, hunting, canoeing, kayaking, boating and swimming. The Department of Natural Resources and Kenosha County both own land along the shoreline of Hooker Lake.

The mix of wetlands and submergent vegetation present on Hooker Lake provides critical habitat for a variety of fish and wildlife species. According to the DNR Fish Master File, 25 fish species have been documented in Hooker Lake. These species include: northern pike, largemouth bass, smallmouth bass, walleye, yellow perch, bluegill, pumpkinseed, black crappie, green sunfish, warmouth, grass pickerel, common carp, yellow bullhead, black bullhead, brown bullhead, channel catfish, Iowa darter, golden shiner, white sucker, common shiner, spotted sucker, emerald shiner, bluntnose minnow, central mudminnow and a State Special Concern species, lake chubsucker.

The aquatic plant management on Hooker Lake consists only of selective treatment of eurasian water milfoil with 2,4-D products. No mechanical harvesting takes place. Manual harvesting is conducted by many riparian landowners. The Hooker Lake Management District oversees aquatic plant management activities for Hooker Lake. In 2007, 9 acres in Hooker Lake were chemically treated for eurasian water milfoil.

Exotic Species

Exotic species, most notably curly leaf pondweed, eurasian water milfoil, and purple loosestrife have invaded southeastern Wisconsin lakes. Boaters traveling from lake to lake often facilitate the propagation of exotic species. The introduction of exotic species into a lake ecosystem can lead to a decline in the native plant population and cause problems with nutrient loading. Also, the disturbance of lake bottoms from human activity (boating, plant harvesting, chemical treatments, etc.) enhances the colonization and/or expansion of exotic species. Two simple steps to prevent the spread of exotic species include 1) Removing aquatic plants, animals, and mud from trailers and boats before leaving the water access; and 2) Draining water from boats, motors, bilges, live wells, and bait containers before leaving the water access.

Eurasian water milfoil is present in Hooker Lake. Eurasian water milfoil is one of eight milfoil species currently found in Wisconsin. It is often misidentified as one of its seven native cousins, and vice versa. In many areas within the Lakes, this non-native milfoil has established large monotypic stands that out compete many native plants. These dense beds of milfoil not only impede the growth of native plant species but also inhibit fish movement and create navigational problems for boaters.

The regenerative ability of eurasian water milfoil is another obstacle when attempting to control this species. Fragments of eurasian water milfoil detached by harvesting, boating, and other recreational activities can float to non-colonized areas of the lake or downstream to additional lakes in the drainage system and create new colonies. Therefore, when controlling eurasian water milfoil, selective chemicals and harvesting, coupled with skimming, often produces the best results. In some lakes, biological agents such as the milfoil weevil have helped suppress milfoil populations. However, the most effective "treatment" of exotic milfoil is prevention through public education.

Curly leaf pondweed is another submerged, exotic species found Hooker Lake. Like eurasian water milfoil, curly-leaf often grows into large, homogenous stands. It can crowd out native vegetation, create navigational problems, and limit fish movement. Curly-leaf pondweed dies off in mid-summer, increasing nutrient availability in the water column. This often contributes to summer algal blooms and decreasing water quality.

The unusual life cycle of curly leaf pondweed makes management difficult. The plant germinates as temperatures decrease in fall. Curly leaf is highly tolerant of cold temperatures and reduced sunlight, continuing to grow under lake ice and snow cover. With ice off and increasing water temperatures in the spring, the plant produces fruit, flowers, and buds (turions). Turions are the main reproductive mechanism of curly leaf. To control the species in lakes, the plant must be combated before turions become viable. Most plant harvesters have not started cutting when curly leaf is most susceptible and a small window of opportunity exists for chemical treatment. Therefore, prevention through public education is once again very important.

Purple loosestrife, a hardy perennial native to Europe, is another exotic species common to Wisconsin. Since its introduction to North America in the early 1800s, purple loosestrife has become common in gardens and wetlands, and around lakes, rivers, and roadways. The species is highly invasive and thrives in disturbed areas. Purple loosestrife plants often outcompete native plants, resulting in the destruction of food, cover, and nesting sites for wildlife and fish. Several stands of purple loosestrife have been documented on Hooker Lake.

Purple loosestrife most often spreads when seeds adhere to animals. Humans should be aware of picking up seeds on clothing and equipment when in the vicinity of the plant. Loosestrife can be controlled manually, biologically, or with a broad-leaf herbicide. Young plants can be pulled, but adult plants have large root structures and must be excavated with a garden fork. Biological control is most effective on large stands of purple loosestrife. Five different insects are known to feed on this plant. Four of those have been used as control agents in the United States. Of the five species, *Galerucella pusilla* and *G. calmariensis* are leaf-eating beetles; *Nanophyes brevis* and *N. marmoratus* are flower-eating beetles; and *Hylobius trasversovittatus* is a root-boring weevil. Only *N. brevis* has not been released in the United States (WDNR 2003). Lastly and most importantly, prevention through public education plays an important role in the management of this species.

Zebra mussels are native to the Baltic and Caspian Sea region or Eastern Europe, and were introduced to the great lakes via ballast water discharged from ocean-going vessels. These mussels attach to nearly every available surface – boats, docks, intake pipes, and are a great threat to native mussel populations. They are filter feeders, and thus eat plankton in the water column that many young fish and native mussels rely on for food. Zebra mussels begin their life cycle at a microscopic level. This stage of life stage is called a veliger. Water that is transferred from water body to water body can lead to new infestations by these veligers. Adults may also hitch a ride on aquatic plants that are transported from one body of water to another by means of boat trailers, river flow, or animal dispersion. Zebra mussels have not been documented in Hooker Lake.

Shoreland Management

Wisconsin's Shoreland Management Program, a partnership between state and local governments, works to protect clean water, habitat for fish and wildlife, and natural scenic beauty. The program establishes minimum standards for lot sizes, structural setbacks, shoreland buffers, vegetation removal, and other activities within the shoreland zone. The shoreland zone includes land within 1000 feet of lakes, 300 feet of rivers, and floodplains. Current research shows that present standards are probably inadequate for the protection of water resources. (Woodford and Meyer 2003, Garn 2002) Therefore, many communities have chosen to go beyond minimum standards to ensure protection of our natural resources. This report provides management guidelines for activities within the lake and in the immediate shoreland areas. Before any recommendations in this report are completed, please check with the Department of Natural Resources and local units of government for required approvals.

A vital step in protecting our water resources is to maintain effective vegetative buffers. A shoreland buffer should extend from the water onto the land at least 35 to 50 feet. Studies have shown that buffers less than 35 feet are not effective in reducing nutrient loading. (Wenger, 1999) Wider buffers of 50 feet or more can help provide important wildlife habitat for songbirds, turtles, frogs, and other animals, as well as filter pollutants from runoff. (Castelle 1994) In general, no mowing should occur in the buffer area, except perhaps in a viewing access corridor. The plant composition of a buffer should match the flora found in natural Wisconsin lakeshores. A buffer should include three layers - herbaceous, shrub, and tree.

In addition, citizens living around Hooker Lake and the community at large should investigate other innovative ways to reduce the impacts of runoff flowing into the lake while improving critical shoreline habitat. (A. Greene 2003) This may include the use of phosphorus-free fertilizers, installing rain gardens, setting the lawnmower at a higher mower height, decreasing the area of impervious surfaces, or restoring aquatic plant communities.

Introduction

Department personnel conducted sensitive area designation surveys on Hooker Lake both on September 4th, 2001 and June 12th, 2007 following the Wisconsin Department of Natural Resources' sensitive area survey protocol. This study utilized an integrated team of DNR resource managers with input from multiple disciplines: water regulation and zoning, fisheries, lake biology, wildlife, and aquatic plant management. Two sites were identified on Hooker Lake as containing critical habitat and were therefore designated as sensitive areas. Map 1 provides the boundaries of each sensitive area.

Department biologists observed fifteen native aquatic plant species in sensitive area #1 and ten native aquatic plant species in sensitive area #2. Three exotic aquatic plant species were observed in these sensitive areas as well. These included eurasian water milfoil (*Myriophyllum spicatum*), curly leaf pondweed (*Potamogeton crispus*) and purple loosestrife (*Lythrum salicaria*).

Overview of Sensitive Area Designations

Sensitive areas have aquatic or wetland vegetation, terrestrial vegetation, gravel or rubble lake substrate, or areas that contain large woody cover (fallen trees or logs). These areas provide water quality benefits to the lake, reduce shoreline erosion, and provide habitat necessary for seasonal and/or life stage requirements of fish, invertebrates, and wildlife. A sensitive area designation alerts interested parties (i.e., DNR personnel, county zoning personnel, lake associations, etc.) that the area contains critical habitat vital to sustaining a healthy lake ecosystem, or may feature an endangered plant or animal. Information presented in a sensitive area report is often utilized in the process of making Chapter 30 (Wisconsin State Statutes) permit decisions.

Sensitive areas are defined in Wisconsin Administrative Code NR 107.05 (3)(i)(1) as *areas of aquatic vegetation identified by the department as offering critical or unique fish and wildlife habitat, including seasonal or life stage requirements, or offering water quality or erosion control benefits to the body of water.* **Department resource managers determined that two areas of Hooker Lake met the criteria.**

Whole Lake Recommendations

These recommendations apply to Hooker Lake as a whole rather than a specific sensitive area.

1. Native aquatic plant beds should be protected and maintained for species diversity and to discourage invasion of exotic species.
2. Prevent the spread of exotic species through signage, education, etc. and control exotic species where established.
3. Compliance with Shoreland Zoning standards including setbacks, removal of nonconforming structures and limiting impervious surfaces.
4. Create shoreline buffers and maintain existing buffers, especially in areas not currently developed.
5. Monitor water quality for early detection of change and possible degradation.
6. Use phosphorus free lawn care to control nutrient runoff.
7. Establish a citizen lake monitor on Hooker Lake.

Resource Value of Sensitive Area #1

Sensitive Area #1 is located on the north side of Hooker Lake. The site is approximately 4000 feet long and has an average depth of 2 feet. Approximately two thirds of the frontage is owned by the Department of Natural Resources. This site was chosen because of the high value of the wetland plants for wildlife. Sensitive area #1 provides crucial habitat for many wildlife species. The aquatic bed/marsh wetland complex in this area provides quality habitat for marsh hawks, songbirds, ducks, geese, wading birds and some types of reptiles and amphibians. The wetland complex is important due to its relatively large size and adjacency to a large undeveloped upland corridor to the west.

The site was also chosen for the floating leaf and submergent aquatic vegetation, which provides spawning, nursery, feeding and protective habitat for northern pike, largemouth bass, panfish and minnow species. The aquatic plant diversity in this area is good with 16 native aquatic plant species documented as well 3 exotic aquatic plant species. Table 1 below lists the plant species observed and shows their relative abundance within sensitive area #1.

