MEMORANDUM REPORT NO. 301

# AN AQUATIC PLANT MANAGEMENT PLAN FOR GAWICKA LAKE

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**MEMORANDUM REPORT**
**NUMBER 161**

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# WAUKESHA COUNTY, WISCONSIN

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## Chapter I

# INTRODUCTION

Nagawicka Lake, located within Waukesha County, Wisconsin, is a valuable natural resource offering a variety of recreational and related opportunities to the resident community and its visitors. The Lake is an integral part of this lake-oriented community. However, the recreational and aesthetic value of the Lake is perceived to be adversely affected by excessive aquatic plant growth within portions of the Lake. Seeking to improve the usability and to prevent the deterioration of its natural assets and recreational potential, the City of Delafield, through its Lake Welfare Committee and in cooperation with the Village of Nashotah, continues to undertake an annual program of lake and aquatic plant management in the basin.

Nagawicka Lake has been the subject of a comprehensive lake management plan prepared by the Southeastern Wisconsin Regional Planning Commission.[1] This plan included an aquatic plant management plan element that has been adopted and implemented by the City of Delafield Lake Welfare Committee. This report further refines that aquatic plant management plan element by reporting on the condition of the aquatic plant community in Nagawicka Lake during 2004, and updating the recommended aquatic plant management plan set forth in the aforereferenced comprehensive lake management plan.

### BACKGROUND

Specifically, this report represents part of the ongoing commitment of the City of Delafield and its Lake Welfare Committee, in cooperation with the Village of Nashotah, to sound planning with respect to the Lake. The report sets forth an inventory of the aquatic plant communities present within Nagawicka Lake. That inventory was prepared by the Southeastern Wisconsin Regional Planning Commission in cooperation with the City of Delafield and its Lake Welfare Committee, and includes the results of field surveys conducted by the Commission in June 2004. The aquatic plant survey was conducted by Commission staff using the modified Jesson and Lound[2] transect method employed by the Wisconsin Department of Natural Resources (WDNR). The planning program was funded under an NR 191 Lake Protection Grant administered by the WDNR and awarded to the City of Delafield.

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[1]*SEWRPC Memorandum Report No. 130,* A Lake and Watershed Inventory for Nagawicka Lake, Waukesha County, Wisconsin, *March 1999;* and *SEWRPC Community Assistance Planning Report No. 262,* A Lake Management Plan for Nagawicka Lake, Waukesha County, Wisconsin, *March 2001.*

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

As noted above, this inventory is intended to refine the aquatic plant management plan element of the comprehensive lake management plan for Nagawicka Lake. This updated aquatic plant management plan has been prepared pursuant to recommendations made in the aforereferenced comprehensive plan. The scope of this report is limited to a consideration of the aquatic plant communities present within Nagawicka Lake, the documentation of historic changes in this plant community based upon currently existing data and information, and refinement of those management measures which can be effective in the control of aquatic plant growth. Recommendations are made with respect to the City of Delafield Lake Welfare Committee operations relating to aquatic plant and in-lake management activities.

## AQUATIC PLANT MANAGEMENT PROGRAM GOALS AND OBJECTIVES

The lake use goals and objectives for Nagawicka Lake were developed in consultation with the City of Delafield Lake Welfare Committee. The agreed goals and objectives are to:

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

2. Effectively control the quantity and density of aquatic plant growths in portions of the Nagawicka Lake basin to better facilitate the conduct of water-related recreation, improve the aesthetic value of the resource to the community, and enhance the resource value of the waterbody;

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

4. Promote a quality, water-based experience for residents and visitors to Nagawicka Lake consistent with the policies and objectives of the WDNR as set forth in the regional water quality management plan, SEWRPC Planning Report No. 30, *A Regional Water Quality Management Plan for Southeastern Wisconsin—2000*, adopted by the Regional Planning Commission on July 12, 1979, and as refined in the adopted lake management plan for Nagawicka Lake, SEWRPC Community Assistance Planning Report No. 262, *A Management Plan for Nagawicka Lake, Waukesha County, Wisconsin*, March 2001.

This inventory and aquatic plant management plan element conforms to the requirements and standards set forth in the relevant *Wisconsin Administrative Codes.*[3] Implementation of the recommended actions set forth herein should continue to serve as an important step in achieving the stated lake use objectives over time.

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

## Chapter II

# INVENTORY FINDINGS

## INTRODUCTION

Nagawicka Lake is located in the City of Delafield and Village of Nashotah in Waukesha County, as shown on Map 1. As set forth in the adopted lake management plan,[1] Nagawicka Lake is a natural lake comprised of a single deep basin and a kettle lake at the extreme northern end of the Lake. The Lake is fed and drained by the Bark River. The level of the Lake is augmented by a system of water level control gates located in two different structures sited on the southwestern shore of the Lake. The presence of the control structures provides sufficient depth to hydrologically link the main lake basin and the kettle lake as a single unit for lake management purposes.

## WATERBODY CHARACTERISTICS

Nagawicka Lake is a 957-acre waterbody, the hydrographical characteristics of which are set forth in Table 1. The Lake is a throughflow lake with a single deep basin. The waterbody has a maximum depth of approximately 90 feet, a mean depth of 48 feet, and a volume of 45,936 acre-feet. The bathymetry of the Lake is shown on Map 2.

## TRIBUTARY DRAINAGE AREA AND LAND USE CHARACTERISTICS

The drainage area directly tributary to Nagawicka Lake is situated entirely within Waukesha County. This area, which drains directly to Nagawicka Lake without passing through any upstream waterbody, is approximately 7.5 square miles (4,821 acres) in areal extent, as shown on Map 1. The drainage area directly tributary to Nagawicka Lake includes portions of the City of Delafield and the Village of Nashotah, both in Waukesha County.[2] The total drainage area tributary to Nagawicka Lake is approximately 45 square miles (28,950 acres) in areal extent, as shown on Map 1, and includes the entire upstream area drained by the Bark River. The drainage area is situated in the north central portions of Waukesha County and extends into Washington County at its furthest extent.

The land uses within the portion of the drainage basin directly tributary to Nagawicka Lake are primarily urban, with low- to medium-density residential and commercial development being the dominant urban land uses. The

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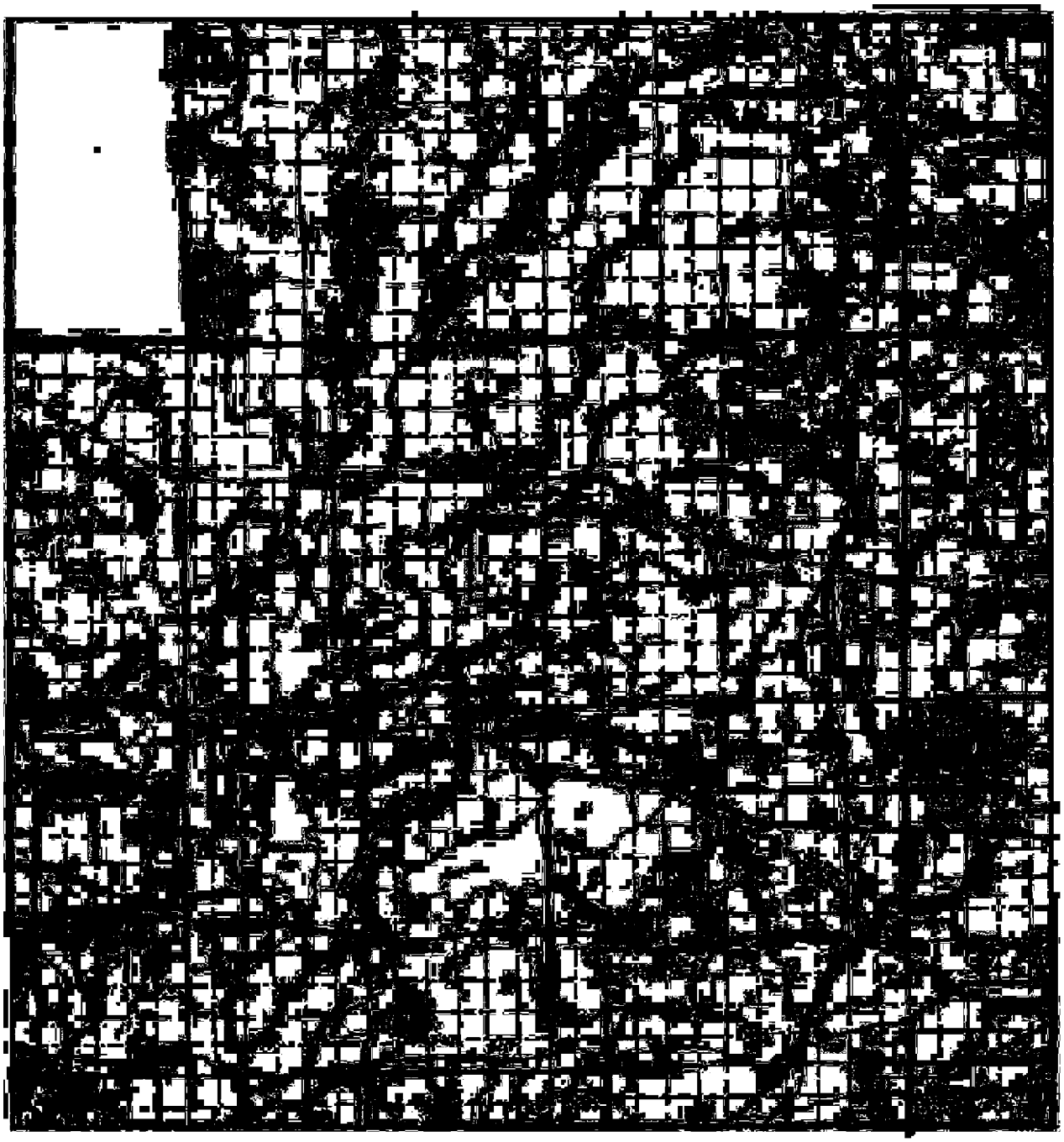
[1]*SEWRPC Community Assistance Planning Report No. 262,* A Management Plan for Nagawicka Lake, Waukesha County, Wisconsin*, March 2001.*

[2]*Note: Refined topographic mapping of Waukesha County shows the drainage areas tributary to Beaver and Pine Lakes to be part of the Oconomowoc River subbasin and hydrologically distinct from that of the Bark River.*

Map 1

[illegible]



[illegible] Total Working Boundary

[illegible] Closed Working Boundary

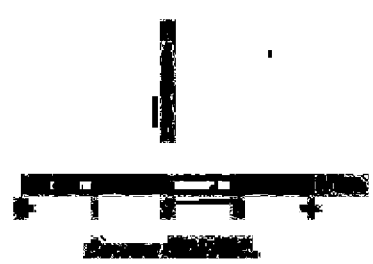


**Table 1**

**HYDROLOGY AND MORPHOMETRY OF NAGAWICKA LAKE**

| Parameter | Measurement |
|---|---|
| Size (total) | |
| Total Area | 957 acres[a] |
| Total Drainage Area | 28,952 acres |
| Direct Drainage Area | 4,763 acres |
| Volume (total) | 45,936 acre-feet |
| Residence Time[b] (1984 USGS study period) | 1.6 years |
| Shape | |
| Maximum Length of Lake | 2.8 miles |
| Length of Shoreline | 8.6 miles |
| Maximum Width of Lake | 1.1 mile |
| Shoreline Development Factor[c] | 1.65 |
| Depth | |
| Mean Depth | 48 feet |
| Maximum Depth | 90 feet |

[a]*The surface area of Nagawicka Lake has been variously reported as 917 acres by the Wisconsin Department of Natural Resources in 1995; 1,026 acres by the Southeastern Wisconsin Regional Planning Commission in 1979; and 957 acres by Waukesha County and the Southeastern Wisconsin Regional Planning Commission in 1996. This variation reflects the estimated surface area based upon inclusion or exclusion of the "Kettle" and/or of the constructed channels adjacent to the northern shorelines of the waterbody, as well as lake level variations over time. For purposes of the adopted lake management plan and this report, the areal measurement of 957 acres has been used as it reflects the most recent measurement of the Lake surface area.*

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

[c]*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.*

shoreline, except for the northern and portions of the southern shores, is almost entirely developed for residential uses. These natural shorelands were augmented by the dredging of constructed channels during the 1920s to provide lake access to subdivisions located along the northeastern and northwestern shorelines of the Lake. The shoreline of the northern basin, known as the "Kettle," is composed of an undisturbed wetland, while portions of the southeastern shoreline are in public ownership, being part of the Nagawaukee County Park.

Map 3 shows existing land uses as of 2000, for the total drainage area tributary to Nagawicka Lake. Those uses are summarized in Table 2. Future changes in land use within the direct drainage area tributary to the Lake may include limited further urban development, infilling of already platted lots, and possible redevelopment of existing properties. Details of planned land use conditions are set forth in the adopted lake management plan for Nagawicka Lake. Under proposed 2020 land use conditions, approximately two-thirds of the drainage area directly tributary to the Lake are expected to be in urban land uses, and approximately half of the total drainage area to the Lake is expected to be in urban land uses. Agricultural uses are anticipated to be eliminated from the direct drainage area, and significantly reduced, from about 39 percent of the land coverage as of 2000, to about 23 percent of the land coverage under 2020 conditions. These land use changes have the potential to modify the nature and delivery of nonpoint sourced contaminants to the Lake, with concomitant impacts on the aquatic plant communities within the waterbody.

## SHORELINE PROTECTION STRUCTURES

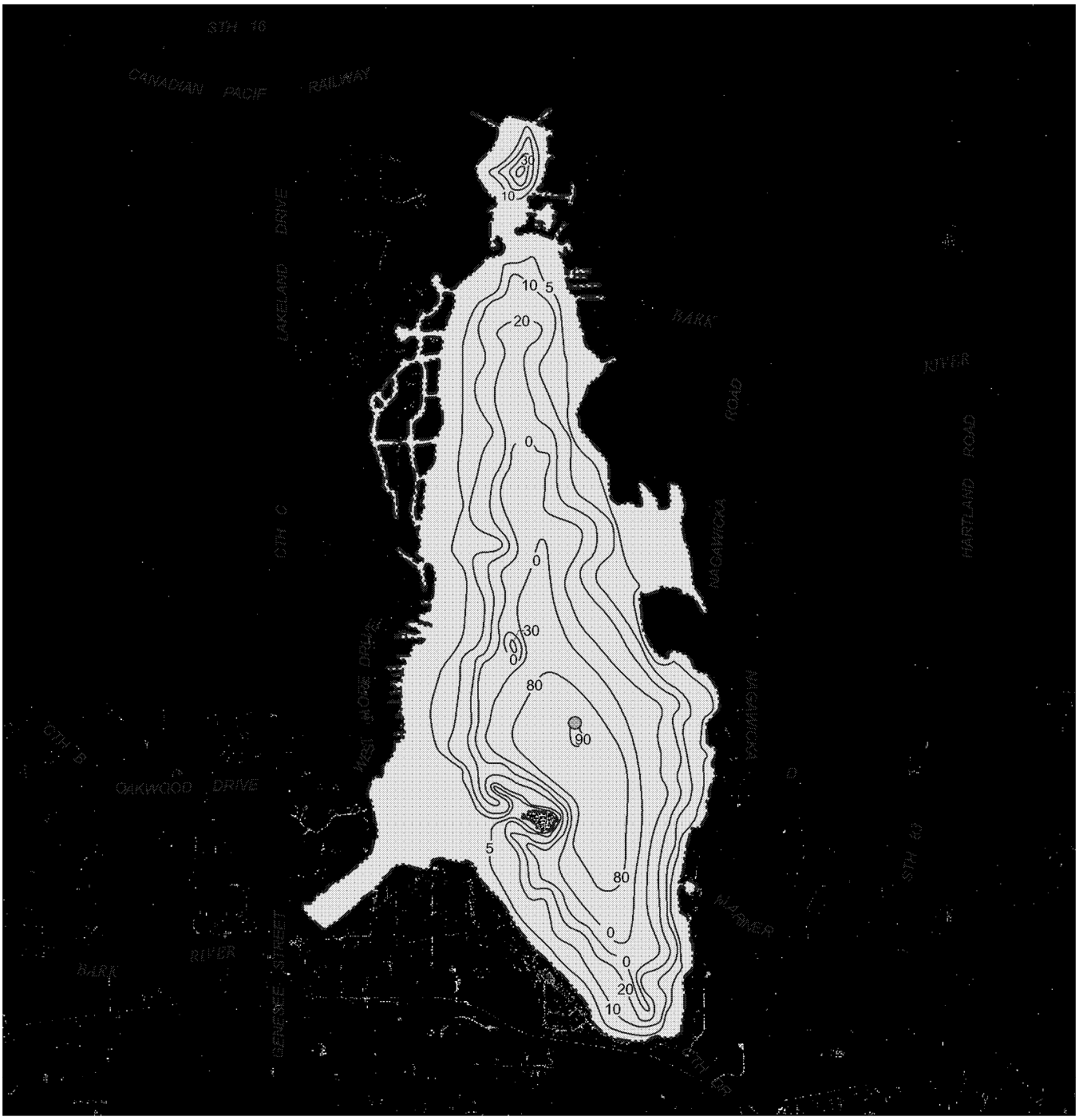
Erosion of shorelines results in the loss of land, damage to shoreline infrastructure, and interference with lake access and use. Wind-wave erosion, ice movement, and motorized boat traffic usually cause such erosion. A survey of the Nagawicka Lake shoreline, conducted by Commission staff during the summer of 1997 and reviewed by Commission staff during a reconnaissance of the lake shore conducted during the summer of 2004, identified an approximately equal distribution of areas within the main Lake basin with natural shorelines and areas protected by riprap and similar structural shoreline protection measures, as shown on Map 4. The northern and northwestern portions of the Lake remained in largely a natural or vegetated state. No obvious erosion-related problems were observed beyond those previously identified in the adopted lake management plan, which were limited in extent and considered to be a transient phenomenon associated with the elevated water levels experienced during the late 1990s.

