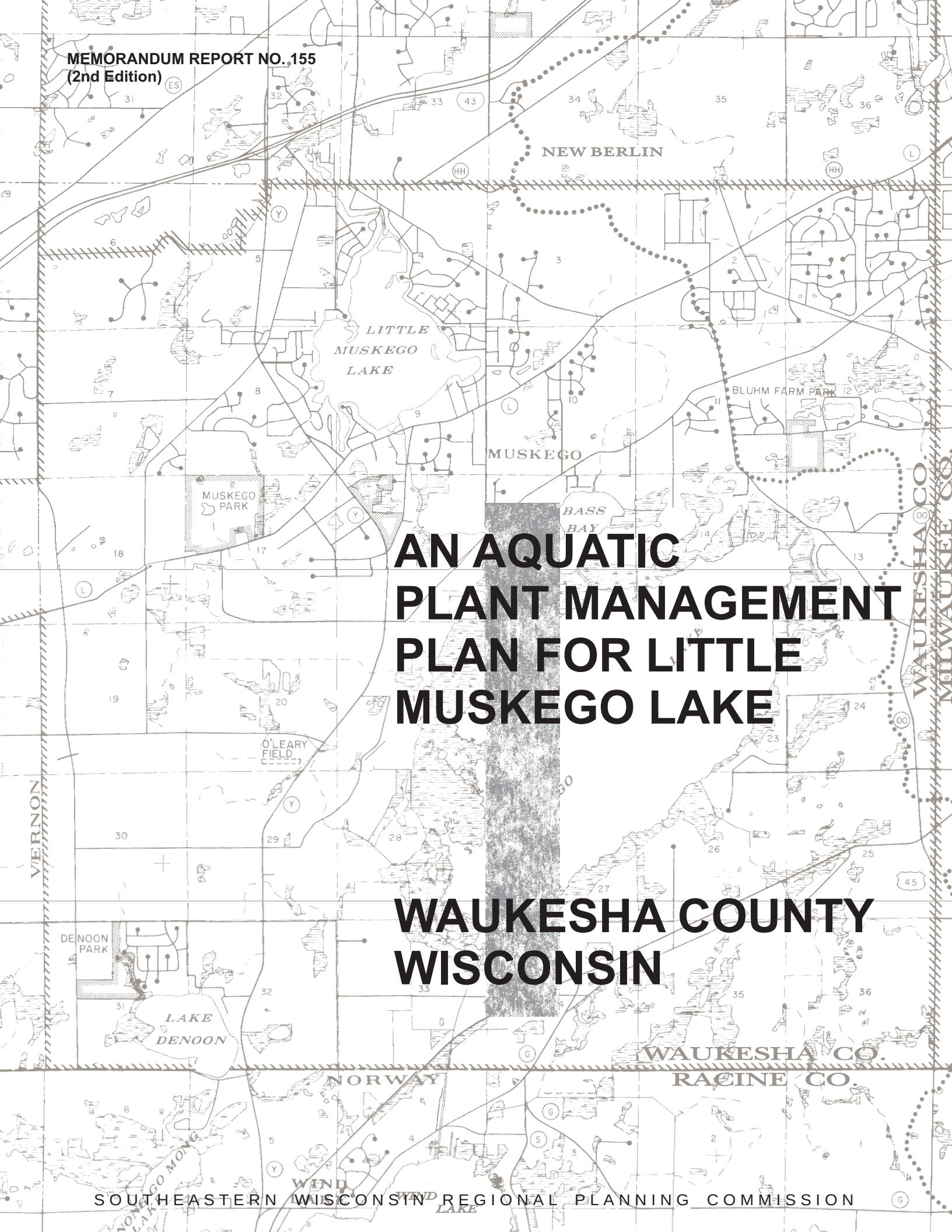

MEMORANDUM REPORT NO. 155
(2nd Edition)

AN AQUATIC PLANT MANAGEMENT PLAN FOR LITTLE MUSKEGO LAKE

WAUKESHA COUNTY WISCONSIN

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Special acknowledgement is due to Dr. Jeffrey A. Thornton, CLM, PH, and Dr. Thomas M. Slawski, SEWRPC Principal Planners; Ms. Sara W. Teske, SEWRPC Research Analyst; Mr. Edward J. Schmidt, SEWRPC GIS Planning Specialist; and Mr. Michael A. Borst, SEWRPC Research Aide, for their contributions to the conduct of this study and the preparation of this report.

MEMORANDUM REPORT
NUMBER 155, 2nd Edition

AN AQUATIC PLANT MANAGEMENT PLAN FOR LITTLE MUSKEGO LAKE

WAUKESHA COUNTY, WISCONSIN

Prepared by the

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February 2009

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Chapter I

INTRODUCTION

Little Muskego Lake, located in the City of Muskego, Waukesha County, Wisconsin, is a 506-acre flow through lake and a valuable natural resource offering a variety of recreational and related opportunities to the resident community and its visitors. The Lake is located along a tributary stream to the Fox River entirely within U.S. Public Land Survey Township 5 North, Range 20 East, Sections 4, 5, 8, and 9, City of Muskego, in Waukesha County.

In recent years, the recreational and aesthetic values of Little Muskego Lake have been perceived to be adversely affected by excessive aquatic plant growth within portions of the Lake. Seeking to improve the usability and to prevent the deterioration of its natural assets and recreational potential, the Little Muskego Lake community, through the Little Muskego Lake Protection and Rehabilitation District (LMLPRD) and in cooperation with the City of Muskego and the Little Muskego Lake Association Inc. (LMLA), continues to undertake annual programs of lake and aquatic plant management in the basin.[1]

Little Muskego Lake has been the subject of several previous comprehensive lake management-related investigations, including the Wisconsin Department of Natural Resources (WDNR) Muskego-Wind Lakes Priority Watershed Project Area,[2] a comprehensive lake management plan published by the Southeastern Wisconsin Regional Planning Commission (SEWRPC),[3] and a refined aquatic plant management plan published by SEWRPC in 2004.[4] This report further refines the aquatic plant management plan for Little Muskego Lake by reporting on the condition of the aquatic plant communities in Little Muskego Lake during 2007, including relevant tributary area and waterbody data, and updating the recommendations for the management of the aquatic plant community within the Lake.

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[1]*The Little Muskego Lake Association was formed in 1968 to protect, preserve and rehabilitate Little Muskego Lake and its watershed; the Lake Management District was created during 1974 as a special purpose governmental unit tasked with conducting a program of lake protection and rehabilitation pursuant to Chapter 33 of the* Wisconsin Statutes.

[2]*Wisconsin Department of Natural Resources Publication No. PUBL-WR-375-94,* A Nonpoint Source Control Plan for the Muskego-Wind Lakes Priority Watershed Project, *October 1993.*

[3]*SEWRPC Community Assistance Planning Report No. 222,* A Lake Management Plan for Little Muskego Lake, Waukesha County, Wisconsin, *June 1996.*

[4]*SEWRPC Memorandum Report No. 155,* An Aquatic Plant Management Plan for Little Muskego Lake, Waukesha County, Wisconsin, *January 2004.*

BACKGROUND

This report represents part of the ongoing commitment of the Little Muskego Lake community through the LMLPRD, LMLA, and the City of Muskego, to sound planning with respect to the Lake. The report sets forth an inventory of the aquatic plant community present within Little Muskego Lake during 2007, and compares and contrasts that community with previously recorded survey data from the Lake. The 2007 inventory was prepared by SEWRPC in cooperation with the LMLPRD, and includes the results of field surveys conducted by the Commission during September 2007. The aquatic plant survey was conducted by Commission staff using the modified Jesson and Lound[5] transect method developed by the WDNR.

As noted above, this report is intended to refine the existing aquatic plant management plan for Little Muskego Lake.[6] The scope of this report is limited to a consideration of the aquatic plant communities present within Little Muskego Lake, the documentation of historic changes in the plant communities based upon currently existing data and information, and refinement of those management measures which can be effective in the control of aquatic plant growth. Recommendations are made with respect to the ongoing land and water management programs of the LMLPRD, LMLA, and the City of Muskego. This planning program was supported, in part, by the WDNR through the Chapter NR 190 Lake Management Planning Grant program.

AQUATIC PLANT MANAGEMENT PROGRAM GOALS AND OBJECTIVES

The lake use goals and objectives for Little Muskego Lake were developed in consultation with the LMLPRD. The agreed goals and objectives are to:

1. Protect and maintain public health, and promote public comfort, convenience, necessity, and welfare, in concert with the natural resource, through the environmentally sound management of native vegetation, fishes, and wildlife populations in and around Little Muskego Lake;

2. Effectively control the quantity and density of aquatic plant growths in portions of the Little Muskego Lake basin to better facilitate the conduct of water-related recreation, improve the aesthetic value of the resource to the community, and enhance the natural resource value of the waterbody by promoting the growths of native aquatic plant species while minimizing the growths of nonnative aquatic plant species, especially those designated as invasive species pursuant to Chapter NR 109 of the *Wisconsin Administrative Code*;

3. Effectively maintain the water quality of Little Muskego Lake to better facilitate the conduct of water-related recreation, improve the aesthetic value of the resource to the community, and enhance the natural resource value of the waterbody; and,

4. Promote a quality, water-based experience for residents and visitors to Little Muskego Lake consistent with the policies and objectives of the WDNR, as set forth in the regional water quality management plan and refined in the aforereferenced SEWRPC lake management and aquatic plant management plans.[7]

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[5]*R. Jesson, and R. Lound, Minnesota Department of Conservation Game Investigational Report No. 6,* An Evaluation of a Survey Technique for Submerged Aquatic Plants*, 1962.*

[6]*SEWRPC Memorandum Report No. 155,* op. cit.

[7]*See SEWRPC Planning Report No. 30,* A Regional Water Quality Management Plan for Southeastern Wisconsin—2000*, adopted by the Regional Planning Commission on July 12, 1979; SEWRPC Community Assistance Planning Report No. 222,* op. cit.*; and, SEWRPC Memorandum Report No. 155,* op. cit.

This aquatic plant management plan conforms to the requirements and standards set forth in the relevant *Wisconsin Administrative Codes.*[8] Implementation of the recommended actions set forth herein should continue to serve as an important step in achieving the stated lake use objectives over time.

[8]*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 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."*

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Chapter II

INVENTORY FINDINGS

INTRODUCTION

Little Muskego Lake is located in the City of Muskego in Waukesha County, Wisconsin. The location of the Lake is shown on Map 1. Little Muskego Lake is a flow through, or drainage, lake situated along a tributary stream to the Illinois Fox River. Little Muskego Lake is comprised of a single, natural deep lake basin surrounded by extensive shallow areas. The Lake level has been augmented by the construction of an impoundment along the southern extreme of the Lake. Outflow from Little Muskego Lake is controlled by a fixed-height dam.

Little Muskego Lake is the second in a chain of lakes that receives water principally from Jewel Creek, which passes through Linnie Lac prior to entering Little Muskego Lake from the north. Little Muskego Lake discharges in a southerly direction through a concrete culvert into Muskego Creek, and thence into Big Muskego Lake, Wind Lake, and, ultimately, the Fox River, about 10 miles downstream of the Little Muskego Lake outlet.

Little Muskego Lake has been the subject of several reports and plans, including the 1969 Wisconsin Department of Natural Resources (WDNR) Lake Use Report,[1] a nonpoint source pollution abatement plan prepared by the WDNR in 1993,[2] a comprehensive lake management plan prepared by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) during 1996,[3] and a refined aquatic plant management plan prepared by the SEWRPC in 2004.[4] The 2004 aquatic plant management plan updated the aquatic plant management plan element set forth in the initial 1996 lake management plan. This plan further refines the aquatic plant management element of the 1996 lake management plan based upon observed 2007 in-lake conditions.

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[1]*Wisconsin Department of Natural Resources Lake Use Report No. FX-10,* Little Muskego Lake, Waukesha County, Wisconsin, *1969.*

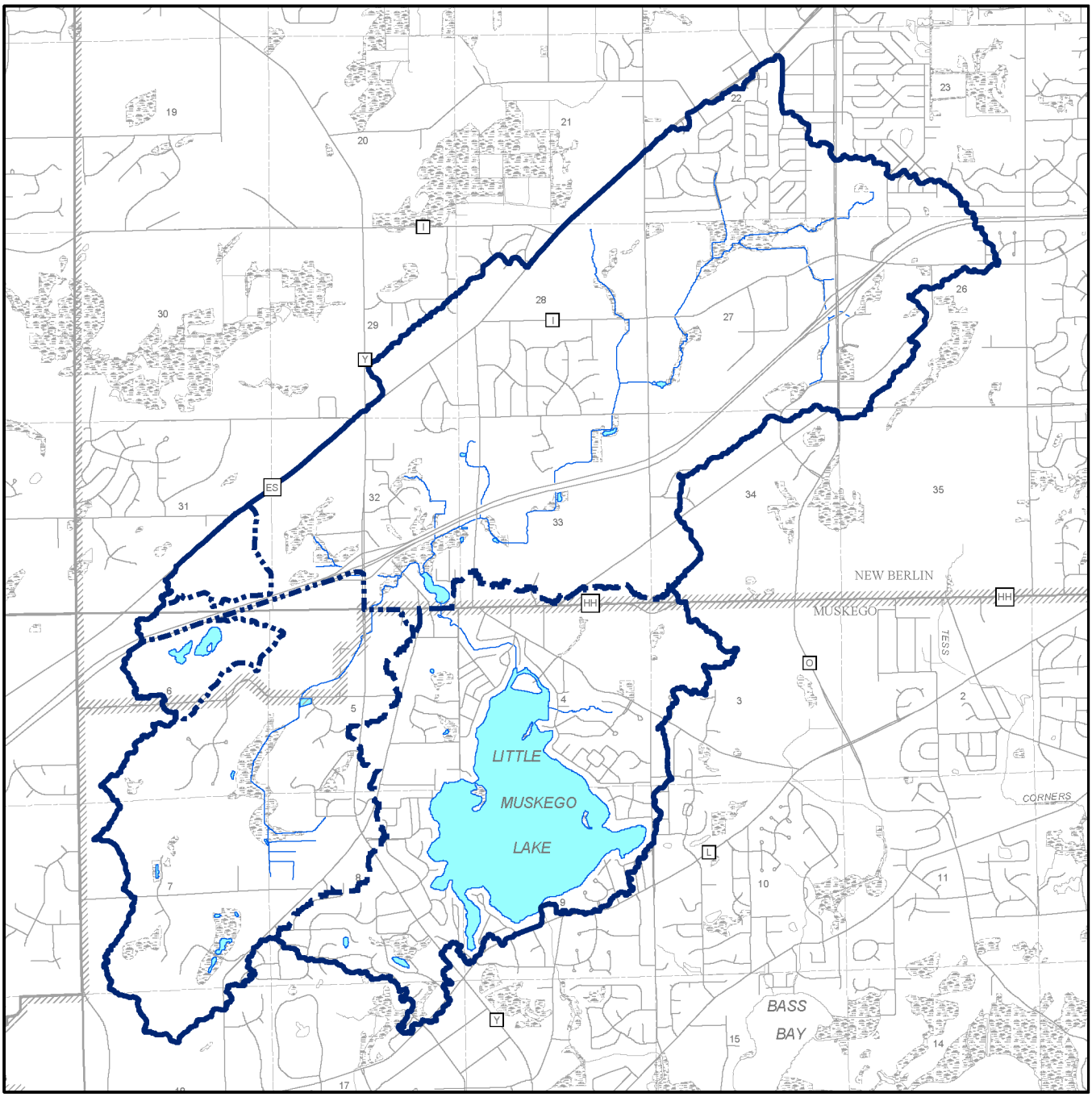
[2]*Wisconsin Department of Natural Resources Publication No. PUBL-WR-375-94,* A Nonpoint Source Control Plan for the Muskego-Wind Lakes Priority Watershed Project, *October 1993.*

[3]*SEWRPC Community Assistance Planning Report No. 222,* A Lake Management Plan for Little Muskego Lake, Waukesha County, Wisconsin, *June 1996.*

[4]*SEWRPC Memorandum Report No. 155,* An Aquatic Plant Management Plan for Little Muskego Lake, Waukesha County, Wisconsin, *January 2004.*

Map 1

LOCATION OF LITTLE MUSKEGO LAKE



Total Tributary Area Boundary for Little Muskego Lake

Direct Tributary Area Boundary Where Not Coincident with Total Area Boundary

Internally Drained Area Boundary Where Not Coincident with Total Area Boundary

Surface Water

N

0 3,000 6,000 Feet

Source: SEWRPC.

WATERBODY CHARACTERISTICS

Little Muskego Lake is a 481-acre waterbody, the hydrographical characteristics of which are set forth in Table 1. As aforementioned, the Lake is a flow through lake with a single basin. The Lake has a maximum depth of approximately 65 feet, a mean depth of 14 feet, and a volume of 7,170 acre-feet. The general orientation of Little Muskego Lake is north-south. The most steeply sloped portions of the lakebed are located at the southern end of the Lake adjacent to the deep hole. Extensive shallow water areas are located around the periphery of the Lake, principally along the northern, southwestern, and eastern shorelines.

The bathymetry of the Lake is shown on Map 2. The Lake is 7.1 miles long, with a shoreline development factor of 1.9, indicating that, due to its natural irregularities, the shoreline is nearly two times longer than a perfectly circular lake of the same area. Shoreline development factor is important because it is often related to the amount of littoral zone (the shallower, nearshore area of a lake usually rich in plant and animal life) in a lake. The greater a lake's shoreline development factor, the more irregular its shoreline and, therefore, the greater the likelihood of the lake providing more littoral zone area with habitat suitable for plant and animal life. For purposes of comparison, the shoreline development factor of 1.9 can be compared to that of Silver Lake in Waukesha County, which has a shoreline development factor of 1.3 indicating a nearly circular shape, and that of Okauchee Lake, also in Waukesha County, which has a shoreline development factor of 3.2 reflecting that waterbody's highly irregular shape.

In addition to the shape of the lake basin, other factors, such as bottom sediment composition and basin contours, impact the amount of biological activity in a lake. Lake bottom sediment types in the nearshore areas of Little Muskego Lake consist of soft sediments along about 70 percent of the shoreline, mainly along the western and northern shorelines; gravel and rubble along about 25 percent of the shoreline, mostly along the southeastern shoreline and around the small island on the eastern side of the Lake; and, sand along about 5 percent of the shoreline. Additionally, the Lake bottom has fairly extensive areas of shallow water along the less steeply sloped portions of the Lake, primarily along the northern, southwestern, and eastern sides of the Lake. A preponderance of soft bottom sediments and the relatively flat lake bottom contours in the shallower areas of the Lake are conditions often associated with lakes of aquatic plant higher productivity.

Table 1

HYDROLOGY AND MORPHOMETRY OF LITTLE MUSKEGO LAKE

Parameter	Little Muskego Lake
Size[a]	
Surface Area of Lake	481 acres
Direct Tributary Area	1,903 acres
Total Tributary Area	7,214 acres
Lake Volume	7,170 acre-feet
Residence Time[b]	0.9 year
Shape	
Length of Lake	1.3 miles
Width of Lake	1.0 mile
Length of Shoreline	7.1 miles
Shoreline Development Factor[c]	1.9
General Lake Orientation	North-South
Depth	
Mean Depth	14 feet
Maximum Depth	65 feet
Percentage of Lake Area	
Less than Three Feet	27 percent
Three to 20 Feet	47 percent
Greater than 20 Feet	26 percent

[a]Lake surface area and tributary area measurements listed above may differ from those presented in SEWRPC Memorandum Report No. 155, An Aquatic Plant Management Plan for Little Muskego Lake*, 2004, and other earlier reports. The current measurements are based on elevation refinements made possible through Commission digital terrain modeling analysis, as well as exclusion of island surface areas.*

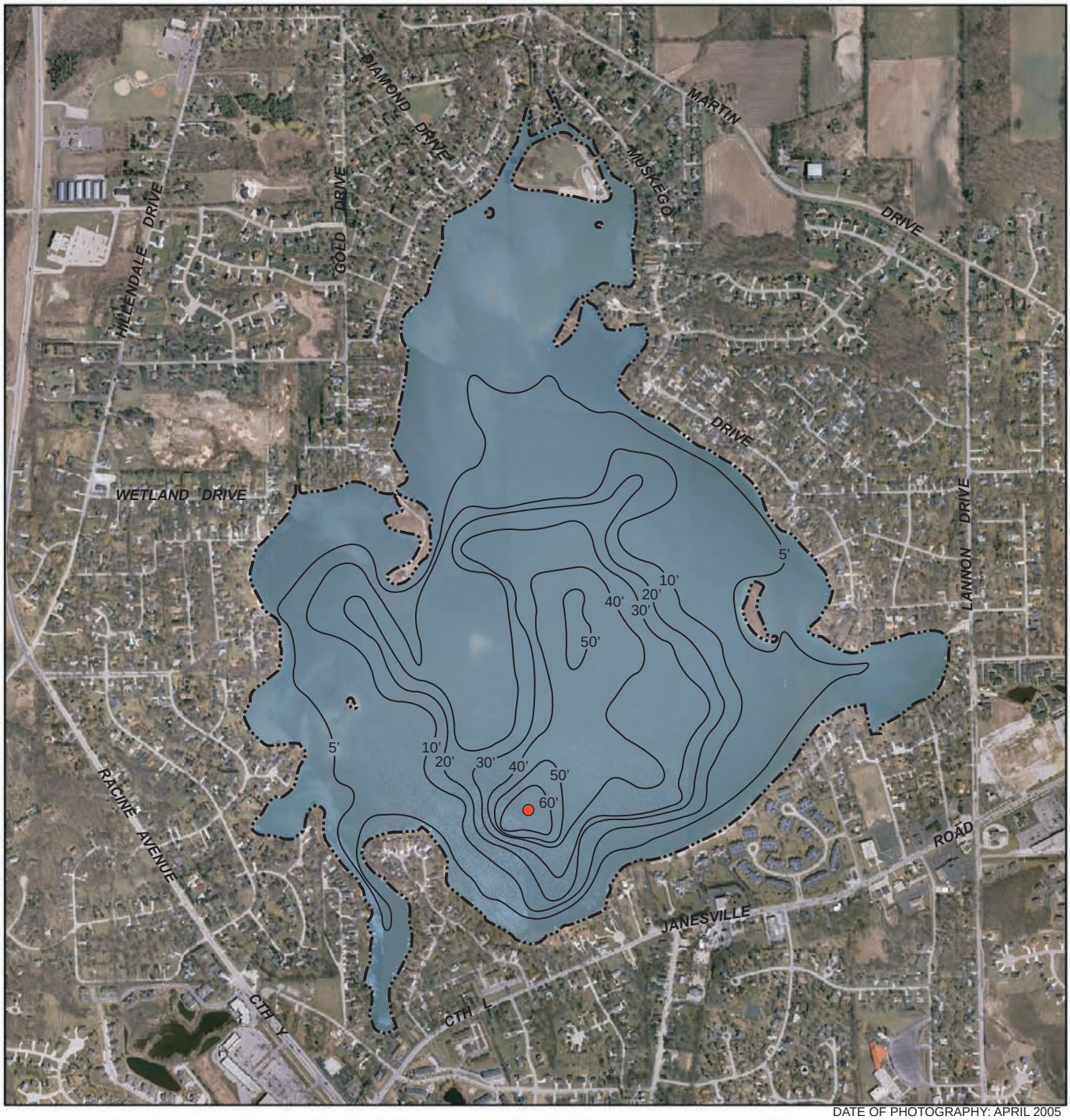
[b]Residence time is estimated as the time period required for a volume of water equivalent to the volume of the lake to enter the lake during years of normal precipitation. This data based on 1984 USGS study period.

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

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

Map 2

BATHYMETRIC MAP OF LITTLE MUSKEGO LAKE



DATE OF PHOTOGRAPHY: APRIL 2005

—20'— WATER DEPTH CONTOUR IN FEET

MONITORING SITE

Source: U.S. Geological Survey and SEWRPC.

GRAPHIC SCALE

0 650 1300 FEET

TRIBUTARY AREA AND LAND USE CHARACTERISTICS

The area directly tributary to Little Muskego Lake is situated entirely within the City of Muskego in Waukesha County. This area, which drains directly to Little Muskego Lake without passing through any upstream waterbody, is approximately 1,903 acres in areal extent. As shown on Map 3, the total area tributary to Little Muskego Lake is approximately 7,214 acres and includes portions of the City of New Berlin, as well as the City of Muskego, both in Waukesha County. The tributary area to Little Muskego Lake is situated in the southeastern portion of Waukesha County, and includes lands tributary to Linnie Lac, located upstream of Little Muskego Lake, as well as internally drained areas that do not drain directly to Little Muskego Lake.

Population and Housing Units

The population and the number of housing units within the Little Muskego Lake direct tributary area have generally shown a steady increase since 1960, as shown in Table 2. The greatest increase in population occurred between 1960 and 1970 when the number of people increased from about 2,947 persons to approximately 4,178 persons, an increase of over 40 percent. The number of housing units also increased during this period, but showed the greatest rate of increase between 1990 and 2000, when the number of dwelling units increased from about 1,544 units to about 2,016 units, an increase of over 30 percent.

Within the total area tributary to Little Muskego Lake, increases in population and the numbers of households also have been fairly steady since the 1960s, as shown in Table 2. In the total drainage area tributary to the Lake, the largest increase in population occurred between 1960 and 1970, when the number of individuals living within the drainage area increased by nearly 40 percent, from about 5,740 individuals to about 7,977 individuals. The greatest increase in the number of households within the total tributary area occurred during the 1980 to 1990 period, or about a decade earlier than that recorded in the portion of the drainage area directly tributary to the Lake.

Land Uses

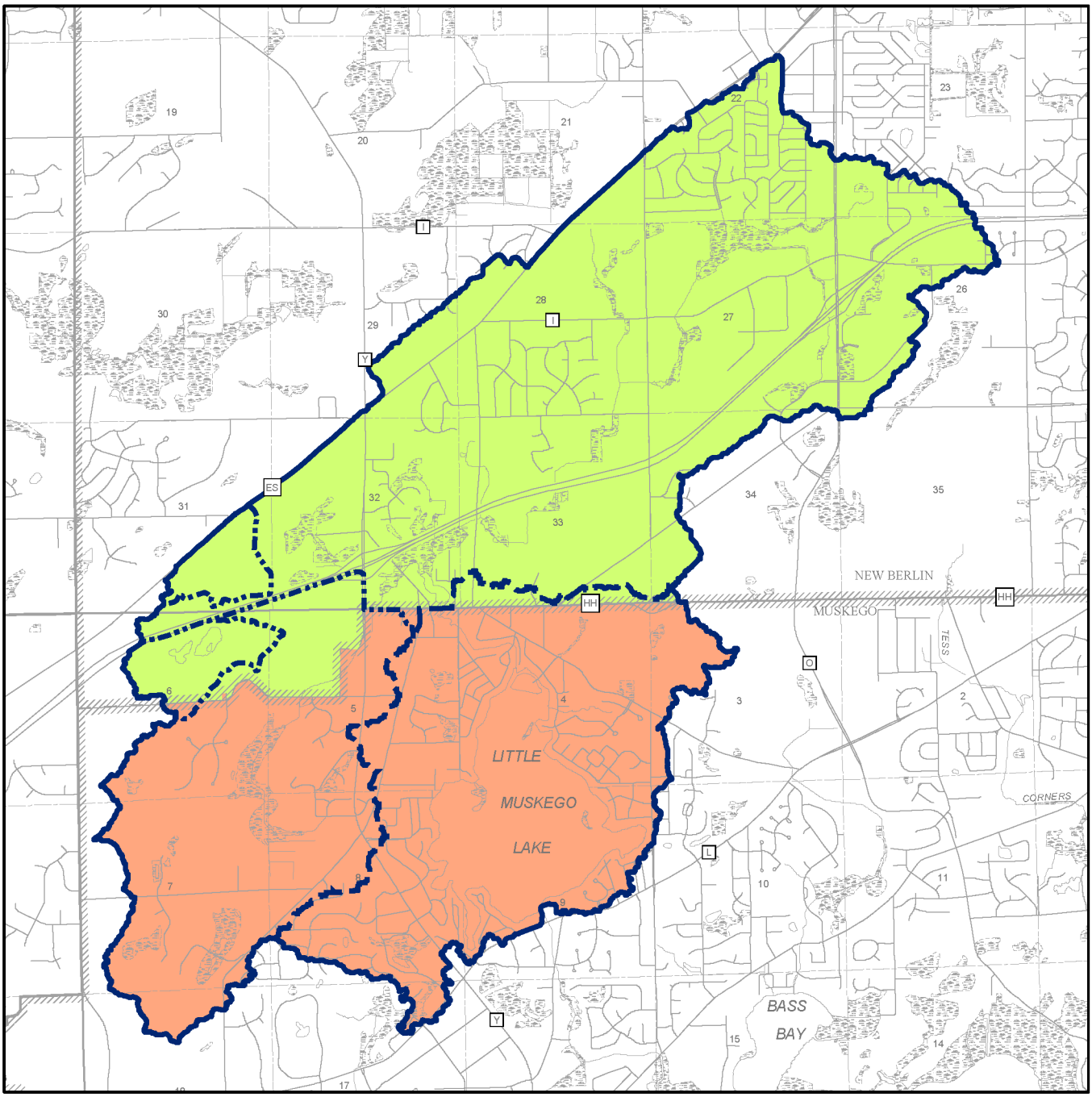
The land uses within the portion of the drainage area directly tributary to Little Muskego Lake are primarily urban, with low- to medium-density residential uses being the dominant forms of urban land use. The shoreline of the Lake is almost entirely developed for residential uses. Existing land uses in the direct tributary area to the Lake, as of 2000, are shown on Map 4, and are summarized in Table 3. Future changes in land use within the area tributary to the Lake are expected to include further limited urban development, infilling of already platted lots, and the possible redevelopment of existing properties at urban densities. Under proposed year 2035 conditions, as summarized in Table 3 and shown on Map 5, urban land uses in the direct tributary area of Little Muskego Lake are expected to increase from about 54 percent of the land cover in 2000, to about 68 percent of the land cover in 2035. Agricultural uses are anticipated to decline from about 54 percent of the land cover as of 2000, to about 1 percent of the land cover under year 2035 conditions. As shown on Map 5, these changes are predicted to occur mostly in the central portion of the tributary area. These land use changes have the potential to modify the nature and delivery of nonpoint source contaminants to the Lake, with concomitant impacts on the aquatic plant communities within the waterbody.

In the total area tributary to Little Muskego Lake, existing land uses are summarized in Table 4. As shown on Map 6, as of the year 2000, land uses in the total tributary area were more rural than urban, with agricultural land uses being the dominant form of rural land use. Urban density residential land uses were the dominant urban land use. Future changes in land use within the total area tributary to Little Muskego Lake are expected to be similar in nature to those anticipated within the area directly tributary to the Lake, albeit not as pronounced. Rural land uses are anticipated to diminish from 51 percent of the land coverage to about 31 percent, while urban land uses are expected to increase from about 49 percent of the land cover to approximately 69 percent, as shown on Map 7.

An unusual feature of the lands tributary to Little Muskego Lake is the presence of several internally drained areas. These areas, shown on Map 1, contain topographical features that would retain rainfall runoff during normal precipitation events. Land uses within the three internally drained areas, under both year 2000 and anticipated year

Map 3

CIVIL DIVISION BOUNDARIES WITHIN THE LITTLE MUSKEGO LAKE TOTAL TRIBUTARY AREA



Source: SEWRPC.

Table 2

POPULATION AND HOUSEHOLDS WITHIN THE DIRECT AND TOTAL AREAS TRIBUTARY TO LITTLE MUSKEGO LAKE: 1960-2000[a]

Year	Direct Tributary Area		Total Tributary Area	
	Population	Households	Population	Households
1960	2,947	754	5,740	1,501
1970	4,178	1,026	7,977	1,928
1980	4,292	1,285	8,849	2,584
1990	4,680	1,544	10,476	3,376
2000	5,410	2,016	11,592	4,156

[a]*These data differ slightly from those reported in the 2004 SEWRPC study on Little Muskego Lake due to refinements of the Little Muskego Lake tributary area boundaries made possible through Commission digital terrain modeling analysis.*

Source: U.S. Bureau of the Census and SEWRPC.

2035 land use conditions, are summarized in Table 5. Water retained in these internally drained features would be slowly released through the groundwater system into surface water features, such as streams and wetlands, or lost to the atmosphere through evaporation, although during extreme precipitation events, some of these areas could overflow to the Lake. Under typical conditions, these areas would not contribute pollutant loads to the Lake, and these lands have been excluded from the nonpoint source pollution loading estimates set forth in Tables 6 and 7.