The plants create a nutrient buffer zone, utilizing lake nutrients (especially phosphorus) as part of their growth process, reducing the amount available for algal blooms. The root systems of the plants help stabilize the lake sediments. A biological and physical buffer zone is created by the dense plant beds. The dense beds reduce the ability for exotic plant species to invade Hooker Lake and protect properties from shoreline erosion. The shoreland buffer zone is wetland and dominated with herbaceous and shrub vegetation. The west half of the sensitive area's substrate is primarily silt, muck and detritus while the east portion is mostly sand. The natural scenic beauty in this area is average with minimal human impact.

Table 1. Plant Species Observed in Hooker Lake Sensitive Area #1

PRESENT (0-25%)	**COMMON (26-50%)**	**ABUNDANT (51-75%)**	**DOMINANT (76-100%)**
Shrubs *Salix* (willow)	**Emergents** *Impatiens* (jewelweed)	**Algae** Filamentous Algae	**Emergents** *Typha* (cattail)
Floating Leaf *Nuphar* (yellow water lily) *Nymphaea* (white water lilly)	**Pondweeds** *P. richardsonii* (clasping-leaf)	**Pondweeds** *Stuckenia pectinatus* (sago)	**Algae** *Chara* (muskgrass)
Submergents *Ceratophylum* (coontail) *Zosterella* (water stargrass) Native milfoil	**Exotics** *P. cripsus* (curly leaf) *Myriophyllum spicatum* (eurasian water milfoil)	**Submergents** *Vallisneria* (wild celery)	
Pondweeds *P.Illinoensis* (Illinois) *P. amplifolius* (Large-leaf pondweed) *P. Foliosus* (leafy pondweed)			
Exotics *Lythrum salicaria* (purple loosestrife)			

The vegetation and substrates in this area provide excellent spawning, nursery, feeding and protective habitat for northern pike and yellow perch. Largemouth bass and other sunfish will utilize this area for feeding, nursery and protective cover. In areas where the sunfish species can locate sand or sand/gravel bars under the fine substrates associated with this area, they too will use this area for establishing spawning nests. Table 2 below portrays the habitat each species relies on for the different stages of their respective life cycles.

Table 2. Sensitive Area #1 Plant Species and Substrates (Habitat) Utilized by Hooker Lake Resident Fish Species (2002 Survey)				
Fish Species	**Spawning**	**Nursery**	**Feeding**	**Protective Cover**
Walleye	Habitat lacking	Cattail, water lily, chara, coontail, wild celery, milfoil, pondweeds	Coontail, wild celery, milfoil, pondweeds	Coontail, milfoil, pondweeds
Northern Pike	Cattail, chara	Cattail, water lily, chara, coontail, wild celery, milfoil, pondweeds	water lily, coontail, wild celery, milfoil, pondweeds	Water lily, coontail, wild celery, milfoil, pondweeds
Smallmouth Bass	Habitat lacking	Cattail, water lily, chara, coontail, wild celery, milfoil, pondweeds	milfoil, pondweeds	Milfoil, pondweeds
Largemouth Bass	Coontail, watermilfoil Sand/gravel	Cattail, water lily, chara, coontail, wild celery, milfoil, pondweeds	Water lily, coontail, wild celery, milfoil, pondweeds, woody debris	Water lily, coontail, wild celery, milfoil, pondweeds, woody debris
Bluegill and Pumpkinseed	Sand/gravel	Cattail, water lily, chara, coontail, wild celery, milfoil, pondweeds	Water lily, coontail, wild celery, milfoil, pondweeds	Water lily, coontail, wild celery, milfoil, pondweeds
Black Crappie	*Chara* (muskgrass) Fine gravel and sand	Water lily, chara, coontail, wild celery, milfoil, pondweeds	pondweeds, milfoil, woody debris	pondweeds, milfoil, woody debris
Yellow Perch	woody debris, cattail, coontail, milfoil, pondweeds	Water lily, chara, coontail, wild celery, milfoil, pondweeds	pondweeds, milfoil	pondweeds, milfoil
Golden Shiner	Submergent vegetation (coontail, milfoil, pondweeds)	Submergent vegetation (coontail, *Chara*, milfoil, pondweeds)	Submergent vegetation (coontail, *Chara*, milfoil, pondweeds)	Submergent vegetation (coontail, *Chara*, milfoil, pondweeds)

Bluntnose Minnow	Underside of submerged objects (logs, rocks, bark or mussel shells) Sand/gravel shoals	Submergent vegetation (coontail, *Chara*, milfoil, pondweeds)	Submergent vegetation (coontail, *Chara*, milfoil, pondweeds)	Submergent vegetation (coontail, *Chara*, milfoil, pondweeds)

Management Recommendations for Sensitive Area #1

1. Do not remove fallen trees along shoreline, except where navigation is impaired. If navigation is impaired by a fallen tree, cut into smaller pieces and place outside of boating lane.

2. No chemical treatment should be allowed except to target an infestation of an exotic species such as purple loosestrife, eurasian water milfoil or curly leaf pondweed. Biological controls such as the purple loosestrife beetle and the milfoil weevil should be considered where appropriate.

3. No chemical treatment of eurasian water milfoil should occur adjacent to stands of susceptible aquatic plant species such as bladderwort or northern water milfoil.

4. Maintain the "Slow, No Wake" ordinance in this area of Hooker Lake. This ordinance minimizes boat motor disturbance of aquatic plants, fish and wildlife.

5. Minimize disturbance of the diverse stands of native aquatic vegetation.

6. Provide seasonal protection of fish spawning habitat.

7. Minimize disturbance of herbs, shrubs and trees on the shoreline to maintain wildlife habitat.

8. Mechanical harvesting should not be permitted.

9. New piers may be considered for a permit. However, additional piers are restricted to the existing, privately owned, developed shoreline. The number of moorings allowed will be less than listed in State Statutes 30.12 (1g) (f). The number of moorings permitted will be limited and based on the carrying capacity of the resource.

10. Limit manual harvesting to minimal swim/wading areas along the privately owned frontage. No manual harvesting should take place along the frontage of the state owned property. (*Manual removal of aquatic plants in Sensitive Areas must be permitted by DNR according to Wis. Adm. Code NR 109*).

11. Shoreline stabilization should not be needed in most areas of Sensitive Area # 1. If shoreline stabilization is needed, it must be accomplished by bioengineering.

12. A DNR permit should not be issued for any of the following:

Dredging	Pea gravel/sand blankets
Filling of wetlands	Recreational floating devices
Aquatic plant screens	Boat Ramps
Sea Walls/Retaining Walls/Riprap	Boardwalks

Resource Value of Site #2

Sensitive Area #2 is located in the southwestern corner of Hooker Lake. The approximate length of this site is 1000 ft with an average water depth of 4.5 ft. Kenosha County owns a small parcel on the north/northwest part of the bay. The location of the sensitive area habitat is the shoreline and littoral zone. The lake bed substrate consists of sand and muck. The shoreland area is approximately 33% wetland and 66% developed land with an abundance of lawns, some trees and herbaceous plants as well as a few shrubs. The natural scenic beauty rating in this area is poor, with major human disturbance. Important habitat components present at this site are emergent and submergent aquatic vegetation, floating leaf vegetation, and over-hanging vegetation.

This site was chosen due to the value of the aquatic plants for fish, amphibians and reptiles, as well as migratory waterfowl. The emergent vegetation is utilized by birds, frogs and turtles. Floating vegetation provides overhanging cover and shading for fish species and resting areas for frogs. Insect larvae hide underneath the blades of the plants, providing food for fish, frogs, turtles and birds. Table 3 below exhibits the plant species observed in sensitive area # 2 on Hooker Lake.

Table 3. Plant Species Observed in Sensitive Area # 2

PRESENT (0-25%)	COMMON (26-50%)	ABUNDANT (51-75%)	DOMINANT (76-100%)
Emergents *Impatiens* (jewelweed)	**Emergents** *Typha* (cattail)	**Floating Leaf** *Nuphar variegata* (spatterdock) *Nymphaea odorata* (white water lily)	**Submergents** *Ceratophylum* (coontail) *Ranunculus longirostris* (white water crowfoot)
Submergents *Myriophylum sibiricum* (northern water milfoil)	**Pondweeds** *P. richarsonii* (clasping-leaf pondweed)	**Pondweeds** *P. illinoensis* (Illinois pondweed) P. zosteriformis (Flat stem pondweed)	**Exotics** *Myriophylum spicatum* (Eurasian Water milfoil)
		Exotics *P. cripsus* (curly leaf)	

The combination of emergent vegetation and the silt/muck substrate provide an ideal spawning habitat for northern pike. Largemouth bass and other sunfish species will seek out sand and gravel areas for placement of spawning nests. Yellow perch will drape fertilized egg masses over woody debris and existing vegetation where available. All fish species can utilize the vegetative cover in sensitive area #2 for feeding, cover and resting areas. Table 4 below illustrates how some of resident fish species on Hooker Lake utilize the habitat in sensitive area #2.

Table 4. Sensitive Area # 2 Plant Species and Substrates (Habitat) Utilized by Hooker Lake Resident Fish Species

Fish Species	Spawning	Nursery	Feeding	Protective Cover
Walleye	Habitat lacking	Cattail, water lily, coontail, milfoil, pondweeds	Coontail, milfoil, pondweeds	Coontail, milfoil, pondweeds
Northern Pike	Cattail	Cattail, water lily, coontail, milfoil, pondweeds	Water lily, coontail, milfoil, pondweeds	Water lily, coontail, wild celery, milfoil, pondweeds
Smallmouth Bass	Habitat lacking	Cattail, water lily, coontail, milfoil, pondweeds	Milfoil, pondweeds	Milfoil, pondweeds
Largemouth Bass	Coontail, watermilfoil Sand/gravel	Cattail, water lily, coontail, milfoil, pondweeds	Water lily, coontail, wild celery, milfoil, pondweeds, woody debris	Water lily, coontail, wild celery, milfoil, pondweeds, woody debris
Bluegill and Pumpkinseed	Sand/gravel	Cattail, water lily, coontail, milfoil, pondweeds	Water lily, coontail, wild celery, milfoil, pondweeds	Water lily, coontail, wild celery, milfoil, pondweeds
Black Crappie	*Chara* (muskgrass) Fine gravel and sand	Water lily, coontail, milfoil, pondweeds	pondweeds, milfoil, woody debris	pondweeds, milfoil, woody debris
Yellow Perch	woody debris, cattail, coontail, milfoil, sago, clasping leaf	Water lily, coontail, milfoil, pondweeds	pondweeds, milfoil	pondweeds, milfoil

Golden Shiner	Submergent vegetation (coontail, milfoil, pondweeds)	Submergent vegetation (coontail, milfoil, pondweeds)	Submergent vegetation (coontail, *Chara*, milfoil, pondweeds)	Submergent vegetation (coontail, *Chara*, milfoil, pondweeds)
Bluntnose Minnow	Underside of submerged objects (logs, rocks, bark or mussel shells) Sand/gravel shoals	Submergent vegetation (coontail, milfoil, pondweeds)	Submergent vegetation (coontail, *Chara*, milfoil, pondweeds)	Submergent vegetation (coontail, *Chara*, milfoil, pondweeds)

Management Recommendations for Sensitive Area #2

1. Do not remove fallen trees in the bay, except where navigation is impaired. If navigation is impaired by a fallen tree, cut into smaller pieces and place outside of boating lane.