## WATER QUALITY

Water quality data on Nagawicka Lake have been collected by the Wisconsin Department of Natural Resources as part of their Long-Term Trend Monitoring Program from 1986 through 1997, as shown in Figure 1. Secchi-disc

**Map 2**

**BATHYMETRIC MAP OF NAGAWICKA LAKE**




DATE OF PHOTOGRAPHY: MARCH 2000

—20′— WATER DEPTH CONTOUR IN FEET

MONITORING SITE

*Source: U.S. Geological Survey and SEWRPC.*

GRAPHIC SCALE

0 1200 2 00 FEET

[redacted]

[redacted]

[redacted]

**Table 2**

**EXISTING AND PLANNED LAND USE WITHIN THE TOTAL DRAINAGE AREA TRIBUTARY TO NAGAWICKA LAKE: 2000 AND 2020**

| Land Use Categories[a] | 2000 | | 2020 | |
|---|---|---|---|---|
| | Acres | Percent of Total Tributary Drainage Area | Acres | Percent of Total Tributary Drainage Area |
| Urban | | | | |
| Residential | 6,448 | 22.3 | 9,030 | 31.2 |
| Commercial | 299 | 1.0 | 467 | 1.6 |
| Industrial | 174 | 0.6 | 314 | 1.1 |
| Governmental and Institutional | 409 | 1.4 | 531 | 1.8 |
| Transportation, Communication, and Utilities | 2,134 | 7.4 | 2,837 | 9.8 |
| Recreational | 619 | 2.1 | 640 | 2.2 |
| Subtotal | 10,083 | 34.8 | 13,819 | 47.7 |
| Rural | | | | |
| Agricultural and Other Open Lands | 11,195 | 38.7 | 6,746 | 23.3 |
| Wetlands | 2,750 | 9.5 | 2,750 | 9.5 |
| Woodlands | 2,826 | 9.8 | 2,826 | 9.8 |
| Water | 1,306 | 4.5 | 1,306 | 4.5 |
| Extractive | 7903 | 2.7 | 1,503 | 5.2 |
| Subtotal | 18,867 | 65.2 | 15,131 | 52.3 |
| Total | 28,950 | 100.0 | 28,950 | 100.0 |

[a]*Parking included in associated use.*

*Source: SEWRPC.*

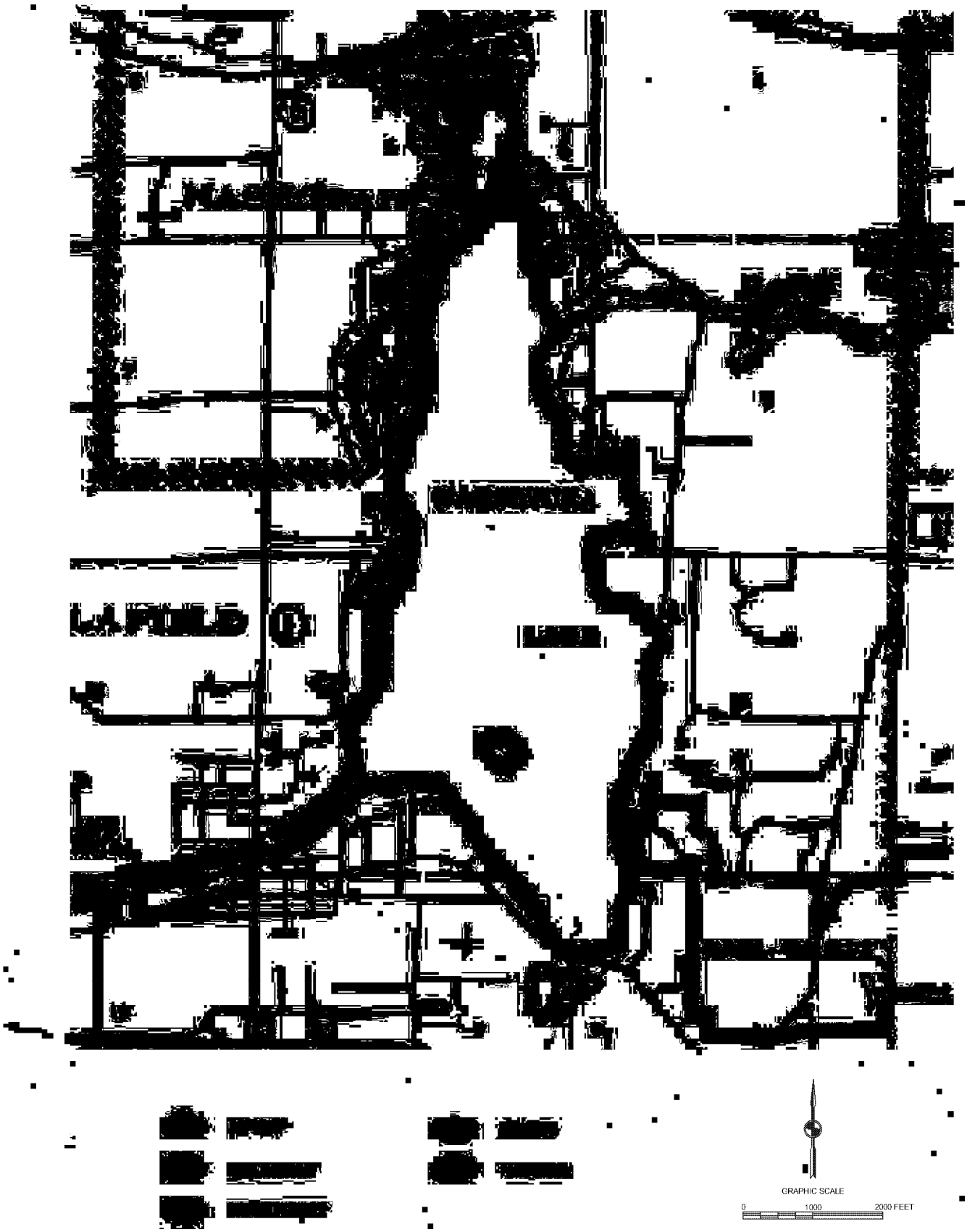
transparency readings were often in excess of 10 feet, and are indicative of a waterbody with good to very good water clarity.[3] The chlorophyll-a concentrations observed in the Lake, of about five micrograms per liter (µg/l), are indicative of low to moderate growths of algae in the water column, and are consistent with the total phosphorus concentrations of less than 20 µg/l reported from the Lake. This level of total phosphorus in the water column of lakes in Southeastern Wisconsin, and higher values, forms the threshold above which nuisance growths of algae and aquatic plants may be expected to occur.

Since 1997, few additional water quality data are available, although the U.S. Geological Survey initiated the collection of such data under their Trophic State Index water quality sampling program during the 2003 water year. With the development of a significant population of zebra mussel (*Dreissena polymorpha*) in the Lake in recent years, somewhat higher Secchi-disc transparencies (clearer water conditions) than those reported above are anticipated. This could potentially increase the maximum depth of colonization of rooted aquatic plants in the Lake, although the physical presence of zebra mussel on the plants has been observed by Commission staff to disadvantage some species, such as Eurasian water milfoil, in Southeastern Wisconsin Lakes by physically dragging the plants out of the euphotic zone. These impacts will become more apparent, and should be monitored, during subsequent aquatic plant surveys of Nagawicka Lake.

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

**Map 4**

**SHORELINE PROTECTION STRUCTURES ON NAGAWICKA LAKE: 2002**




*Source: SEWRPC.*

**Figure 1**

**NAGAWICKA LAKE PRIMARY WATER QUALITY INDICATORS: 1972-2003**

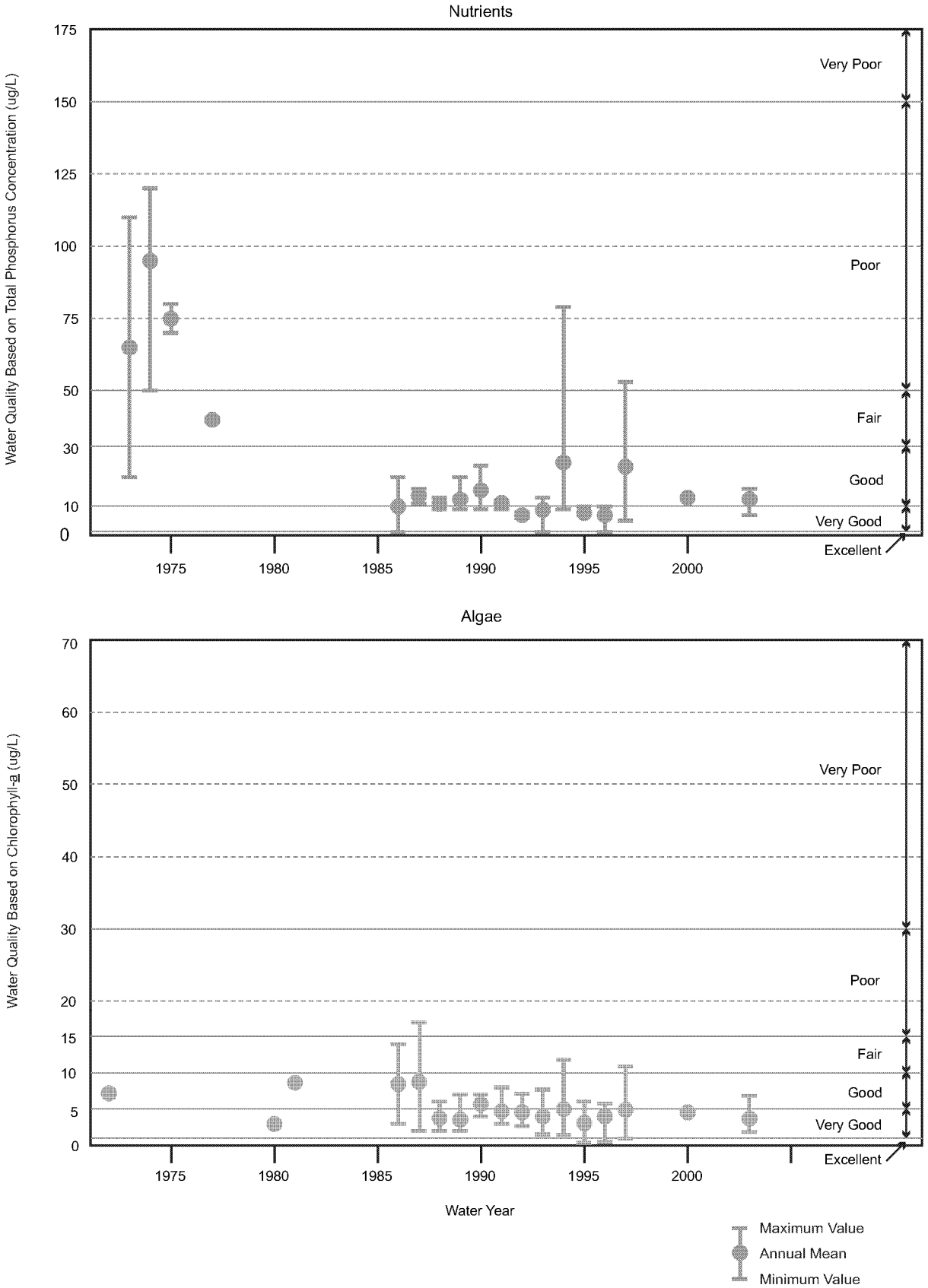
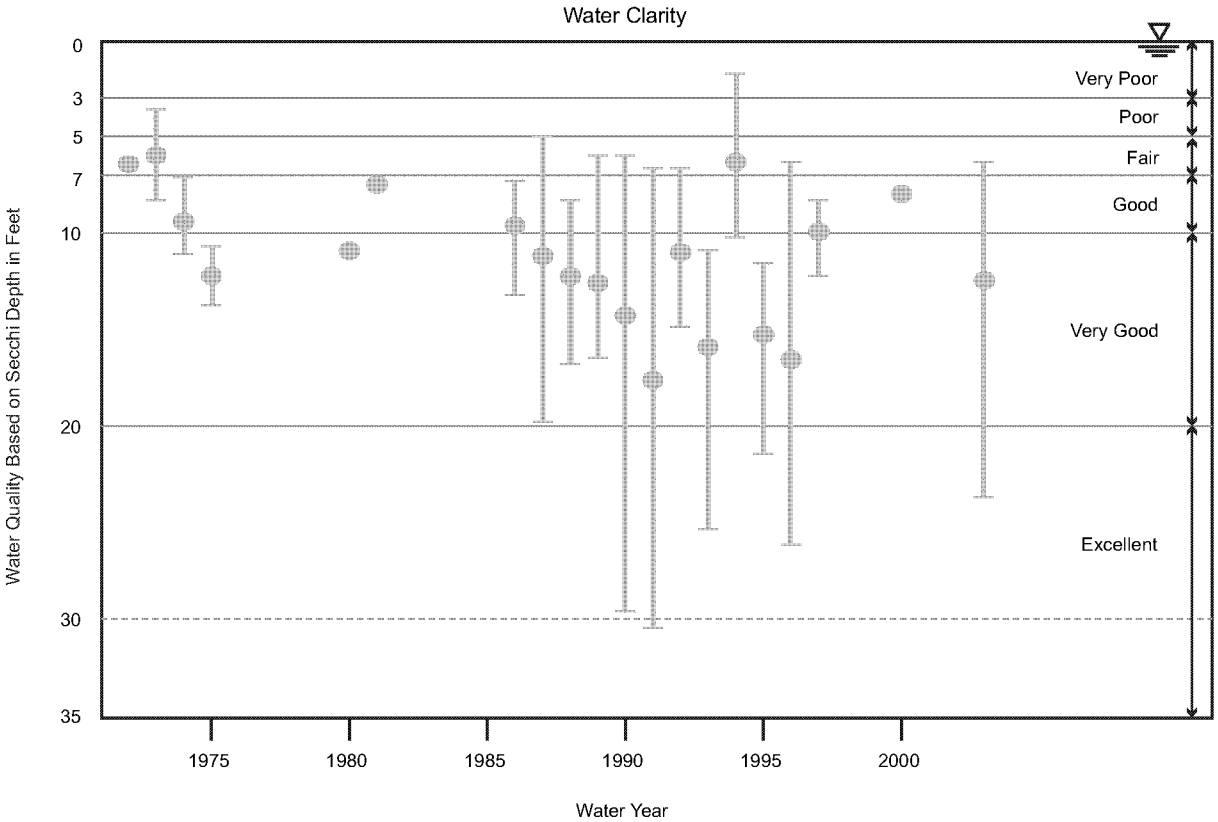


**Figure 1 (continued)**




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

Based upon the Long-Term Trend Monitoring data, Nagawicka Lake had a Wisconsin Trophic State Index (WTSI) value that generally was between 40 and 50,[4] indicative of moderately-enriched conditions. This TSI value, shown in Figure 2, is consistent with the historically good to very good transparency conditions noted above, and indicates that the Lake remains a mesotrophic waterbody. Mesotrophic lakes, while relatively fertile and supporting abundant aquatic plant growths and productive fisheries, generally do not exhibit nuisance growths of algae and plants. Many of the cleaner lakes in Southeastern Wisconsin are classified as mesotrophic.[5]

## AQUATIC PLANTS: DISTRIBUTION AND MANAGEMENT AREAS

Two previous surveys of the aquatic plant communities in Nagawicka Lake have been conducted. The first of these surveys was that of Aron & Associates, conducted during August 1993.[6] Subsequently, the Commission staff

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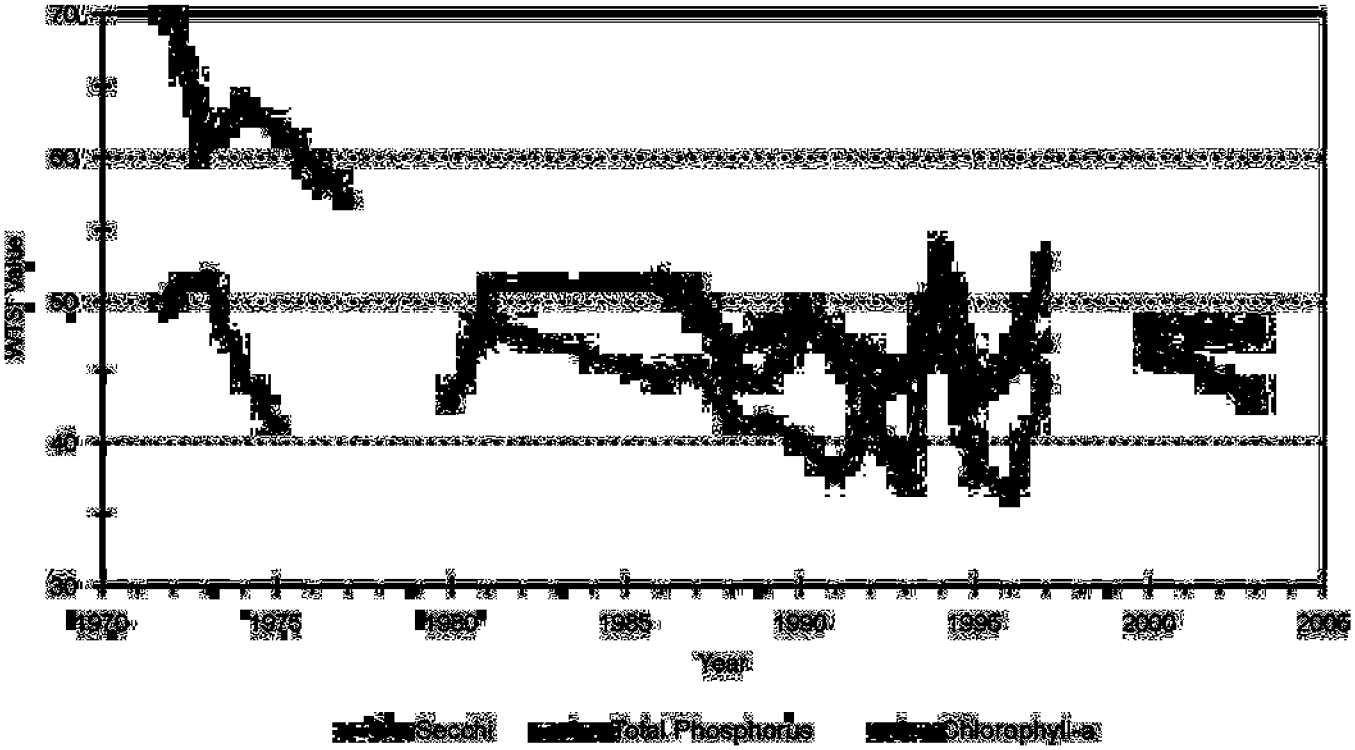
[4]*R.E. Carlson, "A Trophic State Index for Lakes,"* Limnology and Oceanography*, Volume 22, No. 2, 1977, as refined by* R.A. Lillie, S. Graham, and P. Rasmussen, "Trophic State Index Equations and Regional Predictive Equations for Wisconsin Lakes," *Research and Management Findings*, Wisconsin Department of Natural Resources Publication No. PUBL-RS-735 93, May 1993.

