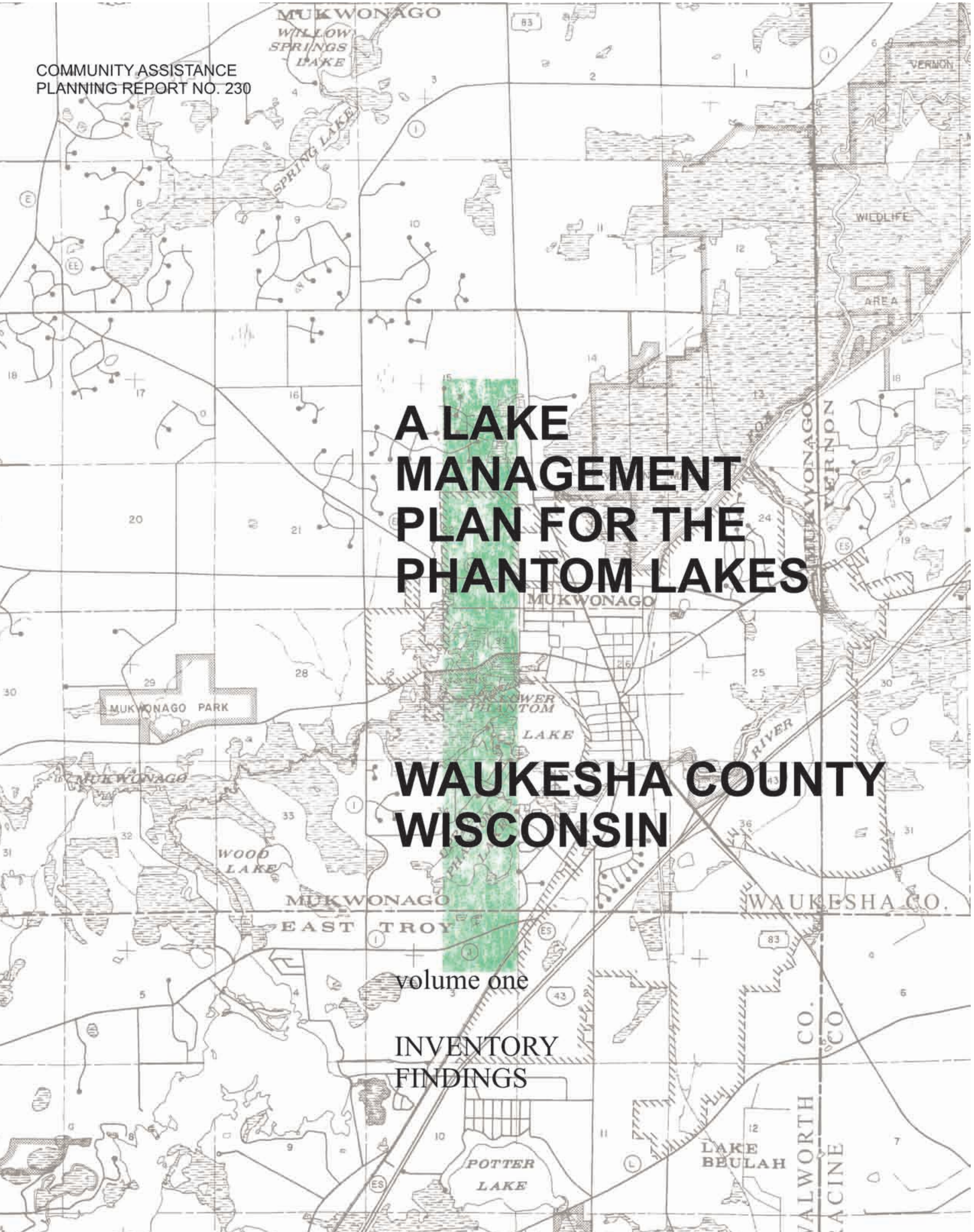
COMMUNITY ASSISTANCE
PLANNING REPORT NO. 230

A LAKE MANAGEMENT PLAN FOR THE PHANTOM LAKES

WAUKESHA COUNTY WISCONSIN

volume one

INVENTORY
FINDINGS



SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

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WAUKESHA COUNTY, WISCONSIN

Volume One

INVENTORY FINDINGS

Prepared by the

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

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Chapter I

INTRODUCTION

The Phantom Lakes are comprised of two connected waterbodies, Upper Phantom Lake and Lower Phantom Lake. Both lakes are located entirely within U.S. Public Land Survey Township 5 North, Range 18 East, Sections 26, 27, 34 and 35, Town and Village of Mukwonago, in Waukesha County. Upper Phantom Lake is a 107-acre drained lake connected by a narrow waterway to Lower Phantom Lake, a 433-acre through-flow lake located along the Mukwonago River. The Lakes, while exhibiting distinctly contrasting hydrographical characteristics, both offer a variety of water-based recreational opportunities and are the focus of the lake-oriented communities surrounding the Lakes. Proper management of the 52,170-acre total drainage area tributary to the Phantom Lakes will be required in order to maintain the Lakes as valuable recreational resources to the residents of the County and of the Region of which the County is an integral part.

In July, 1993, the Southeastern Wisconsin Regional Planning Commission, in conjunction with the Phantom Lakes Management District, published an aquatic plant management plan for the Phantom Lakes. This plan summarized the physical, chemical, and biological characteristics of the Lake, together with pertinent related characteristics of the tributary drainage area, as well as the feasibility of various alternatives and recommendations for aquatic plant management.[1] This plan continues to form the basis for lake management activities undertaken by the Phantom Lakes Management District and the local units of government within the drainage area tributary to the Lakes.

Continuing changes within both the direct and total drainage areas tributary to the Phantom Lakes have created a range of current concerns among this lake-centered community. Consequently, the Phantom Lakes Management District requested the Southeastern Wisconsin Regional Planning Commission to provide planning assistance in the development of a comprehensive lake management plan for the Lakes. This plan refines and extends the aforereferenced aquatic plant management plan, and forms a logical complement to the 1993 report. This plan documents lake management actions that have been implemented subsequent to the adopted aquatic plant management plan in and around the Phantom Lakes, and represents an ongoing commitment by the Phantom Lakes Management District to sound environmental planning.

This lake management plan was prepared by the Regional Planning Commission in cooperation with the Phantom Lakes Management District, and other agencies, organizations and governmental units as appropriate. It incorporates the data and analyses developed in the aforementioned lake management-related studies. In addition, this plan also incorporates pertinent water quality data collected by the Wisconsin Department of Natural Resources. This report addresses specific concerns expressed by residents and presents feasible alternative in-lake

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[1]*SEWRPC Memorandum Report No. 81,* An Aquatic Plant Management Plan for the Phantom Lakes, Waukesha County, Wisconsin, *July 1993*.

measures for enhancing the water quality conditions and for providing opportunities for the safe and enjoyable use of the Lakes. More specifically, this plan describes the physical, chemical, and biological characteristics of the Lake and pertinent related characteristics of the tributary watershed, as well as the feasibility of various watershed and in-lake management measures which may be applied to enhance the water quality conditions, biological communities, and recreational opportunities of the Lakes.

The primary management objectives for the Phantom Lakes include: 1) providing water quality suitable for the maintenance of fish and other aquatic life, 2) reducing the severity of existing nuisance problems resulting from excessive macrophyte and algal growths and limited water clarity which constrain or preclude intended water uses, and 3) improving opportunities for water based recreational activities. The lake management plan herein presented should constitute a practical guide for the management of the water quality of the Phantom Lakes and for the management of the land surfaces which drain directly to these important bodies of water. This plan conforms to the requirements and standards set forth in the relevant *Wisconsin Administrative Code*s.[2]

The plan is presented in two volumes. Volume One sets forth the inventory data used as the basis for reviewing the alternative lake management measures and developing the recommended management measures set forth in Volume Two. The inventory data include an overview of the Lakes and their watersheds, a review of the governance structures currently in place surrounding the Lakes, a summary of their water quality, a summary of their biology, and a review of the water use objectives established for the Phantom Lakes. Volume Two sets forth alternative lake and watershed management measures considered for application to the management of the Phantom Lakes, and identifies a subset of these measures recommended for use to address current and forecast future lake management issues relevant to Upper and Lower Phantom Lakes.

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[2]*This plan has been prepared pursuant to the standards and requirements set forth in four 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 & Mechanical Control Regulations."*

Chapter II

PHYSICAL DESCRIPTION

INTRODUCTION

The physical characteristics of a lake and its watershed are important factors in any evaluation of existing and likely future water quality conditions and lake uses, including recreational uses. Characteristics, such as watershed topography, lake morphometry, and local hydrology, ultimately influence water quality conditions and the composition of plant and fish communities within the lake. Therefore, these characteristics must be considered during the lake management planning process. Accordingly, this chapter provides pertinent information on the physical characteristics of the Phantom Lakes, their watersheds, and on the climate and hydrology of the drainage areas tributary to the Phantom Lakes. Subsequent chapters deal with the land use conditions, and the chemical and biological environments of the Lakes.

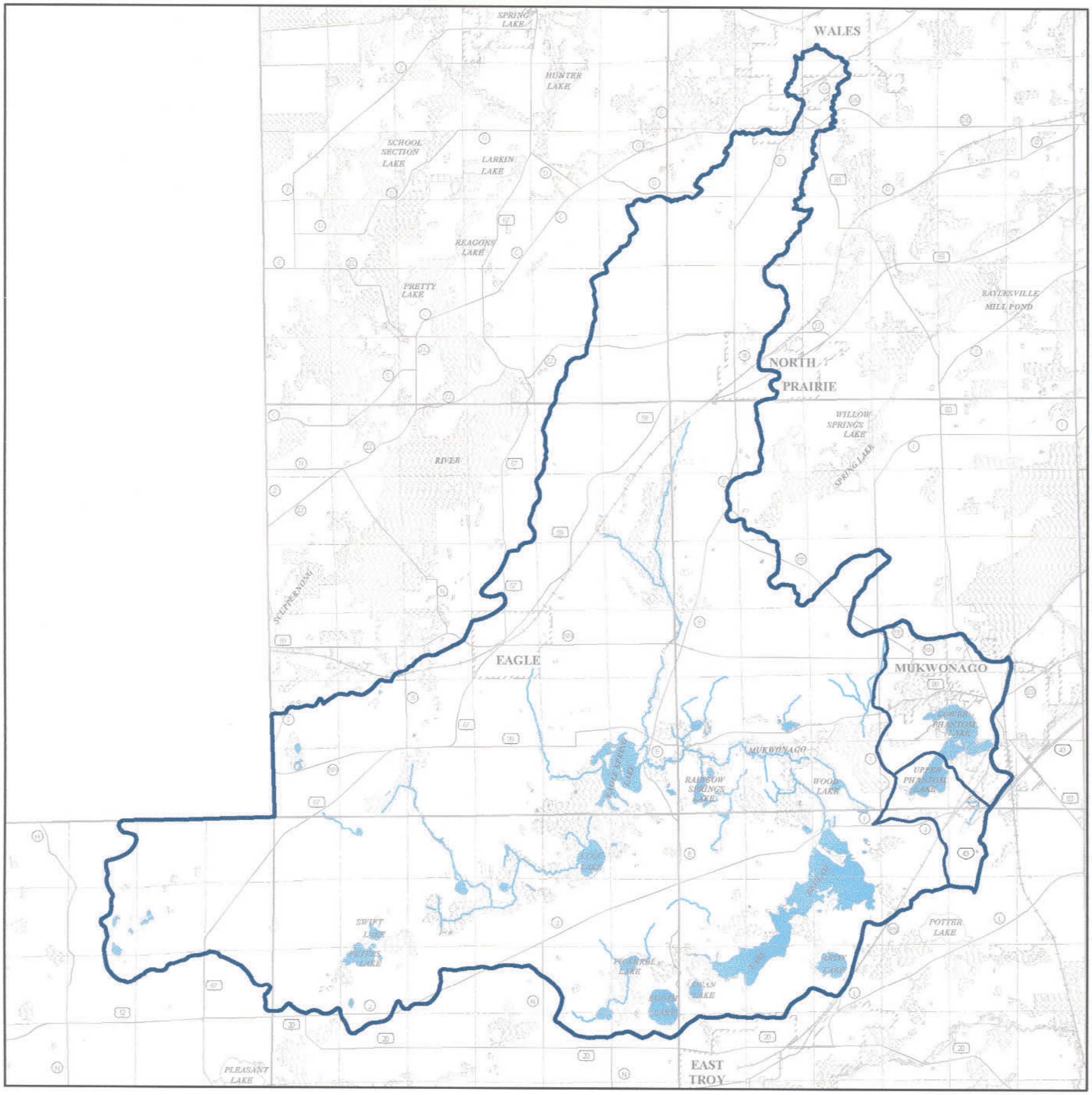
WATERBODY CHARACTERISTICS

The Phantom Lakes are located in the Town and Village of Mukwonago, in Waukesha County. The entire drainage area tributary to the Phantom Lakes extends into the Towns of Eagle, East Troy, Genesee, LaGrange, Mukwonago, Ottawa, and Troy, and the Villages of Eagle, East Troy, Mukwonago, North Prairie, and Wales, as shown on Map 1. Upper Phantom Lake is a drained lake which depends principally on precipitation falling directly on the Lake's surface and on groundwater flowing into the lake from inside and outside the immediate surface drainage area for its source of water. Upper Phantom Lake does have an outlet, in this case a navigable narrows at the northeastern end of the Lake, which flows into Lower Phantom Lake, a through-flow lake situated along the Mukwonago River. The Mukwonago River provides the principal inflow and outflow to Lower Phantom Lake, which also receives water from Upper Phantom Lake. A significant wetland area occupies most of the western half of the Lower Phantom Lake's shoreline, starting from about midpoint on the northern shore around the west to a comparable location on the southwestern shore. Lower Phantom Lake is the third Lake in a chain of three lakes located along the mainstem of the Mukwonago River, Lulu Lake, and Eagle Spring Lake being upstream waterbodies also located on the Mukwonago River. In addition, the Mukwonago River upstream of Lower Phantom Lake receives inflow from several tributary streams, including Jericho Creek and the Lake Beulah Outlet.

Both Lakes are served by numerous access points, many with parking. Most of the lake access points are owned and maintained by either the Town or the Village of Mukwonago, with a few being owned and maintained commercially. There is a Wisconsin Department of Natural Resources fishing pier located on Lower Phantom Lake, adjacent to the public recreational boating access point, within a Village park. The Lakes have adequate public recreational boating access pursuant to Chapter NR 1 of the *Wisconsin Administrative Code*, and provide a range of complementary recreational services to the lake-oriented municipalities and wider community.

Map 1

LOCATION OF UPPER AND LOWER PHANTOM LAKES



Surface Water

Source: SEWRPC.

0 1 2 3 4 Miles

Upper Phantom Lake has a surface area of 107 acres, with a maximum depth of 29 feet and a mean depth of about 11 feet. Approximately 8 percent of the Lake area is less than three feet deep and about 12 percent of the Lake has a water depth of more than 20 feet. Upper Phantom Lake is approximately 0.7 mile long and 0.4 mile wide at its widest point. The major axis of the Lake lies in a northeasterly-southwesterly direction. The Lake shoreline is two miles long, with a shoreline development factor of 1.3, indicating that the Lake is roughly circular in aspect, its shoreline being about 1.3 times longer than that of a circular lake of the same area. Upper Phantom Lake has a total volume of approximately 1,154 acre-feet. The hydrographical and morphometric data for Upper Phantom Lake is presented in Table 1 and the bathymetry of the Lake is shown on Map 2.

Lower Phantom Lake has a surface area of 433 acres, with about 79 percent of the Lake less than five feet deep. The Lake has a maximum depth of 12 feet and a mean depth of about four feet. Lower Phantom Lake is approximately 1.7 miles long and 0.8 mile wide at its widest point. The major axis of the Lake lies in an east-west direction. The Lake has a total volume of about 1,555 acre-feet, and a shoreline length of 5.6 miles. The shoreline development factor of 1.9 suggests that the Lake is irregularly shaped, with a shoreline length of approximately two times that of a circle of the same area. As noted, Lower Phantom Lake is a river-run lake that receives inflows from Upper Phantom Lake as well as the Mukwonago River. The hydrographical and morphometric data for Lower Phantom Lake is presented in Table 1 and the bathymetry of the Lake is shown in Map 2.

More than 80 percent of the shoreline of Upper Phantom Lake is developed for residential uses; about one-half of Lower Phantom Lake is similarly developed. The lesser degree of urban residential development on the shores of Lower Phantom Lake reflects the presence of the extensive wetland systems that fringe portions of this Lake basin. Given its greater shoreline length, shoreline erosion around the lakeshore is a potential concern in Lower Phantom Lake. Such concern, however, is not limited to Lower Phantom Lake, but extends to the shoreline of Upper Phantom Lake, portions of which are steeply sloping to the water’s edge. Erosion of shorelines results in the loss of land, damage to shoreline infrastructure, and interference with recreational access and lake use. Such erosion is usually caused by wind-wave erosion, ice movement, and motorized boat traffic. A survey of the Phantom Lakes shorelines, conducted by Regional Planning Commission staff, identified existing shoreline protection structures around Upper Phantom Lake and Lower Phantom Lake, as shown on Map 3. Most were in a good state of repair. More than half of the developed shoreland had some form of shoreline protection in 2004. However, improperly installed and failing shoreline protection structures, and the erosion of natural shorelines on the Phantom Lakes, are limited causes for concern.

Silt and muck are the predominant lake bottom materials. It is likely that some of this accumulation is comprised of organic materials from decomposed terrestrial leaf litter and decayed aquatic vegetation, with a contribution of inorganic materials likely to be comprised primarily of calcium carbonate (marl) deposited as a consequence of groundwater inflow into the Lakes. Marl deposition is especially likely in Upper Phantom Lake as groundwater inflows form a significant contribution to the water balance in this waterbody, as described further below. Other bottom sediment types primarily along the shoreline consist of combinations of silt and sand, attesting to the glacial heritage of these Lakes.

WATERSHED CHARACTERISTICS

The total drainage area tributary to the Phantom Lakes is about 52,170 acres, or about 80 square miles, in areal extent, as shown on Map 1. The portion of this total drainage area that is directly tributary to Upper Phantom Lake is approximately 1,020 acres in areal extent. Consequently, Upper Phantom Lake has a watershed-to-lake surface area ratio of about 10:1. The balance of the total drainage area is comprised of the Mukwonago River watershed draining to Lower Phantom Lake. The watershed-to-lake surface area ratio for Lower Phantom Lake is approximately 115:1, excluding the portion of the watershed draining to Upper Phantom Lake. Inclusive of this additional watershed area, the watershed-to-lake surface area ratio for Lower Phantom Lake increases to about 120:1. These ratios are typical of river-run drainage lakes.

Table 1

HYDROLOGY AND MORPHOMETRY OF THE PHANTOM LAKES

Parameter	Upper Phantom Measurements	Lower Phantom Measurements
Size (total)		
Total Surface Area	107 acres	433 acres
Total Drainage Area	1,020 acres	52,170 acres
Direct Drainage Area	1,020 acres	2,262 acres
Volume (total)	1,154 acre-feet	1,555 acre-feet
Residence Time[a]	361 days	13 days
Shape		
Maximum Length of Lake	0.7 miles	1.7 miles
Length of Shoreline	2 miles	5.6 miles
Maximum Width of Lake	0.4 miles	0.8 miles
Shoreline Development Factor[b]	1.3	1.9
Depth		
Percentage of Surface Area of Lake		
Less than Three Feet	8.1 percent	79 percent
Greater than 20 Feet	12.2 percent	0 percent
Mean Depth	11 feet	4 feet
Maximum Depth	29 feet	12 feet

[a]*Residence Time: Time required for a volume equivalent to the full volume of the Lake to flow into the Lake.*

[b]*Shoreline Development Factor: Ratio of shoreline length to that of a circular lake of the same area.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

As noted above, Upper Phantom Lake is a drained lake with a single outlet that connects Upper Phantom Lake to Lower Phantom Lake. Lower Phantom Lake is a through-flow lake, having both a defined inflow and outflow formed by the Mukwonago River. Inflow to Lower Phantom Lake from the Mukwonago River enters at the western end of the Lake, near County Trunk Highway (CTH I), and outflow from the Lake drains to the Mukwonago River at the eastern end of the Lower Phantom Lake in the vicinity of CTH ES in the Village of Mukwonago. The Mukwonago River joins the Fox River at a point in Waukesha County about two miles downstream from the confluence with the lake outlet.

SOIL TYPES AND CONDITIONS

Soil type, land slope, and land use are among the more important factors determining lake water quality conditions. Soil type, land slope, and vegetative cover are also important factors affecting the rate, amount, and quality of stormwater runoff. Soil texture and soil particle structure influence the permeability, infiltration rate, and erodibility of soils. Land slopes are important determinants of stormwater runoff rates and of the susceptibility of soils to erosion. The erosivity of the runoff can be moderated or modified by vegetation. Soil types and land slope are discussed immediately below; land use is discussed in Chapter III of this report.

The U.S. Natural Resources Conservation Service, formerly the U.S. Soil Conservation Service, under contract to the Southeastern Wisconsin Regional Planning Commission, completed a detailed soil survey of the Phantom Lakes area in 1966.[1] The soil survey contained interpretations for planning and engineering applications, as well as for agricultural applications. Using the regional soil survey, an assessment was made of hydrologic characteristics of the soils in the drainage area of the Phantom Lakes. Soils within the Phantom Lakes watershed can be categorized into four main hydrologic groups. These classifications are presented in Table 2 for the drainage area tributary to Upper Phantom Lake, and in Table 3 for Lower Phantom Lake for the Mukwonago River drainage area. Soils that could not be categorized were included in an "other" group.

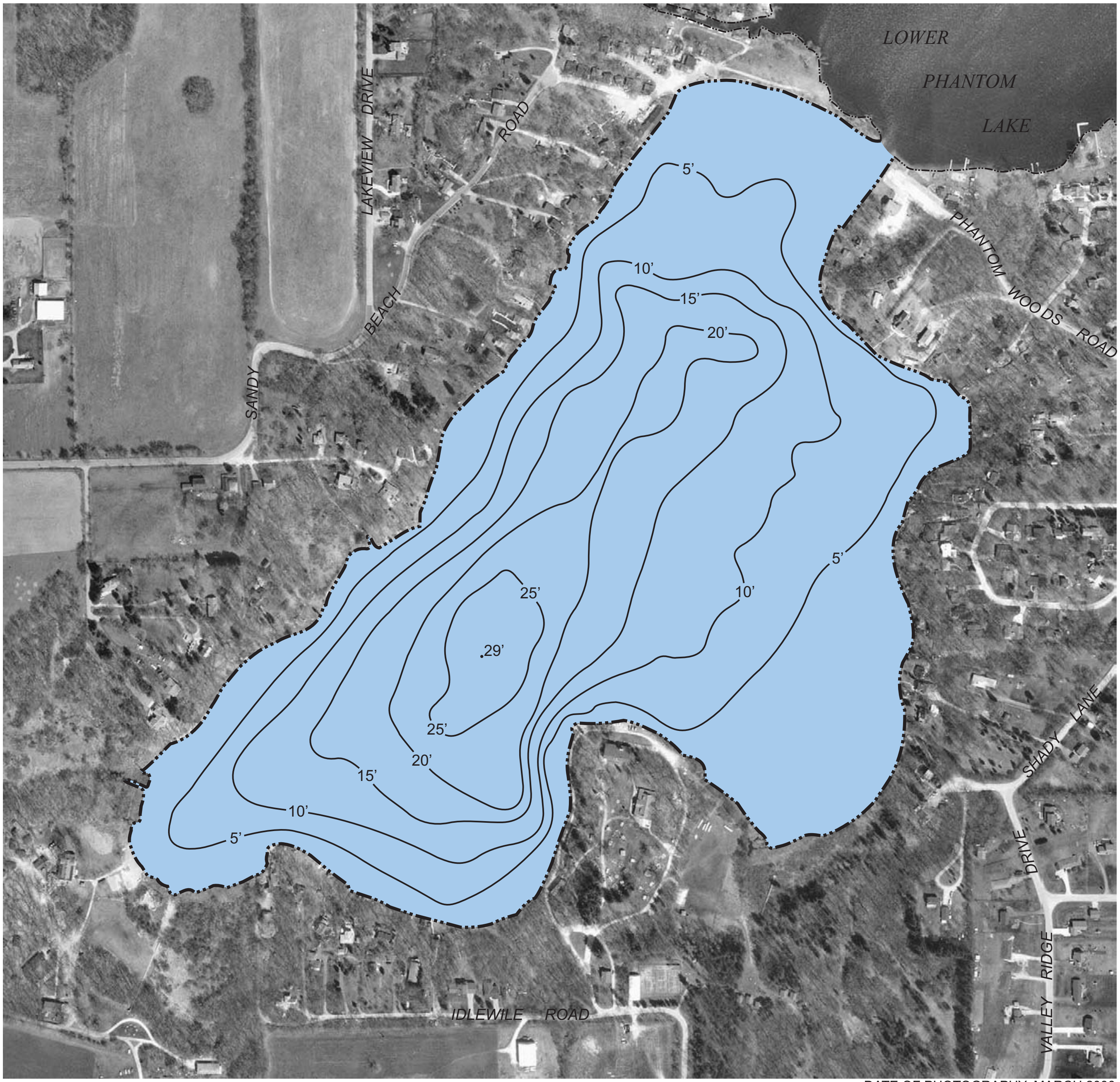
More than three-quarters of the drainage area tributary to Upper Phantom Lake is covered by moderately well drained soils. These soils reflect the glacial history of the lands surrounding Upper Phantom Lake. Moderately well-drained soils are suitable for most economic purposes. More than three-quarters of the drainage area tributary to Lower Phantom Lake, situated at the lower end of the extensive Mukwonago River drainage area, is comprised of moderately well drained soils. Within the portion of the drainage area that is directly tributary to Lower Phantom Lake, about two-thirds of the area is comprised of moderately well drained soils. The areal extent of these soils and their locations within the watershed for the Phantom Lakes are shown on Map 4.

The major soil associations within the tributary drainage area for the Phantom Lakes include: the Houghton-Palms-Adrian association of very poorly drained organic soils situated in the region along the Mukwonago River immediately upstream of its inlet to Lower Phantom Lake, the Fox-Casco association of well drained soils located in the drainage areas directly tributary to the Phantom Lakes, the Warsaw-Lorenzo association of well drained

[1]*SEWRPC Planning Report No. 8,* Soils of Southeastern Wisconsin, *June 1966.*

Map 2

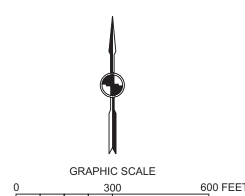
BATHYMETRIC MAP OF UPPER PHANTOM LAKE



DATE OF PHOTOGRAPHY: MARCH 2000

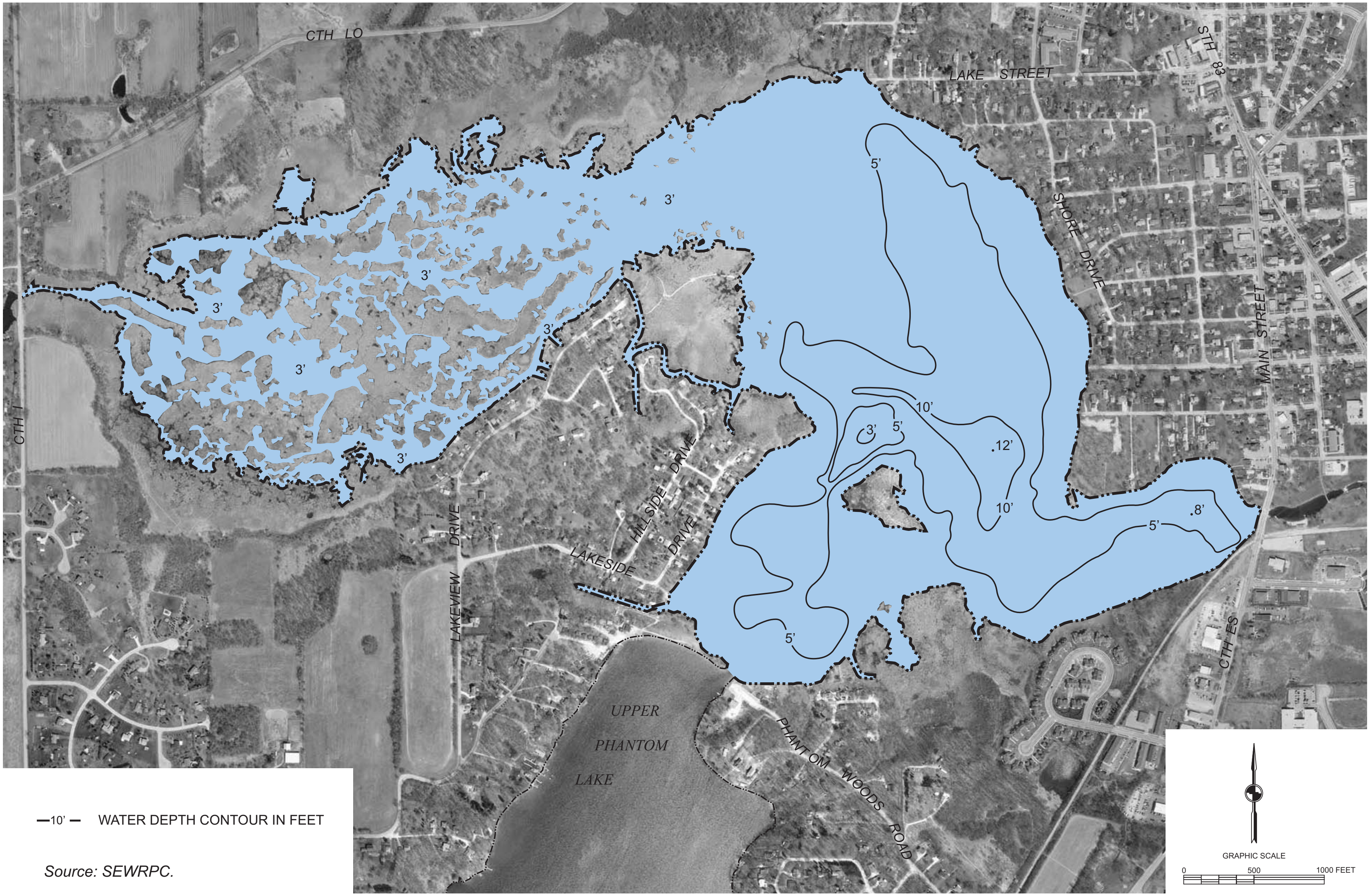
—20' — WATER DEPTH CONTOUR IN FEET

Source: SEWRPC.



Map 2 (continued)

BATHYMETRIC MAP OF LOWER PHANTOM LAKE



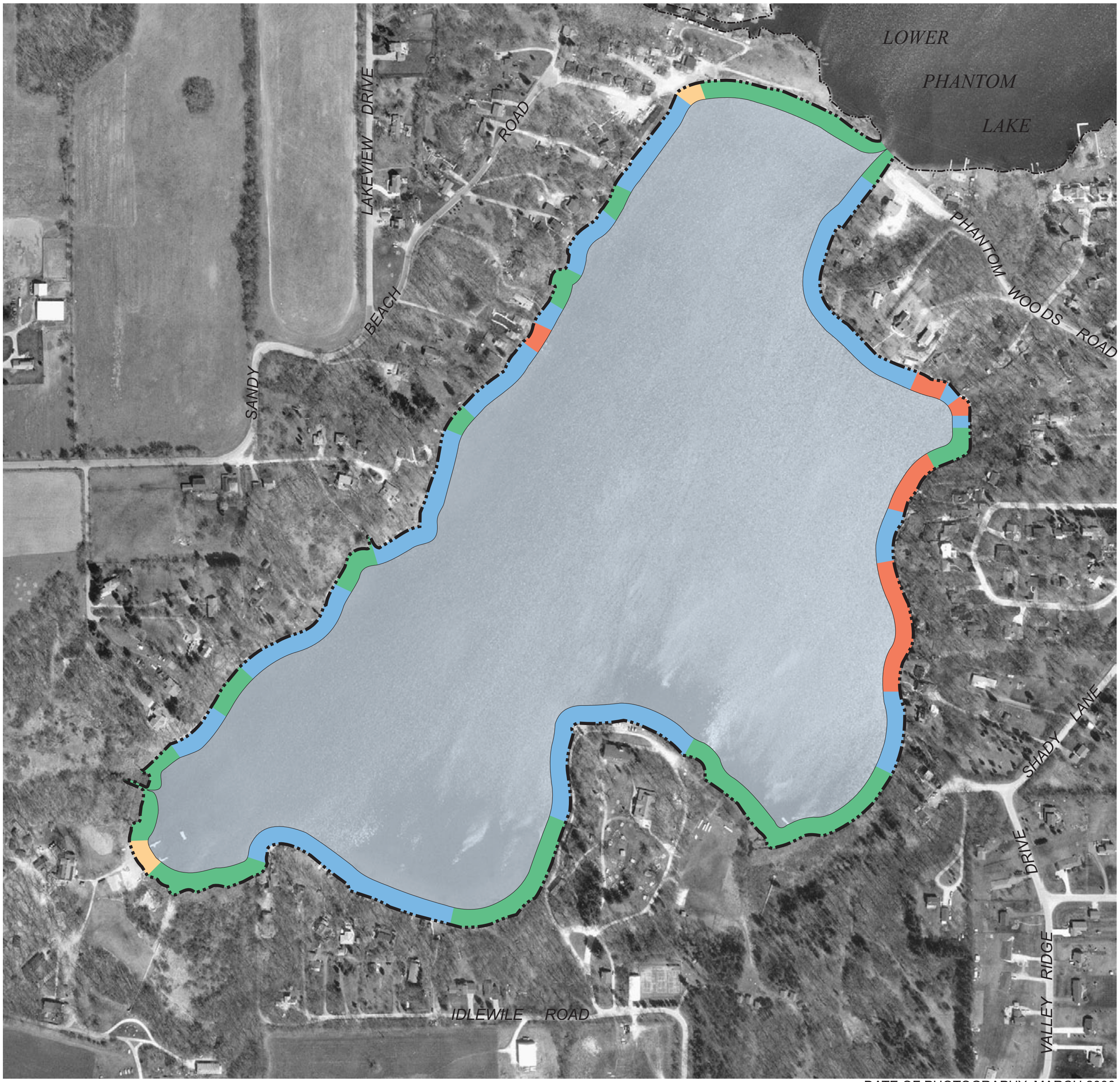
—10' — WATER DEPTH CONTOUR IN FEET

Source: SEWRPC.

DATE OF PHOTOGRAPHY: MARCH 2000

Map 3

SHORELINE PROTECTION STRUCTURES ON UPPER PHANTOM LAKE: 2002



DATE OF PHOTOGRAPHY: MARCH 2000

RIPRAP

BEACH

NATURAL

BULKHEAD

GRAPHIC SCALE

0 300 600 FEET

Source: SEWRPC.

Map 3 (continued)

SHORELINE PROTECTION STRUCTURES ON LOWER PHANTOM LAKE: 2002

Source: SEWRPC.

DATE OF PHOTOGRAPHY: MARCH 2000

Table 2

GENERAL HYDROLOGIC SOIL TYPES WITHIN THE DRAINAGE AREA TRIBUTARY TO UPPER PHANTOM LAKE

Group	Soil Characteristics	Direct Tributary Drainage Area (acres)	Percent of Total
A	Well drained; very rapidly to rapid permeability; low shrink-swell potential	3	0.3
B	Moderately well drained; texture intermediate between coarse and fine; moderately rapid to moderate permeability; low to moderate shrink-swell potential	819	80.0
C	Poorly drained; high water table for part or most of the year; mottling, suggesting poor aeration and lack of drainage, generally present in A to C horizons	14	1.0
D	Very poorly drained; high water table for most of the year; organic or clay soils; clay soils having high shrink-swell potential	50	5.7
Other	Group not determined	18	2.0
Water	- -	116	11.0
- -	Total	1,020	100.0

Source: SEWRPC.

Table 3

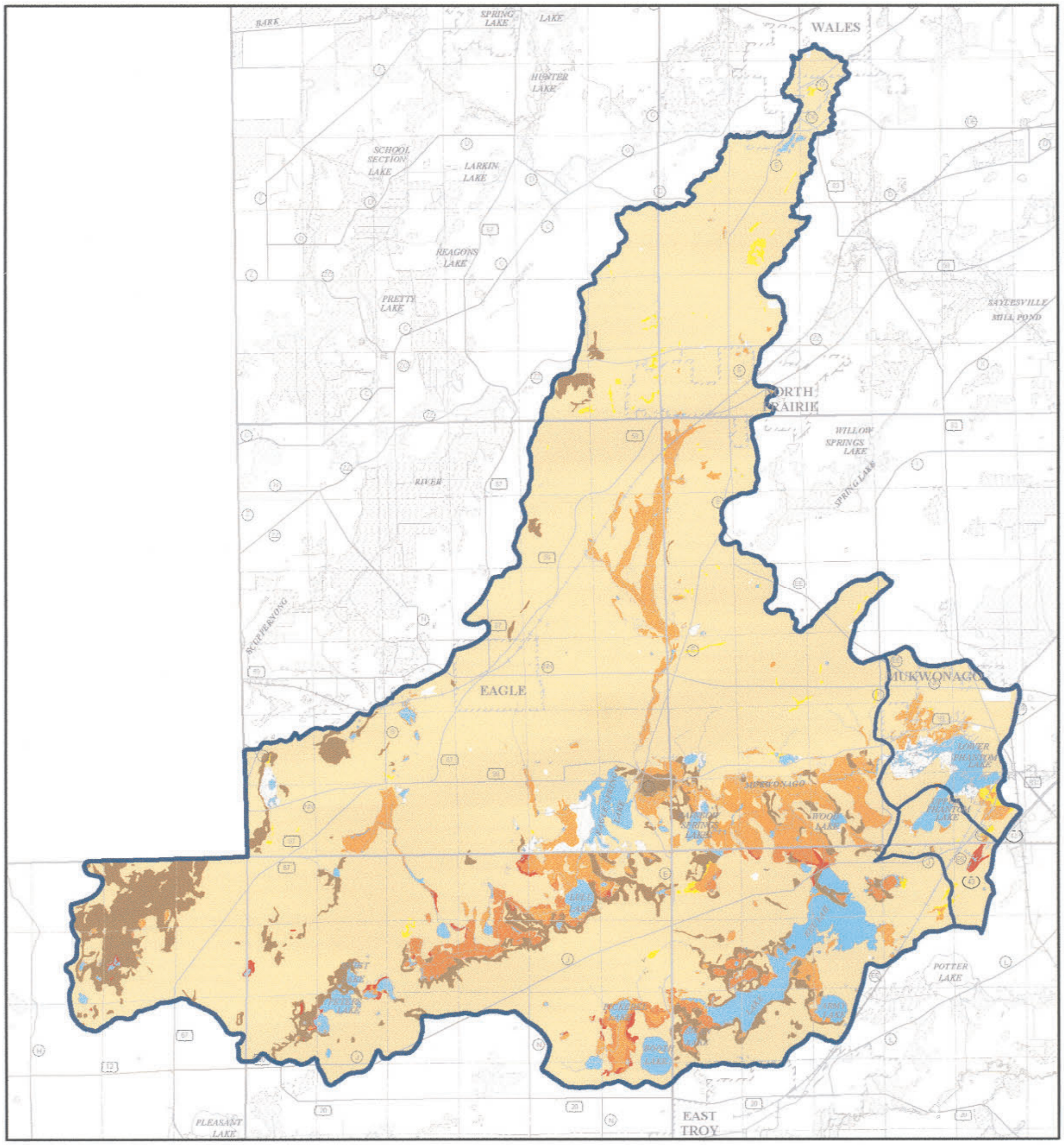
GENERAL HYDROLOGIC SOIL TYPES WITHIN THE TOTAL AND DIRECT DRAINAGE AREAS TRIBUTARY TO LOWER PHANTOM LAKE

Group	Soil Characteristics	Direct Tributary Drainage Area (acres)	Percent of Total	Total Tributary Drainage Area (acres)	Percent of Total
A	Well drained; very rapidly to rapid permeability; low shrink-swell potential	0	0	3,063	6
B	Moderately well drained; texture intermediate between coarse and fine; moderately rapid to moderate permeability; low to moderate shrink-swell potential	1,459	65	41,379	79
C	Poorly drained; high water table for part or most of the year; mottling, suggesting poor aeration and lack of drainage, generally present in A to C horizons	54	2	329	1
D	Very poorly drained; high water table for most of the year; organic or clay soils; clay soils having high shrink-swell potential	216	9	4,200	8
Other	Group not determined	283	13	990	2
Water	- -	250	11	2,209	4
- -	Total	2,262	100	52,170	100

Source: SEWRPC.

Map 4

HYDROLOGIC SOIL GROUPS WITHIN THE DRAINAGE AREA TRIBUTARY TO THE PHANTOM LAKES



GROUP A: Well-drained

GROUP A/B: Well-drained soils/Moderately drained[1]

GROUP A/D: Well-drained soil/Very poorly drained soil[2]

GROUP B: Moderately drained soil

GROUP B/D: Moderately drained soil/Very poorly drained soil[3]

GROUP C: Poorly drained soil

GROUP C/D: Poorly drained soil/Very poorly drained soil[4]

GROUP D: Very poorly drained soil

OTHER

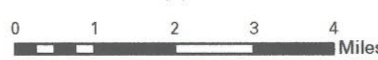
Surface Water

1 Well-drained soil if water table is lowered through provision of a drainage system. Moderately drained soil if water table is not lowered.

2 Well-drained soil if water table is lowered through provision of a drainage system. Very poorly drained soil if water table is not lowered.

3 Moderately-drained soil if water table is lowered through provision of a drainage system. Very poorly drained soil if water table is not lowered.

4 Poorly-drained soil if water table is lowered through provision of a drainage system. Very poorly drained soil if water table is not lowered.



Source: U.S. National Resource Conservation Service and SEWRPC.

soils situated primarily in the Jericho Creek subbasin, the Rodman-Casco association of excessively well drained to well drained soils, and the Hochheim-Theresa association of well drained soils situated mostly in the area north of the Mukwonago River, immediately upstream of Lower Phantom Lake. The principle soil types present in the shoreland areas of the drainage areas directly tributary to the Phantom Lakes include: Casco loam, Casco-Rodman complex, Fox loam, Fox silt loam, Matherton silt loam, Navan silt loam, Houghton muck, and marsh soils.

Interpretations associated with the soil survey are such that they provide insights into the potential for land-based sources of pollution to affect the Lake water quality either as a consequence of overland flows during storm events or through groundwater interflows in the Lake. These interpretations are based upon ratings that reflected the requirements of Chapter Comm 83 of the *Wisconsin Administrative Code* governing onsite sewage disposal systems as they existed through the year 2000. During 2000, the Wisconsin Legislature amended Chapter Comm 83 and the new rules, which had an effective date of July 1, 2000, significantly altered the existing regulatory framework and have effectively increased the area in which onsite sewage disposal systems may be utilized. Nevertheless, insofar as these ratings reflect the potential for the transport of contaminants into lakes through groundwater inflows, these assessments are presented herein as an index of the likelihood of groundwater-sourced contaminants entering the Phantom Lakes. The locations and suitability ratings of soils for conventional onsite sewage disposal systems, pursuant to the requirements of the pre-year 2000 Chapter Comm 83 of the *Wisconsin Administrative Code*, are shown on Map 5. Based upon this analysis, it is useful to note that less than 10 percent of the lands within the drainage area directly tributary to Upper Phantom Lake are covered by soils that are categorized as having a potential sensitivity to disturbance and likelihood of being permeable to pollutants. In the drainage area directly tributary to Lower Phantom Lake, less than 20 percent of the lands are covered by such soils.