2. No chemical treatment should be allowed except to target an infestation of an exotic species such as purple loosestrife, eurasian water milfoil or curly leaf pondweed. Biological controls such as the purple loosestrife beetle and the milfoil weevil should be considered where appropriate.

3. No chemical treatment of eurasian water milfoil should occur adjacent to stands of susceptible aquatic plant species such as bladderwort or northern water milfoil.

4. Maintain the "Slow, No Wake" ordinance in this area of Hooker Lake. This ordinance minimizes boat motor disturbance of aquatic plants, fish and wildlife.

5. Minimize disturbance of the diverse stands of native aquatic vegetation, especially the lily pads and bulrushes on the northern side of the bay.

6. Mechanical harvesting should not be permitted.

7. New piers may be considered for a permit. The number of moorings allowed will be equal to that listed in State Statutes 30.12 (1g) (f). The shoreline is already extensively developed. As a result, the number of additional moorings permitted will be limited and based on the carrying capacity of the resource.

8. Limit manual harvesting to minimal swim/wading areas along the privately owned frontage. (*Manual removal of aquatic plants in Sensitive Areas must be permitted by DNR according to Wis. Adm. Code NR 109*).

9. Any replacement of the existing shoreline stabilization practices must include an element of bioengineering such as vegetated rip rap and biologs.

10. Installation of buffer strips along the highly developed shoreline is strongly recommended.

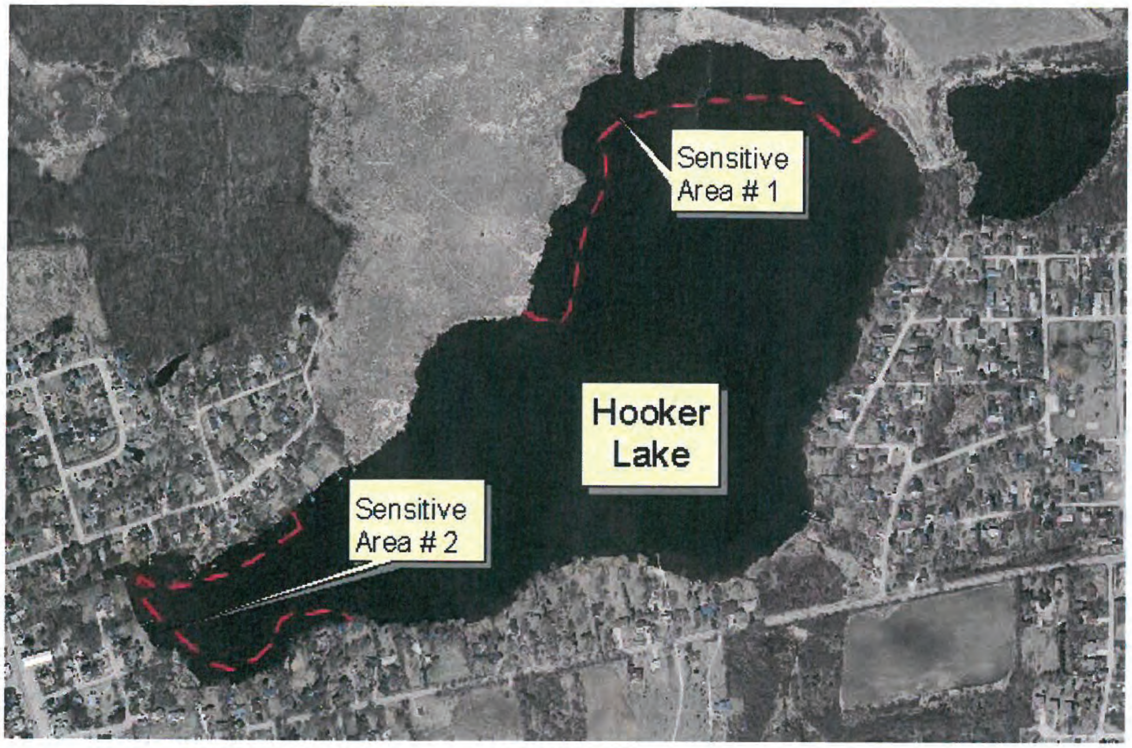
11. A DNR permit should not be issued for any of the following:

Dredging	Pea gravel/sand blankets
Filling of wetlands	Aquatic plant screens

Conclusion

Two sensitive areas were designated on Hooker Lake. Three quarters of the shoreline is highly developed. The lake is heavily used for fishing and pleasure boating. The wetland complex located on the north and northwest shorelines of the lake provides a reasonably large refuge for wildlife. The protection of the submergent and floating leaf aquatic plants found in the two sensitive areas is critical to maintaining the fishery in Hooker Lake.

Eurasian water milfoil has increased in coverage and density in recent years. Boating disturbance through the milfoil beds is likely the cause of much of the spread of eurasian water milfoil. The Hooker Lake Management District is currently applying for a lake planning grant. The grant, if awarded, would be used to conduct a plant survey and develop an aquatic plant management plan.



Source: Wisconsin Department of Natural Resources.

(This page intentionally left blank)

Appendix K

MEASURING STREAM FLOW

(This page intentionally left blank)

Water Action Volunteers

Volunteer Monitoring

Factsheet Series

2006

Stream Flow:

Flow Speaks Volumes

Why are we concerned?

Stream flow, or *discharge*, is the volume of water moving past a cross-section of a stream over a set period of time. It is usually measured in cubic feet per second (cfs). Stream flow is affected by the amount of water within a *watershed*, increasing with rainstorms or snowmelt, and decreasing during dry periods. Flow is also important because it defines the shape, size and course of the stream. It is integral not only to water quality, but also to habitat. Food sources, spawning areas and migration paths of fish and other wildlife are all affected and defined by stream flow and velocity. Velocity and flow together determine the kinds of organisms that can live in the stream (some need fast-flowing areas; others need quiet, low-velocity pools). Different kinds of vegetation require different flows and velocities, too.

Stream flow is affected by both forces of nature and by humans. *(continued on page 2)*

Time Needed:

30 minutes

Equipment Needed:

— Tape Measure

— Yardstick or marked D-frame net pole

— Surveying flags/flagging

— Float (an orange works best)

— Net (Can use D-frame net to catch the float)

— Stopwatch or digital watch

— Calculator

— Form to record data

— Pencil

— Hip boots or waders

— String (optional)

— Stakes (optional)

Definition of Terms

Discharge: Another term for stream flow, or the volume of water moving past a designated point over a set period of time.

Flow Regime: The pattern of stream flow over time, including increases with stormwater runoff inputs and decreases to a base-flow level during dry periods.

Impervious Surface: A surface that does not allow water (e.g., rain) to pass through (infiltrate).

Rating Curve: A graphical representation of the relationship between the stage height and the discharge (flow).

Run: An area of a stream that has swift water flow and is slightly deeper than a riffle (a run will be about knee/thigh deep).

Stage Height: Height of the water in a stream above a baseline.

Watershed: An area of land that drains to a main water body.

In undeveloped watersheds, soil type, vegetation, and slope all play a role in how fast and how much water reaches a stream. In watersheds with high human impacts, water flow might be depleted by withdrawals for irrigation, domestic or industrial purposes. Dams used for electric power generation may affect flow, particularly during periods of peak need when stream flow is held back and later released in a surge. Drastically altering landscapes in a watershed, such as with development, can also change *flow regimes*, causing faster runoff with storm events and higher peak flows due to increased areas of *impervious surface.* These altered flows can negatively affect an entire ecosystem by upsetting habitats and organisms dependent on natural flow rates.

Tracking stream flow measurements over a period of time can give us baseline information about the stream's natural flow rate.

Safety considerations

You will need to enter the stream channel to make width and depth measurements and to calculate velocity. Be aware of stream velocity, water depth, and bottom conditions at your stream-monitoring site. Do not attempt to measure stream flow if water velocity appears to be fast enough to knock you down when you are working in the stream. If you are unsure of water depth across the width of the stream, be sure to proceed with caution as you move across the stream, or choose an alternate point from which to measure stream flow.

Determining Stream Flow (Area x Velocity = Flow)

The method you are going to use in determining stream flow is known as a velocity-area approach. The task is to find out the volume of water in a 20-ft. (at least) section of stream by determining both the stream's velocity and the area of the stream section. You will first measure the width of the stream, and then measure water depth at a number of locations across the width to find the average depth at your monitoring site. Then by multiplying the average depth by the width, you can determine the average cross-sectional area (ft^2) of the stream. Water velocity (ft/sec) is determined simply by measuring the number of seconds it takes a float to travel along the length of stream you are studying. Since water velocity varies at different depths, (surface water moves more quickly than subsurface water because water moving against rough bottom surfaces is slowed down by friction) you will need to multiply velocity by a correction factor to adjust your measurement to account for the effect of friction. The actual equation you will use to determine flow is this: Flow=Area x Corrected Velocity. This method was developed and adapted from several sources (see bibliography). Alternative methods that may be better for your monitoring site are featured in the sidebar below.

Stream Flow Monitoring Methods: Professional and Home-Made

The type of monitoring station used by professionals depends on the conditions at the site including size, slope, accessibility, and sedimentation of the stream. Flow can also be measured at spillways, dams, and culverts or by using a weir or flume, which are man-made structures within a stream that provide a fixed stage-flow relation. Another method, using a home-made combination staff/crest gage, allows volunteer monitors to measure the water level (stage) both at the time of inspection and at the highest level reached since last inspected. This tool is made of PVC pipe, granulated cork and other materials. For more information, including how to make your own, visit:

www.epa.gov/owow/monitoring/volunteer/newsletter/volmon07no2.pdf

Measuring and Calculating Stream Flow

Site location

1. At your monitoring site, locate a straight section of stream that is at least 20 feet in length and has a uniform width. The water should be at least 6 inches deep, and have some movement. Unobstructed runs or riffles are ideal sites to choose.