[5]*R.A. Lillie, and J.W. Mason,* Limnological Characteristics of Wisconsin Lakes*, Wisconsin Department of Natural Resources Technical Bulletin No. 138, 1983. Also see SEWRPC Memorandum Report No. 93,* A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report*, March 1995.*

[6]*Aron & Associates,* Nagawicka Lake Plant Management Plan*, August 1993.*

**Figure 2**

**WISCONSIN TROPHIC STATE INDEX FOR NAGAWICKA LAKE: 1972-2003**




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

conducted a reconnaissance survey of aquatic plant species in the Lake basin during June 1997. These surveys are summarized in Table 3.

During the 1997 survey, 12 species of submergent plants were identified in Nagawicka Lake. Several species that interfere with the recreational and aesthetic use of the Lake were reported, including Eurasian water milfoil (*Myriophyllum spicatum*), coontail (*Ceratophyllum demersum*), and curly-leaf pondweed (*Potamogeton crispus*).

Plant growth occurred in water depths of less than 15 feet in depth, with the exception of the southeastern and southwestern portions of the Lake where growth was sparse, perhaps due to the sudden change in depth. Musk grass (*Chara* spp.), wild celery (*Vallisneria americana*), and native milfoil (*Myriophyllum* spp.) were dominant in portions of the main lake basin, while healthy populations of pondweeds (*Potamogenton* spp.) were scattered throughout the Lake, generally in the five to 10 feet depth range. Eurasian water milfoil was also scattered throughout the Lake but more commonly found at between 10 feet and 15 feet of depth.

During 2004, the Commission staff conducted a further survey of the aquatic plant community in Nagawicka Lake. Sixteen species of submergent aquatic plants were identified, including both native and nonnative species. Both Eurasian water milfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*), two species designated as nonnative and invasive plants pursuant to Section NR 109.07 of the *Wisconsin Administrative Code*, were noted as being present in the Lake. However, these species appeared to be present in significantly reduced abundance from the densities observed during the 1997 reconnaissance. Such periodicity, especially in Eurasian water milfoil populations, has been observed elsewhere in Southeastern Wisconsin, and potentially reflects the influences of a combination of stressors. These stressors include biological factors, such as the activities of the Eurasian water milfoil weevils, as well as climatic and limnological factors, such as

**Table 3**

**AQUATIC PLANT SPECIES IN NAGAWICKA LAKE: 1993 THROUGH 2004**

| Plant Species | 1993 | 1997 | 2004 |
|---|---|---|---|
| *Ceratophyllum demersum* (coontail) | X | X | X |
| *Chara vulgaris* (musk grass) | X | X | X |
| *Elodea canadensis* (elodea) | - - | - - | X |
| *Myriophyllum sibericum* (northern water milfoil) | X | X | X |
| *Myriophyllum spicatum* (Eurasian water milfoil) | X | X | X |
| *Najas flexilis* (bushy pondweed) | X | X | X |
| *Najas marina* (spiny naiad) | X | X | X |
| *Nitella* sp. (stonewort) | X | - - | - - |
| *Potamogeton amplifolius* (curly-leaf pondweed) | X | X | X |
| *Potamogeton crispus* (curly-leaf pondweed) | X | X | X |
| *Potamogeton illinoensis* (Illinois pondweed) | - - | - - | X |
| *Potamogeton pectinatus* (Sago pondweed) | - - | - - | X |
| *Potamogeton pusillus* (small pondweed) | - - | - - | - - |
| *Potamogeton richardsonii* (clasping-leaf pondweed) | X | X | X |
| *Potamogeton zosterformis* (flat-stemmed pondweed) | X | X | X |
| *Ranunculus* sp. (water crowfoot) | - - | - - | - - |
| *Utricularia* sp. (bladderwort) | - - | - - | X |
| *Vallisneria americana* (water celery) | X | X | X |
| *Zosterella dubia* (water star grass) | - - | - - | X |

*Source: Aron & Associates and SEWRPC.*

insolation, water temperature, and current circulation patterns. A species list, compiled from the results of the Regional Planning Commission aquatic plant survey, is set forth in Table 4, along with comments on the ecological significance of each plant on the list. Representative illustrations of these aquatic plants can be found in Appendix A. The results of the 2004 survey are graphically depicted on Map 5.

**Past and Present Aquatic Plant Management Practices**

The residents of Nagawicka Lake, in conjunction with the City of Delafield and in partnership with the Village of Nashotah, have long recognized the importance of informed and timely action in the management of Nagawicka Lake. The City of Delafield Lake Welfare Committee was created in 1987 as the principle organ for the conduct of lake management activities within the Nagawicka Lake basin. As noted in the aforereferenced adopted lake management plan, this Committee, in cooperation with the Village of Nashotah and riparian property owners associations, has undertaken regular water quality and aquatic plant monitoring. Some of these activities were conducted under the auspices of the Wisconsin Department of Natural Resources Long Term Trends Monitoring Program. Since 2003, Nagawicka Lake has been included in the U.S. Geological Survey trophic state monitoring program.[7]

Aquatic plants have occurred within Nagawicka Lake in such abundance that they have been frequently perceived of as a problem, interfering with recreational uses and the aesthetic enjoyment of the Lake. Aquatic plant surveys conducted on Nagawicka Lake within the last 10 years indicate a relatively stable aquatic plant community, with few changes in species composition and abundance being apparent during this period. The Lake generally supports a healthy and diverse aquatic macrophyte community, although extensive stands of Eurasian water milfoil (*Myriophyllum spicatum*) occur throughout the waterbody.

[7]*See U.S. Geological Survey Open-File Report 95-190,* Water-Quality and Lake-Stage Data for Wisconsin Lakes, Water Year 1994*, 1995, and subsequent editions through 2001.*

**Table 4**

**FREQUENCY OF OCCURRENCE AND DENSITY RATINGS OF SUBMERGENT PLANT SPECIES IN NAGAWICKA LAKE: 2004**

| Aquatic Plant Species Present | Sites Found | Frequency of Occurrence (percent) | Relative Density | Importance Value |
|---|---|---|---|---|
| *Ceratophyllum demersum* (coontail) | 48 | 34.5 | 2.08 | 72 |
| *Chara vulgaris* (muskgrass) | 80 | 57.6 | 2.39 | 137 |
| *Elodea canadensis* (waterweed) | 12 | 8.6 | 1.83 | 16 |
| *Myriophyllum sibiricum* (northern water milfoil) | 65 | 46.8 | 2.28 | 106 |
| *Myriophyllum spicatum* (Eurasian water milfoil) | 39 | 28.1 | 2.10 | 59 |
| *Najas flexilis* (bushy pondweed) | 5 | 3.6 | 1.00 | 4 |
| *Najas marina* (spiny naiad) | 1 | 0.7 | 1.00 | 1 |
| *Potamogeton amplifolius* (large-leaf pondweed) | 4 | 2.9 | 2.00 | 6 |
| *Potamogeton crispus* (curly-leaf pondweed) | 22 | 15.8 | 1.36 | 22 |
| *Potamogeton illinoensis* (Illinois pondweed) | 20 | 14.4 | 1.40 | 20 |
| *Potamogeton pectinatus* (Sago pondweed) | 10 | 7.2 | 1.40 | 10 |
| *Potamogeton pusillus* (small pondweed) | - - | - - | - - | - - |
| *Potamogeton richardsonii* (clasping-leaf pondweed) | 15 | 10.8 | 1.53 | 17 |
| *Potamogeton zosteriformis* (flat-stem pondweed) | 53 | 38.1 | 1.85 | 71 |
| *Ranunculus longirostris* (stiff-water crow foot) | - - | - - | - - | - - |
| *Utricularia* spp. (bladderwort) | 1 | 0.7 | 1.00 | 1 |
| *Vallisneria americana* (water celery/eelgrass) | 76 | 54.7 | 2.41 | 132 |
| *Zosterella dubia* (water stargrass) | 1 | 0.7 | 3.00 | 2 |

NOTE: There were 139 sites sampled during the 2004 survey.

*Source: SEWRPC.*

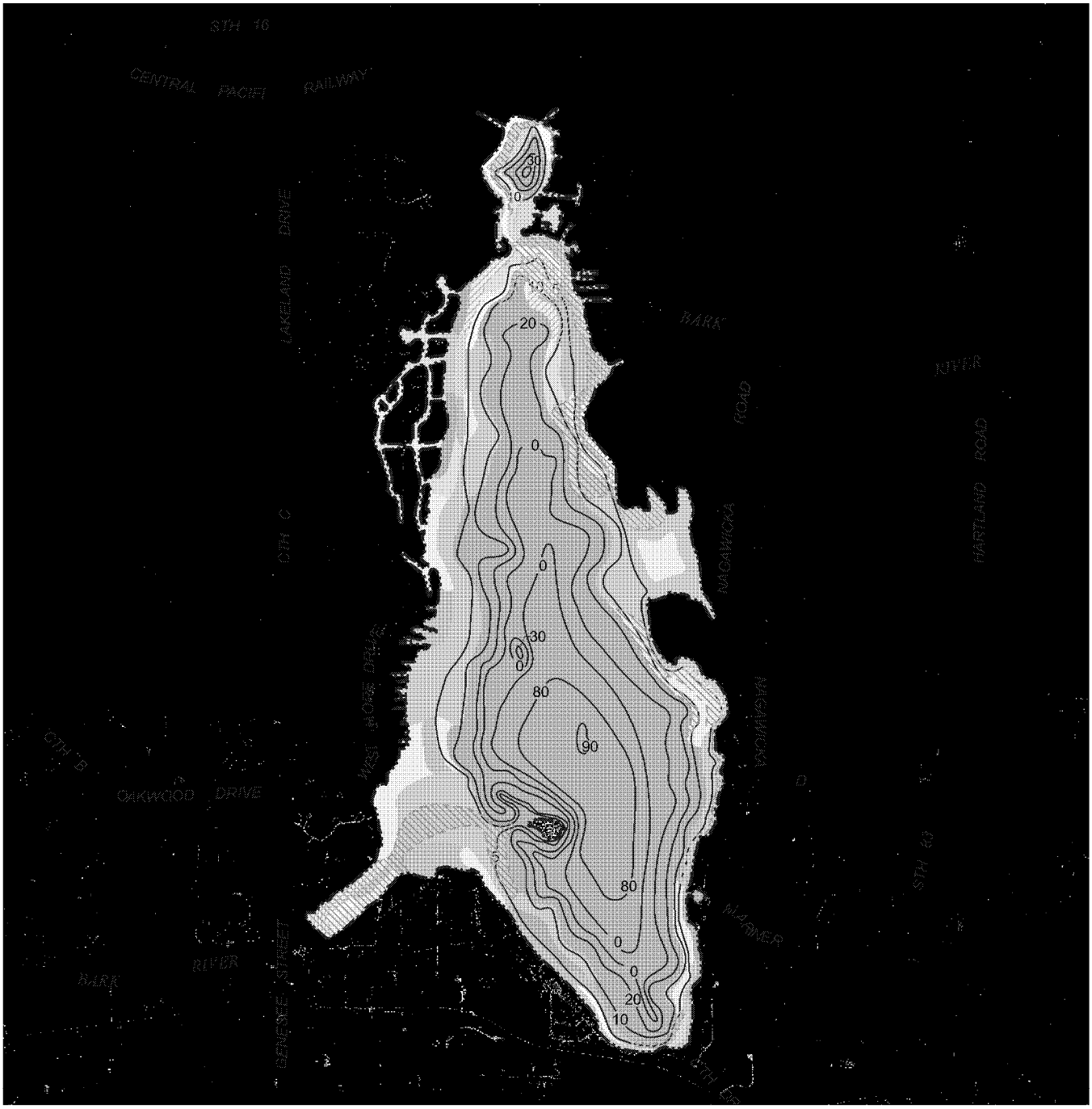
The abundant aquatic plant growths in Nagawicka Lake have led the City of Delafield to operate an aquatic plant harvester throughout the summer months. In addition, individual riparians and some property owners associations manually harvest aquatic plants around piers and docks and along their shorelines, and some have treated specific areas of the Lake with chemical herbicides. Where harvested materials are deposited on piers, the City of Delafield collects the accumulated plant materials as part of their harvesting program. Even so, concerns continue to exist over lake water quality, primarily in relation to the control of aquatic plants in the northern portions of the Lake and in the Kettle. Five areas on Nagawicka Lake, shown on Map 6, were designated as environmentally sensitive areas by the Wisconsin Department of Natural Resources during 1990 because of the importance of these areas to the maintenance of good water quality conditions in, and the biological integrity of, the Lake.

As set forth in the adopted lake management plan, an aquatic plant management program has been carried out on Nagawicka Lake in a documented manner since 1950, when records of aquatic plant management efforts were first maintained by the Wisconsin Department of Natural Resources. Prior to 1950, aquatic plant management interventions are likely, but were not recorded. The early aquatic plant control program conducted on Nagawicka Lake can be categorized as a chemical control program designed to minimize nuisance growths of aquatic macrophytes and algae. Between 1950 and 1970, 87,214 pounds of sodium arsenite and 11,110 pounds of copper sulphate were applied to Nagawicka Lake to control perceived nuisance growths of these plants.[8] These applications and subsequent applications of a range of other aquatic herbicides through 2003 are summarized in

[8]*Wisconsin Department of Natural Resources Technical Bulletin No. 57,* op. cit. *Also see Table 24, SEWRPC Community Assistance Planning Report No. 187,* A Management Plan for Nagawicka Lake, Waukesha County, Wisconsin, *March 1994.*

**Map 5**

**AQUATIC PLANT COMMUNITY DISTRIBUTION IN NAGAWICKA LAKE: 2004**




DATE OF PHOTOGRAPHY: MARCH 2000

- 20 — WATER DEPTH CONTOUR IN FEET
- OPEN WATER
- CURLY LEAF PONDWEED
- EURASIAN WATER MILFOIL
- WILD CELERY FLAT STEM PONDWEED MUSKGRASS AND COONTAIL NATIVE WATER MILFOIL ILLINOIS PONDWEED CLASPING PONDWEED AND SAGO PONDWEED
- WILD CELERY MUSKGRASS NATIVE WATER MILFOIL FLAT STEM PONDWEED CLASPING LEAF PONDWEED COONTAIL ILLINOIS PONDWEED WATERWEED SAGO PONDWEED AND BUSHY PONDWEED
- MUSKGRASS WILD CELERY NATIVE WATER MILFOIL FLAT STEM PONDWEED COONTAIL ILLINOIS PONDWEED SAGO PONDWEED CLASPING LEAF PONDWEED LARGE LEAF PONDWEED WATER STAR GRASS AND BUSHY PONDWEED
- ILLINOIS PONDWEED MUSKGRASS AND NATIVE WATER MILFOIL FLAT STEM PONDWEED COONTAIL LARGE LEAF PONDWEED SAGO PONDWEED WATERWEED WILD CELERY AND BLADDERWORT
- WILD CELERY NATIVE WATER MILFOIL COONTAIL AND FLAT STEM PONDWEED MUSKGRASS WATERWEED AND ILLINOIS PONDWEED
- COONTAIL MUSKGRASS WILD CELERY NATIVE WATER MILFOIL FLAT STEM PONDWEED WATERWEED CLASPING LEAF PONDWEED BUSHY PONDWEED AND LARGE LEAF PONDWEED
- WILD CELERY NATIVE WATER MILFOIL MUSKGRASS FLAT STEM PONDWEED ILLINOIS PONDWEED CLASPING LEAF PONDWEED LARGE LEAF PONDWEED WATERWEED AND COONTAIL