SHORELINE PROTECTION STRUCTURES

Erosion of shorelines results in the loss of land, damage to shoreline infrastructure, and interference with lake access and use. Wind-wave erosion, ice movement, and motorized boat traffic usually cause such erosion. A survey of the shoreline of Little Muskego Lake, conducted by SEWRPC staff during the previous 2004 study, identified an approximately equal distribution of areas with natural shorelines and areas protected by riprap, bulkheads, and similar structural shoreline protection measures. A similar survey of the shoreline of the Lake, conducted during the late summer of 2007, showed no major changes from the earlier survey, although there were some areas in the southwestern corner and at the northern end of the Lake where sections of bulkhead had been replaced by riprap, and a few areas in the southwestern corner of the Lake where riprap had been replaced by natural shoreline, as shown on Map 8. No severe erosion-related problems were observed during the 2007 survey.

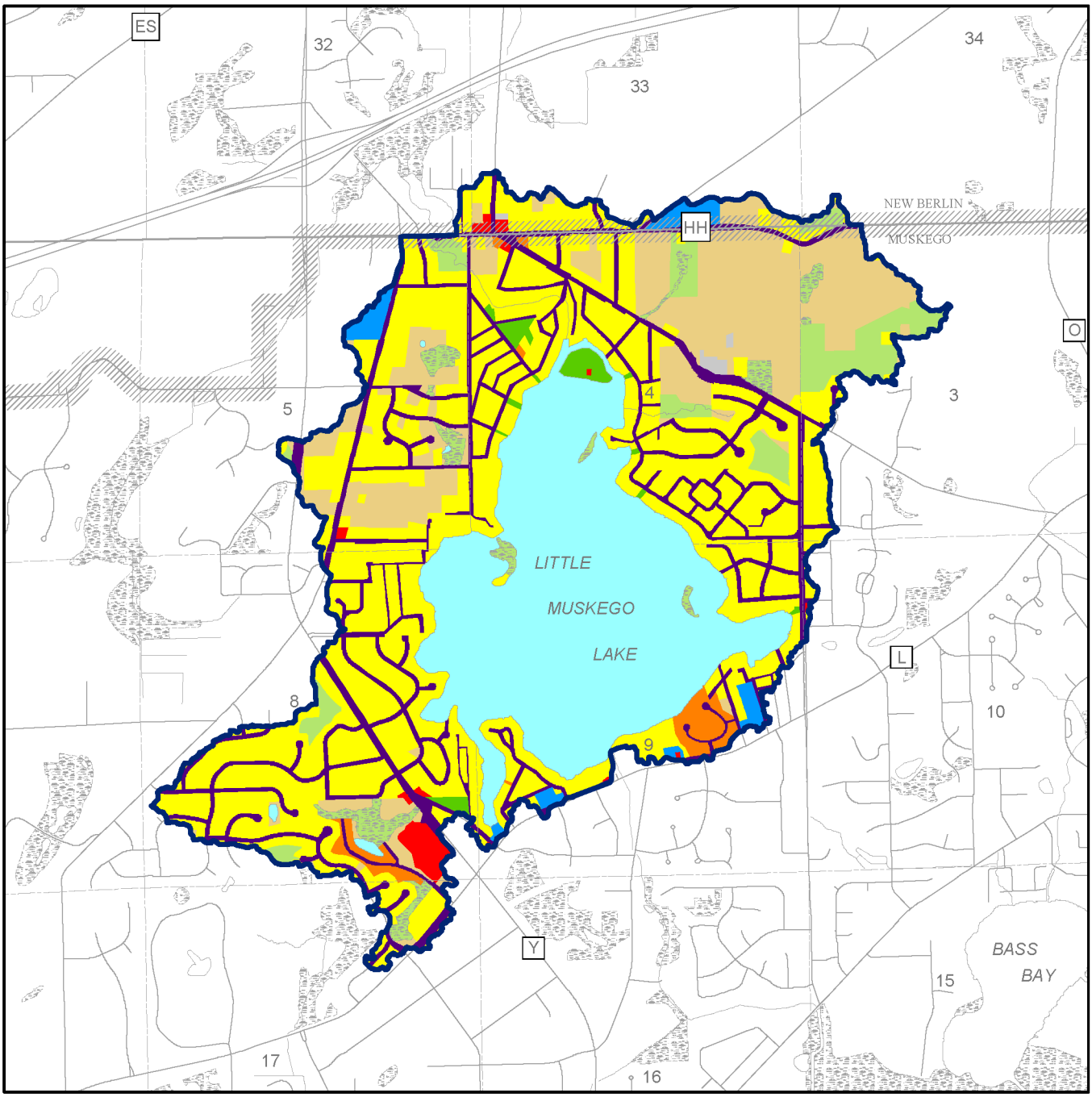
WATER QUALITY

As noted in the previous report, water quality data on Little Muskego Lake have been collected under the auspices of the WDNR Self-Help Monitoring Program, now the University of Wisconsin-Extension (UWEX) Citizen Lake Monitoring Network (CLMN), with these data being supplemented at intervals by data collected under the auspices of the U.S. Geological Survey (USGS) Trophic State Index (TSI) monitoring program since 1986.[5] At the time of the previous report in 2004, the Lake was considered to have fair to poor water quality, based on measurements of Secchi-disk water transparency and chlorophyll-*a* concentration. At that time, it was noted that somewhat higher Secchi-disk transparency readings had been observed in the years immediately prior to the 2004 aquatic plant survey.

[5]*See U.S. Geological Survey Open-File Report 03-99,* Water-Quality and Lake-Stage Data for Wisconsin Lakes, Water Year 2002, *2003.*

Map 4

EXISTING LAND USE WITHIN THE LITTLE MUSKEGO LAKE DIRECT TRIBUTARY AREA: 2000



Source: SEWRPC.

Table 3

EXISTING AND PLANNED LAND USE WITHIN THE DIRECT AREA TRIBUTARY TO LITTLE MUSKEGO LAKE: 2000 AND 2035

Land Use Categories[a]	2000		2035	
	Acres	Percent of Tributary Area	Acres	Percent of Tributary Area
Urban				
Residential	775	40.7	918	48.2
Commercial	18	0.9	35	1.8
Industrial	4	0.2	11	0.6
Governmental and Institutional	24	1.3	24	1.3
Transportation, Communication, and Utilities	192	10.1	232	12.2
Recreational	17	0.9	69	3.6
Subtotal	1,030	54.1	1,289	67.7
Rural				
Agricultural and Other Open Lands	280	14.7	21	1.1
Wetlands	38	2.0	38	2.0
Woodlands	74	3.9	74	3.9
Surface Water	481	25.3	481	25.3
Extractive	- -	- -	- -	- -
Landfill	- -	- -	- -	- -
Subtotal	873	45.9	614	32.3
Total	1,903	100.0	1,903	100.0

[a]*Parking included in associated use.*

Source: SEWRPC.

Water Clarity

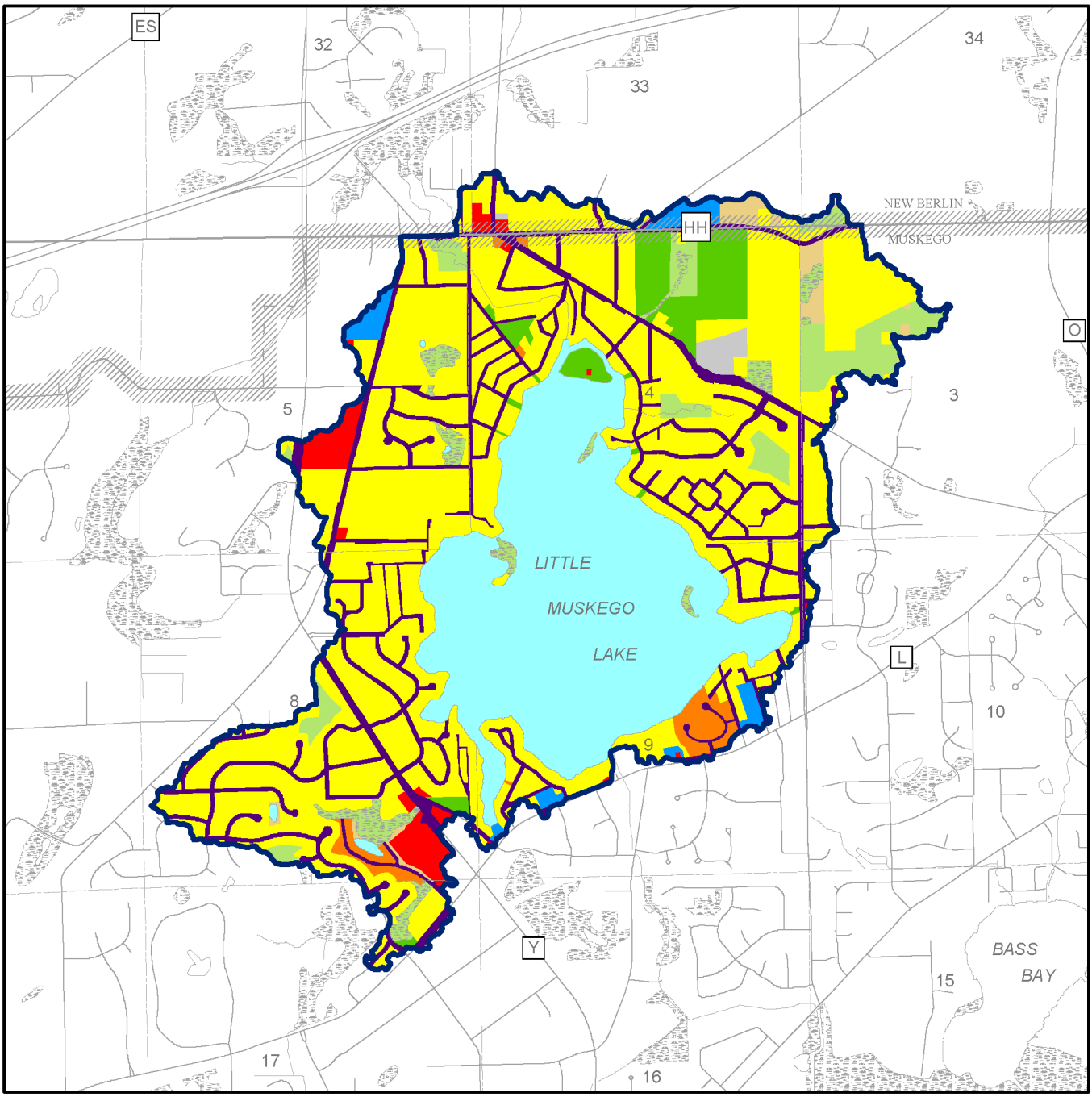
Water clarity, or transparency typically measured using a Secchi disk—a black-and-white, eight-inch-diameter disk, which is lowered into the water until a depth is reached at which the disk is no longer visible—is often used as an indicator of water quality. Transparency can be affected by physical factors, such as water color and suspended particles, and by various biologic factors, including seasonal variations in planktonic algae populations and activities of fish and other organisms living in the lake. Measurements of water clarity comprise an important part of the aforementioned CLMN program in which citizen volunteers assist in lake water quality monitoring efforts.

Secchi-disk measurements from Little Muskego Lake for the period from 1987 through 1991 were often between three feet and six feet, indicating poor to fair water quality.[6] During the period from 1992 through 1994, transparency had increased to between six feet and eight feet, and it was hypothesized that this increase in water clarity might possibly be the result of the development of a significant population of zebra mussels (*Dreissena polymorpha*) in the Lake. Since 1997, WDNR Self-Help/CLMN water clarity data have indicated that Little Muskego Lake generally has fair to very good water quality, as shown in Figure 1, with significant increases in water clarity being observed since 2001. Between 2001 and 2003, for example, and again during 2005, water clarity exceeded 10 feet on average, being categorized as good to very good during this period. This period of increased water clarity coincides with the confirmed presence of zebra mussel in the Lake; the WDNR officially list Little Muskego Lake as containing an established population of zebra mussels since 1999.

[6]*See SEWRPC Community Assistance Planning Report No. 222,* A Lake Management Plan for Little Muskego Lake, Waukesha County, Wisconsin, *June 1996; see also SEWRPC Memorandum Report No. 155,* An Aquatic Plant Management Plan for Little Muskego Lake, Waukesha County, Wisconsin, *January 2004.*

Map 5

PLANNED LAND USE WITHIN THE LITTLE MUSKEGO LAKE DIRECT TRIBUTARY AREA: 2035



Source: SEWRPC.

Table 4

EXISTING AND PLANNED LAND USE WITHIN THE TOTAL AREA TRIBUTARY TO LITTLE MUSKEGO LAKE: 2000 AND 2035

Land Use Categories[a]	2000		2035	
	Acres	Percent of Tributary Area	Acres	Percent of Tributary Area
Urban				
Residential	1,718	31.2	2,211	40.2
Commercial	85	1.5	214	3.9
Industrial	72	1.3	208	3.8
Governmental and Institutional	48	0.9	113	2.0
Transportation, Communication, and Utilities	707	12.8	877	15.9
Recreational	45	0.8	168	3.1
Subtotal	2,675	48.5	3,791	68.9
Rural				
Agricultural and Other Open Lands	1,790	32.6	701	12.7
Wetlands	223	4.1	223	4.1
Woodlands	296	5.4	294	5.3
Surface Water	491	8.9	496	9.0
Extractive	30	0.5	- -	- -
Landfill	- -	- -	- -	- -
Subtotal	4,116	51.5	1,714	31.1
Total	7,214	100.0	5,505	100.0

[a]*Parking included in associated use.*

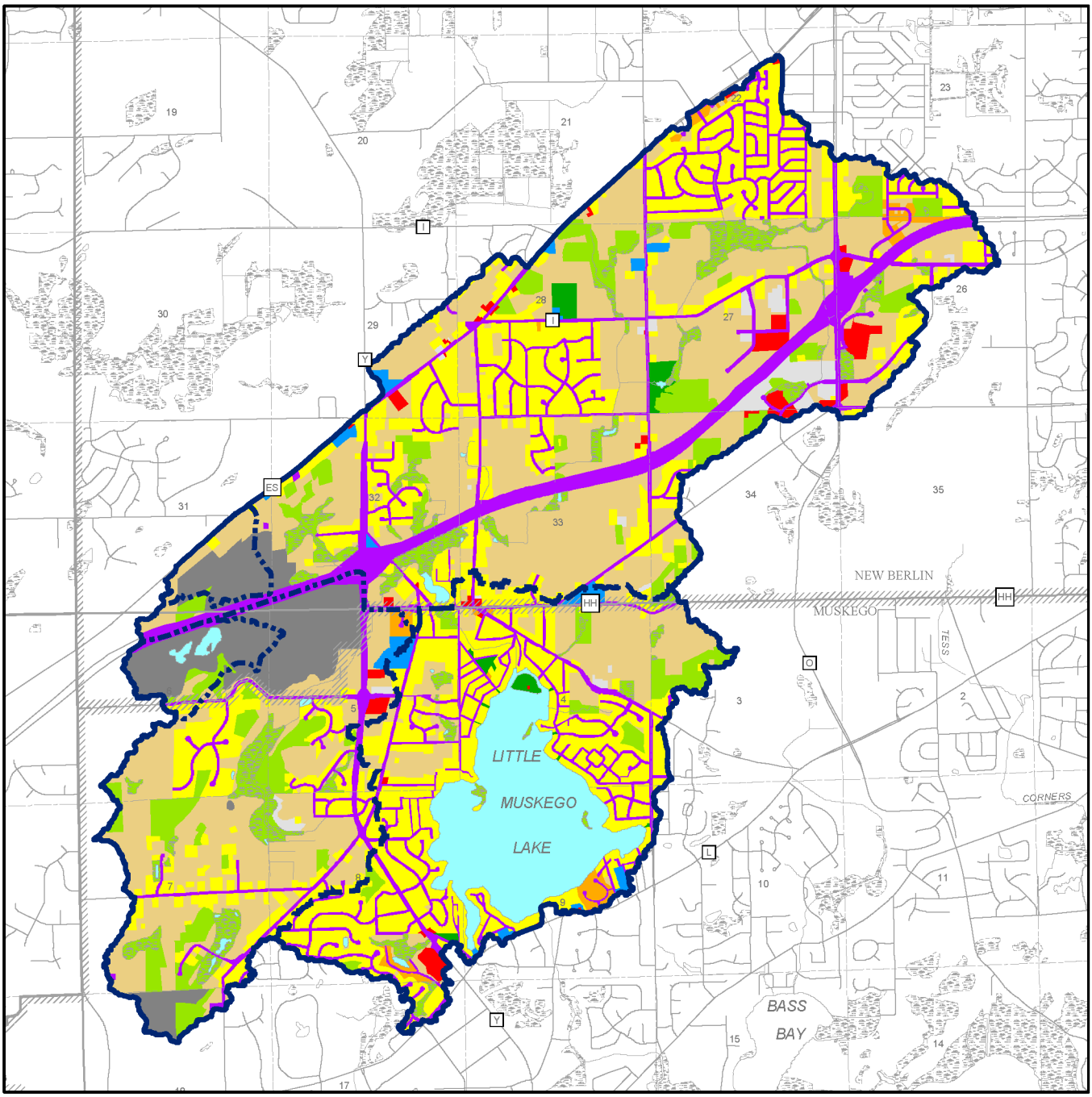
Source: SEWRPC.

The zebra mussel is a nonnative species of shellfish with known negative impacts on native benthic populations. Zebra mussels are having a varied impact on inland lakes in the Upper Midwest. They disrupt the food chain by removing significant amounts of phytoplankton which serve as food, not only for themselves, but also for larval and juvenile fish and many forms of zooplankton. However, many lakes experience improved water clarity as a result of the filter feeding proclivities of these animals. This improved clarity has led to increased growths of rooted aquatic plants, including Eurasian water milfoil. Curiously, within the Southeastern Wisconsin Region, zebra mussels have been observed attaching themselves to the stalks of the Eurasian water milfoil plants, dragging these stems out of the zone of light penetration, due to the weight of the zebra mussel shells, and interfering with the competitive strategy of the Eurasian water milfoil plants. This, in turn, has contributed to improved growths of native aquatic plants, in some cases, and to the growths of filamentous algae too large to be ingested by the zebra mussels in others. Regardless of the seemingly beneficial impacts of these animals, the overall effect is that, as zebra mussels and other invasive species spread to inland lakes and rivers, so to do the environmental, aesthetic, and economic costs to water users. Because zebra mussels have become established in Little Muskego Lake, their populations should be carefully monitored and recreational boaters advised of measures to minimize the risk of spreading this invasive species to other area lakes.

In addition to direct in-lake measurements of water clarity using a Secchi-disk, the transparency of many Wisconsin lakes has been measured using remote sensing satellite technology. The Environmental Remote Sensing Center (ERSC), established in 1970 at the University of Wisconsin-Madison, was one of the first remote sensing facilities in the United States. Using data gathered by satellite remote sensing over a three-year period, the ERSC generated a map based on a mosaic of satellite images showing the estimated water clarity of the largest 8,000 lakes in Wisconsin. The WDNR, through its volunteer Self-Help monitoring program, was able to gather water clarity measurements as Secchi-disk readings from about 800 of these lakes, or from about 10 percent of Wisconsin's largest lakes. In the case of Little Muskego Lake, water clarity measurements estimated by ERSC

Map 6

EXISTING LAND USE WITHIN THE LITTLE MUSKEGO LAKE TOTAL TRIBUTARY AREA: 2000



SINGLE-FAMILY RESIDENTIAL
MULTI-FAMILY RESIDENTIAL
COMMERCIAL
INDUSTRIAL
GOVERNMENTAL AND INSTITUTIONAL
RECREATIONAL

TRANSPORTATION, COMMUNICATIONS, AND UTILITIES
SURFACE WATER
WETLANDS AND WOODLANDS
EXTRACTIVE AND LANDFILL
AGRICULTURAL, UNUSED, AND OTHER OPEN LANDS

TOTAL TRIBUTARY AREA BOUNDARY FOR LITTLE MUSKEGO LAKE
DIRECT TRIBUTARY AREA BOUNDARY WHERE NOT COINCIDENT WITH TOTAL AREA BOUNDARY
INTERNALLY DRAINED AREA BOUNDARY WHERE NOT COINCIDENT WITH TOTAL AREA BOUNDARY

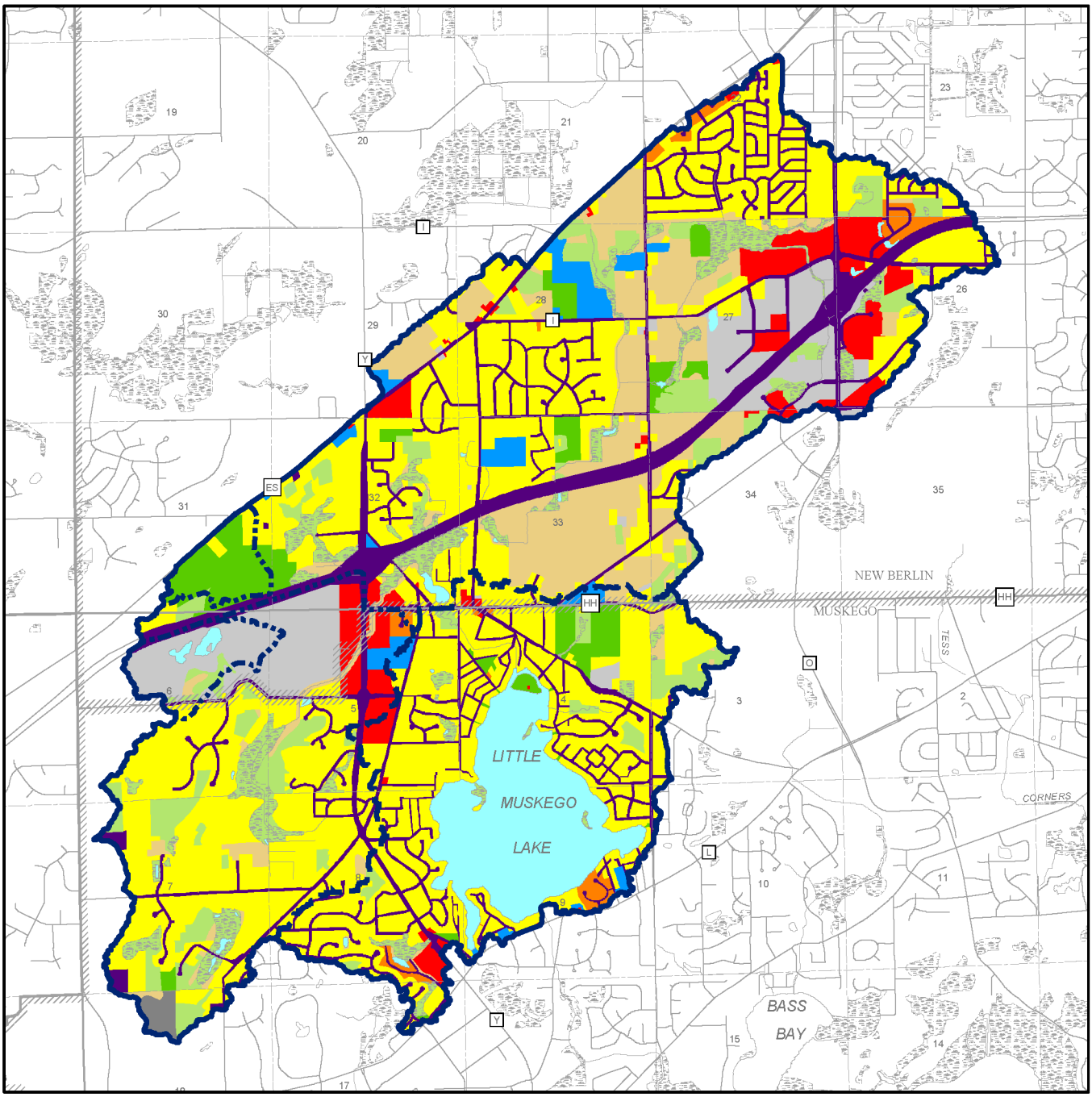
N

0 3,000 6,000 Feet

Source: SEWRPC.

Map 7

PLANNED LAND USE WITHIN THE LITTLE MUSKEGO LAKE TOTAL TRIBUTARY AREA: 2035



- SINGLE-FAMILY RESIDENTIAL
- MULTI-FAMILY RESIDENTIAL
- COMMERCIAL
- INDUSTRIAL
- GOVERNMENTAL AND INSTITUTIONAL
- RECREATIONAL
- TRANSPORTATION, COMMUNICATIONS, AND UTILITIES
- SURFACE WATER
- WETLANDS AND WOODLANDS
- EXTRACTIVE AND LANDFILL
- AGRICULTURAL, UNUSED, AND OTHER OPEN LANDS
- TOTAL TRIBUTARY AREA BOUNDARY FOR LITTLE MUSKEGO LAKE
- DIRECT TRIBUTARY AREA BOUNDARY WHERE NOT COINCIDENT WITH TOTAL AREA BOUNDARY
- INTERNALLY DRAINED AREA BOUNDARY WHERE NOT COINCIDENT WITH TOTAL AREA BOUNDARY

N

0 3,000 6,000 Feet

Source: SEWRPC.

Table 5

EXISTING AND PLANNED LAND USE WITHIN THE INTERNALLY DRAINED AREAS TRIBUTARY TO LITTLE MUSKEGO LAKE: 2000 AND 2035

Land Use Categories[a]	2000		2035	
	Acres	Percent of Tributary Area	Acres	Percent of Tributary Area
Urban				
Residential	276	16.1	691	40.5
Commercial	9	0.5	59	3.4
Industrial	11	0.6	228	13.3
Governmental and Institutional	8	0.5	13	0.8
Transportation, Communication, and Utilities	119	7.0	276	16.2
Recreational	- -	- -	96	5.6
Subtotal	423	24.7	1,363	79.8
Rural				
Agricultural and Other Open Lands	646	37.9	53	3.1
Wetlands	96	5.6	96	5.6
Woodlands	157	9.2	154	9.0
Surface Water	17	1.0	17	1.0
Extractive	334	19.6	- -	- -
Landfill	35	2.0	25	1.5
Subtotal	1,285	75.3	345	20.2
Total	1,708	100.0	1,708	100.0

[a]*Parking included in associated use.*

Source: SEWRPC.

Table 6

ESTIMATED ANNUAL POLLUTANT LOADINGS TO LITTLE MUSKEGO LAKE BY LAND USE CATEGORY: 2000

Land Use Category	Pollutant Loads			
	Sediment (tons)	Phosphorus (pounds)	Copper (pounds)	Zinc (pounds)
Urban				
Residential	16.8	343.6	0.0	1.6
Commercial	33.3	102.0	18.7	3.0
Industrial	27.1	84.2	15.8	1.5
Governmental and Institutional	12.3	64.8	3.4	24.8
Transportation, Communication, and Utilities	3.4	77.8	0.0	0.0
Recreational	0.5	12.2	0.0	0.0
Subtotal	93.4	684.6	37.9	30.9
Rural				
Agricultural and Other Open Lands	402.8	1,539.4	0.0	0.0
Wetlands	0.4	8.9	0.0	0.0
Woodlands	0.5	11.8	0.0	0.0
Water	46.2	63.8	0.0	0.0
Extractive	6.8	25.8	0.0	0.0
Subtotal	456.7	1,649.7	0.0	0.0
Total	550.1	2,334.3	37.9	30.9

Source: SEWRPC.

Table 7

ESTIMATED ANNUAL POLLUTANT LOADINGS TO LITTLE MUSKEGO LAKE BY LAND USE CATEGORY: 2035

Land Use Category	Pollutant Loads			
	Sediment (tons)	Phosphorus (pounds)	Copper (pounds)	Zinc (pounds)
Urban				
Residential	21.6	442.2	0.0	1.6
Commercial	83.9	256.8	47.1	3.0
Industrial	78.2	243.4	45.8	1.5
Governmental and Institutional	28.9	152.6	7.9	24.8
Transportation, Communication, and Utilities	4.2	96.5	0.0	0.0
Recreational	2.0	45.4	0.0	0.0
Subtotal	218.8	1,236.9	100.8	30.9
Rural				
Agricultural and Other Open Lands	157.7	602.9	0.0	0.0
Wetlands	0.4	8.9	0.0	0.0
Woodlands	0.5	11.8	0.0	0.0
Water	46.6	64.5	0.0	0.0
Extractive	0.0	0.0	0.0	0.0
Subtotal	205.2	688.1	0.0	0.0
Total	424.0	1,925.0	100.8	30.9

Source: SEWRPC.

remote sensing indicated that average water clarity in Little Muskego Lake was about eight feet, a value indicative of generally fair to good water quality. This agreement between field measurements and the satellite remote sensing estimates generated by ERSC enabled ERSC to estimate water clarity in the remaining 90 percent of large lakes with a high level of certainty, providing a comprehensive "snap shot" of lake conditions in Wisconsin's largest lakes.

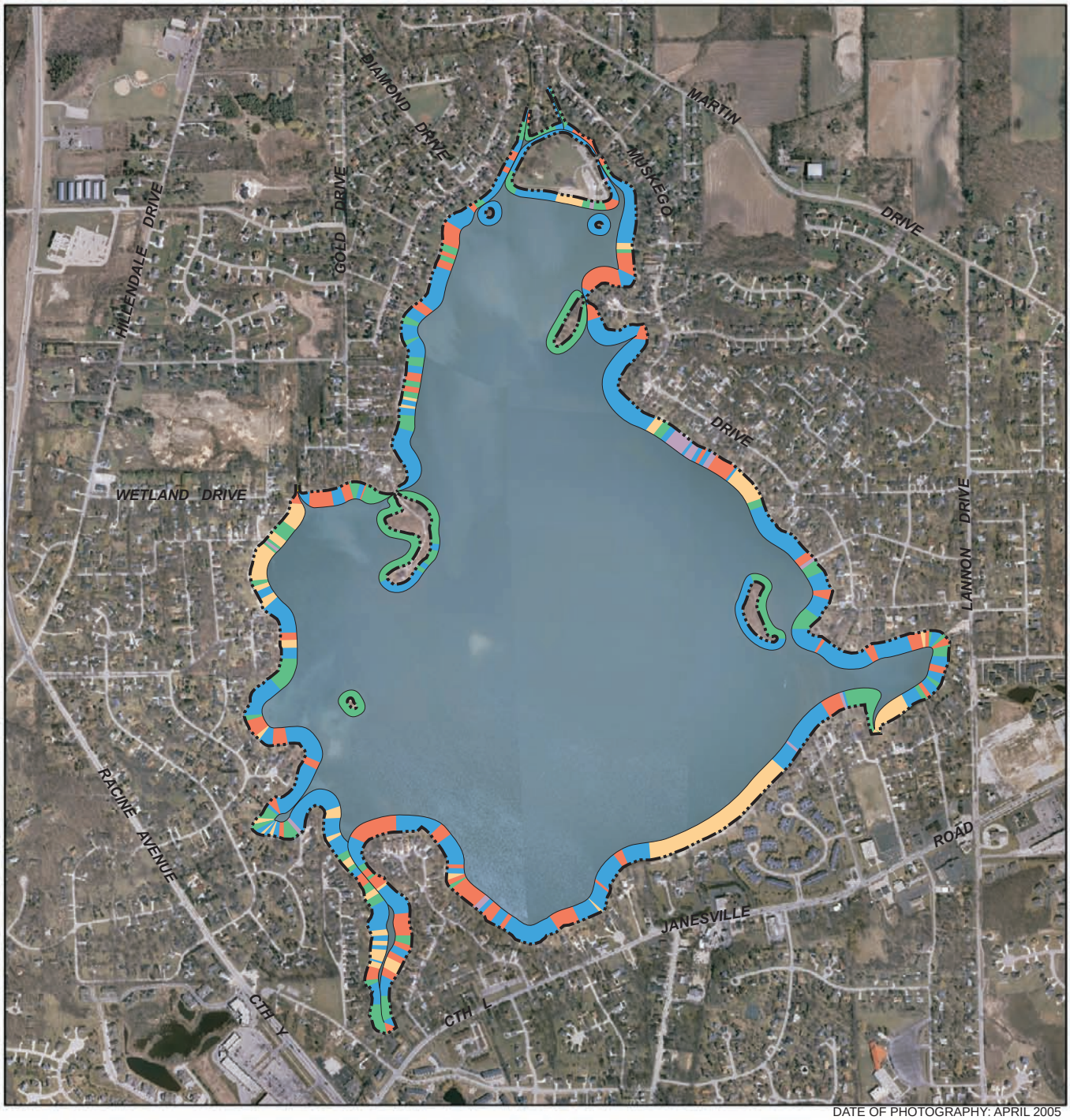
Dissolved Oxygen

Dissolved oxygen levels are one of the most critical factors affecting the living organisms of a lake ecosystem. As was indicated by the USGS water quality data for the period between 1994 and 2002, dissolved oxygen levels generally were higher at the surface of Little Muskego Lake, where there is an interchange between the water and atmosphere, stirring by wind action, and production of oxygen by plant photosynthesis, than they were in the bottom waters of the Lake. Dissolved oxygen levels generally were lowest near the bottom of the Lake, where decomposer organisms and chemical oxidation processes utilized oxygen in the decay process. When a lake becomes stratified, that is, when a thermal or chemical gradient of sufficient intensity produces a barrier separating the upper waters, called the epilimnion, from lower waters, known as the hypolimnion, the surface supply of oxygen to the hypolimnion is cut off. Eventually, if there is not enough dissolved oxygen to meet the demands from the bottom dwelling aquatic life and decaying organic material, the dissolved oxygen levels in the bottom waters may be reduced to zero, a condition known as anoxia or anaerobiasis. During the abovementioned USGS study period, between 1994 and 2002, Little Muskego Lake thermally stratified at depths of between about 15 to 25 feet by mid- to late-summer. This stratification is generally consistent with measurements summarized in the comprehensive lake management plan of 1996.[7] That plan noted that Little Muskego Lake generally became anoxic between late-May and late-June, based on dissolved oxygen concentration data for the period from 1986 through 1993. During the 1994 to 2002 study period, Little Muskego Lake became anoxic during the late

[7]*SEWRPC Community Assistance Planning Report No. 222,* op. cit.