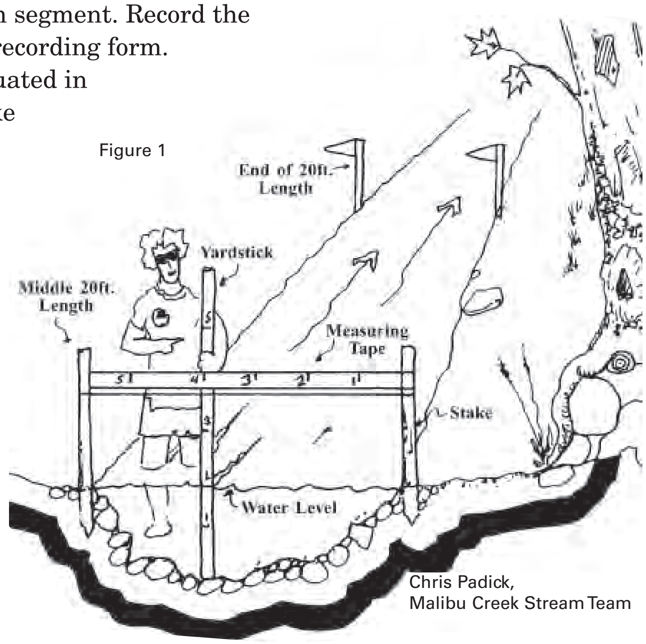
2. Measure 20 feet along the length of your chosen stream segment with your measuring tape and mark both the up and downstream ends of the section with flagging.

Width and depth measurements

3. Working with a partner, measure stream width (wetted edge to wetted edge) by extending a measuring tape across the stream at the midway point of your marked stream segment. Record the width in feet on your recording form. (A tape measure graduated in tenths of feet will make calculations easier.)

4. Secure the measuring tape to both shores so that the tape is taut and above the surface of the water. You might choose to attach the tape or a length of string to two stakes secured on opposite banks to create a transect line across the stream if it is impractical to secure the tape using shoreline vegetation. (Figure 1)

Figure 1



Chris Padick,
Malibu Creek Stream Team

5. Using your yardstick or pre-marked (in tenths of feet) D-frame net pole, measure the water depth (ft) at one-foot intervals across the stream where you measured width (and secured the measuring tape). Be sure to measure depth in tenths of feet, not in inches (See conversion chart from inches to tenths of feet on data recording form). Record depth measurements (ft) on the recording form. If your stream is greater than 20 feet wide, measure depth in 20 equal intervals across the stream.

Velocity measurement

Velocity will be measured by tracking the time it takes a floating object to move the marked 20-foot length of stream. You will time the floating object (in seconds) a total of four times, at different locations across the stream. Repeating your measurements across the stream, in both slower and faster areas, will help to ensure the closest approximation to the stream's true velocity. This in turn will make your flow calculations more accurate. However, be sure your float travels freely downstream (during every float trial) without catching in slack water areas of the stream. For narrower streams (less than 10 feet), you can conduct only three float trials to assess velocity.

6. Position the person who will release the float upstream from the upper flag. Position the timekeeper on the stream bank (or out of the main flow path) at the downstream flag with the stopwatch. Position the person who will catch the float downstream from the timekeeper (Note: Unless velocity is very fast, the timekeeper should be able to catch the float with a net after they have finished timing its run down the stream).

7. The float-releaser will gently drop the float into the stream a few feet upstream from the upper flag, and will alert the timekeeper to begin timing as the float passes the upstream flag (the float should have time to get up to speed by the time it passes the upper flag into the marked length of stream). If the float gets stuck on a log, rock or other obstruction, it should be released from the starting point again.

8. The timekeeper should stop the stopwatch as the float passes the downstream flag and retrieve the float using the net.

9. Record the float time for the first trial on the recording form.

10. Repeat steps 7-9 for each of the remaining float time trials in different sections of the stream. Record the float time (seconds) for each trial on the recording form.

Calculating stream flow

11. To determine the average depth at the site, first find the sum of your depth measurements. Then divide the sum of the depths by the number of depth measurements (intervals) you made. Record the average depth (ft) in the appropriate location on your recording form.

12. Next, multiply your average depth by the stream width. This is the average cross-sectional area (ft^2) of the stream. Record this in the appropriate box on your recording form.

13. Determine the average float time by first determining the sum of float times measured. Then divide the sum of the times by the number of float time measurements taken. Record this average float time (seconds) on your recording form.

14. Divide the length of your stream segment (e.g., 20 feet) by the average float time (seconds) to determine the average surface velocity at the site. Record the average surface velocity (ft/sec) on your recording form.

15. Determine the correction factor below that best describes the bottom of your stream and multiply it by the average velocity measurement to account for the effects of friction with the stream bottom on water velocity. Record your corrected average surface velocity on your recording form.

a. Correction factor for rough, loose rocks, course gravel or weeds: 0.8

b. Correction factor for smooth mud, sand, or bedrock: 0.9

16. Multiply the average cross-sectional area (ft^2) by the corrected average surface velocity (ft/sec) to determine stream flow. Record stream flow (ft^3/sec or cfs) in the space provided on your recording form.

Bibliography:
We reviewed and adapted information and methods from Missouri Stream Team Program, the WI DNR, the *EPA Volunteer Stream Monitoring Methods Manual* (EPA 841-B-97-003), the *Nohr Network of Monitors*, the Washington Co. (WI) Waterways Program, Hoosier Riverwatch, Project SEARCH, and California's Nonpoint Source Pollution Control Program as well as other technical information.

Water Action Volunteers is a cooperative program between the University of Wisconsin-Extension and the Wisconsin Department of Natural Resources. For more information, contact the Water Action Volunteers Coordinator at 608/264-8948.

What is a Staff Gage?

A staff gage is a tool that is often used in conjunction with other methods to determine stream flow. It looks like a large ruler placed vertically within a stream in a position least likely to catch floating debris, and that will be stable during high water flows and the winter freeze. Staff gages are calibrated in tenths of feet and allow a monitor to read and record the stage height (the height of water in the stream at a certain level) any time a monitor has the opportunity to visit the stream site. Staff gages are often placed at the stream's edge on a bridge abutment. WAV monitors may choose to place a staff gage at their monitoring site. You may need a permit to do this, however. Contact your local DNR Service Center for more information on permits.

If a staff gage is installed, monitors can simply record the water level on the staff gage without measuring flow. This method will provide added detail when assessing other parameters. However, scores cannot be compared between sites because each reading is germane only to that site.

Monitors may also choose to install a staff gage at their monitoring site and then, at a number of different water levels, record the stage height and determine the flow in the stream by following methods provided in this fact sheet. This type of monitoring is similar to what professionals do to determine a *rating curve* for a stream discharge monitoring station. The rating curve will reveal the stream's unique relationship between flow and stage height. Eventually, a monitor could determine stream flow simply by reading the stage height on the staff gage and looking at the site's rating curve to see what the flow is at that stage height. Caution must be used with this method since weeds, ice, or other factors can cause ponding of the stream water or movement of the staff gage over time, thus affecting rating curve results.

Appendix L

HEALTHY LAKES INITIATIVE

(This page intentionally left blank)

Green Lake, Green Lake County - Lisa Reas

WISCONSIN'S HEALTHY LAKES IMPLEMENTATION PLAN

2014-2017

(This page intentionally left blank)

TABLE OF CONTENTS

Team Members:
Dave Ferris, Burnett County Land and Water Conservation Department
Pat Goggin, Lake Specialist, UW-Extension Lakes
Jane Malischke, Wisconsin DNR Environmental Grants Specialist
Tom Onofrey, Marquette County Zoning Department
Carroll Schaal, Wisconsin DNR Lakes and Rivers Section Chief
Pamela Toshner, Wisconsin DNR Lake Biologist

The statewide Healthy Lakes initiative is a true, collaborative team effort. The Healthy Lakes Implementation Plan describes relatively simple and inexpensive best practices that lakeshore property owners can implement. The Plan also includes funding/accountability, promotion, and evaluation information so we can grow and adapt the Plan and our statewide strategy to implement it into the future. Working together, we can make Healthy Lakes for current and future generations.

Design and layout by Amy Kowalski, UWEX Lakes

Wisconsin's lakes define our state, local communities, and our own identities. Fond memories of splashing in the water, seeing moonlight reflect off the lake, and catching a lunker last a lifetime. With over 15,000 lakes dotting the landscape, it's no surprise that fishing alone generates a $2.3 billion economic impact each year , and the majority of property tax base rests along shorelines in some of our counties. Unfortunately, we've learned through science that our love for lakes causes management challenges, including declines in habitat and water quality. In fact, the loss of lakeshore habitat was the number one stressor of lake health at a national scale. Lakes with poor lakeshore habitat tend to have poor water quality. Working together to implement *Wisconsin's Healthy Lakes Implementation Plan* (Plan), we can improve and protect our lakes for future generations to enjoy, as well.

This Plan identifies relatively simple habitat and water quality best practices that may be implemented on the most typical lakeshore properties in Wisconsin. We encourage do-it-yourselfers to use these practices but have also created a Wisconsin Department of Natural Resources (DNR) Lake Classification and Protection Grant *Healthy Lakes* sub-category for funding assistance. Furthermore, local partners like lake groups and counties may choose to integrate the Plan into their lake management, comprehensive planning, and shoreland zoning ordinance efforts.

It's important to consider this plan in the context of the lake and local community's management complexity. The best practices' effectiveness will increase cumulatively with additional property owner participation and depend on the nature and location of the lake. For example, if every property owner implemented appropriate Healthy Lakes best practices on a small seepage lake, also known as a pothole or kettle lake, within a forested watershed, the impact would be greater than on a large impoundment in an agricultural region of Wisconsin. Nevertheless, all lakes will benefit from these best practices, and even with limited impact, they are a piece of the overall lake management puzzle that lakeshore property owners can directly control. More lakeshore property owners choosing to implement Healthy Lakes best practices through time means positive incremental change and eventually success at improving and protecting our lakes for everyone.

GOALS AND OBJECTIVES

Wisconsin's Healthy Lakes Implementation Plan goal is to protect and improve the health of our lakes by increasing lakeshore property owner participation in habitat restoration and runoff and erosion control projects.

- Statewide objective: single-parcel participation in Healthy Lakes will increase 100% in 3 years (i.e. 2015 to 2017).
- Individual lake objective: lake groups or other partners may identify their own habitat, water quality, and/or participation goal(s) through a local planning and public participation process.
  - Partners may adopt this Plan, as is by resolution, or integrate the Plan into a complimentary planning process such as lake management or comprehensive planning.

Wisconsin's Healthy Lakes Implementation Plan, and the diversion and rock infiltration practices in particular, are not intended for heavily developed parcels, sites with large volumes of runoff, or sites with complex problems that may require engineering design. Technical assistance and funding are still available for these sites; contact your county land and water conservation department or local DNR lakes biologist for more information.