With respect to wastewater treatment, portions of the drainage area directly tributary to Lower Phantom Lake are served by public sanitary sewage disposal systems, as shown on Map 6, with the balance of the lands surrounding both Upper and Lower Phantom Lakes being served by onsite sewage disposal systems. The residential lands within the drainage areas directly tributary to Upper Phantom Lake are served exclusively by onsite sewage disposal systems and the lands directly tributary to Lower Phantom Lake are served by both public and onsite sewage disposal systems. Future expansion of the public sanitary sewerage system to additional areas riparian to the Phantom Lakes is foreseen,[2] and a facilities planning program has been completed for the lands within and adjacent to the Phantom Lakes Management District.[3] As of 2005, the District, which adopted town sanitary district powers pursuant to Chapter 33 of the *Wisconsin Statutes* by majority vote at the annual meeting of the District during 1995, has chosen not to implement this plan. Rather onsite sewage disposal systems within the jurisdiction of the Phantom Lakes Management District are regularly inspected for operational status under an agreement concluded between the Phantom Lakes Management District and Waukesha County. This agreement provides for the inspection of all onsite sewage disposal systems within the District, regardless of their date of construction. Onsite sewage disposal systems installed after 1983 are currently subject to periodic inspection pursuant to the provisions of Chapter Comm 83 of the *Wisconsin Administrative Code*.

Climate and Hydrology

Long-term average monthly air temperature and precipitation values for the Phantom Lakes area are set forth in Table 4. These averages were taken from official National Oceanic and Atmospheric Administration (NOAA) records for the weather recording station at Waukesha, Wisconsin. The records of this station may be considered typical of the lake area.

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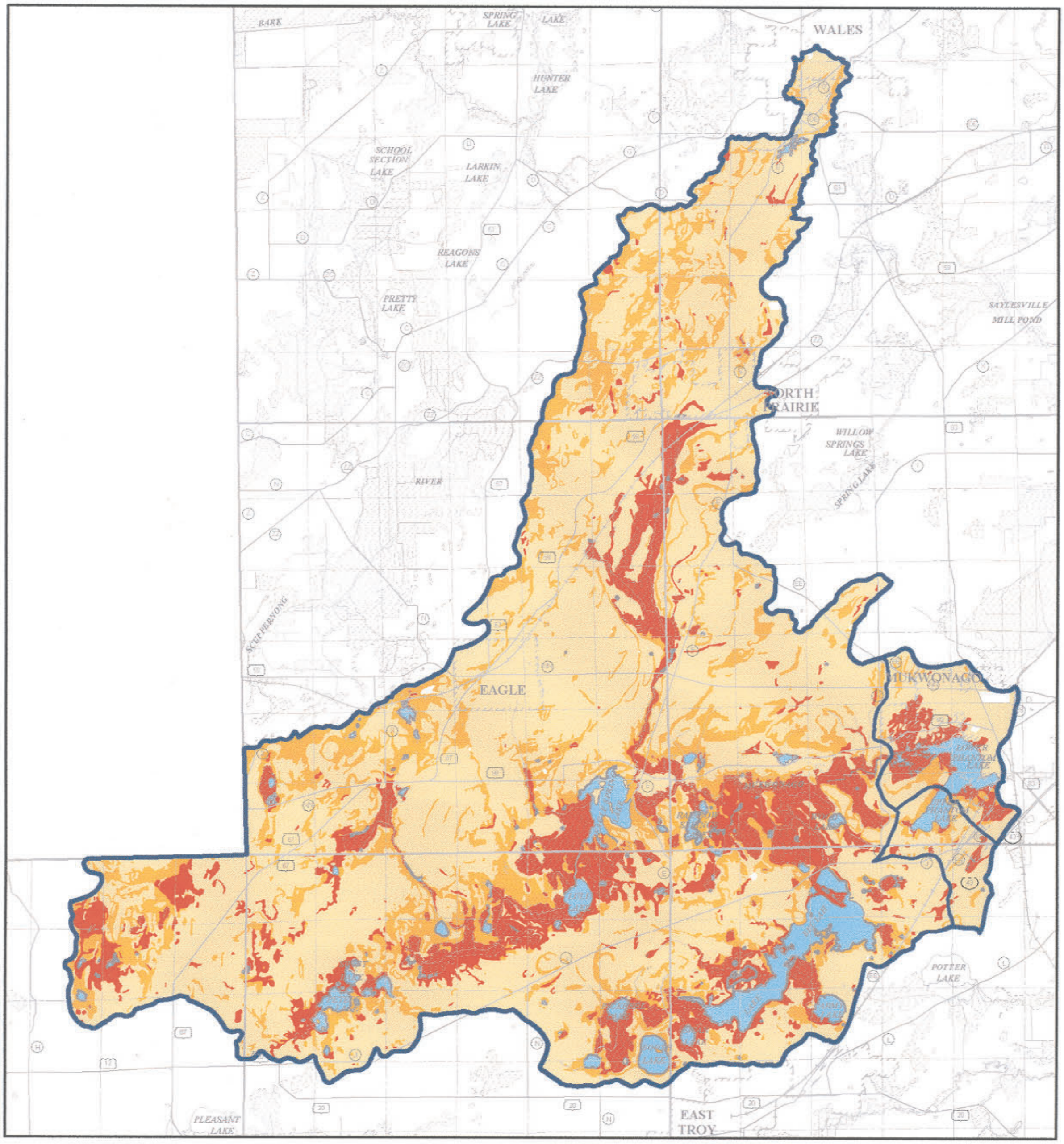
[2]*SEWRPC Community Assistance Planning Report No. 191*, Sanitary Sewer Service Area for the Village of Mukwonago, Waukesha County, Wisconsin, *November 1990.*

[3]*Ruekert & Mielke, Inc.*, Sanitary Sewerage System Plan: Village of Mukwonago, Waukesha County, Wisconsin, *August 2001.*

Map 5

GROUNDWATER CONTAMINATION POTENTIAL WITHIN THE DRAINAGE AREA TRIBUTARY TO THE PHANTOM LAKES



UNSUITABLE: Areas covered by soils which have a high probability of not meeting the June 2000 criteria of Chapter Comm. 83 of the *Wisconsin Administrative Code* governing conventional mound sewage disposal systems

UNDETERMINED: Areas covered by soils having a range of characteristics and or slopes which span the June 2000 criteria of Chapter Comm. 83 of the *Wisconsin Administrative Code* governing conventional mound sewage disposal systems so that no classification can be assigned

SUITABLE: Areas covered by soils having a high probability of meeting the June 2000 criteria of Chapter Comm. 83 of the *Wisconsin Aministrative Code* governing conventional mound sewage disposal systems

OTHER: Areas consisting for the most part of disturbed land for which no interpretive data are available

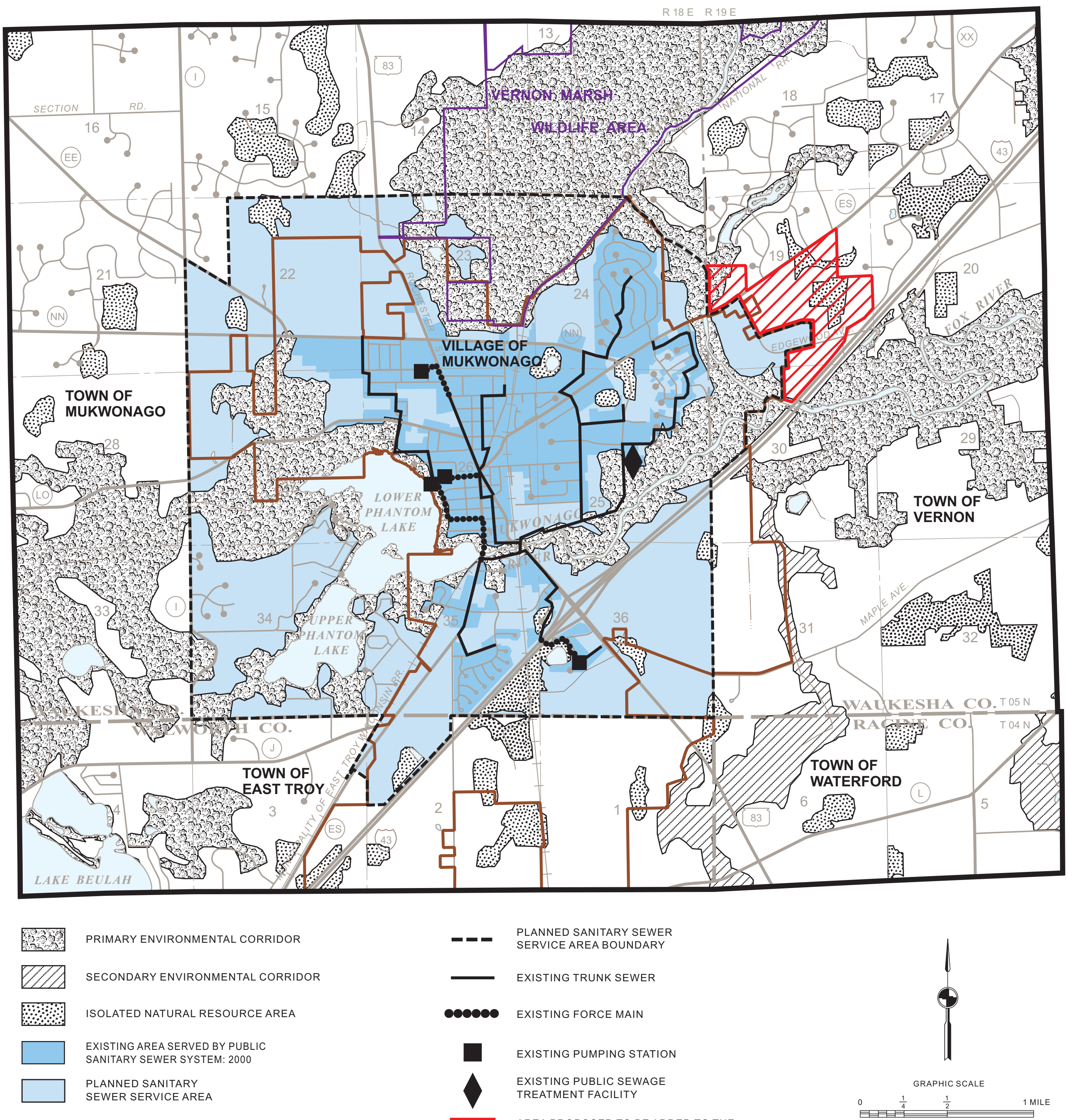
SURFACE WATER

0 1 2 3 4 Miles

Source: U.S. National Resources Conservation Service and SEWRPC.

Map 6

SANITARY SEWER SERVICE AREA WITHIN THE VICINITY OF THE PHANTOM LAKES



Source: SEWRPC.

Table 4

LONG-TERM AND 2002 STUDY YEAR TEMPERATURE, PRECIPITATION, AND RUNOFF DATA FOR THE PHANTOM LAKES AREA

Temperature													
Air Temperature Data (°F)	January	February	March	April	May	June	July	August	September	October	November	December	Mean
Long-Term Mean Monthly	19.5	24.7	35.3	47.3	59.3	69.1	73.8	71.7	63.2	51.3	37.6	25.2	48.2
2002 Mean Monthly	27.4	28.5	29.7	46.3	52.2	67.9	74.8	70.7	64.3	46.8	35.2	27.3	47.6
Departure from Long-Term Mean	7.9	3.8	-5.6	-1.0	-7.1	-1.2	1.0	-1.0	1.1	-4.5	-2.4	2.1	-0.6

Precipitation														
Precipitation Data (inches)	January	February	March	April	May	June	July	August	September	October	November	December	Mean	Total
Long-Term Mean Monthly	1.48	1.31	2.28	3.53	3.02	3.78	3.83	4.77	3.52	2.62	2.63	1.87	2.88	34.64
2002 Total Monthly	0.87	1.56	1.73	3.96	2.89	3.30	3.32	8.50	3.32	2.76	0.73	0.69	2.80	33.63
Departure from Long-Term Mean	-0.61	0.25	-0.55	0.43	-0.13	-0.48	-0.51	3.73	-0.20	0.14	-1.90	-1.18	-.08	-1.01

Runoff													
Runoff Data (inches)	January	February	March	April	May	June	July	August	September	October	November	December	Mean
Long-Term Mean Monthly	0.72	0.77	1.15	1.17	0.99	0.82	0.66	0.71	0.71	0.75	0.83	0.82	0.84
2002 Mean Monthly	0.64	0.75	0.92	1.14	0.90	0.99	0.35	0.85	0.50	0.66	0.54	0.58	0.74
Departure from Mean Monthly	-0.08	-0.02	-0.23	-0.03	-0.09	0.17	-0.31	0.14	-0.21	-0.09	-0.29	-0.24	-0.10

Source: National Oceanic and Atmospheric Administration, U.S. Geological Survey, and SEWRPC.

The mean annual temperature of 48.2°F at Waukesha is similar to that reported from other recording locations in southeastern Wisconsin. The 12-month period for calendar year 2002, as indicated in Table 4, was a period during which temperatures were generally slightly below normal.

The mean annual precipitation at Waukesha is about 34.64 inches. Precipitation at Waukesha, during the calendar year 2002, was about 33.63 inches, or about 3 percent below normal, with the greatest decrease from the average, 1.90 inches, occurring during November, and the greatest increase above the average, 3.73 inches, occurring during August. Eight of the 12 months experienced below normal amounts of precipitation.

Table 4 also sets forth storm water runoff values derived from the U.S. Geological Survey (USGS) flow records for the Mukwonago River at Mukwonago. More than one-half the normal yearly precipitation falls during the growing season, from May to September. Runoff rates are generally low during this period, since evapotranspiration rates are high, vegetative cover is good, and soils are not frozen. Normally, about 20 percent of the summer precipitation is expressed as surface runoff, but intense summer storms occasionally produce higher runoff fractions. In contrast, approximately 45 percent of the annual precipitation, which occurs during the winter or early spring when the ground is frozen, may result in high surface runoff during those seasons.

Land surface slopes within the drainage area tributary to the Phantom Lakes range from less than 1 percent to greater than 20 percent in the watershed, with the more steeply sloping lands located along the eastern and western shorelands of Upper Phantom Lake's basin and along Lower Phantom Lake's southern shorelands, as shown on Map 7. In general, slopes of over 12 percent have limitations for urban residential development and, if developed, can present potential erosion and drainage problems. Based upon soil-slope interpretations, about two-thirds of the drainage area tributary to the Phantom Lakes has slopes of less than 6 percent, while 10 percent of the drainage area has slopes of between 6 percent and 12 percent, as shown on Map 7. Only about 15 percent of the total drainage area tributary to the Phantom Lakes is considered to have slopes that exceed 20 percent.

Lake Stage

The water level of the Phantom Lakes, although generally recorded to be at an elevation of 789 feet above mean sea level, National Geodetic Vertical Datum-1929, varies with local precipitation patterns and runoff conditions. In the case of Upper Phantom Lake, lake stage depends primarily on groundwater levels and rates of inflow, and direct precipitation onto the lake surface. In the case of Lower Phantom Lake, while groundwater inflows and direct precipitation form a portion of the hydrologic budget of the Lake, lake stage depends primarily on inflow from the Mukwonago River. Water levels in the Lakes are considered to be linked and maintained by a dam at the outflow of Lower Phantom Lake just east of CTH ES. However, during exceptionally dry periods or periods of drawdown of Lower Phantom Lake, water levels in Upper Phantom Lake may be controlled by the elevation of the sandy sill that exists between Upper and Lower Phantom Lakes. The presence of this sill, under such circumstances, could result in elevation differences between the Lakes, with Upper Phantom Lake retaining a higher water level than that of Lower Phantom Lake.

Water Budget

A water budget for Upper Phantom Lake prepared by the Wisconsin Department of Natural Resources in 1982[4] estimated that water flowing into the Lake was comprised of about 16 percent, or 180 acre-feet, surface runoff; about 31 percent, or about 350 acre-feet, direct precipitation onto the lake surface; and, about 53 percent, or 580 acre-feet, groundwater. Review of groundwater elevations in the vicinity of the Phantom Lakes indicates that groundwater flows towards the Lakes from the north, south and west, and from the Lakes in the east, as shown on Map 8. Of the water flowing out of Upper Phantom Lake, about 28 percent, or 315 acre-feet, was the result of evaporation and about 72 percent, or 795 acre-feet, was due to surface outflows to Lower Phantom Lake. In contrast, estimates of the volumes of water flowing into and out of Lower Phantom Lake indicated that about 93 percent of the inflow, or about 44,670 acre-feet, was the result of surface runoff; about 3 percent, or 1,280 acre-feet, was the result of direct precipitation onto the lake surface; and, about 4 percent, or 2,130 acre-feet, was the result of groundwater inflow. Of the water flowing out of Lower Phantom Lake, about 2 percent, or 1,150 acre-feet, was the result of evaporation and about 98 percent, or 46,925 acre-feet, was the result of surface outflows. Groundwater outflows in both cases were considered to be negligible.

A water budget for the Phantom Lakes for the year 2002 was computed from the rainfall data shown in Table 4. For the year 2002, it was estimated that about 1,760 acre-feet of water entered Upper Phantom Lake. Of this volume, about 850 acre-feet of water, or 48 percent, entered Upper Phantom Lake by surface runoff; 330 acre-feet, or 19 percent, entered the Lake by direct precipitation onto the lake surface; and, 580 acre-feet, or 33 percent, entered the Lake by groundwater inflow.[5] Of this amount, about 380 acre-feet, or about 22 percent, were calculated to have been lost due to evaporation from the lake surface and 1,380 acre-feet, or about 78 percent, are estimated to have flowed out to Lower Phantom Lake. For Lower Phantom Lake, an estimated 1,380 acre-feet of water, or 3 percent, entered from Upper Phantom Lake; about 33,325 acre-feet of water, or 88 percent, entered as surface runoff from the Mukwonago River; 1,215 acre-feet, or 3 percent, entered the Lake by direct precipitation onto the lake surface; and, 2,130 acre-feet, or 6 percent, entered the Lake by groundwater inflow. Of this amount,

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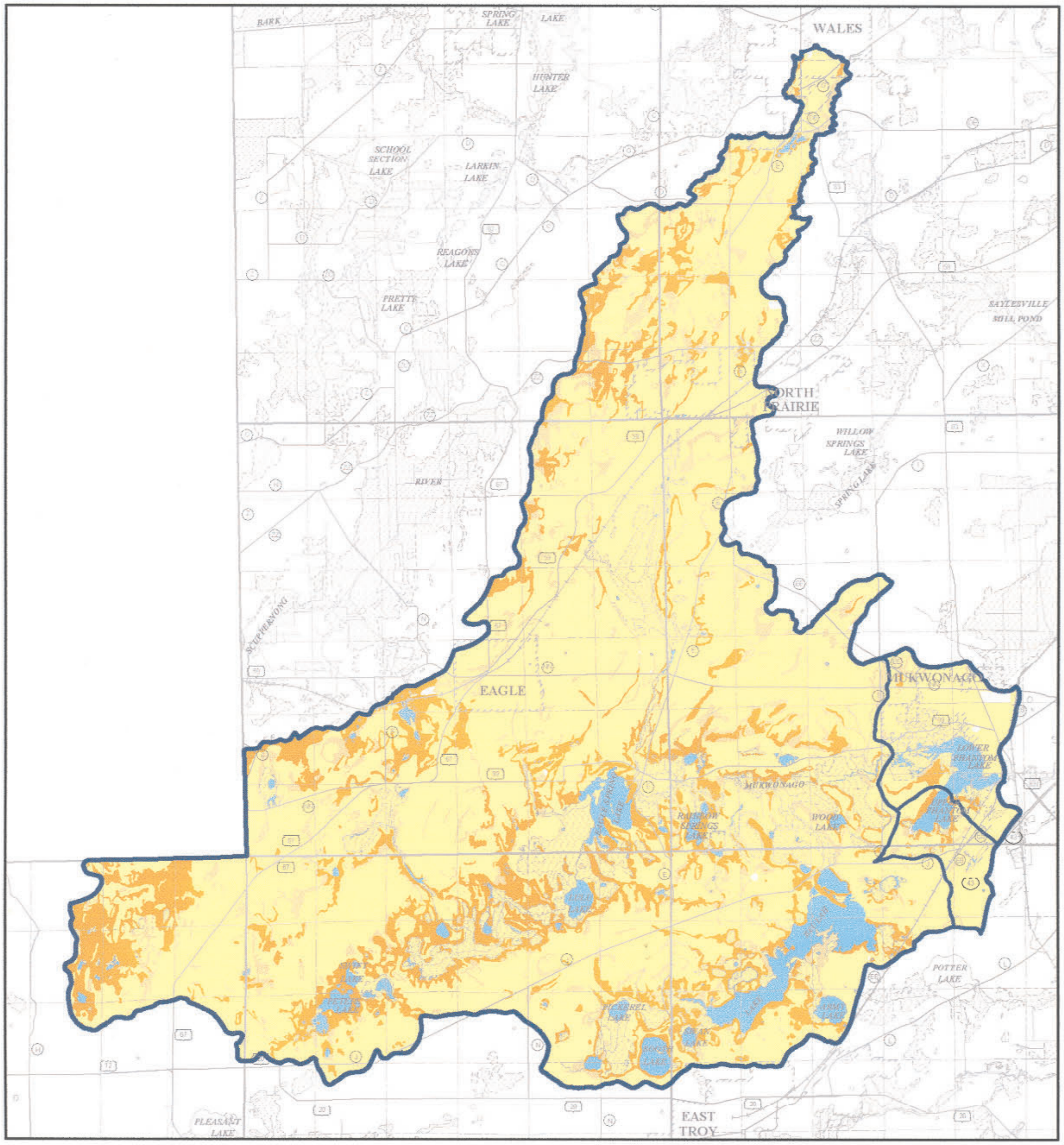
[4]*Wisconsin Department of Natural Resources, Bureau of Water Resources Management, Inland Lakes Renewal Section*, Phantom Lakes, Waukesha County Feasibility Study Results; Management Alternatives, *1982.*

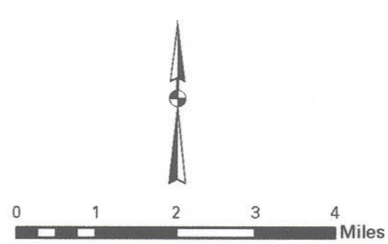
[5]*Groundwater inflows and outflows to the Upper and Lower Phantom Lakes were considered to be unchanged from those measured during the 1980-1981 Wisconsin Department of Natural Resources study*.

Map 7

LAND SLOPES WITHIN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO THE PHANTOM LAKES



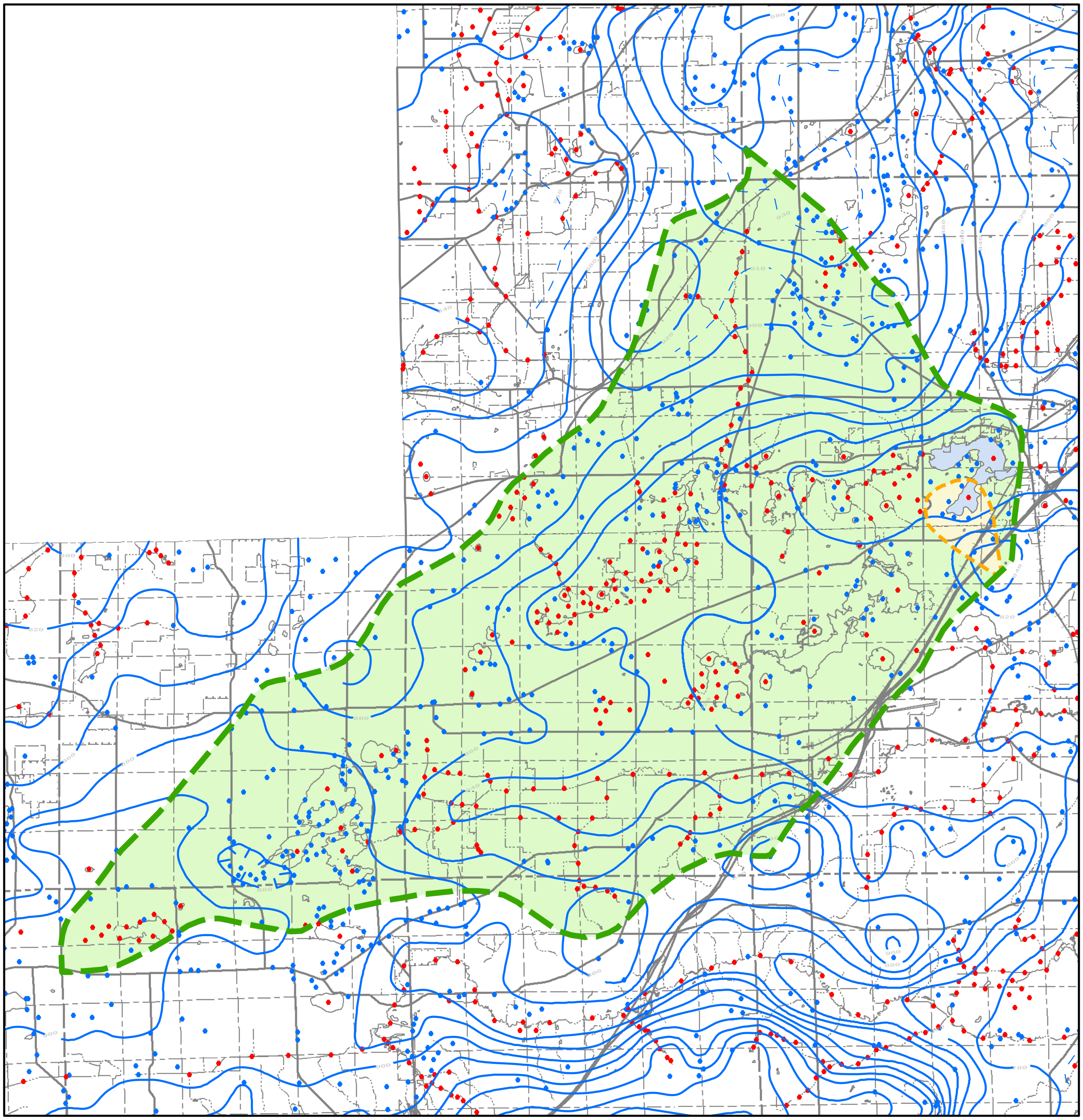
- 0 - 6 Percent
- 6 - 12 Percent
- 12 - 20 Percent
- Greater than 20 Percent
- Mostly Disturbed Lands
- Surface Water



Source: SEWRPC.

Map 8

AREAS FROM WHICH GROUNDWATER IS CONTRIBUTED TO THE PHANTOM LAKES



AVERAGE WATER-TABLE ELEVATION (FEET ABOVE MEAN SEA LEVEL)

SUPPLEMENTAL CONTOUR

WELL DATA POINT

SURFACE WATER POINT

GENERAL DIRECTION OF SHALLOW GROUND-WATER FLOW

AREA CONTRIBUTING GROUNDWATER-UPPER PHANTOM LAKE (1.3sq. miles)

AREA CONTRIBUTING GROUNDWATER-LOWER PHANTOM LAKE (100sq. miles)

N

GRAPHIC SCALE

0 7,000 14,000 21,000 Feet

Source: SEWRPC.

about 1,150 acre-feet, or about 3 percent, were calculated to have been lost due to evaporation from the lake surface and 36,900 acre-feet, or about 97 percent, are estimated to have flowed out through the Mukwonago River. As previously noted, groundwater outflows were considered to be negligible.

A long-term water budget for the Phantom Lakes was computed using the estimated groundwater inflows combined with estimated inflows from direct precipitation and surface water runoff from surrounding land, and estimated outflows due to evaporation from the Lakes' surfaces as well as surface water outflow through the Mukwonago River, calculated from long term climatic data, and set forth in Figure 1. About 680 acre-feet of water, or 43 percent, entered Upper Phantom Lake by surface runoff; 340 acre-feet, or 21 percent, entered the Lake by direct precipitation onto the lake surface; and, 580 acre-feet, or 36 percent, entered the Lake by groundwater inflow.[6] Of this amount, about 380 acre-feet, or about 24 percent, were calculated to have been lost due to evaporation from the lake surface and 1,220 acre-feet, or about 76 percent, are estimated to have flowed out to Lower Phantom Lake. For Lower Phantom Lake, an estimated 1,220 acre-feet of water, or 4 percent, entered from Upper Phantom Lake; about 34,650 acre-feet of water, or 88 percent, entered as surface runoff from the Mukwonago River; 1,250 acre-feet, or 3 percent, entered the Lake by direct precipitation onto the lake surface; and, 2,130 acre-feet, or 5 percent, entered the Lake by groundwater inflow. Of this amount, about 1,150 acre-feet, or about 3 percent, were calculated to have been lost due to evaporation from the lake surface and 38,100 acre-feet, or about 97 percent, are estimated to have flowed out through the Mukwonago River.

The total amount of water leaving the Phantom Lakes during 2002 represents an approximate decrease of about 3 percent over the amounts determined as the long-term outflow from the Lake system, the decrease is due, in part, to the aforementioned decrease in precipitation observed during 2002 and the proportionately greater impact of evaporative losses in the system.

The hydraulic residence time for Upper Phantom Lake, during years of average precipitation, was determined to be approximately one year, while that of Lower Phantom Lake was determined to be about 0.04 year. The hydraulic residence time is important in determining the expected response time of the Lake to increased or reduced nutrient and other pollutant loadings. In the case of Lower Phantom Lake, the very short hydraulic residence time is approaching the hydraulic residence time below which phytoplankton growth will have a negligible impact on the Lake water quality due to the "wash out" of the algae.[7]

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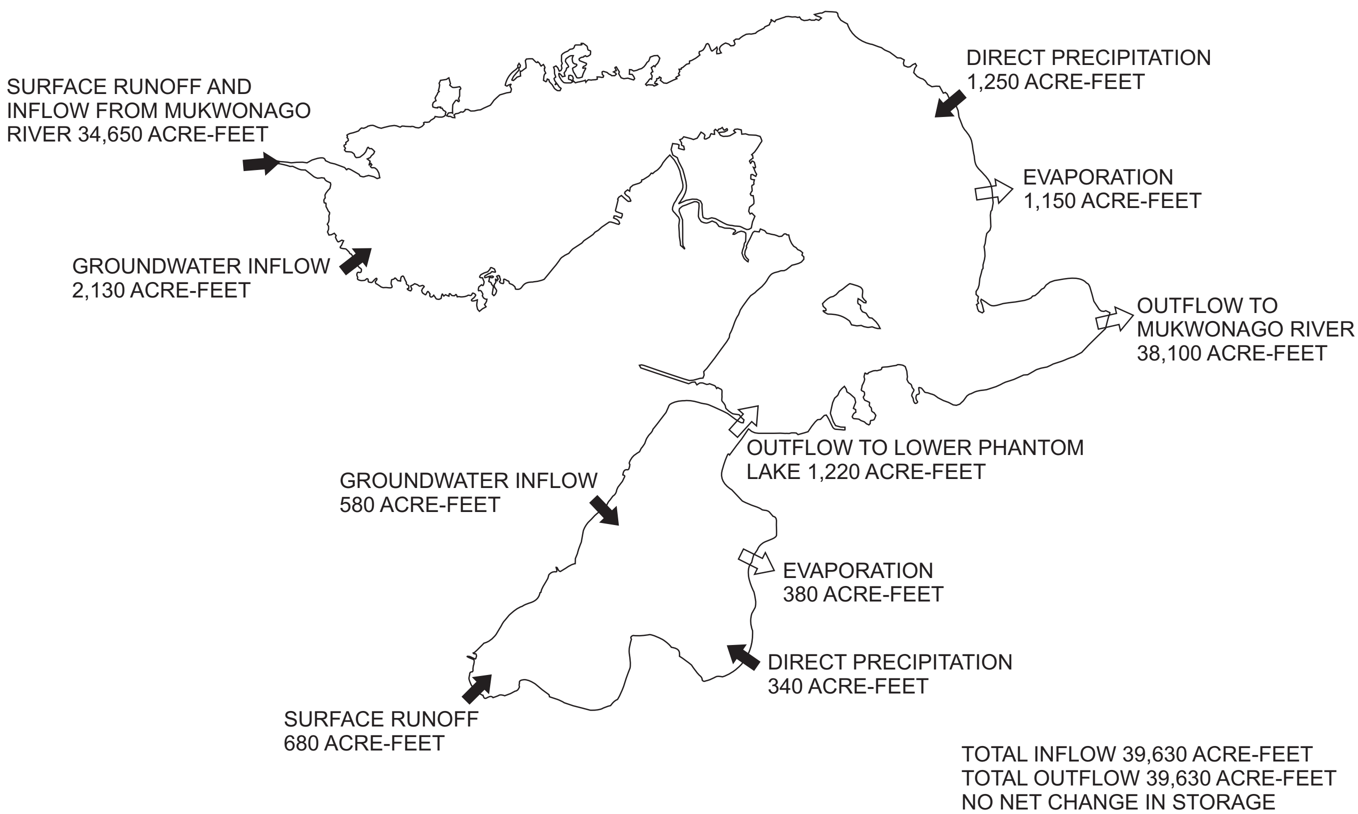
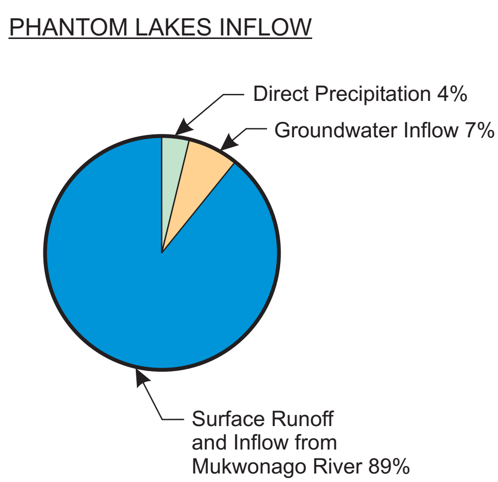
[6]Ibid.

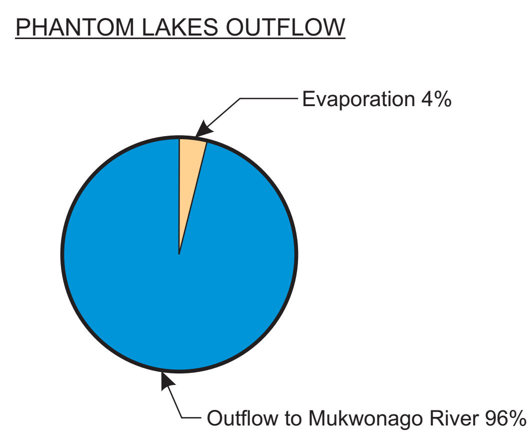
[7]*At water residence times of less than 0.02 year, phytoplankton tend to be washed out of lakes and reservoirs before they can reproduce, resulting in less algal growth in these systems relative to that which would be expected from the same phosphorus load in lakes and reservoirs with longer water residence times. See P. J. Dillon, "The Phosphorus Budget of Cameron Lake, Ontario: The Importance of Flushing Rate to the Degree of Eutrophy of Lakes,"* Limnology and Oceanography*, Vol. 20, 1975, pp. 2-39.*

Figure 1

LONG-TERM HYDROLOGIC BUDGET FOR THE PHANTOM LAKES







Source: U.S. Geological Survey and SEWRPC.

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Chapter III

HISTORICAL, EXISTING, AND FORECAST LAND USE AND POPULATION

INTRODUCTION

Water pollution problems, recreational use conflicts, and deterioration of the natural environment are all primarily a function of the human activities within the drainage area of a waterbody, as are the ultimate solutions to these problems. This is especially true with respect to lakes, which are highly susceptible to deterioration from human activities because of relatively long pollutant retention times, and because of the variety of often conflicting uses to which lakes are subjected. Furthermore, urban development is often concentrated in the direct drainage areas, around the shorelines of lakes, where there are no intermediate stream segments to attenuate pollutant runoff and loadings. This type of lake degradation is more likely to interfere with desired water uses and is often more difficult and costly to correct than degradation arising from clearly identifiable point sources of pollution in the watershed. Accordingly, the land uses and attendant population levels in the drainage area directly tributary to a lake must be important considerations in any lake management planning effort. In the case of the Phantom Lakes, which are comprised, in part, of a through-flow lake which is part of a larger river drainage system and a drained lake which is dependent upon groundwater inflows from a limited groundwater recharge area, the importance of nonpoint-sourced pollutants in determining lake water quality and in influencing downstream water quality is paramount. For this reason, land usage and population distributions are summarized in this chapter, together with a review of jurisdictional issues relevant to water quality and lake management.

CIVIL DIVISIONS

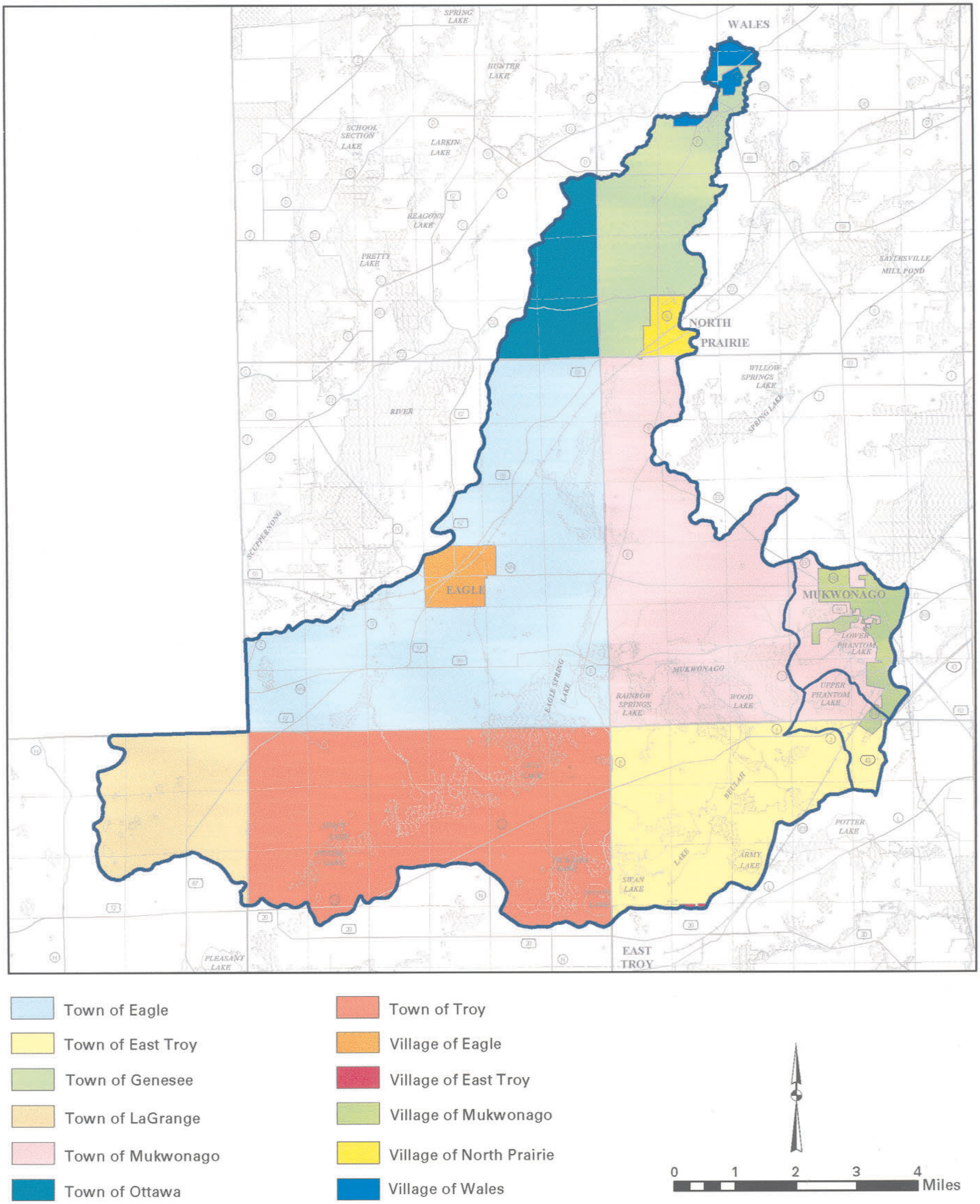
The geographic extent and functional responsibilities of civil divisions and special-purpose units of government are important factors related to land use and management, since these local units of government provide the basic structure of the decision-making framework within which land use development and redevelopment must be addressed. Superimposed on the Phantom Lakes' total drainage area are the local civil division boundaries shown on Map 9. These civil divisions include the Towns of East Troy, LaGrange, and Troy in Walworth County, and the Towns of Eagle, Genesee, Mukwonago, and Ottawa in Waukesha County, as well as the Village of East Troy in Walworth County, and the Villages of Eagle, Mukwonago, North Prairie, and Wales in Waukesha County. The area and proportion of the drainage area lying within the jurisdiction of each civil division, as of 2000, are set forth in Table 5.

POPULATION

As set forth in Table 6, the resident population of the drainage area tributary to the Phantom Lakes has continued to increase. The resident population reported during the 1990 United States Census was about 3,850 individuals

Map 9

CIVIL DIVISIONS WITHIN THE DRAINAGE AREA TRIBUTARY TO THE PHANTOM LAKES



Source: SEWRPC.

Table 5

AREAL EXTENT OF CIVIL DIVISION BOUNDARIES WITHIN THE TOTAL DRAINAGE AREA TRIBUTARY TO THE PHANTOM LAKES

Civil Division	Civil Division Area within Total Drainage Area (acres)	Percent of Total Drainage Area within Civil Division
Town of Eagle	12,978	24.8
Town of East Troy	6,448	12.4
Town of Genesee	3,354	6.4
Town of LaGrange	3,367	6.5
Town of Mukwonago	9,941	19.1
Town of Ottawa	1,804	3.4
Town of Troy	10,805	20.8
Village of Eagle	756	1.4
Village of East Troy	17	0.1
Village of Mukwonago	1,327	2.5
Village of North Prairie	997	1.9
Village of Wales	376	0.7
Total	52,170	100.0

Source: SEWRPC.

Table 6

HISTORIC RESIDENT POPULATION AND HOUSEHOLD LEVELS WITHIN THE TOTAL DRAINAGE AREA TRIBUTARY TO THE PHANTOM LAKES: 1990-2000

Year	Number of Residents	Number of Households
1990	3,851	1,408
2000	4,215	1,741

Source: SEWRPC.

resident within the Census blocks riparian to the Lakes. This population had increased to about 4,220 individuals by the year 2000. These individuals were resident in about 1,410 housing units during 1990. The numbers of housing units had increased to about 1,740 housing units by 2000. Continuing population growth within the Town and Village of Mukwonago is anticipated, although the opportunities for ongoing growth in population and housing units within the drainage area directly tributary to Upper and Lower Phantom Lakes is limited by the few remaining buildable lots within this narrowly confined geographic area.

LAND USE

The type, intensity, and spatial distribution of the various land uses within the drainage area tributary to the Phantom Lakes are important determinants of lake water quality and recreational use demands. The current and planned land use patterns placed in the context of the historical development of the area are, therefore, important considerations in any lake management planning effort for the Phantom Lakes.

The movement of European settlers into the Southeastern Wisconsin Region began about 1830. Completion, within Southeastern Wisconsin, of the U.S. Public Land Survey in 1836, and the subsequent sale of public lands in Wisconsin, brought a rapid influx of settlers into the area. Map 10 shows the an 1873 plat of the Phantom Lakes area.