Map 8

SHORELINE PROTECTION STRUCTURES ON LITTLE MUSKEGO LAKE: 2007



DATE OF PHOTOGRAPHY: APRIL 2005

RIPRAP

REVETMENT

BULKHEAD

BEACH/PEA GRAVEL

NATURAL

GRAPHIC SCALE

0 650 1300 FEET

Source: SEWRPC.

Figure 1

PRIMARY WATER QUALITY INDICATORS FOR LITTLE MUSKEGO LAKE: 1986-2008

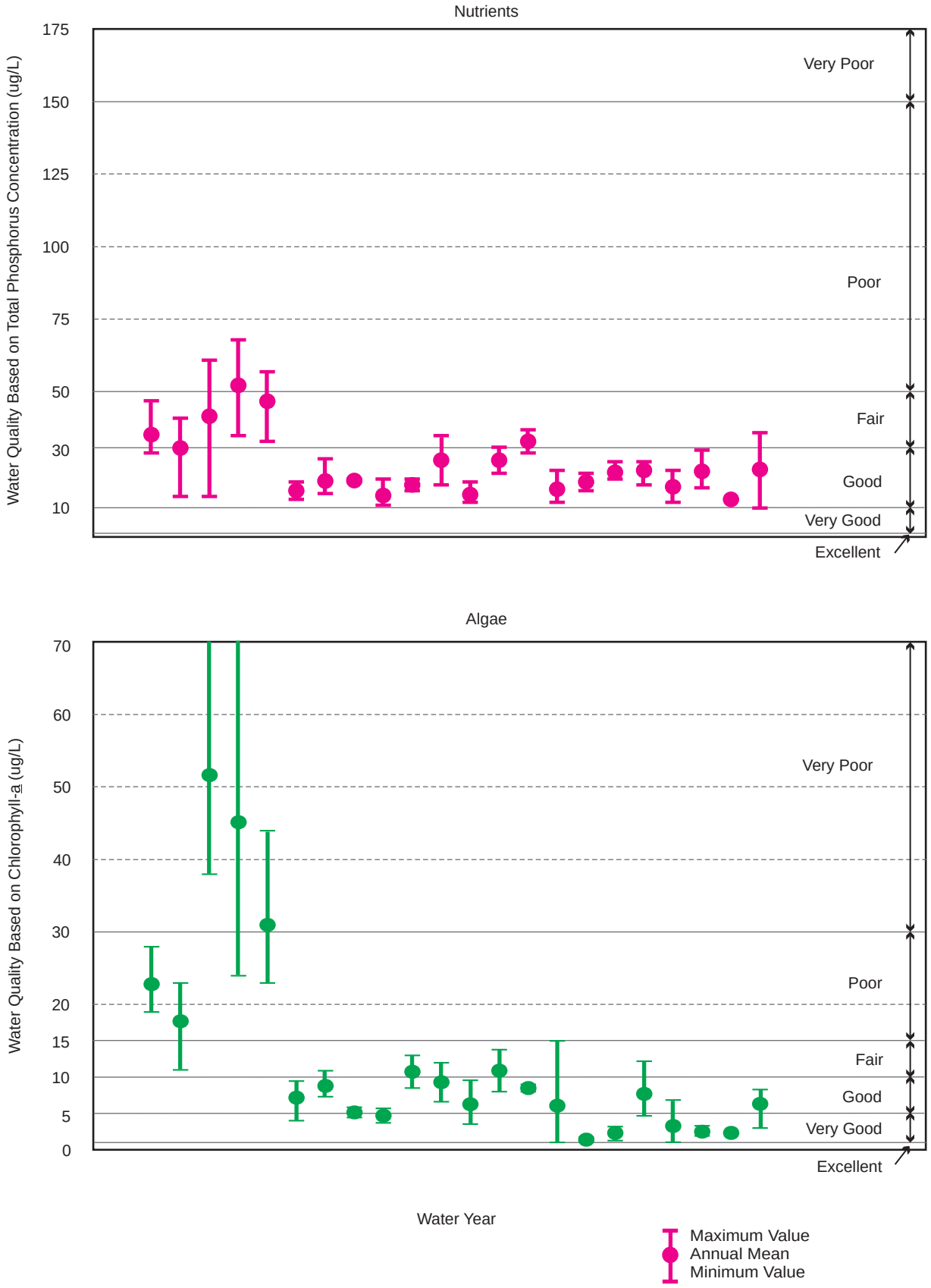
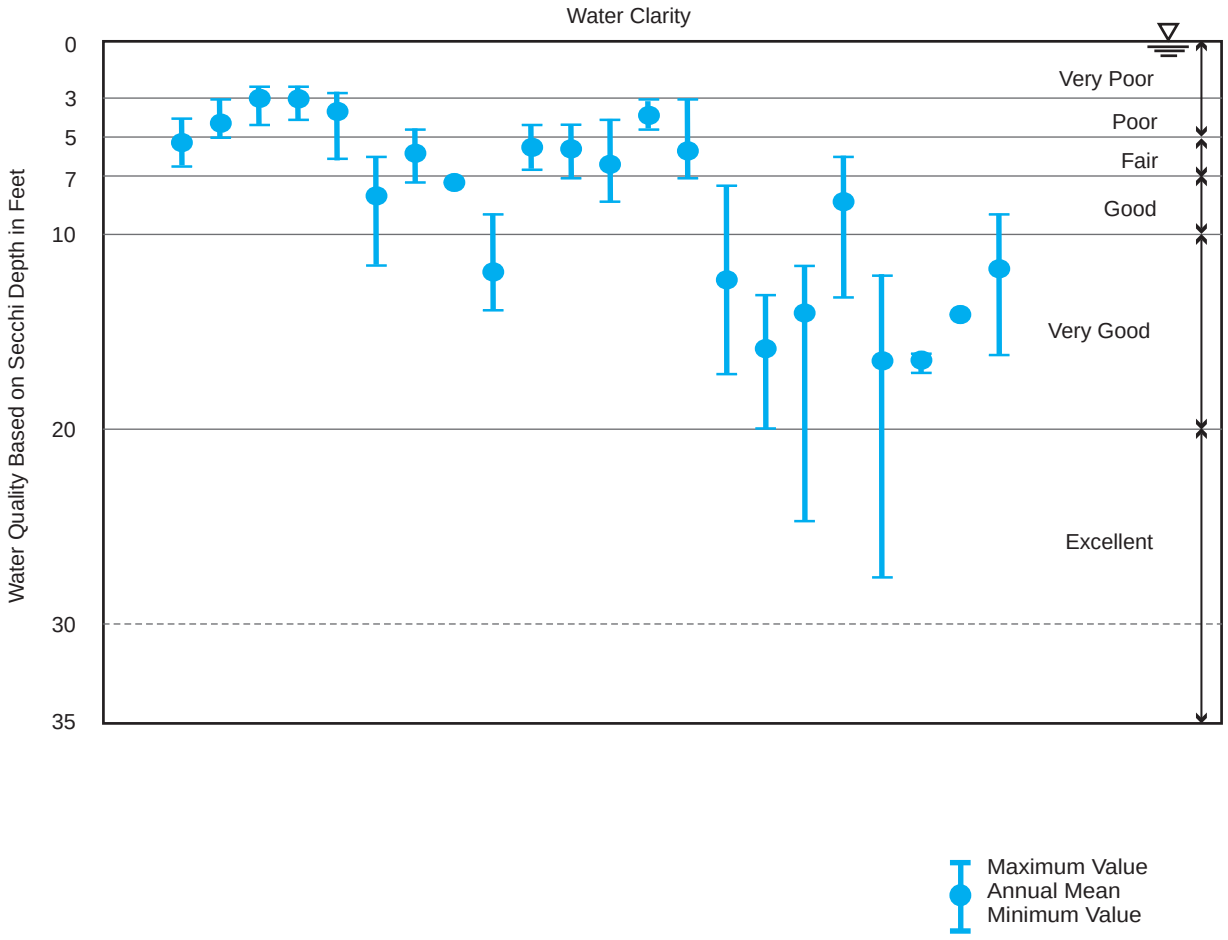


Figure 1 (continued)



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

summers of 1999 and 2000; during the other years of this study period, while levels of dissolved oxygen in the hypolimnion were significantly depressed far below the level—5.0 milligrams per liter (mg/l)—necessary to sustain fish, they did not reach anoxic conditions. During the current study period, depressed oxygen levels approaching anoxic conditions in the hypolimnion were observed during 2003. No dissolved oxygen concentration data are available for the Lake since 2003.

Hypolimnetic anoxia is common in many of the lakes in southeastern Wisconsin during summer stratification. The depleted oxygen levels in the hypolimnion cause fish to move upward, nearer to the surface of the lakes, where higher dissolved oxygen concentrations exist. This migration, when combined with temperature, can select against some fish species that prefer the cooler water temperatures that generally prevail in the lower portions of the lakes. When there is insufficient oxygen at these depths, these fish are susceptible to summer-kills, or, alternatively, are driven into the warmer water portions of the lake where their condition and competitive success may be severely impaired.

In addition to these biological consequences, the lack of dissolved oxygen at depth can enhance the development of chemoclines, or chemical gradients, with an inverse relationship to the dissolved oxygen concentration. For example, the sediment-water exchange of elements, such as phosphorus, iron, and manganese, is increased under anaerobic conditions, resulting in higher hypolimnetic concentrations in these elements. Under anaerobic conditions, iron and manganese change oxidation states enabling the release of phosphorus from the iron and manganese complexes to which they were bound under aerobic conditions. This “internal loading” can affect

water quality significantly if these nutrients and salts are mixed into the epilimnion, especially during early summer when these nutrients can become available for algae and rooted aquatic plant growth.

Although the previous study did not report on phosphorus concentrations, the comprehensive lake management plan noted that data from 1987 through 1993 indicated the potential for considerable internal loading of phosphorus from the bottom sediments of Little Muskego Lake. The import of internal loading to the nutrient budget of Little Muskego Lake during the current period is difficult to assess due to the lack of total phosphorus measurements in the hypolimnion of the Lake. Nevertheless, it is likely that such loading may remain an important source of dissolved phosphorus for aquatic plants in the epilimnion of the Lake under certain weather conditions. Should any such loading occur, the magnitude of the release and its subsequent effects in contributing to algal growth in the surface waters of the Lake may be moderated by a number of circumstances, including the rates of mixing during the spring and fall overturn events. Slow mixing generally results in any phosphorus released into the bottom waters of the Lake being reprecipitated and unavailable to aquatic plants.[8]

Chlorophyll-*a*

Chlorophyll-*a* is the major photosynthetic ("green") pigment in algae. The amount of chlorophyll-*a* present in the water, therefore, is an indication of the biomass, or amount of algae, in the water. Prior to the current study period, average chlorophyll-*a* concentrations ranged from less than 10 to more than 30 micrograms per liter (μg/l), with a mean chlorophyll-*a* concentration of about 20 μg/l. Chlorophyll-*a* levels above about 10 μg/l result in a green coloration of the water that may be severe enough to impair recreational activities, especially full-body-contact recreational uses, such as swimming or waterskiing.[9] Since the confirmed presence of zebra mussel in the Lake, chlorophyll-*a* values for Little Muskego Lake typically averaged about 11 μg/l, indicating fair water quality bordering on good water quality, as shown in Figure 1. These chlorophyll-*a* concentrations are only slightly higher than those recorded in other lakes in the Region,[10] which is consistent with the action of the zebra mussels.

Nutrient Characteristics

Aquatic plants and algae require such nutrients as phosphorus and nitrogen for growth. In hard-water alkaline lakes, most of these nutrients are generally found in concentrations that exceed the needs of the growing plants. However, in lakes where the supply of one or more of these nutrients is limited, plant growth is limited by the amount of the nutrient that is available in the least quantity relative to all of the others.[11]

Unfortunately, few recent nutrient data are available for Little Muskego Lake. Data for the period between 2000 and 2004 indicate variable water quality conditions in recent years. Data from 2000 and 2004, respectively, are consistent with the data reported in the previous plans, which indicate that total phosphorus concentrations in the Lake averaged between 25 μg/l and about 30 μg/l. These data are in marked contrast to those measured during 2001 and 2002, which indicated that average total phosphorus concentrations in the Lake exceeded 75 μg/l, as shown in Figure 1. These latter levels are well above the guideline value of 20 μg/l of total phosphorus set forth in

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[8]*See, for example, R.D. Robarts, P.J. Ashton, J.A. Thornton, H.J. Taussig, and L.M. Sephton, "Overturn in a hypertrophic, warm, monomictic impoundment (Hartbeespoort Dam, South Africa),"* Hydrobiologia, *Volume 97, 1982, pp. 209-224.*

[9]*J.R. Vallentyne, "The Process of Eutrophication and Criteria for Trophic State Determination" in* Modeling the Eutrophication Process—Proceedings of a Workshop at St. Petersburg, Florida, *November 19-21, 1969, pp. 57-67.*

[10]*R.A. Lillie and J.W. Mason, Wisconsin Department of Natural Resources Technical Bulletin No. 138,* Limnological Characteristics of Wisconsin Lakes, *1983.*

[11]*M.O. Allum, R.E. Gessner, and T.H. Gakstatter, U.S. Environmental Protection Agency Working Paper No. 900,* An Evaluation of the National Eutrophication Data, *1976.*

the adopted regional water quality management plan. Such values are likely to support nuisance algal blooms, and exceed the level above which algal and aquatic plant growths reach levels likely to interfere with recreational uses and a warmwater fishery established pursuant to Chapters NR 102 and NR 104 of the *Wisconsin Administrative Code*. Total phosphorus concentrations include the phosphorus contained in plant and animal fragments suspended in the lake water, phosphorus bound to sediment particles, and phosphorus dissolved in the water column. Total phosphorus concentrations, therefore, usually are considered to be a good indicator of nutrient status of a lake.

POLLUTION LOADINGS AND SOURCES

Pollutant loads to a lake are generated by various natural processes and human activities that take place in the area tributary to a lake. These loads are transported to the lake through the atmosphere, across the land surface, and by way of inflowing streams. Pollutants transported by the atmosphere are deposited onto the surface of a lake as dry fallout and direct precipitation. Pollutants transported across the land surface enter a lake as direct runoff and, indirectly, as groundwater inflows, including drainage from onsite wastewater treatment systems. Pollutants transported by streams enter a lake as surface water inflows. In flow through lakes like Little Muskego Lake, pollutant loadings transported across land surfaces and by inflowing streams comprise the principal routes by which contaminants enter a waterbody.[12] Currently, there are no significant point source discharges of pollutants to Little Muskego Lake or to the surface waters tributary to Little Muskego Lake, and the majority of the tributary area is served by public sewerage systems.[13] For this reason, the discussion that follows is based upon nonpoint source pollutant loadings to the Lake. Nonpoint sources of water pollution include urban sources, such as runoff from residential, commercial, transportation, construction, and recreational activities, and rural sources, such as runoff from agricultural lands and onsite sewage disposal systems.

For purposes of the comprehensive lake management plan, annual loading budgets for phosphorus and sediment were developed for the tributary area; in addition, an annual loading budget for zinc was developed for the urban areas of the tributary area of Little Muskego Lake. No such contaminant budgets were developed in the 2004 aquatic plant management plan for Little Muskego Lake. In this plan, nonpoint source phosphorus, suspended solids, and urban-derived metals inputs to Little Muskego Lake are estimated using the Wisconsin Lake Model Spreadsheet (WILMS version 3.0),[14] and the unit area load-based models developed for use within the Southeastern Wisconsin Region.[15]

Phosphorus Loadings

In the 1996 comprehensive lake management plan, phosphorus was identified as the factor generally limiting aquatic plant growth in Little Muskego Lake. Thus, excessive levels of phosphorus in the Lake are likely to result

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[12]*Sven-Olof Ryding and Walter Rast,* The Control of Eutrophication of Lakes and Reservoirs, *Unesco Man and the Biosphere Series, Volume 1, Parthenon Press, Carnforth, 1989; Jeffrey A. Thornton, Walter Rast, Marjorie M. Holland, Geza Jolankai, and Sven-Olof Ryding,* The Assessment and Control of Nonpoint Source Pollution of Aquatic Ecosystems, *Unesco Man and the Biosphere Series, Volume 23, Parthenon Press, Carnforth, 1999.*

[13]*See SEWRPC Community Assistance Planning Report No. 64, 3rd Edition,* Sanitary Sewer Service Area for the City of Muskego, Waukesha County, Wisconsin, *December 1997.*

[14]*John C. Panuska and Jeff C. Kreider, Wisconsin Department of Natural Resources Publication No. PUBL-WR-363-94,* Wisconsin Lake Modeling Suite Program Documentation and User's Manual, Version 3.3 for Windows, *August 2002.*

[15]*SEWRPC Planning Report No. 30,* A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000, *Volume One,* Inventory Findings, *September 1978; Volume Two,* Alternative Plans, *February 1979; and Volume Three,* Recommended Plan, *June 1979.*

in conditions that interfere with the desired use of the Lake. The comprehensive lake management plan estimated that between 5,000 and 6,000 pounds of phosphorus entered Little Muskego Lake annually, with the major source being Jewel Creek which was estimated to contribute 88 percent of the total phosphorus load. Of the total phosphorus load to the Lake from external sources, about 71 percent was estimated to have been generated from rural lands within the tributary area, and about 29 percent from urban lands. Phosphorus release from the lake bottom sediments, or internal loading, as discussed above, also appeared to have been a contributing factor during the initial study period, adding an estimated 930 pounds of phosphorus to the water column each year during periods of stratification. At that time, it was estimated that 47 percent, or about 2,900 pounds, of the total external phosphorus load was used by the biomass within the Lake or deposited into the Lake sediments, resulting in a downstream net transport of phosphorus to Big Muskego Lake of about 3,300 pounds, or about 53 percent of the total phosphorus load to Little Muskego Lake.

During the current study, as shown in Table 6, existing year 2000 phosphorus loads to Little Muskego Lake were identified and quantified using Commission land use inventory data. It was estimated that, under year 2000 conditions, the total phosphorus load to Little Muskego Lake was 2,334 pounds. Of the annual total phosphorus load, it was estimated that 1,650 pounds per year, or 71 percent of the total loading, were contributed by runoff from rural lands, mostly from agricultural sources, and 685 pounds per year, or 29 percent, were contributed by runoff from urban lands, mostly from urban residential sources. About 64 pounds, or about 3 percent, were estimated to be contributed by direct precipitation onto the lake surface.

The apparent decrease in phosphorus loading to the Lake relative to those estimated in the 1996 report can likely be attributed to various factors, such as changes in land use, as well as redefining the Lake's tributary area boundary based upon the more-detailed Commission and Waukesha County digital terrain model. This latter refinement has led to the exclusion of several internally drained portions of the watershed in the tributary area that previously had been included in the 1996 loading estimates. These refinements better reflect the actual nutrient loads being delivered to the Lake.

Table 7 shows the estimated phosphorus loads to Little Muskego Lake under planned year 2035 conditions, as set forth in the adopted regional land use plan.[16] Under planned conditions, the annual total phosphorus load to the Lake is anticipated to continue to diminish by about 18 percent as agricultural activities within the area tributary to Little Muskego Lake are replaced by urban residential land uses. The most likely annual total phosphorus load to the Lake under buildout conditions is estimated to be 1,925 pounds of phosphorus. Of the total annual forecast phosphorus load of 1,925 pounds of phosphorus to Little Muskego Lake, 688 pounds per year, or about 36 percent of the total loading, are estimated to be contributed by runoff from rural lands, mostly from agricultural land uses, while 1,237 pounds per year, or about 64 percent, are estimated to be contributed by runoff from urban lands, mostly from urban residential lands. It is anticipated that about 65 pounds, or about 3 percent, would be contributed by direct precipitation onto the lake surface. Thus, it may be anticipated that, not only will the total phosphorus load to the Lake decrease, but also the distribution of the sources of the phosphorus load to the Lake will change. The amount of phosphorus being contributed to the Lake from urban sources would be expected to increase and become the dominant phosphorus source to the Lake, with the proportion of the total load increasing from about 29 percent during 2000 to about 64 percent during 2035. It further is estimated that the proportion of phosphorus from rural sources will decreases from about 71 percent of the total load during 2000 to about 36 percent of the total load during 2035.

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

However, this trend may be offset by the increasing utilization of agro-chemicals in urban landscaping.[17] Studies within the Southeastern Wisconsin Region indicate that urban residential lands fertilized with a phosphorus-based fertilizer can contribute up to two-times more dissolved phosphorus to a lake than lawns fertilized with a phosphorus-free fertilizer or not fertilized at all.[18] The City of Muskego has requested City residents to voluntarily avoid the use of phosphorus-based fertilizers.[19]

Sediment Loadings

In the 1996 comprehensive lake management plan, it was estimated that 2,612 tons of sediment were delivered to the Lake each year, with about 58 percent of this sediment loading being contributed by Jewel Creek, and the remaining 42 percent being contributed by runoff from the areas in the City of Muskego which drain directly to the Lake or to minor tributaries of the Lake. Sediment loadings to Little Muskego Lake were not calculated as part of the 2004 aquatic plant management plan.

For the current study period, the estimated sediment loadings to Little Muskego Lake for existing year 2000 land use conditions are set forth in Table 6. A total annual sediment loading of about 550 tons was estimated to be contributed to Little Muskego Lake under existing year 2000 conditions. Of the likely annual sediment load, it was estimated that 457 tons per year, or 83 percent of the total loading, were contributed by runoff from rural lands, mostly from agricultural lands, with 93 tons, or 17 percent of the total load, being contributed by urban lands, mostly from commercial and industrial sources. Approximately 46 tons, or 8 percent, were contributed by atmospheric deposition onto the lake surface. The apparent decrease in sediment loadings relative to those estimated in the 1996 report are the result of changes in land use and the redefined tributary area boundary, as noted above.

As shown in Table 7, under planned year 2035 conditions, as set forth in the adopted regional land use plan,[20] the annual sediment load to the Lake is expected to diminish by about 23 percent. The annual sediment load to the Lake under buildout conditions is estimated to be 424 tons. As in the case of the total annual phosphorus load to the Lake, the distribution of the sources of the sediment load are expected to change, with an increased mass of sediment being contributed from urban sources, estimated to be 219 tons of sediment per year, and a decreased mass of sediment from rural sources, estimated to be 205 tons of sediment per year. The amount of sediment entering the Lake from deposition to the Lake surface should remain about the same as during the base year 2000, about 47 tons.

Urban Heavy Metals Loadings

Urbanization brings with it increased use of metals and other materials that contribute pollutants to aquatic systems.[21] The majority of these metals become associated with sediment particles,[22]and are likely to be

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[17]*U.S. Geological Survey Water-Resources Investigations Report No. 02-4130,* Effects of Lawn Fertilizer on Nutrient Concentration in Runoff from Lakeshore Lawns, Lauderdale Lakes, Wisconsin*, July 2002.*

[18]Ibid.

[19]City of Muskego Newsletter*, May 2008, page 3.*

[20]*SEWRPC Planning Report No. 48,* op. cit.

[21]*Jeffrey A. Thornton, et. al.*, op. cit.

[22]*Werner Stumm and James J. Morgan,* Aquatic Chemistry: An Introduction Emphasizing Chemical Equilibria in Natural Waters*, Wiley-Interscience, New York, 1970.*

encapsulated into the bottom sediments of the Lake. Nevertheless, a number of these metals are known to cause unacceptable changes in certain bottom dwelling aquatic organisms and to potentially bioaccumulate in other animals that consume these organisms, which include fishes and birds.

As previously noted, contaminant loadings, including heavy metal loadings, were not determined in the 2004 aquatic plant management plan for Little Muskego Lake. The 1996 comprehensive lake management plan noted that the annual loadings of zinc likely to be contributed to Little Muskego Lake were estimated to be 1,287 pounds, with 34 percent of this load being generated from the Jewel Creek watershed and 53 percent being contributed by urban runoff from lands within the City of Muskego draining directly to the Lake or to minor tributaries.

For the current study, the loadings of copper and zinc estimated for existing year 2000 and forecast year 2035 land use conditions are shown in Tables 6 and 7, respectively. Under year 2000 land use conditions, it is estimated that 38 pounds of copper and 31 pounds of zinc were contributed annually to Little Muskego Lake, all from urban sources.

Under planned 2035 conditions, with the expected increase in urban lands within the tributary area to Little Muskego Lake as set forth in the adopted regional land use plan,[23] the annual heavy metal loads to the Lake are anticipated to increase. The annual loads to the Lake under buildout conditions are estimated to be 101 pounds of copper and 31 pounds of zinc.

TROPHIC STATUS

Lakes are commonly classified according to their degree of nutrient enrichment, or their trophic status. The ability of lakes to support a variety of recreational activities and healthy fish and other aquatic life communities is often correlated to the degree of nutrient enrichment which has occurred. There are three terms generally used to describe the trophic status of a lake: oligotrophic, mesotrophic, and eutrophic.

Oligotrophic lakes are nutrient-poor lakes. These lakes characteristically support relatively few aquatic plants and often do not contain very productive fisheries. Oligotrophic lakes may provide excellent opportunities for swimming, boating, and waterskiing. Because of the naturally fertile soils and the intensive land use activities, there are relatively few oligotrophic lakes in southeastern Wisconsin.

Mesotrophic lakes are moderately fertile lakes which may support abundant aquatic plant growths and productive fisheries. However, nuisance growths of algae and macrophytes are usually not exhibited by mesotrophic lakes. These lakes may provide opportunities for all types of recreational activities, including boating, swimming, fishing, and waterskiing. Many lakes in southeastern Wisconsin are mesotrophic.

Eutrophic lakes are nutrient-rich lakes. These lakes often exhibit excessive aquatic macrophyte growths and/or experience frequent algae blooms. If the lakes are shallow, fish winterkills may be common. While portions of such lakes are not ideal for swimming and boating, eutrophic lakes may support very productive fisheries. Although some eutrophic lakes are present in the Region, severely eutrophic lakes are rare, especially since the regionwide implementation of recommendations put forth in the aforereferenced regional water quality management plan. In extreme cases, highly nutrient enriched lakes are classed as hypertrophic lakes.

Several numeric "scales," based on one or more water quality indicator, have been developed to define the trophic condition of a lake. Because trophic state is actually a continuum from very nutrient poor to very nutrient rich, a numeric scale is useful for comparing lakes and for evaluating trends in water quality conditions. Care must be taken, however, that the particular scale used is appropriate for the lake to which it applies. In this case, two

[23] *SEWRPC Planning Report No. 48,* op. cit.

indices appropriate for Wisconsin lakes have been used; namely, the Vollenweider-OECD open-boundary trophic classification system,[24] and the Carlson TSI,[25] with a variation known as the Wisconsin Trophic State Index (WTSI) value.[26] The WTSI is a refinement of the Carlson TSI designed to account for the greater humic acid content—brown water color—present in Wisconsin lakes, and has been adopted by the WDNR for use in lake management investigations.

The 1996 comprehensive lake management plan for Little Muskego Lake reported TSI ratings that ranged from 40 to 75, indicating that Little Muskego Lake should be rated as a eutrophic or enriched waterbody. The 2004 aquatic plant management plan noted that Little Muskego Lake had a total phosphorus-based TSI value that generally was in excess of 50, indicative of enriched conditions, and consistent with the historically poor-to-fair transparency conditions. Water clarity- and chlorophyll *a*-based TSI values were about 40 during that period, during which Little Muskego Lake was classified as a meso-eutrophic lake. Data gathered during the aforementioned ERSC study supported this trend, indicating that Little Muskego Lake had a TSI value of 47. A value above 50 is generally considered to be indicative of enriched conditions associated with eutrophic lakes. During the current study period, as shown in Figure 2, WTSI values ranged from less than 30 to more than 50. These values are consistent with a mesotrophic state, indicating an improvement in trophic condition in recent years.

AQUATIC PLANTS: DISTRIBUTION AND MANAGEMENT AREAS

Previous surveys and inventories of the aquatic macrophyte communities in Little Muskego Lake were conducted during 1992, 1994, and 2002, and were detailed in the previous SEWRPC studies.[27] The 2002 and 2007 aquatic plant surveys of Little Muskego Lake were conducted using the modified Jesson and Lound transect method as adopted by the WDNR. This methodology, when utilized in successive aquatic plant surveys, will allow the statistical evaluation of changes in the aquatic plant community within the Lake. [28]

Aquatic Plant Communities in Little Muskego Lake

As set forth in the 2004 aquatic plant management plan, aquatic plants have historically occurred in Little Muskego Lake in such abundance as to be perceived of as a problem, interfering with recreational uses and the aesthetic enjoyment of the Lake. Consequently, the Little Muskego Lake community has conducted an extensive aquatic plant management program on the Lake. Because of this program, the Lake has evidenced a relatively stable aquatic plant community during the 10 years prior to the 2002 survey.

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[24]*Organization for Economic Cooperation and Development (OECD),* Eutrophication of Waters: Monitoring, Assessment and Control, *Paris, 1982; see also H. Olem and G. Flock, U.S. Environmental Protection Agency Report EPA-440/4-90-006,* The Lake and Reservoir Restoration Guidance Manual, Second Edition, *Washington D.C., August 1990.*

[25]*R.E. Carlson, "A Trophic State Index for Lakes,"* Limnology and Oceanography, *Vol. 22, No. 2, 1977.*

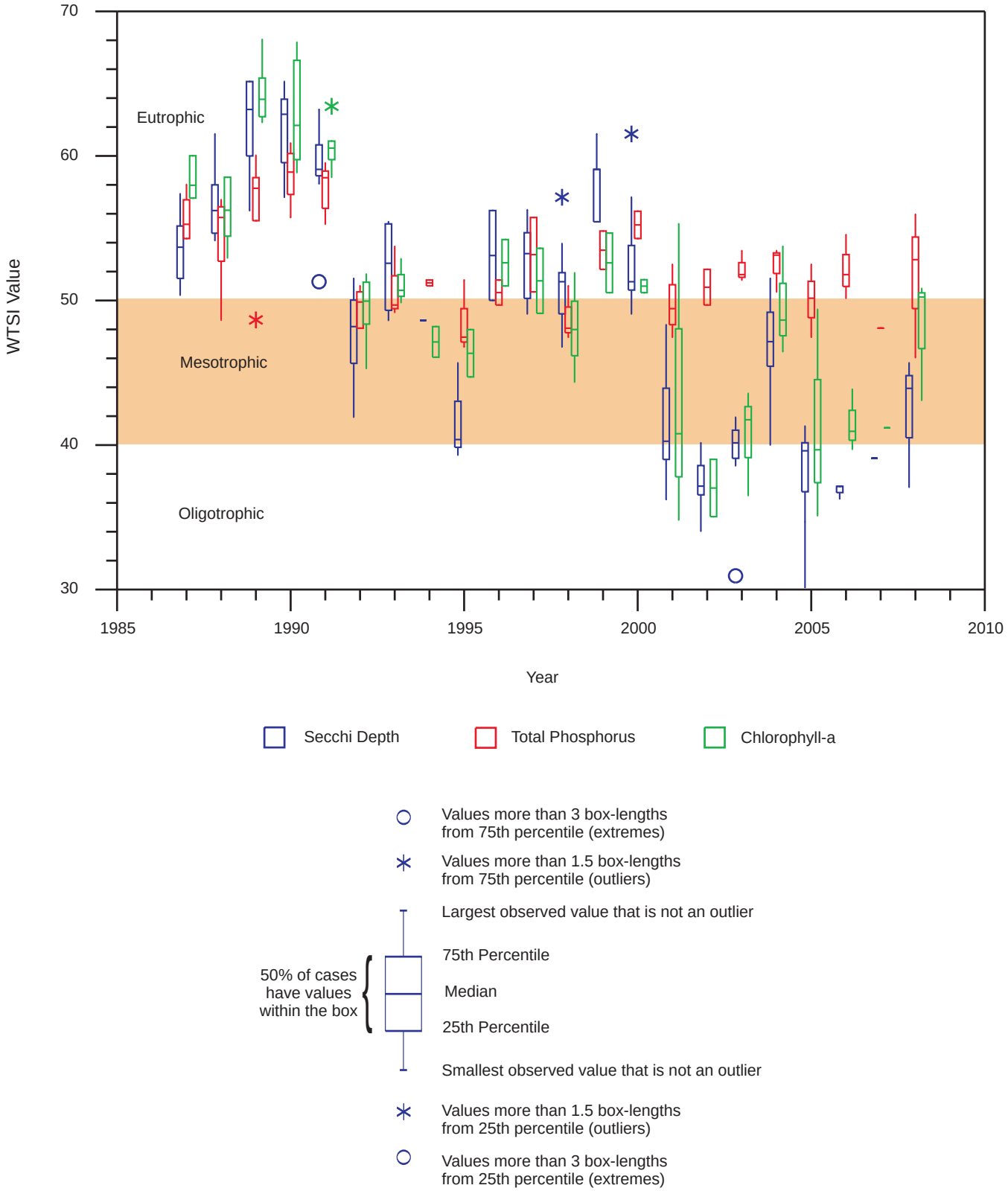
[26]*See R.A. Lillie, S. Graham, and P. Rasmussen, "Trophic State Index Equations and Regional Predictive Equations for Wisconsin Lakes,"* Research and Management Findings, *Wisconsin Department of Natural Resources Publication No. PUBL-RS-735 93, May 1993.*

[27]*SEWRPC Community Assistance Planning Report No. 222,* op. cit.*; SEWRPC Memorandum Report No. 155,* op. cit.