NOTE: INDICATES SPECIES FOUND IN LESS THAN 50 PERCENT OF THE SITE

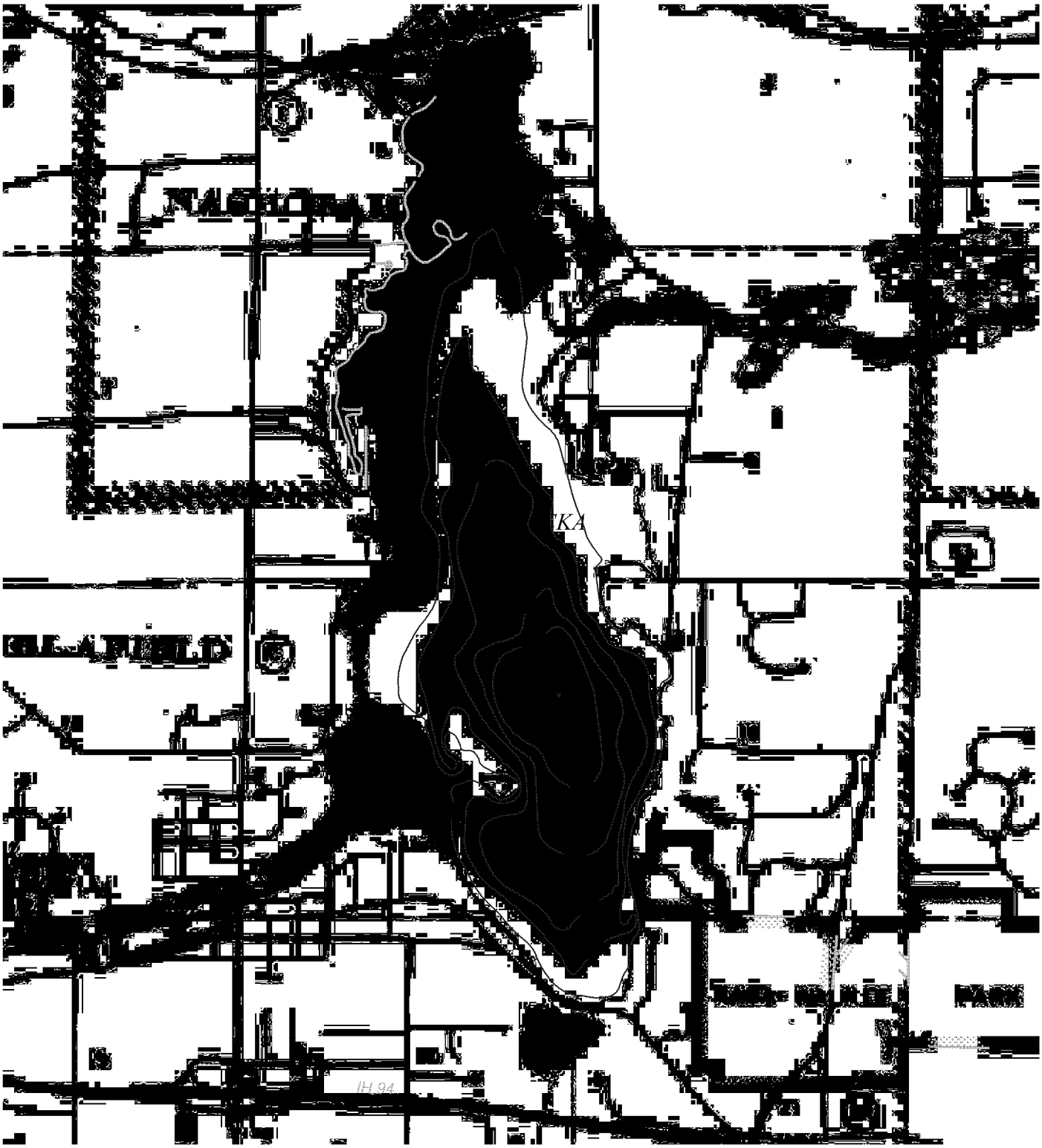
GRAPHIC SCALE

0 1200 2 00 FEET

*Source: SEWRPC.*

**Map 6**

**ENVIRONMENTALLY SENSITIVE AREAS OF NAGAWICKA LAKE**




2 WISCONSIN DEPARTMENT OF NATURAL RESOURCES-DELINEATED SENSITIVE AREAS

—20′— WATER DEPTH CONTOUR IN FEET

DEPTH GREATER THAN 25 FEET

GRAPHIC SCALE

0 1000 2000 FEET

*Source: Wisconsin Department of Natural Resources.*

Table 5. In recent years, the aquatic plant control program conducted on Nagawicka Lake has shifted toward aquatic plant harvesting as a major element of the aquatic plant management strategy in the Lake.

**Aquatic Plant Communities in Nagawicka Lake**

The results of the 1993, 1997 and 2004 macrophyte surveys are summarized in Table 3. The 1993 survey identified 12 species of aquatic plants, many of which were reported to be common to abundant. One fewer plant species was observed during the 1997 survey, but, overall, little change in the aquatic plant community composition was noted during this period. Plant growth occurred in water up to 15 feet deep. Aquatic plants occurred throughout the Lake, with the exception of the southeastern and southwestern shores where growth was sparse, probably due to the sudden change in depth. The most diverse growths of aquatic plants occurred in the vicinity of the eastern and western shorelines, adjacent to the main basin of the Lake.

In 1993, muskgrass (*Chara vulgaris*), water celery or eel grass (*Vallisneria americana*), and native milfoil (*Myriophyllum sibericum*) were the most abundant aquatic plants in many areas of the main lake basin. Healthy populations of pondweeds (*Potamogeton* spp.) appeared to be scattered throughout the Lake, and were most commonly found at depths of between five and 10 feet. Eurasian water milfoil (*Myriopyllum spicatum*) was scattered throughout the Lake, but largely confined to areas of the Lake with depths of between 10 and 15 feet.

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

Eurasian water milfoil reproduces by the rooting of plant fragments. Consequently, some recreational uses of lakes can result in the expansion of Eurasian water milfoil communities, 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.

During the 2004 aquatic plant survey of Nagawicka Lake, 24 species of aquatic plants were identified: 16 species were submergent species, as set forth in Table 4; four, duckweed (*Lemna minor*), watermeal (*Wolffia* sp.), yellow water lily (*Nuphar* sp.) and white water lily (*Nymphaea tuberosa*), were floating-leaved species; and one (*Typha* spp.) was an emergent plant. The number of aquatic plants suggests a more diverse and abundant aquatic plant community than previously recorded from the Lake. As noted above, both previous surveys reported no more than 12 species of submergent aquatic plants, in addition to the floating-leaved water lilies, as being present in the Lake. Nevertheless, there have been few major changes in the composition of the aquatic plant communities previously recorded in Nagawicka Lake. This might indicate that the greater number of species observed during the 2004 survey reflect the more rigorous aquatic plant sampling protocol employed. These differences may also reflect seasonal variations in plant community composition.

Several of the additional species observed during the 2004 survey and not previously reported from Nagawicka Lake were comprised of various species of pondweeds, including Sago pondweed (*Potamogeton pectinatus*), and small pondweed (*Potamogeton pusillus*). The appearance of the pondweeds is generally considered to be a positive sign. The other species not previously reported from the Lake included bladderwort (*Utricularia* sp.) and water star grass (*Zosterella dubia*). Table 6 outlines the positive ecological significance of all aquatic plant species found in Nagawicka Lake.

**Table 5**

**CHEMICAL CONTROLS ON NAGAWICKA LAKE: 1950-2003**

| Year | Macrophyte Control | | | | | | | Algal Control | |
|---|---|---|---|---|---|---|---|---|---|
| | Sodium Arsenite (pounds) | Diquat (gallons) | Glyphosate (gallons) | Endothall | | 2,4-D | | Cutrine-Plus (gallons) | Copper Sulphate (pounds) |
| | | | | Gallons | Pounds | Gallons | Pounds | | |
| 1950 | 300 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 20 |
| 1951 | 200 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 15 |
| 1952 | 0 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0 |
| 1953 | 200 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0 |
| 1954 | 2,560 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0 |
| 1955 | 2,980 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0 |
| 1956 | 2,760 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0 |
| 1957 | 3,216 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0 |
| 1958 | 5,216 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0 |
| 1959 | 2,860 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 200 |
| 1960 | 2,100 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 250 |
| 1961 | 6,520 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 300 |
| 1962 | 5,130 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 400 |
| 1963 | 12,240 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 1,400 |
| 1964 | 11,340 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 2,200 |
| 1965 | 11,700 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 1,400 |
| 1966 | 9,702 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 1,440 |
| 1967 | 8,190 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 1,150 |
| 1968 | 0 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0 |
| 1969 | 0 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 405 |
| 1970 | 0 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 1,930 |
| 1971-79[a] | - - | - - | - - | - - | - - | - - | - - | - - | - - |
| 1980 | 0 | 0.00 | 0.00 | 6.0 | 0.00 | 0.00 | 0.00 | 9.00 | 0 |
| 1981 | 0 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0 |
| 1982 | 0 | 17.00 | 0.00 | 15.0 | 0.00 | 0.00 | 0.00 | 20.00 | 0 |
| 1983 | 0 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0 |
| 1984 | 0 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0 |
| 1985 | 0 | 10.00 | 0.00 | 20.5 | 0.00 | 0.00 | 3.00 | 33.00 | 0 |
| 1986 | 0 | 19.00 | 0.00 | 21.5 | 0.00 | 0.00 | 9.00 | 38.50 | 0 |
| 1987 | 0 | 17.25 | 0.00 | 22.5 | 0.00 | 0.00 | 0.00 | 21.75 | 0 |
| 1988 | 0 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 20.00 | 38.00 | 0 |
| 1989 | 0 | 0.00 | 0.00 | 3.0 | 0.00 | 0.00 | 31.25 | 2.25 | 350 |
| 1990 | 0 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0 |
| 1991 | 0 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 8.25 | 0.75 | 0 |
| 1992 | 0 | 1.75 | 0.00 | 0.0 | 0.00 | 0.00 | 7.00 | 1.75 | 0 |
| 1993 | 0 | 2.75 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 7.00 | 0 |
| 1994 | 0 | 1.00 | 0.00 | 0.0 | 0.00 | 2.50 | 0.00 | 1.00 | 0 |
| 1995 | 0 | 1.25 | 0.00 | 1.0 | 0.00 | 3.25 | 0.00 | 1.10 | 0 |
| 1996 | 0 | 0.00 | 0.00 | 0.0 | 0.00 | 8.75 | 0.00 | 0.00 | 0 |
| 1997 | 0 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0 |
| 1998[b] | - - | - - | - - | - - | - - | - - | - - | - - | - - |
| 1999 | 0 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0 |
| 2000 | 0 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0 |
| 2001 | 0 | 0.00 | 0.25 | 0.0 | 0.25 | 0.00 | 0.00 | 0.00 | 0 |
| 2002 | 0 | 0.00 | 1.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0 |
| 2003 | 0 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0 |
| Total | 87,214 | 70.00 | 1.25 | 89.5 | 0.25 | 14.50 | 78.50 | 174.10 | 11,460 |

[a]*No chemical controls were used during these years.*

[b]*No records available for these years.*

*Source: Wisconsin Department of Natural Resources and SEWRPC.*

**Table 6**

**ECOLOGICAL SIGNIFICANCE OF AQUATIC PLANTS IN NAGAWICKA LAKE**

| 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 |
| *Cladophora* spp. (filamentous algae)[a] | Best food producer in fast water, especially for rainbow trout |
| *Elodea canadensis* (waterweed) | Provides shelter and support for insects which are valuable as fish food |
| *Lemna minor* (small duckweed)[a] | Important food source for ducks and geese; food source also for muskrat and beaver; provides shade and shelter for fish |
| *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 |
| *Nymphaea tuberose* (white water lily)[a] | Provides food for waterfowl, deer, muskrat and beaver; provides shade and shelter for fish |
| *Nymphaea variegate* (yellow water lily/spadderdock)[a] | Provides food for waterfowl, deer, muskrat and beaver; provides shade and shelter for fish |
| *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 illinoensis* (Illinois pondweed) | Provides shade and shelter for fish; harbor for insects; seeds are eaten by wildfowl |
| *Potamogeton pectinatus* (Sago pondweed) | This plant is the most important pondweed for ducks, in addition to providing food and shelter for young fish |
| *Potamogeton pusillus* (small pondweed) | Provides food for ducks, geese, muskrat, beaver, and deer, and provides food and shelter for fish |
| *Potamogeton richardsonii* (clasping-leaf pondweed) | Provides food, shelter and shade for some fish, food for some wildfowl, and food for muskrat. Provides shelter and support for insects, which are valuable as fish food |
| *Potamogeton zosteriformis* (flat-stem pondweed) | Provides some food for ducks |
| *Ranunculus longirostris* (stiff-water crow foot) | Provides food for trout, upland game birds, and wildfowl |
| *Typha* spp. (cattail)[a] | 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 |
| *Wolffia* spp. (watermeal)[a] | Good waterfowl food; when it forms large floating mats it can prevent mosquito larvae from reaching the surface for oxygen |
| *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.

[a]*Species observed but not collected.*

*Source: SEWRPC.*

During 2004, the aquatic plant survey of Nagawicka Lake was conducted using the modified Jesson and Lound transect method as adopted by the Wisconsin Department of Natural Resources. This methodology, when utilized in successive aquatic plant surveys, will allow the statistical evaluation of changes in the aquatic plant community within the Lake. [9] Where specific indices can be calculated based upon available data collected during the year 2004 aquatic plant survey, the values are given in Table 4. These indices include:

1. The frequency of occurrence (FREQ) is the number of occurrences of a species divided by the number of samples 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.

2. The relative frequency of occurrence (RFREQ) is the frequency of a species divided by the total frequency of all species. The sum of the relative frequencies should equal 100 percent. This statistic presents an indication of how the plants occur throughout a lake in relation to each other. It is used in the calculation of the Importance Value and Simpson Diversity Index set forth below.

3. The average or relative density (ADEN) is the sum of the density ratings for a species divided by the number of sampling points with vegetation. The maximum density rating of 4.0 is assigned to plants that occur at all points sampled at a given depth, the modified Jesson and Lound protocol adopted by the Wisconsin Department of Natural Resources uses four sampling points per depth sampled. The average density presents an indication of how abundant the growth of a particular plant is throughout the lake.

4. The Simpson Diversity Index (SDI) is defined as one minus the sum of the relative frequencies squared, and is expressed in equation form as:

   $$SDI = 1 - \sum(RFREQ)^2$$

   where SDI is the Simpson Diversity Index and RFREQ is the relative frequency value defined above. Based upon this index of community diversity, the closer the SDI value is to one, the greater the diversity between the communities being compared.

5. The importance value (IV) is defined as the product of the relative frequency and the average density, expressed as a percentage:

   $$IV = (RFREQ)\ (ADEN)\ (100)$$

   where IV is the importance value, RFREQ is the relative frequency, and ADEN is the average density. This number provides an indication of the dominance of a species within a community based upon both frequency and density. It also somewhat addresses the problem of difference in stature between different plant species.

6. The similarity index (SI) is a means of comparing two communities by estimating the degree to which the communities share common components. The index is calculated as:

   $$SI = 2W/(A + B)$$

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

where SI is the similarity index value, W is the amount two communities have in common or the lowest relative frequency of a species pair, and A plus B is the sum of the relative frequency for both communities, which should always be about 200 since the relative frequency of each community should equal 100 percent. This index could be calculated based upon average density or the importance values. However, relative frequency is a better measure since it does not change much during the growing season so the results remain comparable, even if the timing of sampling is not exactly the same, and, given that there are several methods for assigning average density, use of average density may yield a result that is not directly comparable. Use of relative frequency avoids such interpretation problems. It should be noted that, although a 100 percent similarity is theoretically possible, repeated sampling studies from the same community has shown that a similarity index of 85 percent or higher should be considered indicative of no community change.

7. The p-value, or Pearson chi-squared test, is calculated using a statistical program for personal computers.[10] The p-values are calculated based upon a two by two frequency table. A p-value of less than or equal to 0.05 is the limit used to identify a significant difference between two populations. This means that, at $p = 0.05$, there is a 95 percent probability that two populations are different, or that, after comparing 100 mean values from each data set, 95 would be different and five would overlap.

## FISHERIES AND WILDLIFE

Nagawicka Lake supports a relatively large and diverse fish community. The Wisconsin Department of Natural Resources reports more than 30 species of fish, including the pugnose shiner, a State Threatened Species.[11] Largemouth and white bass; black, yellow and brown bullhead; bluegill, green sunfish and pumpkinseed; northern pike; yellow perch; bluntnose minnow; brook silverside; warmouth; black crappie; lake chubsucker; and, common carp are all reported to be common or abundant in the Lake. As noted in the adopted lake management plan, the Lake is managed for bluegill, largemouth bass, and northern pike production.

Given the land uses present around the shorelands of the Lake, only smaller animals and waterfowl generally inhabit the Lakeshore. Muskrats, beaver, grey and fox squirrels, and cottontail rabbits are probably the most abundant and widely distributed fur-bearing mammals in the immediate riparian areas. Larger mammals, such as the whitetail deer, are generally confined to the larger wooded areas and the open meadows found in the park and open space lands within the drainage areas of the Lake. The Nagawicka Lake drainage areas support a significant population of waterfowl including mallards, wood duck, and blue-winged teal. During the migration seasons a greater variety of waterfowl may be present and in greater numbers.