The target audience for this Plan and implementation of the associated practices is lakeshore property owners, including: permanent and seasonal homeowners, municipalities, and businesses.

It will be necessary to do additional planning work to implement Wisconsin's Healthy Lakes Plan and, again, the level of effort will depend on the complexity of the lake and its local community. Planning could be as simple as site-specific property visits and development of design plans, to integrating the Plan into a broader and more comprehensive effort. Your lake group, county land and water conservation department, non-profit conservation association, UW-extension lakes specialist or local educator, and/or DNR lake biologist can provide planning guidance or contacts.

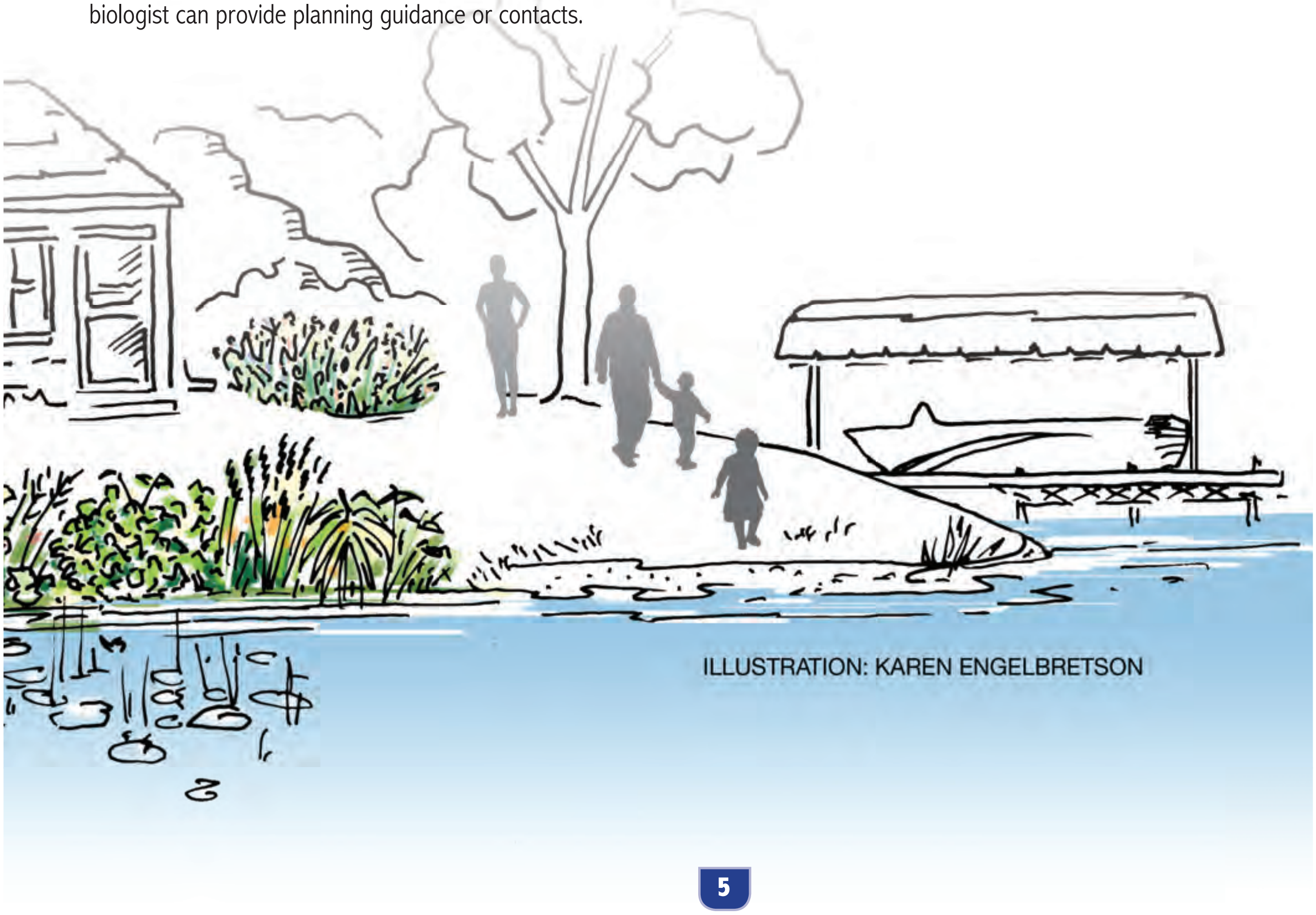


ILLUSTRATION: KAREN ENGELBRETSON

DEFINITIONS

Best practice: a working method, described in detail, which has consistently shown results.

Divert: redirect runoff water.

Habitat: where a plant or animal lives.

Infiltrate: soak into the ground.

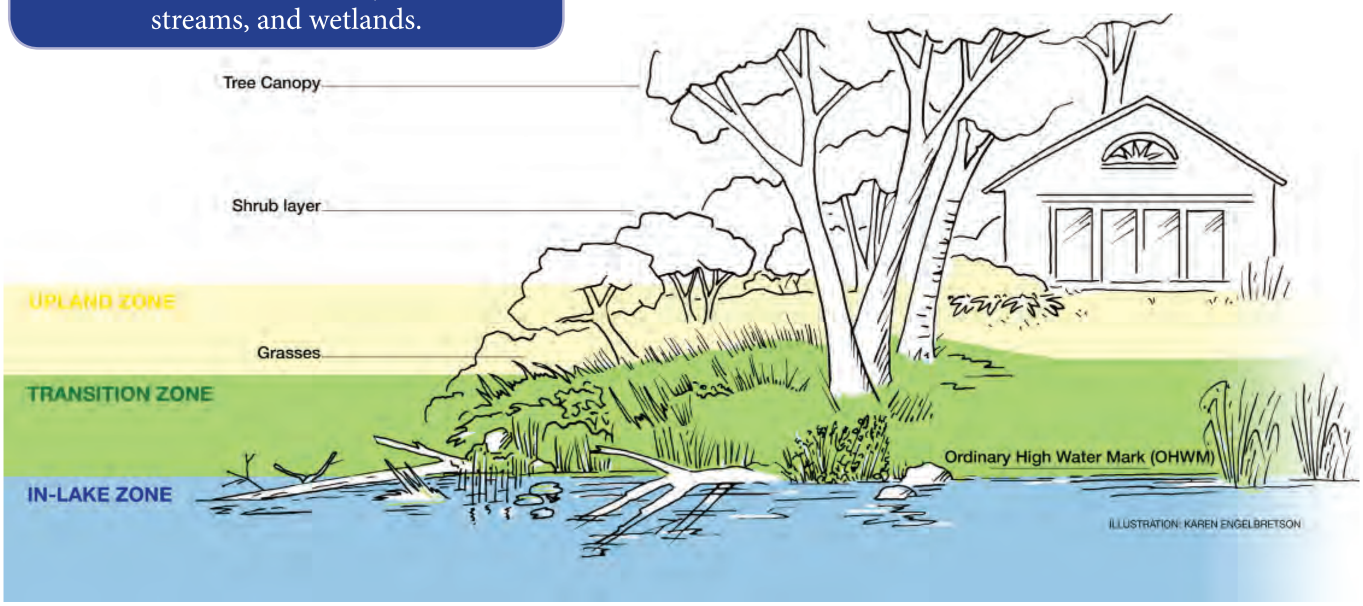
Installed: project cost that includes all materials, labor, and transportation.

Runoff: rain and snowmelt that doesn't soak into the ground and instead moves downhill across land and eventually into lakes, streams, and wetlands.

Wisconsin's Healthy Lakes Implementation Plan divides a typical lakeshore parcel into the following 3 management zones: 1) in-lake, 2) transition, and 3) upland (see illustration below). Best practices are identified for each zone. A team selected these practices based on customer feedback. These practices are:

- relatively simple and inexpensive to implement,
- appropriate for typical lakeshore properties, and
- beneficial to lake habitat and/or water quality.

The Plan also provides cost ranges and averages and technical, regulatory, and funding information for each practice. Fact sheets for each best practice support the Plan and provide more technical detail, and additional guidance is referenced if it currently exists. There is also a funding and administration FAQ fact sheet for those considering pursuing Healthy Lakes grants.



HEALTHY LAKES PLAN

BEST PRACTICES

Best practice descriptions follow. Each description defines the practice, identifies lake health benefits, provides cost ranges and averages based on recent projects, and identifies additional technical and regulatory information. The costs provided are installed costs, which include all materials, labor, and transportation but do not include technical assistance, including design and project management/administration work. Cost ranges are a result of geographic location, property conditions like soils and slopes, and contractor supply and proximity to the project site.

ZONE 1: IN-LAKE

PRACTICE 1 | FISH STICKS

...large woody habitat structures that utilize whole trees grouped together resulting in the placement of more than one tree per 50 feet of shoreline. Fish Sticks structures are anchored to the shore and are partially or fully submerged.

Bony Lake, Bayfield County - Pamela Toshner

LAKE HEALTH BENEFITS	Improve fish and wildlife habitat Prevent shoreline erosion
COSTS	Range - \$100-\$1000 per cluster (3-5 trees), installed Average - Cost per unit (3-5 trees) averages \$500, installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *Fish Sticks* http://tinyurl.com/healthylakes DNR Fish Sticks Best Practices Manual http://dnr.wi.gov (search for *Fish Sticks best practices*)
REGULATORY INFORMATION	DNR: **Habitat Structure - Fish Sticks General Permit** (\$303 fee unless DNR grant-funded) Fish Sticks must comply with the local shoreland zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of \$1000/cluster of 3-5 trees Fish Sticks may be a stand-alone grant activity only if the vegetation protection area (i.e. buffer) complies with local shoreland zoning. If not, the property owner must commit to leaving a 350 ft^2 area un-mowed at the base of the cluster(s) or implement native plantings (Practice 2).

PRACTICE 2 | 350 FT² NATIVE PLANTINGS

...template planting plans with corresponding lists of native plants suited to the given function of the plan. The 350 ft² area should be planted adjacent to the lake and include a contiguous area, rather than be planted in patches. Functions are based on the goals for the site. For example, one property owner may want to increase bird and butterfly habitat while another would like to fix an area with bare soil. Native planting functions include the following: lakeshore, bird/butterfly habitat, woodland, low-growing, deer resistant, and bare soil area plantings.

Green Lake, Green Lake County - Lisa Reas

LAKE HEALTH BENEFITS	Improve wildlife habitat Slow water runoff Promote natural beauty
COSTS	Range - $480-$2400 for 350 ft² area, installed Average - $1000 per 350 ft², installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *350 ft² Native Plantings* http://tinyurl.com/healthylakes 350 ft² Native Plantings Best Practices Manual
REGULATORY INFORMATION	DNR: an aquatic plant chemical control permit may be necessary if using herbicides in or adjacent to the lakeshore. Native plantings must comply with the local shoreland zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of $1000/350 ft² native plantings installed and implemented according to the technical requirements. Only one 350 ft² native planting per property per year is eligible for funding. The native plantings dimension must be 350 ft² of contiguous area at least 10 feet wide and installed along the lakeshore. Final shape and orientation to the shore are flexible.