[28]*Memo from Stan Nichols, to J. Bode, J. Leverence, S. Borman, S. Engel, D., Helsel, entitled "Analysis of Macrophyte Data for Ambient Lakes-Dutch Hollow and Redstone Lakes example," Wisconsin Geological and Natural History Survey, University of Wisconsin-Extension, February 4, 1994.*

Figure 2

WISCONSIN TROPHIC STATE INDICES FOR LITTLE MUSKEGO LAKE: 1986-2008



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

The 1992 and 1994 surveys each identified about 10 species of aquatic plants. A comparison of the plant species recorded during these surveys suggests that there was little change in the aquatic plant community over that period. In 1994, muskgrass (*Chara vulgaris*) was the dominant plant in the Lake, with water celery or eel-grass (*Valisneria americana*) and several species of pondweed (*Potamogeton* spp.) generally being widespread throughout the lake basin. Eurasian water milfoil (*Myriophyllum spicatum*) also was reported to be abundant in much of the Lake.

During the 2002 survey, 17 species of aquatic plants were identified. In general, the 2002 data suggested a more diverse and abundant aquatic plant community than the earlier surveys had indicated. Most of the additional species reported during the 2002 survey were comprised of various species of pondweeds, a change considered to be a positive sign.

During the current study period, the Commission staff conducted an aquatic plant survey on Little Muskego Lake during September of 2007, the results of which are shown in Table 8. Map 9 shows the distribution of aquatic plants in Little Muskego Lake at the time of the 2007 aquatic plant survey. A species list, compiled from the results of this survey, is set forth in Table 9, along with comments on the ecological significance of each plant observed. Representative illustrations of these aquatic plants can be found in Appendix A.

The dominant aquatic plant species observed during the current study were coontail (*Ceratophyllum demersum*) and northern water milfoil (*Myriophyllum sibiricum*), with eel-grass and water stargrass (*Zosterella dubia*) also being present in significant numbers. Other species present in fair abundance included clasping-leaf pondweed (*Potamogeton richardsonii*), waterweed (*Elodea canadensis*), bushy pondweed (*Najas flexilis*), Eurasian water milfoil, Sago pondweed (*Potamogeton pectinatus*), Illinois pondweed (*Potamogeton illinoensis*), and muskgrass.

Table 10 compares the frequencies of occurrence of submergent aquatic plant species present in Little Muskego Lake during the 2002 and 2007 surveys. These data would seem to indicate that the aquatic plant community in Little Muskego Lake has undergone several changes. Although coontail was a dominant plant during both 2002 and 2007, the amount of Eurasian water milfoil in the Lake seems to have diminished as the abundance of northern (also known as "native") water milfoil has increased. In 2002, Eurasian water milfoil was widely spread throughout the Lake, being particularly abundant and exhibiting extensive growths in the shallow northern areas of the Lake. In 2007, Eurasian water milfoil was either not observed, or only observed in very low numbers, at most of the sampling sites along the northern shoreline of the Lake, as well as along the eastern and southern shorelines of the Lake. These were areas where the plant had been widespread during the 2002 survey. Areas with the greatest density of Eurasian water milfoil during 2007 were the southwestern corner of the Lake and the shallow bay along the western shores of the Lake. These differences between the 2002 and 2007 surveys of the Eurasian water milfoil population may reflect: 1) the results of aquatic management practices, 2) differences in sampling dates during the growing season, or 3) the natural periodicity of the species. Such periodicity has been observed elsewhere in southeastern Wisconsin, and potentially reflects the influences of a combination of stressors. These stressors include biological factors, such as the activities of the Eurasian water milfoil weevil (*Eurhychiopsis lecontei*), as well as climatic and limnological factors, such as insolation, water temperature, and current circulation patterns.

Eurasian water milfoil is an invasive plant species capable of explosive growth, resulting in an ability to outcompete important native aquatic plant species, which can lead to significant ecological disruptions in the aquatic plant community of a lake, degrading water quality and habitat for fish, invertebrates, and other wildlife.[29] Eurasian water milfoil and curly-leaf pondweed, two nonnative species, both of which have been recorded from Little Muskego Lake, are declared nuisance species identified in Chapter NR 109 of the *Wisconsin Administrative Code*. As shown in Table 10, both of these species seem to have diminished in number between 2002 and 2007, concomitant with an increase in several native species of plants.

[29]*Wisconsin Department of Natural Resources,* Eurasian Water Milfoil in Wisconsin: A Report to the Legislature, *1992.*

Table 8

AQUATIC PLANT SPECIES OBSERVED IN LITTLE MUSKEGO LAKE: 2007

Aquatic Plant Species	Number of Sites Found	Frequency of Occurrence[a]	Relative Density[b]	Importance Value[c]
Ceratophyllum demersum (coontail)	97	90.7	3.2	287.9
Chara vulgaris (muskgrass)	20	18.7	1.6	29.9
Elodea canadensis (waterweed)	41	38.3	2.1	81.3
Myriophyllum sibiricum (northern water milfoil)	101	94.4	2.8	265.4
Myriophyllum spicatum (Eurasian water milfoil)	38	35.5	1.8	63.6
Najas flexilis (bushy pondweed)	39	36.4	2.0	73.8
Potamogeton crispus (curly-leaf pondweed)	1	0.9	1.0	0.9
Potamogeton foliosis (leafy pondweed)	4	3.7	1.0	3.7
Potamogeton gramineus (variable pondweed)	2	1.9	1.0	1.9
Potamogeton illinoensis (Illinois pondweed)	30	28.0	1.7	47.7
Potamogeton pectinatus (Sago pondweed)	36	33.6	1.8	60.7
Potamogeton pusillus (small pondweed)	3	2.8	1.7	4.7
Potamogeton richardsonii (clasping-leaf pondweed)	46	43.0	1.9	82.2
Potamogeton zosteriformis (flat-stem pondweed)	2	1.9	1.0	1.9
Ranunculus longirostris (stiff-water crowfoot)	1	0.9	1.0	0.9
Utricularia spp. (bladderwort)	1	0.9	1.0	0.9
Vallisneria americana (water celery/eel-grass)	74	69.2	2.8	196.3
Zosterella dubia (water stargrass)	82	76.6	2.7	206.5

NOTE: Sampling occurred at 107 sampling sites along 33 transects.

[a]*The percent frequency of occurrence is the number of occurrences of a species divided by the number of samplings with vegetation, expressed as a percentage. It is the percentage of times a particular species occurred when there was aquatic vegetation present, and is analogous to the Jesson and Lound point system.*

[b]*The average density is the sum of density ratings for a species divided by the number of sampling points with vegetation. The maximum density possible of 4.0 is assigned to plants that occur at all four points sampled at a given depth and is an indication of how abundant a particular plant is throughout a lake.*

[c]*The importance value is the product of the relative frequency of occurrence and the average density, expressed as a percentage. This number provides an indication of the dominance of a species within a community.*

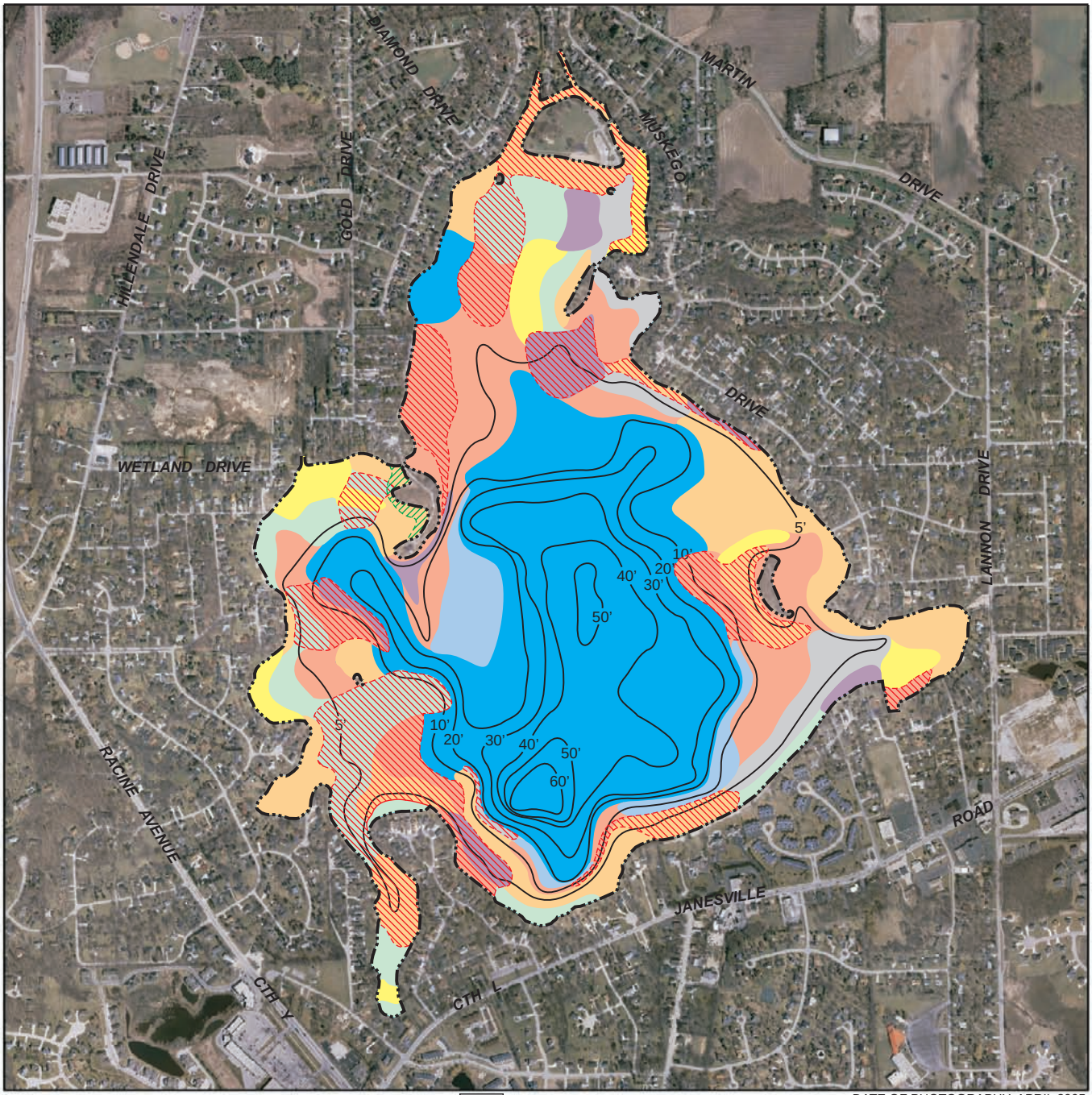
Source: SEWRPC.

A comparison of submergent aquatic plant species identified in Little Muskego Lake during the period from 1992 to 2007 is displayed in Table 11. Aquatic plant communities do undergo cyclical and periodic changes, which reflect, in part, changing climatic conditions on an interannual scale, as well as, in part, the evolution of the aquatic plant community itself in response to changing hydroclimate conditions in the Lake. Interannular changes, brought about by such factors as changes in nutrient loading, sedimentation rates, and recreational usage patterns, occur over a period of three to seven years and may be temporary; other plant community changes may occur over a decadal period or longer and are longer-lasting. In reviewing the data set from 1994 to the present, it is likely that the variations observed in muskgrass and coontail abundances, for example, may reflect interannual variability, with coontail being reported as sparse in 1994 and abundant in 2002 and 2007; muskgrass being considered dominant (most abundant) in 1994 and sparse in 2002 and 2007. Elodea and water stargrass abundances exhibited a similar cyclical pattern.[30] In contrast, the introduction of Eurasian water milfoil into many lakes in the Region frequently leads to a more permanent alteration in the aquatic plant community composition.

[30]*Interannual changes in abundances described above are based upon anecdotal descriptions from the initial 1996 report (using 1994 survey data) and Relative Densities calculated from 2002 and 2007 survey data; Descriptors for the 2002 and 2007 surveys are based on numeric values for Average Density where the maximum density possible is 4.0; "Abundant" = 3.5-4.0; "Common = 2.5-3.4; "Sparse" = 1.5-2.4; "Very Sparse" = 0.5-1.4; and, " - -" = 0.0-0.4. The Average Density is the sum of the density ratings for a species divided by the number of sampling points with vegetation. The maximum density possible of 4.0 is assigned to plants that occur at all four points sampled at a given depth and is an indication of how abundant a particular plant is throughout a lake.*

Map 9

AQUATIC PLANT COMMUNITY DISTRIBUTION IN LITTLE MUSKEGO LAKE: 2007



—20'— WATER DEPTH CONTOUR IN FEET

OPEN WATER

WATER LILIES

EURASIAN WATER MILFOIL

COONTAIL, NATIVE WATER MILFOIL, AND SAGO PONDWEED

COONTAIL, NATIVE WATER MILFOIL, WILD CELERY, WATER STAR GRASS, MUSKGRASS, AND CLASPING-LEAF PONDWEED

COONTAIL, NATIVE WATER MILFOIL, WILD CELERY, WATER STAR GRASS, CLASPING-LEAF PONDWEED, MUSKGRASS, AND WATERWEED

COONTAIL, NATIVE WATER MILFOIL, WILD CELERY, AND WATER STAR GRASS

COONTAIL, NATIVE WATER MILFOIL, WILD CELERY, WATER STAR GRASS, CLASPING-LEAF PONDWEED, MUSKGRASS, WATERWEED, BUSHY PONDWEED, SMALL PONDWEED, AND BLADDERWORT

COONTAIL, NATIVE WATER MILFOIL, WILD CELERY, WATER STAR GRASS, CLASPING-LEAF PONDWEED, MUSKGRASS, WATERWEED, BUSHY PONDWEED, SAGO PONDWEED, LEAFY PONDWEED, FLAT-STEM PONDWEED, AND SMALL PONDWEED

COONTAIL, NATIVE WATER MILFOIL, WILD CELERY, WATER STAR GRASS, CLASPING-LEAF PONDWEED, MUSKGRASS, WATERWEED, BUSHY PONDWEED, SAGO PONDWEED, ILLINOIS PONDWEED, CURLY-LEAF PONDWEED, VARIABLE PONDWEED, AND WHITE WATER CROWFOOT

DATE OF PHOTOGRAPHY: APRIL 2005

GRAPHIC SCALE

0 650 1300 FEET

Source: SEWRPC.

Table 9

POSITIVE ECOLOGICAL SIGNIFICANCE OF AQUATIC PLANT SPECIES PRESENT IN LITTLE MUSKEGO LAKE: 2007

Aquatic Plant Species Present	Ecological Significance
Ceratophyllum demersum (coontail)	Provides good shelter for young fish and supports insects valuable as food for fish and ducklings
Chara vulgaris (muskgrass)	Excellent producer of fish food, especially for young trout, bluegills, small and largemouth bass, stabilizes bottom sediments, and has softening effect on the water by removing lime and carbon dioxide
Elodea canadensis (waterweed)	Provides shelter and support for insects which are valuable as fish food
Myriophyllum sibiricum (northern water milfoil)	Provides food for waterfowl, insect habitat and foraging opportunities for fish
Myriophyllum spicatum (Eurasian water milfoil)	None known; nonnative plant
Najas flexilis (bushy pondweed)	Stems, foliage, and seeds important wildfowl food and produces good food and shelter for fish
Potamogeton crispus (curly-leaf pondweed)	Provides food, shelter and shade for some fish and food for wildfowl; a nonnative plant
Potamogeton foliosis (leafy pondweed)	Provides food for geese and ducks; food for muskrat, beaver and deer; good surface area for insects and cover for juvenile fish
Potamogeton gramineus (variable pondweed)	Provides habitat for fish and food for waterfowl, muskrat, beaver and deer
Potamogeton illinoensis (Illinois pondweed)	Provides shade and shelter for fish; harbor for insects; seeds are eaten by wildfowl
Potamogeton pectinatus (Sago pondweed)	This plant is the most important pondweed for ducks, in addition to providing food and shelter for young fish
Potamogeton pusillus (small pondweed)	Provides food for ducks, geese, muskrat, beaver, and deer, and provides food and shelter for fish
Potamogeton richardsonii (clasping-leaf pondweed)	Provides food, shelter and shade for some fish, food for some wildfowl, and food for muskrat. Provides shelter and support for insects, which are valuable as fish food
Potamogeton zosteriformis (flat-stem pondweed)	Provides some food for ducks
Ranunculus longirostris (white-water crowfoot)	Provides food for trout, upland game birds, and wildfowl
Utricularia spp. (bladderwort)	Provides cover and foraging for fish
Vallisneria americana (water celery/eel-grass)	Provides good shade and shelter, supports insects, and is valuable fish food
Zosterella dubia (water stargrass)	Provides food and shelter for fish, locally important food for waterfowl

NOTE: Information obtained from *A Manual of Aquatic Plants* by Norman C. Fassett, University of Wisconsin Press; *Guide to Wisconsin Aquatic Plants*, Wisconsin Department of Natural Resources; and, *Through the Looking Glass...A Field Guide to Aquatic Plants*, Wisconsin Lakes Partnership, University of Wisconsin-Extension.

Source: SEWRPC.

In addition to the types of changes described above, some of the variations in reported aquatic plant abundance may reflect seasonal variability associated with the timing of the various surveys. The pondweeds, in particular, are subject to greater seasonality than some of the other species. In such cases, the actual community composition may reflect changes associated with seasonal differences, such as water temperature and photoperiod, rather than

Table 10

FREQUENCY OF OCCURRENCE[a] OF AQUATIC PLANT SPECIES OBSERVED IN LITTLE MUSKEGO LAKE: 2002 AND 2007

Aquatic Plant Species	Native or Nonnative	2002	2007
Ceratophyllum demersum (coontail)	Native	95.7	90.7
Chara vulgaris (muskgrass)	Native	36.2	18.7
Elodea canadensis (waterweed)	Native	70.2	38.3
Myriophyllum sibiricum (northern water milfoil)	Native	- -	94.4
Myriophyllum spicatum (Eurasian water milfoil)	Nonnative	92.6	35.5
Najas flexilis (bushy pondweed)	Native	23.4	36.4
Potamogeton crispus (curly-leaf pondweed)	Nonnative	14.9	0.9
Potamogeton foliosis (leafy pondweed)	Native	- -	3.7
Potamogeton gramineus (variable pondweed)	Native	9.6	1.9
Potamogeton illinoensis (Illinois pondweed)	Native	5.3	28.0
Potamogeton pectinatus (Sago pondweed)	Native	43.6	33.6
Potamogeton pusillus (small pondweed)	Native	2.1	2.8
Potamogeton richardsonii (clasping-leaf pondweed)	Native	23.4	43.0
Potamogeton zosteriformis (flat-stem pondweed)	Native	48.9	1.9
Ranunculus longirostris (stiff-water crowfoot)	Native	2.1	0.9
Utricularia spp. (bladderwort)	Native	- -	0.9
Vallisneria americana (water celery/eel-grass)	Native	57.4	69.2
Zosterella dubia (water stargrass)	Native	21.3	76.6

NOTE: Sampling occurred at 107 sampling sites along 33 transects in 2007 and at 94 sample sites in 2002.

[a]*The percent frequency of occurrence is the number of occurrences of a species divided by the number of samplings with vegetation, expressed as a percentage. It is the percentage of times a particular species occurred when there was aquatic vegetation present, and is analogous to the Jesson and Lound point system.*

Source: SEWRPC.

Table 11

SUBMERGENT AQUATIC PLANT SPECIES IN LITTLE MUSKEGO LAKE: 1992-2007

Aquatic Plant Species	Native or Nonnative	1992	1994	2002	2007
Ceratophyllum demersum (coontail)	Native	X	X	X	X
Chara sp. (muskgrass)	Native	X	X	X	X
Elodea canadensis (waterweed)	Native	- -	- -	X	X
Myriophyllum sibiricum (northern water milfoil)	Native	- -	- -	- -	X
Myriophyllum spicatum (Eurasian water milfoil)	Nonnative	X	X	X	X
Najas flexilis (bushy pondweed)	Native	X	X	X	X
Nitella sp. (stonewart)	Native	X	- -	- -	- -
Potamogeton crispus (curly-leaf pondweed)	Nonnative	X	X	X	X
Potamogeton foliosis (leafy pondweed)	Native	- -	- -	- -	X
Potamogeton gramineus (variable pondweed)	Native	- -	- -	X	
Potamogeton illinoensis (Illinois pondweed)	Native	- -	- -	X	X
Potamogeton pectinatus (Sago pondweed)	Native	- -	- -	X	X
Potamogeton pusillus (small pondweed)	Native	- -	- -	X	X
Potamogeton richardsonii (clasping-leaf pondweed)	Native	X	X	X	X
Potamogeton zosteri formis (flat-stem pondweed)	Native	X	X	X	X
Ranunculus sp. (water crowfoot)	Native	- -	- -	X	X
Utricularia spp. (bladderwort)	Native	- -	- -	- -	X
Vallisneria americana (eel-grass/wild celery)	Native	X	X	X	X
Zosterella dubia (water stargrass)	Native	- -	- -	X	X

Source: Wisconsin Department of Natural Resources and SEWRPC.

actual changes in aquatic plant community composition. Consequently, in evaluating the integrity of the aquatic plant community within a lake, the pondweeds often are taken as a group (genus *Potamogeton*) as the various species within the genus contribute similar ecological values, as summarized in Table 9.

One notable aspect concerning the variations in the abundance of Eurasian water milfoil in Little Muskego Lake—from abundant in 1994, to common in 2002, and sparse in 2007—is a type of interannual periodicity observed in this species in many lakes within southeastern Wisconsin, which potentially reflects the influences of a combination of stressors. These stressors include biological factors, such as the predator-prey cycles that include the plant and milfoil weevil (*Eurhychiopsis lecontei*), as well as climatic and limnological factors, such as insolation, water temperature, lake circulation patterns, and the relative severity of the winters during the intervening years. Endemic populations of the milfoil weevil have been found to occur in many of the Region's lakes within which Eurasian water milfoil is present. Speculation is that these weevils were introduced into the lakes naturally along with the initial inocula of Eurasian water milfoil.[31]

Biodiversity

A critical element of the ability of an ecosystem, such as a lake, to maintain its ecological integrity is through the conservation of the ecosystem's natural biological diversity. Conserving the biological diversity, or *biodiversity*, of an ecosystem helps, not only helps to sustain the system, but preserves a spectrum of options for future decisions regarding the management of that system. During the 2007 aquatic plant survey of Little Muskego Lake, several aquatic plant communities in the Lake showed significant biodiversity, being comprised of at least 10 different species. These highly diverse communities were distributed widely in most of the nearshore areas of the Lake. By contrast, only a few areas of the Lake contained plant communities with low diversity, communities with four or fewer species. Such areas included the nearshore areas in the northeastern corner of Little Muskego Lake and several areas at the southern extreme of the Lake, usually at depths of five to 10 feet. There were some areas of the Lake containing plant communities with moderate diversity, of between six and seven species. Such moderate diversity communities were found generally equally distributed around the Lake, mostly in depths of five feet or less. In general, much of Little Muskego Lake appears to have aquatic plant communities of moderate to good biodiversity.

Aquatic Plant Species of Special Significance

Native Aquatic Plants

There were several native aquatic plant species observed during the 2007 survey of the Lake, one of which is of exceptionally high ecological value; namely, muskgrass. Muskgrass is a favorite waterfowl food source and serves as an effective bottom sediment stabilizer, benefiting water quality in the Lake. Its prevalence in the aquatic plant community of a lake may be a significant contributing factor to establishing and maintaining good water quality in a lake and, subsequently, to establishing water quality conditions that assist other native aquatic plant species to successfully compete with nonnative species, such as curly-leaf pondweed, for example.

Two other native species of high ecological value, large-leaf pondweed and white-stem pondweed, have not been observed in Little Muskego Lake. Large-leaf pondweed, also known as musky weed or bass weed, enjoys a reputation as a highly valuable provider of fish habitat. White-stem pondweed, because of its sensitivity to changes in water quality and intolerance of turbidity, is considered to be an excellent indicator species; its disappearance from water systems is typically an indication of declining water quality in disturbed systems.

Nonnative Species

As aforementioned, during the 2007 and earlier aquatic plant surveys on Little Muskego Lake, several nonnative aquatic plant species of significance were observed. Two of these species, Eurasian water milfoil and curly-leaf pondweed (*Potamogeton crispus*), are designated as exotic species pursuant to Chapter NR 109 of the *Wisconsin Administrative Code*, and are considered to be detrimental to the ecological health of the Lakes.

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[31]*See, for example, Sally P. Sheldon, "The Potential for Biological Control of Eurasian Water Milfoil (*Myriophyllum spicatum*) 1990-1995 Final Report," Department of Biology Middlebury College, February 1995.*

Eurasian water milfoil is one of eight milfoil species found in Wisconsin and the only one known to be exotic or nonnative. Because of its nonnative nature, Eurasian water milfoil has few natural enemies that can inhibit its often explosive growth. The plant exhibits this characteristic growth pattern in lakes with organic-rich sediments, or where the lake bottom has been disturbed. It frequently has been reported as a colonizing species following dredging unless its growth is anticipated and controlled. Eurasian water milfoil populations can displace native plant species and interfere with the aesthetic and recreational use of the waterbodies. This plant has been known to cause severe recreational use problems in lakes within the Southeastern Wisconsin Region.

Eurasian water milfoil reproduces by the rooting of plant fragments. Consequently, some recreational uses of lakes can result in the expansion of Eurasian water milfoil communities, such as when boat propellers fragment Eurasian water milfoil plants. These fragments, as well as fragments that occur for other reasons, such as wind-induced turbulence or fragmentation of the plant by fishes, are able to generate new root systems, allowing the plant to colonize new sites. The fragments also can cling to boats, trailers, and motors, and/or remain viable in bait buckets and live wells, and can stay alive for weeks, contributing to the transfer of milfoil to other lakes. For this reason, it is very important to remove all vegetation from boats, trailers, and other equipment after removing them from the water and prior to launching in other waterbodies. To this end, as part of an ongoing commitment to the protection of Wisconsin waterways from the effects of harmful aquatic invasive species (AIS), the WDNR, in cooperation with local lake management districts and similar organizations, conducts the Clean Boats-Clean Waters© Programs that function to raise awareness of AIS and promote inspection practices that help to control the spread of nuisance species, such as Eurasian water milfoil between lakes. Many lake organizations in the Region, including the Little Muskego Lake Protection and Rehabilitation District, participate in this program.

Another potentially detrimental aquatic invasive species is curly-leaf pondweed, a plant that thrives in cool water and exhibits a peculiar split-season growth cycle that helps give it a competitive advantage over native plants. In late summer, the plant produces specialized over-wintering structures, or “turions.” The main body of the plant dies off and drops to the lake bottom where the turions lie dormant until the cooler fall water temperatures trigger the turions to germinate. Over the winter, the turions produce winter foliage that thrives under the ice. In spring, when water temperatures begin to rise again, the plant has a head start on the growth of native plants and quickly grows to full size, producing flowers and fruit earlier than its native competitors. Because it can grow in more turbid waters than many native plants, protecting or improving water quality is an effective method of control of this species; clearer waters in a lake can help native plants compete more effectively with curly-leaf pondweed.

Past and Present Aquatic Plant Management Practices

An aquatic plant management program has been carried out on Little Muskego Lake in a documented manner since 1950, when records of aquatic plant management efforts were first maintained by the WDNR. Prior to 1950, aquatic plant management interventions were likely, but were not recorded. Currently, all forms of aquatic plant management are subject to permitting by the WDNR pursuant to authorities granted the Department under Chapters NR 107 and NR 109 of the *Wisconsin Administrative Code*.

The early aquatic plant management activities on Little Muskego Lake can be categorized primarily as chemical control. Recorded chemical herbicide treatments that have been applied to Little Muskego Lake are set forth in Table 12. In Wisconsin, the use of chemicals to control aquatic plants and algae has been regulated since 1941, even though records of aquatic herbicide applications have only been maintained by the WDNR since 1950.

As shown in Table 12, between 1950 and 1969, a total of 47,096 pounds of sodium arsenite and 200 pounds of copper sulfate were applied to Little Muskego Lake to control perceived nuisance growths of aquatic plants and algae. In this regard, Little Muskego Lake ranks as having received the 12th largest amount of sodium arsenite amongst all of the lakes in the State. Applications of a range of other aquatic herbicides used through 2007 are summarized in Table 12. In recent years, the aquatic plant control program has shifted toward aquatic plant harvesting as a major element of the aquatic plant management strategy in the Lake. In 2006, over 8,000 tons of aquatic plants were harvested and removed from Little Muskego Lake; in 2007, over 10,000 tons of harvested aquatic plant biomass were removed from the Lake. Harvesting of aquatic plant biomass not only removed the organic matter contained within the plants from the Lake, reducing the mass of organic material that will add to

Table 12

CHEMICAL CONTROL OF AQUATIC PLANTS IN LITTLE MUSKEGO LAKE: 1950-2007

Year	Total Acres Treated	Algae Control			Macrophyte Control				
		Copper Sulfate (pounds)	Blue Vitriol (pounds)	Cutrine or Cutrine Plus (gallons)	Sodium Arsenite (pounds)	2, 4-D (gallons)	Diquat (gallons)	Glyphosate (gallons)	Endothall/ Aquathol (gallons)
1950-1969	- -	200	- -	- -	47,096	20 lbs.	- -	- -	4.96 lbs.
1970	- -	50	- -	- -	- -	- -	5.0	- -	7.0
1971-1974	- -	- -	- -	- -	- -	- -	- -	- -	- -
1975	- -	- -	- -	160.0	- -	- -	- -	- -	- -
1976	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1977	- -	- -	- -	- -	- -	- -	- -	- -	- -
1978	- -	- -	- -	- -	- -	20 lbs.	- -	- -	- -
1979	- -	- -	- -	83.5	- -	165.5	- -	- -	7.0
1980	- -	35	- -	49.0	- -	129.0	- -	- -	36.0
1981	- -	- -	- -	52.5	- -	167.0	- -	- -	49.0
1982	- -	- -	- -	72.0	- -	63.0	- -	- -	119.0
1983	- -	- -	- -	- -	- -	- -	- -	- -	- -
1984	- -	80	- -	123.5	- -	120.5 + 40.0 lbs.	- -	- -	61.0 + 40.0 lbs.
1985	- -	- -	- -	88.5	- -	86.0	- -	- -	27.0
1986	- -	25	- -	22.0	- -	31.0 + 27.0 lbs.	2.0	- -	43.0
1987	- -	- -	- -	101.0	- -	- -	50.5	- -	10.0
1988	- -	- -	- -	41.0	- -	89.0	- -	- -	61.5
1989	- -	- -	- -	68.5	- -	17.5	11.0	- -	90.4
1990	- -	- -	- -	68.0	- -	- -	6.0	- -	25.0
1991	- -	- -	- -	- -	- -	- -	- -	- -	18.0 lbs.
1992	- -	- -	- -	35.0	- -	- -	35.0	- -	36.25
1993	- -	- -	- -	52.5	- -	- -	29.0	- -	27.0
1994	- -	- -	- -	13.5	- -	- -	19.0	- -	21.5
1995	16.00	- -	- -	18.5	- -	- -	18.5	- -	18.5
1996	- -	- -	- -	- -	- -	- -	- -	- -	- -
1997	27.82	- -	- -	- -	- -	- -	27.5	- -	27.5
1998	N/A	N/A	N/A	2.5	N/A	N/A	N/A	N/A	N/A
1999	36.60	2.5 gallons	- -	2.5	- -	3,530 lbs.	- -	- -	- -
2000	16.40	- -	- -	- -	- -	1,600 lbs.	- -	- -	- -
2001	36.00	- -	- -	- -	- -	3,600 lbs.	- -	- -	- -
2002	62.25	- -	- -	- -	- -	6,225 lbs.	1.5	- -	- -
2003	63.58	12.5 gallons	- -	- -	- -	5,750 lbs.	- -	- -	- -
2004	- -	- -	- -	- -	- -	2,100 lbs.	- -	- -	- -
2005	- -	- -	- -	- -	- -	7,600 lbs.	- -	- -	- -
2006	- -	- -	- -	- -	- -	5,150 lbs.	- -	- -	- -
2007	- -	- -	- -	- -	- -	2,300 lbs.	- -	- -	- -
Total	- -	390 + 15.0 gallons	- -	1,054.0	47,096	868.5 + 37,962 lbs.	205.0	- -	666.65 + 62.96 lbs.