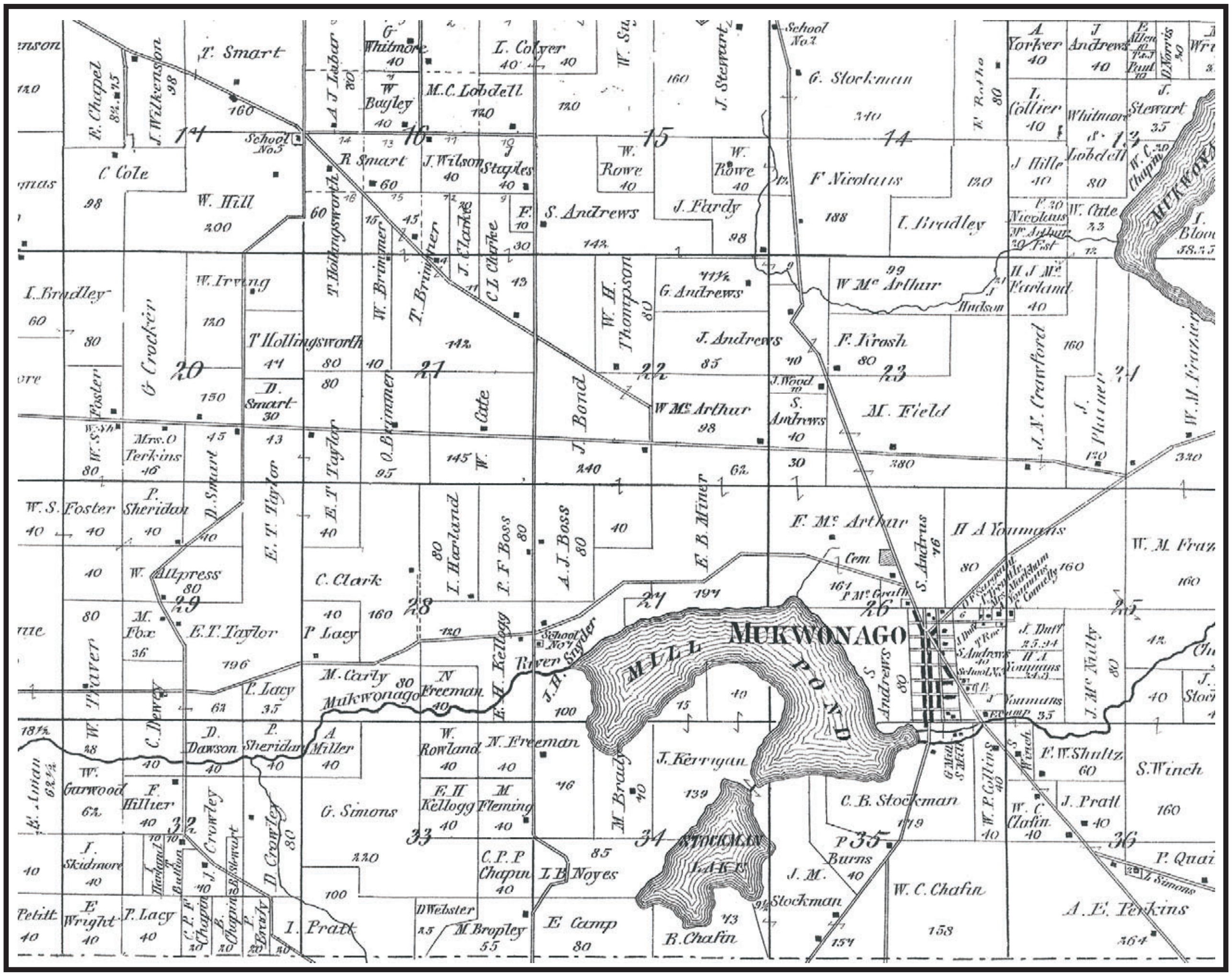
During the 1830s, the division of rural lands in the drainage area tributary to the Phantom Lakes began. Initially, urban growth within the drainage area directly tributary to the Lakes was focused within the Village of Mukwonago. Urban growth within the Village began in the mid-1800s, with periods of significant urban growth occurring between 1920 and 1940. Later, from about 1950 to 1963, and from 1975 to 1980, additional periods of urban residential development took place within the Village, around Lower Phantom Lake. During the 1950s, additional urban growth occurred in the Town of Mukwonago, around Upper Phantom Lake. Historic urban growth patterns for the Phantom Lakes area are shown in Table 7 and displayed graphically on Map 11.

The existing land use patterns in the drainage areas directly tributary to Upper and Lower Phantom Lakes, as of 2000, are shown on Maps 12 and 13, and are quantified in Tables 8 and 9. The data for the total tributary drainage area to the Phantom Lakes are shown in Map 14 and Table 10.

As indicated in Table 8, as of 2000, about 330 acres, or one-third, of the drainage area directly tributary to Upper Phantom Lake were devoted to urban land uses. The dominant urban land use was residential, encompassing about 190 acres, or 60 percent of the area in urban use. As of 2000, about 700 acres, or two-thirds of the drainage

Map 10

HISTORICAL PLAT MAP FOR THE PHANTOM LAKES: 1873



Source: Harrison and Warner, combination Atlas Map of Waukesha County, Wisconsin, 1873.

Table 7

EXTENT OF URBAN GROWTH WITHIN THE DRAINAGE AREAS DIRECTLY TRIBUTARY TO UPPER AND LOWER PHANTOM LAKES: 1850-2000

Year	Lower Phantom Lake		Upper Phantom Lake	
	Extent of New Urban Development Occurring Since Previous Year (acres)[a]	Cumulative Extent of Urban Development (acres)[a]	Extent of New Urban Development Occurring Since Previous Year (acres)[a]	Cumulative Extent of Urban Development (acres)[a]
1850	6.6	- -	- -	- -
1880	5.6	12.2	- -	- -
1900	10.0	22.2	- -	- -
1920	79.8	92.0	- -	- -
1940	74.1	166.1	16.6	- -
1950	34.3	200.4	- -	16.6
1963	249.6	450.0	69.0	85.6
1970	16.1	466.1	15.1	100.7
1975	41.2	507.3	49.1	149.8
1980	126.1	633.4	2.9	152.7
1985	35.3	668.7	32.6	185.3
1990	33.8	702.5	7.2	192.5
2000	29.9	732.4	- -	192.5

[a]*Urban development, as defined for the purposes of this discussion, includes those areas within which houses or other buildings have been constructed in relatively compact groups, thereby indicating a concentration of urban land uses. Scattered residential developments were not considered in this analysis.*

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

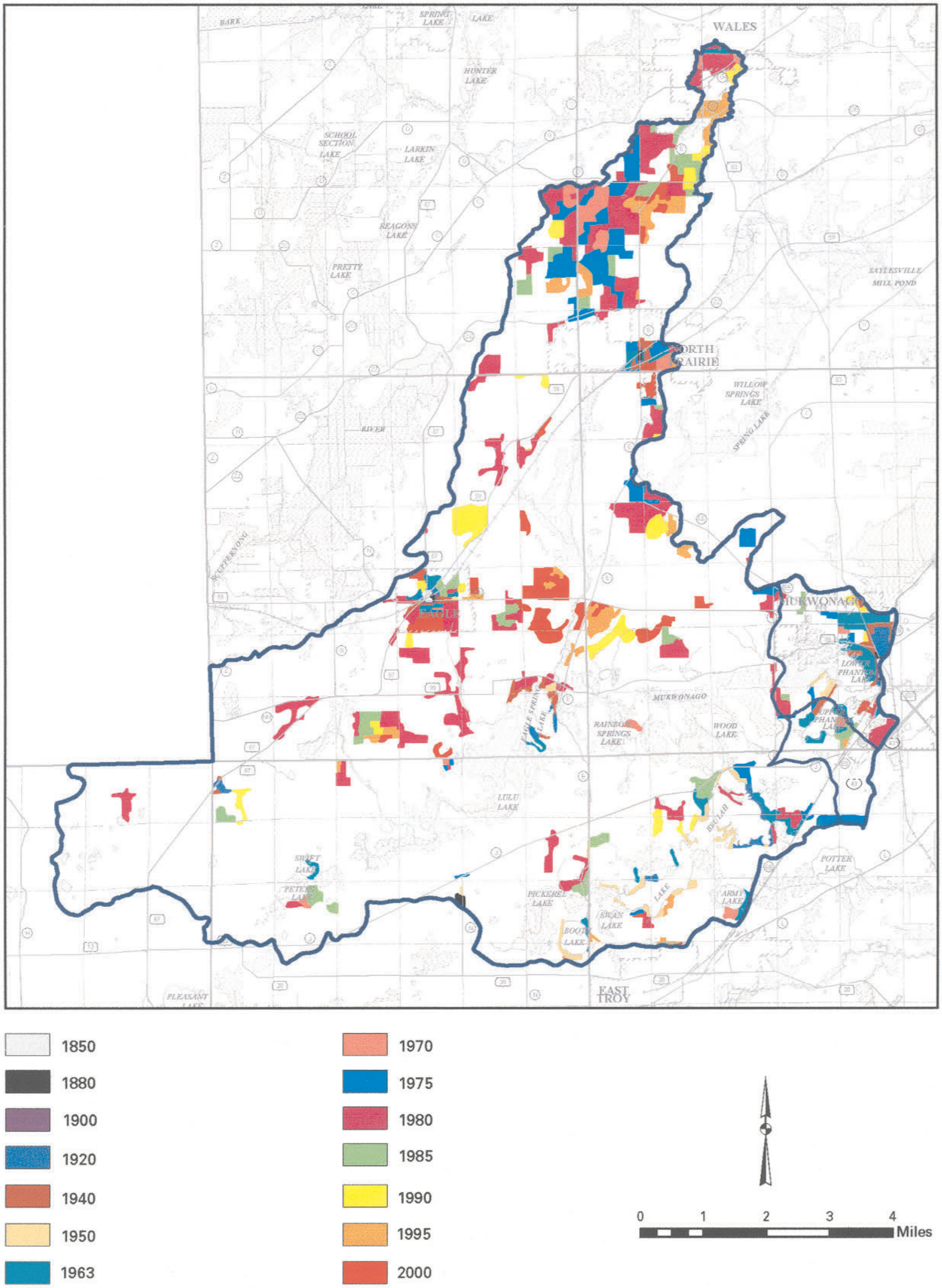
area directly tributary to the Upper Phantom Lake, were still devoted to rural land uses. About 470 acres, or about 70 percent of the rural area, were in agricultural land uses. Woodlands, wetlands, and surface waters, including the surface area of Upper Phantom Lake, accounted for approximately 220 acres, or 30 percent, of the area in rural uses. Between 1995 and 2000, approximately 40 acres of land within the drainage area directly tributary to Upper Phantom Lake were converted to urban land uses, primarily through the conversion of agricultural lands to residential land uses.

The drainage area directly tributary to Lower Phantom Lake was somewhat more urbanized than Upper Phantom Lake, reflecting the earlier settlement of this portion of the community. As indicated in Table 9, as of 2000, about 945 acres, or about 40 percent, of the drainage area directly tributary to Lower Phantom Lake were devoted to urban land uses. The dominant urban land use was residential, encompassing about 515 acres, or 55 percent of the area in urban use. As of 2000, about 1,320 acres, or about 60 percent of the drainage area directly tributary to the Lower Phantom Lake, were still devoted to rural land uses. About 650 acres, or about 50 percent of the rural area, were in agricultural land uses. Woodlands, wetlands, and surface waters, including the surface area of Lower Phantom Lake, accounted for approximately 670 acres, or about a further 50 percent, of the area in rural uses. Between 1995 and 2000, approximately 40 acres of land within the drainage area directly tributary to Lower Phantom Lake also were converted to urban land uses, primarily through the conversion of agricultural lands to residential land uses.

Within the total drainage area tributary to the Phantom Lakes, as of 2000, about 12,200 acres, or about one-quarter of the total drainage area, were devoted to urban land uses, as shown in Table 10. The dominant urban land use was residential, encompassing about 7,900 acres, or about 65 percent, of the area in urban use. As of 2000, about 40,000 acres, or about three-quarters of the total drainage area tributary to the Phantom Lakes, were still devoted to rural land uses. About 24,000 acres, or about 60 percent of the rural area, were in agricultural land

Map 11

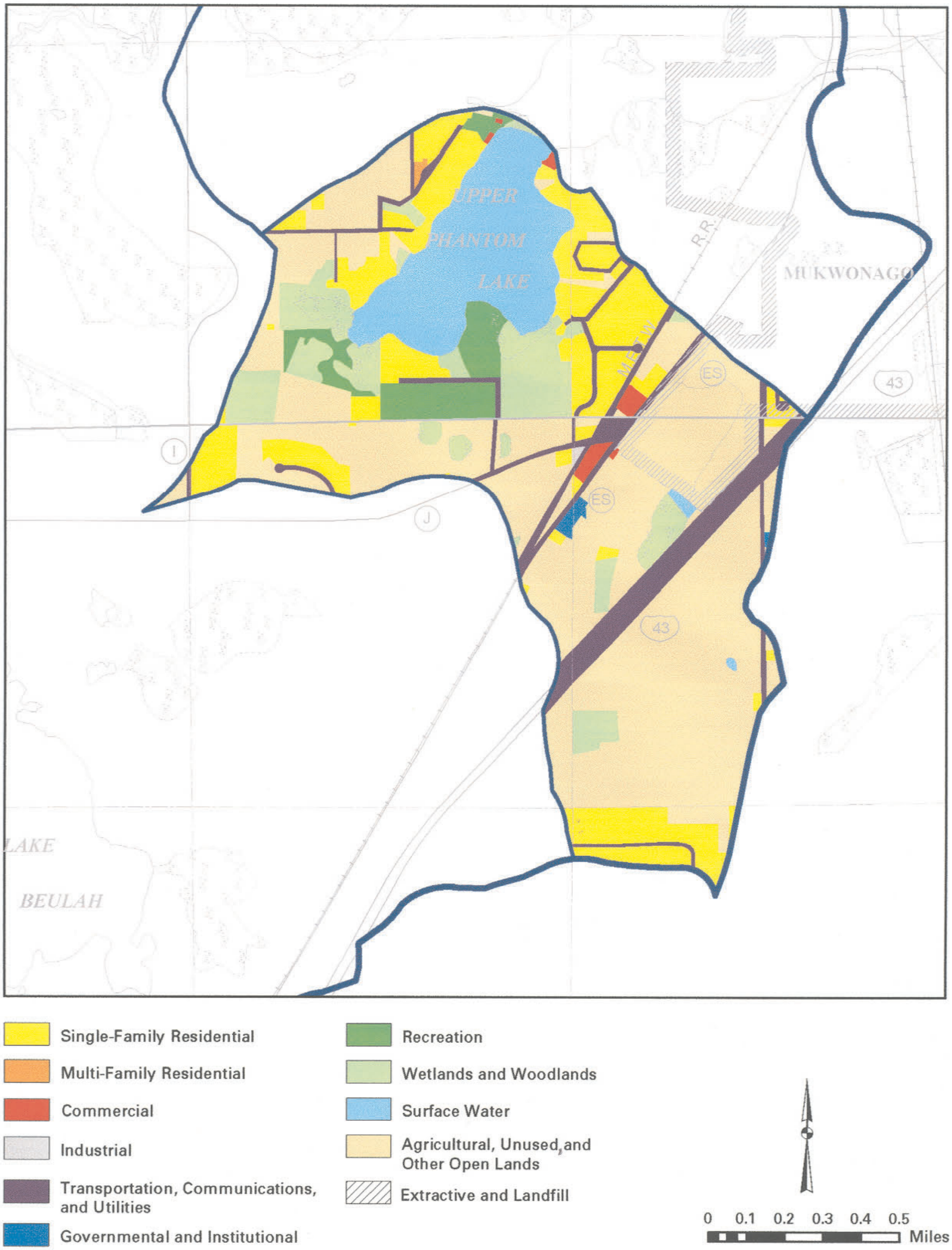
HISTORIC URBAN GROWTH WITHIN THE DRAINAGE AREA TRIBUTARY TO THE PHANTOM LAKES



Source: SEWRPC.

Map 12

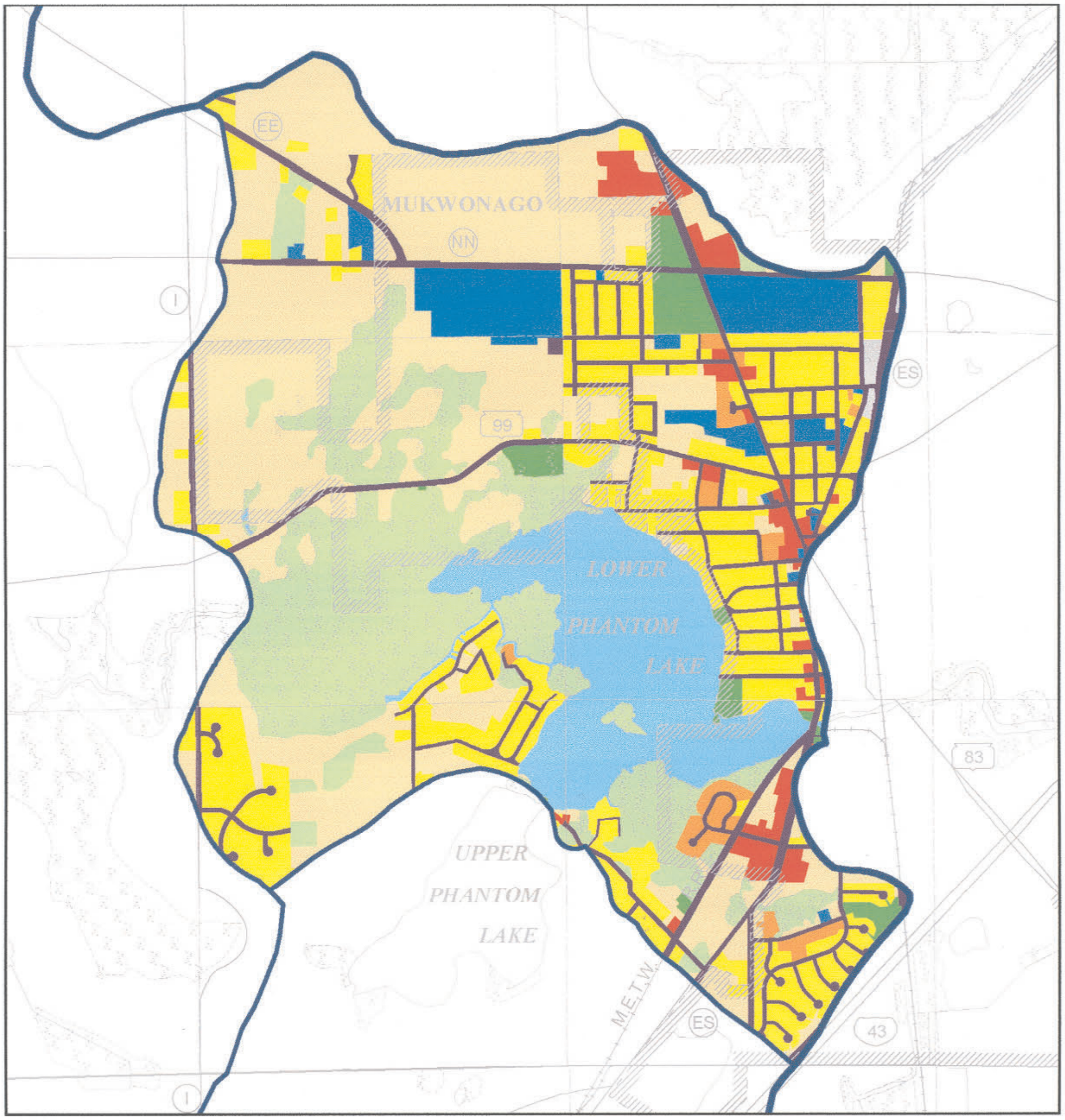
EXISTING LAND USE WITHIN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO UPPER PHANTOM LAKE: 2000



Source: SEWRPC.

Map 13

EXISTING LAND USE WITHIN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO LOWER PHANTOM LAKE: 2000



Single-Family Residential
Multi-Family Residential
Commercial
Industrial
Transportation, Communications, and Utilities
Governmental and Institutional
Recreation
Wetlands and Woodlands
Surface Water
Agricultural, Unused, and Other Open Lands
Extractive and Landfill

0 0.1 0.2 0.3 0.4 0.5 Miles

Source: SEWRPC.

Table 8

EXISTING AND PLANNED LAND USE WITHIN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO UPPER PHANTOM LAKE: 2000 AND 2020

Land Use Categories[a]	2000		2020	
	Acres	Percent of Direct Tributary Drainage Area	Acres	Percent of Direct Tributary Drainage Area
Urban				
Residential	190	18.5	353	34.6
Commercial	4	0.4	7	0.7
Industrial	1	0.1	1	0.1
Governmental and Institutional	2	0.2	3	0.3
Transportation, Communication, and Utilities	90	8.9	128	12.5
Recreational	41	4.0	24	2.4
Subtotal	328	32.1	516	50.6
Rural				
Agricultural	474	46.5	287	28.1
Wetlands	29	2.8	29	2.8
Woodlands	72	7.2	72	7.1
Water	116	11.4	116	11.4
Subtotal	692	67.9	504	49.4
Total	1,020	100.0	1,020	100.0

[a]*Parking included in associated use.*

Source: SEWRPC.

uses. Woodlands, wetlands, and surface waters, including the surface areas of Upper and Lower Phantom Lakes, accounted for approximately 15,765 acres, or about 40 percent, of the area in rural uses.

Under planned 2020 conditions, the trend toward more intense urban land usage is also expected to be reflected in the total drainage area tributary to the Lakes.[1] As noted above, much of this development is expected to occur as agricultural lands are converted to urban lands, primarily for residential use. However, some redevelopment of existing properties and the reconstruction of existing single-family homes may be expected, especially on lakeshore properties. Recent surveillance indicates that such changes in land usage appear to be due to large-lot residential development. If this trend continues, some of the open space areas remaining in the drainage area are likely to be replaced with large-lot urban residential development, resulting in the potential for increased pollutant loadings to the Lake. This development could occur in the form of residential clusters on smaller lots within conservation subdivisions, thereby preserving portions of the remaining open space and, thus, reducing the impacts on the Lake.[2]

LAND USE REGULATIONS

The comprehensive zoning ordinance represents one of the most important and significant tools available to local units of government in directing the proper use of lands within their area of jurisdiction. Local zoning regulations

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[1]*SEWRPC Planning Report No. 45,* A Regional Land Use Plan for Southeastern Wisconsin: 2020, *December 1997; SEWRPC Community Assistance Planning Report No. 209,* A Development Plan for Waukesha County, Wisconsin, *August 1996.*

[2]*See SEWRPC Planning Guide No. 7,* Rural Cluster Development Guide, *December 1996.*

Table 9

EXISTING AND PLANNED LAND USE WITHIN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO LOWER PHANTOM LAKE: 2000 AND 2020

Land Use Categories[a]	2000 Acres	2000 Percent of Direct Tributary Drainage Area	2020 Acres	2020 Percent of Direct Tributary Drainage Area
Urban				
Residential	516	22.8	824	36.4
Commercial	34	1.5	82	3.6
Industrial	5	0.2	5	0.2
Governmental and Institutional	95	4.2	135	6.0
Transportation, Communication, and Utilities	252	11.2	298	13.2
Recreational	43	1.9	47	2.1
Subtotal	945	41.8	1,391	61.5
Rural				
Agricultural	648	28.6	203	9.0
Wetlands	365	16.2	365	16.1
Woodlands	54	2.4	54	2.4
Water	250	11.0	250	11.0
Subtotal	1,317	58.2	872	38.5
Total	2,262	100.0	2,262	100.0

[a]*Parking included in associated use.*

Source: SEWRPC.

include general, or comprehensive, zoning regulations and special-purpose regulations governing floodland and shoreland areas. General zoning and special-purpose zoning regulations may be adopted as a single ordinance or as separate ordinances; they may or may not be contained in the same document. Any analysis of locally proposed land uses must take into consideration the provisions of both general and special-purpose zoning. As already noted, the total drainage area tributary to the Phantom Lakes includes the Towns of Eagle, Genesee, Mukwonago, and Ottawa, and the Villages of Eagle, Mukwonago, North Prairie, and Wales, in Waukesha County; and the Towns of East Troy, LaGrange, and Troy, and the Villages of East Troy and Mukwonago in Walworth County. The ordinances administered by these units of government are summarized in Table 11.

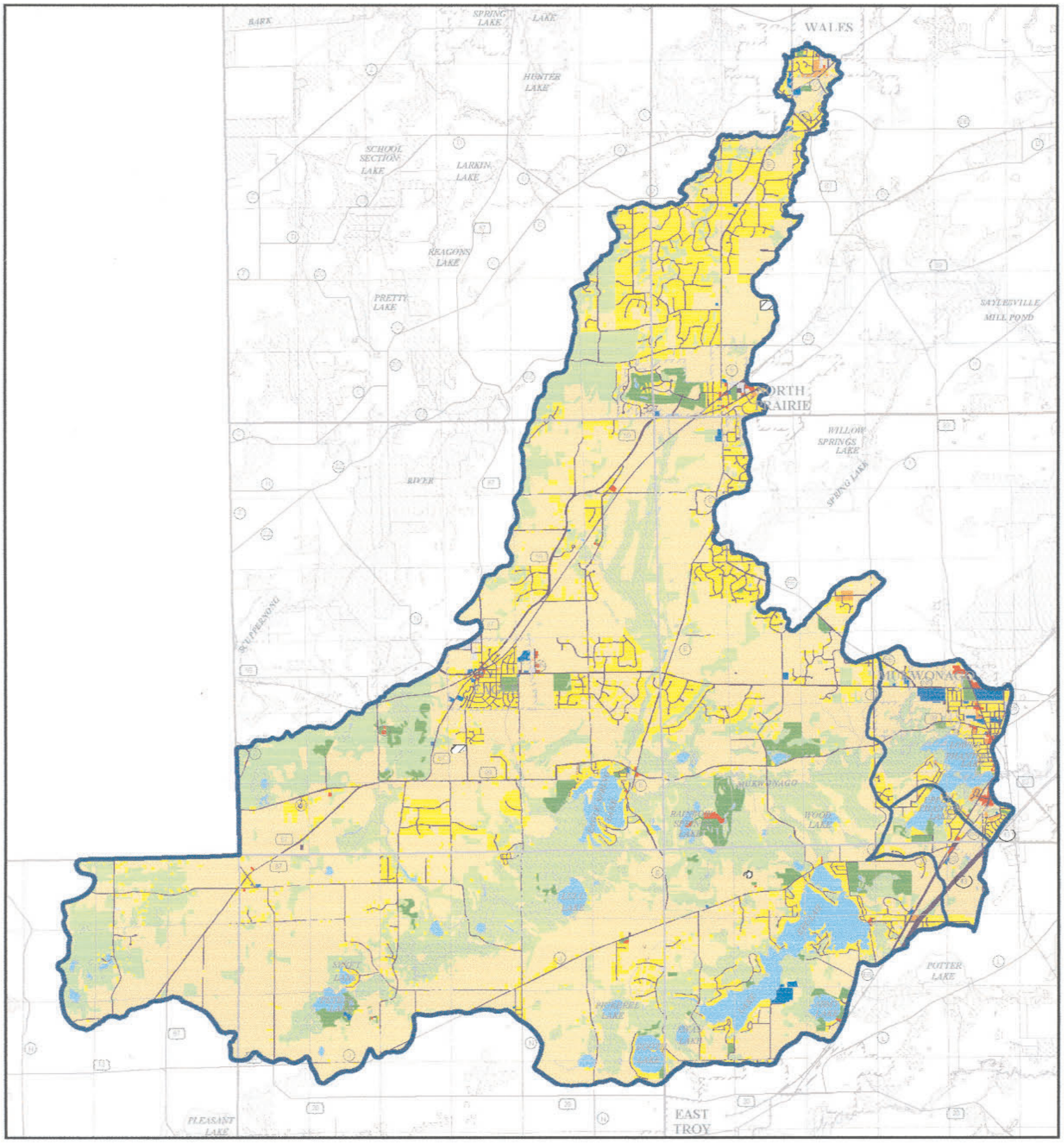
General Zoning

Villages in Wisconsin are granted comprehensive, or general, zoning powers under Section 61.35 of the *Wisconsin Statutes*. Counties are granted general zoning powers within their unincorporated areas under Section 59.69 of the *Statutes*. However, a county zoning ordinance becomes effective only in those towns that ratify the county ordinance. Towns that have not adopted a county zoning ordinance may adopt village powers, and subsequently utilize the village zoning authority conferred in Section 62.23, subject, however, to county board approval where a general-purpose county zoning ordinance exists. Alternatively, a town may adopt a zoning ordinance under Section 60.61 of the *Wisconsin Statutes* where a general-purpose county zoning ordinance has not been adopted, but only after the county board fails to adopt a county ordinance at the petition of the governing body of the town concerned.

General zoning is in effect in all communities within the drainage area tributary to the Phantom Lakes.

Map 14

EXISTING LAND USE WITHIN THE TOTAL DRAINAGE AREA TRIBUTARY TO THE PHANTOM LAKES: 2000



Single-Family Residential	Recreation
Multi-Family Residential	Wetlands and Woodlands
Commercial	Surface Water
Industrial	Agricultural, Unused, and Other Open Lands
Transportation, Communications, and Utilities	Extractive and Landfill
Governmental and Institutional	

0 1 2 3 4 Miles

Source: SEWRPC.

Table 10

EXISTING AND PLANNED LAND USE WITHIN THE DRAINAGE AREA TRIBUTARY TO UPPER AND LOWER PHANTOM LAKES: 2000 AND 2020

Land Use Categories[a]	2000 Acres	2000 Percent of Direct Tributary Drainage Area	2020 Acres	2020 Percent of Direct Tributary Drainage Area
Urban				
Residential	7,909	15.2	11,318	21.7
Commercial	97	0.2	173	0.3
Industrial	36	0.1	316	0.6
Governmental and Institutional	227	0.4	297	0.6
Transportation, Communication, and Utilities	2,621	5.0	2,417	4.6
Recreational	1,315	2.5	1,678	3.2
Subtotal	12,205	23.4	16,199	31.0
Rural				
Agricultural	24,199	46.4	29,420	39.2
Wetlands	4,512	8.6	4,484	8.6
Woodlands	8,924	17.1	8,852	17.0
Water	2,330	4.5	2,213	4.2
Subtotal	39,965	76.6	35,969	69.0
Total	52,170	100.0	52,170	100.0

[a]*Parking included in associated use.*

Source: SEWRPC.

Floodland Zoning

Section 87.30 of the *Wisconsin Statutes* requires that villages and counties, with respect to their unincorporated areas, adopt floodland zoning to preserve the floodwater conveyance and storage capacity of floodplain areas and to prevent the location of new flood-damage-prone development in flood hazard areas. The minimum standards which such ordinances must meet are set forth in Chapter NR 116 of the *Wisconsin Administrative Code*. The required regulations govern filling and development within a regulatory floodplain, which is defined as the area subject to inundation by the 100-year recurrence interval flood event, the event which has a 1 percent probability of occurring in any given year. Under Chapter NR 116, local floodland zoning regulations must prohibit nearly all forms of development within the floodway, which is that portion of the floodplain required to convey the 100-year recurrence peak flood flow. Local regulations must also restrict filling and development within the flood fringe, which is that portion of the floodplain located outside the floodway that would be covered by floodwater during the 100-year recurrence flood. Permitting the filling and development of the flood fringe area, however, reduces the floodwater storage capacity of the natural floodplain, and may thereby increase downstream flood flows and stages. It should be noted that towns may enact floodland zoning regulations which may be more restrictive than those in the County Shoreland and Floodland Protection Zoning Ordinance. All of the lands within the drainage area tributary to the Phantom Lakes currently are regulated by either the county ordinance or village ordinances for floodplain zoning.

Shoreland Zoning

Under Section 59.692 of the *Wisconsin Statutes,* counties in Wisconsin are required to adopt zoning regulations within statutorily defined shoreland areas, those lands within 1,000 feet of the ordinary high water mark (OHWM) of a navigable lake, pond, or flowage, or 300 feet of the OHWM of a navigable stream, or to the landward side of the floodplain, whichever distance is greater, within their unincorporated areas. Minimum standards for county

Table 11

LAND USE REGULATIONS WITHIN THE DRAINAGE AREA TRIBUTARY TO THE PHANTOM LAKES IN WAUKESHA AND WALWORTH COUNTIES BY CIVIL DIVISION: 2001

Community	Type of Ordinance				
	General Zoning	Floodland Zoning	Shoreland or Shoreland-Wetland Zoning	Subdivision Control	Erosion Control and Stormwater Management
Waukesha County	Adopted	Adopted	Adopted and Wisconsin Department of Natural Resources approved	Floodland and shoreland only	Adopted
Town of Eagle	Adopted	County ordinance	County ordinance	Adopted	County ordinance
Town of Genesee	County ordinance	County ordinance	County ordinance	Adopted	County ordinance
Town of Mukwonago	Adopted	County ordinance	County ordinance	Adopted	County ordinance
Town of Ottawa	County ordinance	County ordinance	County ordinance	Adopted	County ordinance
Village of Eagle	Adopted	Adopted	Adopted	Adopted	Adopted
Village of Mukwonago	Adopted	Adopted	Adopted	Adopted	Adopted
Village of North Prairie	Adopted	Adopted	Adopted	Adopted	Adopted
Village of Wales	Adopted	Adopted	County ordinance	Adopted	None
Walworth County	Adopted	Adopted	Adopted and Wisconsin Department of Natural Resources approved	Adopted	Adopted
Town of East Troy	County ordinance	County ordinance	County ordinance	Adopted	Adopted
Town of LaGrange	County ordinance	County ordinance	County ordinance	County ordinance	Adopted
Town of Troy	County ordinance	County ordinance	County ordinance	County ordinance	County ordinance
Village of East Troy	Adopted	Adopted	Adopted	Adopted	Adopted
Village of Mukwonago	Adopted	Adopted	Adopted	Adopted	Adopted

Source: SEWRPC.

shoreland zoning ordinances are set forth in Chapter NR 115 of the *Wisconsin Administrative Code*.[3] Chapter NR 115 sets forth minimum requirements regarding lot sizes and building setbacks; restrictions on cutting of trees and shrubbery; and restrictions on filling, grading, lagooning, dredging, ditching, and excavating that must be incorporated into county shoreland zoning regulations. In addition, Chapter NR 115 requires that counties place all wetlands five acres or larger and within the statutory shoreland zoning jurisdiction area into a wetland conservancy zoning district to ensure their preservation after completion of appropriate wetland inventories by the Wisconsin Department of Natural Resources.

In 1982, the State Legislature extended shoreland-wetland zoning requirements to villages in Wisconsin. Under Section 61.351 of the *Wisconsin Statutes*, villages in Wisconsin are required to place wetlands five acres or larger and located in statutory shorelands into a shoreland-wetland conservancy zoning district to ensure their preservation. Minimum standards for village shoreland-wetland zoning ordinances are set forth in Chapter NR 117 of the *Wisconsin Administrative Code*.

It should be noted that the basis for identification of wetlands to be protected under Chapters NR 115 and NR 117 is the Wisconsin Wetlands Inventory. Mandated by the State Legislature in 1978, the Wisconsin Wetlands

[3]*As of 2005, Chapter NR 115 was in the process of being refined, with significant changes being anticipated in this Chapter of the* Wisconsin Administrative Code *based upon the public review draft of the Chapter. The proposed amendments to Chapter NR 115 are intended to allow counties more flexibility in the regulation of land use in shoreland areas, and provide shoreland property owners with more land use options, while still protecting the structure and function of the aquatic resources of the State.*

Inventory resulted in the preparation of wetland maps covering each U.S. Public Land Survey township in the State. The inventory was completed for counties in Southeastern Wisconsin in 1982, the wetlands being delineated by the Regional Planning Commission on its 1980, one inch equals 2,000 feet scale, ratioed and rectified aerial photographs as discussed in Chapter V.

County shoreland zoning ordinances are in effect in all unincorporated areas of Waukesha and Walworth Counties which includes much of the drainage area tributary to the Phantom Lakes. The Villages of Eagle, Mukwonago, North Prairie and East Troy have all adopted their own Shoreland and Wetland Zoning regulations.

Subdivision Regulations

Chapter 236 of the *Wisconsin Statutes* requires the preparation of a subdivision plat whenever five or more lots of 1.5 acres or less in area are created either at one time or by successive divisions within a period of five years. The *Statutes* set forth requirements for surveying lots and streets, for plat review and approval by State and local agencies, and for recording approved plats. Section 236.45 of the *Statutes* allows any village, town, or county that has established a planning agency to adopt a land division ordinance, provided the local ordinance is at least as restrictive as the State platting requirements. Local land division ordinances may include the review of other land divisions not defined as "subdivisions" under Chapter 236, such as when fewer than five lots are created or when lots larger than 1.5 acres are created.

The subdivision regulatory powers of towns and counties are confined to unincorporated areas. Village subdivision control ordinances may be applied to extraterritorial areas, as well as to the incorporated areas. It is possible for both a county and a town to have concurrent jurisdiction over land divisions in unincorporated areas, or for a village to have concurrent jurisdiction with a town or county in the village extraterritorial plat approval area. In the case of overlapping jurisdiction, the most restrictive requirements apply. The Towns of LaGrange and Troy have each adopted their own set of subdivision ordinances. The remaining Towns and Villages in the drainage area tributary to the Phantom Lakes have adopted those subdivision control ordinances adopted and administered by Waukesha and Walworth Counties.

Construction Site Erosion Control and Stormwater Management Regulations

Section 62.23 of the *Wisconsin Statutes* grants authority to villages in Wisconsin to adopt ordinances for the prevention of erosion from construction sites and the management of stormwater runoff from lands within their jurisdictions. Towns may adopt village powers and subsequently utilize the authority conferred on villages under Section 62.23 to adopt their own erosion control and stormwater management ordinances, subject, however, to county board approval where a county ordinance exists.

Waukesha and Walworth Counties have adopted construction erosion control and stormwater management ordinances. These ordinances apply to the unincorporated town lands in the county. The Waukesha County construction site erosion control ordinance applies to all lands requiring a subdivision plat or certified survey, to sites upon which construction activities will disturb 3,000 (4,000 for Walworth County) square feet or more and/or 400 cubic yards or more of material, and to sites where pipeline placement operations disturb 300 linear feet or more of land surface. These ordinances require persons engaging in land disturbing activities to employ soil erosion control practices on affected sites that are consistent with those set forth in the *Wisconsin Construction Site Best Management Practice Handbook*[4] or equivalent practices. In general, these practices are designed to minimize soil loss from disturbed sites through prior planning and phasing of land disturbing activities and use of appropriate onsite erosion control measures.

The Waukesha and Walworth County stormwater management ordinances apply to residential lands of five acres or more in areal extent, residential lands of between three and five acres in areal extent where there is at least 1.5 acres of impervious surface, nonresidential lands of 1.5 (2.0 in Walworth County) acres in areal extent where

[4]*Wisconsin League of Municipalities and Wisconsin Department of Natural Resources,* Wisconsin Construction Site Best Management Practices Handbook, *April 1994.*

there is at least 0.5 (1.0 in Walworth County) acre of impervious surface, or other lands on which development activities may result in stormwater runoff likely to harm public property or safety. Lands within an area covered by an approved stormwater management plan are specifically exempted from the Waukesha County ordinance. The stormwater management ordinance establishes performance standards to manage both rate and volume of stormwater flows from regulated sites and water quality.

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Chapter IV

WATER QUALITY

INTRODUCTION

The earliest data on water quality conditions in many Wisconsin lakes date back to the early 1900s, when E.A. Birge and C. Juday, widely recognized pioneering lake researchers from the University of Wisconsin-Madison, collected basic information on Wisconsin lakes.[1] However, most water quality information for the Phantom Lakes is relatively recent, having been collected and recorded periodically from 1992 to the present. Data for this report included Secchi-disc readings, temperature-depth profiles, and dissolved oxygen, total phosphorus and chlorophyll-*a* concentration data, as well as various other Wisconsin Department of Natural Resources reports and file data and data set forth in earlier SEWRPC reports for the period 1993 through 2004 for Upper Phantom Lake, and for the period 1992 through 1999 for Lower Phantom Lake.

EXISTING WATER QUALITY CONDITIONS

Water quality data gathered under the auspices of the Lakes Program of the University of Wisconsin-Stevens Point, Water and Environmental Analysis Laboratory (WEAL, formerly known as the Environmental Task Force Laboratory) and the Wisconsin Department of Natural Resources volunteer Self-Help Monitoring Program were used to assess Lake water quality in Upper and Lower Phantom Lakes, and to characterize the suitability of the Lakes for recreational use and for the support of fish and aquatic life. Water quality samples generally were taken seasonally from the main basin of the Lake.

Thermal Stratification

Data gathered as part of the Wisconsin Department of Natural Resources Self-Help Monitoring Program, between 1993 and 2004, indicate that water temperatures in both Upper and Lower Phantom Lakes ranged from a minimum of 32°F (0°C) during the winter to 82°F (28°C) during the summer. Additional Self-Help monitoring data suggest that Lower Phantom Lake does not thermally stratify for any significant period of time during the summer. This is not unusual for shallow lakes in southeastern Wisconsin having a maximum depth of less than 20 feet. Self-Help monitoring data for Upper Phantom Lake, in contrast, suggest that this Lake is dimictic, mixing completely two times per year and subject to thermal stratification during summer and winter. Such a condition is typical of many of the deeper lakes in the Region. This seasonal process of stratification and mixing is illustrated diagrammatically in Figure 2. Thermal stratification is a result of the differential heating of the lake water, and the resulting water temperature-density differences at various depths within the lake water column. Water is

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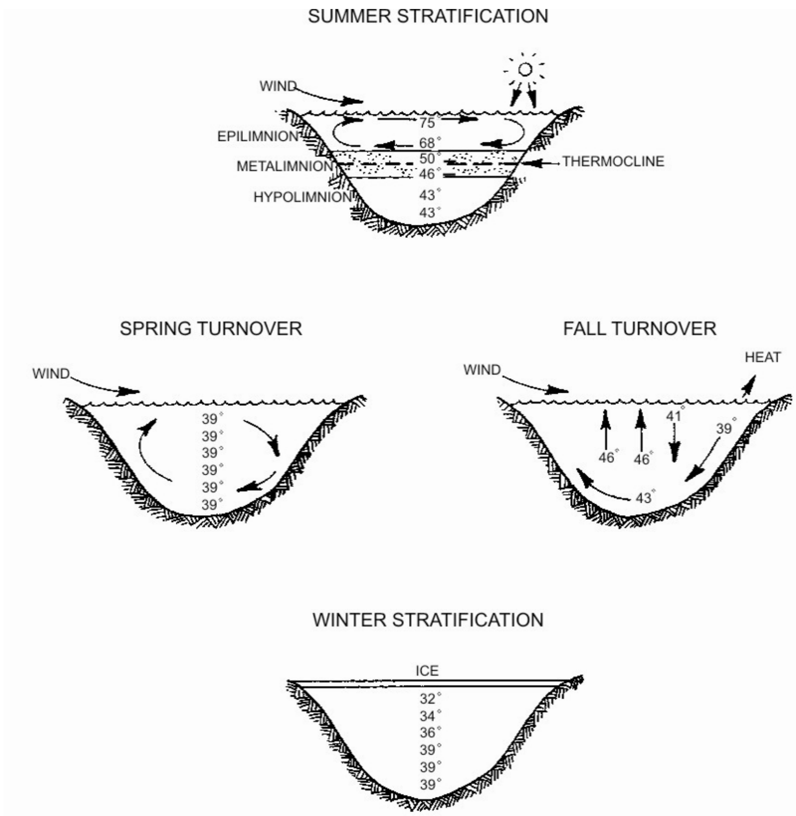
[1] *E.A. Birge and C. Juday,* The Inland Lakes of Wisconsin, *1.* The Dissolved Gases and their Biological Significance, *Bulletin, Wisconsin Geological and Natural History Survey, Volume 22, 1911.*

Figure 2

THERMAL STRATIFICATION OF LAKES



Source: University of Wisconsin-Extension and SEWRPC.

unique among liquids because it reaches its maximum density, or mass per unit of volume, at about 39°F (4°C). The development of summer thermal stratification begins in early summer, reaches its maximum in late summer, and disappears in the fall. Stratification may also occur during winter under ice cover. This annual thermal cycle for dimictic lakes such as Upper Phantom Lake is described below.

As summer begins, the Lake absorbs solar energy at the surface. Wind action and, to some extent, internal heat transfer mechanisms transmit this energy to the underlying portions of the waterbody. As the upper layer of water is heated by solar energy, a physical barrier, created by differing water densities between warmer and cooler water, begins to form between the warmer surface water and the colder, heavier bottom water, as shown in Figure 2. This barrier is marked by a sharp temperature gradient known as the “thermocline” and is characterized by a 1°C drop in temperature per one meter (or about a 2°F drop in temperature per three feet) of depth that separates the warmer, lighter, upper layer of water (the epilimnion) from the cooler, heavier, lower layer (the hypolimnion), as shown in Figure 2. Although this barrier is readily crossed by fish, provided sufficient oxygen exists, it essentially prohibits the exchange of water between the two layers. This condition has a major impact on both the chemical and biological activity in a lake.