Amphibians and reptiles are vital components of the Nagawicka Lake ecosystem, and include frogs, toads, and salamanders, and turtles and snakes, respectively. About 14 species of amphibians and 16 species of reptiles would normally be expected to be present in the Nagawicka Lake area, at least one, Blanding's turtle, is considered a State Threatened Species.

## RECREATIONAL USES AND FACILITIES

As set forth in the adopted lake management plan, Nagawicka Lake is a multi-purpose waterbody serving a variety of recreational uses. Active recreational uses include boating, waterskiing, swimming, and fishing during the summer months, and cross-country skiing, snowmobiling, and ice-fishing during the winter. The Lake is well-served by public access sites, including both developed and fully operational public recreational boating access

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[10] *Statistics for Windows, General Conventions and Statistics, 1995, Statsoft, Inc., Tulsa, Oklahoma.*

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

sites and relatively undeveloped public parks and walk-in trails. The Lake use zones identified in the adopted lake management plan for Nagawicka Lake and shown on Map 7 recognize the variety of uses to which the Lake is subjected, especially during the open water seasons.

The Lake is used year-round as a visual amenity. Walking, bird watching and picnicking are popular passive recreational uses of the waterbody, and it is heavily utilized during open water periods, as shown in Table 7. Recreational boating is a popular active recreational use of the Lake, as shown in Table 7. The types of watercraft found on the Lake include powered or ski boats, fishing boats, paddleboats, canoes, sailboats, and personal watercraft ("jetskis"), as shown in Table 8. The Lake is considered by the Wisconsin Department of Natural Resources to have adequate public recreational boating access, as defined in Section NR 1.91 of the *Wisconsin Administrative Code*.

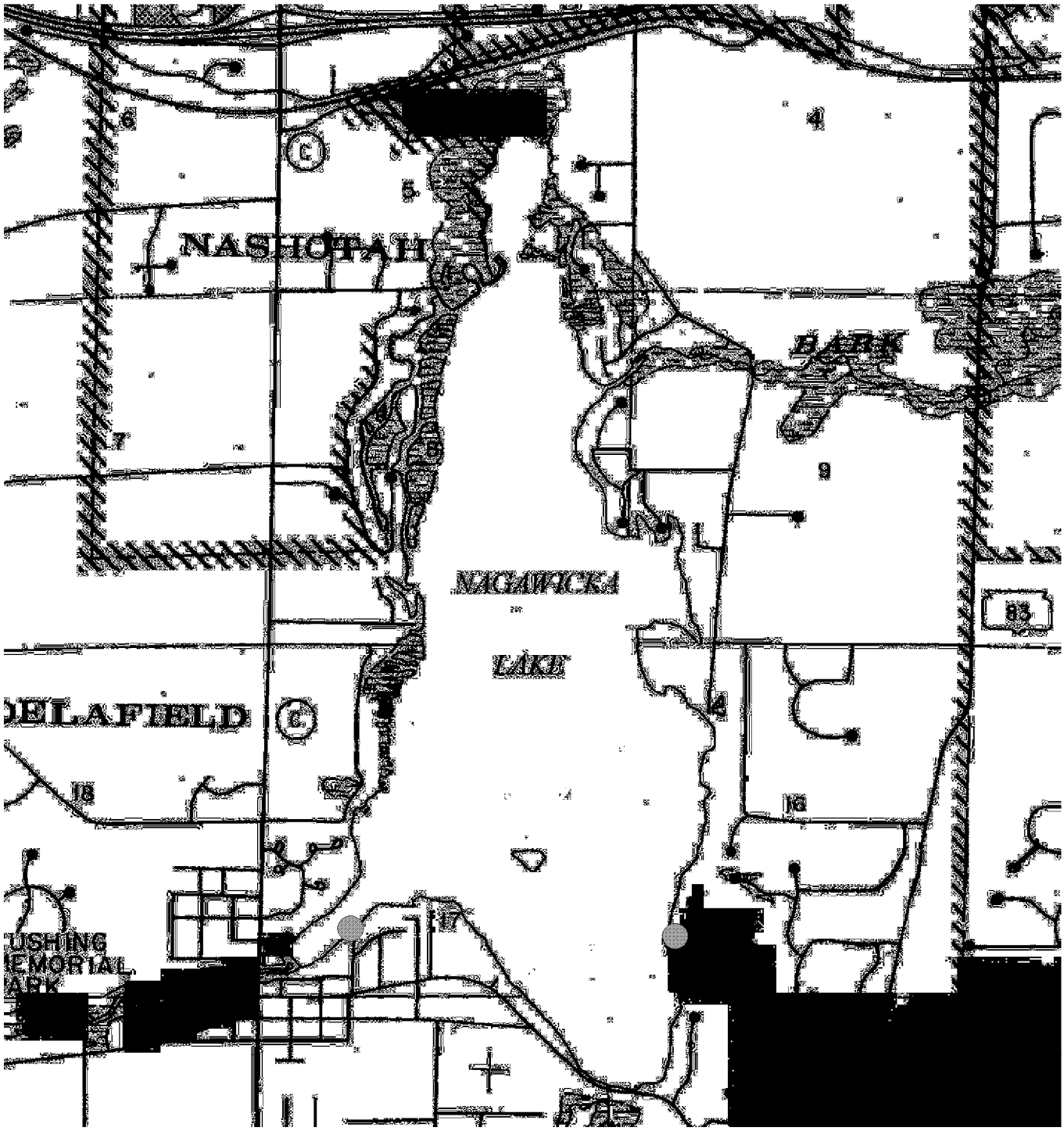
## LOCAL ORDINANCES

Nagawicka Lake is subject to State of Wisconsin boating and water safety laws as set forth in Chapter 30, *Wisconsin Statutes*.

The City of Delafield and Village of Nashotah have adopted a construction site erosion control ordinance that is administered and enforced in the shoreland areas tributary to the Lake. The Villages of Chenequa and Hartland have adopted similar ordinance language in an effort to better protect the water resources shared by these neighboring communities. These ordinances differ from the County model only in that they are applicable to sites of 4,000 square feet or more in areal extent, rather than sites of 3,000 square feet or more. Shoreland wetlands are protected pursuant to Chapter 17, Zoning Code, of the City of Delafield Code of Ordinances, as set forth under the requirements of Chapter NR 117 of the *Wisconsin Administrative Code*. Final state wetland inventory maps were delivered to the riparian municipalities during 1982, when the enabling ordinances were adopted. These ordinances are summarized in Table 9.

**Map 7**

**PARK AND LAKE-ACCESS SITES IN THE VICINITY OF NAGAWICKA LAKE**




PUBLIC BOATING ACCESS

PUBLIC PARKS AND RECREATIONAL AREAS

GRAPHIC SCALE

0 1000 2000 FEET

*Source: SEWRPC.*

**Table 7**

**RECREATIONAL USE SURVEY ON NAGAWICKA LAKE: 1997-1998**

| Date and Time | Weekday Participants | | | | | | |
|---|---|---|---|---|---|---|---|
| | Fishing | Pleasure Boating | Skiing | Sailing | Personal Watercraft | Other Uses[a] (nonboating) | Total |
| June 26, 1998 | | | | | | | |
| 11:00 a.m. to 11:30 a.m. | 11 | 4 | - - | 9 | - - | 37 | 61 |
| 4:00 p.m. to 4:30 p.m. | 6 | 17 | 3 | - - | 4 | 48 | 78 |
| Total | 17 | 21 | 3 | 9 | 4 | 85 | 139 |
| Percent | 12 | 15 | 2 | 6 | 3 | 62 | 100 |

| Date and Time | Weekend Participants | | | | | | |
|---|---|---|---|---|---|---|---|
| | Fishing | Pleasure Boating | Skiing | Sailing | Personal Watercraft | Other Uses[a] (nonboating) | Total |
| July 19, 1997 | | | | | | | |
| 10:45 a.m. to 11:30 a.m. | 17 | 14 | 11 | - - | 14 | 8 | 64 |
| 1:00 p.m. to 4:00 p.m. | 19 | 29 | 15 | 2 | - - | 196 | 261 |
| Total | 36 | 43 | 26 | 2 | 14 | 204 | 325 |
| Percent | 11 | 13 | 8 | 1 | 4 | 63 | 100 |

[a]*Nonboating uses include persons fishing from the shore, picnicking, walking, swimming, and sight-seeing.*

*Source: SEWRPC.*

**Table 8**

**WATERCRAFT ON NAGAWICKA LAKE: 2002**

| Type of Watercraft | | | | | | | |
|---|---|---|---|---|---|---|---|
| Power Boat | Fishing Boat | Pontoon Boat | Canoe | Paddleboat | Sailboat | Personal Watercraft | Total |
| 150 | 300 | 250 | 75 | 100 | 115 | 70 | 1,050 |

*Source: SEWRPC.*

**Table 9**

**LAND USE REGULATIONS WITHIN THE DRAINAGE AREA TRIBUTARY TO NAGAWICKA LAKE IN WASHINGTON AND WAUKESHA COUNTIES BY CIVIL DIVISION: 2004**

| 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 |
| City of Delafield | Adopted | Adopted | Adopted | Adopted | Adopted |
| Village of Chenequa | Adopted | None[a] | Adopted | None | Adopted[b] |
| Village of Hartland | Adopted | Adopted | Adopted | Adopted | Adopted |
| Village of Merton | Adopted | Adopted | Adopted | Adopted | None |
| Village of Nashotah | Adopted | None[a] | Adopted and Wisconsin Department of Natural Resources approved | Adopted | Adopted |
| Town of Delafield | Adopted | County ordinance | County ordinance | Adopted | County ordinance |
| Town of Lisbon | Adopted | County ordinance | County ordinance | Adopted | County ordinance |
| Town of Merton | Adopted | County ordinance | County ordinance | Adopted | County ordinance |
| Washington County | Adopted | Adopted | Adopted and Wisconsin Department of Natural Resources approved | Floodland and shoreland only | Adopted |
| Town of Richfield | Adopted | County ordinance | County ordinance | Adopted | County ordinance |

[a]*No flood hazard areas have been identified or mapped.*

[b]*Erosion control ordinance only.*

*Source: SEWRPC.*

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## Chapter III

# ALTERNATIVE AND RECOMMENDED AQUATIC PLANT MANAGEMENT PRACTICES

## INTRODUCTION

The abundance of aquatic plants in portions of the lake basin, including curly-leaf pondweed and Eurasian water milfoil, designated nonnative aquatic plant species pursuant to Section NR 109.07 of the *Wisconsin Administrative Code*, continues to be perceived as a nuisance by Nagawicka Lake users. Ongoing aquatic plant management measures, in part, have maintained the abundance and distribution of these plants in such a condition as to minimize user-related concerns. Notwithstanding, localized recreational use problems are experienced in various areas of the Lake. These problems depend on the uses in those portions of the Lake, but generally involve the abundant growths of Eurasian water milfoil and other aquatic plants. Eurasian water milfoil often grows to the surface of the Lake, making certain recreational uses in those areas of the Lake less enjoyable, in addition to impairing the aesthetic quality of the Lake. These plants primarily interfere with recreational boating activities by entangling propellers and clogging cooling water intakes, impairing slow-speed boating activity, and impeding navigation by sailing vessels and human-powered watercraft. The shallow, northern portions of the Lake can have especially severe boating limitations as a result of the extensive and abundant growths of aquatic plants in this area. Without control measures, this area could become impassable for navigation.

In addition to boating activities, use of the Lake for fishing and swimming also is adversely affected by aquatic plant growth. The swimming area at Nagawaukee Park on the southeastern shore of the Lake is coincident with an area of Eurasian water milfoil dominance. Milfoil occurs in this area at swimming depth, and exists in portions of the Lake having water depths of up to about 15 feet. Other plants that are found at slightly shallower depths, five feet to 10 feet, in this area include eelgrass, muskgrass, and a number of pondweeds. These plants also pose potential problems for swimming and can interfere with angling activities, especially in shoreline areas.

In general, the abundance of aquatic plants throughout the lake basin, with the possible exception of the southern portions of the basin, is perceived as adversely affecting the aesthetic enjoyment of lake residents and visitors to the Lake. Thus, aquatic plant management is an important issue to be considered.

Following a brief summary of the ongoing lake management program, alternatives and recommended refinements to the existing aquatic plant management element of the adopted lake management plan[1] are described in this chapter. The alternatives and recommendations set forth herein are focused on those measures that are applicable

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[1]*SEWRPC Community Assistance Planning Report No. 262,* A Lake Management Plan For Nagawicka Lake, Waukesha County, Wisconsin, *March 2001.*

to the City of Delafield (in partnership with the Village of Nashotah), with lesser emphasis given to measures which are applicable to others with jurisdiction within the drainage area tributary to Nagawicka Lake. The recommended plan follows the format adopted by the Wisconsin Department of Natural Resources (WDNR) for aquatic plant management plans pursuant to Chapters NR 103, NR 107 and NR 109 of the *Wisconsin Administrative Code*. The aquatic plant management plan for the Nagawicka Lake is comprised of six elements:

1. A set of aquatic plant management objectives;

2. A statement of the current use restrictions and the need for aquatic plant management in the Nagawicka Lake;

3. An evaluation of alternative means of aquatic plant management and a recommended plan for such management;

4. A description of the recommended plan;

5. A description of the equipment needs for the recommended plan; and

6. A recommended means of monitoring and evaluating the efficacy of the plan.

## STATEMENT OF AQUATIC PLANT MANAGEMENT OBJECTIVES

The aquatic plant management program objectives for the Nagawicka Lake were developed in consultation with the City of Delafield Lake Welfare Committee, which Committee included representation from Village of Nashotah. The objectives are to:

1. Effectively control the quantity and density of aquatic plant growths in the Nagawicka Lake to enhance water-related recreational activities; to improve the aesthetic character of the resource; and to preserve and enhance the overall value of the waterbody;

2. Contribute to the overall conservation and wise use of the Nagawicka Lake through the environmentally sound management of vegetation, fishes and wildlife populations in and around the Lake; and,

3. Promote a high-quality, water-based recreational experience for residents and visitors to the Nagawicka Lake.

## USE RESTRICTIONS IMPOSED BY AQUATIC PLANTS

Excessive plant growth on Nagawicka Lake impedes boat traffic, making some areas of the Lake impassable without aquatic plant control. The dense plant growths generally occur near the outlet in the portion of the Lake basin known as "St. John's Bay," and along portions of the western shoreline of the Lake, severely restricting boating and shoreline angling and swimming, and even impairing the aesthetic enjoyment of the waterbody. The littoral areas of the northern embayment, known as the "Kettle," are also subject to abundant plant growths that impede boating access to and from the "Kettle" to the main lake basin. The plant growth limits recreational use of the Lake and shoreline, and results in public complaints throughout the summer season. Failure to remove floating vegetation that is left behind by the plant harvesters, or cut by boat propellers, leads to a buildup of vegetation along the shoreline. During the summer months, these beds of vegetation can become foul smelling and unsightly. The excessive plant growth also contributes to the accumulation of organic sediment on the bottom of the Lake.

## ALTERNATIVE AQUATIC PLANT MANAGEMENT MEASURES

Aquatic plant management[2] refers to a group of management and restoration measures aimed at both removal of nuisance vegetation and manipulation of species composition in order to enhance and provide for recreational water use and encourage the development of a natural plant community that will result in a healthy lake ecosystem. Generally, aquatic plant management measures are classed into four groups; namely, physical measures that include water level management; manual and mechanical measures that include harvesting and removal; chemical measures that include using aquatic herbicides; and biological controls that include the use of various organisms, including insects. All forms of aquatic plant control measures are stringently regulated and require a State permit pursuant to the provisions of Chapters NR 107 and/or NR 109 of the *Wisconsin Administrative Code*.

Various aquatic plant management techniques, manual, mechanical, physical and chemical, are potentially applicable to the Nagawicka Lake. A number of these methods have been employed with varying success on Nagawicka Lake in the past.

The costs of aquatic plant management actions range from minimal for manual removal of plants using rakes and hand-pulling to upwards of $120,000 for the purchase of a mechanical plant harvester with operational costs of about $45,000 per year or more, depending on staffing and operating policies. Harvesting is probably the measure best applicable to large areas, while chemical controls may be best suited to confined areas and initial control of invasive plants. Whole-lake herbicide treatments, planting of native plant species and control of Eurasian water milfoil by the weevil, *Eurhychiopsis lecontei*, remain largely experimental in lakes, but the latter two alternatives could be considered in specific areas.

**Aquatic Herbicides**

Chemical treatment with aquatic herbicides is a short-term method of controlling heavy growths of aquatic macrophytes and algae. The use of herbicides can contribute to an ongoing aquatic plant problem by increasing the natural rates of accumulation of decaying organic matter, in turn contributing to an increased oxygen demand that may cause anoxia. The use of herbicides can also potentially damage or destroy nontarget plant species that provide needed habitat for fish and other aquatic organisms. As a result, less desirable, invasive, introduced plant species may outcompete the more beneficial, native species. Hence, this is not a feasible management option to be used on a large scale. However, chemical control is often a viable technique for the control of relatively small-scale infestations of Eurasian water milfoil and certain other plants, such as curly-leaf pondweed and purple loosestrife. Chemicals are applied to the growing plants in either liquid or granular form. Chemical treatment can be administered at a relatively low cost and has been utilized by individual landowners within portions of the Nagawicka Lake basin, especially the embayment along the eastern shore of the Lake locally known as Zastrow (or Zastrow's) Bay. Consequently, the use of aquatic herbicides is considered as being viable for use in selected areas of Nagawicka Lake.