ZONE 2: TRANSITION

PRACTICE 3 | DIVERSION PRACTICE

...includes a water bar, diverter, and broad-based dip. These practices use a berm or shallow trench to intercept runoff from a path or road and divert it into a dispersion area. Depending on the site, multiple diversion practices may be necessary.

http://awwatersheds.org

LAKE HEALTH BENEFITS	Divert runoff water.
COSTS	<u>**Range**</u> - $25-$3750, installed <u>**Average**</u> - $200, installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *Diversion Practice* http://tinyurl.com/healthylakes
REGULATORY INFORMATION	DNR: none. Diversion practices must comply with the local shoreland and floodplain zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of $1000/diversion practice installed and implemented according to the technical requirements. Healthy Lakes diversion practice grant funding is not intended for large, heavily developed parcels, sites with large volumes of runoff, or sites with complex problems that may require engineering design.

PRACTICE 3 | DIVERSION PRACTICE

...includes a water bar, diverter, and broad-based dip. These practices use a berm or shallow trench to intercept runoff from a path or road and divert it into a dispersion area. Depending on the site, multiple diversion practices may be necessary.

http://awwatersheds.org

LAKE HEALTH BENEFITS	Divert runoff water.
COSTS	Range - $25-$3750, installed Average - $200, installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *Diversion Practice* http://tinyurl.com/healthylakes
REGULATORY INFORMATION	DNR: none. Diversion practices must comply with the local shoreland and floodplain zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of $1000/diversion practice installed and implemented according to the technical requirements. Healthy Lakes diversion practice grant funding is not intended for large, heavily developed parcels, sites with large volumes of runoff, or sites with complex problems that may require engineering design.

ZONE 3: UPLAND

PRACTICE 4 | ROCK INFILTRATION PRACTICE

...ian excavated pit or trench filled with rock that reduces runoff by storing it underground to infiltrate. A catch basin and/or perforated pipe surrounded by gravel and lined with sturdy landscape fabric may be integrated into the design to capture, pre-treat, and redirect water to the pit or trench. Pit and trench size and holding capacity are a function of the area draining to it and the permeability of the underlying soil.

Deer Lake, Polk County - Cheryl Clemens

LAKE HEALTH BENEFITS	Divert runoff water. Clean runoff water. Infiltrate runoff water.
COSTS	Range - $510-$9688 per rock infiltration practice, installed Average - $3800 per rock infiltration practice, installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *Rock Infiltration Practice* http://tinyurl.com/healthylakes
REGULATORY INFORMATION	DNR: none. Rock infiltration practices must comply with the local shoreland zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of $1000/rock infiltration practice installed and implemented according to the technical requirements. Healthy Lakes rock infiltration practice grant funding is not intended for heavily developed parcels, sites with large volumes of runoff, or sites with complex problems that may require engineering design.

PRACTICE 5 | RAIN GARDEN

...a landscaped shallow depression with loose soil designed to collect roof and driveway runoff.

Shell Lake, Washburn County - Brent Edlin

LAKE HEALTH BENEFITS	Improve wildlife habitat. Divert runoff water. Clean runoff water. Infiltrate runoff water. Promote natural beauty.
COSTS	Range - $500-$9000 per rain garden, installed Average - $2500 per rain garden, installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *Rain Garden* http://tinyurl.com/healthylakes *Rain Gardens: A How-to Manual for Homeowners* http://dnr.wi.gov/topic/Stormwater/documents/RgManual.pdf
REGULATORY INFORMATION	DNR: none. Rain gardens must comply with the local shoreland zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of $1000/rain garden installed and implemented according to the technical requirements. Healthy Lakes rain garden grant funding is not intended for heavily developed parcels, sites with large volumes of runoff, or sites with complex problems that may require engineering design.

FUNDING AND ACCOUNTABILITY

Administrative details and the application process are described in detail in the DNR's Water Grant Application and Guidelines (http://dnr.wi.gov/ search for surface water grants) and the Healthy Lakes website (http://tinyurl/healthylakes) and *Administration and Funding FAQ* fact sheet.

Healthy Lakes grant funding highlights:

- 75% state share grant with a maximum award of $25,000, including up to 10% of the state share available for technical assistance and project management. Technical assistance and project management do not include labor and are based on the entire state share of the grant, not the best practice caps.
- 25% match from sponsors, participating property owners or other partners. The grant sponsor may determine individual property owner cost share rates, provided the state's share of the practice caps ($1000) and total grant award (75%) are not exceeded. The grant sponsor's match may include technical assistance and project management costs beyond the state's 10% share.
- Sponsor may apply on behalf of multiple property owners, and the property owners do not have to be on the same lake.
- Standard 2-year grant timeline to encourage shovel-ready projects.
- Landowners may sign a participation pledge to document strong interest in following through with the project.
- Standard deliverables, including a signed Conservation Commitment with operation and maintenance information and 10-year requirement to leave projects in place. Also:
    - Native plantings must remain in place according to local zoning specs if within the vegetation protection area (i.e. buffer).
    - Fish Sticks projects require a 350 ft^2 native planting at shoreline base or commitment not to mow, if the property does not comply with the shoreland vegetation protection area (i.e. buffer) specifications described in the local shoreland zoning ordinance.
- Standardized application and reporting forms and process.
- 10% of projects randomly chosen each year for self-reporting and/or professional site visits.

PROMOTION

Wisconsin's Healthy Lakes Implementation Plan will be supported and promoted as a statewide program. Lake groups, counties, towns, villages, cities, and other partners may choose to adopt and implement the Plan as is or to integrate into their own planning processes. Statewide promotion, shared and supported by all partners, includes the following:

- A Healthy Lakes logo/brand.
- A website with plan, practice, and funding detail to be housed on the Wisconsin Department of Natural Resources' and University of Wisconsin-Extension Lakes' websites. It may also include the following:
    - Link to science and supporting plans.
    - Shoreline restoration video.
    - How-to YouTube clips.
    - Tips on how to communicate and market healthy lakeshores.
    - Maps with project locations without personally identifiable information.

Healthy Lakes

EVALUATION OF RESULTS

Wisconsin's Healthy Lakes Implementation Plan and results will be evaluated annually and updated in 2017, if warranted. Best practices may be modified, removed, or added depending on the results evaluation.

Lime Lake, Portage County - Robert Korth

The following information will be collected to support an objective evaluation:

- County and lake geographic distribution and participation in Healthy Lakes projects.
- Lakeshore property owner participation in Healthy Lakes projects, including numbers and locations of best practices implemented.
- Standardized Healthy Lakes grant project deliverable report including:
    - Numbers of Fish Sticks trees and clusters.
    - Dimensional areas restored.
    - Structure/floral diversity (i.e. species richness).
    - Impervious surface area and estimated water volumes captured for infiltration.

The results may be used to model nutrient loading reductions at parcel, lake, and broader scales and to customize future self-reporting options, like plant mortality and fish and wildlife observations, for lakeshore property owners.

ACKNOWLEDGEMENTS

Amy Kowalski

L to R: Patrick Goggin, Jane Malischke, Pamela Toshner, Carroll Schaal, Tom Onofrey, Dave Ferris

Wisconsin's Healthy Lakes Implementation Plan and corresponding technical information and grant funding are the results of a collaborative and participatory team effort. We would like to thank the staff, agency, business, and citizen partners, including *Advanced Lake Leaders*, who provided feedback for our team, including the many partners who completed a customer survey and provided valuable comments during the public review of proposed DNR guidance. We would like to express our gratitude to the following contributors and information sources, respectively: Cheryl Clemens, John Haack, Dave Kafura, Amy Kowalski, Jesha LaMarche, Flory Olson, Tim Parks, Bret Shaw, Shelly Thomsen, Scott Toshner, Bone Lake Management District, Maine Lake Smart Program, and Vermont Lake Wise Program.

We appreciate your continued feedback as our Healthy Lakes initiative evolves into the future. Please contact DNR Lake Biologist Pamela Toshner (715) 635-4073 or pamela.toshner@wisconsin.gov if you have comments or questions.

Appendix M

TREATING LAKES WITH ALUM

(This page intentionally left blank)

ALUM TREATMENTS TO CONTROL PHOSPHORUS IN LAKES

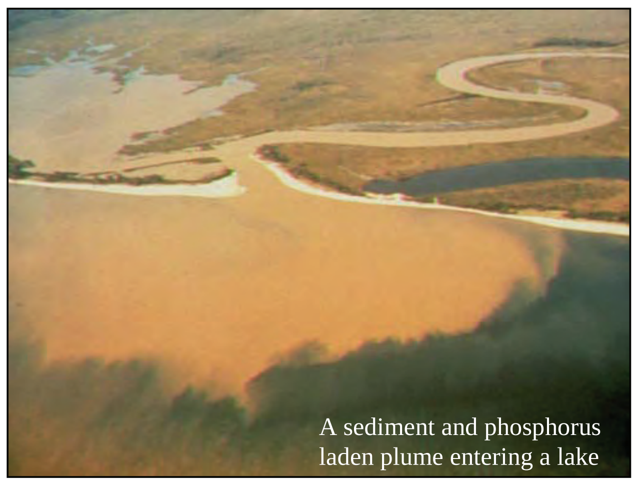
March 2003

What is alum and how does it work?

ALUM (aluminum sulfate) is a nontoxic material commonly used in water treatment plants to clarify drinking water. In lakes alum is used to reduce the amount of the nutrient **phosphorus** in the water. Reducing phosphorus concentrations in lake water can have a similar clarifying effect by limiting the availability of this nutrient for algae production. Phosphorus enters the water either **externally**, from run-off or ground water, or **internally**, from the nutrient rich sediments on the bottom of the lake. Phosphorus is released from the sediments under anoxic conditions that occur when the lake stratifies and oxygen is depleted from the lower layer. Even when external sources of phosphorus have been curtailed by best management practices, the internal recycling of phosphorus can continue to support explosive algal growth. Alum is used primarily to control this internal recycling of phosphorus from the sediments of the lake bottom. On contact with water, alum forms a fluffy aluminum hydroxide precipitate called **floc**. Aluminum hydroxide (the principle ingredient in common antacids such as Maalox) binds with phosphorus to form an aluminum phosphate compound. This compound is insoluble in water under most conditions so the phosphorus in it can no longer be used as food by algae organisms. As the floc slowly settles, some phosphorus is removed from the water. The floc also tends to collect suspended particles in the water and carry them down to the bottom, leaving the lake noticeably clearer. On the bottom of the lake the floc forms a layer that acts as a phosphorus barrier by combining with phosphorus as it is released from the sediments.