NOTE: N/A = Records are not available. Additionally, in 1960, 0.5 pound of silvex were applied; and in 1980, 8.5 gallons of hydrothol were applied.

Source: Wisconsin Department of Natural Resources and SEWRPC.

the decomposed organic materials that contribute to the muck bottom sediments noted in the Lake, but also remove the nutrients contained within the aquatic plant biomass that would otherwise be available for future aquatic plant growths in the Lake. Estimates of the mass of aquatic plant nutrients removed from lakes as a result of harvesting aquatic plants range up to about 10 percent of the total nutrient loads to a lake.[32]

[32]*See, for example, SEWRPC Community Assistance Planning Report No. 224,* A Lake Management Plan for Whitewater and Rice Lakes, Walworth County, Wisconsin, *February 1997.*

FISHERIES AND WILDLIFE

Fish Management

As noted in the 2004 aquatic plant management plan, Little Muskego Lake is managed for bluegill, largemouth bass, and northern pike. The WDNR reports that the fish population in Little Muskego Lake is comprised of numerous fish species, with panfish and largemouth bass being common and walleye and northern pike being present.[33] The populations of various gamefishes have been maintained through WDNR stocking programs. As summarized in Table 13, stocking of walleye, largemouth bass, and northern pike into Little Muskego Lake has occurred periodically since 1973.

Birds and Other Wildlife

Given the land uses present around the shorelands of the Lake, generally only smaller animals and waterfowl can be expected to inhabit the lakeshore. Muskrats, beaver, grey and fox squirrels, and cottontail rabbits are probably the most abundant and widely distributed fur-bearing mammals in the immediate riparian areas. Larger mammals, such as the whitetail deer, would generally be expected to be confined to the larger wooded areas and the open meadows found in the park and open space lands within the tributary areas of the Lake.

The Little Muskego Lake tributary areas support a significant population of waterfowl including mallards, wood duck, and blue-winged teal. During the migration seasons a greater variety of waterfowl may be present and in greater numbers.

Amphibians and reptiles are vital components of the Little Muskego Lake ecosystem, and include frogs, toads, and salamanders, and turtles and snakes, respectively. About 14 species of amphibians and 16 species of reptiles would normally be expected to be present in the Little Muskego Lake area. These species are identified in the aforereferenced comprehensive lake management plan for Little Muskego Lake.

WDNR-Designated Sensitive Areas

Within or around lakes, the WDNR identifies sites that have special importance biologically, historically, geologically, ecologically, or even archaeologically. Areas are identified as sensitive areas after comprehensive examination and study is completed by WDNR staff from many different disciplines and fields of study. Currently, Little Muskego Lake has four WDNR-designated sensitive areas, as shown on Map 10. To protect aquatic life, as well as the water quality of the lake itself, the WDNR places restrictions on specific activities within such sensitive areas. Such restrictions for sensitive areas include: limiting the use of aquatic herbicides to treatment of Eurasian water milfoil; prohibiting inlake activities, such as filling and the use of pea gravel, sand blankets, aqua screens, and concrete, timber, or steel seawalls; limiting the use of riprap to areas with erosion problems; minimizing the numbers of individual and marina piers to those allowable on a case-by-case basis; prohibiting mechanical harvesting other than that associated with a research program to increase the diversity of aquatic plants, although small hand-cleared areas for swimming or navigation are allowable; and adopting and strictly enforcing construction site erosion controls, and shoreland and wetland ordinances.

RECREATIONAL USES AND FACILITIES

As set forth in the regional water quality management plan, [34] Little Muskego Lake is a multi-purpose waterbody serving a variety of recreational uses. Active recreational uses include boating, waterskiing, swimming, and fishing during the summer months, and cross-country skiing, snowmobiling, and ice-fishing during the winter. The Lake has numerous public access sites, as shown on Map 11, and is considered by the WDNR to have adequate public recreational boating access, as defined in Section NR 1 of the *Wisconsin Administrative Code.*

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[33] *Wisconsin Department of Natural Resources Publication No. PUBL-FM-800-2005,* Wisconsin Lakes, *2005.*

[34] *SEWRPC Planning Report No. 30,* op. cit. *See also SEWRPC Memorandum Report No. 93,* A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report, *March 1995.*

Table 13

FISH STOCKED INTO LITTLE MUSKEGO LAKE

Year	Species Stocked	Number	Average Fish Length (inches)
1973	Walleye	30,215	4.00
1973	Largemouth bass	345,500	1.00
1973	Northern pike	1,154,500	Fry
1973	Walleye	2,500,000	Fry
1974	Largemouth bass	19,500	3.00
1974	Walleye	46,875	3.00
1974	Northern Pike	500,000	Fry
1975	Walleye	22,500	4.00
1975	Northern pike	640,000	Fry
1975	Walleye	1,000,000	Fry
1976	Walleye	50,000	3.00
1976	Northern pike	495,000	Fry
1977	Walleye	15,275	5.00
1984	Walleye	460,000	1.00
1986	Northern pike	2,000	9.00
1991	Northern pike	2,000	8.00
1991	Walleye	12,330	4.00
1992	Northern pike	2,000	8.00
1992	Walleye	24,000	2.00
1993	Northern pike	2,300	8.00
1994	Northern pike	1,559	4.80
1995	Northern pike	2,242	6.20
1995	Walleye	25,300	2.10
1997	Walleye	25,300	1.50
1998	Northern pike	2,450	Small fingerling
1999	Northern pike	2,722	2.40
1991	Walleye	49,564	2.70
2000	Northern pike	2,500	3.70
2001	Northern pike	3,795	3.60
2001	Walleye	50,150	2.45
2002	Northern pike	1,250	3.10
2003	Walleye	51,250	2.10
2005	Walleye	25,371	1.50
2006	Northern pike	2,530	2.50

Source: Wisconsin Department of Natural Resources and SEWRPC.

The Lake is used year-round as a visual amenity. Walking, bird watching, and picnicking are popular passive recreational uses of this waterbody, and it is heavily utilized during open water periods. In acknowledgement of this, the comprehensive lake management plan proposed the designation of recreational use zones in recognition of the variety of uses to which the Lake is subjected. Enforcement within these recreational use zones is accomplished through the water safety patrol operated by the City of Muskego Police Department.

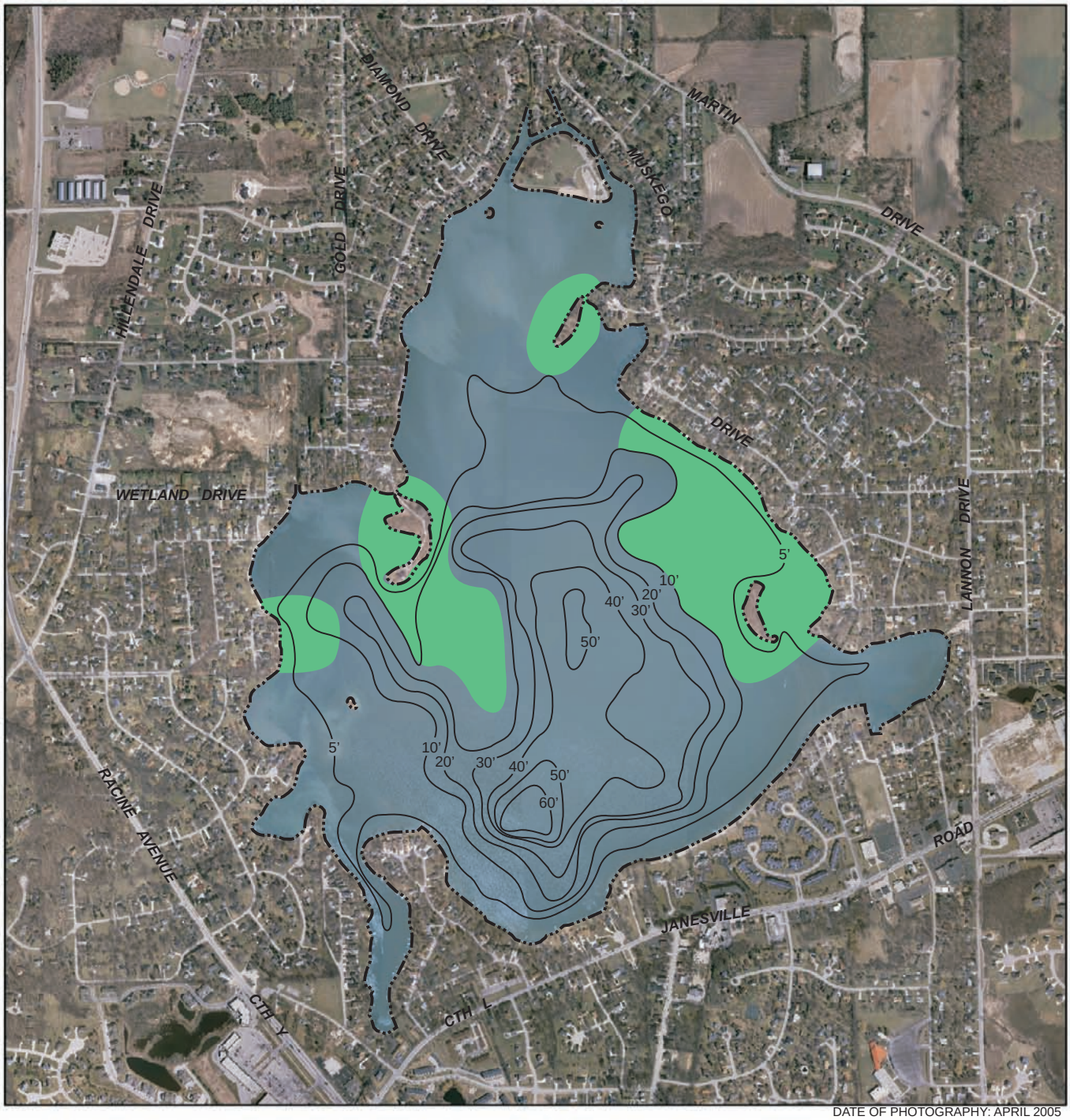
Recreational Boating

During the current study, a boat survey was conducted on Little Muskego Lake in 2007. This survey indicated that about 769 boats were either moored in the water or stored on land in the shoreland areas around the Lake, as shown in Table 14. This represents about 12 percent fewer boats than were counted during a similar survey conducted in 2004, when the total number of boats was reported to be about 875 watercraft. The types of watercraft found on the Lake included powered or skiboats, fishing boats, pontoon boats, paddleboats, canoes, sailboats, kayaks, and personal watercraft (“jetskis”).

Recreational boating remains a popular active recreational use of the Lake, with nearly three-fourths of all watercraft moored in the water or stored on land in the shoreline areas capable of high-speed operation. Of the

Map 10

ENVIRONMENTALLY SENSITIVE AREAS OF LITTLE MUSKEGO LAKE



DATE OF PHOTOGRAPHY: APRIL 2005

—20'— WATER DEPTH CONTOUR IN FEET

ENVIRONMENTALLY SENSITIVE AREA

Source: Wisconsin Department of Natural Resources and SEWRPC.

GRAPHIC SCALE

0 650 1300 FEET

Map 11

PARK AND LAKE-ACCESS SITES IN THE VICINITY OF LITTLE MUSKEGO LAKE

DATE OF PHOTOGRAPHY: APRIL 2005

PARK OR LAKE ACCESS SITE

GRAPHIC SCALE

0 650 1300 FEET

Source: SEWRPC.

Table 14

WATERCRAFT DOCKED OR MOORED ON LITTLE MUSKEGO LAKE: 2007[a]

Type of Watercraft									
Powerboat	Fishing Boat	Pontoon Boat	Personal Watercraft	Canoe	Sailboat	Kayak	Paddleboat	Rowboat	Total
174	30	245	114	42	19	23	79	43	769

[a]*Including trailered watercraft and watercraft on land observable during survey.*

Source: SEWRPC.

motorized watercraft observed moored or stored, pontoon boats represented the largest group, with powerboats and personal watercraft the next most common categories. This same pattern was found during the previous survey, although the current survey shows a slight increase in the number of pontoon boats and a moderate decrease in the number of powerboats. There was a significant drop in the number of fishing boats since the time of the previous survey. Of the nonmotorized watercraft observed for the current survey, rowboats and paddleboats represented the most common types on the Lake, with kayaks also observed in good numbers.

The types of motorized watercraft docked or moored on a lake, as well as the relative proportion of nonmotorized to motorized watercraft, reflect the attitudes of the primary users of the lake, the lakeshore residents. On Pewaukee Lake for example,[35] nearly 80 percent of all watercraft on the Lake were motorized watercraft compared to about 73 percent of the watercraft on Little Muskego Lake. Additionally, of all watercraft on Pewaukee Lake, powerboats made up the largest proportion, comprising almost 40 percent of the watercraft observed. On Little Muskego Lake, the largest proportion of all watercraft was comprised of pontoon boats, which represented about 32 percent of all watercraft on the Lake.

To assess the degree of recreational boat use on a lake, it has been estimated that, in southeastern Wisconsin, the numbers of watercraft of all kinds operating on a lake at any given time is between 2 percent and 5 percent of the total number of watercraft docked and moored. On Little Muskego Lake, this would amount to somewhere between 15 and 38 watercraft, about three-fourths of which would be motorized.

There is a range of opinion on the issue of what constitutes optimal recreational boating densities, or the numbers of acres of open water within which to safely operate a boat on a lake. In the mid-1980s, an average area of 16 acres per powerboat or sailboat was considered suitable for the safe and enjoyable use of a boat on a lake.[36] Over time, motorized watercraft of all kinds have steadily increased in power and speed. Consequently, for safe waterskiing and high-speed boating, an area of 40 acres per boat was suggested in the aforementioned regional guidelines as the minimum area necessary for safe operations. Using these guidelines and the indirect estimates of boating densities of boats capable of high speeds on Little Muskego Lake, based on the counts of watercraft docked or moored around the Lake, boating densities of between 19 and 46 acres per high-speed boat would be anticipated on Little Muskego Lake. Subsequently, Chapter NR 1 of the *Wisconsin Administrative Code* has established recreational boating standards that suggest densities of between 25 acres and 35 acres per watercraft. Public recreational boating access opportunities on Little Muskego Lake are consistent with these standards.

[35]*See SEWRPC Community Assistance Planning Report No. 58, 2nd Edition,* A Lake Management Plan for Pewaukee Lake, Waukesha County, Wisconsin, *May 2003.*

[36]*See SEWRPC Planning Report No. 27,* A Regional Park and Open Space Plan for Southeastern Wisconsin: 2000, *November 1977.*

Table 15

LAND USE REGULATIONS WITHIN THE AREA TRIBUTARY TO LITTLE MUSKEGO LAKE IN WAUKESHA COUNTY BY CIVIL DIVISION: 2000

Community	Type of Ordinance				
	General Zoning	Floodland Zoning	Shoreland or Shoreland-Wetland Zoning	Subdivision Control	Construction Site Erosion Control and Stormwater Management
Waukesha County.....	Adopted	Adopted	Adopted and Wisconsin Department of Natural Resources Approved	Floodland and shoreland only	Adopted
City of Muskego	Adopted	Adopted	Adopted	Adopted	- -[a]
City of New Berlin	Adopted	Adopted	Adopted	Adopted	- -[a]

[a]*Erosion control and stormwater management standards are built into other ordinances.*

Source: SEWRPC.

Direct counts of the numbers and types of boats in use on Little Muskego Lake were not made during the current study period. However, data set forth in the 2004 aquatic plant management plan indicated that Little Muskego Lake was a popular recreational boating destination, especially on weekends when waterskiing- and fishing-boats comprised the greatest proportion of watercraft in use on the Lake.

LOCAL ORDINANCES

Recreational boating activities on Little Muskego Lake are subject to State of Wisconsin boating and water safety laws as set forth in Chapter 30, *Wisconsin Statutes*. Additionally, the Lake is subject to boating ordinances promulgated by the City of Muskego, included herein as Appendix B.

The Cities of Muskego and New Berlin have adopted their own general zoning, floodland zoning, shoreland-wetland zoning, and subdivision control ordinances; construction site erosion control/stormwater management control ordinances have been built into these other ordinances in both communities, as summarized in Table 15.

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Chapter III

ALTERNATIVE AND RECOMMENDED AQUATIC PLANT MANAGEMENT PRACTICES

INTRODUCTION

Little Muskego Lake generally contains a robust and fairly diverse aquatic plant community capable of supporting a warmwater fishery, although some areas of the Lake suffer impairment of recreational boating opportunities and other lake-oriented activities due to an overabundance of algae and aquatic macrophytes, such as coontail and Eurasian water milfoil. For example, in those areas of the Lake where Eurasian water milfoil is abundant, certain recreational uses are limited, the aesthetic quality of the Lake is impaired, and in-lake habitat degraded. The plant primarily interferes with recreational boating activities by clogging propellers and cooling water intakes, snagging paddles, and slowing sailboats by wrapping around keels and control surfaces. The plant also causes concern among swimmers who can become entangled within the plant stalks. Thus, without control measures, these areas can become problematic for boat navigation, fishing, and swimming. In contrast, native aquatic plants, generally found at slightly deeper depths, pose fewer potential problems for navigation, swimming, and fisheries, and many native aquatic plants provide good fish habitat, sustaining food resources and offering shelter for juvenile fishes and young-of-the-year. Consequently, aquatic plant management continues to be an important issue of concern to this lake-oriented community and its visitors.

In this chapter, alternatives and recommended refinements to the existing aquatic plant management plan are presented.[1] These measures are focused on those actions which are applicable to the Little Muskego Lake Protection and Rehabilitation District (LMLPRD) and the City of Muskego, with lesser emphasis given to those measures which are applicable to other agencies with jurisdiction within the area tributary to the Lake.

The alternative shoreland and aquatic macrophyte management elements set forth in this plan consider the application of measures consistent with the provisions of Chapters NR 103, NR 107, and NR 109 of the *Wisconsin Administrative Code*. Further, these 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 set forth under Chapter NR 1 of the *Wisconsin Administrative Code*.

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[1]*SEWRPC Memorandum Report No. 155,* An Aquatic Plant Management Plan for Little Muskego Lake, Waukesha County, Wisconsin, *January 2004.*

AQUATIC PLANT MANAGEMENT MEASURES

As stated in Chapter II of this report, aquatic plant management activities in Little Muskego Lake can be categorized primarily as mechanical control, with harvesting being used in concert with an annual herbicide treatment to control aquatic plant growth in the Lake. This dual control approach allows for herbicide use to be minimized and, when synchronized with mechanical harvesting, provides for maximum impact of the harvesting operations. In addition, individual householders on Little Muskego Lake are known to have engaged in manual harvesting in the vicinities of their piers and docks, complementing the aquatic plant management activities of the LMLPRD.

Array of Management Measures

Aquatic plant management measures can be classed into four groups: physical measures, which include lake bottom coverings and water level management; biological measures, which include the use of various organisms, including herbivorous insects and plantings of aquatic plants; manual and mechanical measures, which include harvesting and removal of aquatic plants; and, chemical measures, which include the use of aquatic herbicides. All control measures are stringently regulated and require a State of Wisconsin permit; chemical controls are regulated under Chapter NR 107 of the *Wisconsin Administrative Code*, and all other aquatic plant management practices are regulated under Chapter NR 109 of the *Wisconsin Administrative Code*. Placement of bottom covers, a physical measure, also requires a Wisconsin Department of Natural Resources (WDNR) permit under Chapter 30 of the *Wisconsin Statutes*. Costs range from minimal for manual removal of plants using rakes and hand-pulling, to upwards of $75,000 for the purchase of a mechanical plant harvester, for which the operational costs can approach $2,500 to $25,000 per year depending on staffing and operation policies.

Physical Measures

Lake bottom covers and light screens provide limited control of rooted plants by creating a physical barrier which reduces or eliminates the sunlight available to the plants. Sand and gravel are usually widely available and relatively inexpensive to use as cover materials, but plants readily recolonize areas so covered in about a year. Synthetic materials, such as polyethylene, polypropylene, fiberglass, and nylon, can provide relief from rooted plants for several years. However, such materials, known as bottom screens or barriers, generally have to be placed and removed annually. Such barriers also are susceptible to disturbance by watercraft propellers or the build-up of gasses from decaying plant biomass trapped under the barriers. In the case of Little Muskego Lake, the need to encourage native aquatic plant growth while simultaneously controlling the growth of Eurasian water milfoil, suggests that the placement of lake bottom covers as a method to control aquatic plant growth does not appear to be warranted. Thus, such measures are not considered viable for Little Muskego Lake.

Biological Measures

Biological controls offer an alternative approach to controlling nuisance plants, particularly purple loosestrife (*Lythrum salicaria*), an invasive shoreland wetland plant, and Eurasian water milfoil. Classical biological control techniques have been successfully used to control both nuisance plants with herbivorous insects.[2] Recent evidence shows that *Galerucella pucilla* and *Galerucella calmariensis*, beetle species, and *Hylobius transversovittatus* and *Nanophyes brevis*, weevil species, have potential as biological control agents for purple loosestrife.[3] Extensive field trials conducted by the WDNR in the Southeastern Wisconsin Region since 1999 have indicated that these insects can provide effective management of large infestations of purple loosestrife. In contrast, the few studies of

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[2]*B. Moorman, "A Battle with Purple Loosestrife: A Beginner's Experience with Biological Control,"* LakeLine, *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.*

[3]*Sally P. Sheldon, "The Potential for Biological Control of Eurasian Water Milfoil (*Myriophyllum spicatum*) 1990-1995 Final Report," Department of Biology Middlebury College, February 1995.*

Eurasian water milfoil control utilizing *Eurhychiopsis lecontei*, an aquatic weevil species, have resulted in variable levels of control, with little control being achieved on those lakes having extensive motorized boating traffic. Predation of the weevils by insectivorous fishes also has limited to successful use of these organisms as control agents, although there is some anecdotal evidence that naturally-occurring weevil populations may be associated with the approximately decadal declines in Eurasian water milfoil success. Thus, while the use of insects as a means of shoreland wetland plant management is considered to be viable, the use of *Eurhychiopsis lecontei* as a means of aquatic plant management control, is not considered a viable option for use on Little Muskego Lake at this time.

The use of grass carp, *Ctenopharyngodon idella*, an alternative biological control used elsewhere in the United States, is not permitted in Wisconsin.

A variation on the theme of biological control is the introduction of aquatic plants into a waterbody as a means of encouraging or stimulating the growth of desirable native aquatic plant species in a lake. While few projects of this nature have been undertaken in the Southeastern Wisconsin Region, the Lac La Belle Management District, in partnership with the WDNR and University of Wisconsin-Milwaukee, did attempt to supplement the aquatic plant community of that Lake by selectively planting pondweeds (*Potamogeton* spp.).[4] Several hundred pondweeds were transplanted into Lac La Belle, and, while there is some evidence that a few of these transplants were successful, the net outcome of the project was disappointing. Few of the introduced plants were observed in subsequent years.[5] Given the extensive and diverse aquatic plant community present in many areas of Little Muskego Lake, supplemental plantings are not considered to be a viable aquatic plant management option.

Manual and Mechanical Measures

The physical removal of specific types of vegetation by selective harvesting of plants provides a highly selective means of controlling the growths of nuisance aquatic plant species, including purple loosestrife and Eurasian water milfoil. Pursuant to Chapter NR 109 of the *Wisconsin Administrative Code*, manual harvesting of aquatic plants within a 30-foot-wide corridor along a shoreline would be allowed without a WDNR permit, provided: 1) piers and other access-related structures are located within this area, 2) the plant material is removed from the Lake, and 3) the removal of nonnative plant species does not harm native plants. Notwithstanding, manual harvesting of any aquatic plants within WDNR-delineated environmentally sensitive areas established under Chapter NR 107 of the *Wisconsin Administrative Code* would require a State permit, as would any other manual harvesting.

Aquatic macrophytes also may be harvested mechanically with specialized equipment consisting of a cutting apparatus, which cuts up to about five feet below the water surface, and a conveyor system that picks up the cut plants. Mechanical harvesting can be a practical and efficient means of controlling plant growth as it removes the plant biomass and nutrients from a lake. Mechanical harvesting is particularly effective as a measure to control large-scale growths of aquatic plants. Narrow channels can be harvested to provide navigational access and "cruising lanes" for predator fish to migrate into the macrophyte beds to feed on smaller fish. The harvesting of water lilies and other emergent native plants should be avoided.

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[4]*Donald H. Les and Glenn Guntenpergen, "Laboratory Growth Experiments for Selected Aquatic Plants, Final Report, July 1989 – June 1990 (Year 1)," Report to the Wisconsin Department of Natural Resources, June 1990; Wisconsin Department of Natural Resources, Environmental Assessment: Improvement of the Water Quality and Fisheries Habitat of LacLaBelle [sic] and the Lower Oconomowoc River, s.d.*

[5]*At the 2003 annual meeting of the Lac La Belle Management District, a citizen reported observing a herbicide application in the vicinity of the planted area of the Lake. Such an application might explain the observed lack of success of this management measure. See SEWRPC Community Assistance Planning Report No. 47, 2nd Edition,* A Water Quality Management Plan for Lac La Belle, Waukesha County, Wisconsin, *May 2007.*

"Clear cutting" aquatic plants and denuding the lake bottom of flora, using either manual or mechanical harvesting, should be avoided. However, top cutting of plants, such as Eurasian water milfoil, using mechanical harvesters, as shown in Figure 3, has proven to be beneficial in some lakes as a means of minimizing the competitive advantage of the Eurasian water milfoil plant and encouraging native aquatic plant growths.[6]

In the shoreland area, where purple loosestrife may be expected to occur, bagging and cutting loosestrife plants prior to the application of chemical herbicides to the cut ends of the stems, can be an effective control measure for small infestations of this plant. Loosestrife management programs, however, should be followed by an annual monitoring and control program for up to 10 years following the initial control program to manage the regrowth of the plant from seeds. Manual removal of such plants is recommended for isolated stands of purple loosestrife when and where they occur.

In the nearshore area, specially designed rakes are available to assist in the manual removal of nuisance aquatic plants, such as Eurasian water milfoil. The use of such rakes also provides a safe and convenient method of controlling aquatic plants in deeper nearshore waters around piers and docks. The advantage of the rakes is that they are relatively inexpensive, easy and quick to use, and immediately remove the plant material from the lake, without a waiting period. Removal of the plants from the lake avoids the accumulation of organic matter on the lake bottom, which adds to the nutrient pool that favors further plant growth. State permitting requirements for manual aquatic plant harvesting mandate that the harvested material be removed from the lake. Should the LMLPRD acquire a number of these specially designed rakes, they could be made available for the riparian owners to use on a trial basis to test their operability before purchasing them.

Hand-pulling of stems, where they occur in isolated stands, provides an alternative means of controlling plants, such as Eurasian water milfoil, in the Lake, and purple loosestrife, on the lakeshore. Because this is a more selective measure, the rakes being nonselective in their harvesting, manual removal of Eurasian water milfoil is considered a viable option in Little Muskego Lake, where practicable and feasible.

An advantage of mechanical aquatic plant harvesting is that the harvester typically leaves enough plant material in the lake to provide shelter for fish and other aquatic organisms, and to stabilize the lake bottom sediments. Aquatic plant harvesting also has been shown to facilitate the growth of native aquatic plants in harvested areas by allowing light penetration to the lakebed. Many native aquatic plants are low-growing species that are less likely to interfere with human recreational and aesthetic uses of a lake. A disadvantage of mechanical harvesting is that the harvesting operation may cause fragmentation of plants and, thus, unintentionally facilitate the spread of some plants that utilize fragmentation as a means of propagation, namely Eurasian water milfoil. Harvesting may also disturb bottom sediments in shallower areas where such sediments are only loosely consolidated, thereby increasing turbidity and resulting in deleterious effects, including the smothering of fish breeding habitat and nesting sites. Disrupting the bottom sediments also could increase the risk that an exotic species, such as Eurasian water milfoil, may colonize the disturbed area since this is a species that tends to thrive under disturbed bottom conditions. To this end, most WDNR-issued permits do not allow harvesting in areas having a water depth of less than three feet. Harvesting also is typically restricted during fish breeding seasons in late-spring and early-summer to avoid loss of eggs or juvenile fishes. If done correctly and carefully, harvesting has been shown to be of benefit in ultimately reducing the regrowth of nuisance plants when used under conditions suitable for this method of control. Both manual and mechanical harvesting techniques are considered to be viable options for control of aquatic plants in Little Muskego Lake.

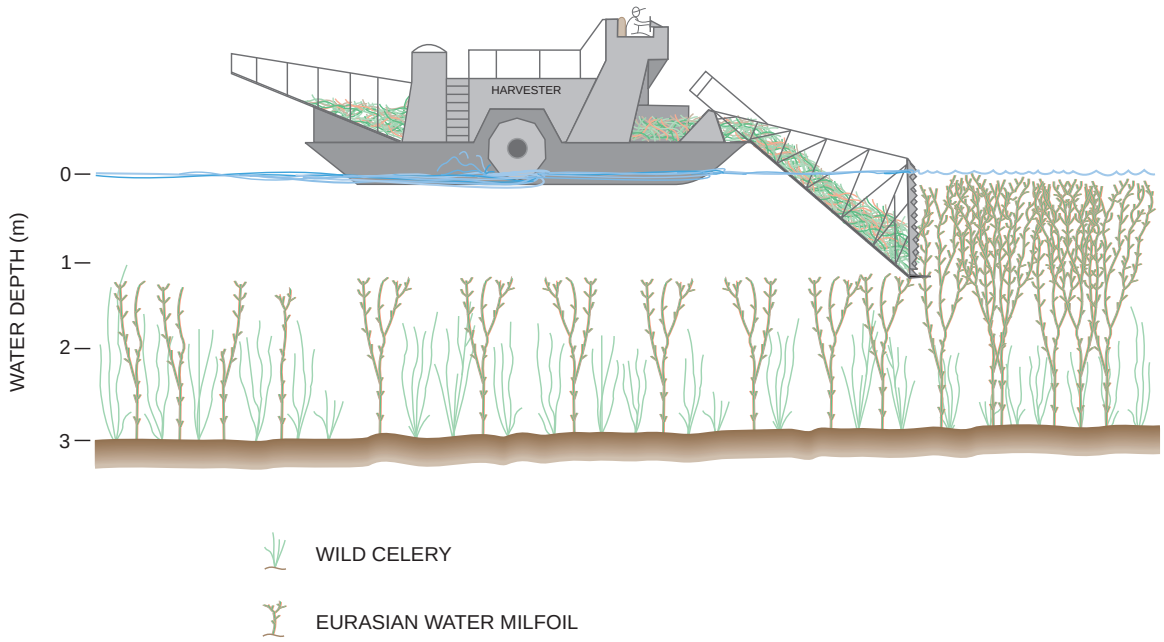
Chemical Measures

Chemical treatment with herbicides is a short-term method of controlling heavy growths of nuisance aquatic plants. Chemicals are generally applied to the growing plants in either a liquid or granular form. The advantages

[6]*See SEWRPC Memorandum Report No. 143,* An Aquatic Plant Management Plan for the Lauderdale Lakes, Walworth County, Wisconsin, *August 2001.*

Figure 3

PLANT CANOPY REMOVAL 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: Wisconsin Department of Natural Resources and SEWRPC.

of using chemical herbicides to control aquatic macrophytes growth are the relatively low-cost and the ease, speed, and convenience of application. The disadvantages associated with chemical control include unknown long-term effects on fish, fish food sources, and humans; a risk of increased algal blooms due to the eradication of macrophyte competitors; an increase in organic matter in the sediments, possibly leading to increased plant growth, as well as anoxic conditions which can cause fish kills; adverse effects on desirable aquatic organisms; loss of desirable fish habitat and food sources; and, finally, a need to repeat the treatment the following summer due to existing seed banks and/or plant fragments. Widespread chemical treatments can also provide an advantage to less desirable, invasive, introduced plant species to the extent that such treatments may produce conditions in which nonnative species can outcompete the more beneficial, native aquatic plant species. Hence, this is seldom a feasible management option to be used on a large scale. Widespread chemical treatment, therefore, is not considered a viable option for widespread use on Little Muskego Lake, although limited chemical control is considered to be a viable technique for the control of the relatively small-scale infestations of aquatic plants, such as Eurasian water milfoil, or shoreland plants, such as purple loosestrife in confined areas such as around piers and docks should manual harvesting not be possible in these areas.