Chemical control measures can be viewed by the community as having uncertain long-term environmental impacts, as well as possible consequences for human health. While the herbicides used in recent years on Nagawicka Lake meet applicable U.S. Environmental Protection Agency standards and are applied by licensed personnel, the use of chemical control measures can have negative effects. Accordingly, chemical control measures should not be relied upon to fully control the infestations of aquatic plants in Nagawicka Lake, but could be considered for the control of the nuisance conditions over relatively small areas of the Lake.[3] If

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[2]*U.S. Environmental Protection Agency Report No. EPA-440/4-90-006,* The Lake and Reservoir Restoration Guidance Manual, *August 1990.*

[3]*The treatment of larger areas of the Lake, or the conduct of a whole-lake treatment, using aquatic Herbicides, such as fluridone, is considered to be an experimental approach in Wisconsin and is not recommended for application in Nagawicka Lake.*

considered necessary, chemical applications should be made in accordance with current administrative rules. Records accurately delineating treated areas, and the type and amount of herbicide used in each area, should be deposited with the WDNR by the applicators, and can be used as a reference when applying for permits in subsequent years. A recommended checklist is provided as Figure 3.

**Aquatic Plant Harvesting**

On the basis of previous use of a mechanical harvester on Nagawicka Lake, mechanical harvesting of aquatic plants appears to be a practical and efficient means of controlling plant growth as it removes the plant biomass and nutrients from the Lake. Aquatic macrophytes are mechanically harvested with specialized equipment consisting of a cutting apparatus that cuts up to five feet below the water surface and a conveyor system that picks up the cut plants and hauls them to shore. Harvesting removes the plant biomass, and nutrients from the Lake, but leaves enough plant material in the lake to provide shelter for fish and other aquatic organisms and to stabilize sediments. Harvesting also removes attached, epiphytic algal growths with the harvested plant material, and leaves sufficient plant material in the Lake to continue to provide forage and shelter for fish and other aquatic life. Mechanical harvesting does have some potentially negative impacts to fish and other aquatic life, may cause fragmentation and spread of some plants, and could disturb loosely consolidated bottom sediments. However, if done correctly and carefully, it has shown to be of benefit in ultimately reducing the regrowth of nuisance plants. Mechanical harvesting is a recommended method for the control of aquatic plants in Nagawicka Lake.

Of the various types of harvesters available, one alternative would be to purchase a smaller harvester, with about a five-foot removable cutter bar, which also could be operated for cleanup of floating aquatic plant fragments—the City currently operates a harvester with an eight-foot cutter bar. The smaller harvester could operate in shallower water, such as in the constructed channels located on the northeastern and northwestern shores of the Lake, with a harvesting capacity of about 8,500 pounds of vegetation, or slightly less than the 10,000 pound capacity of the current harvester. Options exist which could allow for the replacement of the paddlewheels with a hydraulically powered propeller system decreasing the width of the machine. This particular system can be operated with diesel fuel that is more economical than the standard option while remaining compatible with a transporter.

Accessory equipment needed to accompany a new harvester would include a trailer to move the harvester and a shore conveyor to unload the plants, if the new and currently owned harvesters are to work simultaneously. The options exist to buy each piece of equipment separately or to purchase one piece of equipment that is designed for both needs.

A harvesting program should be designed to provide optimal benefits and minimal adverse impacts. Small fish are common in dense macrophyte beds, but larger fish, such as largemouth bass, do not normally utilize these dense beds. Narrow channels may be harvested to provide navigational access and "cruising lanes" for predator fish to migrate into the macrophyte beds to feed on smaller fish. Shared access lanes may also be cut, allowing several residents to use the same lane. Increased use of these lanes should keep them open for longer periods than would be the case if a less directed harvesting program was followed. Because of the demonstrated need for control of aquatic plants in Nagawicka Lake and because the current lake management decisions have indicated a need for aquatic plant harvesting, harvesting is considered a viable management option that should be continued by the City of Delafield.

**Manual Harvesting**

Manual methods of aquatic plant control, such as raking or hand-pulling, while environmentally sound, are difficult to employ on a large-scale. Although very effective in small-scale applications, for example, in and around docks and piers, manual techniques are generally not practicable for large-scale plant control methods.

Due to an inadequate depth of water, it is not always possible for harvesters to reach the shoreline of every property. Manual harvesting, using rakes or other devices, can be effective in these limited water depths. Specially designed rakes are available to manually remove aquatic plants from the shoreline area and can be purchased commercially.

**Figure 3**

**DISTRICT CHECKLIST FOR HERBICIDE APPLICATION**

- [ ] Nuisance report completed defining areas of potential treatment
- [ ] Permit filed with the Wisconsin Department of Natural Resources
- [ ] Certified applicator hired[a]
- [ ] Required public notice in the newspaper
- [ ] Public informational meeting (required if five or more parties request a meeting)
- [ ] Posting of areas to be treated in accordance with regulations (discussed previously in report)
- [ ] Weather conditions cooperating
  - Wind direction and velocity
  - Temperature

[a]*A licensed applicator will determine the amount of herbicide to be used, based upon discussions with appropriate staff from the Wisconsin Department of Natural Resources, and will keep records of the amount applied.*

*Source: SEWRPC.*

The advantage of the rake is that it is easy and quick to use, immediately removing the plants from the lake. Using this method avoids the accumulation of organic matter on the lake bottom adding to the nutrients that favor more plant growth. This method, when used in concert with mechanical harvesting methods, gives the harvester more time to cover larger areas of the lake since it does not have to maneuver between piers, which takes time and skill, and increases risk of collateral damage to boats and property.

Manual means are considered a viable option on Nagawicka Lake to control nearshore plant growths, for removal of rooted vegetation along shorelines in shallow waters of limited surface area, and around docks by individual riparian landowners. The advantage of these manual control methods, as opposed to chemical treatment, is that the response is immediate and potential long-term affects of chemicals are not a concern. Individual homeowners who manually harvest adjacent to their property to a width not to exceed 30 linear feet as measured along the shoreline are exempted from Chapter NR 109 permitting, although permits are required in WDNR-designated sensitive areas and for more extensive areas.

**Biological Controls**

Another approach to controlling nuisance aquatic plant conditions, particularly in the case of Eurasian water milfoil, is biological control. Classical biological control has been successfully used to control a variety of aquatic

plants.[4] Recent documentation states that *Eurhychiopsis lecontei*, an aquatic weevil species, has potential as a biological control agent for Eurasian water milfoil.[5] In 1989, the weevil was discovered during a study investigating a decline of Eurasian water milfoil growth in a Vermont pond. *Euhrychiopsis* proved to have significant effects on Eurasian water milfoil in the field and in the laboratory. The adult weevil feeds on the milfoil causing lesions that make the plant more susceptible to pathogens, such as bacteria or fungi. The weevil burrows into the stem of the plant causing enough tissue damage for the plant to lose buoyancy and collapse. While few studies have been completed in Wisconsin using *Eurhychiopsis lecontei* as a means of aquatic plant control, those studies that have been completed suggest variable responses to these aquatic insects. In general, these findings have indicated that the success of aquatic weevils for Eurasian water milfoil control in lakes that experience heavy boating traffic has been limited, with the insects being easily disturbed and washed off the plants by boat-generated wakes. Thus, use of biological controls is not recommended for use on Nagawicka Lake at this time. The use of grass carp, *Ctenopharyngodon idella*, is not permitted in Wisconsin.

A modification of the traditional biological control program, which would require augmentation of the aquatic plant community through plantings of desirable species of aquatic plants within selected areas of the Lake, has been suggested by the community as a means of mitigating the loss of aquatic plants within areas proposed to be remediated. Such plantings would ensure that a desirable aquatic plant community is established, and limit the potential for undesirable, nonnative aquatic plant species to invade or colonize these disturbed areas. Attempts to promote submergent aquatic plant growth in southeastern Wisconsin lakes were pioneered in Lac La Belle by the Lac La Belle Management District, in partnership with the WDNR and University of Wisconsin-Milwaukee. This experimental program attempted to supplement the aquatic plant community of the Lake by selective plantings of pondweeds,[6] with several hundred pondweeds being planted from pontoon boats. While there is some evidence that a few of these transplants were successful, the net outcome of the project was disappointing and few of the introduced plants were observed in subsequent years. On the other hand, experiences elsewhere in Wisconsin suggest that removal of accumulated flocculent sediments can expose the pre-existing seed bank contained within the lake sediments, allowing native plants to resurge. Consequently, should the proposed lake restoration activities be undertaken, it is recommended that aquatic plant management measures focus on the control of Eurasian water milfoil in order to promote and encourage the resurgence of native submergent aquatic plants from seed stocks contained within the historic lakebed.

**Physical Controls**

One physical method of aquatic plant control involves the drawing down of a waterbody in order to change or create specific types of habitat and thereby manage species composition within the waterbody. Such drawdown was not considered to be practicable on Nagawicka Lake due to the heavy recreational demands placed on the Lake throughout the year.

Other physical controls, such as the placement of bottom barriers and use of shoreline protection structures, such as riprap, may be practicable. Lake bottom covers and light screens provide limited control of rooted plants by creating a physical barrier which reduces or eliminates the sunlight available to the plants. They have been used to create swimming beaches on muddy shores, to improve the appearance of lakefront property, and to open

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[4]*C.B. Huffacker, D.L. Dahlsen, D.H. Janzen, and G.G. Kennedy,* Insect Influences in the Regulation of Plant Population and Communities*, 1984, pp. 659-696; C.B. Huffacker and R.L. Rabb, editors,* Ecological Entomology*, John Wiley, New York, New York, USA.*

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

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

channels for motorboating. Sand and gravel are usually readily available and relatively inexpensive to use as cover materials, but plants readily recolonize areas so covered in about a year. Synthetic materials, such as polyethylene, polypropylene, fiberglass, and nylon, can provide relief from rooted plants for several years. However, these structures must be placed and removed annually. Barriers should not be used in areas of strong surf, heavy angling, or shallow water where motorboating occurs. Because of the limitations involved, lake bottom covering as a method to control aquatic plant growth is not recommended for Nagawicka Lake.

Extensive use has been made of shoreline protection structures along the developed areas of the Nagawicka Lake shoreline, as shown on Map 4 in Chapter II of this report. Because of the uniqueness of each shoreline situation these control methods are recommended for Nagawicka Lake only for installation by homeowners on a site-specific basis.

**Boating Ordinances**

The promulgation of more stringent controls on the use of powered watercraft within Nagawicka Lake is one means of regulating the conduct of boat traffic that could be harmful to the most important ecologically valuable areas in the Lake. These areas include the WDNR-designated environmentally sensitive areas in the northern, eastern and western portions of the Lake basin and areas in which the greatest diversity of native aquatic plant species occurs. The major islands in the Lake basin are located within the WDNR-designated sensitive areas, and stabilization of erosional areas on their shorelines could also benefit from reduced wake waves in their vicinities.

Controls on boat traffic are currently set forth in *Chapter 19, Parks and Public Waters*, in the City of Delafield Code of Ordinances, appended hereto as Appendix B.

Additional controls could be put in place by amending the current provisions to further limit boating activity within specific areas of the Lake to defined traffic lanes within the Lake, thereby minimizing new colonization and proliferation of Eurasian water milfoil and the propagation of nuisance plant species by the operation of watercraft. This concept is inherent in the lake access zones previously identified in the adopted lake management plan, especially as they relate to habitat areas. Should such an alternative be considered, boat traffic lanes must be designated by approved regulatory markers and conform to Section NR 5.09 of the *Wisconsin Administrative Code*.[7] This section requires that restrictions placed on the use of the waters of the State be predicated upon the protection of public health, safety, or welfare. Boating ordinances, enacted in conformity with State law, must be clearly posted at public landings in accordance with the requirements of Section 30.77(4) of the *Wisconsin Statutes*.

Given the current level of regulation of public recreational boating traffic on the Lake, no further regulation appears to be warranted at this time on Nagawicka Lake. However, both the shoreland wetlands in the northwestern portion of the main lake basin of Nagawicka Lake and the channel between the main lake basin and the "Kettle" could benefit from reduced boat wakes as suggested above.[8] To this end, it is recommended that

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[7]*Two general types of buoyage exist: regulatory buoys, such as those used to demarcate slow-no-wake or exclusionary areas; and informational buoys, such as those used to enhance public awareness. Buoys must be white in color, cylindrical in shape, seven or more inches in diameter, and extend 36 or more inches above the water line. Regulatory buoys include buoys used to demarcate restricted areas, prohibit boating or types of boating activities in specific areas, and control the movements of watercraft. Regulatory buoys used to demarcate regulated areas display their instructions in black lettering. Some types of regulatory buoys display an orange diamond with an orange cross inside; others display an orange circle. Informational buoys are similar in construction to the regulatory buoys, but contain an orange square on the white background. Whereas regulatory markers are enforceable, informational buoys are not.*

[8]*The shoreland wetlands located around the northern perimeter of Nagawicka Lake have been subjected to considerable anthropogenic modification, which, when combined with weather related changes to the lakeshore caused by variations in precipitation that have led to interannual changes in lake levels and wind wave erosion, (Footnote Continued)*

consideration be given by the City of Delafield to the placement of regulatory markers demarcating the navigational lanes that connect both the constructed channels and the "Kettle" to the main lake basin in this area. Some markers are currently in place within the constructed channels. Therefore, this recommendation would require placement of additional markers of various types. Those that are recommended would include regulatory markers to indicate travel lanes to and from the various channels, and either regulatory or informational markers indicating proximity to the shoreland wetlands. Of these alternatives, only the regulatory markers are enforceable and will provide a higher degree of protection for this sensitive shoreline.

**Public Information**
Aquatic plant management usually centers on the eradication of nuisance aquatic plants for the improvement of recreational lake use. The majority of the public views all aquatic plants as "weeds" and residents often spend considerable time and money removing desirable plant species from a lake without considering their environmental impacts. Thus, public information is an important component of an aquatic plant management program for Nagawicka Lake, and is recommended as an ongoing element of the aquatic plant management program on the Lake. Posters and pamphlets are available from the University of Wisconsin-Extension and Wisconsin Department of Natural Resources that provide information and illustrations of aquatic plants, their importance in providing habitat and food resources in aquatic environments, and the need to control the spread of undesirable and nuisance plant species.

## RECOMMENDED AQUATIC PLANT MANAGEMENT MEASURES

The goal of the management program is to accommodate a range of recreational uses of the Lake to the extent practicable and to enhance the public perception of the Lake as a centerpiece of the City of Delafield, without inflicting irreparable damage to the ecosystem of Nagawicka Lake and its structure and functioning. To accomplish this goal, specific control measures are recommended to be applied in various areas of the Lake. The refined recommended Nagawicka Lake aquatic plant management measures are graphically summarized on Map 8, and the recommended measures are summarized in Table 10. It is recommended that the City of Delafield Nagawicka Lake Welfare Committee continue to take the lead in implementing the refined plan.

The recommended aquatic plant management plan consists of integrated use of mechanical and manual harvesting and chemical treatment designed to minimize the negative impacts on the ecologically valuable areas of the Lake, while providing the control needed to achieve the desired recreational uses of the Lake.

**Aquatic Plant Management**
In order to implement the recommended aquatic plant management program the following management actions are recommended:

1. Mechanical harvesting is recommended as the primary management method. As indicated in Chapter III of the lake management plan, this will, in the long-term, help to maintain good water quality conditions by removing plant materials that are currently contributing to an accumulation of decomposing vegetation and associated nutrient recycling. The harvesting should be carried out by the City of Delafield using its existing harvester and transport equipment.