Why treat a lake with alum?

Increased nutrient loading, particularly phosphorus has accelerated eutrophication of lakes and consequently reduced their ecological health and recreational value. Frequent and pervasive algal blooms, low water transparency, noxious odors, depletion of dissolved oxygen, and fish kills frequently accompany cultural eutrophication. External sources of phosphorus delivered in run-off from the watershed are often the main contributor of excessive phosphorus to lakes.



A sediment and phosphorus laden plume entering a lake

Typically, the first steps taken in a lake rehabilitation effort target the control the external sources of phosphorus and can include: encouraging the use of phosphorus free fertilizers; improving agricultural practices, reducing urban run-off; and restoring vegetation buffers around waterways.

Lake researchers have learned that lakes are very slow to recover after excessive phosphorus inputs have been eliminated. Furthermore, it's extremely difficult to achieve recovery of lake conditions without additional in-lake management. This is due to the fact that lake sediments become phosphorus rich and can deliver excessive amounts of phosphorus to the overlying water. When dissolved oxygen levels decrease in the bottom waters of the lake (anaerobic conditions), large amounts of phosphorus trapped in the bottom sediments are released into the overlying water. This process is often called **internal** nutrient loading or recycling.

Is alum toxic to aquatic life?

Some studies have been conducted to determine the toxicity of aluminum for aquatic biota. Freeman and Everhart (1971) used constant flow bioassays, to determine that concentrations of dissolved aluminum below 52 μg Al/L had no obvious effect on rainbow trout. Similar results have been observed for salmon. Cooke, et al (1978) adopted 50 mg Al/L as a safe upper limit for post-treatment dissolved aluminum concentrations. Kennedy and Cooke (1982) indicate that: Since, based on solubility, dissolved aluminum concentrations, regardless of dose, would remain below 50 μg Al/L in the pH range 5.5 to 9.0, a dose producing post treatment pH in this range could also be considered environmentally safe with respect to aluminum toxicity. Guidelines for alum application require that the ph remain with the 5.5-9.0 range.

According to Cooke et al (1993) the most detailed study of the impact of alum treatments on benthic insects was that of Narf (1990). He assessed the long term impacts on two soft water and three hardwater Wisconsin lakes. He found that benthic insect populations either increased in diversity or remained at the same diversity after treatment. The treatment of lakes with alkalinities above 75 mg/L as $CaCO_3$ are not expected to have chronic or acute effects to biota. Fish related problems associated with alum treatments have been primarily documented in soft water lakes. However, many softwater lakes have been successfully treated with alum, when the treatments are ph buffered.

Health concerns for people?

Concerns about a connection between aluminum and Alzheimer's have been debated for some time. More recent research points to a gene rather than aluminum as the cause. In addition, aluminum is found naturally in the environment. Some foods, such as tea, spinach and other leafy green vegetables, are high in aluminum. Use of aluminum cookware has not been found to contaminate food sources.

How much does an alum treatment cost?

Costs of alum application are primarily dependent on the form of alum used (wet or dry), dosage rate, area treated, equipment rental or purchase, and labor. Liquid alum has been used when large alum doses were needed. Treatment costs range from $280/acre to $700/acre ($450=approximate average) depending on the dosage requirements and costs to mobilize equipment.

How effective are alum treatments, and how long do they last?

A number of case studies have been conducted on lakes that have undergone nutrient inactivation with alum. Eugene Welch and Dennis Cooke (1995) evaluated the effectiveness and longevity of treatments on twenty one lakes across the United States. They concluded that the treatments were effective in six of the nine shallow lakes, controlling phosphorus for at least eight years on average. Applications in stratified lakes were highly effective and long lasting. Percent reduction in controlling internal phosphorus loading has been continuously above eighty percent. The study did however find that alum treatment of lakes with high external loading was not effective.

References

Cooke, Dennis G. Restoration and Management of Lakes and Reservoirs, Second Edition. Lewis Publishers, 1993.

Cooke, G.D., R.T. Heath, R.H. Kennedy, and M.R. McComas. 1978. Effects of diversion and alum application on two eutrophic lakes. EPA-600/3-81-012.

Freemen, R.A. and W.H. Everhart. 1971. Toxicity of Aluminum Hydroxide Complexes in neutral and basic media to rainbow trout. Transactions of the American Fisheries Society 100: 644-658.

Kennedy, R. and Cooke, G. 1982 . Control of Lake Phosphorus with Aluminum Sulfate: Dose Determination and Application Techniques". Water Resources Bulletin 18:389-395.

Narf, R.P. 1990. Interaction of Chrionomidae and Chaoboridae (Diptera) with alumninum sulfate treated lake sediments. Lake Reserv. Manage. 6: 33-42.

Welch, E.B. and G.D. Cooke. 1999. Effectiveness and longevity of phosphorus inactivation with alum. J. Lake and Reserv.Manag. 15:5-27.

Appendix N

PREVENTING THE SPREAD OF AQUATIC INVASIVE SPECIES

(This page intentionally left blank)

FOR MORE INFORMATION

If you would like more information about aquatic invasive species, the problems they cause, regulations to prevent their spread, or methods and permits for their control, contact one of the following offices:

Wisconsin Department Of Natural Resources
888-WDNRINFO
DNR.WI.GOV search "Aquatic Invasives"

University of Wisconsin- Extension
(715) 346-2116
WWW.UWSP.EDU/CNR/UWEXLAKES

Wisconsin Sea Grant
(608) 262-0905
WWW.SEAGRANT.WISC.EDU
WWW.PROTECTYOURWATERS.NET

Thanks to the following for supporting educational efforts on aquatic invasive species:

- *U.S. Fish and Wildlife Service*
- *Great Lakes Indian Fish and Wildlife Commission*
- *National Park Service*

Printed on recycled paper containing a minimum of 10% post-consumer waste and vegetable based ink.

PUB WT-801 2011

Graphic Design by Amy Torrey, Environmental Resources Center, UW-Extension

Photo Credits: Sea Grant, UW-Extension, DNR

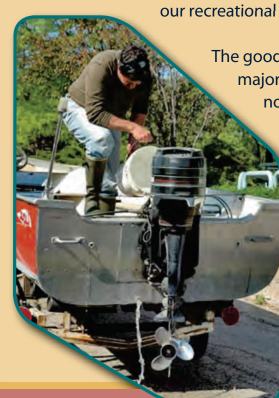
STOP Aquatic HITCHHIKERS

ENJOYING THE GREAT OUTDOORS

Enjoying the great outdoors is important to many of us. Boating, fishing, hunting, and wildlife watching are traditions that we want to preserve for our children and their children. Today, these traditions are at risk. Aquatic invaders such as zebra mussels, purple loosestrife, Eurasian water-milfoil, bighead and silver carp, threaten our valuable waters and recreation. These and other non-native, or exotic, plants and animals do not naturally occur in our waters and are called invasive species because they cause ecological or economic harm.

These invasive species can get into lakes, rivers, and wetlands by "hitching" rides with anglers, boaters, and other outdoor recreationists, who transport them from one waterbody to another.

Once established, these "aquatic hitchhikers," can harm native fisheries, degrade water quality, disrupt food webs and reduce the quality of our recreational experiences.

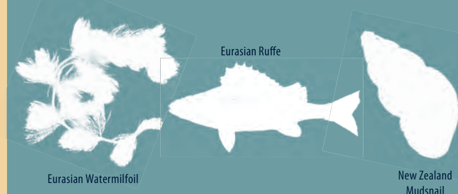


The good news is that the majority of waters are not yet infested with invasive species and by taking the necessary steps you can help protect our valuable waters.

If you think you have found an INVASIVE SPECIES:

REPORT NEW SIGHTINGS

If you suspect a new infestation of an invasive plant or animal, save a specimen and report it to a local Department of Natural Resources or Sea Grant office. Wisconsin has "ID" cards, websites, and volunteer monitoring networks to help you identify and report invasive species.



CONSULT YOUR NATURAL RESOURCE AGENCY

Do-it-yourself control treatments may be illegal and can make matters worse by harming native fish, wildlife, and plants. Before attempting to control an invasive species or add new plants along your shoreline, contact your local Department of Natural Resources office. DNR staff can provide recommendations and notify you what permits are required.

DNR.WI.GOV search "Aquatic Invasives"

STOP AQUATIC HITCHHIKERS

IS A NATIONAL CAMPAIGN THAT HELPS RECREATIONAL USERS TO BECOME PART OF THE SOLUTION TO STOP THE TRANSPORT AND SPREAD OF AQUATIC INVASIVE SPECIES.

IN WISCONSIN IT IS THE LAW...

Aquatic hitchhikers can spread in many ways such as on recreational equipment, and in water. Fortunately, there are a few simple actions you can take to prevent them from spreading.

INSPECT boats, trailers, and equipment

REMOVE all attached aquatic plants, animals, and mud before launching and before leaving the water access.

Many invasive species spread by attaching themselves to boats, trailers, and equipment and "hitching a ride" to another waterbody. Therefore, Wisconsin law requires that you remove these aquatic hitchhikers before you launch your boat or leave the access area.

DRAIN all water from your boat, motor, bilge, live wells, bait containers and all equipment before leaving the water access.

Many types of invasive species are very small and easily overlooked. In fact, some aquatic hitchhikers, like zebra mussel larvae, are invisible to the naked eye. To prevent the transport of these aquatic hitchhikers drain water from all equipment before you leave the access area.

For more information visit:
DNR.WI.GOV and search "bait laws"

Draining ballast water and lake or river water can prevent the spread of aquatic invasive species and fish diseases, like VHS.

NEVER MOVE plants or live fish away from a waterbody.

In Wisconsin, it is illegal to transport any aquatic plants, mud, live fish or live fish eggs away from any state waterbody. This includes live gamefish and roughfish, like gizzard shad. There are exceptions for minnows obtained from a Wisconsin licensed bait dealer or registered fish farm, which may be transported away live and used again:

- *On the same waterbody, or*
- *On any other waterbody if no lake or river water, or other fish were added to their container*

BUY minnows from a Wisconsin licensed bait dealer.

For more information on collecting your own minnows visit:
DNR.WI.GOV and search "VHS Prevention"

DISPOSE of unwanted bait and other animals or aquatic plants in the trash.

If possible, dispose of ALL unwanted bait (including earthworms) in a trash can at the boat landing or access point. Otherwise, take them home and dispose of them by placing them in the trash, composting them, or using them in a garden as fertilizer. Likewise, other aquatic plants or animals that you collect, or buy in a pet store, should NEVER be released into the wild.

When possible, dispose of unwanted bait in the trash at access points. Never release them into the environment.