To minimize the possible impacts of deoxygenation, loss of desirable plant species, and contribution of organic matter to the sediments, early spring or late fall applications should be considered. Such applications also minimize the concentration and amount of chemicals used due to the fact that colder water temperatures enhance the herbicidal effects, while the application of chemical herbicides during periods when most native aquatic plants species are dormant limit the potential for collateral damage. Use of chemical herbicides in aquatic environments is stringently regulated and requires a WDNR permit and WDNR staff oversight during applications.

Use of early spring or late fall chemical controls, especially in those shoreline areas where mechanical harvesting would not be deemed viable, targeting growths of Eurasian water milfoil and purple loosestrife in and around the Lake, is considered a viable option for Little Muskego Lake.

Recommended Management Measures

Few lakes in southeastern Wisconsin lack aquatic plant growth, and Little Muskego Lake is no exception. The Lake would benefit from a greater diversity of native aquatic plants, albeit some measure of progress toward this goal seems to have been achieved since the previous aquatic plant survey as noted in Chapter II of this plan. Low-growing plants, such as muskgrass, which provide food and shelter for fish and waterfowl, do occur in the Lake. However, because of their low-growing height, this species is often outcompeted by the nonnative Eurasian water milfoil—Eurasian water milfoil grows rapidly to the lake surface, capturing the available sunlight and shading out the native species. Thus, control of the Eurasian water milfoil, using a variety of measures, is one means of promoting the growth of native plants, and is recommended for Little Muskego Lake.

The most effective plans for managing aquatic plants rely on a combination of the methods and techniques described above. Due to the nature of the combination approach to aquatic plant control recommended to be employed on the Lake, the specific control measures recommended to be applied in various areas of the Lake are shown on Map 12 and summarized in Table 16. In order to enhance the use of Little Muskego Lake while maintaining the quality and diversity of the biological communities, the following actions generally are recommended:

- Manual harvesting around piers and docks is the recommended means of controlling nonnative nuisance species of plants in those areas. In this regard, the LMLPRD could consider purchasing several specialty rakes designed for the removal of vegetation from shoreline property and make these available to riparian owners. This would allow the riparian owners to use the rakes on a trial basis before purchasing their own. Although the rakes may not require a permit for use within a 30-feet width of shoreline, provided certain requirements are met, State permitting requirements for manual aquatic plant harvesting mandate that the harvested material be removed from the Lake—more extensive removal of aquatic vegetation would require a State permit pursuant to Chapter NR 109 of the *Wisconsin Administrative Code*.

- Where feasible and practicable, hand pulling of stems, where they occur in isolated stands, is also recommended as an alternative means of controlling Eurasian water milfoil and purple loosestrife. Manual control should target nonnative species.

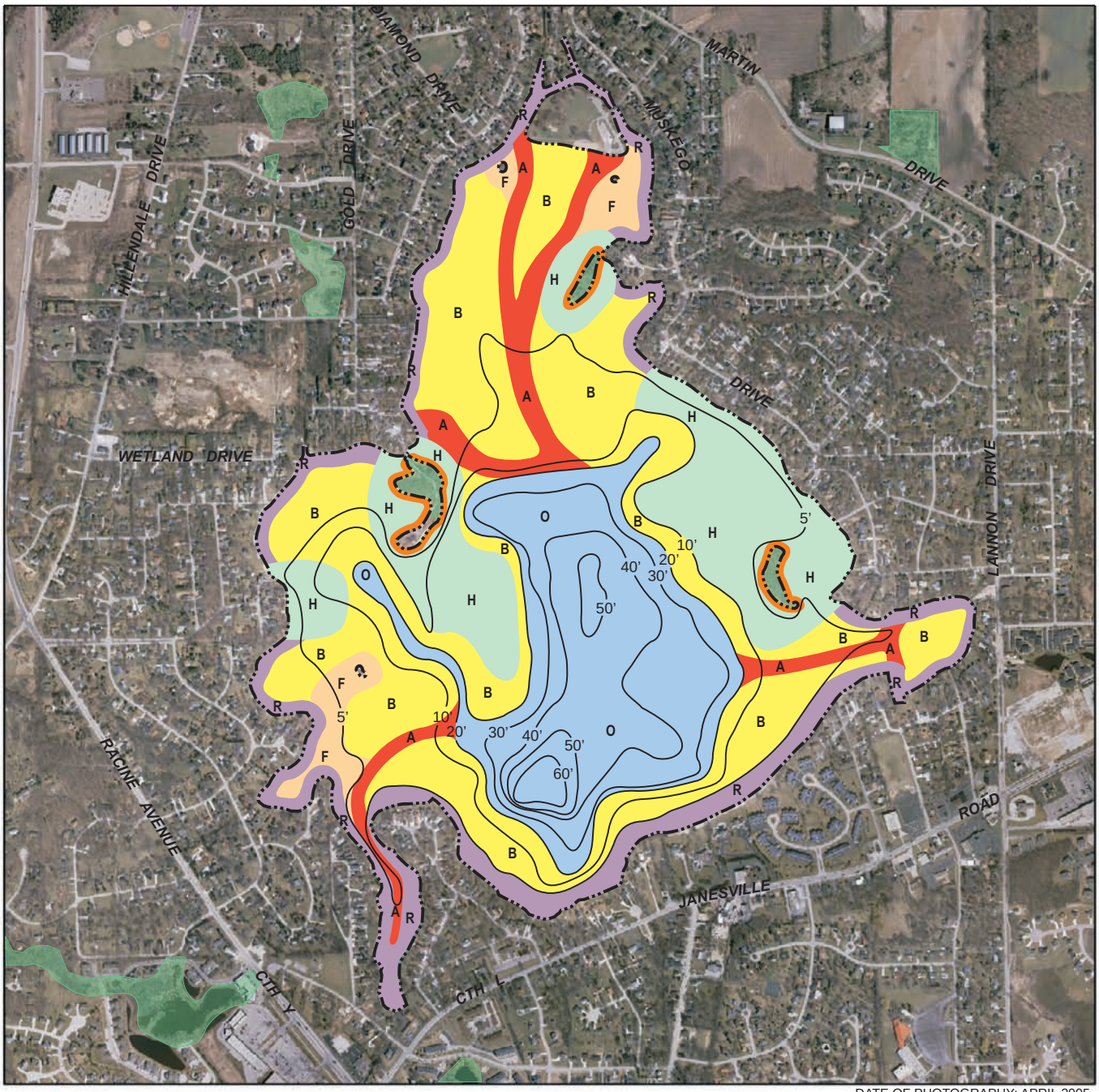
- It is recommended that the supplemental use of chemical herbicides be limited to and targeted on controlling nuisance growths of exotic species, particularly Eurasian water milfoil, purple loosestrife, and curly-leaf pondweed, State-designated invasive species pursuant to Chapter NR 109 of the *Wisconsin Administrative Code*. Chemical applications, if required, must be made by licensed applicators subject to State permitting requirements. Such applications should be evaluated annually and the herbicide applied only on an as-needed basis. Only herbicides that selectively control milfoil, such as 2,4-D and endothall, should be used.

- It is recommended that chemical herbicide applications be made in early spring or late fall to maximize their effectiveness on nonnative plant species, while minimizing their impacts on native plant species. Such treatments will typically act as preventive measures to reduce the development of nuisance conditions during peak summer recreational use periods.

- Algicides, such as Cutrine Plus, generally are not recommended because there are few significant, recurring filamentous algal or planktonic algal problems in Little Muskego Lake, and valuable macroscopic algae, such as *Chara* and *Nitella*, are killed by this product.

Map 12

RECOMMENDED AQUATIC PLANT MANAGEMENT PLAN FOR LITTLE MUSKEGO LAKE



DATE OF PHOTOGRAPHY: APRIL 2005

— 20' — WATER DEPTH CONTOUR IN FEET

REPAIR ERODED AREAS USING VEGETATION

H WISCONSIN DEPARTMENT OF NATURAL RESOURCES -DELINEATED ENVIRONMENTALLY SENSITIVE AREAS RECOMMENDED FOR PROTECTION

AQUATIC PLANT MANAGEMENT

A ACCESS: HARVEST RECREATIONAL BOATING ACCESS CHANNELS APPROXIMATELY 50 FEET WIDE

B BOATING / RECREATION: SURFACE CUT OF EURASIAN WATER MILFOIL, HARVESTING MODERATE PRIORITY

R RIPARIAN ZONE: MAINTAIN SHORELINE PROTECTION STRUCTURES AS NECESSARY, INSTALL VEGETATIVE BUFFERS, MANUALLY HARVEST AQUATIC PLANTS AROUND PIERS AND DOCKS

O OPEN WATER: DEPTH GREATER THAN 20 FEET - NO AQUATIC MANAGEMENT MEASURES RECOMMENDED

F FISH BREEDING AND HABITAT/ANGLING AREAS - NO AQUATIC PLANT MANAGEMENT MEASURES RECOMMENDED DURING FISH BREEDING SEASON

LAND USE MANAGEMENT

PROTECT ENVIRONMENTAL CORRIDORS

- OBSERVE GUIDELINES SET FORTH IN THE COUNTY DEVELOPMENT PLAN, MAINTAIN HISTORIC LAKEFRONT RESIDENTIAL DWELLING DENSITIES
- PROMOTE GOOD HOUSEKEEPING PRACTICES IN URBAN AREAS

WATER QUALITY MANAGEMENT

- CONTINUE PARTICIPATION IN WISCONSIN DEPARTMENT OF NATURAL RESOURCES SELF-HELP MONITORING PROGRAM

FISHERIES MANAGEMENT

- CONTINUE TO MONITOR FISH POPULATIONS, MODIFY STOCKING/ HARVESTING PROGRAM AND REGULATIONS, AS NECESSARY

PUBLIC INFORMATION AND EDUCATION

- CONTINUE PUBLIC AWARENESS PROGRAM

GRAPHIC SCALE

0 650 1300 FEET

Source: SEWRPC.

Table 16

RECOMMENDED AQUATIC PLANT MANAGEMENT PLAN ELEMENTS FOR LITTLE MUSKEGO LAKE

Plan Element	Subelement	Management Measures	Management Responsibility
Aquatic Plant Management	Manual harvesting	Harvest nuisance plants, including Eurasian water milfoil and purple loosestrife, as required around docks and piers; collect plant fragments arising from boating and harvesting activities	LMLPRD and individuals
	Mechanical harvesting	Harvest nuisance plants, including Eurasian water milfoil, to maintain public recreational boating access, promote public safety and convenience, and enhance angling opportunities by protecting fish habitat and reproduction	LMLPRD
	Chemical controls	Selectively control nuisance aquatic plants through limited use of herbicides in spring; manual removal, as noted above, is recommended during summer and fall	LMLPRD
	Eurasian water milfoil control; encouragement of native plant communities	Control nonnative, invasive species as required to prevent the spread of nuisance species within the Lake; use of herbicides in spring to limit the volume of decomposing biomass and quantity of herbicides required is recommended Additional periodic monitoring of the aquatic plant community for the early detection and control of future-designated nonnative species that may occur Conduct periodic in-lake reconnaissance surveys of aquatic plant communities and update aquatic plant management plan every three to five years	LMLPRD and individuals
	Public informational programming	Continue public awareness and information programming; continue monitoring of aquatic plant communities	LMLPRD and Little Muskego Lake Association, Inc.
Ancillary Management Measures	Recreational use management	Protect native aquatic plant communities, fish breeding and habitat areas, and designated environmentally sensitive areas as set forth in the adopted lake management plan Reduce motorized boat traffic within Eurasian water milfoil control areas Maintain signage at public access sites regarding boating ordinance, invasive species and WDNR Clean Boats-Clean Waters Program; provide disposal containers for disposal of plant material removed from watercraft	LMLPRD, City of Muskego and WDNR
	Lakewide nonnative species management program	Prevent the spread of nonnative plants and animals through cleaning of boats, trailers and related facilities throughout the Lake	LMLPRD, City of Muskego and WDNR
	Water quality management	Continue participation in WDNR CLMN program and consider participation in WDNR Expanded Self-Help Program; periodic participation in U.S. Geological Survey TSI or similar programs	LMLPRD
	Public informational programming	Continue public awareness and information programming	LMLPRD and Little Muskego Lake Association, Inc.
	Lake district board continuing education	Maintain awareness of current developments in the area of lake management through informative publications such as “Lake Tides” (available free through the Wisconsin Lakes Partnership) and attendance at lake education conventions, workshops, and seminars	LMLPRD

NOTE: LMLPRD = Little Muskego Lake Protection and Rehabilitation District; WDNR = Wisconsin Department of Natural Resources.

Source: SEWRPC.

- Maintenance of shoreland areas around docks and piers is recommended to remain the responsibility of individual property owners. Treatment of purple loosestrife stands is recommended to be undertaken prior to the flowering of the plant; treatment conducted thereafter should be done in such a manner as to ensure that the seed heads are "bagged" prior to cutting the plant and applying the herbicide to limit reseeding of the plant.

- Continued informational programming encouraging riparian owners to monitor their shoreline areas, as well as open-water areas of the Lake, for new growths of nonnative nuisance plants is recommended. Any such growths should be reported to the LMLPRD at the earliest opportunity so that a timely and effective response can be executed.

- In-lake aquatic plant surveys are recommended to be conducted at about three- to five-year intervals, depending upon the observed degree of change in the aquatic plant communities. In addition, information on the aquatic plant control program should be recorded and should include descriptions of major areas of nuisance plant growth and areas to be managed. Additional periodic monitoring of the aquatic plant community is recommended for the early detection and control of future-designated nonnative species that may occur. Such control could be effected with the assistance of funds provided under the Chapter NR 198, aquatic invasive species control grant program, and should be undertaken as soon as possible once the presence of a nonnative, invasive species is observed and confirmed, reducing the risk of spread from waters where they are present and restoring native aquatic communities. Control of currently designated invasive species, identified pursuant to Chapter NR 109 of the *Wisconsin Administrative Code*, using appropriate control measures,[7] is recommended throughout the Lake.

- Continued observance of the restrictions set forth by the WDNR within the Chapter NR 107 delineated environmentally sensitive areas of Little Muskego Lake is recommended (Appendix C).

- Mechanical harvesting is recommended to be the primary method of aquatic plant management in Little Muskego Lake, especially for large-scale management of aquatic plant growths in boating channels, embayments, and open water areas of the Lake.

HARVESTING PLAN FOR LITTLE MUSKEGO LAKE

The recommended plan includes continuation of the integrated use of mechanical, chemical, and manual methods of aquatic plant management, supplemented with informational and educational programming to encourage lakefront residents and property owners to employ lake-friendly household management measures when engaging in lawn care, gardening, and related activities. The following specific actions are recommended with respect to the aquatic plant harvesting program conducted by the LMLPRD:

1. Continued operation by the LMLPRD of the existing harvesting and transport equipment, and replacement of that equipment, as required.

2. Collection of aquatic plant fragments by riparian householders to limit the spread of Eurasian water milfoil, with consideration to be given to the acquisition of skimming equipment as a means of facilitating clean-up of plant fragments in the nearshore areas. In areas near the boat-launching site, harvested plant material should be collected and disposed of. Harvesting equipment operators should

[7]*Appropriate control measures include, but are not limited to, any permitted aquatic plant management measure, placement of signage, and use of buoys to isolate affected areas of the Lake. Such measures as may be appropriate should be determined in consultation with WDNR staff and conducted in accordance with required permits under Chapters NR 107, NR 109, and NR 198, amongst others, of the* Wisconsin Administrative Code.

strictly police the off-loading site to ensure minimal disruption of boaters and of the people using the riparian areas of the Lake.

3. Demarcation and maintenance of navigational access channels within the boating access areas, shown on Map 12, using regulatory buoys, to discourage regrowth of vegetation in these areas and to minimize the spread of nonnative plants, such as Eurasian water milfoil, within the Lake.

4. Control of State-designated nonnative aquatic plant species, especially Eurasian water milfoil and curly-leaf pondweed, using a combination of methods including mechanical harvesting, herbicide treatment, and manual removal.

5. Top cutting of plants at depths of approximately two feet to remove the surface canopy on Eurasian water milfoil, as shown in Figure 3, to minimize resuspension of lake bottom sediments, provide a competitive advantage to the low-growing native plants, and continue to provide adequate habitat for fish and aquatic life, especially in Zones B and F shown on Map 12, and in other areas with extensive growths of Eurasian water milfoil.

6. Harvesting of narrow channels in areas of extensive aquatic plant growth to provide navigational access and "cruising lanes" for predator fish to migrate into the macrophyte beds to feed on smaller fish.

7. Selective use of chemical herbicides, in addition to those applications described above for the control of State-designated nonnative invasive species, to control nuisance growths of aquatic plants in shallow water around docks and piers where householders are unable or unwilling to use manual harvesting means; chemical applications, if required, should be made in early spring to maximize their effectiveness on nonnative plant species, minimize their impacts on native plant species, and act as a preventive measure to reduce the development of nuisance conditions. Algicides, such as Cutrine Plus, generally are not recommended as algal blooms are rare in the Lake, and valuable macroscopic algae, such as *Chara*, may be killed by these products.

8. Control of rooted vegetation between adjacent piers by the riparian owners concerned, in consideration of the limited maneuverability of mechanical harvesters and the resultant liability issues that could arise from damage to boats and piers from harvesting equipment.

9. Restriction of aquatic plant management activities in WDNR-delineated environmentally sensitive areas (see Appendix C), except insofar as necessary to maintain the existing boating access channels especially during fish spawning seasons in early summer and autumn, or except in special instances where selective herbicide application may be allowed for control of nuisance species. Other areas to be excluded from aquatic plant management operations include those considered important for fish spawning and areas of three feet or less in depth. In addition to these generalized precautions, the LMLPRD should train staff to visually observe fishes and aquatic animals being captured during the harvesting operations, and adjust their operations accordingly, returning "harvested" animals to the water to the extent that operator safety and safe operation of the vessel is ensured. Continuation of these practices is recommended to protect fish and wildlife within Little Muskego Lake, especially in proximity to WDNR-designated environmentally sensitive areas.

10. Continued educational and informational programming, especially with regard to the aquatic plant management program for the Lake; sources of information and technical assistance include the WDNR Aquatic Plant Monitoring Program and the University of Wisconsin-Extension (UWEX). The aquatic plant illustrations provided in Appendix A may assist individuals interested in identifying plants near their residences. Residents should be encouraged to observe and document changes in the abundance and types of aquatic plants in their part of the Lake on an annual basis.

To aid in the execution of this harvesting plan, the Lake has been divided into high-, moderate-, and low-priority harvesting areas. High-priority harvesting areas are those areas that are used for public recreational boating access. Moderate-priority harvesting areas are the areas used for general recreation. Low-priority harvesting areas are areas that are used primarily for passive recreation and/or where aquatic plant growth is observed to be sparse. Additional areas have been designated as "no control" areas, and include important areas for fish spawning and habitat. These spawning and habitat areas should not be subjected to aquatic plant control measures before mid-June of each year, except in Eurasian water milfoil control areas where the dense growths of Eurasian water milfoil can negatively affect such habitat. Specific control measures should be applied in each of the lake zones as summarized in Table 17 and shown on Map 13.

Harvesting operations elsewhere in the lake basin should begin in mid- to late-May of each year to minimize any impact on the fish spawning season and should not take place in shallow waters, generally three feet or less in depth, to avoid disturbance to fish habitat and beds of native aquatic plants. In areas where operators observe significant capture of fishes, eggs, fry, or fingerlings, harvesting should be immediately curtailed so as to minimize potential impacts on the lake fishery. The recommended, generalized sequence of the harvester operations on Little Muskego Lake is set forth in Figure 4. The operators of the harvester should be provided with laminated copies of the approved harvesting plan showing the limits of harvesting operations. A copy of this map is to be kept on the harvester at all times.

Harvesting Schedule

The harvesting season is recommended to begin in mid- to late-May to accommodate the fish spawning activities and should end no later than mid-September of each year, with no harvesting in habitat areas before mid-June of each year. Special care should be taken to avoid disturbing bass spawning areas in Little Muskego Lake between May 1 and June 30 of each year. Harvesting should average between 30 and 35 hours per week over a five-day week, depending on weather conditions and plant growth, to minimize recreational use conflicts. In addition, harvesting will be confined to daylight hours to minimize public disturbances resulting from these operations.

Evaluation and Monitoring

The operators of the harvesting equipment should record daily harvesting activities in a harvesting log. This log should include daily maintenance and service records showing engine hours, fuel consumed, and oil used, as well as areas harvested and notes of observations relevant to the harvesting program. An annual summary of the harvesting program, based upon these harvesting log records, should be submitted to the LMLPRD Board of Commissioners (or other designated committee) at the annual meeting of the District, and made available to the electors of the District at that time.

It is the intention of the LMLPRD to undertake a periodic, formal review of the harvesting program and to publish periodic refinements of the aquatic plant management plan. It is recommended that a further inventory be prepared in three to five years to confirm that any changes in the aquatic plant community are for reasons other than annual variability and are not indicative of longer term changes within the aquatic plant community of the Lake.

ANCILLARY PLAN RECOMMENDATIONS

Recreational Use Management

It is recommended that the City reduce motorized boat traffic within the Eurasian water milfoil control areas, shown on Map 13, to essential traffic only and define watercraft transit speeds and lanes consistent with the milfoil control areas and established patterns of recreational boating usage on the Lake through its existing boating ordinance. Such regulation may require buoyage depending on the sufficiency of the signage and notices provided to lake users and the level of compliance achieved. Permits may be required pursuant to Chapter 30 of the *Wisconsin Statutes* for the placement of regulatory and/or informational buoys within public waters. In addition, should such buoyage be placed pursuant to local ordinance requirements, copies of any such ordinances must be placed at the public access site as set forth in Section 30.77(4) of the *Wisconsin Statutes*. It is further recommended that an explanation of any such signage as may be utilized for aquatic plant management purposes

Table 17

RECOMMENDED ZONE-RELEVANT AQUATIC PLANT MANAGEMENT TREATMENTS FOR LITTLE MUSKEGO LAKE

Zone and Priority	Recommended Aquatic Plant Management Treatment[a]
Zone B (Boating) Moderate-Priority Harvesting	Harvesting to be limited to maintaining 75-foot-wide navigational channels along the perimeter of the Lake, and 30-foot-wide shared access lanes perpendicular to the shoreline extending towards the center of the Lake to allow boat access to the open water area of the Lake
	Limited late season harvesting (late August to early September) may be necessary to maintain adequate open water areas in the central portion of the Lake
Zone F (Fishing) Low-Priority Harvesting	Zone F is intended to accommodate fishing from a boat
	It is recommended that approximately 15-foot-wide channels be harvested perpendicular to the shore at about 100-foot intervals
	Chemical use, if required, should be restricted to selective control of nuisance species near the public access sites; no chemical controls are recommended during fish spawning periods in early spring and late autumn
Zone H (Habitat) No Harvesting	Wisconsin Department of Natural Resources-delineated environmentally sensitive areas; these selected areas of the Lake are recommended to be preserved as high-quality habitat area
	No harvesting or in-lake chemical application should be permitted, except in special instances where selective herbicide application may be allowed for the control of nuisance species
	Debris and litter cleanup would be needed in some adjacent areas; the immediate shoreline should be preserved in natural, open use to the extent possible
Zone O (Open Water) Low-Priority Harvesting[b]	Harvesting should be conducted in selected areas of the deeper water to provide a larger shared space for boating and fishing
	Navigation channels approximately 30 feet in width, should be harvested
Zone R (Riparian Access) High-Priority Harvesting	Littoral zone. The entire area may not require intensive plant management
	Nuisance aquatic macrophyte growth within 150 feet of shoreline should be harvested to provide maximum opportunities for boating, fishing, and limited swimming
	Areas between piers should not be mechanically harvested due to potential liability and maneuverability problems. Residents are encouraged to manually harvest aquatic plants in these areas
	Additional 30-foot-wide shared access channels should be harvested to extend to the center of the Lake
Zone A (Recreational Boating Access) High-Priority Harvesting	Harvest a 75-foot-wide channel following the shorelines of the bays to connect to channels perpendicular to shore to allow access to the main body of the Lake
	Patterns of harvesting will vary yearly dependant on macrophyte abundance
	Chemical use, if required, should be restricted to pier and dock areas and should not extend more than 100 feet from shore; [c] subject to permit requirements
Approximate Total Area to Be Harvested	230 acres

[a]*Control of State-designated nonnative aquatic plant species, currently including Eurasian water milfoil and curly-leaf pondweed, using appropriate aquatic plant control measures including harvesting, targeted herbicide treatment, and public informational programming, is recommended for lakewide application.*

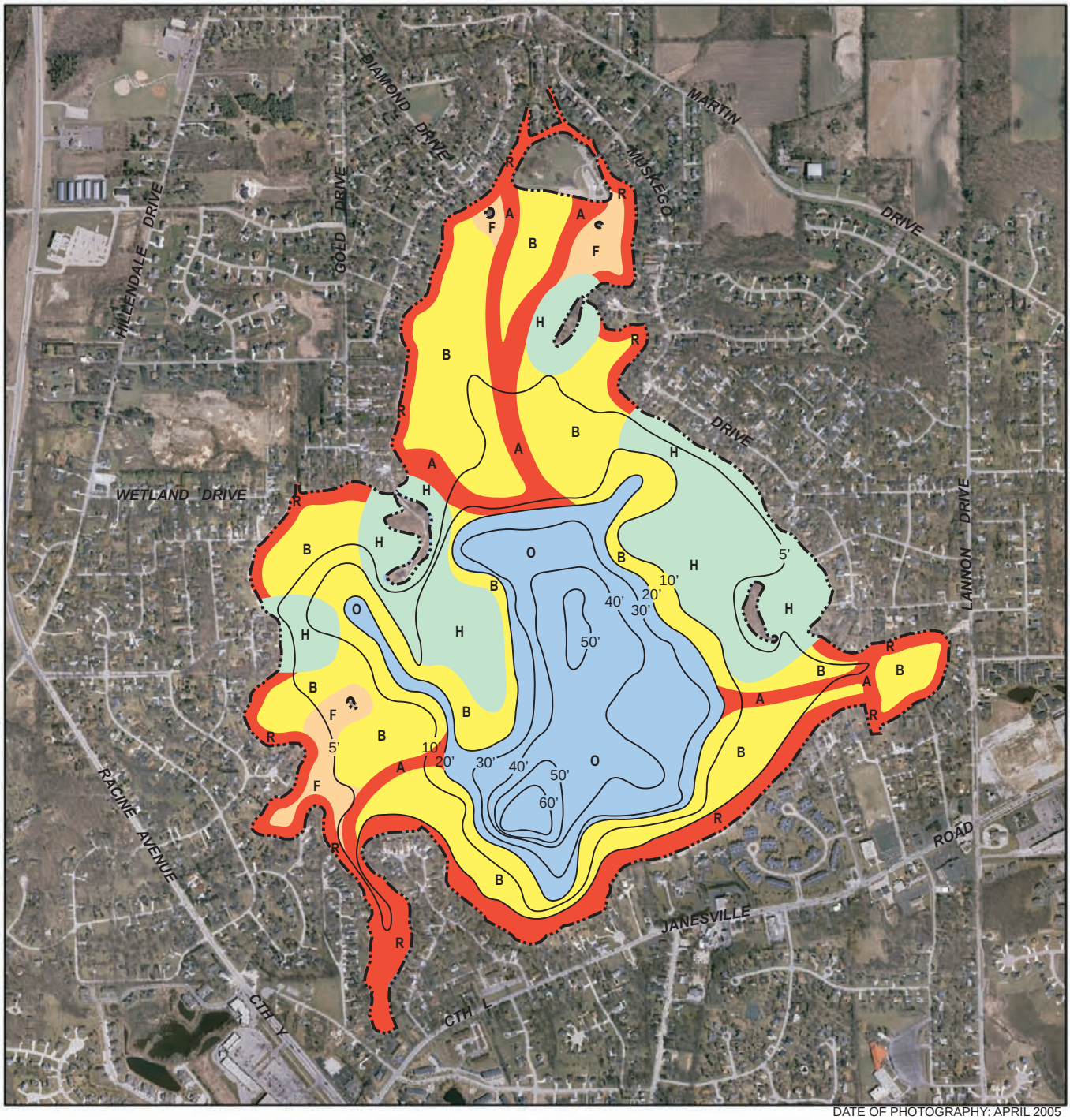
[b]*Excludes areas greater than 15 feet which require no harvesting.*

[c]*Section NR 107.05(3)(f) of the* Wisconsin Administrative Code *limits chemical applications to a maximum distance of 150 feet from shore, except in certain specific instances associated with public navigation.*

Source: SEWRPC.

Map 13

AQUATIC PLANT HARVESTING ZONES FOR LITTLE MUSKEGO LAKE



DATE OF PHOTOGRAPHY: APRIL 2005

— 20' — WATER DEPTH CONTOUR IN FEET

R AQUATIC PLANT MANAGEMENT ZONES AS DEFINED IN TABLES 16 AND 17

HIGH-PRIORITY HARVESTING: RIPARIAN AND ACCESS ZONES

MODERATE-PRIORITY HARVESTING: BOATING ZONE

LOW-PRIORITY HARVESTING: FISHING AND OPEN WATER ZONES

WISCONSIN DEPARTMENT OF NATURAL RESOURCES-DELINEATED ENVIRONMENTALLY SENSITIVE AREAS RECOMMENDED FOR PROTECTION

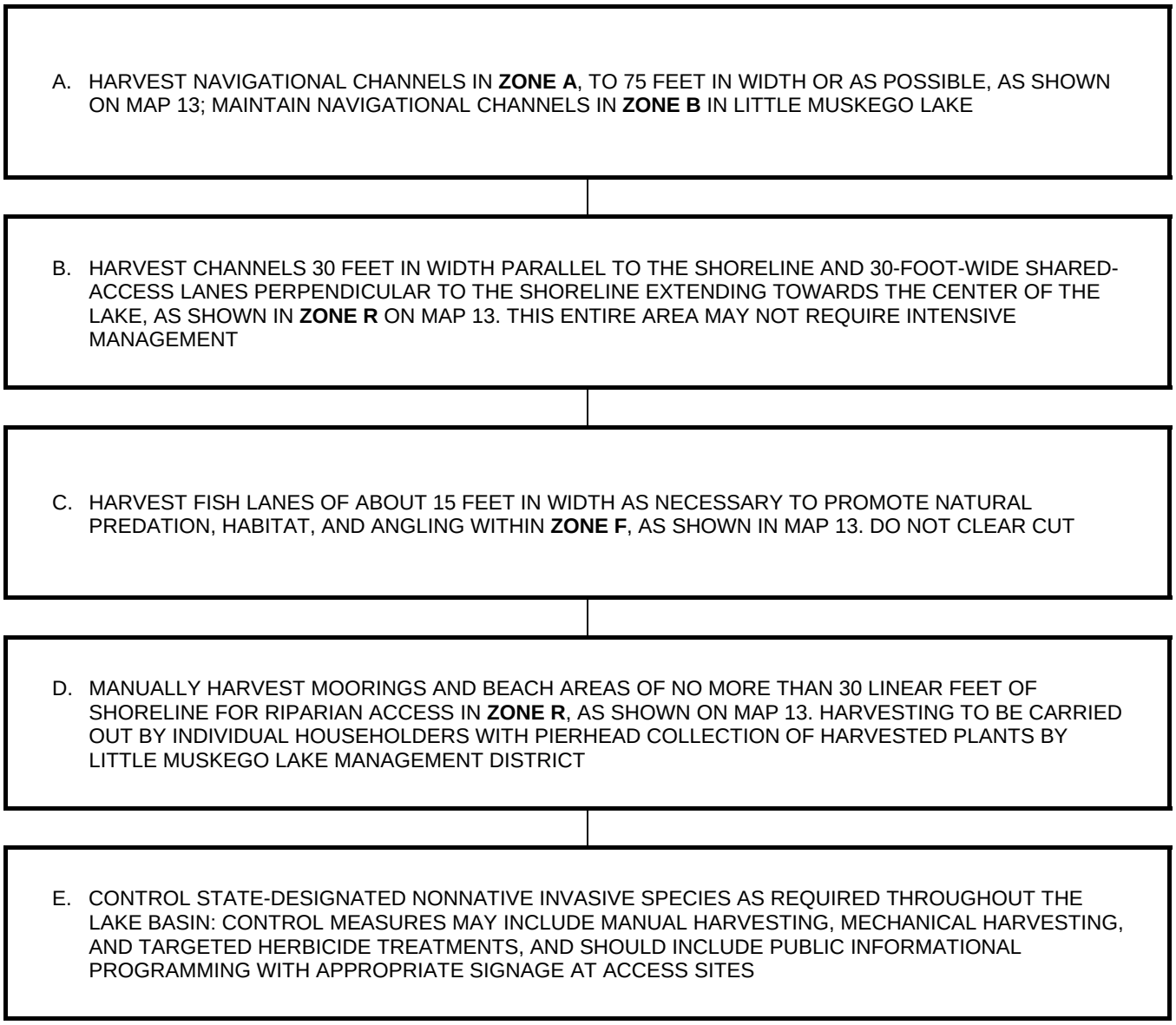
GRAPHIC SCALE

0 650 1300 FEET

Source: SEWRPC.