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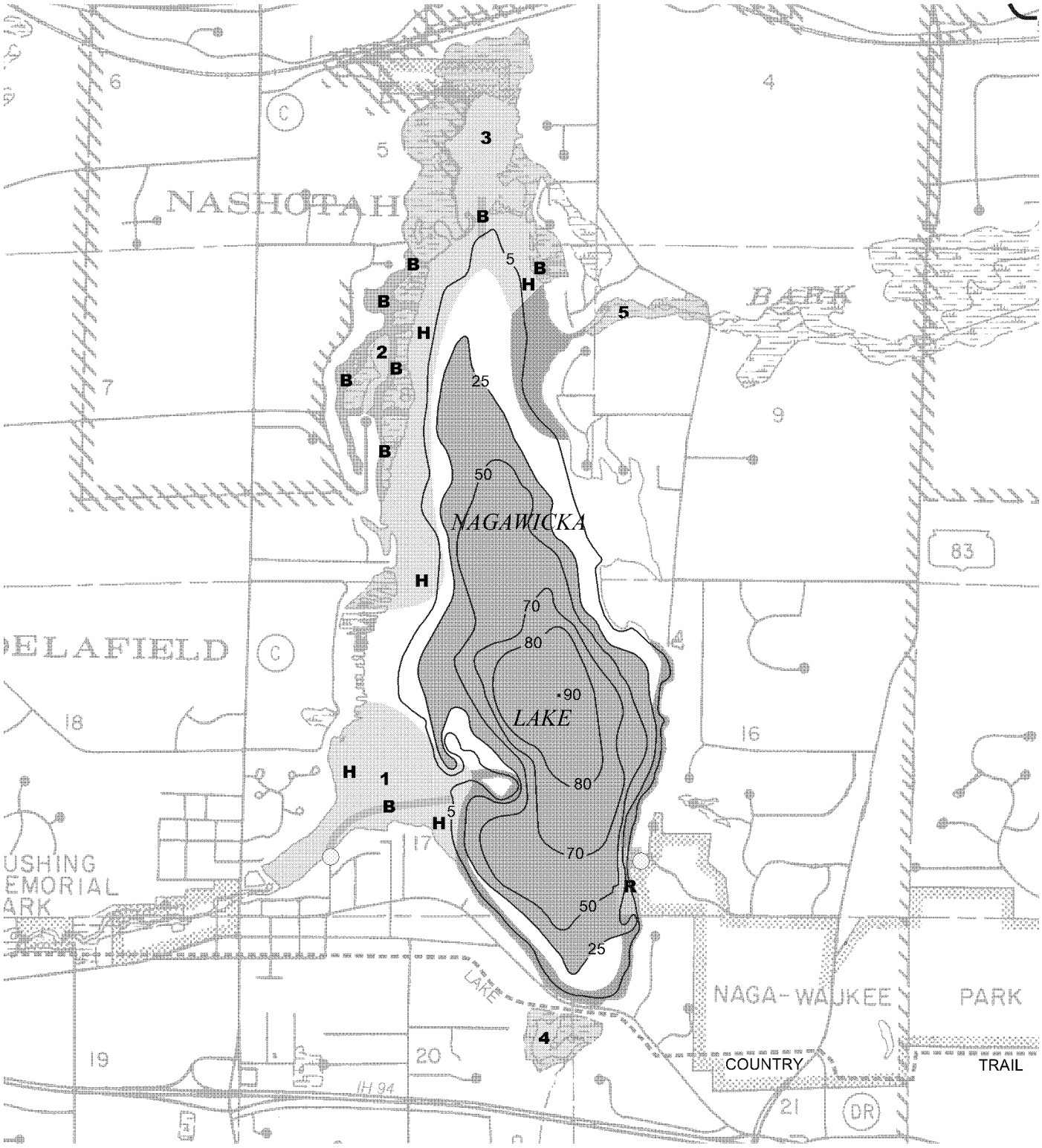
*as noted in the adopted lake management plan, has led to significant recession of the western wetland fringe between 1940 and 2005 as shown in Map 9. Such modifications are continuing. As can also be seen on Map 9, portions of this wetland fringe are currently formalized and protected by shoreline protection structures, and the northern and eastern shoreland wetlands have increased in extent and density during this 65-year period. While these changes have occurred largely in concert, with no net loss of wetlands overall within the Lake basin during the period of record, the application of measures to control the anthropogenic element of this shoreland wetland loss is recommended through implementation of recreational boating management measures limiting the creation of boat wakes in this area. This recommendation also will enhance boating safety in these confined waterways.*

**Map 8**

**AQUATIC PLANT MANAGEMENT PLAN FOR NAGAWICKA LAKE**




*Source: SEWRPC.*

*REVISED FEBRUARY 2007*

**Table 10**

**RECOMMENDED AQUATIC PLANT MANAGEMENT PLAN ELEMENTS FOR NAGAWICKA LAKE**

| Plan Element | Subelement | Location | Management Measures | Initial Estimated Cost | Management Responsibility |
|---|---|---|---|---|---|
| Recreational Use Management | Recreational use zoning | Entire Lake | Protect native aquatic plant communities, fish breeding and habitat areas, and designated environmentally sensitive areas as set forth in the adopted lake management plan | $ 500 | City of Delafield and WDNR |
| | Lakewide non-native species management program | Eurasian water milfoil control zone, purple loosestrife and zebra mussel control | Prevent the spread of nonnative plants and animals through cleaning of boats, trailers and related facilities throughout the Lake; limited use of herbicides in spring, manual removal during summer and fall, is recommended | - - | City of Delafield and WDNR |
| | Regulation of recreational boating activities | Northern and northwestern portions of the main lake basin | Consider placement of regulatory and/or regulatory and informational buoys along the northwestern shoreland wetland fringe and at the ingress and egress channels to the "Kettle" and constructed channels | $100 per buoy[a] | City of Delafield and WDNR |
| | Public informational programming | Direct drainage area tributary to Nagawicka Lake | Continue public awareness and information programming | - - | Nagawicka Lake Welfare Committee and City of Delafield |
| Aquatic Plant Management | Manual harvesting | Localized areas of shoreline and around piers and docks | Harvest nuisance plants, including Eurasian water milfoil and purple loosestrife, as required around docks and piers; collect plant fragments arising from boating and harvesting activities | - -[b] | Individual property owners |
| | Mechanical harvesting | Major and minor channel harvesting | Harvest nuisance plants, including Eurasian water milfoil, to maintain public recreational boating access, promote public safety and convenience, and enhance angling opportunities | $45,000 | City of Delafield |
| | Chemical controls | Localized areas of the Lake, especially in proximity to docks and piers | Control aquatic plants through limited use of herbicides in spring; manual removal, as noted above, is recommended during summer and fall | $ 5,000 | Individual property owners |
| | Eurasian water milfoil control | Lakewide, especially in nuisance aquatic plant management areas | Control nonnative, invasive species as required to prevent the spread of nuisance species within the Lake; use herbicides in spring to limit the volume of decomposing biomass and quantity of herbicides required is recommended | $10,000 | City of Delafield and individual property owners |
| | Selective plantings | Localized areas of the Lake, especially in areas where lake restoration activities are proposed | Introduce emergent and/or floating-leaved aquatic plants into disturbed areas of the lake (such as bulrush into St. John's Bay); aggressively surface harvest pioneer Eurasian water milfoil colonies in these areas | - -[a,c] | City of Delafield |

**Table 10 (continued)**

| Plan Element | Subelement | Location | Management Measures | Initial Estimated Cost | Management Responsibility |
|---|---|---|---|---|---|
| Aquatic Plant Management (continued) | Public informational programming | Direct drainage area tributary to Nagawicka Lake | Continue public awareness and information programming; continue monitoring of aquatic plant communities | $ 1,500[a,d] | Nagawicka Lake Welfare Committee and City of Delafield |

[a]*Partial funding available through the Wisconsin Department of Natural Resources grant programs.*

[b]*Measures recommended generally involve low or no cost and would be borne by private property owners. Cost is included under public informational and educational component.*

[c]*Costs to be determined; harvesting costs are subsumed into the aquatic plant management program costs associated with lakewide harvesting activities. Harvesting costs include labor, fuel, maintenance, and repair costs.*

[d]*Periodic additional surveys are recommended at five- to 10-year intervals.*

*Source: SEWRPC.*

2. It is recommended that shared-access channels be harvested to minimize the potential detrimental effects on the fish and invertebrate communities. Directing boat traffic through these common channels would help to delay the regrowth of vegetation in these areas. Demarcation of these channels, especially in the northern portion of the Lake, should be considered.

3. Surface harvesting is recommended, cutting to a depth of approximately two feet to remove the surface canopy of nonnative aquatic plants, such as the Eurasian water milfoil, as shown in Figure 4. Such harvesting would provide a competitive advantage to the low-growing native plants present in the Lake. By not disturbing the low-growing species that generally grow at relatively low densities within one to two feet of the lake bottom, and leaving the root stocks and stems of all cut plants in place, the resuspension of sediments in Nagawicka Lake will be minimized, and some degree of cover will continue to be provided for panfish populations that support the bass population in the Lake. Further, cutting should not be general, but focused on boating channels. It is recommended that the use of chemical herbicides be limited to controlling nuisance growth of exotic species in shallow water around docks and piers where the harvester is unable to reach. Such use should be evaluated annually and the herbicide applied only on an as needed basis. Only herbicides that selectively control milfoil, such as 2,4 D, should be used. Algicides, such as Cutrine Plus, are not recommended generally at this time because there are no significant filamentous algae or planktonic algae problems in the Nagawicka Lake and valuable macroscopic algae, such as *Chara* and *Nitella*, are killed by this product.

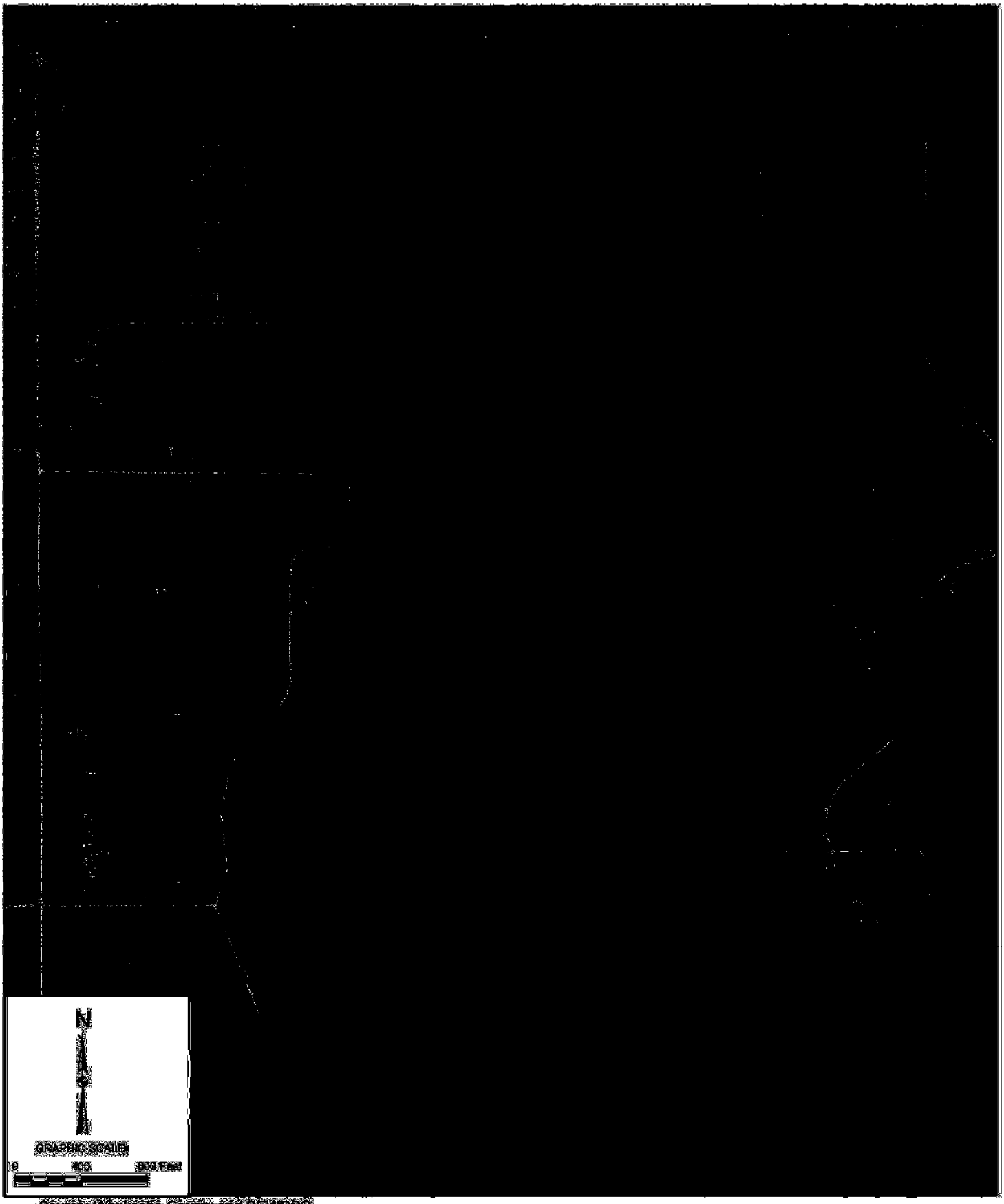
4. It is recommended that chemical applications, if required, be made in early spring to maximize their effectiveness on nonnative plant species, while minimizing impacts on native plant species and acting as a preventative measure to reduce the development of nuisance conditions.

5. The control of rooted vegetation between adjacent piers is recommended to be left to the riparian owners concerned, as it is time consuming and costly for a mechanical harvester to maneuver between piers and boats and such maneuvering may entail liability for damage to boats and piers. The City of Delafield Lake Welfare Committee may wish to obtain informational brochures regarding shoreline maintenance, such as information on hand-held specialty rakes made for this specific purpose, to inform residents of the control options available.

Map 9

EXTENT OF SHORELAND WETLANDS WITHIN THE NORTHERN QUADRANT OF NAGAWICKA LAKE: 1941 AND 2005

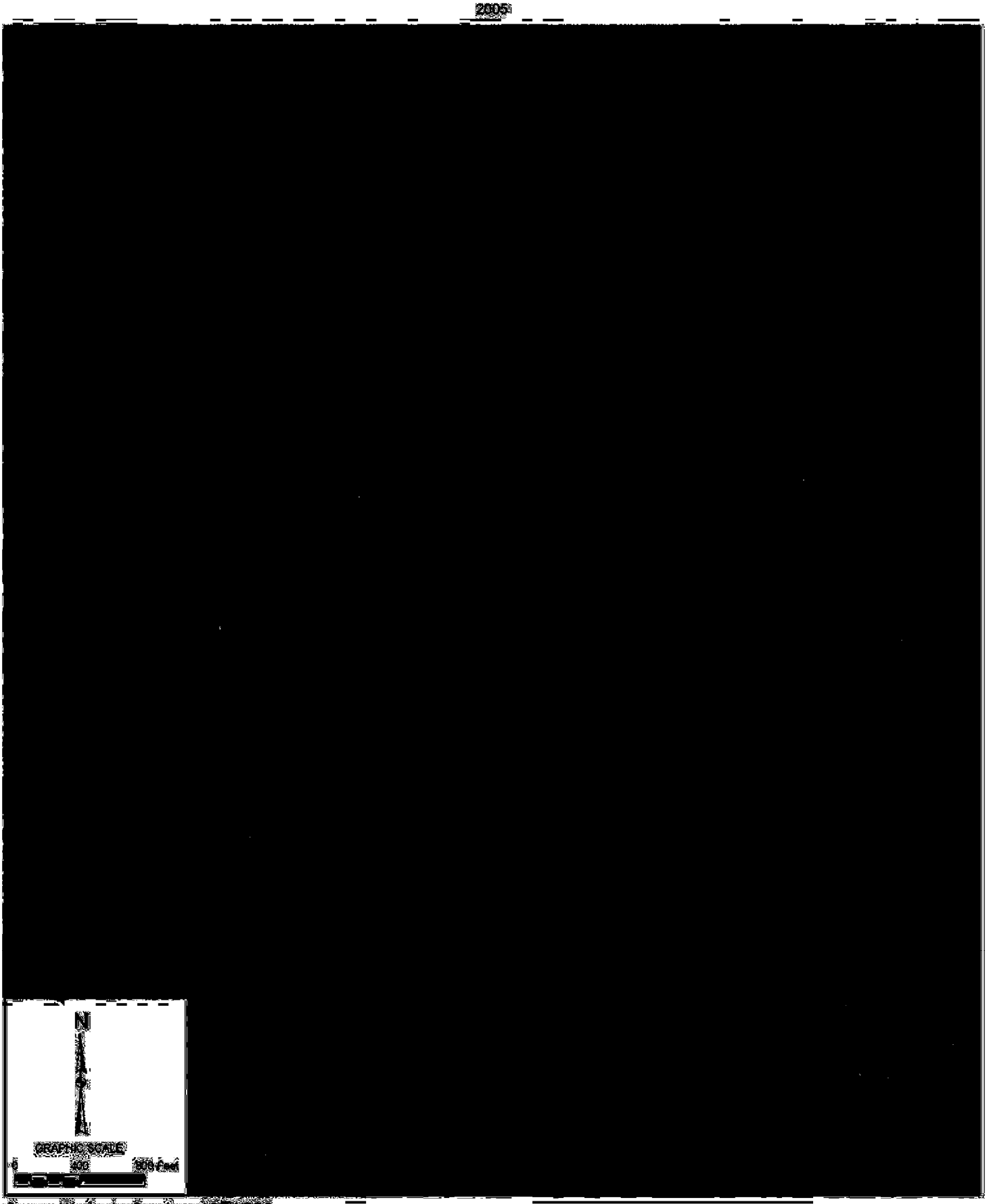
1941




*Source: Waukesha County and SEWRPC.*

Map 9 (continued)

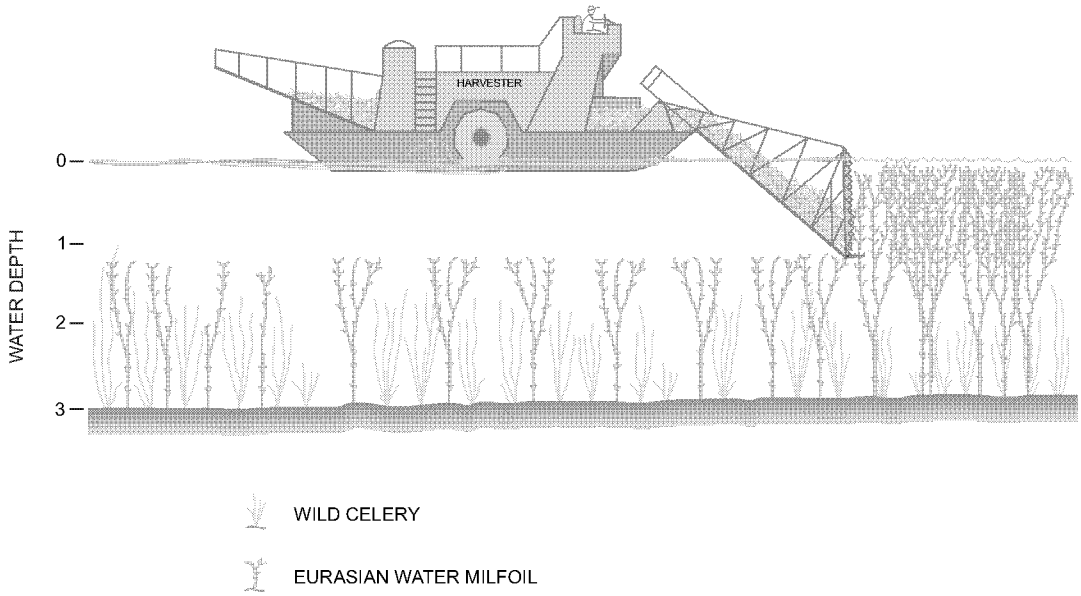
2005




Source: Waukesha County and SEWRPC.