WISCONSIN REGULATION

Wisconsin has several laws to prevent the spread of aquatic invasive species and the fish disease Viral Hemorrhagic Septicemia (VHS). Failure to follow Wisconsin law can result in fines up to or exceeding **$2000**. Don't be caught unaware!

ADDITIONAL STEPS:

Although not required by WI law, additional steps are highly recommended, particularly if you are transporting a boat and/or equipment from one waterbody to another. Additional steps include:

SPRAY, RINSE, or DRY boats and recreational equipment to remove or kill species that were not visible when leaving a waterbody. Before transporting to another water: ***Spray/rinse with high pressure, and/or hot tap water (above 104° F or 40° C), especially if moored for more than a day. OR Dry for at least five days.***

DISINFECT boats and recreational equipment to kill species and fish diseases that were not visible when leaving a waterbody. Many aquatic hitchhikers can survive out of water for some period of time. ***To prevent their spread, you can sanitize your boat, trailer or equipment by washing it with a mixture of 2 Tbs of household bleach per 1 gallon of water.***

OTHER WATER USES:

Don't get caught spreading aquatic invasive plants or animals! Wisconsin laws, as highlighted above, can apply to many types of water activities, not just boating and fishing. Although these activities might not seem dangerous, they CAN establish and spread invasive species. It is important you follow the steps above for all water activities in order to prevent the spread of aquatic invasive species. These activities include:

- ***Using personal watercraft***
- ***Shore and fly-fishing***
- ***Sailing***
- ***Scuba Diving***
- ***Waterfowl hunting***

FAILURE TO FOLLOW WISCONSIN LAWS CAN LEAD TO FINES.

For additional information contact your local DNR staff or visit:
DNR.WI.GOV

Protect Your Boat

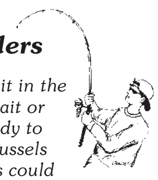
Zebra mussels attach to a variety of materials, including fiberglass, aluminum, wood, and steel and may damage a boat's finish. Veligers are extremely small and can be drawn into engine passages. Once they settle out in the engine cooling system, they can grow into adults and may block intake screens, internal passages, hoses, seacocks, and strainers. The best ways for boat owners to avoid these types of damage are:

- **Use a boatlift** to completely remove the watercraft from the water when not in use.

- **Run your boat regularly** if it is moored in zebra mussel infested waters. Run the engine at least twice a week at slow speeds (about 4-½ mph) for 10 to 15 minutes. Monitor engine temperatures – if you notice an increase, it may mean that zebra mussels are clogging your cooling system. Immediately inspect the system and remove any zebra mussels. The end of boating season is also a good time to inspect and clean the cooling system.
- **Lift the motor out of the water between uses if mooring.** Fully discharge any water that may still remain in the lower portion of the cooling system.
- **Tip down the motor and discharge the water when leaving a waterbody** to reduce the likelihood of transporting veligers (in water) to another waterbody.
- **Clean your boat and equipment.** Physically remove (scrape) adult mussels from your boat, trailer, and equipment by hand. Young zebra mussels and veligers may be too small to see. Wash your boat with high-pressure hot water (use water >104˚F if possible). Use high-pressure cold water if hot water is not available. *(Avoid pressure washing classic wooden boats or others not made of metal.)*
- **Apply anti-fouling paints or coatings to the hull and the engine's cooling system** to prevent zebra mussel attachment. It is best to purchase these from an area boat dealer or your local marina. Anti-fouling paints that are copper based can be used in Wisconsin, and typically need to be reapplied every one to two years. In-line strainers can also be installed in the engine's cooling system.
- **Use motor "muffs", also known as motor flushers, to remove zebra mussels and other materials from your boat engine or personal watercraft.** Clamp the motor flusher onto the lower unit over the cooling inlets on either side of the motor, and screw the nozzle of your garden hose into it. Run the boat engine for approximately 10 minutes or as suggested by the manufacturer.

Amy Bellows, WI DNR

Special note of caution for anglers



Dispose of unwanted bait in the trash - do not transfer bait or water from one waterbody to another. Larval zebra mussels or other invasive species could be present in the water with the bait.

Help prevent aquatic hitchhikers from catching a ride on your boat or equipment:

✓ **Inspect** and **remove** aquatic plants and animals,

✓ **Drain** water,

✓ **Dispose** of unwanted bait in the trash,

✓ **Rinse** with hot and/or high-pressure water, OR

✓ **Dry** for 5 days.

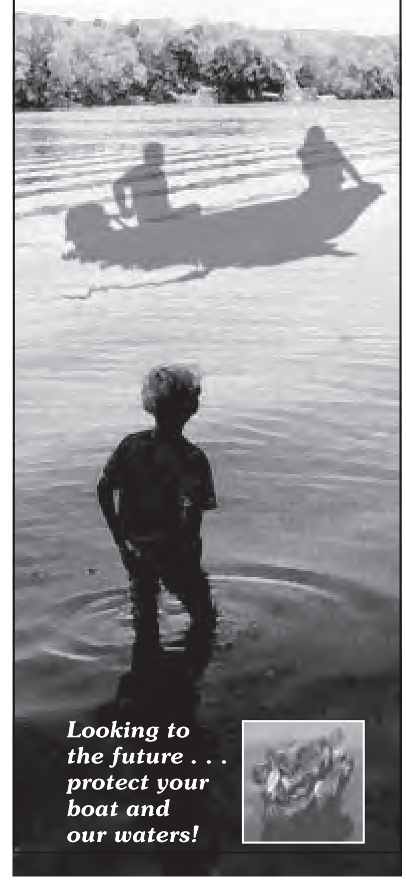
Clean Boats . . . Clean Waters

For a list of known zebra mussel infested waters, visit:
www.dnr.wi.gov/org/water/wm/GLWSP/exotics/zebra.html

WISCONSIN DEPT. OF NATURAL RESOURCES
UW Extension
STOP AQUATIC HITCHHIKERS!
PRINTED ON RECYCLED PAPER
Sea Grant

Cover photo: L. Pohlod. Inset: Great Lakes Sea Grant Network
Designed by L. Pohlod, Blue Sky Design, LLC *PUB-WT-383 2004*

Zebra Mussel Boater's Guide



Zebra mussel identification and life cycle


Ohio Sea Grant

Mature zebra mussels look like small D-shaped clams. Their yellowish-brown shells have alternating light and dark stripes. Zebra mussels can reach a maximum of 2 inches in length, though most are smaller than an inch. They are typically found attached to solid objects, often growing in large clusters.


Ontario Ministry of Natural Resources


Amy Bellows, WI DNR

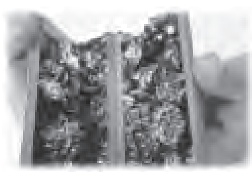
Zebra mussels begin as eggs, then develop into free-swimming larvae (called **veligers**), which are microscopic. The veliger photos shown above were taken with the aid of a microscope. Veligers are spread by currents; after about three weeks, they settle out and firmly attach themselves to hard surfaces, where they grow into adults. Their lifespan is typically three to five years. They begin to reproduce after a year or two - females can release up to one million eggs per year!


James Lubner, University of Wisconsin Sea Grant

What do zebra mussels do?

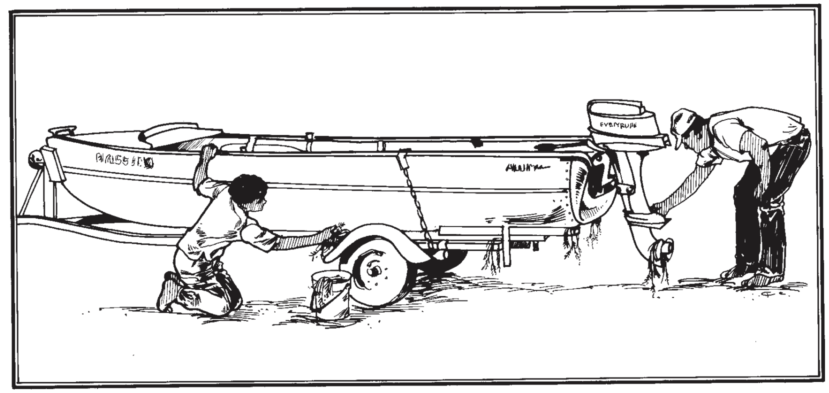
Zebra mussels are **filter feeders** that can filter large volumes of water (up to 1 Liter/day). In some cases they can filter the whole volume of a lake in a few months. They remove plankton – tiny plants and animals – from the water. What they eat (and what they don't eat) ultimately ends up on the lake or river bottom. Plankton is an important food source for young fish, native mussels, and other aquatic organisms. Zebra mussels may concentrate this food at the bottom, leaving open water species with **less to eat**!

Because they are so good at filtering, zebra mussels often **make water clearer**. This may force **light-sensitive fish**, like salmon and walleye, into deeper water to seek shelter from the sun. Increased light penetration allows aquatic plants to grow in deeper water and spread to a larger area. This may help smaller fish to survive by giving them places to hide, but makes it harder for large, predatory fish to find food. **Thicker plant growth** may also cause problems for boaters and anglers.


Don Schloesser, Great Lakes Science Center, National Biological Services

Zebra mussels cause people additional problems. They **clog water intakes and pipes** – large water users on the Great Lakes spent $120 million from 1989 to 1994 to combat zebra mussels. They also **attach to piers, boatlifts, boats, and motors,** which can cause damage requiring costly repair and maintenance. Even when they die, their **sharp shells** wash up on beaches, creating foul odors and cutting the feet of swimmers.

How can I help prevent the spread of zebra mussels?



Microscopic veligers may be carried in livewells, bait buckets, bilge water – any water that's transported to another waterbody. They can also travel in currents to downstream waters. Adults can attach to boats or boating equipment that are moored in the water. They frequently attach to aquatic plants, which themselves may hitch a ride on boats and equipment. For these reasons, it is important to take the following steps to prevent the spread of zebra mussels and other aquatic invasive species while boating:

Before moving your boat from one water body to another:

✓ **Inspect** and **remove** aquatic plants, animals, and mud from your boat, trailer, and equipment,

✓ **Drain** all water from your equipment (boat, motor, bilges, transom wells, live wells, etc.),

✓ **Dispose** of unwanted bait in the trash, not in the water,

✓ **Rinse** your boat and equipment with hot (> 104˚F) and/or high pressure water, particularly if moored for more than one day, OR

✓ **Dry** your boat and equipment thoroughly (in the sun) for five days.

Pressure washing note:

Avoid pressure washing classic and wooden boats, along with canoes and kayaks that are not made of metal. These types of boats should be drained, cleared of all plant and animal materials, and left in the sun to dry completely.

Effective May 2002, Section 30.715, WI Act 16 prohibits launching a boat or placing a boat or trailer in navigable waters if it has aquatic plants or zebra mussels attached.