The autumnal mixing period occurs when air temperatures cool the surface water and wind action results in the erosion of the thermocline: as the surface water cools, it becomes heavier, sinking and displacing the now relatively warmer water below. The colder water sinks and mixes under wind action until the entire column of water is of uniform temperature, as shown in Figure 2. This action, which follows summer stratification, is known as “fall turnover.”

From fall turnover until freeze up, surface waters continue to cool in response to the continued decline in ambient air temperatures. Once the temperature of the water at the surface drops to the point of maximum water density, 39.2°F, these waters will now have become more dense than the warmer waters below them. As a consequence of this density difference, the surface waters begin to “sink” to the bottom. Eventually, the entire water column is cooled to the point of maximum density at 39.2°F. The surface waters continue to cool until they reach about 32°F, and are, once again, less dense than the waters below which remain at about 39°F. At 32°F, the lake surface may then become ice covered, isolating the lake water from the atmosphere for a period of up to four months. On Upper Phantom Lake, ice cover typically exists from December until early April. As shown in Figure 2, winter stratification occurs as the colder, lighter water and ice remains at the surface, separated from the relatively warmer, heavier water near the bottom of the lake. The ice shuts the water column off from the atmospheric source of oxygen.

Spring brings a reversal of the process. Once the surface ice has melted, the upper layer of water continues to warm until it reaches 39°F, the maximum density point of water and, coincidentally, the temperature of the deeper waters below it. At this point, the entire water column is, once again, the same temperature (and density) from surface to bottom and wind action results in a mixing of the entire lake. This is referred to as “spring turnover” and usually occurs within weeks after the ice goes out, as shown in Figure 2. After spring turnover, the water at the surface continues to warm and become less dense, causing it to float above the colder, deeper water. Wind and resulting waves carry some of the energy of the warmer, lighter water to lower depths, but only to a limited extent. Thus begins the formation of the thermocline and another period of summer thermal stratification.

Dissolved Oxygen

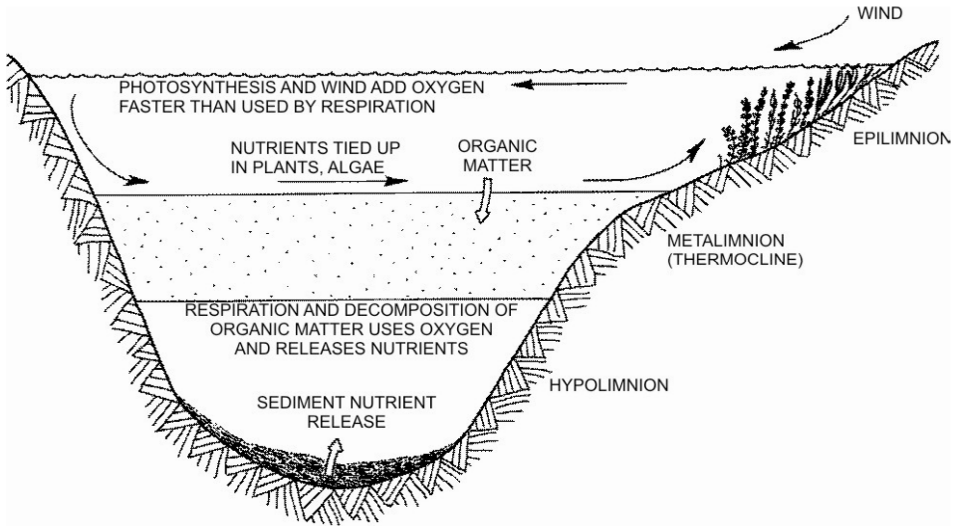
Dissolved oxygen levels are one of the most critical factors affecting the living organisms of a lake ecosystem. Self-Help monitoring data indicate that dissolved oxygen levels are generally higher in the shallower surface layers of Upper Phantom Lake, generally as the result of a combination of interchange between the water and atmosphere, stirring by wind action, and production of oxygen by plant photosynthesis. Dissolved oxygen levels were lowest at the bottom of the Lake, most likely due to decomposer organisms and chemical oxidation processes utilizing oxygen in the decay process. When any lake becomes thermally stratified, as described above, the surface supply of dissolved oxygen to the hypolimnion is cut off. Gradually, if there is not enough dissolved oxygen to meet the total demands from the bottom dwelling aquatic life and decaying organic material, the dissolved oxygen levels in the bottom waters may be reduced, even to zero, a condition known as anoxia or anaerobiasis, as shown in Figure 3. Although total oxygen depletion in the hypolimnion of Upper Phantom Lake has not been documented, it is likely to occur, given the depth of the Lake relative to Lower Phantom Lake. The absence of such documentation may be a function of the limited dissolved oxygen data collected between 1993 and 2004 from Upper Phantom Lake. No current data are available for dissolved oxygen in Lower Phantom Lake, but the likelihood of dissolved oxygen stratification in that Lake is small given the shallow nature of Lower Phantom Lake.

Fall turnover, between September and October in most years, naturally restores the supply of oxygen to the bottom waters of stratified lakes, although hypolimnetic anoxia can be reestablished during winter thermal stratification. Winter anoxia is more common during the years of heavy snowfall, when snow covers the ice, reducing the degree of light penetration and reducing algal photosynthesis that takes place under the ice. In some lakes in the Region, hypolimnetic anoxia can occur during winter stratification. Under these conditions, anoxia can contribute to the winter kill of fish. At the end of winter, dissolved oxygen concentrations in the bottom waters of the lake are restored during the period of spring turnover, which generally occurs between March and May.

Hypolimnetic anoxia is common in many of the deeper 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

Figure 3

LAKE PROCESSES DURING SUMMER STRATIFICATION



Source: University of Wisconsin-Extension and SEWRPC.

success may be severely impaired. As noted above, such stratification is likely to occur in Upper Phantom Lake but unlikely to occur in Lower Phantom Lake which lacks the depth of the Upper Lake.

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 are 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 algal and rooted aquatic plant growth. The likely import of internal loading to the nutrient budget of Upper Phantom Lakes is discussed further below.

Specific Conductance

Specific conductance is an indicator of the concentration of dissolved solids in the water; as the amount of dissolved solids increases, the specific conductance increases. During periods of thermal stratification, specific conductance can increase at the lake bottom due to an accumulation of dissolved materials in the hypolimnion. This is a consequence of the “internal loading” phenomenon noted above. As shown in Table 12, specific conductance of Upper Phantom Lake during the current study period ranged from 526 to 545 micromhos per centimeter (µmhos/cm); for Lower Phantom Lake the range was from 499 to 562 µmhos/cm. These values are within the expected range of values commonly observed in lakes in southeastern Wisconsin.[2]

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

Table 12

UPPER AND LOWER PHANTOM LAKES SURFACE WATER QUALITY DATA: 2003-2004

Water Quality Parameter	November 17, 2003		March 29, 2004		November 14, 2004	
	Upper Phantom	Lower Phantom	Upper Phantom	Lower Phantom	Upper Phantom	Lower Phantom
Specific Conductance (μS/cm)	545	562	526	499	532	541
pH	8.26	8.24	8.16	8.11	8.35	8.47
Color (SU)	9	22	6	12	12	14
Turbidity (NU)	1.9	1.6	0.5	0.8	3.0	1.9
Hardness mg/l as $CaCO_3$	263	278	275	269	260	280
Calcium (mg/l) as $CaCO_3$	103	134	120	137	113	142
Magnesium (mg/l) as $CaCO_3$	160	144	155	132	147	138
Potassium (mg/l K)	2.3	2.5	2.1	1.7	2.0	2.2
Alkalinity (mg/l) as $CaCO_3$	201	222	213	216	212	244
Total Inorganic Nitrogen (mg/l N)	0.34	0.48	0.51	0.61	0.29	0.53
Nitrate/Nitrite Nitrogen (mg/l N)	0.08	0.36	0.21	0.56	0.03	0.46
Ammonia Nitrogen (mg/l N)	0.26	0.12	0.30	0.05	0.26	0.07
Kdeldahl Nitrogen (mg/l N)	0.95	0.72	0.81	0.67	0.96	1.05
Total Nitrogen (mg/l N)	1.03	1.08	1.02	1.23	0.99	1.51
Total Phosphorus (mg/l P)	0.037	0.034	0.012	0.009	0.021	0.022
Reactive phosphorus (mg/l P)	0.012	0.013	0.006	0.005	0.010	0.004
N:P Ratio	27.8	31.8	85.0	136.7	47.1	68.6
Chloride (mg/l Cl)	35	26	34	22	38	29.5
Sulfate	34.4	30.6	33.7	24.1	35.1	25.3
Sodium (mg/l Na)	16.2	11.7	15.1	9.4	15.6	11.5

Source: University of Wisconsin-Stevens Point, Environmental Task Force Lakes Program, and SEWRPC.

Chloride

Chloride concentrations for Upper Phantom Lake ranged from 34 to 38 milligrams per liter (mg/l); for Lower Phantom Lake the range was from 22 to 29.5 mg/l. Based on a summary of lake surface water chemistry data collected from 1967 to 1979 by the Wisconsin Department of Natural Resources, the average chloride concentration for similar types of lakes was about 20 mg/l in the case of drained lakes like Upper Phantom Lake and about 21 mg/l in the case of drainage or through flow lakes like Lower Phantom Lake.[3] Since that study, there has been a generally increasing trend in chloride concentrations in lakes within the Southeastern Wisconsin Region. While there are no historic data available for Upper and Lower Phantom Lakes, the current data suggest that the chloride concentrations observed in these waterbodies are consistent with the generally increasing trend observed, as shown in Figure 4. Observed chloride concentrations during 2003 and 2004 were between 20 and 40 mg/l for both Lakes. Important sources of chlorides to lakes in southeastern Wisconsin are anthropogenic in origin because of the underlying bedrock of the Region's watersheds, and include salts used on streets and highways for winter snow and ice control, salts discharged from water softeners and salts from sewage and animal wastes.

Alkalinity and Hardness

Alkalinity is an index of the buffering capacity of a lake, or the capacity of a lake to absorb and neutralize acids. The alkalinity of a lake depends on the levels of bicarbonate, carbonate, and hydroxide ions present in the water. Lakes in southeastern Wisconsin typically have a high alkalinity because of the types of soils and underlying bedrock in the Region's watersheds. Typically, drained lakes in the region have an alkalinity of about 187 mg/l;[4] Upper Phantom Lake, a drained lake, had an alkalinity range of from 201 to 213 mg/l. Through flow lakes in the

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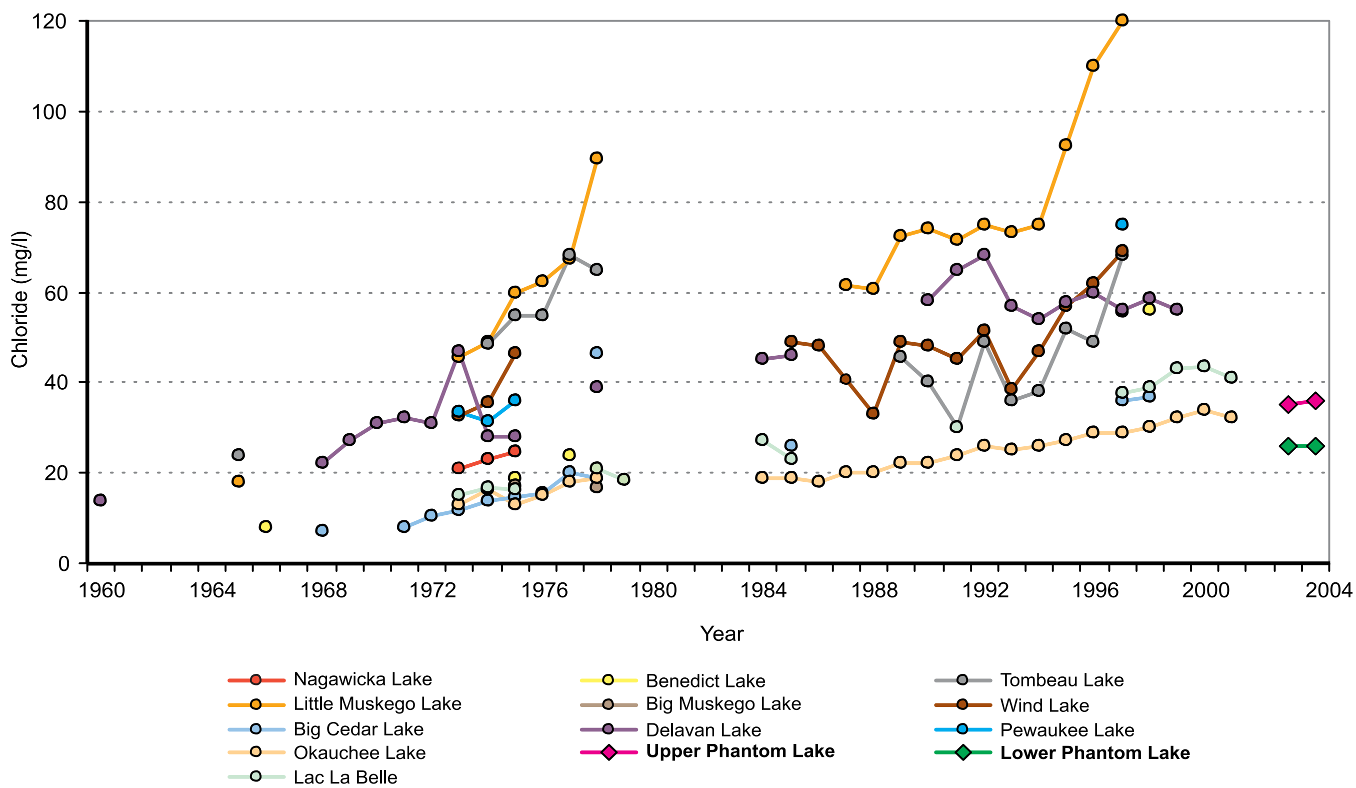
[3]Ibid.

[4]Ibid.

Figure 4

CHLORIDE CONCENTRATION TRENDS FOR ASSORTED LAKES IN SOUTHEASTERN WISCONSIN: 1960-2001



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

region typically have an alkalinity of about 216 mg/l;[5] Lower Phantom Lake, a through flow lake, had an alkalinity range of from 216 to 244 mg/l. Thus both Lakes are near the expected range of values commonly observed in lakes in southeastern Wisconsin.[6]

In contrast to alkalinity, water hardness is a measure of the multivalent metallic ion concentrations, such as those of calcium and magnesium, present in a lake. Hardness is usually reported as an equivalent concentration of calcium carbonate ($CaCO_3$). Upper Phantom Lake had a hardness that ranged from 260 to 275 mg/l while the hardness of Lower Phantom Lake ranged from 269 to 280 mg/l. Thus, as is typical for most lakes in southeastern Wisconsin, Upper and Lower Phantom Lakes are generally regarded as hardwater alkaline lakes.

Hydrogen Ion Concentration (pH)

The pH is a logarithmic measure of hydrogen ion concentration on a scale of 0 to 14 standard units, with 7 indicating neutrality. A pH above 7 indicates basic (or alkaline) water, and a pH below 7 indicates acidic water. In Upper Phantom Lake, the pH was found to range from 8.2 to 8.4 standard units, slightly above the average of 8.1

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[5]Ibid.

[6]Ibid.

for other similar lakes in the Region. In Lower Phantom Lake, the pH was found to range from 8.1 to 8.5 standard units, slightly higher than the average of 7.9 for other similar lakes in the region. Thus, the pH values are within the expected range of values commonly observed in lakes in southeastern Wisconsin.[7]

Water Clarity

Water clarity, or transparency, provides an indication of overall water quality; clarity may decrease because of turbidity caused by high concentrations of organic and inorganic suspended materials, such as algae and zooplankton, and suspended sediment, and/or because of color caused by high concentrations of dissolved organic substances. Water clarity is measured with a Secchi disc: a black-and-white, eight-inch-diameter disc, which is lowered into the water until a depth is reached at which the disc is no longer visible. This depth is known as the "Secchi-disc reading." Such measurements comprise an important part of the Wisconsin Department of Natural Resources Self-Help Monitoring Program in which citizen volunteers assist in lake water quality monitoring efforts.

Water clarity generally varies throughout the year as algal populations increase and decrease in response to changes in weather conditions and nutrient loadings. Secchi-disc depth measurements for Upper Phantom Lake gathered from 1993 to 2004 as part of the Wisconsin Department of Natural Resources Self-Help Monitoring Program averaged 9.8 feet in the spring, 8.5 feet in summer and 7.8 feet in fall; by comparison, other drained lakes in the Region typically averaged about 6.7 feet in spring, 5.4 feet in summer and 7.4 feet in fall. Secchi-disc readings for Lower Phantom Lake gathered from 1992 to 1999 as part of the same Self-Help Monitoring Program averaged 9.9 feet in spring, 9.0 feet in summer and 7.7 feet in fall; by comparison, other through flow lakes in the Region typically average about 4.5 feet in spring, 5.2 feet in summer and 5.9 feet in fall. Seasonal variations in Secchi-disc measurements for Upper Phantom Lake and Lower Phantom Lake indicate a trend of gradually diminishing Secchi-disc depths as the seasons progress from spring through summer into fall. This is not unusual for lakes in the region, and reflects the growth of algae and zooplankton during the warmer months as well as the effects of surface runoff from the watershed and inflows into the Lakes. Overall, Upper Phantom Lake data were within the expected range of values commonly observed in lakes in southeastern Wisconsin, while Lower Phantom Lake has somewhat greater transparencies than other lakes within the Region.[8]

As shown in Figure 5, the Secchi-disc transparency values for the Upper and Lower Phantom Lakes indicate fair to very good water quality compared to other lakes in southeastern Wisconsin.[9] In recent years, some lakes in southeastern Wisconsin have experienced improved water clarity that may be related to the presence of the zebra mussel, *Dreissena polymorpha,* an invasive, nonnative filter feeding mollusk known to impact water clarity in inland lakes. The presence of zebra mussels has been reported in the Phantom Lakes.

Chlorophyll-*a*

Chlorophyll-*a* is the major photosynthetic ("green") pigment in algae. The amount of chlorophyll-*a* present in the water is an indication of the biomass or amount of algae in the water. Chlorophyll-*a* concentrations for Upper Phantom Lake ranged from 3.0 to 14.5 micrograms per liter (μg/l) with a mean spring chlorophyll-*a* concentration of about 5.5 μg/l, a summer average of about 4.9 μg/l and a fall average of about 7.0 μg/l. In Lower Phantom Lake, chlorophyll-*a* concentrations ranged from 2.0 to 7.0 μg/l with a mean chlorophyll-*a* concentration of less than 5.0 μg/l. Chlorophyll-*a* levels above about 10 μg/l range result in a green coloration of the water that may be

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[7]Ibid.

[8]Ibid.

[9]Ibid.

Figure 5

PRIMARY WATER QUALITY INDICATORS FOR PHANTOM LAKES: 1992-2004

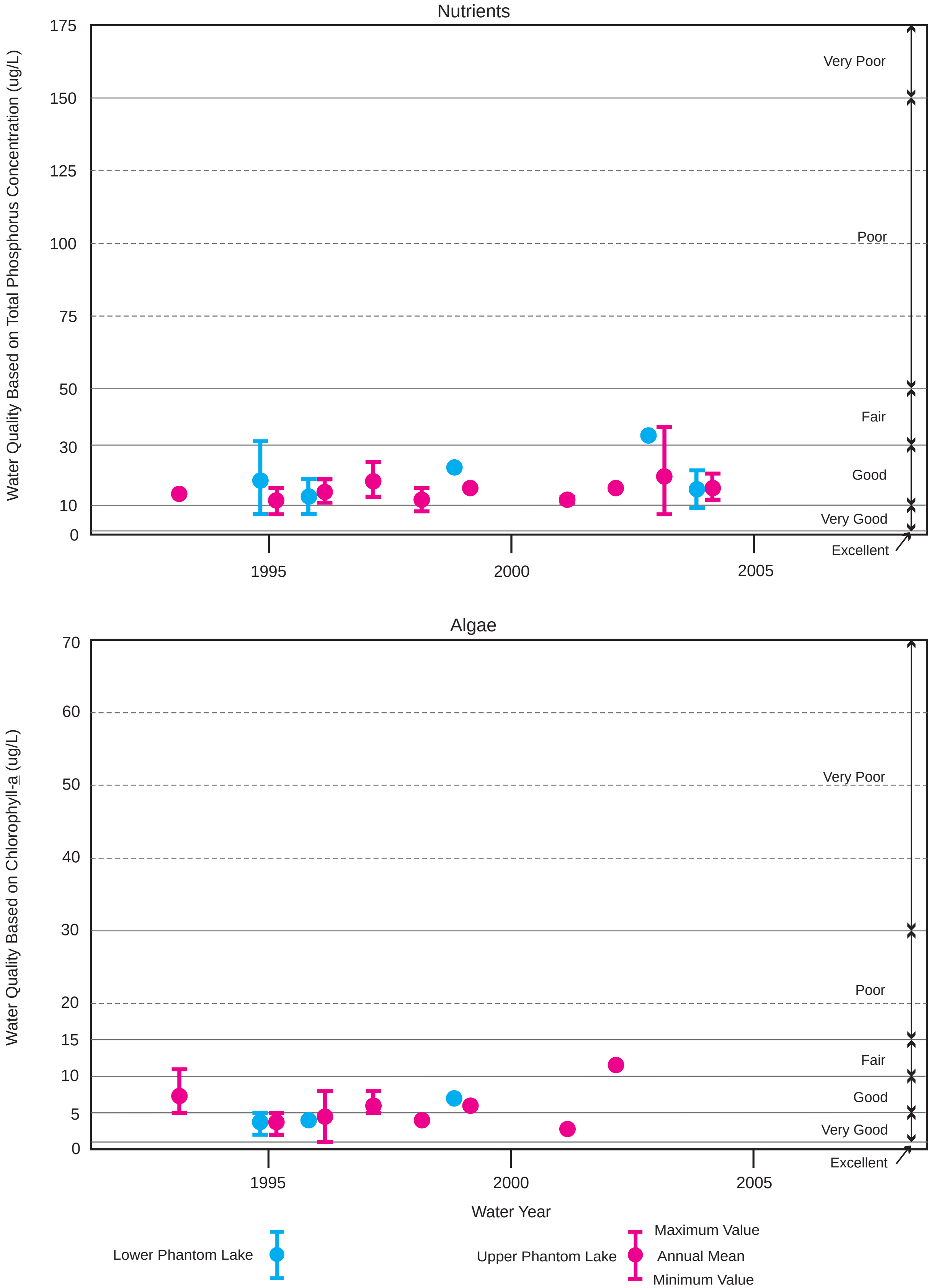
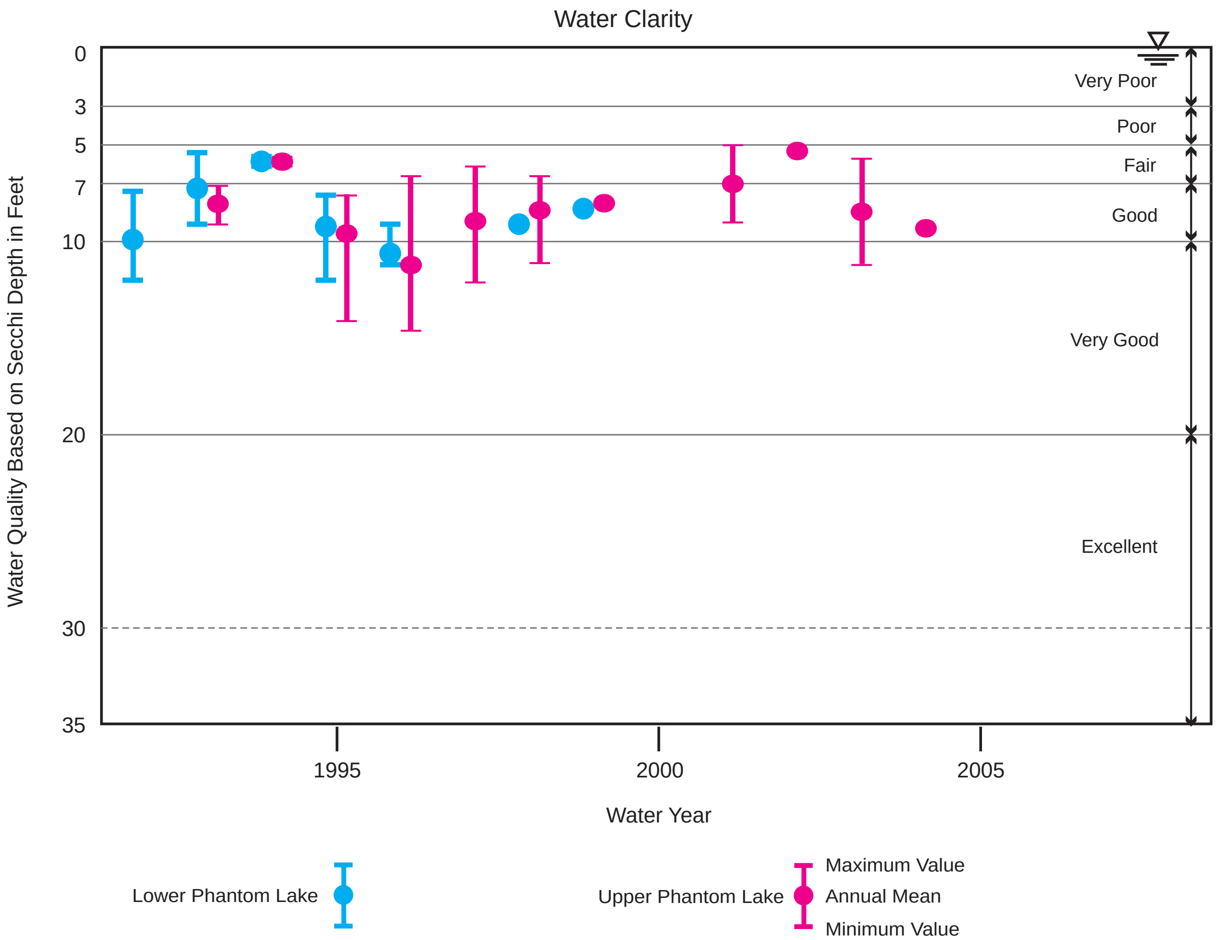


Figure 5 (continued)



Source: Wisconsin Department of Natural Resources and SEWRPC.

severe enough to impair recreational activities such as swimming and skiing.[10] Seasonal variations of chlorophyll-*a* indicated a drop in average amounts during the summer to less than 5.0 µg/l in both Upper and Lower Phantom Lakes, followed by an increase in the fall in both Lakes. These values are within the range of chlorophyll-*a* concentrations recorded in other lakes in the Region,[11] and indicate fair to very good water quality, as shown in Figure 5.

Nutrient Characteristics

Aquatic plants and algae require such nutrients as phosphorus and nitrogen for growth. In hardwater alkaline lakes, most of these nutrients are generally found in concentrations that exceed the needs of growing plants.

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[10]*J.R. Vallentyne, 1969 "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.*

[11]*R.A. Lillie and J.W. Mason, Wisconsin Department of Natural Resources Technical Bulletin No. 138,* op. cit.

However, in lakes where the supply of one or more of these nutrients is limited, plant growth is limited by the amount of that nutrient available. The ratio of total nitrogen (N) to total phosphorus (P) in lake water indicates which nutrient is the factor most likely limiting aquatic plant growth in a lake.[12] Where the N:P ratio is greater than 14:1, phosphorus is most likely to be the limiting nutrient. If the ratio is less than 10:1, nitrogen is most likely to be the limiting nutrient. As shown in Table 12, the nitrogen-to-phosphorus ratios in samples collected from both Upper and Lower Phantom Lakes were greater than 14:1. This indicates that plant production in Upper Phantom Lake was most likely limited by phosphorus.

Phosphorus in a lake can exist in several forms. Soluble phosphorus, being dissolved in the water column, is readily available for plant growth. However, its concentration can vary widely over short periods of time as plants take up and release this nutrient. Therefore, total phosphorus is usually considered a better indicator of nutrient status. Total phosphorus includes 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.

In Upper Phantom Lake, as shown in Table 12, the concentration of total phosphorus was about 12 μg/l during the spring turnover. This level was found not to exceed the level necessary to support nuisance algae blooms and fell generally within the recommended water quality standard for phosphorus, which is set forth in the Commission's adopted regional water quality management plan for lakes as 20 μg/l of total phosphorus or greater during spring turnover. Phosphorus concentrations below this level are considered in the regional plan as limiting algal and aquatic plant growths to levels consistent with the recreational and warmwater fishery and other aquatic life water use objectives, and indicative of generally good water quality conditions. In Lower Phantom Lake, the mean concentration of total phosphorus was about nine μg/l during the spring turnover and, likewise, indicates generally good water quality conditions.

The seasonal gradients of phosphorus concentration between the epilimnion and hypolimnion reflect the biogeochemistry of this growth element. When aquatic organisms die, they usually sink to the bottom of the lake, where they are decomposed. Phosphorus from these organisms is then either stored in the bottom sediments or rereleased into the water column. Because phosphorus is not highly soluble in water, it readily forms insoluble precipitates with calcium, iron, and aluminum under aerobic conditions and accumulates, predominantly, in the lake sediments. If the bottom waters become depleted of oxygen during stratification, as may be the case in Upper Phantom Lake, certain chemical changes occur, especially the change in the oxidation state of iron from the insoluble Fe^{3+} state to the more soluble Fe^{2+} state. The effect of these chemical changes is that phosphorus becomes soluble and is more readily released from the sediments. This process also occurs under aerobic conditions, but generally at a slower rate than under anaerobic conditions. As the waters mix, this phosphorus may be widely dispersed throughout the lake waterbody and become available for algal growth.

CHARACTERISTICS OF BOTTOM SEDIMENT

Sediment composition has an important effect on the biogeochemistry of a lake. Sediment particles serve as transport mechanisms for a variety of pollutants and play a key role in establishing benthic habitat and macrophyte substrate.

In 1982, the Wisconsin Department of Natural Resources published a Feasibility Study for the Phantom Lakes in which it was reported that in the eastern part of Lower Phantom Lake the sediment was estimated to contain approximately 2.4 million cubic yards of soft sediment, or about one-half of the original impoundment volume.[13] Sediment thicknesses measured during that study averaged greater than six feet. There is no current data for

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[12]*M.0. 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.*

[13]*Wisconsin Department of Natural Resources Bureau of Water Resources Management Inland Lakes Renewal Section,* Phantom Lakes Waukesha County Feasibility Study Results; Management Alternatives*, 1982.*

sediment thickness or composition for either Upper or Lower Phantom Lakes. In Upper Phantom Lake, given the significance of the groundwater inflows to the hydrologic budget of the Lake, it is likely that some of the sediment deposition reported is comprised of marl formed by precipitation of calcium carbonate from groundwater.

POLLUTION LOADINGS AND SOURCES

Pollutant loads to a lake are generated by various natural processes and human activities that take place in the drainage 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 the lake as dry fallout and direct precipitation. Pollutants transported across the land surface enter the 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 drained lakes, like Upper Phantom Lake, pollutant loadings transported across the land surface directly tributary to a lake, in the absence of identifiable or point source discharges from industries or wastewater treatment facilities, comprise the principal route by which contaminants enter the waterbody.[14] In through-flow lakes, like Lower Phantom Lake, the total drainage area tributary to the Lake, in this case encompassing the entire drainage basin of the Mukwonago River, is often of a size large enough to elevate exposure to potential pollutant loadings. Currently, there are no significant point source discharges of pollutants to the Phantom Lakes or to the surface waters tributary to the Phantom Lakes. For this reason, the discussion that follows is based upon nonpoint source pollutant loadings to the Phantom Lakes.

Nonpoint sources of water pollution include urban sources, such as runoff from residential, commercial, transportation, construction, and recreational activities and from onsite sewage disposal systems; and rural sources, such as runoff from agricultural lands. The tributary drainage area of Upper Phantom Lake is about 1,020 acres in areal extent; the drainage area directly tributary to Lower Phantom Lake is about 2,262 acres in areal extent. Both of these drainage areas are contained within the 52,170 acre total drainage area tributary to Lower Phantom Lake, which drainage area includes Upper Phantom Lake. Nonpoint-sourced phosphorus loads to the Phantom Lakes were estimated using the Wisconsin Lake Model Spreadsheet (WILMS version 3.0).

Phosphorus Loadings

Phosphorus has been identified as the factor generally limiting aquatic plant growth in the Phantom Lakes. Thus, excessive levels of phosphorus in either lake are likely to result in conditions that interfere with the desired use of that lake. During the study period, as shown in Table 13, existing year 2000 phosphorus sources to the Lakes were identified and quantified using Commission land use inventory data.

Table 13 sets forth the estimated phosphorus loads to Upper Phantom Lake. It was estimated that, under year 2000 conditions, the total phosphorus load to Upper Phantom Lake was about 160 pounds.

Table 13 also sets forth the estimated phosphorus loads to Lower Phantom Lake. It was estimated that, under year 2000 conditions, the total phosphorus load to Lower Phantom Lake was about 20,155 pounds. This total loading is not dissimilar to the estimated 1975 phosphorus loading to the Lakes which was estimated at about 17,150 pounds of phosphorus as set forth in the adopted regional water quality management plan.[15] However, it is higher

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[14]*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.*

[15]*SEWRPC Planning Report No. 30,* A Regional Water Quality Management Plan for Southeastern Wisconsin—2000, *Volume Two,* Alternative Plans, *February 1979.*

Table 13

ESTIMATED TOTAL PHOSPHORUS LOADS TO UPPER AND LOWER PHANTOM LAKES: 2000

Source	Upper Phantom Lake			Lower Phantom Lake[a]		
	Area (acres)	Total Loading (pounds per year)	Percent Distribution	Area (acres)	Total Loading (pounds per year)	Percent Distribution
Urban						
Residential Land	281	13[b]	8	10,758	957[b]	5
Commercial Land	4	2	1	97	44	<1
Industrial Land	1	- -	- -	36	48	<1
Recreational Land	42	5	3	1,315	352	2
Subtotal	328	20	12	12,206	1,401	7
Rural						
Agricultural Land	474	128	79	24,199	17,237	86
Atmospheric Contribution (area of receiving surface water)	116	11	7	2,330	519	3
Woodlands	73	2	1	8,923	715	3
Wetlands	29	1	1	4,512	284	1
Subtotal	692	142	88	39,964	18,755	93
Total	1,020	162	100	52,170	20,156	100

[a]*Includes the contribution to the total phosphorus load from Upper Phantom Lake.*

[b]*Includes the contribution from onsite sewage disposal systems that remain in use outside of the portion of the tributary drainage area to the Phantom Lakes served by public sanitary sewerage systems, estimated as ranging from approximately 10 pounds per year to as much as 1,600 pounds per year for the area directly tributary to Upper Phantom Lake and 180 pounds per year for the additional total area tributary to Lower Phantom Lake, yielding a total of 190 to 1,360 pounds per year to Lower Phantom Lake, depending upon soil type, system condition, and system location. For purposes of this analysis, to lower limit loads of 10 and 180 pounds per year to Upper and Lower Phantom Lakes, respectively, were used as the contribution from onsite sewage disposal systems under year 2000 conditions, as those values provided the loadings that were best correlated to the measured in-lake phosphorus concentrations. A more-detailed analysis is required to precisely determine the impact of onsite sewage disposal systems on the Lakes.*

Source: SEWRPC.

than the then forecast year 2000 phosphorus loadings to the Lakes, which were estimated to be about 16,725 pounds of phosphorus annually. This difference may be related in part to the fact that the adopted regional water quality management plan anticipated that onsite sewage treatment systems serving lands adjacent to Upper Phantom Lake and portions of Lower Phantom Lake would have been replaced by public water-borne sanitary sewerage service. As noted, the electors and property owners of the Phantom Lakes Management District determined not to proceed with the implementation of such sewerage services at this time. Consequently, any anticipated benefits expected to be achieved through the provision of public water-borne sanitary sewerage services have not been realized.

Phosphorus release from the lake bottom sediments—internal loading—may also contribute phosphorus to Lakes. However, this loading was assumed to be negligible given the good agreement between predicted and observed phosphorus concentrations.

Under 2020 conditions, as set forth in the Waukesha County development plan and adopted regional land use plan, the annual total phosphorus load to the Lakes is anticipated to continue to diminish slightly as agricultural activities within the drainage area tributary to Phantom Lakes are replaced by urban residential land uses. However, this trend may be offset by the increasing utilization of agro-chemicals in urban landscaping.[16] Studies

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[16]*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.*

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.[17]

Sediment Loadings

The estimated sediment budget for Upper Phantom Lake under existing 2000 land use conditions is shown in Table 14. A total annual sediment loading of about 110 tons of sediment was estimated to be contributed to Upper Phantom Lake. Of the likely annual sediment load, it was estimated that about 99 percent of the total loading was contributed by runoff from rural lands, with minimal masses of sediment, about 2.4 tons, being contributed from urban lands and by direct precipitation onto the Lake surface. Of the sediment load generated from rural land uses, almost all of the load, about 99 percent, was indicated as being of agricultural origin.

The estimated sediment budget for Lower Phantom Lake under existing 2000 land use conditions also is shown in Table 14. A total annual sediment loading of about 5,500 tons of sediment was estimated to be contributed to Lower Phantom Lake from the Mukwonago River watershed. Of the likely annual sediment load, it was estimated that about 99 percent of the total loading was contributed by runoff from rural lands, with minimal masses of sediment, about 122 tons, being contributed from urban lands and by direct precipitation onto the Lake surface. Of the sediment load generated from rural land uses, almost all of the load, about 99 percent, was indicated as being of agricultural origin.

Under planned 2020 conditions, as set forth in the Waukesha County development plan and adopted regional land use plan, the annual sediment load to the Lakes is anticipated to decrease as agricultural lands become fallow and are converted to urban land uses.

Urban Heavy Metals Loadings

Urbanization brings with it increased use of metals and other materials that contribute pollutants to aquatic systems. Table 14 sets forth the estimated loadings of copper, zinc, and cadmium likely to be contributed to Upper Phantom Lake from urban development surrounding the Lake. The majority of these metals become associated with sediment particles and are likely to be encapsulated into the bottom sediments of the Lake.

The estimated heavy metal budget for Upper Phantom Lake under existing 2000 land use conditions is shown in Table 14. Less than one pound of copper and about two pounds of zinc were estimated to be contributed annually to Upper Phantom Lake from urban lands.

The estimated heavy metal budget for Lower Phantom Lake under existing 2000 land use conditions is shown in Table 14. Less than one pound of copper and about 130 pounds of zinc were estimated to be contributed annually to Lower Phantom Lake from urban lands.

Under 2020 conditions, as set forth in the Waukesha County development plan and adopted regional land use plan, the annual heavy metal loads to the Lake are anticipated to increase as rural agricultural lands are converted to urban land uses.

RATING OF TROPHIC CONDITION

Lakes are commonly classified according to their degree of nutrient enrichment—or 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.

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[17]Ibid.

Table 14

ESTIMATED TOTAL SEDIMENT AND HEAVY METAL LOADS TO UPPER AND LOWER PHANTOM LAKES: 2000

Source	Upper Phantom Lake				Lower Phantom Lake[a]			
	Area (acres)	Sediment Loading (tons per year)	Copper Loading (pounds per year)	Zinc Loading (pounds per year)	Area (acres)	Sediment Loading (tons per year)	Copper Loading (pounds per year)	Zinc Loading (pounds per year)
Urban								
Residential Land	281	1.8	- -	2.3	10,758	104.9	- -	129.1
Commercial and Industrial Lands	5	0.1	0.06	0.1	133	1.3	0.06	1.6
Recreational Land	42	0.5	- -	- -	1,315	15.8	- -	- -
Subtotal	328	2.4	0.06	2.4	12,206	121.9	0.06	130.7
Rural								
Agricultural Land	474	106.6	- -	- -	24,199	5,444.5	- -	- -
Atmospheric Contribution (receiving surface water)	116	<0.1	- -	- -	2,330	<0.1	- -	- -
Woodlands	73	0.1	- -	- -	8,923	16.5	- -	- -
Wetlands	29	0.1	- -	- -	4,512	11.8	- -	- -
Subtotal	692	106.8	- -	- -	39,964	5,472.9	- -	- -
Total	1,020	109.2	0.06	2.4	52,170	5,594.8	0.06	130.7

[a]*Includes the contribution to the total phosphorus load from Upper Phantom Lake.*

Source: SEWRPC.

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.

Several numeric "scales," based on one or more water quality indicators, 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 is applies. In this case, two indices, appropriate for Wisconsin lakes, have been used; namely, the Vollenweider-OECD open-boundary trophic classification system,[18] and the Wisconsin Trophic State Index value (WTSI).[19] The WTSI is a refinement

[18]*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.*

[19]*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.*

of the Carlson Trophic State Index (TSI).[20] The WTSI is designed to account for the greater humic acid content—brown water color—present in Wisconsin lakes, and has been adopted by the Wisconsin Department of Natural Resources for use in lake management investigations.

Vollenweider Trophic State Classification

Using the Vollenweider trophic system and applying the data in Table 12,[21] the Phantom Lakes would be classified as having about a 58 percent probability of being mesotrophic based upon phosphorus levels, as shown in Figure 6. The Lakes would have about an 8 percent probability of being eutrophic, and a 34 percent probability of being oligotrophic, based upon mean annual phosphorus concentrations. Based upon chlorophyll-*a* levels, the Lakes would be classified as having about a 60 percent probability of being mesotrophic, with about a 20 percent probability of being either eutrophic or oligotrophic, as shown in Figure 6. Based upon Secchi-disc readings, the Lakes would be classified as having a 50 percent probability of being eutrophic, with a 35 percent probability of being mesotrophic, a 15 percent probability of being hypertrophic, and a 10 percent probability of being oligotrophic, as shown in Figure 6.

While these indicators result in slightly differing lake trophic state classifications, it may be concluded that Upper and Lower Phantom Lakes should be classified as mesotrophic lakes, or lakes with acceptable water quality for most uses.

Trophic State Index

The Wisconsin Trophic State Index (WTSI) assigns a numerical trophic condition rating based on Secchi-disc transparency, and total phosphorus and chlorophyll-*a* concentrations. The original Trophic State Index as developed by Professor Robert E. Carlson has been modified for Wisconsin lakes by the Wisconsin Department of Natural Resources using data from 184 lakes throughout the State.[22] The Wisconsin Trophic State Index (WTSI) ratings for the Upper and Lower Phantom Lakes are shown in Figure 7 as a function of sampling date. Based on the Wisconsin Trophic State Index rating of between 40 and 55, Upper Phantom Lake may be classified as mesotrophic. Likewise, Lower Phantom Lake can also be classified as mesotrophic based upon a similar range in Wisconsin Trophic State Index ratings. Figure 7 shows almost no change in lake trophic status between 1990 and 2005, with the WTSI values remaining nearly constant within a range of seasonal and inter-annual variation.