Figure 4

HARVESTING SEQUENCE FOR LITTLE MUSKEGO LAKE[a]



NOTE: Sequence A and B could be done concurrently in one area of the Lake as a time-saving measure.

[a]*No harvesting would be conducted in Zone H, within 100 feet of the island areas, or in Zone O, except as required for control of State-designated nonnative invasive species.*

Source: SEWRPC.

on Little Muskego Lake be included in the District's informational programming, along with information regarding the WDNR Clean Boats-Clean Waters Program and other outreach efforts of the District.

Water Quality Management

Water quality is one of the key parameters used to determine the overall health of a waterbody. The importance of good water quality can hardly be underestimated as it impacts nearly every facet of the natural balances and relationships that exist in a lake between the myriad of abiotic and biotic elements present. Because of the

importance water quality plays in the functioning of a lake ecosystem, careful monitoring of this lake water quality element represents a fundamental management tool. To this end, continued participation by the LMLPRD in the UWEX Citizen Lake Monitoring Network (CLMN; formerly the WDNR Self-Help Monitoring Program) is recommended. Volunteers enrolled in this program gather data at regular intervals on water clarity through the use of a Secchi disk. Because pollution tends to reduce water clarity, Secchi-disk measurements are generally considered one of the key parameters in determining the overall quality of a lake's water, as well as a lake's trophic status. Secchi disk measurement data are added to the WDNR-sponsored data base containing lake water quality information for many of the lakes in Wisconsin and is accessible on-line through the WDNR website. An expanded version of the CLMN monitoring program that involves collecting data on several key physical and chemical parameters in addition to the Secchi-disk measurements is available, and the LMLPRD should consider participation in this program. Under this program, samples of lake water are collected by volunteers at regular intervals and analyzed by the State Laboratory of Hygiene. Data collection is more extensive and, consequently, places more of a burden on volunteers.

The basic CLMN program is available to lake organizations at no charge, but does require volunteers to be committed to taking Secchi-disk measurements at regular intervals throughout the spring, summer, and fall. The expanded program requires additional commitment by volunteers to take a more extensive array of measurements and samples for analysis, also on a regular basis. As with any volunteer-collected data, despite the implementation of standardized field protocols, individual variations in levels of expertise, due to background and experiential differences, can lead to variations in data and measurements from lake-to-lake and from year-to-year for the same lake, especially when volunteer participation changes.

In addition to the volunteer-based program summarized above, the U.S. Geological Survey (USGS) offers an extensive water quality monitoring program under their Trophic State Index monitoring program. USGS field personnel conduct a series of approximately five monthly samplings beginning with the spring turnover. Samples are analyzed for an extensive array of physical and chemical parameters. The University of Wisconsin-Stevens Point (UW-SP) also offers several water quality sampling programs. Under these latter programs, volunteers collect water samples and send the samples to the UW-SP Water and Environmental Analysis Laboratory (WEAL) for analysis. Many communities in Southeastern Wisconsin supplement their volunteer water quality monitoring efforts through participation in these more extensive programs.

The UW-SP turnover sampling programs require only a once-per-year sampling, thereby requiring a smaller time commitment by the volunteers, but, there is a modest charge for the laboratory analysis and, because sampling is performed by volunteers, is subject to those variations identified above. Additionally, since samples need to be taken as closely as possible to the actual turnover period, which occurs only during a relatively short window of time, volunteers need to monitor lake conditions as closely as possible to be able to determine when the turnover period is occurring. In contrast, the USGS program does not require volunteer sampling. All sampling and analysis is provided by USGS personnel using standardized field techniques and protocols. As a result, a more standardized set of data and measurements may be expected. However, the cost of the USGS program is significantly higher than the UW-SP program, even with State cost-share availability under the Chapter NR 190 lake management planning grant program.

Data gathered as part of this program should be presented annually by the volunteers at meetings of the LMLPRD, where the citizen monitors could be given some recognition for their work. The information gained at first hand by the public from participation in this program can increase the credibility of the proposed changes in the nature and intensity of use to which the Lake is subjected.

Public Informational and Educational Programming

As part of the overall citizen informational and educational programming to be conducted in the Little Muskego Lake community, residents and visitors in the vicinity of the Lake should be made aware of the value of the ecologically significant areas in the overall structure and functioning of the ecosystems of the Lake. Specifically, informational programming related to the protection of ecologically valuable areas in and around the Lake should

focus on the need to minimize the spread of nuisance aquatic species, such as purple loosestrife and Eurasian water milfoil.

With respect to aquatic plants, distribution of posters and pamphlets, available from the UWEX and WDNR, that provide information and illustrations of aquatic plants, their importance in providing habitat and food resources in aquatic environments, and the need to control the spread of undesirable and nuisance plant species, is recommended. Currently, many lake residents often view all aquatic plants as "weeds" and residents often spend considerable time and money removing desirable plant species from a lake without considering their environmental impact. Inclusion of specific public informational and educational programming within the activities of the LMLPRD is recommended. These programs should focus on the value of, and the impacts of, these plants on water quality, fish, and on wildlife; and on alternative methods for controlling existing nuisance plants, including the positive and negative aspects of each method. These programs can be incorporated into the comprehensive informational and educational programs that also would include information on related topics, such as water quality, recreational use, and fisheries.

Educational and informational brochures and pamphlets, of interest to homeowners and supportive of the lake management program, are available from the UWEX, the WDNR, the Waukesha County Offices, and many Federal government agencies. These brochures could be provided to homeowners through local media, direct distribution, or targeted library/civic center displays. Alternately, they could be incorporated into the newsletters produced and distributed by the LMLPRD. Many of the ideas contained in these publications can be integrated into ongoing, larger-scale activities, such as anti-littering campaigns, recycling drives, and similar pro-environment activities.

Other informational programming offered by the WDNR, Waukesha County, and the UWEX, such as the Adopt-A-Lake program and Project WET (Water Education Training) curriculum, can contribute to an informed public, actively involved in the protection of ecologically valuable areas within the area tributary to Little Muskego Lake. Citizen monitoring and awareness of the positive value of native aquatic plant communities are important opportunities for public informational programming and participation that are recommended for the Lake. Where necessary, personal contacts with homeowners should be made, most likely through the Little Muskego Lake Association (LMLA).

Lake District and Lake Association Continuing Education

As part of their commitment to the effective managing of Little Muskego Lake, the LMLPRD Commissioners and LMLA board members should avail themselves of opportunities to learn about current developments and issues involving lake management. Numerous publications, writings, newsletters, seminars, and conventions are available through governmental, educational, and other organizations and agencies dealing with the subject of lake management. The UW-SP, UWEX, Wisconsin Association of Lakes (WAL), North American Lake Management Society (NALMS), and WDNR, all produce written material and conduct meetings and seminars dealing with lake management issues. Publications such as *Lake Tides*, published by the Wisconsin Lakes Partnership and available through UWEX, are also readily available and deal with a wide range of lake-related topics. Additionally, the statewide lakes convention, held annually in Green Bay, provides valuable opportunities to learn about important and timely developments in lake management and learn about lake issues from experts in their fields. Participation in activities that will further understanding of lake management issues is deemed an important part of the lake management experience.

SUMMARY

This plan, which documents the findings and recommendations of a study requested by the LMLPRD, examines existing and anticipated conditions, potential aquatic plant management problems, and recreational use problems on Little Muskego Lake. The plan sets forth recommended actions and management measures for the resolution of those problems. The recommended plan is summarized in Tables 16 and 17 and shown on Maps 12 and 13.

Little Muskego Lake has historically been considered a eutrophic lake with slightly below average water quality. However, water clarity measurements in recent years have indicated improved conditions more consistent with a mesotrophic classification. Preservation of environmental corridor lands, especially within the shoreland and nearshore areas situated immediately adjacent to the Lake, is recommended. Waukesha County, the City of Muskego, and LMLA, together with the LMLPRD, should support appropriate land management practices designed to reduce nonpoint source pollutant discharges in stormwater runoff into the Lake. Further, the City, LMLPRD, and LMLA should promote appropriate shoreline management practices, including the use of riprap and vegetative buffer strips, where applicable and appropriate. Guidance on the appropriate uses of these alternative shoreline protection structures is set forth in Chapter NR 328 of the *Wisconsin Administrative Code*, which includes a worksheet for determining the applicable energy level of a specific shoreline area.

The shoreland and aquatic plant management elements of this plan recommend actions be taken to reduce human impacts on ecologically valuable areas in and adjacent to the Lake, and to limit the spread of nonnative invasive plant species. The plan recommends continued reliance on aquatic plant harvesting as the primary aquatic plant management measure employed on Little Muskego Lake; periodic in-lake aquatic plant surveys; limited use of chemical herbicides, mainly to areas where nuisance levels of nonnative invasive species are present; manually harvesting aquatic plants around piers and docks, with subsequent removal of cut material from the Lake; and monitoring of invasive species populations. The plan also recommends the use of demarcated boating lanes to limit motorized boating traffic through macrophyte beds that contain Eurasian water milfoil (*Myriophyllum spicatum*) to attenuate the further proliferation of this plant.

The plan recommends continued participation in the UWEX CLMN volunteer water quality monitoring program with consideration to periodic USGS, or similar, comprehensive water quality surveys.

Finally, the recommended plan includes continuation of an ongoing program of public information and education, focusing on providing riparian residents and lake users with an improved understanding of the lake ecosystem. For example, additional options regarding household chemical usage, lawn and garden care, onsite sewage disposal system operation and maintenance, shoreland protection and maintenance, and recreational usage of the Lake should be made available to riparian property owners, thereby providing riparian residents with alternatives to traditional activities. Additionally, LMLPRD Commissioners and LMLA board members are encouraged to broaden their awareness and depth of understanding of current developments in the area of lake management through participation in meetings, seminars, conventions, and other lake management-related events and educational opportunities.

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APPENDICES

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Appendix A

ILLUSTRATIONS OF COMMON AQUATIC PLANTS FOUND IN LITTLE MUSKEGO LAKE

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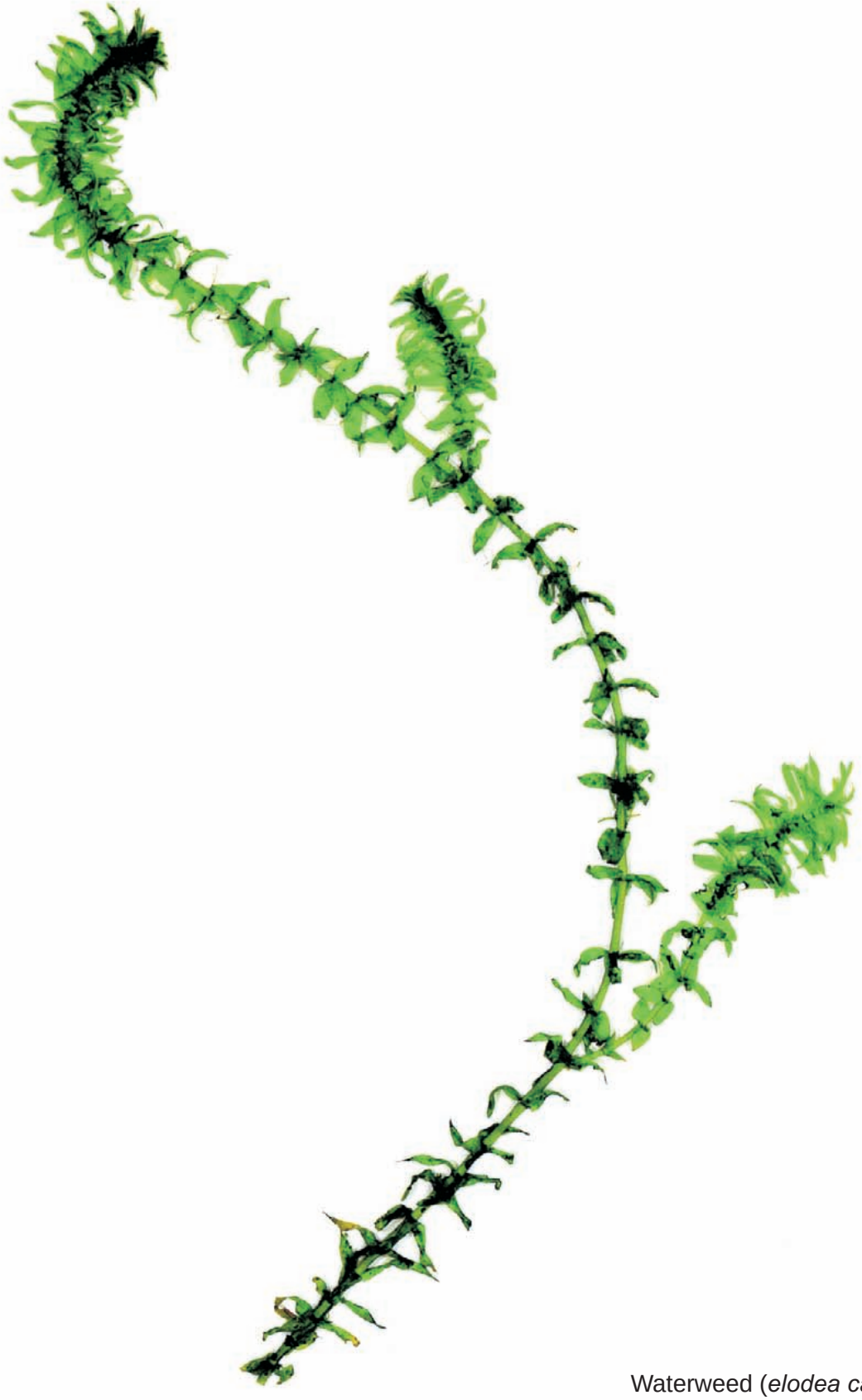
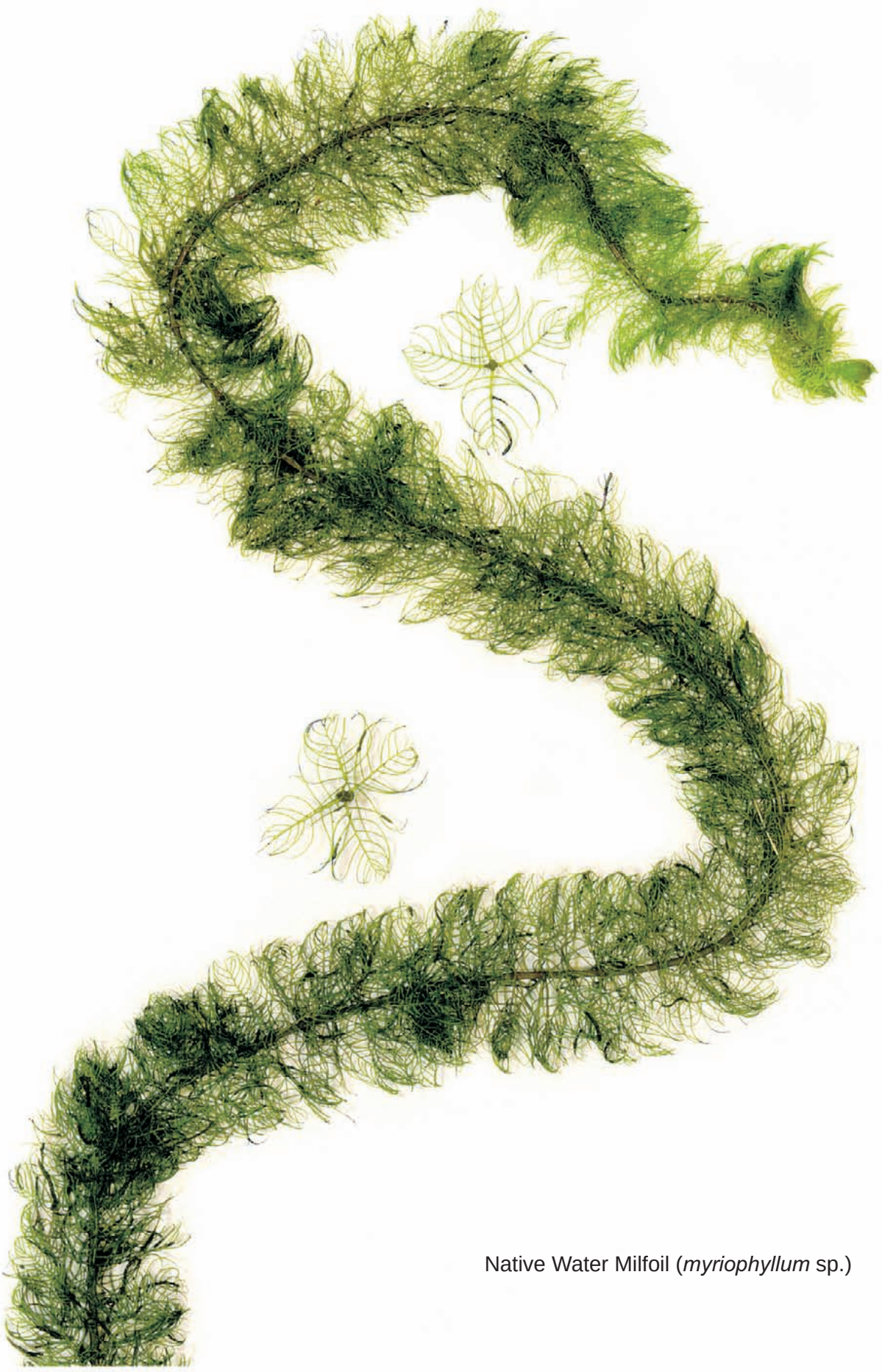
Coontail (*ceratophyllum demersum*)

Muskgrass (*chara vulgaris*)



Waterweed (*elodea canadensis*)



Native Water Milfoil (*myriophyllum* sp.)

Eurasian Water Milfoil (*myriophyllum spicatum*)
Exotic Species (nonnative)

Bushy Pondweed (*najas flexilis*)

Curly-Leaf Pondweed (*potamogeton crispus*)
Exotic Species (nonnative)

Leafy Pondweed (*potamofeton foliosus*)

Variable Pondweed (*potamogeton gramineus*)

Illinois Pondweed (*potamogeton illinoensis*)

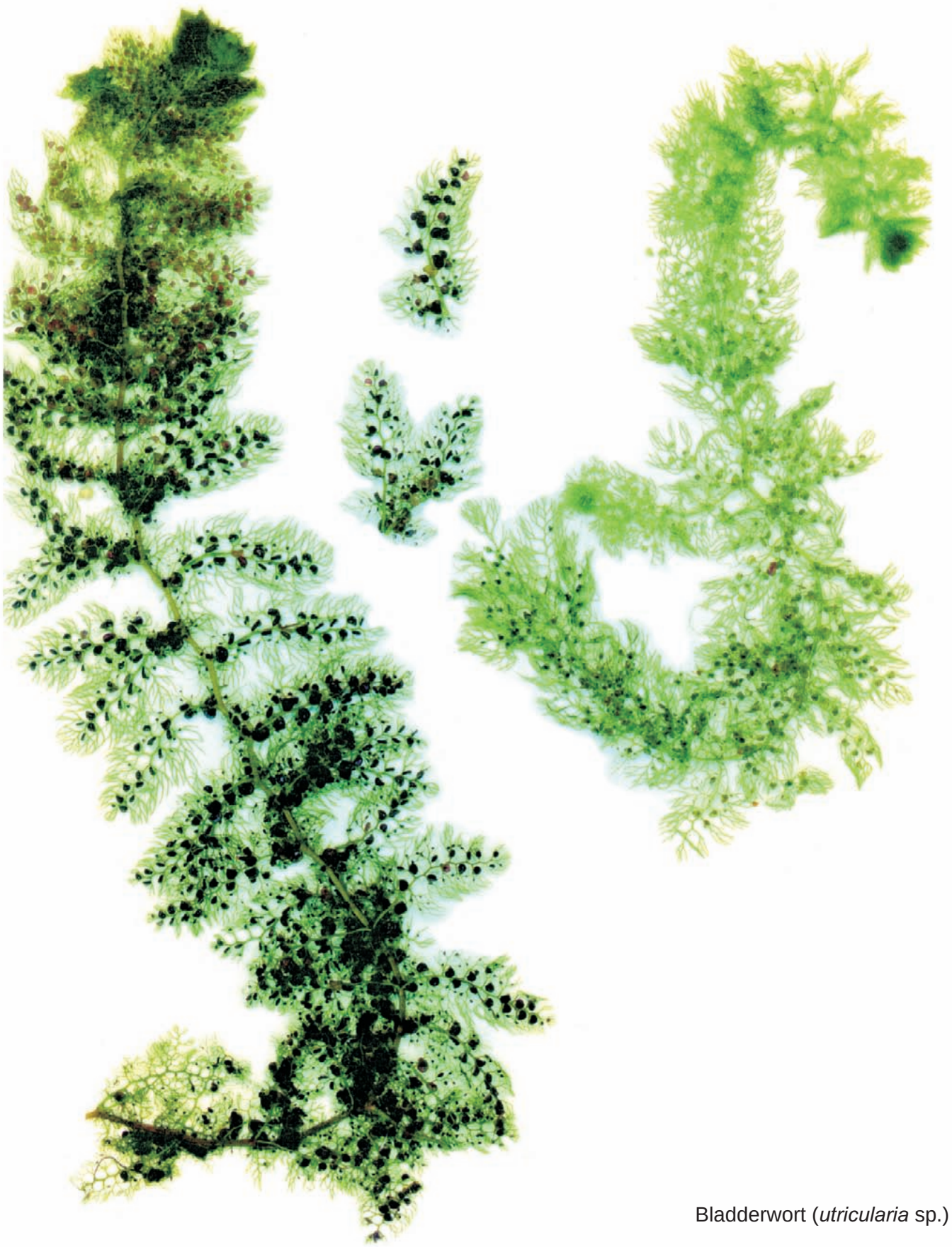
Sago Pondweed (*potamogeton pectinatus*)

Small Pondweed (*potamogeton pusillus*)

Clasping-Leaf Pondweed
(*potamogeton richardsonii*)

Flat-Stem Pondweed (*potamogeton zosteriformis*)

White Water Crowfoot (*ranunculus longirostris*)



Bladderwort (*utricularia* sp.)

Eel-Grass / Wild Celery (*valisneria americana*)

Water Stargrass (*zosterella dubia*)

Appendix B

CITY OF MUSKEGO RECREATIONAL BOATING ORDINANCES APPLICABLE TO LITTLE MUSKEGO LAKE

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CITY OF MUSKEGO
CHAPTER 20 - PUBLIC WATERS AND BEACHES

CITY OF MUSKEGO
CHAPTER 20 - PUBLIC WATERS AND BEACHES

20.01 STATE STATUTES ADOPTED

The statutory provisions describing and defining regulations with respect to boats and boating, and particularly Section 30.50 to 30.71, Wisconsin Statutes and any amendments thereto, exclusive of any provisions therein relating to the penalties to be imposed or the punishment for violation thereof, are hereby adopted. Any act required to be performed or prohibited by any such statute, which are incorporated herein by reference is required or prohibited by this section. (Ord. #725 - 5-12-92)

20.02 ADDITIONAL REGULATIONS - Motorboats. (Ord. #462 - 9-13-83)

(1) (2) and (4) are deleted. (Ord. #462 - 9-13-83)

(3) No person may operate a motorboat within 150 feet of any dock, pier, or buoyed restricted area at a speed in excess of slow-no-wake. (Ord. #983 - 04-13-99)

(5) Excessive Motor Noise. Motorboats shall not be continuously operated without the motor cover firmly secured.

(6) Mufflers. The engine of every motorboat propelled by an internal combustion engine shall be equipped with a muffler which is so constructed and kept in constant operation that it prevents excessive or unusual noise at all times while the engine is in operation. (Ord. #443 - 11-23-82)

20.025 LITTLE MUSKEGO LAKE - SPEED RESTRICTIONS. (Ord. #502 - 10-9-84)

No one shall operate a motorboat upon Little Muskego Lake between the hours of 8:30 P.M. and 8:00 A.M. at a speed in excess of slow-no-wake.

20.03 ADDITIONAL REGULATIONS - WATER SKIING (CR. #167)

(1) Whenever a boat is used for towing purposes, for water sports or otherwise, there shall be no less than 2 persons in the towing boat, one to operate the boat and one to be in charge of the tow line.

(2) When pulling a skier or another boat the tow rope shall not exceed 75 feet in length.

(3) Any person operating a boat or watercraft on Lake Denoon or Big Muskego Lake's Bass Bay which is towing a person or persons engaged in water skiing, aqua planing, or similar sport or activity must operate in a counterclockwise direction on the lake. A counterclockwise direction is determined by viewing the direction of travel of the boat or watercraft as viewed from a bird's-eye view of the entire lake. (Ord. #953 - 02/19/98)

20.04 EMERGENCY ASSISTANCE (Cr. #167)

When the operator of a boat observes the display on a boat or by a person with an orange flag approximately 18 by 30 inches, he shall render to the boat or person displaying the flag, such assistance as may be necessary to save the boat or persons, or to minimize the damages to them, in so far as is

possible to do so without serious danger to his own boat or the persons on board. No person shall display such a flag unless he is in need of assistance to prevent bodily injury or destruction of property.

20.05 WATER SKI JUMPS (Ord. #413 - 06-09-81)

(1) Permit Required. No person shall place or maintain or permit to be placed or maintained any so called "water ski jump" on any lake in the City without a permit from the Council. Such permit shall be for a period of not more than 6 months and shall state the limitations of use.

(2) Application. An application for a permit hereunder shall set forth the following:

(a) Name and address of the owner of the structure.
(b) A scale map of the location of the structure, drawn to a scale of not less than one inch to 200 feet.
(c) Proposed method of securing the structure.
(d) A description of the life and warning devices to be used which shall conform to the rules of the Wisconsin Department of Natural Resources and the U.S. Coast Guard.
(e) Length of time for which the permit is requested.
(f) A copy of a policy of public liability insurance applicable to the structure and its use in an amount of not less than $100,000.00.
(g) A proposed plan for safeguarding the area during jumps from 150 feet before the take off to 100 feet after the landing.
(h) The daylight hours during which the jump will be used.

(3) No person shall tow another person on water skis for the purpose of using a water ski jump which is in violation of this section.

(4) In granting such a license, the City expressly reserves the right to revoke any such license for any reason if it is felt by the City that said license is no longer in the best interest of the public.

(5) A permit fee of $10.00 shall be paid at the time of application. (Ord. #599 03-17-88)

20.06 RACES ON ICE

(1) License Required. No person shall sponsor, promote, participate or engage in any automobile or motorcycle race or other contest on the ice of any lake or other public waters located in the City of Muskego, unless said race or contest has first been specially licensed by the Council and the permit fee therefore as hereinafter provided, has been paid to the City of Muskego.

(2) Application. Application for such a license shall be made to the Council at least 20 days prior to the date on which said race or other contest is to be held. The application for such license shall state:

(a) The name of the person or organization promoting said race or contest;
(b) The type of race or contest and the number of vehicles to be involved;
(c) The names and addresses of the persons who will participate therein;
(d) The time and place of said race or contest;
(e) The number of persons who it is anticipated will attend said race of contest;
(f) The time at which said race or contest will conclude.

(3) License Fee. Each application for such permit shall be accompanied by cash or a certified check in the amount of $200.00, and if a license is granted, the minimum sum of $25 shall be retained

as and for the license fee and such an additional sums shall be retained as is necessary for the purposes stated in (4). (Ord. #523 - 04-09-85)

(4) Purposes of Section. The purpose of this section is to promote and protect the safety, health and welfare of the citizens of the City and persons attending such contest, and amount of license fee theretofore, provided is to be a reasonable sum for making an investigation as to the circumstances of the application to provide for necessary additional police protection and to clean up the area after the event. (Ord. #523 - 04-09-85)

20.07 OPERATION OF MOTOR VEHICLES ON ICE

(1) Operation prohibited on Bass Bay. No person shall use or operate any automobile or other motor driven vehicle in excess of 750 pounds gross vehicle weight upon the ice surface of that part of Big Muskego Lake known as Bass Bay, which is the Bay located at the Northwest end of said Big Muskego Lake.

(2) Operations Regulated. No person shall use or operate any automobile or other motor driven vehicle upon the ice surface of any lake or part thereof located in the City:

(a) In any manner so as to endanger persons engaged in skating or in any other winter sport or recreational activity being engaged in upon the ice.

(b) At a speed in excess of 10 miles per hour

(c) When more than 4 persons occupy said vehicle.

(d) To tow, pull or push any person or persons on sleds, skis, skates, toboggan or device or thing of any kind.

(e) Between the hours of 9:30 p.m. and 5:30 a.m. (Am #94)

(f) Unless the operator of the motor vehicle has a valid operator's license, if the motor vehicle is an automobile, truck, motorcycle or moped. (Ord. #597 - 03-03-88)

(3) Propeller driven vehicles prohibited. No person shall operate any propeller driven vehicle, device or thing, whether or not designed for the transporting of a person or persons upon the ice surface of any lake or part thereof located in the City.

(4) Definitions:

(a) The "automobile" as used in this section shall mean all motor vehicles of the type and kind permitted to be operated on the highways in the State of Wisconsin.

(b) "Motor Driven Vehicle", as used in this section, shall mean any kind of device or thing designed or utilized for propulsion or movement upon the ice using a motor, whether of internal combustion design or not.

(5) No City liability. All traffic on the ice-bound waters lying within the City shall be at the risk of the traveler as set forth in sec. 30.81(3), Wis. Stats., and nothing in this section shall be construed as rendering the enacting authority liable for any accident to those engaged in permitted traffic while this Code is in effect.

(6) Exceptions. Use of snowmobiles and all-terrain vehicles as defined by statutes of the State of Wisconsin, shall not be governed by this section. (Ord. #638 - 04-06-89)

20.08 SKIN DIVING (Ord. #417 - 01-26-82)

(1) No person may engage in underwater diving or swimming with the use of swimming fins or skin diving in waters other than marked swimming areas or within 150 feet of shoreline, and no person may engage in underwater diving or swimming with the use of self-contained underwater breathing apparatus in waters other than marked swimming areas, unless the location of such diving or swimming is distinctly marked by driver's flag, not less than 12 inches high and 15 inches long, displaying one diagonal white stripe 3 inches wide on a red background, and of height above the water so as to be clearly apparent at a distance of 100 yards under normal conditions, and so designed and displayed as to be visible from any point on the horizon. Except in case of emergency, anyone engaging in such diving or swimming shall not rise to the surface outside of a radius of 50 feet from such flag. No person engaged in such diving or swimming in established traffic lanes; nor shall any such person alone or with another, intentionally or unintentionally, block or obstruct any boat in any manner from proceeding to its destination where a reasonable alternative is unavailable. A reasonable alternative route is available when the otherwise unobstructed boat can proceed to its destination without reducing its lawful speed, by passing to the right or to the left of a marked diving operation.

(2) Swimming. When swimming without the use of self-contained underwater breathing apparatus, a suitable boat (motor or otherwise) shall accompany any person or persons swimming more than 150 feet from the shoreline or 75 feet from any anchored swimming raft on any waters within the City of Muskego, and upon adoption of an identical ordinance by the Town of Norway.

20.09 PERMITS REQUIRED FOR SWIMMING BEACHES.

(1) No person shall maintain a swimming beach which is open to the public upon payment of an entrance fee in the City without having first obtained a permit in writing therefore from the Council. Such permit, if issued, shall be for a period of not to exceed one year, and shall not be transferable or assignable.

(2) Before a permit will be issued, an application in writing must be filed with the City Clerk. Such application shall set forth in detail:

(a) The name and address of the owner of the property on which the commercial beach is to be operated.

(b) Length of time for which the permit is requested.

(c) The proposed plan for safeguarding the area during the hours of operation.

(d) The hours during which the commercial venture will be operated.

(3) No person shall operate a commercial beach unless the swimming area is distinctly and clearly marked off by buoys, and it is further required that during the hours that the beach is used by swimmers there shall be a lifeguard on duty who shall possess a Red Cross Life Saving Certificate or its equivalent and who shall be capable of rendering immediate assistance to persons in distress in the water. (Am. #167)

20.10 UNIFORM AIDS TO NAVIGATION: WATERWAY MARKERS. (Cr. #111)

(1) Definitions. A waterway marker is any device designed to be placed in, on or near any navigable water within the City, to convey an official message to a boat operator on matters which may affect health, safety or well-being. Aids to navigation refer to buoys, beacons and other fixed objects in the water which are used to mark obstructions to navigation or to direct navigation through safe channels.