SUMMARY

The Phantom Lakes represent typical hardwater, alkaline lakes that are considered to have relatively good water quality. Physical and chemical parameters measured during the study period indicated that the water quality was within the “fair” to “very good” range, depending upon the parameters considered. Total phosphorus levels were found to be generally below the level considered to cause nuisance algal and macrophytic growths. Summer stratification was likely to occur in Upper Phantom Lake, but unlikely to occur in Lower Phantom Lake due to the latter’s shallow depths. The surface waters of the Lakes remained well oxygenated and supported healthy fish populations. Winterkill was not a problem in the Phantom Lakes because of the substantial volume of Upper Phantom Lake that provided adequate oxygenated water volume and refugia for fishes from Lower Phantom Lake

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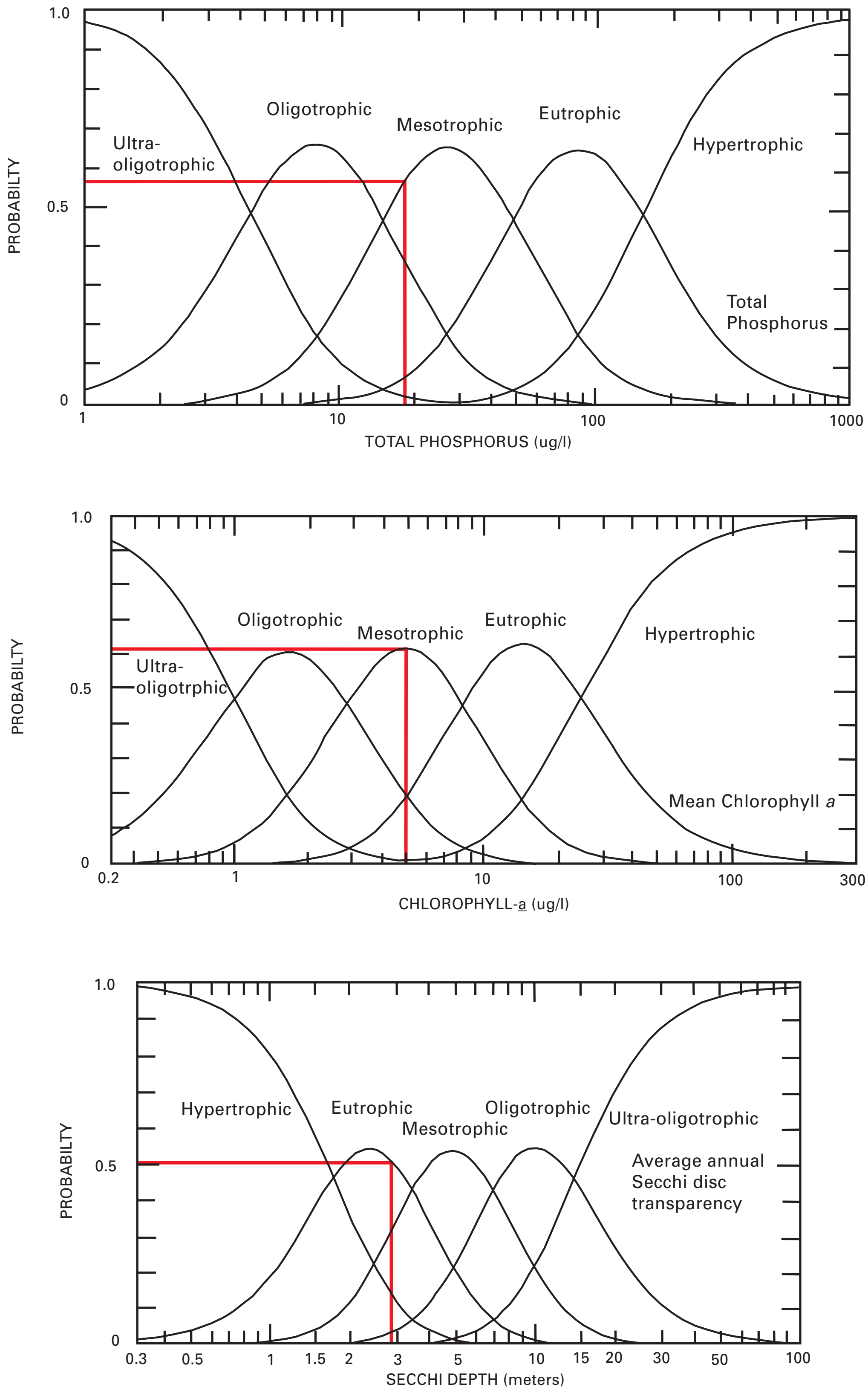
[20]*R.E. Carlson, “A Trophic State Index for Lakes,”* Limnology and Oceanography*, Vol. 22, No. 2, 1977.*

[21]*Statistical analysis of the data set forth in Table 12 suggests that the average values of the water quality parameters of concern: Secchi-disc transparency, total phosphorus concentration, and chlorophyll-*a *concentration, are statistically the same: mean Secchi-disc transparency in Upper Phantom Lake is 8.8 +/- 2.5 feet and in Lower Phantom Lake 9.5 +/- 2.7 feet; mean total phosphorus concentration in Upper Phantom Lake is 15 +/- 6.0 µg/l and in Lower Phantom Lake 19 +/- 9.0 µg/l; and, mean chlorophyll-*a *concentration in Upper Phantom Lake is 5.5 +/- 2.9 µg/l and in Lower Phantom Lake 4.3 +/- 1.8 µg/l. Consequently, both Lakes are assessed in the Vollenweider analysis using a single numeric value for each descriptor.*

[22]*R.A. Lillie, S. Graham, and P. Rasmussen,* op. cit.

Figure 6

TROPHIC STATE CLASSIFICATION OF THE PHANTOM LAKES BASED ON THE VOLLENWEIDER MODEL: 1992-2004



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 7

WISCONSIN TROPHIC STATE INDEX FOR PHANTOM LAKES: 1992-2004

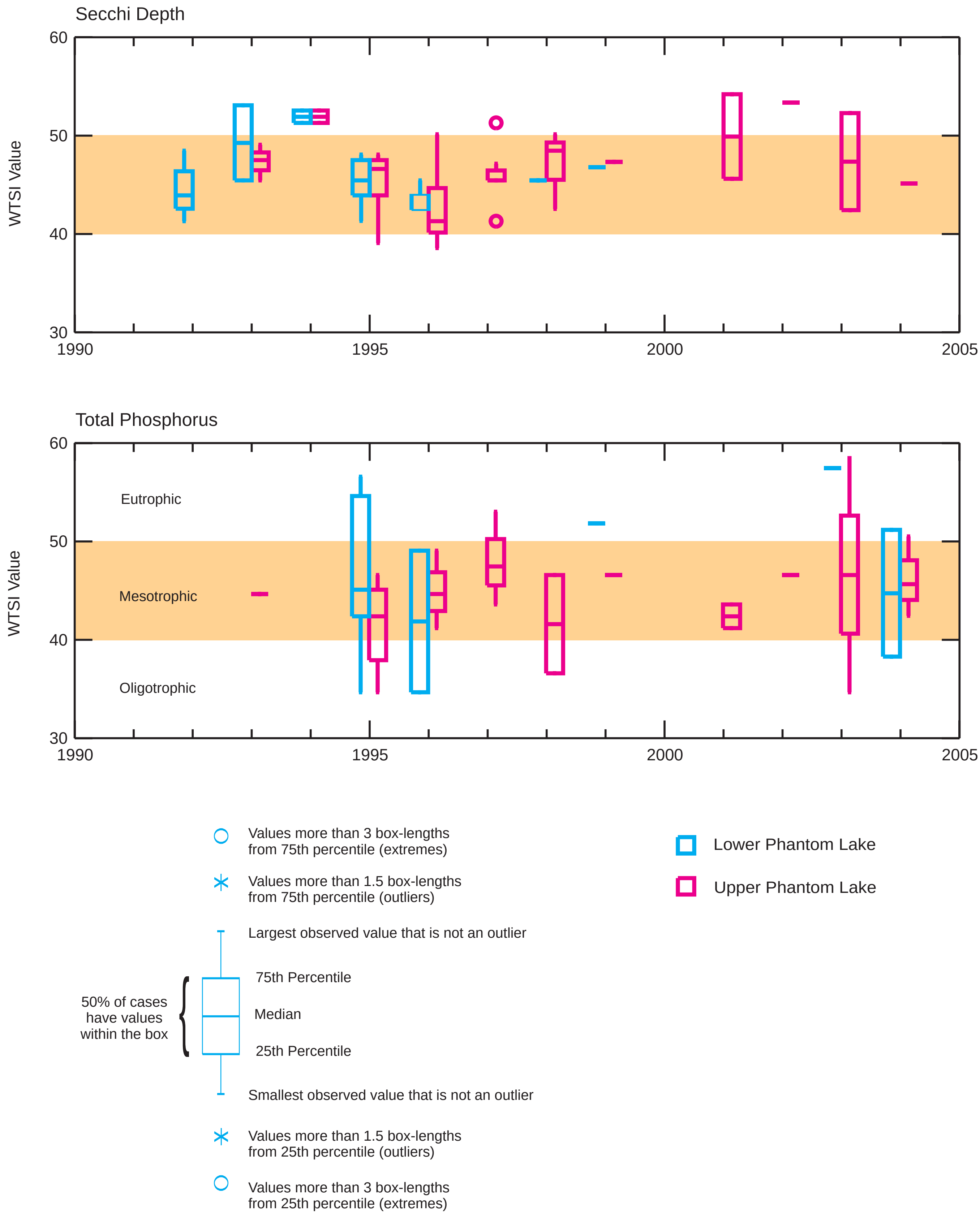
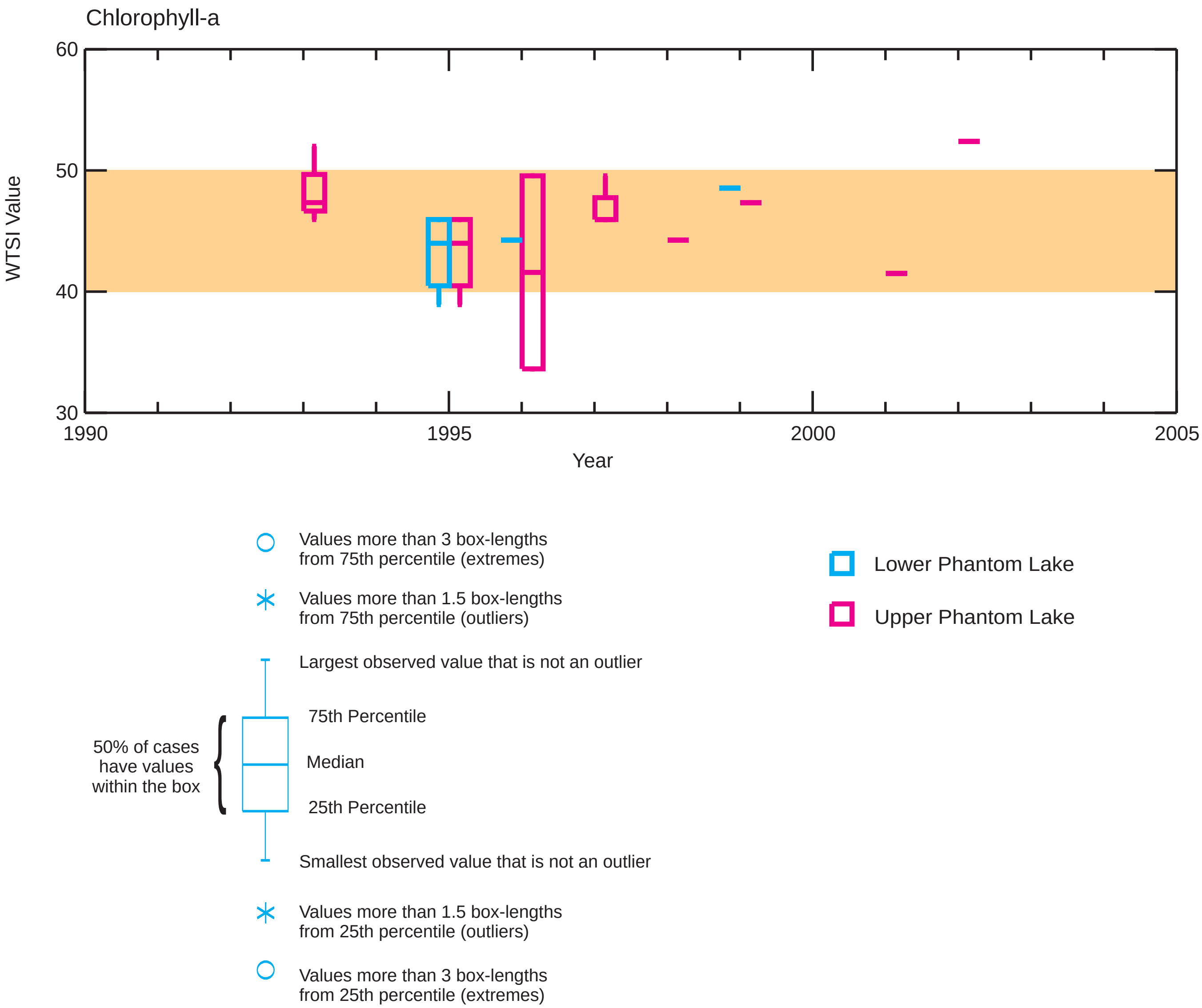


Figure 7 (continued)



Source: Wisconsin Department of Natural Resources and SEWRPC.

for the support of fish throughout the winter. Internal releases of phosphorus from the bottom sediments were not considered to be a problem in the Phantom Lakes.

There were no significant point sources of pollutants in the Phantom Lakes watershed. Nonpoint sources of pollution included stormwater runoff from urban and agricultural areas. In 2000, the total annual phosphorus load to the Phantom Lakes was estimated to be about 20,150 pounds. Runoff from the rural lands contributed the largest amount of phosphorus, about 90 percent of the total phosphorus load, with the runoff from urban lands contributing about 10 percent of the total phosphorus load to the Lakes. Direct precipitation onto the Lake surfaces contributed about 5 percent of the total phosphorus load, or relatively minor amounts of phosphorus, to the Lakes. Agricultural lands constituted the primary source of phosphorus to the Lakes under current land use conditions within the drainage area. Relatively few changes in the total phosphorus loadings to the Lakes are anticipated.

Based on the Vollenweider phosphorus loading model and the Wisconsin Trophic State Index ratings calculated from Phantom Lakes data, the Phantom Lakes may be classified as mesotrophic waterbodies.

Chapter V

AQUATIC BIOTA AND ECOLOGICALLY VALUABLE AREAS

INTRODUCTION

The Phantom Lakes are an important element of the natural resource base of the Town and Village of Mukwonago. The Lakes, their biota, and the surrounding residential lands combine to contribute to the quality of life in the area. When located in urban settings, resource features, such as lakes and wetlands are typically subject to extensive recreational usage and high levels of pollutant discharges, common forms of stress to aquatic systems, and these may result in the deterioration of these natural resource features. For this reason, the formulation of sound management strategies must be based on a thorough knowledge of the pertinent characteristics of the individual resource features, as well as of the urban development in the area concerned. Accordingly, this chapter provides information concerning the natural resource features of the Phantom Lakes watershed, including data on aquatic macrophytes, fish, wildlife, wetlands and woodlands, and environmental corridors. Recreational activities are described and quantified in Chapter VI.

AQUATIC PLANTS

Aquatic plants include larger plants, or macrophytes, and microscopic algae, or phytoplankton. These plants form an integral part of the aquatic food web, converting inorganic nutrients present in the water and sediments into organic compounds that are directly available as food to other aquatic organisms. In this process, known as photosynthesis, plants utilize energy from sunlight and release oxygen required by other aquatic life forms.

To document the types, distribution, and relative abundance of aquatic macrophytes in the Phantom Lakes, an aquatic plant survey was conducted by the Commission staff initially during the summer of 1993,[1] with a further survey being conducted during the summer of 2002 as part of the planning program for the formulation of this comprehensive lake management plan. Additional information on the aquatic plant community of the Phantom Lakes is set forth in Wisconsin Department of Natural Resources reports prepared in 1969 as a Lake Use Report,[2] and in 1982 as a lake rehabilitation feasibility study.[3]

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[1]*SEWRPC Memorandum Report No. 81,* Aquatic Plant Management Plan for Phantom Lakes, Waukesha County, Wisconsin*, July 1993.*

[2]*SEWRPC and Wisconsin Department of Natural Resources Lake Use Report No. FX-14,* Lower Phantom Lake, Waukesha County, Wisconsin*, 1969; SEWRPC and Wisconsin Department of Natural Resources Lake Use Report No. FX-33,* Upper Phantom Lake, Waukesha County, Wisconsin*, 1969.*

[3]*Wisconsin Department of Natural Resources,* Phantom Lakes, Waukesha County: Feasibility Study Results, Management Alternatives*, October 1982.*

Phytoplankton
Phytoplankton, or algae, are small, generally microscopic plants that are found in all lakes and streams. They occur in a wide variety of forms, in single cells or colonies, and can be either attached or free-floating. Phytoplankton abundance varies seasonally with fluctuations in solar irradiance, turbulence due to prevailing winds, and nutrient availability. In lakes with high nutrient levels, heavy growths of phytoplankton, or algal blooms, may occur. Typically, algal groups are determined on the basis of pigmentation as revealed in their color. Two algal groups especially important in aquatic ecosystems are the green algae and the blue-green algae.

Green algae (Chlorophyta) are the most important source of food for zooplankton, or microscopic animals, in the lakes of southeastern Wisconsin. Blue-green algae (Cyanophyta) are not ordinarily utilized by zooplankton or fish populations, and may become over-abundant and out of balance with the organisms that feed on them. Dramatic population increases or "blooms" of blue-green algae may occur when excessive nutrient supplies are available, optimum sunlight and temperature conditions exist, and there is a lack of competition from other aquatic plant species and of grazing by zooplankton.

Algal blooms may reach nuisance proportions in fertile, or eutrophic, lakes, resulting in the accumulation of surface scums or slimes. In some cases, heavy concentrations of wind-blown algae accumulate along shorelines, where they die and decompose, causing noxious odors and unsightly conditions. The decay process consumes oxygen, sometimes depleting available supplies and resulting in fish kills. Also, certain species of blue-green algae may release toxic materials into the water.

During late-winter, February through mid-April, another type of algae, the diatoms, generally become the dominant group. Fluctuations in diatom cell counts are common. This seasonal increase or pulse in diatom growth is common to lakes in the Region, and is known as the spring diatom bloom. Diatoms are adapted to grow well under low light and cool temperature conditions and can, in some instances, form a brownish, slippery covering over submerged objects. After the subsidence of the spring diatom bloom, warmer water temperatures and greater light intensities often result in renewed growth and dominance of blue-green algae.

No current data on algae populations in the Phantom Lakes are available, although a decrease in water clarity during the summer, which may be the result of increased algal populations, has been a concern of the residents during the current study period. Notwithstanding, low values of chlorophyll-*a*, as reported in Chapter IV, suggest that algal blooms are rare and that phytoplankton growth is unlikely to be a major problem in the Lakes.

Aquatic Macrophytes
Aquatic macrophytes, including emergent species such as rushes and cattails, floating-leaves species such as lily pads, and submergent species such as pondweeds, coontail and water milfoil, play an important role in the ecology of southeastern Wisconsin lakes. Depending on their types, distribution and abundance, they can be either beneficial or a nuisance. Macrophytes growing in the locations and in densities that do not significantly interfere with human access to the water and recreational uses such as boating and swimming are beneficial in maintaining lake fisheries and wildlife populations, providing habitat for a variety of aquatic organisms. They also may remove nutrients from the water that otherwise would contribute to excessive algal growth. When their densities become so great as to interfere with swimming and boating activities, when their growth forms limit habitat diversity, and when the plants reduce the aesthetic appeal of the resource, some form of control measures may be required to ensure the ongoing multiple purpose use of the Region's Lakes. Many factors, including lake configuration, depth, water clarity, nutrient availability, bottom substrate, wave action, and type and size of fish populations present, determine the distribution and abundance of aquatic macrophytes in lakes, with most waterbodies within the Southeastern Wisconsin Region naturally supporting abundant and diverse aquatic plant communities. Illustrations of representative macrophyte species observed in the Phantom Lakes are set forth in Appendix A.

As noted above, the most recent aquatic plant surveys of the Phantom Lakes were conducted by staff of the Southeastern Wisconsin Regional Planning Commission during July of 2002, the results of which are shown in Tables 15 and 16. Of the dominant submerged macrophytes identified during that survey, especially in Lower

Table 15

FREQUENCY OF OCCURRENCE OF SUBMERGENT PLANT SPECIES IN UPPER PHANTOM LAKE: JULY 2002

Common Name	Scientific Name	Sites Found	Frequency of Occurrence[a] (percent)	Average Density[b]	Importance Value[c]
Bladderwort	*Utricularia* spp.	7	1.7	1.0	0.6
Bushy Pondweed	*Najas flexilis*	59	25.6	1.7	16.0
Clasping-Leaf Pondweed	*Potamogeton richardsonii*	21	9.0	1.7	5.6
Coontail	*Ceratophyllum demersum*	2	1.0	2.0	0.7
Curly-Leaf Pondweed	*Potamogeton crispus*	2	0.5	1.0	0.2
Eel Grass	*Vallisneria americana*	48	26.6	2.2	21.5
Elodea	*Elodea canadensis*	10	4.2	1.7	2.6
Eurasian Water Milfoil	*Myriophyllum spicatum*	64	36.6	2.3	30.9
Flat-Stem Pondweed	*Potamogeton zosteriformis*	14	5.2	1.5	2.9
Leafy Pondweed	*Potamogeton foliosus*	6	2.5	1.7	1.6
Muskgrass	*Chara* spp.	84	68.9	3.3	83.4
Nitella	*Nitella* spp.	3	1.2	1.7	0.7
Northern Water Milfoil	*Myriophyllum sibiricum*	43	18.2	1.7	11.3
Sago Pondweed	*Potamogeton pectinatus*	42	17.7	1.7	11.0
Small Pondweed	*Potamogeton pusillus*	2	0.5	1.0	0.2
Spiny Naiad	*Najas marina*	48	26.6	2.2	21.5
Variable Pondweed	*Potamogeton gramineus*	45	20.6	1.8	13.6
Water Stargrass	*Zosterella dubia*	4	1.0	1.0	0.4
White-Stem Pondweed	*Potamogeton praelongus*	8	5.0	2.5	4.6

NOTE: There were 106 sites sampled during the July 2002 survey.

[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.

Phantom Lake, Eurasian water milfoil (*Myriophyllum spicatum*), a nonnative, invasive species introduced from Europe, is a plant of concern in the system. Eurasian water milfoil is one of eight milfoil species found in Wisconsin and the only one known to be exotic or nonnative plant pursuant to Chapter NR 109 of the *Wisconsin Administrative Code*. Because of its nonnative nature, Eurasian water milfoil has few natural enemies that can inhibit its explosive growth under suitable conditions. The plant typically exhibits this characteristic growth pattern in lakes with organic-rich sediments, or where the lake bottom has been disturbed. In such cases, the Eurasian water milfoil populations displace native plant species which can lead to the loss of plant diversity, degradation of water quality, and reduction in habitat value for fish, invertebrates and wildlife 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, especially 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, motors, and/or bait buckets, 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.

Table 16

FREQUENCY OF OCCURRENCE OF SUBMERGENT PLANT SPECIES IN LOWER PHANTOM LAKE: JULY 2002

Common Name	Scientific Name	Sites Found	Frequency of Occurrence[a] (percent)	Average Density[b]	Importance Value[c]
Bladderwort	*Utricularia* spp.	40	22.2	1.9	7.5
Bushy Pondweed	*Najas flexilis*	63	58.7	3.1	33.5
Clasping-Leaf Pondweed	*Potamogeton richardsonii*	54	41.6	2.6	19.7
Coontail	*Ceratophyllum demersum*	55	40.1	2.4	17.9
Curly-Leaf Pondweed	*Potamogeton crispus*	6	3.6	2.0	1.3
Eel Grass	*Vallisneria americana*	57	54.5	3.2	31.9
Elodea	*Elodea canadensis*	76	73.4	3.2	43.4
Eurasian Water Milfoil	*Myriophyllum spicatum*	80	74.9	3.1	43.0
Flat-Stem Pondweed	*Potamogeton zosteriformis*	47	31.4	2.2	12.9
Floating-Leaf Pondweed	*Potamogeton natans*	3	0.9	1.0	0.2
Illinois Pondweed	*Potamogeton illinoensis*	7	3.0	1.4	0.8
Large-Leaf Pondweed	*Potamogeton amplifolius*	4	1.2	1.0	0.2
Muskgrass	*Chara* spp.	52	51.2	3.3	30.9
Nitella	*Nitella* spp.	1	0.3	1.0	0.1
Northern Water Milfoil	*Myriophyllum sibiricum*	56	52.1	3.1	29.7
Sago Pondweed	*Potamogeton pectinatus*	33	15.3	1.5	4.3
Spiny Naiad	*Najas marina*	2	0.9	1.5	0.2
Variable Pondweed	*Potamogeton gramineus*	4	1.5	1.3	0.3
Water Stargrass	*Zosterella dubia*	19	9.6	1.7	3.0
White-Stem Pondweed	*Potamogeton praelongus*	18	8.4	1.6	2.4

NOTE: There were 87 sites sampled during the July 2002 survey.

[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.

In Lower Phantom Lake, other common submergent species included elodea (*Elodea canadensis*), bushy pondweed (*Najas flexilis*), and eel grass (*Vallisneria americana*). Emergent species observed included water bulrush (*Scirpus subterminalis*), bulrush (*Scirpus* spp.), and arrowhead (*Sagittaria latifolia*). In Upper Phantom Lake, common submergent macrophytes included muskgrass, also known as stonewort (*Chara* sp.), eel grass (*Vallisneria americana*), and spiny naiad (*Najas marina*). The results of these surveys suggest a diverse and abundant aquatic plant community.

The appearance of various pondweed species such as clasping-leaf pondweed (*Potamogeton richardsonii*), Sago pondweed (*Potamogeton pectinatus*), Illinois pondweed (*Potamogeton illinoensis*), flat-stemmed pondweed (*Potamogeton zosteriformis*), variable pondweed (*Potamogeton gramineus*), and white-stem pondweed (*Potamogeton praelongus*) in the Lakes is generally considered to be a positive sign. Table 17 outlines the positive ecological significance of all aquatic plant species found in the Phantom Lakes. Map 15 shows the distribution of aquatic plant communities in Upper and Lower Phantom Lake as surveyed by the Commission staff during July 2002.

A comparison of the macrophyte surveys conducted by the Commission staff during 1993 with those conducted during the current study is presented in Tables 18 and 19. Data for Upper Phantom Lake would suggest a significant increase in Eurasian water milfoil abundance between 1993 and 2002. A similar increase was observed

Table 17

POSITIVE ECOLOGICAL SIGNIFICANCE OF AQUATIC PLANT SPECIES PRESENT IN THE PHANTOM LAKES

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
Decodon verticillatus (swamp loosestrife, water-willow)	Seeds provide food for waterfowl; food and cover for muskrat
Elodea canadensis (waterweed)	Provides shelter and support for insects which are valuable as fish food
Lemna minor (small duckweed)	Important food source for ducks and geese; food source also for muskrat and beaver; provides shade and shelter for fish
Lythrum aslicaria (purple loosestrife)	Invasive species considered a threat to native ecosystems; has little wildlife value
Myriophyllum sibiricum (northern water milfoil)	Provides food for waterfowl, insect habitat and foraging opportunities for fish
Myriophyllum spicatum (Eurasian water milfoil)	None known
Najas flexilis (bushy pondweed)	Stems, foliage, and seeds important wildfowl food and produces good food and shelter for fish
Najas marina (spiny naiad)	Important food source for ducks
Nitella spp. (stonewarts)	Sometimes eaten by waterfowl; provides foraging for fish
Nymphaea tuberose (white water lily)	Provides food for waterfowl, deer, muskrat and beaver; provides shade and shelter for fish
Nymphaea variegate (yellow water lily/spadderdock)	Provides food for waterfowl, deer, muskrat and beaver; provides shade and shelter for fish
Phalaris arundinacea (reed canary grass)	An effective shoreline stabilizer with little wildlife value; a Eurasian strain has become a threat to native species
Potamogeton amplifolius (large-leaf pondweed)	Offers shade, shelter and foraging for fish; valuable food for waterfowl
Potamogeton crispus (curly-leaf pondweed)	Provides food, shelter and shade for some fish and food for wildfowl
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 natans (floating-leaf pondweed)	Provides food for waterfowl, muskrat, beaver and deer; good fish habitat
Potamogeton pectinatus (Sago pondweed)	This plant is the most important pondweed for ducks, in addition to providing food and shelter for young fish
Potamogeton praelongus (white-stem pondweed)	Good food provider for waterfowl, muskrat, and some fish species; valuable habitat for musky. Considered an indicator species for water quality due to its intolerance of turbid water conditions
Potamogeton pusillus (small pondweed)	Provides food for ducks, geese, muskrat, beaver, and deer, and provides food and shelter for fish

Table 17 (continued)

Aquatic Plant Species Present	Ecological Significance
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 (stiff-water crow foot)	Provides food for trout, upland game birds, and wildfowl
Sagittaria latifolia (arrowhead)	One of the highest value aquatic plants for wildlife; an important food source for a wide variety of waterfowl and animals; provide shade and shelter for young fish.
Scirpus acutus (hard-stem bulrush)	Provides habitat and shelter for insects and young fish, especially northern pike; food source for waterfowl, shorebirds and muskrat; nesting material for birds
Scirpus americanus (chairmaker's rush)	Food source for many varieties of ducks; food source for muskrat; provides cover for waterfowl
Scirpus subterminalis (water bulrush)	Provide habitat and shelter for insects and fish
Sparganium eurycarpum (bur-reed)	Anchor sediment; provide nesting sites and food for waterfowl and shorebirds; food for muskrat and deer.
Typha spp. (cattail)	Important food source for muskrats; provide nesting habitat for many species of birds and spawning habitat for sunfish
Utricularia spp. (bladderwort)	Provides cover and foraging for fish
Vallisneria americana (water celery/eelgrass)	Provides good shade and shelter, supports insects, and is valuable fish food
Zizania spp. (wild rice)	Valuable food source especially for migrating waterfowl.
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.

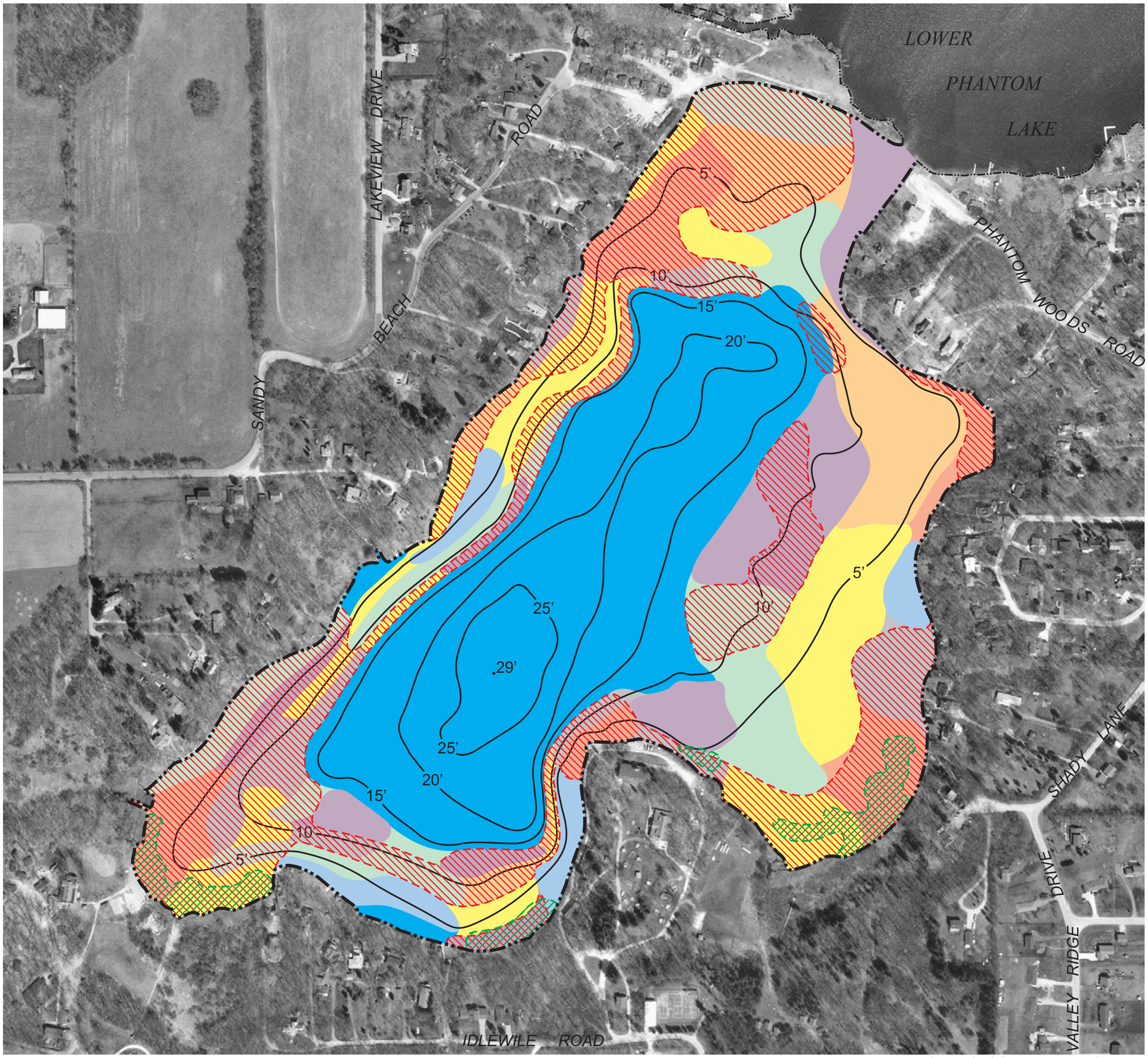
in the data for Lower Phantom Lake over the same time interval, with accompanying increases of eel grass, muskgrass, and elodea and a decrease in native water milfoil. While the precise reasons for the observed changes are unclear, changes in aquatic plant communities are often related to a combination of factors, including the aquatic plant management practices, changes in land use (which affect nutrient supply and availability), lake uses, climatic factors and natural biological processes such as natural population cycles of plants.

A comparison of aquatic plant surveys conducted since 1967 in both lakes is shown in Tables 20 and 21. In general, species identified as "abundant" had a density value of 3.5 to 4.0; "common" had a density value of 2.5 to 3.4; "present" had a density value of 1.5 to 2.4; and "scarce" had a density value less than 1.5. It should be noted that in Table 21, the 1992 data collected by the Wisconsin Department of Natural Resources in Whispering Bay, Lower Phantom Lake, only list species as "present" or not. Consequently, the use of that term in this particular data set is not intended to refer to any definite density value range.

From the data in Table 20, it would appear that *Chara* has been a dominant species in Upper Phantom Lake for several decades. This alga is considered to be an indicator of good water quality, and is frequently present in groundwater-fed lakes in southeastern Wisconsin. Also of note in Upper Phantom Lake is the emergence of white stem pondweed, which is viewed as a sign of good water quality due to the intolerance of this species to turbidity. Notwithstanding, large-leaf pondweed, previously reported to be abundant as recently as 1980, has apparently

Map 15

AQUATIC PLANT COMMUNITY DISTRIBUTION IN UPPER PHANTOM LAKE: 2002



DATE OF PHOTOGRAPHY: MARCH 2000

—20'— WATER DEPTH CONTOUR IN FEET

OPEN WATER

WATER LILIES

EURASIAN WATER MILFOIL

MUSKGRASS, CLASPING LEAF PONDWEED, NATIVE WATER MILFOIL, SPINY NAIAD, SAGO PONDWEED, VARIABLE PONDWEED, AND BLADDERWORT

MUSKGRASS, CLASPING LEAF PONDWEED, NATIVE WATER MILFOIL, FLAT STEM PONDWEED, WATER STAR GRASS, SPINY NAIAD, VARIABLE PONDWEED, AND SAGO PONDWEED

MUSKGRASS, CLASPING LEAF PONDWEED, WILD CELERY, NATIVE WATER MILFOIL, WATER STAR GRASS, SPINY NAIAD, SAGO PONDWEED, VARIABLE PONDWEED, WHITE STEM PONDWEED, WATER BULRUSH, LEAFY PONDWEED, AND CURLY LEAF PONDWEED

MUSKGRASS, CLASPING LEAF PONDWEED, BUSHY PONDWEED, NATIVE WATER MILFOIL, WATERWEED, FLAT STEM PONDWEED, SPINY NAIAD, WHITE STEM PONDWEED, SAGO PONDWEED, LEAFY PONDWEED, VARIABLE PONDWEED, AND BLADDERWORT

MUSKGRASS, WILD CELERY, BUSHY PONDWEED, SAGO PONDWEED, NATIVE WATER MILFOIL, WATERWEED, FLAT STEM PONDWEED, WATER STAR GRASS, SPINY NAIAD, WHITE STEM PONDWEED, VARIABLE PONDWEED, LEAFY PONDWEED, CURLY LEAF PONDWEED, AND NITELLA

MUSKGRASS, WILD CELERY, BUSHY PONDWEED, CLASPING LEAF PONDWEED, NATIVE WATER MILFOIL, FLAT STEM PONDWEED, WATERWEED, WATER STAR GRASS, SPINY NAIAD, SAGO PONDWEED, VARIABLE PONDWEED, WATER BULRUSH, LEAFY PONDWEED, SMALL PONDWEED, BLADDERWORT, AND COONTAIL

WILD CELERY, BUSHY PONDWEED, NATIVE WATER MILFOIL, CLASPING LEAF PONDWEED, FLAT STEM PONDWEED, SPINY NAIAD, WATERWEED, SAGO PONDWEED, WHITE STEM PONDWEED, VARIABLE PONDWEED, WATER BULRUSH, AND NITELLA

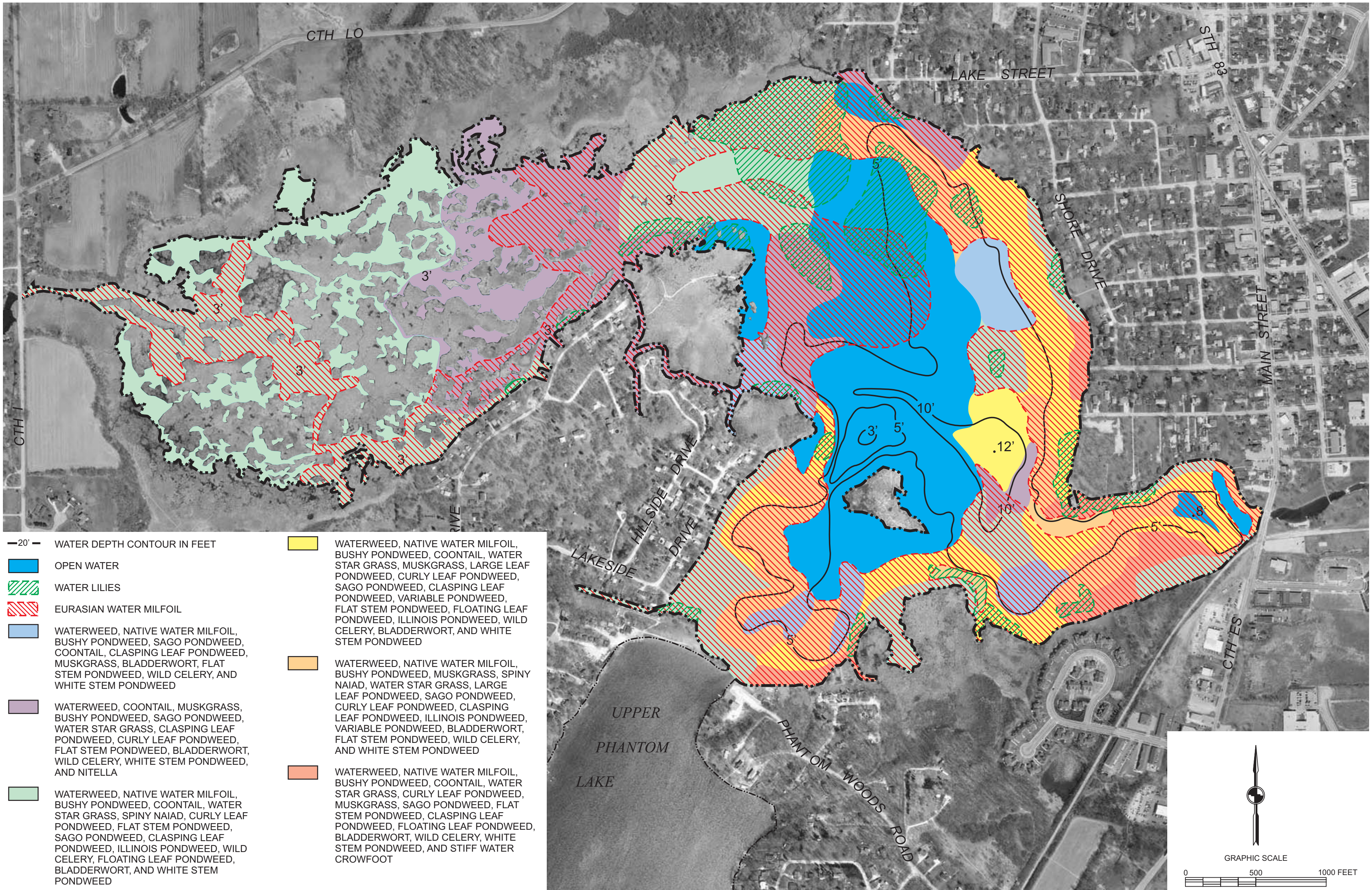
GRAPHIC SCALE

0 300 600 FEET

Source: SEWRPC.

Map 15 (continued)

AQUATIC PLANT COMMUNITY DISTRIBUTION IN LOWER PHANTOM LAKE: 2002



Source: SEWRPC.

DATE OF PHOTOGRAPHY: MARCH 2000

Table 18

FREQUENCY OF OCCURRENCE OF MAJOR PLANT SPECIES PRESENT IN UPPER PHANTOM LAKE: 1993 AND 2002

Common Name	Scientific Name	Frequency of Occurrence (percent)[a]	
		July 1993	July 2002
Coontail	*Ceratophyllum demersum*	- -	1
Eel Grass	*Vallisneria americana*	15	27
Eurasian Water Milfoil	*Myriophyllum spicatum*	8	37
Elodea	*Elodea canadensis*	- -	4
Muskgrass	*Chara* spp.	66	69
Northern Water Milfoil	*Myriophyllum sibiricum*[b]	16	18

NOTE: There were 107 sites sampled during the July 1993 survey and 106 sites during the July 2002 survey.

[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]*This species identified as* M. heterophyllum *in the 1993 survey.*

Source: SEWRPC.

Table 19

FREQUENCY OF OCCURRENCE OF MAJOR PLANT SPECIES PRESENT IN LOWER PHANTOM LAKE: 1993 AND 2002

Common Name	Scientific Name	Frequency of Occurrence (percent)[a]	
		July 1993	July 2002
Coontail	*Ceratophyllum demersum*	43	40
Eel Grass	*Vallisneria americana*	28	55
Eurasian Water Milfoil	*Myriophyllum spicatum*	33	75
Elodea	*Elodea canadensis*	43	74
Muskgrass	*Chara* spp.	23	51
Northern Water Milfoil	*Myriophyllum sibiricum*[b]	83	52

NOTE: There were 83 sites sampled during the July 1993 survey and 87 sites during the July 2002 survey.

[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]*This species identified as* M. heterophyllum *in the 1993 survey.*

Source: SEWRPC.

disappeared in the more recent surveys. While such changes in species composition may reflect sampling protocols and/or seasonality within the macrophyte community, the loss of a particular plant species may indicate changes in the underlying ecosystem. In part, the apparent loss of this pondweed species may be related to an increase in abundance of Eurasian water milfoil, as shown in Table 21. Similar changes in the aquatic plant community in Lower Phantom Lake have been reported since 1992, with an apparent decrease in populations of several native species including coontail, several varieties of pondweed and native water milfoil. This shift in abundance appears to have occurred in parallel with the increase in abundance of Eurasian water milfoil, and is consistent with changes in the aquatic plant community that occur as a result of the presence of Eurasian water milfoil in Lakes.

Table 20

FREQUENCY OF OCCURRENCE OF MAJOR PLANT SPECIES PRESENT IN UPPER PHANTOM LAKE: 1967-2002

Common Name	Scientific Name	Frequency of Occurrence			
		1967	1980	1993	2002
Bladderwort	*Utricularia* spp.	Scarce	- -	Scarce	Scarce
Bushy Pondweed	*Najas flexilis*	Common	Common	Scarce	Present
Clasping-Leaf Pondweed	*Potamogeton richardsonii*	Scarce	- -	- -	Present
Coontail	*Ceratophyllum demersum*	Common	Scarce	- -	Present
Curly-Leaf Pondweed	*Potamogeton crispus*	Scarce	Scarce	- -	Scarce
Eel Grass	*Vallisneria americana*	Common	Common	Scarce	Present
Elodea	*Elodea canadensis*	Scarce	Common	- -	Present
Eurasian Water Milfoil	*Myriophyllum spicatum*	- -	- -	Scarce	Present
Flat-Stem Pondweed	*Potamogeton zosteriformis*	Scarce	- -	Scarce	Present
Floating-Leaf Pondweed	*Potamogeton natans*	Scarce	- -	- -	- -
Large-Leaf Pondweed	*Potamogeton amplifolius*	Scarce	Abundant	- -	- -`
Leafy Pondweed	*Potamogeton foliosus*	- -	- -	- -	Present
Muskgrass	*Chara* spp.	Abundant	Abundant	Abundant	Common
Stonewart	*Nitella* spp.	Common	- -	- -	Present
Northern Water Milfoil	*Myriophyllum sibiricum*[a]	Scarce	Abundant	- -	Present
Oakes Pondweed	*Potamogeton oakesianus*	Scarce	- -	- -	- -
Sago Pondweed	*Potamogeton pectinatus*	Common	Abundant	- -	Present
Small Pondweed	*Potamogeton pusillus*	- -	- -	- -	Scarce
Spiny Naiad	*Najas marina*	- -	- -	- -	Present
Unidentified Pondweed	*Potamogeton* spp.	Scarce	- -	- -	- -
Variable Pondweed	*Potamogeton gramineus*	Scarce	- -	- -	- -
Various-Leaved Milfoil	*Myriophyllum heterophyllum*	- -	- -	Common	- -
Water Stargrass	*Zosterella dubia*	- -	- -	- -	Scarce
White-Stem Pondweed	*Potamogeton praelongus*	- -	- -	Scarce	Common

NOTE: There were 83 sites sampled during the July 1993 survey and 87 sites during the July 2002 survey.

[a]*This species identified as* M. exalbescens *in the 1993 survey.*

Source: SEWRPC.

Aquatic Plant Management

Records of aquatic plant management efforts on Wisconsin lakes were not maintained by the Wisconsin Department of Natural Resources prior to 1950. While previous interventions were likely, the recorded efforts to manage the aquatic plants in the Phantom Lakes have taken place since 1950. As reported in the initial study, aquatic plant management activities in the Phantom Lakes since the mid-1980s can be categorized as primarily mechanical macrophyte harvesting. Currently, all forms of aquatic plant management are subject to permitting by the Wisconsin Department of Natural Resources pursuant to authorities granted the Department under Chapters NR 107 and NR 109 of the *Wisconsin Administrative Code.* The most common forms of aquatic plant management are briefly reviewed below insofar as they apply to the management of the Phantom Lakes aquatic plant communities.

Chemical Controls

Although the use of chemicals to control aquatic plants has been regulated in Wisconsin since 1941, records of aquatic herbicide applications have only been maintained by the Wisconsin Department of Natural Resources beginning in 1950. Recorded chemical herbicide treatments that have been applied to the Phantom Lakes from 1959 through 2003 are set forth in Table 22. However, between 1976 and 2003, documented chemical control of aquatic macrophytes in the Phantom Lakes has not occurred.

In 1926, sodium arsenite, an agricultural herbicide, was first applied to lakes in the Madison area, and, by the 1930s, sodium arsenite was widely used throughout the State for aquatic plant control. No other chemicals were applied in significant amounts to control macrophytes until recent years, when a number of organic chemical herbicides came into general use. The amounts of sodium arsenite applied to the Phantom Lakes, and years of

Table 21

FREQUENCY OF OCCURRENCE OF MAJOR PLANT SPECIES PRESENT IN LOWER PHANTOM LAKE: 1967-2002

Common Name	Scientific Name	Frequency of Occurrence				
		1967	1980	1992	1993	2002
Bladderwort	*Utricularia* spp.	Scarce	Abundant	Present	Common	Present
Bushy Pondweed	*Najas flexilis*	Common	Common	- -	- -	Common
Clasping-Leaf Pondweed	*Potamogeton richardsonii*	- -	Common	Present	- -	Common
Coontail	*Ceratophyllum demersum*	Common	Common	Present	Common	Present
Curly-Leaf Pondweed	*Potamogeton crispus*	Scarce	Scarce	Present	Scarce	Present
Eel Grass	*Vallisneria americana*	Common	Common	Present	Common	Common
Elodea	*Elodea canadensis*	Common	Common	Present	Common	Common
Eurasian Water Milfoil	*Myriophyllum spicatum*	- -	- -	Present	Scarce	Common
Flat-Stem Pondweed	*Potamogeton zosteriformis*	Common	Abundant	Present	Common	Present
Floating-Leaf Pondweed	*Potamogeton natans*	Common	Abundant	Present	Common	Scarce
Illinois Pondweed	*Potamogeton illinoensis*	- -	- -	Present	- -	Scarce
Large-Leaf Pondweed	*Potamogeton amplifolius*	Common	Abundant	Present	Common	Scarce
Muskgrass	*Chara* spp.	Common	Abundant	Present	Abundant	Common
Narrow-Leaf Pondweed	*Potamogeton filiformis*	- -	- -	Present	- -	- -
Northern Water Milfoil	*Myriophyllum sibiricum*[b]	Abundant	Abundant	- -	- -	Common
Sago Pondweed	*Potamogeton pectinatus*	Scarce	Abundant	Present	Common	Present
Spiny Naiad	*Najas marina*	- -	- -	- -	- -	Scarce
Stonewart	*Nitella* spp.	- -	- -	- -	- -	Scarce
Southern Naiad	*Najas guadalupensis*	- -	- -	Present	Scarce	- -
Unidentified Milfoil	*Myriophyllum* spp.	- -	- -	Present	- -	- -
Variable Pondweed	*Potamogeton gramineus*	- -	- -	- -	- -	Scarce
Various-Leaved Milfoil	*Myriophyllum heterophyllum*	- -	- -	- -	Abundant	- -
Water Stargrass	*Zosterella dubia*	- -	- -	- -	- -	Present
White-Stem Pondweed	*Potamogeton praelongus*	Scarce	- -	Present	Common	Common

NOTE: There were 83 sites sampled during the July 1993 survey and 87 sites during the July 2002 survey.

[a]*Based on data collected by the Wisconsin Department of Natural Resources in Whispering Bay, Lower Phantom Lake, July 1992 (WDNR-SED memorandum referenced 3200 and dated September 15, 1992).*

[b]Th*is species identified as* M. exalbescens *in the 1993 survey.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

application during the period 1950 through 1969, are listed in Table 22. The total amount of sodium arsenite applied over this period was about 3,876 pounds.

Sodium arsenite was typically sprayed onto the surface of the Phantom Lakes within an area of up to 200 feet from the shoreline. Treatment typically occurred between mid-June and mid-July. The amount of sodium arsenite used was calculated to result in a concentration of about 10 milligrams per liter (mg/l) sodium arsenite (about five mg/l arsenic) in the treated lake water. The sodium arsenite typically remained in the water column for less than 120 days. Although the arsenic residue was naturally converted from a highly toxic form to a less toxic and less biologically active form, much of the arsenic residue was deposited in the lake sediments.

When it became apparent that arsenic was accumulating in the sediments of treated lakes and that the accumulations of arsenic were found to present potential health hazards both to humans and aquatic life, the use of sodium arsenite was discontinued in the State in 1969. Draft sediment quality criteria, set forth by the Wisconsin Department of Natural Resources, are shown in Table 23.

Also as shown in Table 22, the aquatic herbicides diquat, endothall, and 2,4-D have been applied to the Phantom Lakes to control aquatic macrophyte growth. Diquat and endothall (Aquathol™) are contact herbicides and kill plant parts exposed to the active ingredient. Diquat use is restricted to the control of duckweed (*Lemna* sp.), milfoil (*Myriophyllum* spp.), and waterweed (*Elodea* sp.). However, this herbicide is nonselective and will kill many other aquatic plants, such as pondweeds (*Potamogeton* spp.), bladderwort (*Utricularia* sp.), and naiads

Table 22

CHEMICAL CONTROL OF AQUATIC PLANTS IN THE PHANTOM LAKES: 1950-2003

		Algae Control		Macrophyte Control								
							Diquat		Endothall		Aquathol	
Year	Total Acres Treated	Copper Sulfate (pounds)	Cutrine or Cutrine-+ (gallons)	Sodium Arsenite (pounds)	2, 4-D (pounds)	2,4,5-T (pounds)	Gallons	Pounds	Gallons	Pounds	Gallons	Pounds
1950-1952	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1953	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1954	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1955	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1956	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1957	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1958	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1959	- -	- -	- -	1,080	- -	- -	- -	- -	- -	- -	- -	- -
1960	- -	100.0	- -	1,260	- -	- -	- -	- -	- -	- -	- -	- -
1961	- -	100.0	- -	1,176	- -	- -	- -	- -	- -	- -	- -	- -
1962	- -	- -	- -	360	- -	- -	- -	- -	- -	- -	- -	- -
1963	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1964	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1965	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1966	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1967	- -	- -	- -	- -	60	- -	- -	- -	- -	- -	- -	- -
1968	- -	- -	- -	- -	1,860	- -	- -	- -	- -	- -	- -	- -
1969	- -	45.0	- -	- -	360	40	- -	128	- -	30	- -	- -
1970	45.75	103.5	8	- -	- -	- -	31.5	- -	24	- -	- -	1,117
1971	58.90	115.0	- -	- -	- -	- -	20.0	- -	- -	- -	98	- -
1972	57.50	350.0	- -	- -	- -	- -	15.0	- -	- -	- -	115	- -
1973	103.40	450.0	- -	- -	- -	- -	- -	- -	- -	- -	160	- -
1974	53.70	285.0	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1975	29.00	150.0	- -	- -	- -	- -	- -	- -	90	- -	- -	- -
1976-2003	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Total	- -	1,698.5	8	3,876	2,280	40	66.5	128	114	30	373	1,117

Source: Wisconsin Department of Natural Resources and SEWRPC.

(*Najas* spp.). Endothall primarily kills pondweeds, but does not control such nuisance species as Eurasian water milfoil (*Myriophyllum spicatum*). The herbicide 2,4-D is a systemic herbicide that is absorbed by the leaves and translocated to other parts of the plant; it is more selective than the other herbicides listed above and is generally used to control Eurasian water milfoil. However, it will also kill species such as water lilies (*Nymphaea* sp. and *Nuphar* sp.). The present restrictions on water use after application of these herbicides are given in Table 24**.**

In addition to the chemical herbicides used to control large aquatic plants, algicides have also been applied to the Phantom Lakes. As shown in Table 22, copper sulfate (Cutrine Plus™) has been applied to the Phantom Lakes, on occasion. Like arsenic, copper, the active ingredient in many algicides including copper sulfate-based products, may accumulate in the bottom sediments. Excessive levels of copper may be toxic to fish and benthic organisms, but, generally, have not been found to be harmful to humans.[4] Restrictions on water uses after application of copper sulfate-based algicides are also given in Table 24.

AQUATIC ANIMALS

Aquatic animals include microscopic zooplankton; benthic, or bottom-dwelling, invertebrates; fish and reptiles; amphibians; mammals; and waterfowl and other birds that inhabit the Lakes and their shorelands. These make up the primary and secondary consumers of the food web.

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[4]*Jeffrey A. Thornton and Walter Rast, "The Use of Copper and Copper Compounds as Algicides," in H. Wayne Richardson,* Handbook of Copper Compounds and Applications*, Marcel Dekker, New York, 1997, pp. 123-142.*

Table 23

WISCONSIN DEPARTMENT OF NATURAL RESOURCES DRAFT SEDIMENT QUALITY SCREENING CRITERIA[a]

Chemical	Lowest Effect Level (LEL)	Medium Effect Level (MEL)	Severe Effect Level (SEL)
Arsenic	6.00	33.0	85.0
Copper	25.00	110.0	390.0
Lead	31.00	110.0	250.0
Mercury	0.15	0.2	1.3
Ammonia-Nitrogen	75.00	- -	- -

[a]Units are in mg/kg dry sediment.

Source: Wisconsin Department of Natural Resources.

Table 24

PRESENT RESTRICTIONS ON WATER USES AFTER APPLICATION OF AQUATIC HERBICIDES[a]

Use	Days after Application					
	Copper Sulfate	Diquat	Glyphosate	Endothall	2,4-D	Fluridone
Drinking	- -[b]	14	- -[c]	7-14	- -[d]	- -[e]
Fishing	0	14	0	3	0	0
Swimming	0	1	0	- -	0	0
Irrigation	0	14	0	7-14	- -[d]	7-30

[a]The U.S. Environmental Protection Agency has indicated that, if these restrictions are observed, pesticide residues in water, irrigated crops, or fish will not pose an unacceptable risk to humans and other organisms using or living in the treatment zone.

[b]According to the Wisconsin Department of Natural Resources, if water is to be used as potable water, the residual copper content cannot exceed one part per million (ppm).

[c]According to the Wisconsin Department of Natural Resources, if water is to be used as potable water, the drinking water tolerance of glyphosate (Rodeo®) is one part per million (ppm).

[d]2,4-D products are not to be applied to waters used for irrigation, animal consumption, drinking, or domestic uses, such as cooking and watering vegetation.

[e]According to the Wisconsin Department of Natural Resources, if water is to be used as potable water, the drinking water tolerance of fluridone (Sonar®) is 0.15 parts per million (ppm).

Source: Wisconsin Department of Natural Resources.

Zooplankton

Zooplankton are microscopic animals which inhabit the same environment as phytoplankton, the microscopic plants. An important link in the food chain, zooplankton feed mostly on algae and, in turn, are a good food source for fish. There are no data available, either current or past, on zooplankton species in the Phantom Lakes.

Benthic Invertebrates

The benthic, or bottom dwelling, faunal communities of lakes include such organisms as sludge worms, midges, and caddisfly larvae. These organisms are an important part of the food chain, acting as processors of organic material that accumulates on the lake bottom. Some benthic fauna are opportunistic in their feeding habits, while others are predaceous. The diversity of benthic faunal communities can be used as an indicator of lake trophic status. In general, a reduced or limited diversity of organisms present is indicative of an eutrophic lake; however, there is no single “indicator organism.” Rather, the entire community must be assessed to determine trophic status as populations can fluctuate widely through the year and between years as a consequence of season, climatic variability, and localized water quality changes. There are no current data available regarding benthic organism populations in the Phantom Lakes.

Fishes of the Phantom Lakes

In the initial study, the Phantom Lakes were reported to support good populations of panfish, largemouth bass and northern pike. As of 1993, no stocking of the Lakes had been reported since 1972. Fish surveys conducted in 1966 and 1978 indicated a diverse fishery in the Phantom Lakes that included some 20 species of panfish, predator fish and others.[5] No significant changes have been observed in this fishery. The most recent reconnaissance of the fish community was conducted by the Wisconsin Department of Natural Resources in 1999. As of 2001, in both Upper and Lower Phantom Lakes, “game fish” such as northern pike and largemouth bass were reported to be common, and walleyed pike were reported to be present.[6] In addition, a wide range of “panfish” has been reported present in the Phantom Lakes. “Panfish” is a term commonly applied to a broad group of smaller fishes with a relatively short and usually broad shape that makes them a perfect size for the frying pan. Panfish species known to exist in the Phantom Lakes include bluegills, pumpkinseeds, yellow perch, and black crappies. The habitats of panfish vary widely among the different species, but their cropping of the plentiful supply of insects and plants, coupled with prolific breeding rates, leads to large populations with a rapid turnover. Some lakes within southeastern Wisconsin have stunted, or slow-growing, panfish populations because their numbers are not controlled by predator fishes. Panfish frequently feed on the fry of predator fish and, if the panfish population is overabundant, they may quickly deplete the predator fry population. Figure 8 illustrates the importance of a balanced predator-prey relationship, using walleyed pike and perch as an example.

“Rough fish” is a broad term applied to species, such as carp, that do not readily bite on hook and line, but feed on game fish, destroy habitat needed by more desirable species, and are commonly considered in southeastern Wisconsin as undesirable for human consumption. These species are reported to occur in the Phantom Lakes, but remain at levels below which control actions are indicated.

The Phantom Lakes are currently passively managed for the production of bluegills, yellow perch, black crappie, northern pike, and largemouth and smallmouth bass through the Wisconsin Department of Natural Resources which regulates the harvest of fishes from the Lake under current state fishing regulations. The 2004-2005 regulations governing the harvest of fishes from the waters of the State are summarized in Table 25.

Of particular note, a State-listed threatened species, the long-ear sunfish, is present in the lower reaches of the Mukwonago River, immediately downstream of Lower Phantom Lake and upstream of the confluence of the Mukwonago and Fox Rivers. This area provides a niche habitat for this species, which is at the extreme northern limit of its natural range. This habitat area is likely to be a function of the warmer waters created by warming of the lake surface in Lower Phantom Lake, which is discharged over the impoundment into this stretch of the Mukwonago River, the upper stream reaches of which are significantly influenced by groundwater inflows and, hence, the upstream waters are colder than in this lowest reach.[7]

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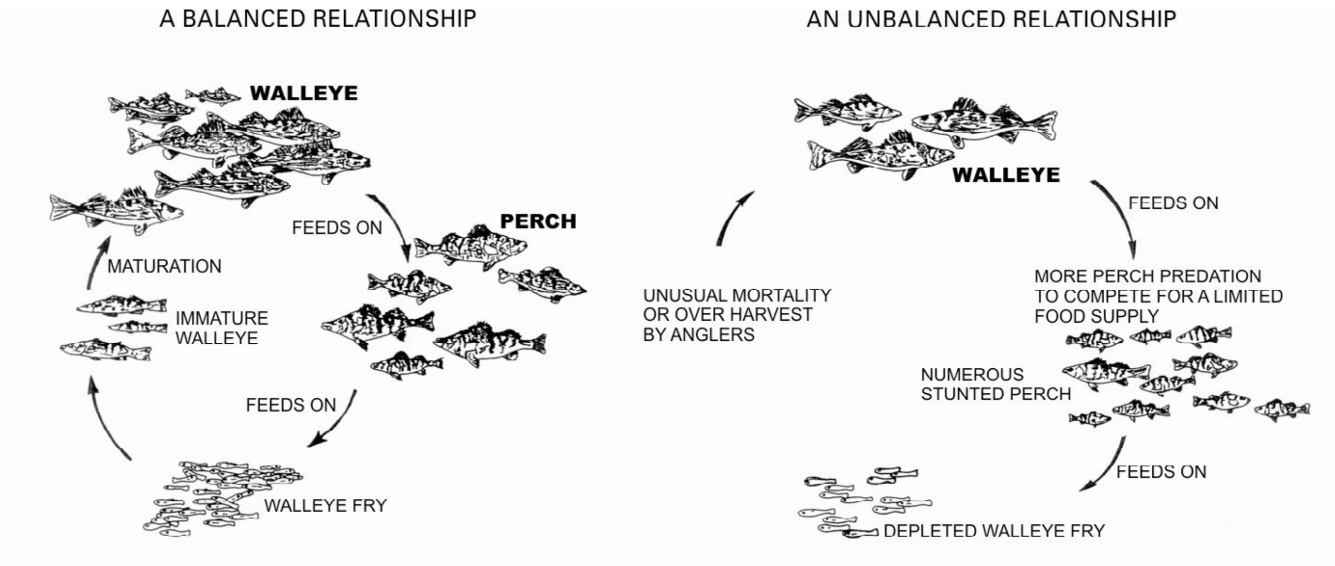
[5]*D. Fago, Wisconsin Department of Natural Resources Research Report No. 148,* Retrieval and Analysis System Used in Wisconsin’s Statewide Fish Distribution Survey, Second Edition, *December 1988.*

[6]*Wisconsin Department of Natural Resources Publication No. PUBL-FH-800 2001,*Wisconsin Lakes, *2001.*

[7]*See data set forth in Timothy J. Ehlinger, Lori Schacht Dethorne, and Chemine Jackels, (Draft)* Status of Stream Habitat, Aquatic Biotic Integrity & Long-ear Sunfish Populations in the Mukwonago River Watershed, Waukesha & Walworth Counties, Wisconsin, *University of Wisconsin-Milwaukee Report to the Wisconsin Department of Natural Resources, December 2003.*

Figure 8

THE PREDATOR-PREY RELATIONSHIP



Source: Wisconsin Department of Natural Resources and SEWRPC.

Other Wildlife

Although a quantitative field inventory of amphibians, reptiles, birds, and mammals was not conducted as a part of the current study, it is possible, by polling naturalists and wildlife managers familiar with the area, to complete a list of amphibians, reptiles, birds, and mammals which may be expected to be found in the area under existing conditions. The technique used in compiling the wildlife data involved obtaining lists of those amphibians, reptiles, birds, and mammals known to exist, or known to have existed, in the Phantom Lakes area; associating these lists with the historic and remaining habitat areas in the Phantom Lakes area as inventoried; and projecting the appropriate amphibian, reptile, bird, and mammal species into the Phantom Lakes area. The net result of the application of this technique is a listing of those species which were probably once present in the drainage area; those species which may be expected to still be present under currently prevailing conditions; and those species which may be expected to be lost or gained as a result of urbanization within the area.

A variety of mammals, ranging in size from large animals like the northern white-tailed deer to small animals like the least shrew, are expected to be found in the Phantom Lakes area. Mink, muskrat, beaver, white-tailed deer, red and grey fox, grey and fox squirrel, and cottontail rabbits are mammals reported to frequent the area. Table 26 lists 38 mammals whose ranges are known to extend into the area.

A large number of birds, ranging in size from large game birds to small songbirds, also are expected to be found in the Phantom Lakes area. Table 27 lists those birds that normally occur in the drainage area. Each bird is classified as to whether it breeds within the area, winters in the area, visits the area only during the annual migration periods, or visits the area only on rare occasions. The Phantom Lakes drainage area supports a significant population of waterfowl, including mallard and teal. Larger numbers of birds move through the drainage area during migrations when most of the regional species may also be present.

Table 25

FISHING REGULATIONS APPLICABLE TO THE PHANTOM LAKES: 2004-2005

Species	Open Season	Daily Limit	Minimum Size
Northern Pike	May 1 to March 6	2	26 inches
Walleyed Pike	May 1 to March 6	5	15 inches
Largemouth and Smallmouth Bass	May 1 to March 6	5 in total	14 inches
Muskellunge	May 1 to November 30 (southern zone)	1	34 inches
Bluegill, Pumpkinseed (sunfish), Crappie, and Yellow Perch	Open all year	25 in total	None
Bullhead and Rough Fish	Open all year	None	None

Source: Wisconsin Department of Natural Resources Publication No. PUBL-FH-301 2004, Guide to Wisconsin Hook and Line Fishing Regulations 2004-2005, January 2004; and SEWRPC.

Mallards, wood ducks, blue-winged teal and Canada geese are the most numerous waterfowl and are known to nest in the area. Many game birds, songbirds, waders, and raptors also reside or visit the Lakes and their environs. Ospreys and loons are notable migratory visitors.

Because of the mixture of lowland and upland woodlands, wetlands, and agricultural or open lands still present in the area, along with the favorable summer climate, the area supports many other species of birds. Hawks and owls function as major rodent predators within the ecosystem. Swallows, whippoorwills, woodpeckers, nuthatches and flycatchers, as well as several other species, serve as major insect predators. In addition to their ecological roles, birds such as robins, red-winged blackbirds, orioles, cardinals, kingfishers, and mourning doves serve as subjects for bird watchers and photographers. Threatened species migrating in the vicinity of the Phantom Lakes include the Cerulean warbler, the Acadian flycatcher, Great egret, and the Red-Shouldered Hawk. Endangered species migrating in the vicinity of the Phantom Lakes include the Common tern, Caspian tern, Forster's tern and the Loggerhead shrike.

Amphibians and reptiles are vital components of the ecosystem in an environmental unit like the Phantom Lakes drainage area. Examples of amphibians native to the area include frogs, toads, and salamanders. Turtles and snakes are examples of reptiles common to the Phantom Lakes area. Table 28 lists 14 amphibian and 15 reptile species normally expected to be present in the Phantom Lakes area under present conditions and identifies those species most sensitive to urbanization. Most amphibians and reptiles have definite habitat requirements that are adversely affected by advancing urban development, as well as by certain agricultural land management practices. The major detrimental factors affecting the maintenance of amphibians in a changing environment is the destruction of breeding ponds, urban development occurring in migration routes, and changes in food sources brought about by urbanization.

The complete spectrum of wildlife species originally native to Waukesha County has, along with its habitat, undergone significant change in terms of diversity and population size since the European settlement of the area. This change is a direct result of the conversion of land by the settlers from its natural state to agricultural and urban uses, beginning with the clearing of the forest and prairies, the draining of wetlands, and ending with the development of extensive urban areas. Successive cultural uses and attendant management practices, both rural and urban, have been superimposed on the land use changes and have also affected the wildlife and wildlife habitat. In agricultural areas, these cultural management practices include draining land by ditching and tiling and the expanding use of fertilizers, herbicides, and pesticides. In urban areas, cultural management practices that affect wildlife and their habitat include the use of fertilizers, herbicides, and pesticides; the use of road salt for snow and ice control; the presence of heavy motor vehicle traffic that produces disruptive noise levels and air pollution and nonpoint source water pollution; and the introduction of domestic pets.

Table 26

MAMMALS OF THE PHANTOM LAKES AREA

Scientific (family) and Common Name	Scientific Name
Didelphidae	
Virginia Opossum	*Didelphis virginiana*
Soricidae	
Cinereous Shrew	Sorex cinereus
Short-Tailed Shrew	*Blarina brevicauda*
Least Shrew	*Cryptotis parva*
Vespertilionidae	
Little Brown Bat	*Myotis lucifugus*
Silver-Haired Bat	*Lasisoncteris octivagans*
Big Brown Bat	*Eptesicus fuscus*
Red Bat	*Lasiurus borealus*
Hoary Bat	*Lasiurus cinereus*
Leporidae	
Cottontail Rabbit	*Sylvilgus floridanus*
Sciuridae	
Woodchuck	*Marmota monax*
Thirteen-lined Ground Squirrel (gopher)	*Spermophilus tridencemilineatus*
Eastern Chipmunk	*Tamias striatus*
Grey Squirrel	*Sciurus carolinensis*
Western Fox Squirrel	*Sciurus niger*
Red Squirrel	*Tamiasciurus hudsonicus*
Southern Flying Squirrel	*Glaucomys volans*
Castoridae	
American Beaver	*Castor canadensis*
Cricetidae	
Woodland Deer Mouse	*Peromyscus maniculatus*
Prairie Deer Mouse	*Peromyscus leucopus bairdii*
White-Footed Mouse	*Microtus pennsylvanicus*
Meadow Vole	*Microtus ochrogaster*
Common Muskrat	*Ondatra zibethicus*
Muridae	
Norway Rat (introduced)	*Rattus norvegicus*
House Mouse (introduced)	*Mus musculus*
Zapodidae	
Meadow Jumping Mouse	*Zapas hudonius*
Canidae	
Coyote	*Canis latrans*
Eastern Red Fox	*Vulpes vulpes*
Gray Fox	*Urocyon cinereoargenteus*
Procyonidae	
Raccoon	*Procyon lotor*
Mustelidae	
Least Weasel	*Mustela nivalis*
Short-Tailed Weasel	*Mustela erminea*
Long-Tailed Weasel	*Mustela frenata*
Mink	*Mustela vison*
Badger (occasional visitor)	*Taxidea taxus*
Striped Skunk	*Mephitis mephitis*
Otter (occasional visitor)	*Lontra canadensis*
Cervidae	
White-Tailed Deer	*Odecoileus virginianus*

Source: H.T. Jackson, Mammals of Wisconsin*, 1961, U.S. Department of Agriculture Integrated Taxonomic Information System, National Museum of Natural History, Smithsonian Institute, and SEWRPC.*

WILDLIFE HABITAT AND RESOURCES

As reported in the initial study, wildlife habitat areas remaining in the Region were originally inventoried by the Regional Planning Commission in 1963 with subsequent updating by the Wisconsin Department of Natural Resources in 1970. The five major criteria used to determine the value of these wildlife habitat areas are listed below:

1. Diversity: An area must maintain a great, but balanced, diversity of species for a temperate climate, balanced in such a way that the proper predatory-prey (consumer-food) relationships can occur. In addition, a reproductive interdependence must exist.

2. Territorial Requirements: The maintenance of proper spatial relationships among species, allowing for a certain minimum population level, can occur only if the territorial requirements of each major species within a particular habitat are met.

3. Vegetative Composition and Structure: The composition and structure of vegetation must be such that the required levels for nesting, travel routes, concealment, and protection from weather are met for each of the major species.

4. Location with Respect to Other Wildlife Habitat Areas: It is very desirable that wildlife habitat maintains its proximity to other wildlife habitat areas.

5. Disturbance: Minimum levels of disturbance from human activities are necessary for good wildlife habitat, other than those activities of a wildlife management nature.

On the basis of these five criteria, the wildlife habitat areas in the Phantom Lakes drainage area were categorized in the current report as either Class I, High-Value; Class II, Medium-Value; or Class III, Good-Value, habitat areas. Class I wildlife habitat areas contain a good diversity of wildlife, are adequate in size to meet all of the habitat requirements for the species concerned, are generally located in proximity to other wildlife habitat areas, and meet all five criteria listed above. Class II wildlife habitat areas generally fail to meet one of the five criteria in the preceding list for a high-value wildlife habitat. However, they do retain a good plant and animal diversity. Class III wildlife habitat areas are remnant in nature in that they generally fail to meet two or more of the five criteria for a high-value wildlife habitat. Nevertheless, Class III habitat areas may be important if located in proximity to medium- or high-value habitat areas if they provide corridors linking wildlife habitat areas of higher value or if they provide the only available habitat in an area.

Table 27

BIRDS KNOWN OR LIKELY TO OCCUR IN THE PHANTOM LAKES AREA

Scientific (family) and Common Name	Breeding	Wintering	Migrant
Gaviidae			
Common Loon[a]	- -	- -	X
Podicipedidae			
Pied-Billed Grebe	X	- -	X
Ardeidae			
American Bittern[a]	X	- -	X
Great Blue Heron[a]	X	R	X
Green Heron	X	- -	X
Anatidae			
Tundra Swan	- -	- -	X
Mute Swan[c]	X	X	X
Canada Goose	X	X	X
Wood Duck	X	- -	X
Green-Winged Teal	- -	- -	X
American Black Duck[a]	- -	X	X
Mallard	X	X	X
Northern Pintail[a]	- -	- -	X
Blue-Winged Teal	X	- -	X
Northern Shoveler	- -	- -	X
American Widgeon[a]	- -	- -	X
Redhead[a]	- -	- -	X
Ring-Necked Duck	- -	- -	X
Lesser Scaup[a]	- -	- -	X
Common Goldeneye[a]	- -	X	X
Bufflehead	- -	- -	X
Red-Breasted Merganser	- -	- -	X
Hooded Merganser[a]	R	- -	X
Common Merganser[a]	- -	- -	X
Cathartidae			
Turkey Vulture	X	- -	X
Accipitridae			
Osprey[a]	- -	- -	X
Bald Eagle[a,d]	- -	- -	R
Northern Harrier[a]	X	R	X
Cooper's Hawk[a]	X	X	X
Northern Goshawk[a]	- -	R	X
Broad-Winged Hawk	R	- -	X
Red-Tailed Hawk	X	X	X
American Kestrel	X	X	X
Phasianidae			
Ring-Necked Pheasant[c]	X	X	- -
Rallidae			
Virginia Rail	X	- -	X
Sora	X	- -	X
American Coot	X	R	X
Gruidae			
Sandhill Crane	X	- -	X
Charadriidae			
Semi-Palmated Plover	- -	- -	X
Killdeer	X	- -	X

Table 27 (continued)

Scientific (family) and Common Name	Breeding	Wintering	Migrant
Scolopacidae			
Greater Yellowlegs	- -	- -	X
Lesser Yellowlegs	- -	- -	X
Solitary Sandpiper	- -	- -	X
Spotted Sandpiper	X	- -	X
Upland Sandpiper[a]	R	- -	X
Semi-Palmated Sandpiper	- -	- -	X
Pectoral Sandpiper	- -	- -	X
Dunlin	- -	- -	X
Common Snipe	R	- -	X
American Woodcock	X	- -	X
Wilson's Phalarope	- -	- -	X
Laridae			
Ring-Billed Gull	- -	- -	X
Herring Gull	- -	X	X
Forster's Tern[e]	- -	- -	R
Black Tern[a]	X	- -	X
Columbidae			
Rock Dove[c]	X	X	- -
Mourning Dove	X	X	X
Cuculidae			
Black-Billed Cuckoo	X	- -	X
Yellow-Billed Cuckoo[a]	X	- -	X
Strigidae			
Eastern Screech Owl	X	X	- -
Great Horned Owl	X	X	- -
Snowy Owl	- -	R	- -
Barred Owl	X	X	- -
Long-Eared Owl[a]	- -	X	X
Short-Eared Owl[a]	- -	R	X
Northern Saw-Whet Owl	- -	- -	X
Caprimulgidae			
Common Nighthawk	X	- -	X
Whippoorwill	- -	- -	X
Apodidae			
Chimney Swift	X	- -	X
Trochilidae			
Ruby-Throated Hummingbird	X	- -	X
Alcedinidae			
Belted Kingfisher	X	X	X
Picidae			
Red-Headed Woodpecker[a]	X	R	X
Red-Bellied Woodpecker	X	X	- -
Yellow-Bellied Sapsucker	- -	R	X
Downy Woodpecker	X	X	- -
Hairy Woodpecker	X	X	- -
Northern Flicker	X	R	X
Tyrannidae			
Olive-Sided Flycatcher	- -	- -	X
Eastern Wood Pewee	X	- -	X
Yellow-Bellied Flycatcher[a]	- -	- -	X
Willow Flycatcher	X	- -	X
Least Flycatcher	R	- -	X

Table 27 (continued)

Scientific (family) and Common Name	Breeding	Wintering	Migrant
Tyrannidae (continued)			
Eastern Phoebe	X	- -	X
Great Crested Flycatcher	X	- -	X
Eastern Kingbird	X	- -	X
Alaudidae			
Horned Lark	X	X	X
Hirundinidae			
Purple Martin[a]	X	- -	X
Tree Swallow	X	- -	X
Northern Rough-Winged Swallow	X	- -	X
Bank Swallow	X	- -	X
Cliff Swallow	X	- -	X
Barn Swallow	X	- -	X
Corvidae			
Blue Jay	X	X	X
American Crow	X	X	X
Paridae			
Black-Capped Chickadee	X	X	X
Sittidae			
Red-Breasted Nuthatch	R	X	X
White-Breasted Nuthatch	X	X	- -
Certhiidae			
Brown Creeper	- -	X	X
Troglodytidae			
Carolina Wren	- -	- -	R
House Wren	X	- -	X
Winter Wren	- -	- -	X
Sedge Wren[a]	X	- -	X
Marsh Wren	X	- -	X
Regulidae			
Golden-Crowned Kinglet	- -	X	X
Ruby-Crowned Kinglet[a]	- -	- -	X
Blue-Gray Gnatcatcher	X	- -	X
Eastern Bluebird	X	- -	X
Veery[a]	X	- -	X
Gray-Cheeked Thrush	- -	- -	X
Swainson's Thrush	- -	- -	X
Hermit Thrush	- -	- -	X
Wood Thrush[a]	X	- -	X
American Robin	X	X	X
Mimidae			
Gray Catbird	X	- -	X
Brown Thrasher	X	- -	X
Motacillidae			
Water Pipit	- -	- -	X
Bombycillidae			
Bohemian Waxwing	- -	R	- -
Cedar Waxwing	X	X	X
Laniidae			
Northern Shrike	- -	- -	X
Sturnidae			
European Starling[c]	X	X	X

Table 27 (continued)

Scientific (family) and Common Name	Breeding	Wintering	Migrant
Vireonidae			
Solitary Vireo	- -	- -	X
Yellow-Throated Vireo	X	- -	X
Warbling Vireo	X	- -	X
Philadelphia Vireo	- -	- -	X
Red-Eyed Vireo	X	- -	X
Parulidae			
Blue-Winged Warbler	X	- -	X
Golden-Winged Warbler[a]	R	- -	X
Tennessee Warbler[a]	- -	- -	X
Orange-Crowned Warbler	- -	- -	X
Nashville Warbler[a]	- -	- -	X
Northern Parula	- -	- -	X
Yellow Warbler	X	- -	X
Chestnut-Sided Warbler	- -	- -	X
Magnolia Warbler	- -	- -	X
Cape May Warbler[a]	- -	- -	X
Black-Throated Blue Warbler	- -	- -	X
Yellow-Rumped Warbler	- -	R	X
Black-Throated Green Warbler	- -	- -	X
Blackburnian Warbler	- -	- -	X
Palm Warbler	- -	- -	X
Bay-Breasted Warbler	- -	- -	X
Blackpoll Warbler	- -	- -	X
Black-and-White Warbler	- -	- -	X
American Redstart	X	- -	X
Ovenbird	X	- -	X
Northern Waterthrush	- -	- -	X
Connecticut Warbler[a]	- -	- -	X
Mourning Warbler	R	- -	X
Common Yellowthroat	X	- -	X
Wilson's Warbler	- -	- -	X
Canada Warbler	R	- -	X
Thraupidae			
Scarlet Tanager	X	- -	X
Cardinalidae			
Northern Cardinal	X	X	- -
Rose-Breasted Grosbeak	X	- -	X
Indigo Bunting	X	- -	X
Emberizidae			
Dickcissel[a]	R	- -	X
Eastern Towhee	X	- -	X
American Tree Sparrow	- -	X	X
Chipping Sparrow	X	- -	X
Clay-Colored Sparrow	R	- -	X
Field Sparrow	X	- -	X
Vesper Sparrow[a]	X	- -	X
Savannah Sparrow	X	- -	X
Grasshopper Sparrow[a]	X	- -	X
Henslow's Sparrow[b]	R	- -	X
Fox Sparrow	- -	R	X
Song Sparrow	X	X	X
Lincoln's Sparrow	- -	- -	X
Swamp Sparrow	X	X	X
White-Throated Sparrow	- -	R	X
White-Crowned Sparrow	- -	- -	X
Dark-Eyed Junco	- -	X	X
Lapland Longspur	- -	R	X
Snow Bunting	- -	R	X

Table 27 (continued)

Scientific (family) and Common Name	Breeding	Wintering	Migrant
Icteridae			
Bobolink[a]	X	- -	X
Red-Winged Blackbird	X	X	X
Eastern Meadowlark[a]	X	R	X
Western Meadowlark[a]	R	- -	X
Rusty Blackbird	- -	R	X
Common Grackle	X	X	X
Brown-Headed Cowbird	X	R	X
Orchard Oriole[a]	R	- -	R
Baltimore Oriole	X	- -	X
Northern Oriole	X	- -	X
Fringillidae			
Purple Finch	- -	X	X
Common Redpoll	- -	X	X
Pine Siskin[a]	- -	X	X
American Goldfinch	X	X	X
House Finch	X	X	X
Passeridae			
House Sparrow[c]	X	X	- -

NOTE: Total number of bird species: 184
Number of alien, or nonnative, bird species: 4 (2 percent)

Breeding: Nesting species
Wintering: Present January through February
Migrant: Spring and/or fall transient

X - Present, not rare
R - Rare

[a]*State-designated species of special concern. Fully protected Federal and State laws under the Migratory Bird Act.*

[b]*State-designated threatened species.*

[c]*Alien, or nonnative, bird species.*

[d]*Federally designated threatened species.*

[e]*State-designated endangered species.*

Source: Samuel D. Robbins, Jr., Wisconsin Bird Life, Population & Distribution, Past and Present*, 1991; John E. Bielefeldt, Racine County Naturalist; Zoological Society of Milwaukee County and Birds Without Borders-Aves Sin Fronteras,* Report for Landowners on the Avian Species Using the Pewaukee, Rosendale and Land O' Lakes Study Sites*, April-August, 1998; Wisconsin Department of Natural Resources; and SEWRPC.*

In the current study, about 20,606 acres, or about 40 percent of the total drainage area tributary to the Phantom Lakes, were classified in the current inventory as wildlife habitat. In that portion of the drainage area directly tributary to the Lakes, shown on Maps 16 and 17 for Upper and Lower Phantom Lakes, respectively, about 20 acres, or about 2 percent, of the drainage area directly tributary to Upper Phantom Lake and about 435 acres, or about 19 percent, of the drainage area directly tributary to Lower Phantom Lake, were classified as Class I habitat; about 52 acres, or about 5 percent, of the drainage area directly tributary to Upper Phantom Lake and about 141 acres, or about 6 percent, of the drainage area directly tributary to Lower Phantom Lake were classified as Class II habitat; and, about 100 acres, or about 10 percent, of the drainage area directly tributary to Upper Phantom Lake and about 197 acres, or about 9 percent, of the drainage area directly tributary to Lower Phantom Lake were classified as Class III habitat. The Class I habitat within the drainage area directly tributary to Upper Phantom Lake lies primarily in the shorelands at the southeastern and southwestern extremes of the Lake. The Class I

Table 28

AMPHIBIANS AND REPTILES OF THE PHANTOM LAKES AREA

Scientific (family) and Common Name	Scientific Name	Species Reduced or Dispersed with Full Area Urbanization	Species Lost with Full Area Urbanization
Amphibians			
Proteidae			
Mudpuppy	*Necturus maculosus maculosus*	X	- -
Ambystomatidae			
Blue-Spotted Salamander	*Ambystoma laterale*	- -	X
Spotted Salamander	*Ambystoma maculatum*		
Eastern Tiger Salamander	*Ambystoma tigrinum tigrinum*	X	- -
Salamandridae			
Central Newt	*Notophthalmus viridescens louisianensi*	X	- -
Bufonidae			
American Toad	*Bufo americanus americanus*	X	- -
Hylidae			
Western Chorus Frog	*Pseudacris triseriata triseriata*	X	- -
Blanchard's Cricket Frog[a,b]	*Acris crepitans blanchardi*	X	- -
Northern Spring Peeper	*Hyla crucifer crucifer*	- -	X
Gray Tree Frog	*Hyla versicolor*	- -	X
Ranidae			
Bull Frog[c]	*Rana catesbeiana*	- -	X
Green Frog	*Rana clamitans melanota*	X	- -
Northern Leopard Frog	*Rana pipiens*	- -	X
Pickerel Frog[c]	*Rana palustris*	- -	X
Reptiles			
Chelydridae			
Common Snapping Turtle	*Chelydra serpentina serpentina*	X	- -
Kinosternidae			
Musk Turtle (stinkpot)	*Sternotherus odoratus*	X	- -
Emydidae			
Western Painted Turtle	*Chrysemys picta belli*	X	- -
Midland Painted Turtle	*Chrysemys picta marginata*	X	- -
Blanding's Turtle[d]	*Emydoidea blandingii*	- -	X
Trionychidea			
Eastern Spiny Softshell	*Trionyx spiniferus spiniferus*	X	- -
Colubridae			
Northern Water Snake	*Nerodia sipedon sipedon*	X	- -
Midland Brown Snake	*Storeria dekayi wrightorum*	X	- -
Northern Red-Bellied Snake	*Storeria occipitomaculata occipitomaculata*	X	- -
Eastern Garter Snake	*Thamnophis sirtalis sirtalis*	X	- -
Chicago Garter Snake	*Thamnophis sirtalis semifasciata*	X	- -
Butler's Garter Snake	*Thamnophis butleri*	X	- -
Eastern Hognose Snake	*Heterodon platyrhinos*	- -	X
Smooth Green Snake	*Opheodrys vernalis vernalis*	- -	X
Eastern Milk Snake	*Lampropeltis triangulum triangulum*	- -	X