(2) Waterway Markers Used On Waters Within The City. No waterway markers shall be placed in, on or near any navigable waters within the City, except such buoys or other markers as have been established by the Department of Natural Resources and the United States Coast Guard as uniform navigational aids. The rules and regulations of the Department of Natural Resources and the United States Coast Guard with respect to specifications, color schemes, lettering and marking requirements of waterway markers and aids to navigation shall be kept on file in the Office of the City Clerk. (Reference Wisconsin Administrative Code, Chapter WCD5, Boat Regulations and Registration)

(3) Display of Waterway Markers. No waterway marker shall be displayed, except in conformity with the requirements of the Department of Natural Resources. (Reference Wisconsin Administrative Code as per Section 2). The areas in Big Muskego Lake, Bass Bay, Little Muskego Lake, and Lake Denoon to be marked with regulatory markers requiring slow, no-wake speed shall be as from time to time established by Resolution of the Common Council. (Ord. #929 - 07-03-97)

(4) Authority To Place Markers: Permit Required.

(a) No person shall place any waterway marker or aid to navigation in any navigable waters within the City without a permit to do so issued by the Common Council. Application for a permit shall be made in duplicate on forms provided by the City and filed with the City Clerk. The application shall be set forth in detail:

1. The name and address of applicant.

2. Description of real estate of owner or occupant.

3. Type of marker requested.

4. A sketch showing proposed location of the markers.

(b) The application shall be accompanied by a permit fee as determined from time to time by the Common Council. The permit when authorized shall be issued by the City Clerk, and it shall not be transferable or assignable. The permit shall remain in effect unless surrendered by the applicant, or canceled or revoked by the Common Council for one year.

(5) Maintenance of Waterway Markers. Waterway markers shall be maintained in proper condition or be replaced or removed.

(6) Exemptions. The temporary placement of mooring buoys, race course markers and water ski course markers for special events may be reviewed and authorized by the Finance Committee on an annual basis. (Ord. #1067 - 05-03-2001)

20.11 ADDITIONAL REGULATIONS

The Common Council may from time to time adopt local regulations not contrary to or inconsistent with state statute relative to the equipment, use, or operation of boats, pursuant to Section 30.77(3) and (4) Statutes. Any regulations so adopted shall be promptly posted at all public access points within the jurisdiction of the City of Muskego and a copy thereof shall also be filed with the Department of Natural Resources. (Ord. #313; 6-8-76.)

20.12 NAMING OF PUBLIC WATERS (Ord. #979 - 02/18/99)

Note: Proposed names for public waters require approval of the Wisconsin Geographic Names Council in order to be recognized on maps outside the City.

(1) Requests to name or rename a creek, stream, river or lake shall be made in writing and brought before the Committee of the Whole for recommendation to the Common Council. The person(s) who submitted the request shall provide background information into the rationale behind the request, including biographical information if to be named after a person. Any letters from appropriate organizations and individuals which provide evidence of substantial local support for the proposal shall be submitted at that time. If the creek, stream, river or lake is included in a Lake Protection and Rehabilitation District, approval from the district must be obtained prior to the submittal of the request to the City. Upon approval of the Common Council, the proposed name change shall be submitted to the Wisconsin Geographic Names Council for approval. The Council meets every February to act on all requests.

(2) Once a public body of water is named after a person, the name of the public body of water cannot be changed for a period of one hundred years.

(3) All costs associated with the naming, including the cost of any recording necessary and the cost of signage shall be paid by the person(s) submitting the request. This cost may be waived by the Common Council.

20.13 PENALTIES (Ord. #979 - 02/18/99)

Wisconsin State boating penalties as found in Section 30.80 Wisconsin Statutes and deposits as established in the Uniform Deposit and Bail Schedule established by the Wisconsin Judicial Conference, are hereby adopted by reference with all references to fines amended to forfeitures and all references to imprisonment deleted. The penalty for violation of local regulations not contrary to or inconsistent with State Statute shall be as provided in Chapter 25 of the Municipal Code, unless a specific penalty for a specific ordinance or regulation contained in Chapter 20 or adopted pursuant thereto is adopted. (Ord. #942 - 08-21-97)

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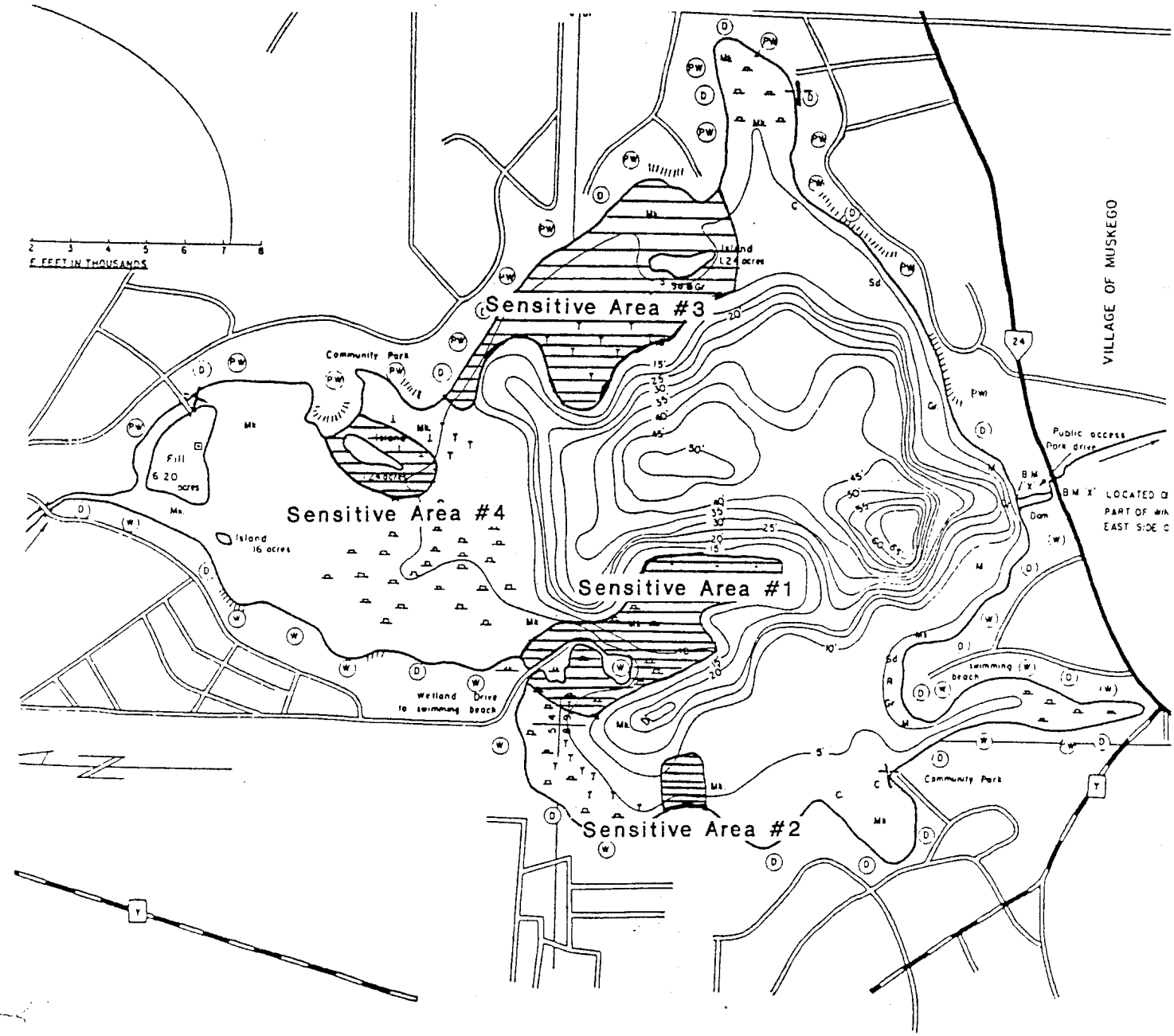
Appendix C

WISCONSIN DEPARTMENT OF NATURAL RESOURCES CHAPTER NR 107 SENSITIVE AREA DELINEATIONS APPLICABLE TO LITTLE MUSKEGO LAKE

Little Muskego Lake
Sensitive Areas



WISCONSIN
DEPT. OF NATURAL RESOURCES

Carroll D. Besadny
Secretary

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Southeast District
Post Office Box 12436
2300 N. Martin Luther King Jr. Drive
Milwaukee, Wisconsin 53212
TELEPHONE: 414-263-8500
TELEFAX #: 414-263-8434

AQUATIC PLANT MANAGEMENT
SENSITIVE AREA DESIGNATION FOR **AREA 1**
LITTLE MUSKEGO LAKE, WAUKESHA COUNTY, WISCONSIN

Date of Designation: July 15, 1992

Sensitive Area Site Description

Sensitive area 1 surrounds the entire peninsula on the western shore and has approximately 2500 feet of shoreline. It includes the shallow sand bar and extends lakeward to include all the lake within the 10 foot contour depth (see map). Substrate in area one is composed of rock and gravel (60%) and muck (40%).

A variety of plant species were identified within this sensitive area. The area currently supports narrow leaf pondweeds, chara, white water lily, cattails, and bulrush. Table 1 lists the aquatic plants found in sensitive area 1 and identifies the benefits each provides.

A portion of the shoreline adjacent to the sensitive area has been mapped and classified as an E2H wetland. This type of wetland is Emergent/Wet Meadow, Narrow-leaved persistent, Standing water, Palustrine. This wetland is regulated by the US Army Corps of Engineers and the City of Muskego.

Why is this area a sensitive area?

Following an inspection of Little Muskego Lake, Department of Natural Resources personnel concluded this area was particularly valuable to the water quality and biological integrity of the lake. Each biologist considered the qualities of this area unique and valuable for the following reasons:

Water Resource Manager Dan Helsel believes this area experiences greater water quality and clarity as a result of the aquatic vegetation. He also recognized the species richness and diversity of the area and considered these plants an excellent source for increasing their distribution. They are also a very good buffer against invasion by non-native species.

Department Fishery Biologist Randy Schumacher states this area "offered an outstanding diversity of all forms of habitat whether it be structure of vegetation, depth, substrate from rock and gravel to soft substrate." He adds, "it certainly is one of the most valuable areas on the lake for preservation of overall fish habitat and quality." Randy's final comment was, "There is no doubt in my mind we have picked out the areas on the lake that need to be preserved in something close their present state for maintenance and long-term water quality."

The aquatic plants in this sensitive area supply valuable wildlife habitat for waterfowl, songbirds, and furbearers. Wildlife Biologist Mark Anderson states he observed a "diverse supply of wildlife habitat." He adds "the littoral (shallow) areas ... offer feeding areas both on the vegetation and the invertebrates by waterfowl and feeding on the emerging insects by the song birds present."

The proximity of the adjacent wetland, quality of the aquatic vegetation, and value these plants provide warrants protection of the area. Little Muskego

The following **riparian activities** will be restricted as follows:

Wetland alterations are not allowed. Wetlands are protected under shoreland wetland ordinances.

Boardwalks are not allowed.

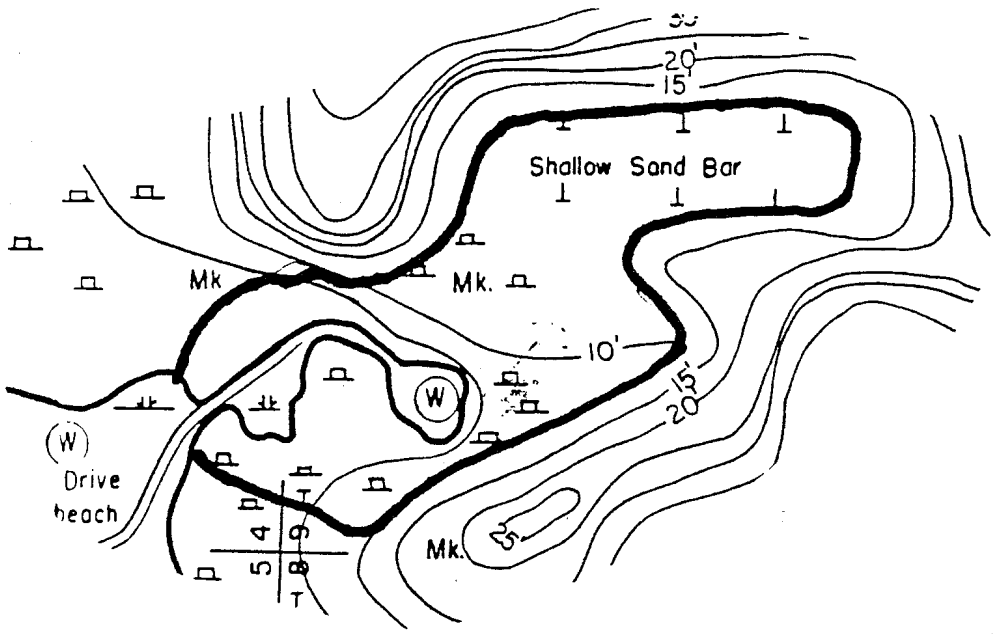
The protection of Little Muskego Lake will require cooperation and understanding by everyone that uses the lake. Positive actions today will help protect the lake for future generations. If you have any questions regarding the identification of Little Muskego Lake as a sensitive area or the management implications, please feel free to contact any one of the identification team members:

Mark Anderson, Wildlife Manager - (414)594-2135
Randy Schumacher, Fish Manager - (414)594-2135
Liesa Nesta, Water Regulation and Zoning - (414)263-8678
Dan Helsel, Water Resources Manager - (414)263-8714
Greg Borzick, Water Resources Specialist - (414)263-8586

Table 1. Aquatic Plants Found in Sensisitive Area 1.

Submergent Plants	
Flatstem Pondweed Potamogeton zosteriformis	Extremely valuable, provides cover for fish and supports insects for fish food excellent food source for waterfowl, stabilizes bottom sediment, characteristic of good water quality
Chara (Macroscopic Algae)	Supports insects for fish food, stabilizes bottom sediments, protects against invasion by exotics, usually low growing
Eurasian Water Milfoil (Myriophyllum spicatum)	Exotic species, limited value, waterfowl occasionally eat its seeds, stabilizes bottom sediments
Floating Plants	
White Water Lily Nymphaea	Provides shade and cover for panfish, largemouth bass, and northern pike, good food source for waterfowl, aesthetically pleasing
Emergent/Wetland Plants	
Cattails Typha	Provide cover for fish and spawning areas for northern pike, good food source for waterfowl and muskrat, stabilizes shoreline and protects against erosion
Bulrush Scirpus	

Little Muskego Lake
Sensitive Area #1



Critical and/or Unique Habitat:

Aquatic Plant Species

Submerged/Floating
- White waterlilies (30%)
- Flatstem pondweed (15%)
- Chara (macro-algae) (20%)
- Eurasian watermilfoil (30%)

Emergent (Shoreline)
Cattails (50%)
Bullrush (50%)

Valuable population of native species which provide an excellent source for increasing their distribution

Fish Spawning, Nursery and Feeding - critical mix of emergent/submergent aquatic plants. May be key area for maintaining healthy fish populations for entire lake especially northern pike

Wildlife - Unique area for waterfowl, heron, songbirds. Predominantly used as feeding and shelter area for waterfowl and shorebirds.

WISCONSIN
DEPT. OF NATURAL RESOURCES

Carroll D. Besadny
Secretary

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AQUATIC PLANT MANAGEMENT
SENSITIVE AREA DESIGNATION FOR **AREA 2**
LITTLE MUSKEGO LAKE, WAUKESHA COUNTY, WISCONSIN

Date of Designation: July 15, 1992

Sensitive Area Site Description

Sensitive area 2 is located on the western shore and has approximately 350 feet of shoreline. It extends perpendicular from the shore to approximately 10 feet of water (see map).

A healthy population of plants was identified within this sensitive area. The area currently supports narrow leaf pondweeds, large leaf pondweeds, and chara. Table 1 lists the aquatic plants found in sensitive area 2 and identifies the benefits each provides.

Why is this area a sensitive area?

Following an inspection of Little Muskego Lake, Department of Natural Resources personnel concluded this area was particularly valuable to the water quality and biological integrity of the lake. Each biologist considered the qualities of this area unique and valuable for the following reasons:

Water Resource Manager Dan Helsel witnessed increased water clarity in this area he believes is a result of the aquatic vegetation. Dan also noted the native species act as an very good buffer against invasion by non-native species. This area also harbors Richardson pondweed, a beneficial native aquatic plant and the only occurrence identified in Little Muskego Lake.

Department Fishery Biologist Randy Schumacher identified this area as outstanding habitat for a variety of fish. The area is very diverse and contains valuable spawning, nursery, and feeding areas. He states the area "has excellent structure for gamefish." Randy's final comment was, "There is no doubt in my mind we have picked out the areas on the lake that need to be preserved in something close their present state for maintenance and long-term water quality."

This aquatic plants in this sensitive area supply valuable wildlife habitat for waterfowl, songbirds, and furbearers. Wildlife Biologist Mark Anderson states he observed a "diverse supply of wildlife habitat." He adds "the littoral (shallow) areas ... offer feeding areas both on the vegetation and the invertebrates by waterfowl and feeding on the emerging insects by the song birds present."

The unique presence of Richardson Pondweed and the valuable qualities of the aquatic vegetation warrant protection of this area. Little Muskego Lake will benefit as a result of this sensitive area designation and subsequent aquatic plant protection.

How will the lake benefit from this area?

This sensitive area supports the only occurrence of Richardson pondweed in Little Muskego Lake. Richardson pondweed is a beneficial large leaf pondweed that is uncommon in southeastern Wisconsin. The area also supports a healthy

The following **riparian activities** will be restricted as follows:

Wetland alterations are not allowed. Wetlands are protected under shoreland wetland ordinances.

Boardwalks are not allowed.

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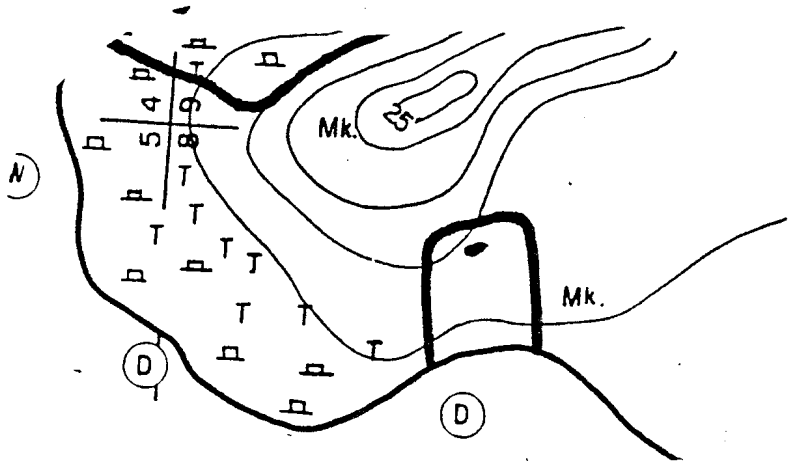
Table 1. Aquatic Plants Found in Sensitive Area 2.

Richardson Pondweed Potamogeton richardsonii	Uncommon and extremely valuable, provides cover for panfish, largemouth bass, and northern pike, supports insects for fish food, excellent food source for waterfowl, stabilizes bottom sediment
Chara (Macroscopic Algae)	Supports insects for fish food, stabilizes bottom sediments, protects against invasion by exotics, usually low growing
Eurasian Water Milfoil Myriophyllum spicatum	Exotic species, limited value, waterfowl occasionally eat its seeds, stabilizes bottom sediments

Little Muskego Lake
Sensitive Area #2



Critical and/or Unique Habitat:

Aquatic Plant Species

Submerged/Floating

- Flatstem pondweed (15%)
- Richards pondweed (15%)
- Chara (macro-algae) (55%)
- Eurasian watermilfoil (15%)

Only occurrence of Richards pondweed observed within the entire lake. Healthy population of Chara contributing to the low occurrence of Eurasian watermilfoil.

Fish Spawning, Nursery and Feeding - Low abundance of native submergent aquatic plants supplies critical habitat for spawning and nursery habitat for bass and panfish.

Wildlife - Pondweed provides a valuable food resource for waterfowl. Area observed to be used by tree swallows, cedar waxwings and woodducks.

WISCONSIN
DEPT. OF NATURAL RESOURCES

Carroll D. Besadny
Secretary

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

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AQUATIC PLANT MANAGEMENT
SENSITIVE AREA DESIGNATION FOR **AREA** 3
LITTLE MUSKEGO LAKE, WAUKESHA COUNTY, WISCONSIN

Date of Designation: July 15, 1992

Sensitive Area Site Description

Sensitive area 3 is located along the eastern shoreline and contains approximately 3000 feet of mainland shoreline. It begins at a point on the shore southeast of Holz island, extends around the 1.24 acre island, and continues north, following the 10 foot depth contour line to a point south of the community park (see map). Substrate is composed of gravel, sand, and muck.

A variety of plant species were identified within this sensitive area. The area currently supports narrow leaf pondweeds, chara, white lily pads, sedges, cattails, and bulrush. Table 1 lists the aquatic plants found in sensitive area 3 and identifies the benefits each provides.

A portion of the shoreline adjacent to the sensitive area has been mapped and classified as a wetland. This wetland is regulated by the US Army Corps of Engineers and the WDNR.

Why is this area a sensitive area?

Following an inspection of Little Muskego Lake, Department of Natural Resources personnel concluded this area was particularly valuable to the water quality and biological integrity of the lake. Each biologist considered the qualities of this area unique and valuable for the following reasons:

Water Resource Manager Dan Helsel suggests this area experiences greater water quality and clarity as a result of the aquatic vegetation. He recognized the species richness and diversity of the area and considered these plants an excellent source for increasing their distribution. He also noted they are an excellent buffer against invasion by non-native species.

Department Fishery Biologist Randy Schumacher notes this area "probably offers the best overall 'mix' of habitats for all important fish" He also noted that there was "plenty of feeding and living habitat. Loss of (aquatic vegetation) quality would significantly benefit carp and could lead to lakewide poor water quality." Randy's final comment was, "There is no doubt in my mind we have picked out the areas on the lake that need to be preserved in something close their present state for maintenance and long-term water quality."

This aquatic plants in this sensitive area supply valuable wildlife habitat for waterfowl, songbirds, and furbearers. Wildlife Biologist Mark Anderson states he observed a "diverse supply of wildlife habitat." He adds "the littoral (shallow) areas ... offer feeding areas both on the vegetation and the invertebrates by waterfowl and feeding on the emerging insects by the song birds present."

Management Restrictions

The following **in-lake activities** will be restricted as follows:

Aquatic plant screens are allowed along developed shorelines only. Reviewed on a case by case basis. WDNR permit required.

Piers and boardwalks allowed along developed shorelines only. Compliance with local pier ordinances and WDNR limits required.

Pea gravel and sand blankets allowed along developed shorelines only. Reviewed on a case by case basis. WDNR permit required.

Mechanical plant harvesting is not recommended.

Chemical control limited to the exotic species Eurasian Water Milfoil (Myriophyllum spicatum) and Curly-Leaf Pondweed (Potamogeton crispus) along developed shorelines only.

Dredging is not allowed.

Filling is not allowed.

The following **riparian activities** will be restricted as follows:

Boardwalks are allowed on island for educational purposes.

Wetland alterations are not allowed. Wetlands are protected under shoreland wetland ordinances.

The protection of Little Muskego Lake will require cooperation and understanding by everyone that uses the lake. Positive actions today will help protect the lake for future generations. If you have any questions regarding the identification of Little Muskego Lake as a sensitive area or the management implications, please feel free to contact any one of the identification team members listed below:

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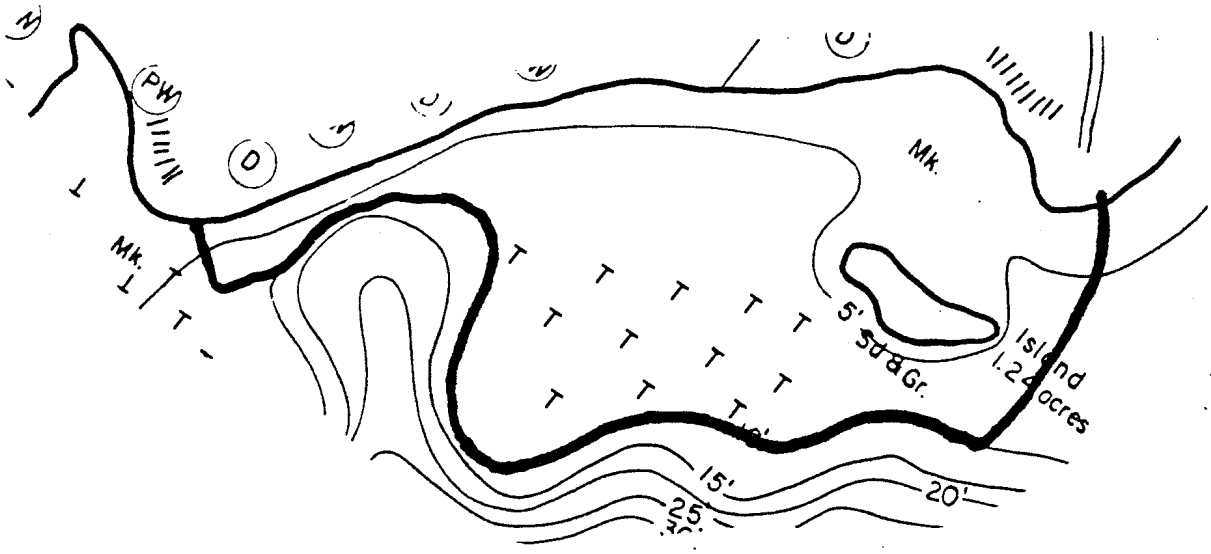
Little Muskego Lake
Sensitive Area #3



Critical and/or Unique Habitat:

Aquatic Plant Species

Submerged/Floating

- White waterlilies (20%)
- Flatstem pondweed (25%)
- Chara (macro-algae) (25%)
- Naiads (10%)
- Eel grass (10%)
- Eurasian watermilfoil (10%)

Emergent (Shoreline)
Bullrush (25%)
Cattail (25%)

Native aquatic plant species are dominant throughout area # 3 providing an excellent source for increasing their distribution in the lake. Water clarity was very good (greater than 6 feet).

Fish Spawning, Nursery and Feeding - The native aquatic plants and good water clarity of this area proivdes excellent feeding and shelter habitat for all species of fish. Loss of native vegetation/water clarity could detrimentally contributed to increased carp habitat.

Wildlife - Native pondweeds and waterliles provide unique habitat and valuable food resources for waterfowl, herons and a variety of songbirds. Island is important to both aquatic and terrestrial furbearers.

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AQUATIC PLANT MANAGEMENT
SENSITIVE AREA DESIGNATION FOR **AREA 4**
LITTLE MUSKEGO LAKE, WAUKESHA COUNTY, WISCONSIN

Date of Designation: July 15, 1992

Sensitive Area Site Description

Sensitive area 4 is located along the eastern shoreline and contains approximately 350 feet of mainland shoreline. It begins on the on the south side of the peninsula near the community park, extends around the 1.24 acre island, and continues north at a distance 300 feet from shore. The sensitive are ends at the tip of the peninsula (see map). The maximum water depth in sensitive area 4 is five feet, the average depth is three feet. The substrate is approximately 50% muck, 30% silt, 15% gravel, and 5% sand.

This area supports a three species of pondweeds. Table 1 lists the aquatic plants found in sensitive area 4 and identifies the benefits each provides.

A portion of the shoreline adjacent to the sensitive area has been mapped and classified as a wetland. This wetland is regulated by the US Army Corps of Engineers and the WDNR.

Why is this area a sensitive area?

Following an inspection of Little Muskego Lake, Department of Natural Resources personnel concluded this area was particularly valuable to the water quality and biological integrity of the lake. Each biologist considered the qualities of this area unique and valuable for the following reasons:

Water Resource Manager Dan Helsel believes this area has excellent location for native plant recolonization if left undisturbed. As seen in other areas of Little Muskego Lake, native plants would increase water quality and clarity and help maintain species diversity.

Department Fishery Biologist Randy Schumacher states this area, "offers adult habitat because it is relatively undisturbed (with the) trees and weed beds close to the island." Randy adds, "There is no doubt in my mind we have picked out the areas on the lake that need to be preserved in something close their present state for maintenance and long-term water quality."

The aquatic plants in this sensitive area supply valuable wildlife habitat for waterfowl, songbirds, and furbearers. Wildlife Biologist Mark Anderson states he observed a "diverse supply of wildlife habitat." He adds "the littoral (shallow) areas ... offer feeding areas both on the vegetation and the invertebrates by waterfowl and feeding on the emerging insects by the song birds present."

The proximity of the adjacent wetland, quality of the aquatic vegetation, and value these plants provide warrants protection of the area. Little Muskego Lake will benefit as a result of this sensitive area designation and subsequent aquatic plant protection.

Pea gravel and sand blankets allowed along developed shorelines only. Reviewed on a case by case basis. WDNR permit required.

Mechanical plant harvesting is not recommended outside 50 feet from the shoreline.

Chemical control limited to the exotic species Eurasian Water Milfoil (Myriophyllum spicatum) and Curly-Leaf Pondweed (Potamogeton crispus) along developed shorelines only.

Dredging is not allowed.

Filling is not allowed.

The following **riparian activities** will be restricted as follows:

Boardwalks are allowed on island for educational purposes.

Wetland alterations are not allowed. Wetlands are protected under shoreland wetland ordinances.

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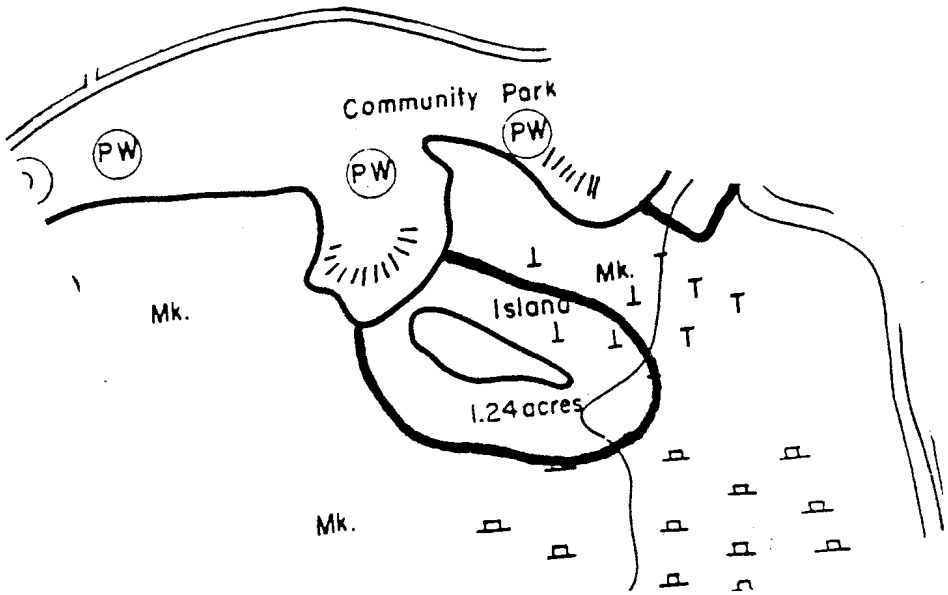
Table 1. Aquatic Plants Found in Sensitive Area 4.

Submergent Plants

Flatstem Pondweed Potamogeton zosteriformis	Very valuable, provides cover for bluegill and largemouth bass, supports insects for fish food, provides food source for waterfowl, stabilizes bottom sediment
Coontail Ceratophyllum demersum	Very valuable, provides cover for young bluegill and largemouth bass, northern pike, and walleye, supports insects for fish food, provides food source for waterfowl
Eurasian Water Milfoil Myriophyllum spicatum	Exotic species, limited value, waterfowl occasionally eat its seeds, stabilizes bottom sediments

Little Muskego Lake
Sensitive Area #4



Critical and/or Unique Habitat:

Aquatic Plant Species
Submerged/Floating

- Coontail (25%)
- Flatstem pondweed (50%)
- Eurasian watermilfoil (25%)

Establishment of a healthy bed of aquatic plants in this location of the lake will help trap sediments entering the lake from the inlet (erosion control). Recolonization by native species should be promoted within this area.

Fish Spawning, Nursery and Feeding - The area provides some spawning habitat for northern and bass species. Predominantly this area provides a nursery and feeding habitat for all gamefish.

Wildlife - One of the critical habitat areas in the northern portion of the lake for wildlife. A number of species were observed to be utilizing the shoreline resource of this area including three kingfishers, tree swallows, mallards, and four great blue herons.