[a]*Likely to be extirpated from the watershed.*

[b]*State-designated endangered species.*

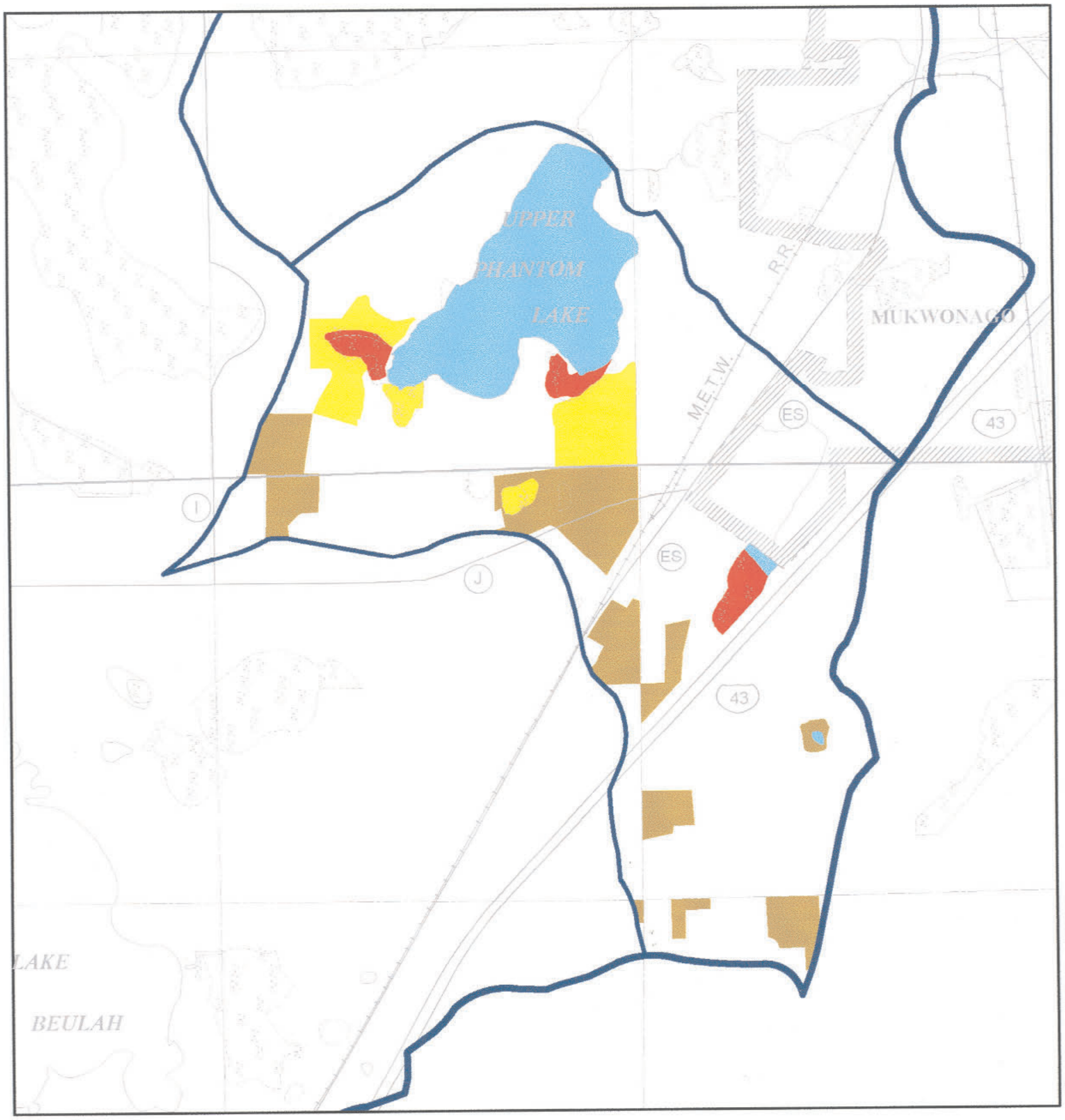
[c]*State-designated special concern species.*

[d]*State-designated threatened species.*

Source: Gary S. Casper, Geographical Distribution of the Amphibians and Reptiles of Wisconsin*, 1996, Wisconsin Department of Natural Resources, Kettle Moraine State Forest, Lapham Peak Unit; and SEWRPC.*

Map 16

WILDLIFE HABITAT AREAS WITHIN THE DRAINAGE AREA TRIBUTARY TO UPPER PHANTOM LAKE: 1985



Class I, High Value Habitat

Class II, Medium Value Habitat

Class III, Good Value Habitat

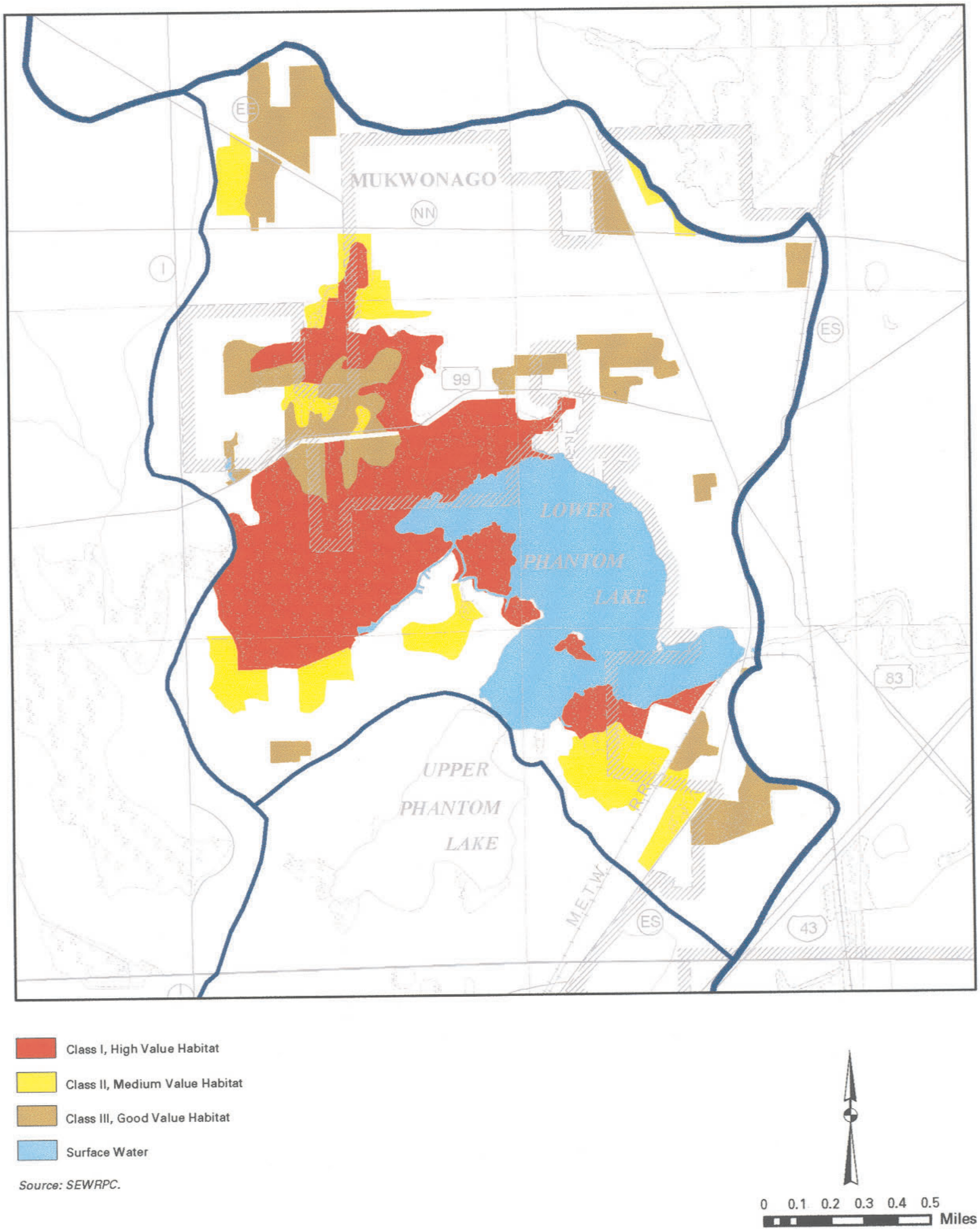
Surface Water

Source: SEWRPC.

0 0.1 0.2 0.3 0.4 0.5 Miles

Map 17

WILDLIFE HABITAT AREAS WITHIN THE DRAINAGE AREA TRIBUTARY TO LOWER PHANTOM LAKE: 1985



Source: SEWRPC.

habitat within the direct drainage area tributary to Lower Phantom Lake lies primarily in the wetland areas along the Mukwonago River to the west of the main waterbody of the Lake. These differences reflect the extensive wetland areas adjacent to Lower Phantom Lake as well as its river-run status as a drainage lake.

NATURAL AREAS AND CRITICAL SPECIES HABITAT

The Phantom Lakes area is one of regional and statewide importance due to its richness of natural habitat and biota as reflected in its designations in the adopted Regional Natural Areas and Critical Species Habitat plan.[8] These areas include:

1. Upper and Lower Phantom Lakes—both lakes are listed as Critical Lakes of Southeast Wisconsin and have been given an AQ-1 designation identifying them as aquatic areas of statewide or greater significance. This designation was the result of an assessment scheme based on water quality, quality of wildlife habitat, presence of endangered, threatened, or special concern species, shoreline development, and physical attributes. In addition, both Lakes were recognized as possessing critical fish species.

2. Mukwonago Fen, Sedge Meadow, and Tamarack Relict—an integral part of the Mukwonago River corridor, this 232-acre wetland complex is all under private ownership. This area is bisected by the Mukwonago River immediately upstream of Lower Phantom Lake. A known Natural Area of Waukesha County, it has been given a rating of NA-1, identifying it as an area of statewide or greater significance.

3. Phantom Lake Wetlands—this good quality wetlands complex consists of deep and shallow marsh and sedge meadow bordering the northern shorelands of Lower Phantom Lake. It has been given a rating of NA-2, identifying it as a site of countywide or regional significance. Comprised of 187 acres, all under private ownership, this area supports a varied biota including habitat for species of plants and animals that are on the endangered, threatened, rare or special concern list for Wisconsin.

4. Mukwonago River—the Mukwonago River from upstream of Lower Phantom Lake to Lulu Lake has been assigned a rating of AQ-1 with an assessment score of 31 points out of a possible 36 based on the Index of Biotic Integrity.[9] This excellent quality system contains approximately 9.7 critical stream-miles, providing good water quality, fish population and biodiversity, and is largely coincident with the area designated by the State of Wisconsin as an Exceptional Resource Water pursuant to Chapter NR 102 of the *Wisconsin Administrative Code*.

Table 29 presents a summation of the endangered, threatened, rare or special concern species and Map 18 shows the locations of natural areas and critical species habitat sites located in the Phantom Lakes area.

WETLANDS

Wetlands are defined by the Regional Planning Commission as “areas that have a predominance of hydric soils and that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions.” This definition, which is also used by the U.S. Army Corps of Engineers and the U.S.

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

[9]*U.S. Department of Agriculture, Forest Service, General Technical Report NC-149.*

Table 29

ENDANGERED, THREATENED, RARE, SPECIAL CONCERN, AND UNCOMMON SPECIES IN THE PHANTOM LAKES AREA: 1994

Species of Concern	Location	Species Status
Fish		
Starhead Topminnow	Upper and Lower Phantom Lakes	Endangered
Lake Chubsucker	Upper and Lower Phantom Lakes	Special concern
Pugnose Shiner	Upper Phantom Lake	Threatened
Longear Sunfish	Mukwonago River (mouth to Lower Phantom Lake)	Threatened
Reptiles and Amphibians		
Blanding's Turtle	Total drainage area tributary to the Phantom Lakes	Threatened
Birds		
Northern Harrier	Lakewood Farms Tamaracks	Rare
Sedge wren	Lakewood Farms Tamaracks	Rare
Sandhill Crane	Lakewood Farms Tamaracks, Lower Phantom Lake, Mukwonago Fen	Uncommon
Black Tern	Lower Phantom Lake	Rare
Least Bittern	Lower Phantom Lake	Rare
Common Snipe	Mukwonago Fen	Uncommon

Source: SEWRPC.

Environmental Protection Agency, is essentially the same as the definition used by the U.S. Natural Resource Conservation Service.[10]

Another definition, which is applied by the State of Wisconsin Department of Natural Resources and which is set forth in Chapter 23 of the *Wisconsin Statutes*, defines a wetland as "an area where water is at, near, or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation, and which has soils indicative of wet conditions." In practice, the Department definition differs from the Regional Planning Commission definition in that the Department considers very poorly drained, poorly drained, and some of the somewhat poorly drained soils as wetland soils meeting the Department "wet condition" criterion. The Commission definition only considers the very poorly drained and poorly drained soils as meeting the "hydric soil" criterion. Thus, the State definition as actually applied is more inclusive than the Federal and Commission definitions in that the Department may include some soils that do not show hydric field characteristics as wet soils capable of supporting wetland vegetation, a condition that may occur in some floodlands.[11]

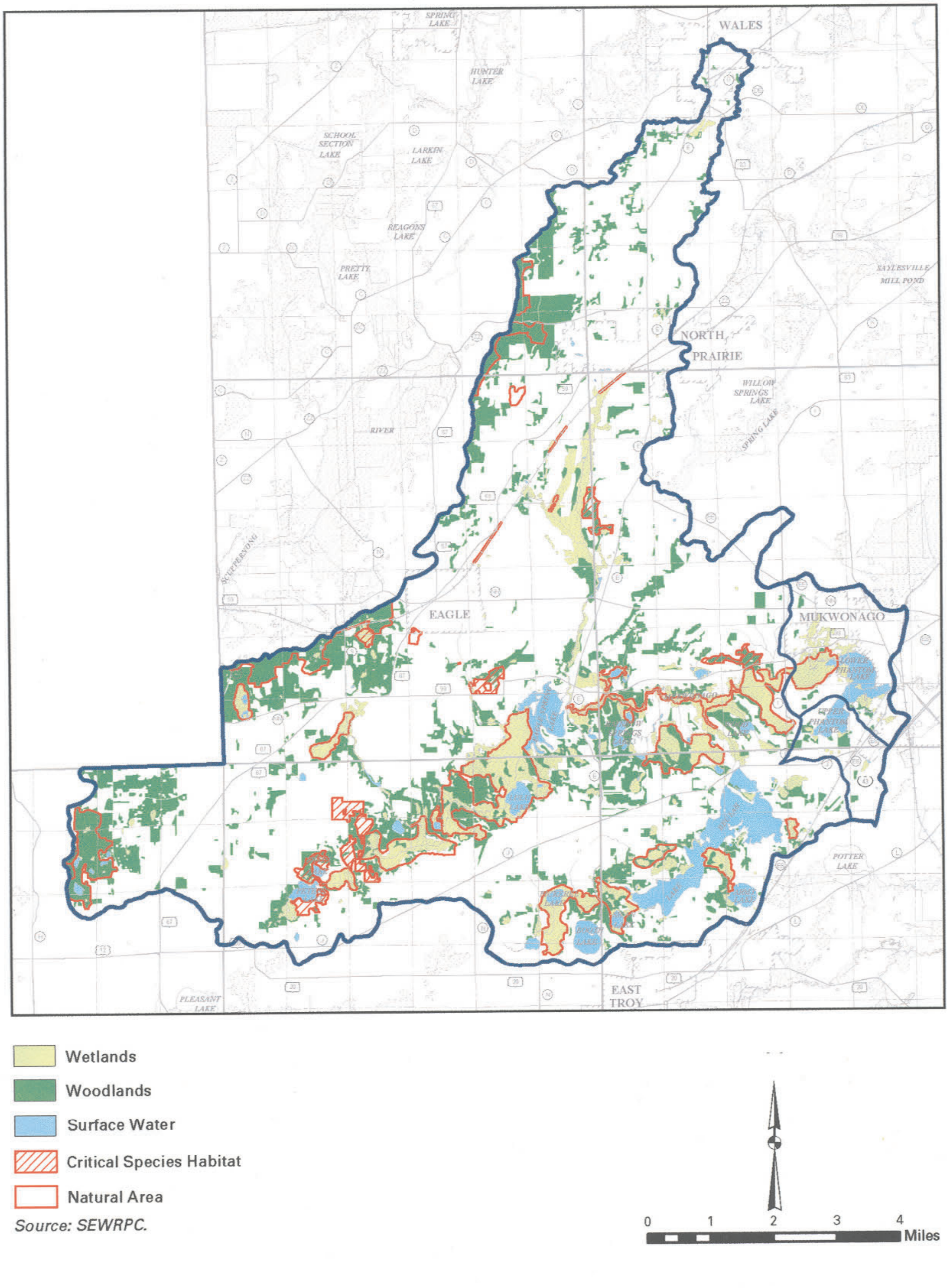
As a practical matter, experience has shown that application of the Wisconsin Department of Natural Resources, the U.S. Environmental Protection Agency and U.S. Army Corps of Engineers, and the Regional Planning

[10]*Lands designated as prior converted cropland, that is, lands that were cleared, drained, filled, or otherwise manipulated to make them capable of supporting a commodity crop prior to December 23, 1985, may meet the criteria of the U.S. Natural Resource Conservation Service wetland definition, but they would not be regulated under Federal wetland programs. If such lands are not cropped, managed, or maintained for agricultural production, for five consecutive years, and in that time the land reverts back to wetland, the land would then be subject to Federal wetland regulations.*

[11]*Although prior converted cropland is not subject to Federal wetland regulations unless cropping ceases for five consecutive years and the land reverts to a wetland condition, the State may consider prior converted cropland to be subject to State wetland regulations if the land meets the criteria set forth in the State wetland definition before it has not been cropped for five consecutive years.*

Map 18

NATURAL AREAS AND CRITICAL SPECIES HABITAT SITES WITHIN THE DRAINAGE AREA TRIBUTARY TO THE PHANTOM LAKES



Source: SEWRPC.

Commission definitions produce reasonably consistent wetland identifications and delineations in the majority of situations within the Southeastern Wisconsin Region. That consistency is due in large part to the provision in the Federal wetland delineation manual that allows for the application of professional judgment in cases where satisfaction of the three criteria for wetland identification is unclear.

Wetlands in southeastern Wisconsin are classified predominantly as deep marsh, shallow marsh, southern sedge meadow, fresh (wet) meadow, shrub carr, alder thickets, low prairie, fens, bogs, southern wet- and wet-mesic hardwood forest, and coniferous swamp. Wetlands form an important part of the landscape in and adjacent to the Phantom Lakes in that they perform an important set of natural functions that make them ecologically and environmentally invaluable resources. Wetlands affect the quality of water by acting as a filter or a buffer zone allowing silt and sediments, and their associated pollutants, to settle out and by absorbing potential contaminants within the plant biomass. They also influence the quantity of water by providing water during periods of drought and holding it back during periods of flood. When located along shorelines of lakes and streams, wetlands help protect those shorelines from erosion. Wetlands also may serve as groundwater discharge and recharge areas in addition to being important resources for overall ecological health and diversity by providing essential breeding and feeding grounds, shelter, and cover or refuge for many forms of fish and wildlife.

Wetlands are poorly suited to urban use. This is due to the high soil compressibility and instability, high water table, low load-bearing capacity, and high shrink-swell potential of wetland soils, and, in some cases, to the potential for flooding. In addition, metal conduits placed in some types of wetland soils may be subject to rapid corrosion. These constraints, if ignored, may result in flooding, wet basements and excessive operation of sump pumps, unstable foundations, failing pavements, broken sewer and water lines, and excessive infiltration of clear water into sanitary sewerage systems. In addition, there are significant onsite preparation and maintenance costs associated with the development of wetlands, particularly as they relate to roads, foundations, and public utilities.

Table 30 characterizes the wetland plant species typically found in the drainage basin. As shown on Maps 19 and 20, wetlands covered about 30 acres, or about 3 percent, of the drainage area directly tributary to Upper Phantom Lake and about 375 acres, or about 17 percent, of the drainage area directly tributary to Lower Phantom Lake. The major wetland communities located in the drainage area tributary to the Phantom Lakes includes deep and shallow marsh, Southern sedge meadow, fresh (wet) meadow, tamarack swamp, and second growth, Southern wet to wet-mesic lowland hardwoods. The amount and distribution of wetlands in the area should remain relatively constant if the recommendations contained in the adopted regional land use plan are followed.

Sedge meadows are considered to be stable wetland plant communities that tend to perpetuate themselves if dredging activities and water level changes are prevented from occurring. Sedge meadows in southeastern Wisconsin are characterized by the tussock sedge (*Carex stricta*) and, to a lesser extent, by Canada blue-joint grass (*Calamagrostis canadensis*). Sedge meadows that are drained or disturbed to some extent typically succeed to shrub carrs.

Shrub carrs, in addition to the sedges and grasses found in the sedge meadows, contain an abundance of shrubs such as willows (*Salix* spp.) and red osier dogwood (*Cornus stolonifera*). In extremely disturbed shrub carrs, the willows, red osier dogwood, and sedges are replaced by such exotic plants as honeysuckle (*Lonicera* sp.), buckthorn (*Rhamnus* sp.), and the very aggressive reed canary grass (*Phalaris arundinacea).*

Fresh (wet) meadows are essentially lowland meadows which are dominated by forbes such as the marsh aster (*Aster simplex*), swamp aster (*Aster lucidulus*), New England aster (*Aster novae-angliae*), and giant goldenrod (*Solidago gigantea*).

Fens are very rare and specialized plant communities growing on water-logged organic soils associated with alkaline springs and seepages. Characteristic plants include shrubby cinquefoil (*Potentilla fruticosa*), Riddell's goldenrod (*Solidago riddellii*), and other species known as calciphiles or calcium tolerant plants. As aforementioned, the Mukwonago Fen is part of a 229-acre wetland complex located within the drainage area tributary to the Phantom Lakes.

Table 30

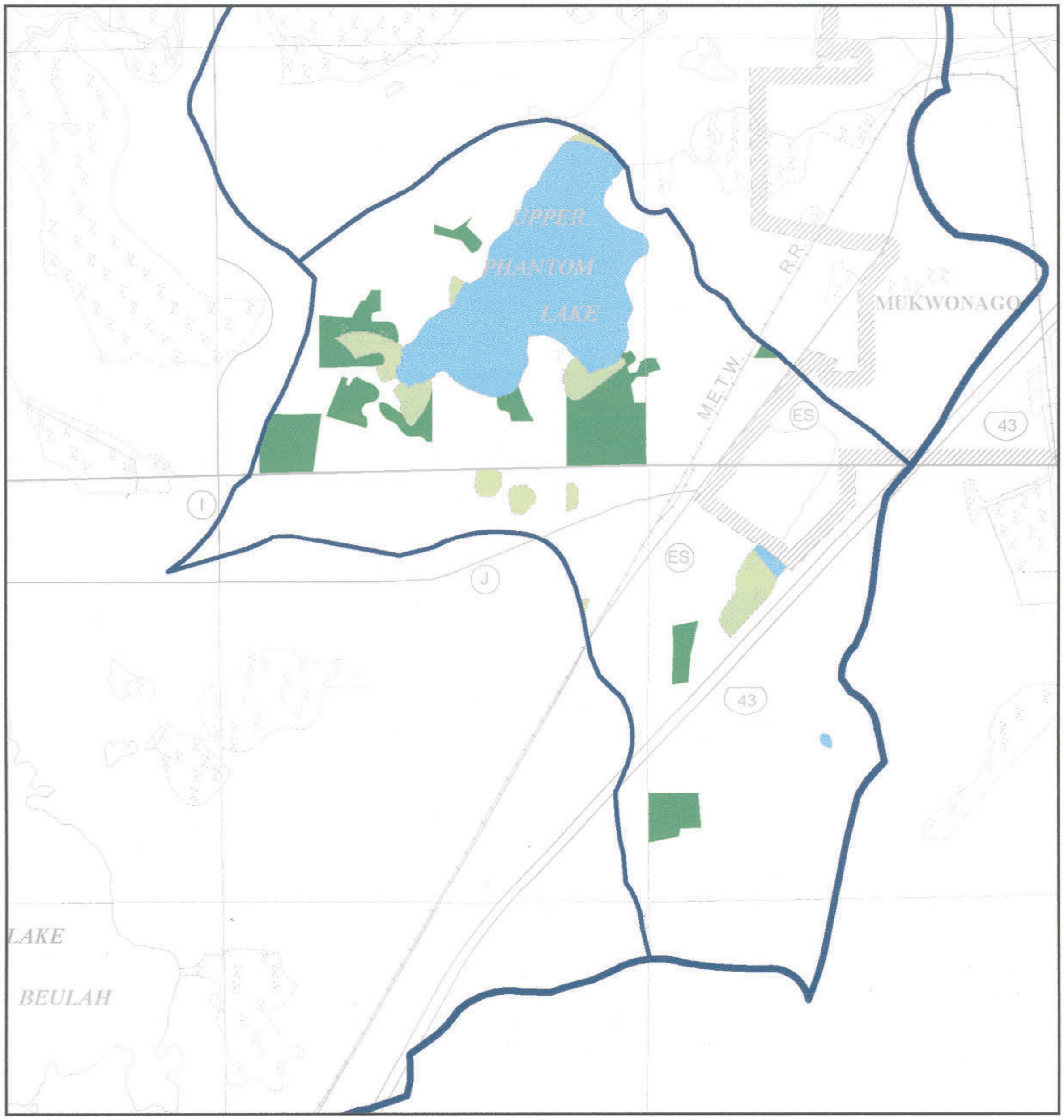
EMERGENT WETLAND PLANT SPECIES IN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO THE PHANTOM LAKES

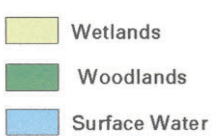
Scientific Name Family, Genus, and Species	Common Name
Equisetaceae	
Equisetum arvense	Marsh fern
Cupressaceae	
Junipernus virginiana	Red cedar
Pinaceae	
Latrix larcina	Tamarack
Alismataceae	
Sagittaria latifolia	Arrow head
Cyperaceae	
Carex bebbii	Bebb's oval sedge
Carex comosa	Bristly sedge
Carex lacustris	Lake sedge
Carex stricta	Tussock sedge
Carex vulpinoidea	Fox sedge
Carex spp.	Sedges
Scirpus acutus	Hardstem bulrush
Scirpus validus	Softstem bulrush
Juncaceae	
Juncus spp.	Rush
Poaceae	
Bromus ciliatus	Ciliated brome grass
Calamagrostis canadensis	Canada bluejoint grass
Muhlenbergia mexicana-racemosa	Muhly grass
Phalaris arundinacea	Reed canary grass
Ziania aquatica	Wild rice
Typhaceae	
Typha latifolia	Broadleaf cat-tail
Typha augustifolia	Narrowleaf cat-tail
Aceraceae	
Acer negundo	Box elder
Apiaceae	
Cicuta bulbifera	Water-hemlock
Daucus carota	Quen Anne's lace
Oxypolus rigidior	Cowbane
Asclepiadaceae	
Asclipias incarnata	Marsh milkweed
Asteraceae	
Ambrosia trifida	Giant ragweed
Aster firmus	Swamp aster
Aster simplex	Marsh aster
Aster puniceus	Red-stemmed aster
Bidens spp.	Beggers-ticks
Cirsium multicum	Swamp thistle
Cirsium vulgare	Bull thistle
Eupatorium maculatum	Joe-pye weed
Eupatorium perfoliatum	Boneset
Helenium autumnale	Sneezeweed
Liatris pycnostachya	Gayfeather
Solidago gigantia	Giant goldenrod
Solidago graminifolia	Grassleaf goldenrod
Solidago patula	Swamp goldenrod
Solidago riddellii	Riddell's goldenrod
Balsaminaceae	
Impatiens capensis	Jewel weed
Brassicaeae	
Cardamine pratensis	Cuckoo flower
Nasturtium officinale	Watercress
Caprifoliaceae	
Lonicera x bella	Hybrid honeysuckle
Caprifoliaceae (continued)	
Sambucus canadensis	Elderberry
Viburnum lentago	Nannyberry
Cornaceae	
Cornus amomum	Silky dogwood
Cornus stolonifera	Red osier dogwood
Cucurbitaceae	
Echinocystis lobata	Wild cucumber
Grossulariaceae	
Ribes americanum	Wild black currant
Labitae	
Lycopus americanus	Cutleaf water-horehound
Lamiaceae	
Lycopus uniflorus	Northern bugleweed
Mentha spp.	Mint
Scutellaria galericulata	Marsh skullcap
Lobeliaceae	
Lobelia kalmii	Brook lobelia
Lythraceae	
Decodon verticillatus	Water willow
Nymphaeaceae	
Nuphar advena	Yellow water lily
Nymjphaea odorata	White water lily
Oleaceae	
Fraxinus nigra	Black ash
Fraxinus pennsylnaia	Green ash
Onagraceae	
Epilobium leptophyllum	Linear-leaf willow-herb
Epilobium strictum	Downy willow-herb
Oenothera biennis	Evening primrose
Polygonaceae	
Polygonum punctatum	Pinkweed
Rumex orbiculatus	Water dock
Rhamnaceae	
Rhamnus frangula	Glossy buckthorn
Rosaceae	
Fragaria virginiana	Wild strawberry
Geum canadensis	White avens
Potentilla froticosa	Shrubby cinquefoil
Rubus occidentalis	Black raspberry
Rubiaceae	
Galium asprellum	Rough bedstraw
Salicaeae	
Salix bebbiana	Beaked willow
Salix interior	Sandbar willow
Salix nigra	Black willow
Salix spp.	Willows
Scrophulariaceae	
Pedicularis lanceolata	Swamp lousewart
Solanaceae	
Solanum dulcamara	Deadly nightshade
Urticaeae	
Pilea pumila	Clearweed
Urtica dioica	Stinging nettle
Verbenaceae	
Verbena hastate	Blue vervain
Vitaceae	
Vitis riparia	Riverbank grape

Source: Wisconsin Department of Natural Resources and SEWRPC.

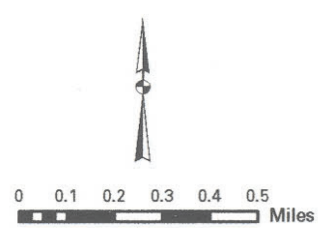
Map 19

WETLANDS AND WOODLANDS WITHIN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO UPPER PHANTOM LAKE: 2000



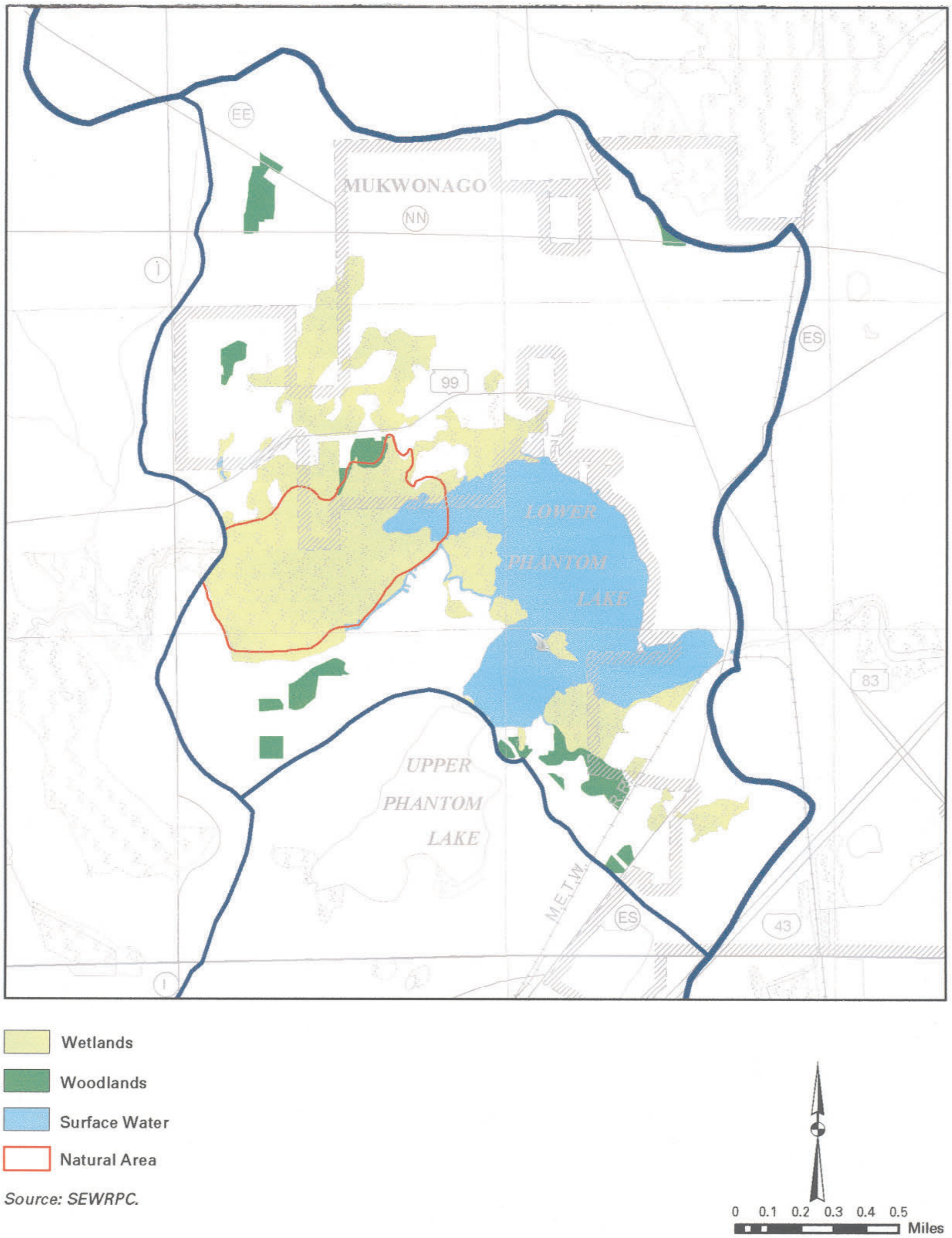


Source: SEWRPC.



Map 20

WETLANDS AND WOODLANDS WITHIN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO LOWER PHANTOM LAKE: 2000



Source: SEWRPC.

The deep and shallow marsh plant communities in the Phantom Lakes are dominated by cattails (*Typha* spp.). Other emergent plant species commonly occurring in the deep and shallow marshes within the Phantom Lakes drainage basin include Arrow-head (*Sagittaria latifolia*), bulrushes (*Scirpus* spp.) and willow (*Salix* spp).

WOODLANDS

Woodlands are defined by the Regional Planning Commission as those areas containing a minimum of 17 trees per acre with a diameter of at least four inches at breast height (4.5 feet above the ground).[12] The woodlands are classified as dry, dry-mesic, mesic, wet-mesic, wet hardwood, and conifer swamp forests; the last three are also considered wetlands. The Regional Planning Commission also maintains an inventory of woodlands within the Region. As shown on Maps 19 and 20, woodlands covered about 73 acres, or about 7 percent, of the drainage area directly tributary to Upper Phantom Lake and about 62 acres, or about 3 percent, of the drainage area directly tributary to Lower Phantom Lake.

The amount and distribution of woodlands in the area should remain relatively stable if the recommendations contained in the Waukesha County development and regional land use plans are followed. If, however, urban development is allowed to continue within the watershed much of the remaining woodland cover may be expected to be lost.

ENVIRONMENTAL CORRIDORS

One of the most important tasks undertaken by the Commission as part of its regional planning effort was the identification and delineation of those areas of the Region having high concentrations of natural, recreational, historic, aesthetic, and scenic resources and which, therefore, should be preserved and protected in order to maintain the overall quality of the environment. Such areas normally include one or more of the following seven elements of the natural resource base which are essential to the maintenance of both the ecological balance and the natural beauty of the Region: 1) lakes, rivers, and streams and the associated undeveloped shorelands and floodlands; 2) wetlands; 3) woodlands; 4) prairies; 5) wildlife habitat areas; 6) wet, poorly drained, and organic soils; and 7) rugged terrain and high-relief topography. While the foregoing seven elements constitute integral parts of the natural resource base, there are five additional elements which, although not a part of the natural resource base *per se*, are closely related to or centered on that base and therefore are important considerations in identifying and delineating areas with scenic, recreational, and educational value. These additional elements are: 1) existing outdoor recreation sites; 2) potential outdoor recreation and related open space sites; 3) historic, archaeological, and other cultural sites; 4) significant scenic areas and vistas; and 5) natural and scientific areas.

The delineation of these 12 natural resource and natural resource-related elements on a map results in an essentially linear pattern of relatively narrow, elongated areas which have been termed "environmental corridors" by the Commission. Primary environmental corridors include a wide variety of the abovementioned important resource and resource-related elements and are at least 400 acres in size, two miles in length, and 200 feet in width. The primary environmental corridors identified in the drainage areas directly tributary to Upper and Lower Phantom Lakes are contiguous with environmental corridors and isolated natural resource areas lying outside the lake drainage area boundary, and, consequently, do meet these size and natural resource element criteria.

It is important to point out that, because of the many interlocking and interacting relationships between living organisms and their environment, the destruction or deterioration of any one element of the total environment may lead to a chain reaction of deterioration and destruction among the others. The drainage of wetlands, for example, may have far-reaching effects, since such drainage may destroy fish spawning grounds, wildlife habitat, groundwater recharge areas, and natural filtration and floodwater storage areas of interconnecting lake and stream systems. The resulting deterioration of surface water quality may, in turn, lead to a deterioration of the quality of

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[12]*Bruce P. Rubin and Gerald H. Emmerich, Jr., "Refining the Delineation of Environmental Corridors in Southeastern Wisconsin,"* SEWRPC Technical Record, *Vol. 4, No. 2, March 1981*.

the groundwater. Groundwater serves as a source of domestic, municipal, and industrial water supply and provides a basis for low flows in rivers and streams. Similarly, the destruction of woodland cover, which may have taken a century or more to develop, may result in soil erosion and stream siltation and in more rapid runoff and increased flooding, as well as destruction of wildlife habitat. Although the effects of any one of these environmental changes may not in and of itself be overwhelming, the combined effects may lead eventually to the deterioration of the underlying and supporting natural resource base, and of the overall quality of the environment for life. The need to protect and preserve the remaining environmental corridors within the drainage area tributary to the Phantom Lakes thus becomes apparent.

In the drainage area tributary to the Phantom Lakes, the riverbanks and lakeshores located within the environmental corridors should be candidates for immediate protection through proper zoning or through public ownership. Of the areas not already publicly owned, the remaining areas of natural shoreline, and riparian wetland areas, are perhaps the most sensitive areas in need of greatest protection. In this regard, the regional natural areas and critical species habitat protection and management plan recommends public acquisition of specific lands.[13] Within the drainage area tributary to the Phantom Lakes, the Phantom Lake Wetlands is comprised of 187 acres, 167 acres of which are already under protective ownership with the remaining 20 acres proposed to be acquired by the Village of Mukwonago as part of the expansion of an existing project. The Mukwonago Fen, Sedge Meadow, and Tamarack Relict combined wetland complex of 229 acres, all of which are not under protective ownership, is recommended for acquisition by Waukesha County in the adopted County park plan.[14] Likewise, the Upper Mukwonago River, comprised of 166 acres, seven acres of which are already under protective ownership, contains 159 acres which are recommended to be acquired by the Towns of Eagle and Mukwonago as set forth in the county park plan.

Primary Environmental Corridors

The primary environmental corridors in southeastern Wisconsin generally lie along major stream valleys and around major lakes, and contain almost all of the remaining high-value woodlands, wetlands, and wildlife habitat areas, and all of the major bodies of surface water and related undeveloped floodlands and shorelands. These corridors are subject to urban encroachment because of their desirable natural resource amenities. Unplanned or poorly planned intrusion of urban development into these corridors, however, not only tends to destroy the very resources and related amenities sought by the development, but tends to create severe environmental and development problems as well. Consequently, as of 2000, about 100 acres, or about 10 percent, of the drainage area directly tributary to Upper Phantom Lake remained as primary environmental corridor, as shown on Map 21; about 454 acres, or about 20 percent, of the drainage area directly tributary to Lower Phantom Lake remained as primary environmental corridor, as shown on Map 22. The preservation of these corridors, thus, is one of the major ways in which the water quality of the Phantom Lakes can be maintained and perhaps improved.

Secondary Environmental Corridors

The secondary environmental corridors in the Phantom Lakes drainage area contain a variety of resource elements, often remnant resources from primary environmental corridors which have been developed for intensive agricultural purposes or urban land uses. Secondary environmental corridors facilitate surface water drainage, maintain “pockets” of natural resource features, and provide for the movement of wildlife, as well as for the movement and dispersal of seeds for a variety of plant species. Such corridors, while not as important as the primary environmental corridors, should be preserved in essentially open, natural uses as urban development proceeds within the direct drainage area, particularly when the opportunity is presented to incorporate the corridors into urban stormwater detention areas, associated drainageways, and neighborhood parks. Secondary environmental corridors encompassed less than 1 percent of the total drainage area tributary to the Phantom Lakes in 2000.

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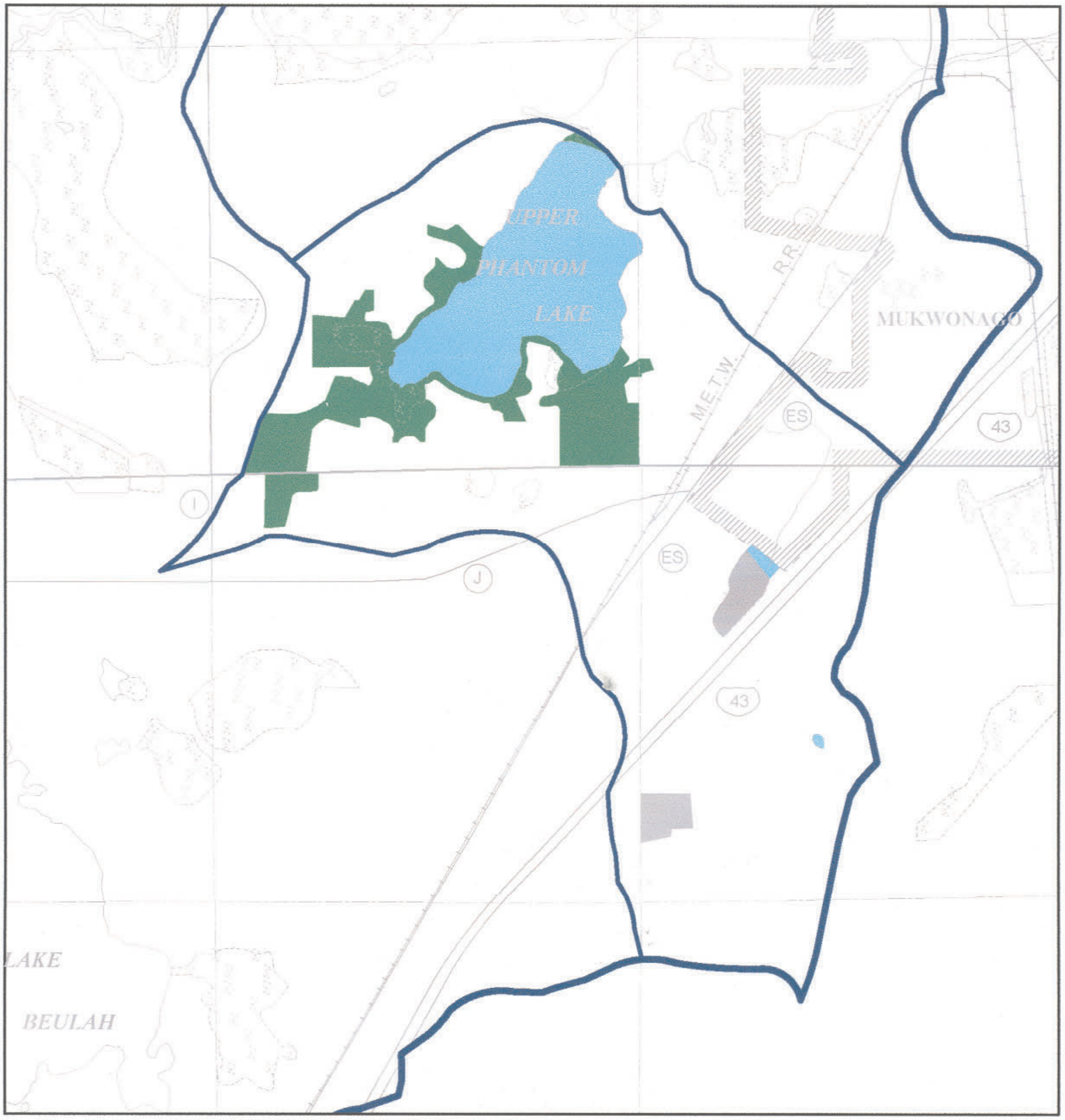
[13]*SEWRPC Planning Report No. 42*, op.cit..

[14]Ibid.

Map 21

ENVIRONMENTAL CORRIDORS AND ISOLATED NATURAL RESOURCE AREAS WITHIN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO UPPER PHANTOM LAKE: 2000

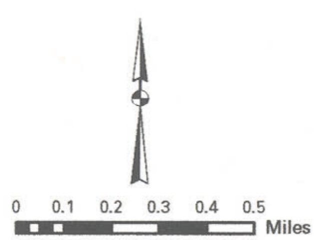


Primary Environmental Corridor

Isolated Natural Resource Areas

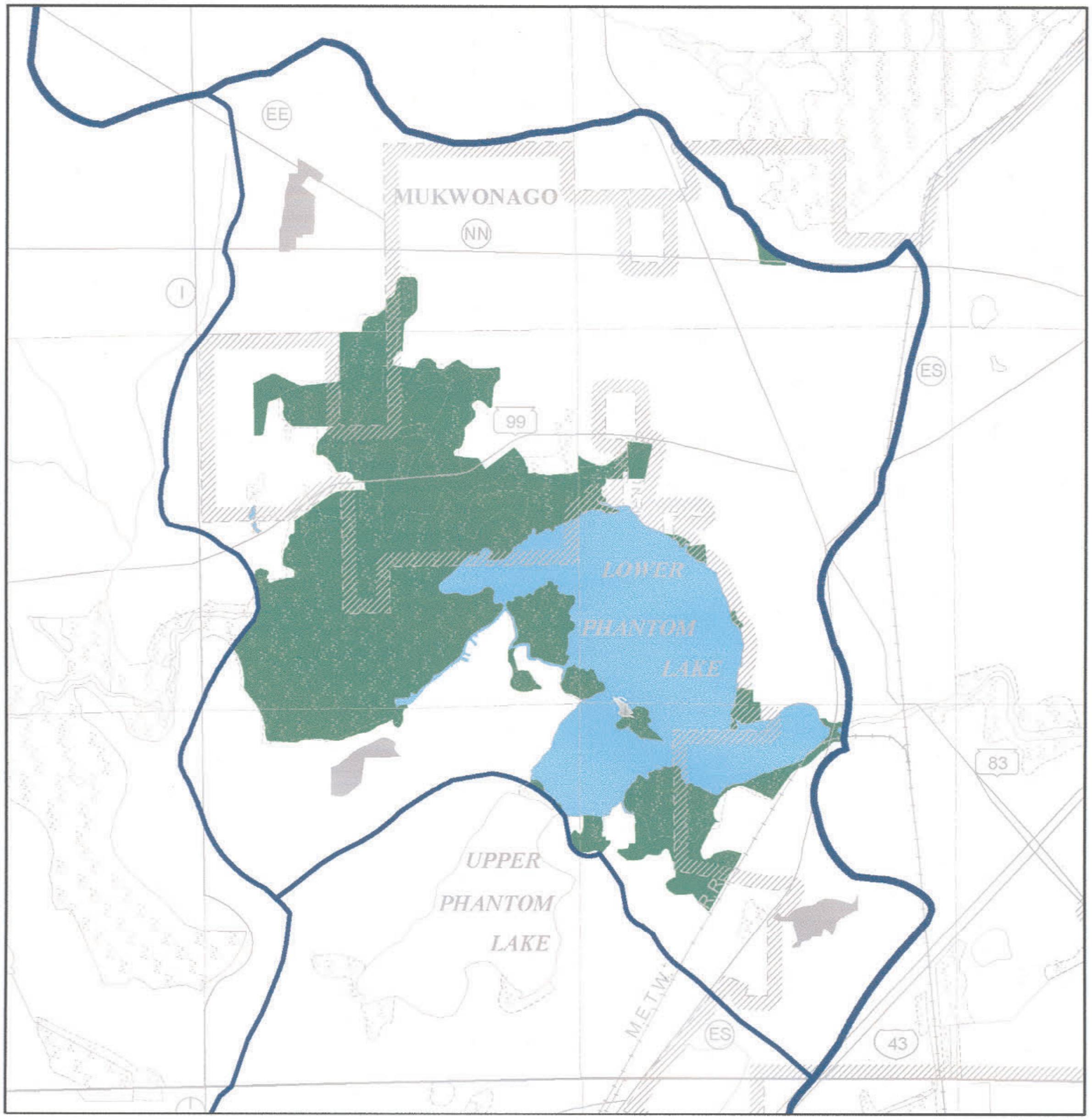
Surface Water

Source: SEWRPC.



Map 22

ENVIRONMENTAL CORRIDORS AND ISOLATED NATURAL RESOURCE AREAS WITHIN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO LOWER PHANTOM LAKE: 2000



Primary Environmental Corridor

Isolated Natural Resource Areas

Surface Water

Source: SEWRPC.

0 0.1 0.2 0.3 0.4 0.5 Miles

Isolated Natural Resource Areas
In addition to the environmental corridors, other, small concentrations of natural resource base elements exist within the drainage areas directly tributary to Upper and Lower Phantom Lakes. These resource base elements are isolated from the environmental corridors by urban development or agricultural uses and, although separated from the environmental corridor network, have important natural values. Isolated natural resource areas may provide the only available wildlife habitat in an area, provide good locations for local parks and nature study areas, and lend an aesthetic character or natural diversity to an area. Important isolated natural resource area features within southeastern Wisconsin include a geographically well-distributed variety of isolated wetlands, woodlands, and wildlife habitat. These isolated natural resource area features should also be protected and preserved in a natural state whenever possible. Such isolated areas, five or more acres in areal extent within the drainage area directly tributary to Upper Phantom Lake, as of 2000, totaled about 15 acres, or about 1 percent, of the drainage area directly tributary to the Lake, as shown on Map 21. Isolated natural resource areas in the drainage area directly tributary to Lower Phantom Lake totaled about 27 acres, or about 1 percent, of watershed, as shown on Map 22.

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Chapter VI

CURRENT WATER USES AND WATER USE OBJECTIVES

INTRODUCTION

Nearly all major lakes in the Southeastern Wisconsin Region serve multiple purposes, ranging from recreation to receiving waters for stormwater runoff. Recreational uses range from noncontact, passive recreational activities such as picnicking and walking along the shoreline, to full-contact, active recreational activities such as swimming, boating, and waterskiing. To accommodate this range of uses, the State of Wisconsin has developed water use objectives for the surface waters of the State, and has promulgated these objectives in Chapters NR 102 and NR 104 of the *Wisconsin Administrative Code*. Complementary water use objectives and supporting water quality guidelines have been adopted by the Southeastern Wisconsin Regional Planning Commission as set forth in the adopted regional water quality management plan for all major lakes and streams in the Region.[1] The current water uses, as well as the water use objectives and supporting water quality guidelines for the Phantom Lakes, are discussed in this chapter.

RECREATIONAL USES AND FACILITIES

The Phantom Lakes support a full range of lake uses. These uses include angling during both the summer and winter fishing seasons, recreational boating, swimming, and aesthetic viewing. Winter recreational uses of the Phantom Lakes also include cross-country skiing, ice skating, and snowmobiling. The scope of these recreational uses engaged in on the Phantom Lakes is sufficiently broad to be consistent with the recommended use objectives of full recreational use and the support of a healthy warmwater sport fishery, as set forth in the adopted regional water quality management plan.

Angling

As discussed in Chapter V, fisheries surveys indicate that the Phantom Lakes support an excellent panfish stock, as well as largemouth bass and northern pike populations. Evidence of the good fishing is provided by the number of ice fishing shelters that occur on the ice during the winter months, and by the numbers of fishing boats and shoreline anglers using the Lakes during the summer.

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

Recreational Boating

Boat traffic on the Phantom Lakes is variable throughout the season. During 2002, the Commission staff conducted recreational use surveys on weekdays and weekends for Upper and Lower Phantom Lakes, the results of which are shown in Tables 31 and 32. The data in these tables indicate significantly different recreational usage of the two lakes. The Upper Phantom Lake data suggest Lake users engage most frequently in nonfishing recreational activities such as swimming, water skiing, canoeing, kayaking and paddle boating. Of all the recreational use activities occurring on Upper Phantom Lake, on the dates observed by the Commission staff, swimming accounted for about 40 percent of the recreational uses, pleasure boating including water skiing accounted for a further approximately 40 percent, and fishing accounted for about 20 percent. During the surveys, powerboating and waterskiing on Upper Phantom Lake exceeded safe levels, as defined by the recreational boating guidelines set forth in the adopted regional park and open space plan, an area of 40 acres per boat being considered to be a minimum area for safe waterskiing and fast boating pursuant to the aforementioned Regional guidelines.

Lower Phantom Lake data, by contrast, indicate a clear preference for fishing compared to all other categories of recreational water uses. During both the weekday and weekend surveys conducted on Lower Phantom Lake, fishing, either from shore or boat, accounted for over 90 percent of all recreational uses. During the surveys, powerboating and waterskiing on Lower Phantom Lake were within safe levels, as defined by the recreational boating guidelines set forth in the adopted regional park and open space plan.

During 2002, an inventory of watercraft was conducted by the Commission staff on Upper and Lower Phantom Lakes. Tables 33 and 34 show the results of these inventories, which included watercraft of all descriptions, fishing and pontoon boats, ski boats, sailboats, and rowing vessels, as well as personal watercraft. The distributions of watercraft types on the two Lakes reflect, to some degree, the recreational uses dominant on each Lake. On Upper Phantom Lake, where about 80 percent of the recreational uses were nonfishing uses, fishing boats accounted for only about 15 percent of the watercraft. On Lower Phantom Lake, where there was a strong tendency toward fishing and related uses, over 30 percent of the watercraft was comprised of fishing boats. A further 30 percent of watercraft on Lower Phantom Lake was pontoon boats, which can, and often do, serve dual purpose roles as both pleasure and fishing craft.

Public Lake Access

The Phantom Lakes provide an ideal setting for the provision of parks and open space sites and facilities. There is ample publicly owned open space and lake access on the Lakes, as shown on Map 23. The largest and best known access is located on Lower Phantom Lake in the Village of Mukwonago. This park site includes a public recreational boating access site, picnic tables, toilet facilities, and an area for parking of automobiles and trailers. These facilities meet the criteria set forth in Chapter NR 1 of the *Wisconsin Administrative Code*, which establishes quantitative standards for determining the adequacy of public recreation boating access, setting maximum and minimum standards based upon available parking facilities for car-top and car-trailer units. As of 2005, pursuant to these standards, both Upper and Lower Phantom Lakes continue to be assessed as having adequate public recreational boating access opportunities.

It is important to note that the provision of park and open space sites within the drainage area tributary to the Phantom Lakes should continue to be guided by the recommendations contained in the Waukesha County development plan.[2] The purpose of this plan, in part, is to guide the preservation, acquisition, and development of lands for park, outdoor recreation, and related open space purposes, and to protect and enhance the underlying and sustaining natural resource base of the locale. With respect to the Phantom Lakes drainage area, the plan recommends the maintenance of existing park and open space sites in the area. In addition, the plan recommends

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[2]*SEWRPC Community Assistance Planning Report No. 209,* A Development Plan for Waukesha County, Wisconsin, *August 1996; see also SEWRPC Community Assistance Planning Report No. 137,* A Park and Open Space Plan for Waukesha County*, December 1989.*

Table 31

RECREATIONAL USE SURVEY ON UPPER PHANTOM LAKE: 2002

Date and Time	Weekday Participants									
	Fishing from Shoreline	Pleasure Boating	Skiing	Sailing	Personal Watercraft	Swimming	Fishing Boat	Kayak/ Canoe	Paddle Boat	Total
July 25, 2002										
10:00 a.m. to 11:00 a.m.	1	0	0	0	0	7	2	6/0	4	20
1:30 p.m. to 2:30 p.m.	1	1	6	0	0	17	1	4/4	4	34
Total	2	1	6	0	0	24	3	10	8	54
Mean	1	1	6	0	0	12	1	5	4	27

Date and Time	Weekend Participants									
	Fishing from Shoreline	Pleasure Boating	Skiing	Sailing	Personal Watercraft	Swimming	Fishing Boat	Paddle Boat	Other	Total
August 3, 2002										
9:50 a.m. to 10:50 a.m.	0	0	0	0	0	4	6	0	0	10
12:15 p.m. to 1:15 p.m.	2	2	6	0	2	12	6	1	1	32
Total	2	2	6	0	2	16	12	1	1	42
Mean	1	1	3	0	1	8	6	1	1	21

Source: SEWRPC.

Table 32

RECREATIONAL USE SURVEY ON LOWER PHANTOM LAKE: 2002

Date and Time	Weekday Participants									
	Fishing from Shoreline	Pleasure Boating	Skiing	Sailing	Personal Watercraft	Swimming	Fishing Boat	Kayak/ Canoe	Paddle Boat	Total
July 25, 2002										
9:30 a.m. to 10:30 a.m.	1	1	0	0	0	0	2	0	0	4
1:30 p.m. to 2:30 p.m.	6	1	0	0	0	0	1	0	0	8
Total	7	2	0	0	0	0	3	0	0	12
Mean	3	1	0	0	0	0	1	0	0	6

Date and Time	Weekend Participants									
	Fishing from Shoreline	Pleasure Boating	Skiing	Sailing	Personal Watercraft	Swimming	Fishing Boat	Kayak/ Canoe	Paddle Boat	Total
August 3, 2002										
9:40 a.m. to 10:45 a.m.	8	0	0	0	0	0	11	0	0	19
12:15 p.m. to 1:15 p.m.	13	1	1	0	0	1	11	0	0	27
Total	21	1	1	0	0	1	22	0	0	46
Mean	10	<1	<1	0	0	<1	11	0	0	23

Source: SEWRPC.

Table 33

WATERCRAFT ON UPPER PHANTOM LAKE: 2002

Type of Watercraft									
Power Boat	Fishing Boat	Pontoon Boat	Canoe/Kayak	Paddle Boat	Sailboat	Personal Watercraft	Sailboards	Other	Total
33	37	36	60/31	29	12	6	5	4	253

Source: SEWRPC.

Table 34

WATERCRAFT ON LOWER PHANTOM LAKE: 2002

Type of Watercraft								
Power Boat	Fishing Boat	Pontoon Boat	Canoe/ Kayak	Paddle Boat	Sailboat	Personal Watercraft	Other	Total
23	55	58	18/3	12	4	2	2	177

Source: SEWRPC.

that the undeveloped lands in the primary environmental corridor drainage area tributary to the Phantom Lakes be retained and maintained as natural open space.

Wisconsin Department of Natural Resources Recreational Rating

In general, the Phantom Lakes provide a variety of outdoor recreational opportunities. Based upon the outdoor recreation rating developed by the Wisconsin Department of Natural Resources, Upper Phantom Lake received 57 of a possible 72 points, as shown in Table 35; Lower Phantom Lake, given its shallow nature, received 52 points as shown in Table 36. These ratings indicate that the Lakes provide a range of recreational opportunities, including boat launch sites, with water quality conditions conducive to boating, and some marsh areas suitable for wildlife observation. Features that were considered to detract from the recreational rating included occasional algal blooms and limited boating area in Upper Phantom; and inadequate boating depths, limited boating area and excessive macrophyte growths in Lower Phantom Lake.

WATER USE OBJECTIVES

The regional water quality management plan recommended the adoption of full recreational and warmwater sport fisheries objectives for the Phantom Lakes. The findings of the inventories of the natural resource base, set forth in Chapters III through V, indicate that the use of the Lake and the resources of the area are generally supportive of such objectives, although it is expected that remedial measures may be required if the Lake is to fully meet the objectives.

The recommended warmwater sport fishery objective is supported in the Phantom Lakes by a sport fishery based largely on largemouth bass, northern pike, and panfish. These fishes have traditionally been sought after in Upper and Lower Phantom Lakes. Fish stocking by the Wisconsin Department of Natural Resources has not been a regular part of the fishery program for the Phantom Lakes, although private stocking of angling species has been suggested in recent years by individuals within the Phantom Lakes community.

Map 23

LOCATIONS OF PUBLIC ACCESS SITES ON THE PHANTOM LAKES

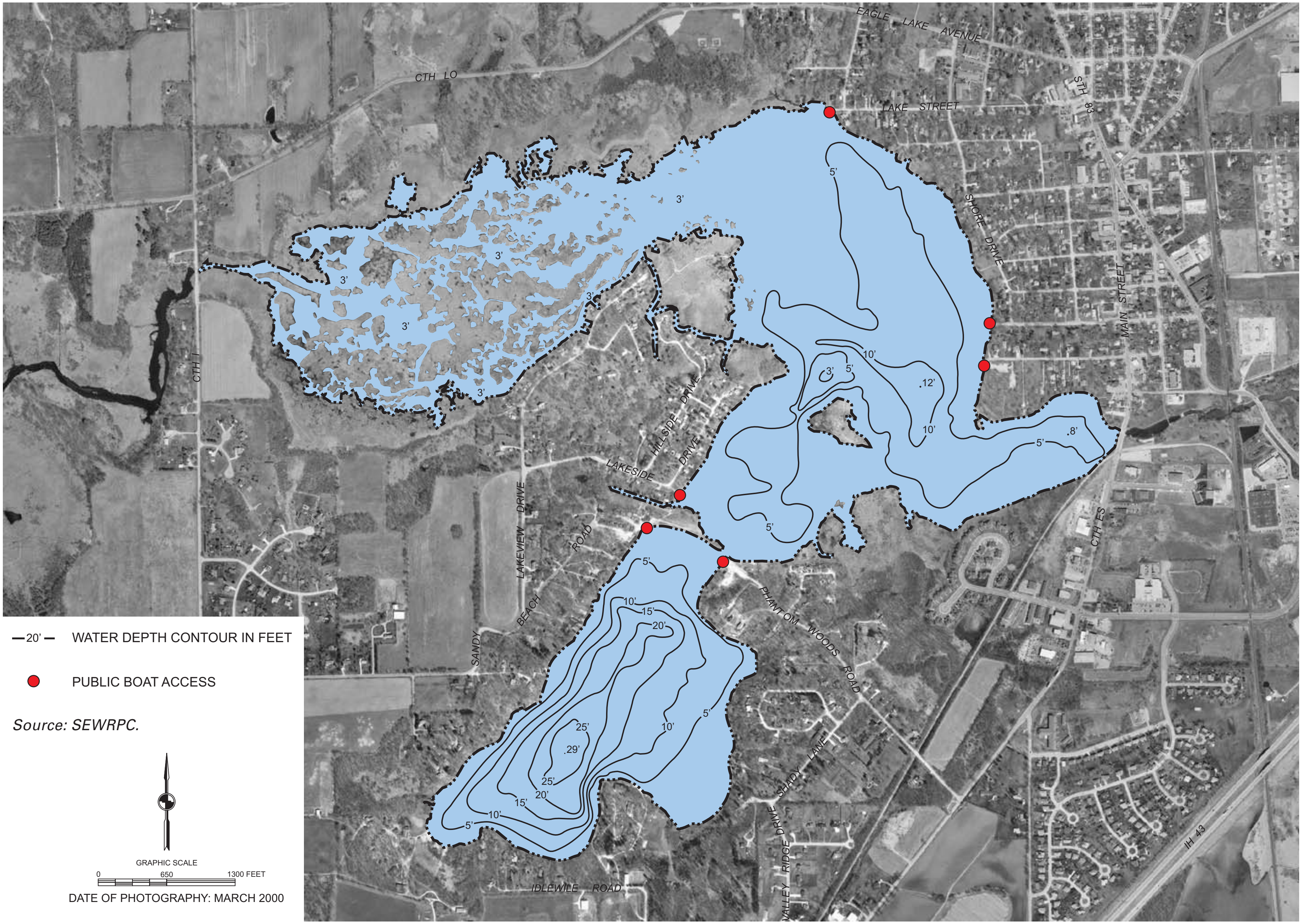

Table 35

WISCONSIN DEPARTMENT OF NATURAL RESOURCES RECREATIONAL RATING OF UPPER PHANTOM LAKE

Fish:					
__ 9	High production	X 6	Medium production	__ 3	Low production
X 9	No problems	__ 6	Modest problems, such as infrequent winterkill, small rough fish problems	__ 3	Frequent and overbearing problems, such as winterkill, carp, excessive fertility
Swimming:					
X 6	Extensive sand or gravel substrate (75 percent or more)	__ 4	Moderate sand or gravel substrate (25 to 50 percent)	__ 2	Minor sand or gravel substrate (less than 25 percent)
__ 6	Clean water	X 4	Moderately clean water	__ 2	Turbid or darkly stained water
__ 6	No algal or weed problems	X 4	Moderate algal or weed problems	__ 2	Frequent or severe algal or weed problems
Boating:					
X 6	Adequate water depths (75 percent of basin more than five feet deep)	__ 4	Marginally adequate water depths (50 to 75 percent of basin more than five feet deep)	__ 2	Inadequate depths (less than 50 percent of basin more than five feet deep)
__ 6	Adequate size for extended boating (more than 1,000 acres)	__ 4	Adequate size for some boating (200 to 1,000 acres)	X 2	Limit of boating challenge and space (less than 200 acres)
__ 6	Good water quality	X 4	Some inhibiting factors, such as weedy bays, algal blooms, etc.	__ 2	Overwhelming inhibiting factors, such as weed beds throughout
Aesthetics:					
__ 6	Existence of 25 percent or more wild shore	X 4	Less than 25 percent wild shore	__ 2	No wild shore
X 6	Varied landscape	__ 4	Moderately varied	__ 2	Unvaried landscape
X 6	Few nuisances, such as excessive algae, carp, etc.	__ 4	Moderate nuisance conditions	__ 2	High nuisance condition
Total Quality Rating: 57 out of a possible 72					

Source: Wisconsin Department of Natural Resources and SEWRPC.

WATER QUALITY STANDARDS

The water quality standards supporting the warmwater fishery and full recreational use objectives, as established for planning purposes in the regional water quality management plan, are set forth in Table 37. These standards are similar to those set forth in Chapters NR 102 and 104 of the *Wisconsin Administrative Code*, but were refined for planning purposes in terms of their application. Standards are recommended for temperature, pH, dissolved oxygen, fecal coliform, and total phosphorus. These standards apply to the epilimnion of the lakes and to streams. The total phosphorus standard applies to spring turnover concentrations measured in the surface waters. Such contaminants as oil, debris, and scum; odors, tastes, and color-producing substances; and toxins are not permitted in concentrations harmful to the aquatic life as set forth in Chapters NR 102 of the *Wisconsin Administrative Code*. The adoption of these standards is intended to specify conditions in the waterways concerned that mitigate against excessive macrophyte and algal growths and promote all forms of recreational use, including angling, in these waters.

Table 36

WISCONSIN DEPARTMENT OF NATURAL RESOURCES RECREATIONAL RATING OF LOWER PHANTOM LAKE

Fish:					
X 9	High production	__ 6	Medium production	__ 3	Low production
X 9	No problems	__ 6	Modest problems, such as infrequent winterkill, small rough fish problems	__ 3	Frequent and overbearing problems, such as winterkill, carp, excessive fertility
Swimming:					
__ 6	Extensive sand or gravel substrate (75 percent or more)	__ 4	Moderate sand or gravel substrate (25 to 50 percent)	X 2	Minor sand or gravel substrate (less than 25 percent)
X 6	Clean water	__ 4	Moderately clean water	__ 2	Turbid or darkly stained water
__ 6	No algal or weed problems	__ 4	Moderate algal or weed problems	X 2	Frequent or severe algal or weed problems
Boating:					
__ 6	Adequate water depths (75 percent of basin more than five feet deep)	__ 4	Marginally adequate water depths (50 to 75 percent of basin more than five feet deep)	X 2	Inadequate depths (less than 50 percent of basin more than five feet deep)
__ 6	Adequate size for extended boating (more than 1,000 acres)	__ 4	Adequate size for some boating (200 to 1,000 acres)	X 2	Limit of boating challenge and space (less than 200 acres)
__ 6	Good water quality	__ 4	Some inhibiting factors, such as weedy bays, algal blooms, etc.	X 2	Overwhelming inhibiting factors, such as weed beds throughout
Aesthetics:					
X 6	Existence of 25 percent or more wild shore	__ 4	Less than 25 percent wild shore	__ 2	No wild shore
X 6	Varied landscape	__ 4	Moderately varied	__ 2	Unvaried landscape
X 6	Few nuisances, such as excessive algae, carp, etc.	__ 4	Moderate nuisance conditions	__ 2	High nuisance condition
Total Quality Rating: 52 out of a possible 72					

Source: Wisconsin Department of Natural Resources and SEWRPC.

As noted in Chapters IV and V, water quality in the Phantom Lakes is generally considered to be fair to very good. In addition, the presence of toxin-producing algal scums in the Lakes is unlikely given the low concentrations of chlorophyll-*a* reported in Chapter IV. Consequently, the likelihood of the Lakes meeting their recreational use objectives is good, and lake management actions should be oriented primarily toward lake protection.

Table 37

RECOMMENDED WATER QUALITY STANDARDS TO SUPPORT RECREATIONAL AND WARMWATER FISH AND AQUATIC LIFE USE

Water Quality Parameter	Water Quality Standard
Maximum Temperature	89°F[a,b]
pH Range	6.0-9.0 standard units
Minimum Dissolved Oxygen	5.0 mg/l[b]
Maximum Fecal Coliform	200/400 MFFCC/100 ml[c]
Maximum Total Residual Chlorine	0.01 mg/l
Maximum Un-ionized Ammonia Nitrogen	0.02 mg/l
Maximum Total Phosphorus	0.02 mg/l[d]
Other	- -[e,f]

[a]*There shall be no temperature changes that may adversely affect aquatic life. Natural daily and seasonal temperature fluctuations shall be maintained. The maximum temperature rise at the edge of the mixing zone above the existing natural temperature shall not exceed 3°F for lakes.*

[b]*Dissolved oxygen and temperature standards apply to the epilimnion of stratified lakes and to the unstratified lakes; the dissolved oxygen standard does not apply to the hypolimnion of stratified inland lakes. Trends in the period of anaerobic conditions in the hypolimnion of stratified inland lakes should be considered important to the maintenance of water quality, however.*

[c]*The membrane filter fecal coliform count per 100 milliliters (MFFCC/100 ml) shall not exceed a monthly geometric mean of 200 per 100 ml based on not less than five samples per month, nor a level of 400 per 100 ml in more than 10 percent of all samples during any month.*

[d]*This standard for lakes applies only to total phosphorus concentrations measured during spring when maximum mixing is underway.*

[e]*All waters shall meet the following minimum standards at all times and under all flow conditions: Substances that will cause objectionable deposits on the shore or in the bed of any body of water shall not be present in such amounts as to interfere with public rights in waters of the State. Floating or submerged debris, oil, scum, or other material shall not be present in such amounts as to interfere with public rights in the waters of the State. Materials producing color, odor, taste, or unsightliness shall not be present in amounts that are acutely harmful to animal, plant, or aquatic life.*

[f]*Unauthorized concentrations of substances are not permitted that alone or in combination with other material present are toxic to fish or other aquatic life. Standards for toxic substances are set forth in Chapter NR 105 of the* Wisconsin Administrative Code*.*

Source: SEWRPC.

APPENDICES

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Appendix A

REPRESENTATIVE ILLUSTRATIONS OF AQUATIC PLANTS FOUND IN THE PHANTOM LAKES

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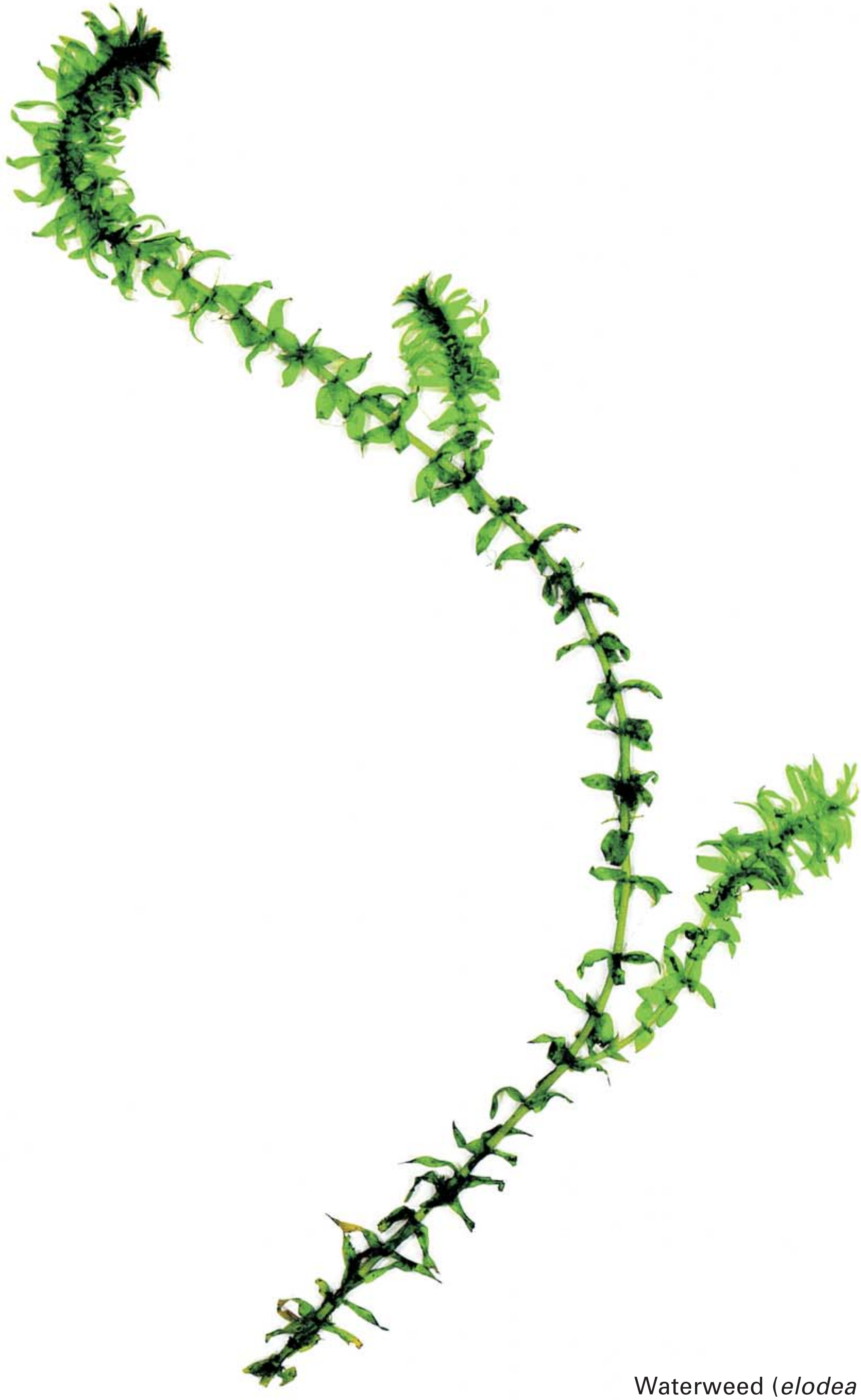
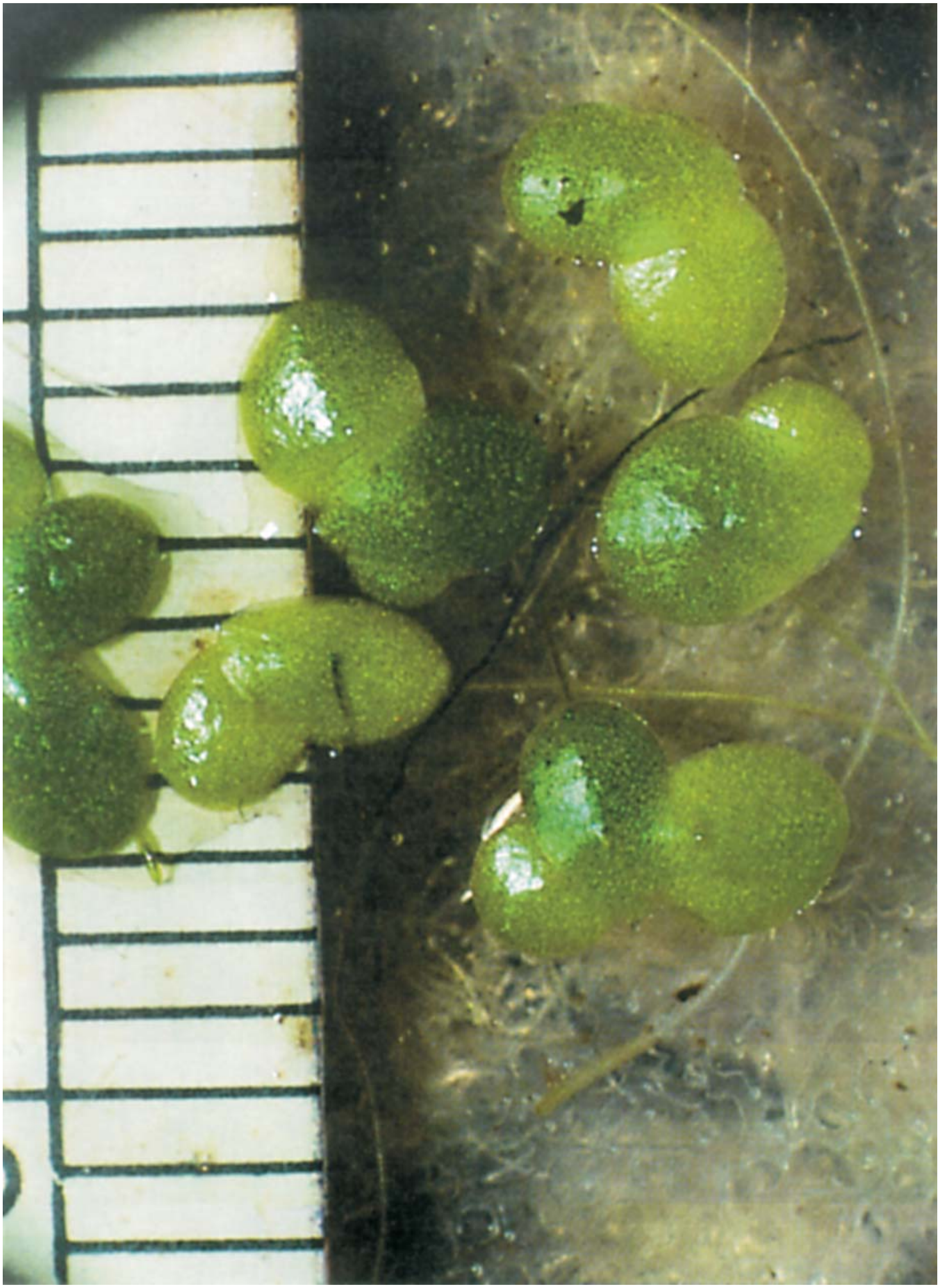
Coontail (*ceratophyllum demersum*)

Muskgrass (*chara vulgaris*)



Waterweed (*elodea canadensis*)



Lesser Duckweed (*lemna minor*)

NOTE: Plant species in photograph are not shown proportionate to actual size

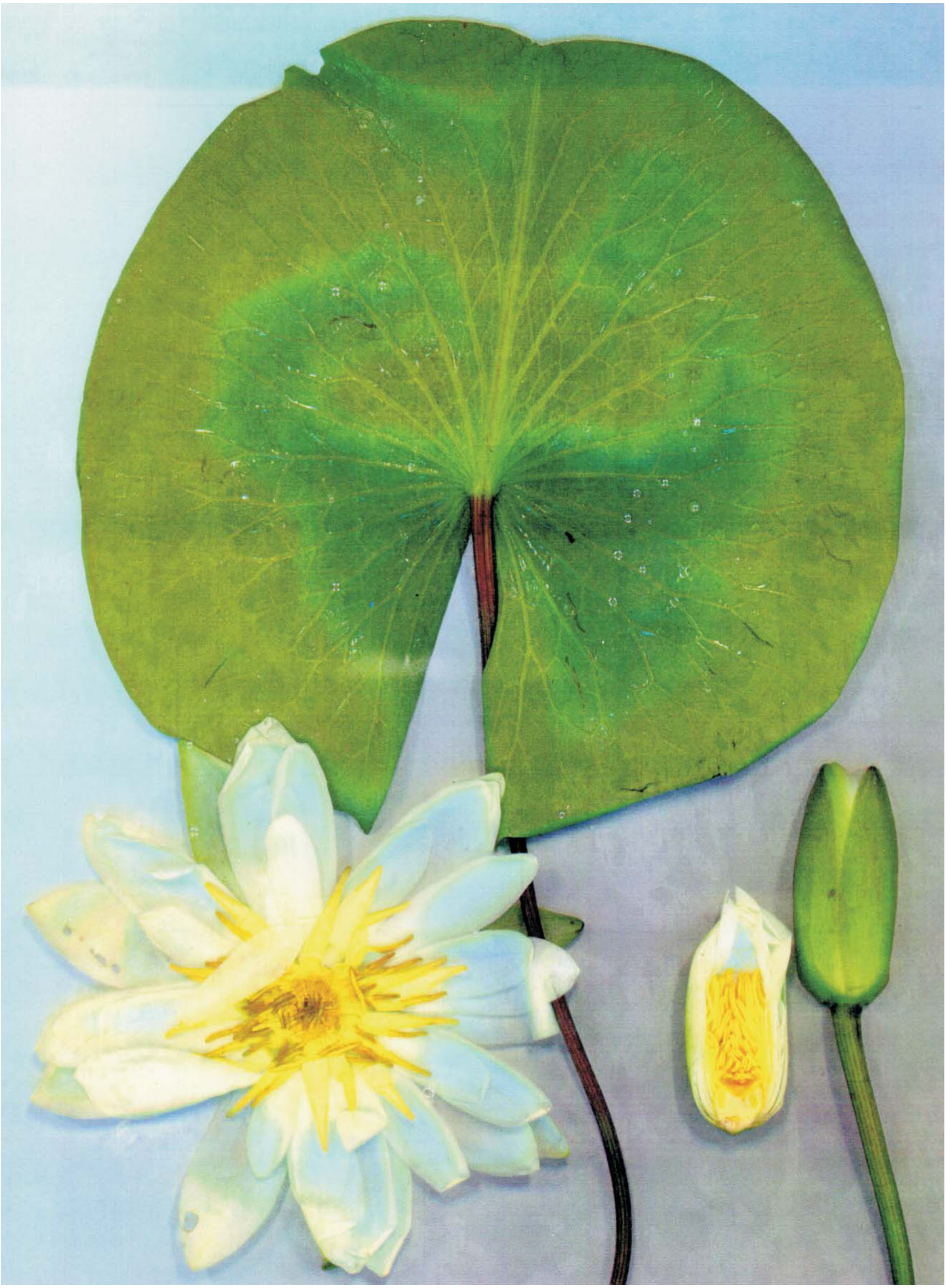
Source: Steve D. Eggers and Donald M. Reed, Wetland Plants and Plant Communities of Minnesota & Wisconsin*, 2nd Edition, 1997*

Native Water Milfoil (*myriophyllum* sp.)

Eurasian Water Milfoil (*myriophyllum spicatum*)

Bushy Pondweed (*najas flexilis*)

Spiny Naiad (*najas marina*)



White Water Lily (*nymphaea odorata*)

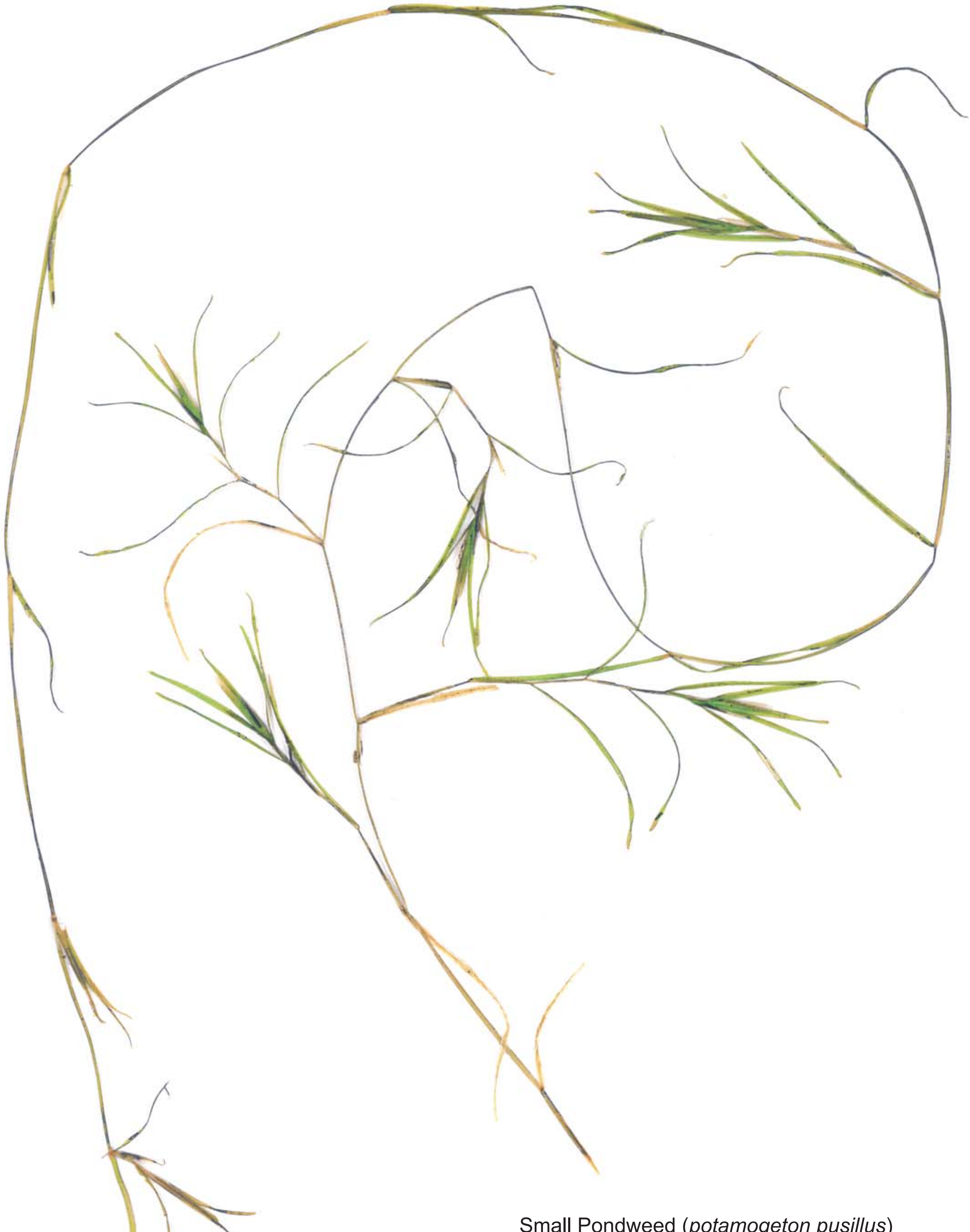
Yellow Water Lily (*nuphar variegatum*)

Large-Leaf Pondweed (*potamogeton amplifolius*)

Curly-Leaf Pondweed (*potamogeton crispus*)

Leafy Pondweed (*potamofeton foliosus*)

Variable Pondweed (*potamogeton gramineus*)



Small Pondweed (*potamogeton pusillus*)

Illinois Pondweed (*potamogeton illinoensis*)

Floating-Leaf Pondweed (*potamogeton natans*)

Sago Pondweed (*potamogeton pectinatus*)

White-Stem Pondweed (*potamogeton praelongus*)

Clasping-Leaf Pondweed
(*potamogeton richardsonii*)

Flat-Stem Pondweed (*potamogeton zosteriformis*)

White Water Crowfoot (*ranunculus longirostris*)

Arrowhead (*sagitarria* sp.)

NOTE: Plant species in photograph are not shown proportionate to actual size.

Source: Steve D. Eggers and Donald M. Reed, Wetland Plants and Plant Communities of Minnesota & Wisconsin*, 2nd Edition, 1997.*

Water Bulrush (*scirpus subterminalis*)

Cattail (*typha latifolia*)

Bladderwort (*utricularia* sp.)

Eel Grass / Wild Celery (*valisneria americana*)

Water Stargrass (*zosterella dubia*)