**Figure 4**

**PLANT CANOPY REMOVAL WITH AN AQUATIC PLANT HARVESTER**




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

*Source: Wisconsin Department of Natural Resources and SEWRPC.*

6. It is recommended that ecologically valuable areas be excluded from aquatic plant management activities, especially during fish spawning seasons in early summer and autumn; however, it is also recommended that WDNR-delineated environmentally sensitive areas, promulgated subject to Section NR 107.05(3)(i) of the *Wisconsin Administrative Code*, be periodically reviewed for continuing applicability given the changing conditions within the Lake.

7. It is further recommended that the City of Delafield Lake Welfare Committee conduct a public informational program on the types of aquatic plants in Nagawicka Lake; on the value of and the impacts of these plants on water quality, on fish, and on wildlife; and on alternative methods for controlling existing nuisance plants including the positive and negative aspects of each method. This program can be incorporated into the comprehensive informational and educational programs that also would include information on related topics, such as water quality, recreational use, fisheries, and onsite sewage disposal systems.

**Ecosystem Renewal Measures**

Subsequent to the publication of the adopted lake management plan for Nagawicka Lake, the City of Delafield engaged Vierbicher Associates, Inc., to undertake a lake restoration feasibility study for portions of the Nagawicka Lake basin identified in the lake management plan as being subject to excessive sedimentation, leading to impaired water quality and diminished recreational use of the waterbody. That the Lake had been subjected to excessive deposition of flocculent sediments during the preceding Century was documented by the WDNR using paleolimnological techniques.[9]

[9]*Paul J. Garrison, Wisconsin Department of Natural Resources Publication No. PUB-SS-993 2004,* Paleoecological Study of Nagawicka Lake, Waukesha County, *March 2004.*

The Vierbicher Associates, Inc., investigations quantified and prioritized eleven potential dredging projects proposed to be considered within the Nagawicka Lake basin and adjacent waterways,[10] and confirmed the actions recommended in the adopted lake management plan for the maintenance of public recreational boating access to the main lake basin from the Bleeker Street public access site. One element considered in these investigations was the potential impact of lake restoration activities on the aquatic plant community of the Lake. Specifically, the need to minimize colonization opportunities for Eurasian water milfoil was identified as an issue of concern. In St. John's Bay, for example, the planting of bulrush (*Scirpus* spp.) in the shallow water areas adjacent to the northern shoreline was considered as one means of providing high value habitat for fish and aquatic life. Given the relatively shallow water depths, and organic character of the substrate in this area, previously identified by the WDNR as an environmentally sensitive area pursuant to Section NR 107.05(3)(i) of the *Wisconsin Administrative Code*, such actions are recommended to limit further proliferation of Eurasian water milfoil and minimize the introduction of Eurasian water milfoil fragments into the dredged areas of the Bay.

Elsewhere, such as in the constructed channels along the northwestern and northeastern shorelines of the Lake, the opportunities to undertake plantings to limit Eurasian water milfoil colonization are more limited. As noted above, attempts to promote submergent aquatic plant growth in southeastern Wisconsin lakes were pioneered in Lac La Belle by the Lac La Belle Management District, in partnership with the WDNR and University of Wisconsin-Milwaukee. Few of these plantings were successful. While the reasons for this lack of success are unknown,[11] this outcome does not augur well for the success of similar plantings in Nagawicka Lake.[12] In contrast, the exposure of the pre-existing seed bank contained within the lake sediments has been shown to allow native plants to resurge. Consequently, it is recommended that aquatic plant management measures continue to focus on the control of Eurasian water milfoil in order to promote and encourage the resurgence of native submergent aquatic plants from seed stocks contained within the historic lakebed. A major element in the control of Eurasian water milfoil growths would include selective harvesting, as shown in Figure 4.

**Aquatic Plant Harvesting Plan**

As previously stated, the recommended aquatic plant management plan for the Nagawicka Lake is graphically summarized on Map 8. As indicated on the map, it is proposed that aquatic plant management activities be restricted in certain ecologically valuable areas of the Lake. For this reason, aquatic plant management activities should be confined to zones related to recreational boating access (Zone B), recreational uses (Zone R), and, if necessary, limited (nearshore) areas of open water. Further, aquatic plant management operations will be concentrated in the areas identified for Eurasian water milfoil control, especially near the boating access ramps, as well as at the debouchement of the Bark River and in the principal boating use areas within the main Lake basin, as shown on Map 8. The majority of the main lake basin, shown on Map 8, is comprised of deep water habitat requiring no aquatic plant management intervention; about 65 percent of the Lake being greater than five-feet in depth.

Existing controls applied within the five environmentally sensitive areas, identified by the Wisconsin Department of Natural Resources in 1990, limit harvesting and restrict chemical applications. In general, harvesting, if permitted within the sensitive areas as currently delineated, should not take place in shallow waters, generally

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[10] *Vierbicher Associates, Inc.,* Lake Restoration Study, Nagawicka Lake, City of Delafield, Wisconsin, *August 2004.*

[11] *At the 2003 annual meeting of the Lac La Belle Management District, a citizen reported observing a herbicide application in the vicinity of the planted area of the Lake. Such an application might explain the observed lack of success of this management measure.*

[12] *This lack of success with the introduction of submergent plants is in contrast to experiences in other southeastern Wisconsin lakes, such as Pewaukee Lake, and aquatic systems, including wet detention basins for stormwater management, where emergent aquatic plants and floating leaf aquatic plants have been successfully transplanted. Unfortunately, planting such species in navigational lanes is impractical.*

three feet or less, to avoid disturbance of fish spawning areas and beds of native aquatic plants. Special care should be taken to avoid disturbing major spawning and habitat areas of bass in the Nagawicka Lake during the spring spawning season, May 1st to June 15th, annually. Periodic review of these areas, as recommended above, should be undertaken.

The primary objective of the management program is to accommodate the multiple recreational uses of the Lake, and to enhance the public perception of the Lake without inflicting irreparable damage on the structure and functioning of the lake ecosystem. To accomplish this objective, only specified control measures should be applied in each of the various lake zones identified on Map 8. The recommended sequence of the harvester operations on Nagawicka Lake is portrayed in Figure 5. The recommended aquatic plant management treatments that should be applied in each of the three lake zones are shown in Table 11.

It is envisioned that the harvesting crew will be required to spend about 25 to 35 hours per week on Nagawicka Lake to accomplish the stated goals.[13]

**Depth of Harvesting and Treatment of Fragments**
The harvesting equipment proposed to be used has a maximum cutting depth of five feet. While this may exceed the actual water depth in some areas it is not the intention of the owners or operators of the equipment to denude the Lake of aquatic plants given the heavy angling use of the waterbody, its morphology (which is not conducive to extensive motorized boat traffic), and the program goals. All plant cuttings and fragments will be collected *in situ* by the harvester. Those fragments accumulating along the shoreland areas will be collected by the riparian homeowners. Fragments can be used by the homeowners as garden mulch.

**Buoyage**
Temporary marker buoys may be used to direct harvesting operations in the lake basin by marking the areas to be cut. However, the size of the Lake generally precludes the need for such buoys, except insofar as they are required for the control of boating traffic on the Lake. The harvester operators will be provided with a laminated copy of the harvesting plan and made familiar with the plan and local landmarks to the degree necessary to carry out the plan without the use of buoyage.

**Harvested Plant Material Transfer Site(s)**
Plant material will be removed from the harvester at the primary off-loading site located at Ridley Road on the eastern shores of the Lake in the area known as Zastrow Bay. A secondary off-loading site is located in the area adjacent to the Bleeker Street public recreational boating access site, which site is used only when the harvesting operations are concentrated in the southern portions of the Lake. Harvested plant material will be transferred to a dump truck using a conveyor and transported to disposal sites identified by the City of Delafield. Plant material will be collected and disposed of daily to avoid leaching of nutrients back into the Lake and to minimize the visual degradation of the environment near the boat launching site. The operators will stringently police the off-loading site to ensure minimal disruption of boaters and of the people using the riparian areas of the Lake.

**Disposal of Harvested Plant Material**
Harvested plant material will be land-spread on area farms or used as compost.

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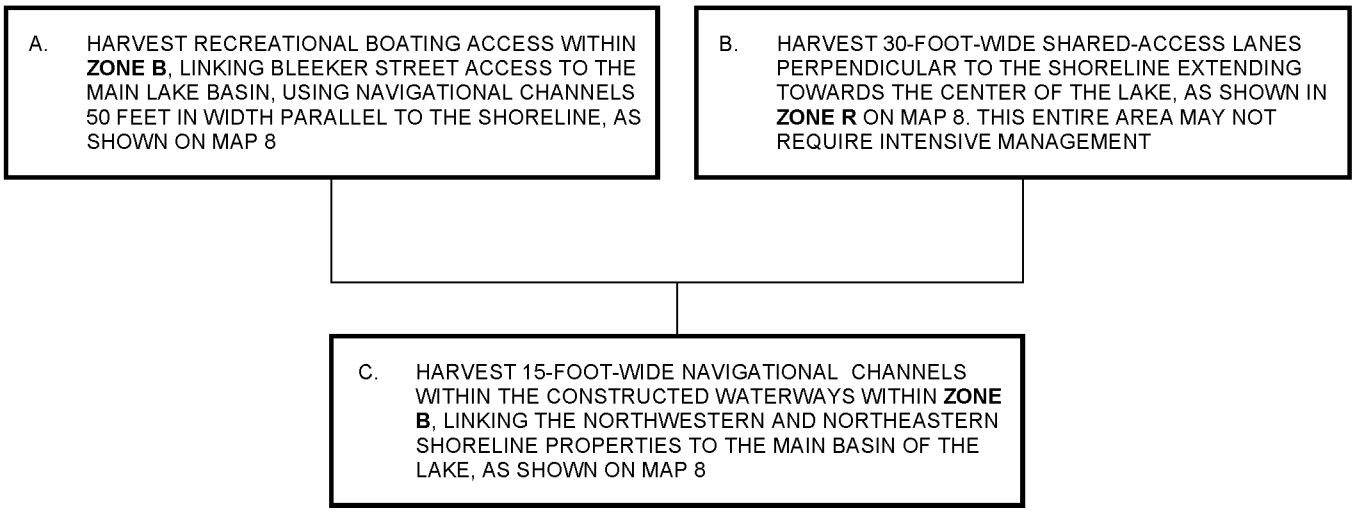
[13]*The City of Delafield staff notes that the total time required to implement this program is comprised of the recommended 25 to 35 hours of active harvesting, plus a further 5 to 15 hours of mobilization time, transit time, maintenance time, and time for related support activities. Harvesting time includes time spent in collecting aquatic plant material that has been manually harvested by riparian owners and placed on pierheads for collection.*

**Figure 5**

**HARVESTING SEQUENCE FOR NAGAWICKA LAKE[a]**




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

[a]*No harvesting would be conducted in Zone H or within 100 feet of the island areas, except in areas designated as Zone B or Zone R.*

*Source: SEWRPC.*

### Precautions to Protect Wildlife and Ecologically Valuable Areas

Operators will be provided with a laminated copy of the approved harvesting plan map as set forth in Map 8, showing the limits of harvesting operations. A copy of the map will be kept on the harvester at all times. Operations should normally not be carried out in those areas with less than three feet of depth to protect bass habitat and spawning areas. Harvesting operations in the areas identified as suitable for bass spawning will be restricted until mid-June to permit undisturbed spawning.

### Public Information

It is the policy of the City of Delafield Lake Welfare Committee to maintain an active dialogue with the community. This dialogue is carried out through the medium of the public press and in public fora through various public meetings and other scheduled hearings.

### Harvesting Schedule

The harvesting season will begin no earlier than May 15th and will end about September 30th of each year. Actual harvesting time, not including unloading, maintenance, and downtime, will average about 40 hours per week over a five-day week, depending on weather conditions and plant growth, to minimize recreational conflicts.[14] During peak-growth periods, this time requirement may be increased somewhat. Further, harvesting will be confined to daylight hours to minimize public disturbances resulting from harvester and plant removal operations. As provided for above, the harvesting operations will also be modified to protect fish spawning areas and other ecologically valuable areas of the lake as set forth on Map 8.

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[14]*The time required to implement this program consists of 25 to 35 hours of active harvesting, plus a further 5 to 15 hours of mobilization time, transit time, maintenance time, and time for related support activities such as collecting manually harvested aquatic plants placed on pierheads for collection.*

**Table 11**

**RECOMMENDED AQUATIC PLANT MANAGEMENT TREATMENTS FOR NAGAWICKA LAKE**

| Zone and Priority | Recommended Aquatic Plant Management Treatment |
|---|---|
| Zone B (Boating)<br>Moderate-Priority Harvesting | Harvesting limited to maintaining 15-foot-wide navigational channels around the northeastern and northwestern perimeter of the Lake, and 50-foot-wide recreational boating access lane from Bleeker Street public recreational boating access site, to allow boat access to the open water area of the Lake<br>Limited late season harvesting, late August to early September, may be necessary to maintain adequate open water areas to the central portion of the Lake |
| Zone H (Habitat)<br>Low-Priority Harvesting | It is recommended that selected areas of the Lake, designated as WDNR sensitive areas, be preserved as high-quality habitat area, subject to review by the WDNR as recommended in the lake management plan<br>This zone and adjacent lands should be managed for fish habitat<br>Limited harvesting and no in-lake chemical application should be permitted, except in special instances where selective herbicide application may be allowed for the control of nuisance species<br>Debris and litter cleanup would be needed in some adjacent areas; the immediate shoreline should be preserved in natural, open use to the extent possible |
| Zone R (Recreational Access)<br>High-Priority Harvesting | The entire area may not require intensive plant management[a]<br>Nuisance aquatic macrophyte growth within 150 feet of shoreline should be harvested to provide maximum opportunities for boating, fishing, and swimming<br>Areas between piers should not be harvested due to potential liability and maneuverability problems. Residents should be encouraged to manually harvest aquatic plants in these areas<br>Chemical use, if required, should be restricted to pier and dock areas and should not extend more than 100 feet from shore, subject to permit requirements, to control of nuisance species |

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

*Source: SEWRPC.*

## EQUIPMENT NEEDS AND OPERATION

### Equipment Needs and Capital Costs

***Manufacturer***: Aquarius Systems, D&D Products, Inc., North Prairie, Wisconsin, or other manufacturer of comparable equipment.

### Existing Equipment Requiring Replacement

***Harvester***: Aquarius Systems model HM-420 or equivalent.

| | | |
|---|---|---|
| ***Costs***: | HM-420 Aquatic Plant Harvester or equivalent | $ 95,000 |
| | TR-12 trailer | 10,000 |
| | SC-23 Shore conveyor (for Nagawicka Lake) | 20,500 |
| ***Shore Barge***: | | |
| ***Costs***: | Shore Barge with conveyor | $ 80,500 |
| | ***Total Cost***[15] | $206,000 |

[15]*Cost-share funding for the purchase of aquatic plant harvesting equipment may be available through the Chapter NR 7 Recreational Boating Facilities Grant Program administered by the Wisconsin Waterways Commission, for whom the WDNR serves as Secretariat. As of 2005, the cost-share rate for the purchase of aquatic plant harvesting equipment was 50 percent State share and 50 percent local share.*

**Maintenance Schedule, Storage, and Related Costs**

Routine maintenance will be performed by the City of Delafield in accordance with the manufacturer's recommended maintenance schedule. Maintenance costs will be borne by the City. Winter storage of the harvesting equipment will be the responsibility of the City of Delafield. The harvesting equipment may be stored in the City of Delafield Department of Public Works shed located about one-half mile west of the Delafield City Hall or other appropriate location.[16] The equipment will be winterized in accordance with manufacturer's instructions prior to storage. Recurring operations and maintenance costs are estimated to be about $ 45,000 per annum as of 2005.

**Insurance Coverage**

Insurance coverage on the harvesting equipment will be incorporated into the policy held by the City of Delafield on all capital equipment. Liability insurance for the operation of the harvesting equipment will also be borne by the City. The relevant certificates of insurance will be held by the City of Delafield.

**Operators, Training, and Supervision**

The harvesting equipment will be owned and operated by the City of Delafield, who will be responsible for day-to-day operations of the equipment. The City will provide operator training as required. City staff have extensive experience in the operation of this type of machinery. Initial training will be provided by the manufacturers on delivery of the machinery.

Day-to-day supervision will be by the City staff.

## EVALUATION AND MONITORING

**Daily Record-Keeping Relating to the Harvesting Operation**

Daily harvesting activities will be recorded by the operators of the harvesting equipment in an operations log. An annual summary of the harvesting program will be submitted to the City of Delafield City Council (or designated Committee thereof),[17] and made available to the public at that time.

It is the intention of the City of Delafield to undertake a periodic, formal review of the harvesting program as set forth in the management plan for Nagawicka Lake, a copy of which has been lodged with the WDNR's Southeast Region Office.

**Daily Record-Keeping Relating to the Harvester**

Daily maintenance and service records showing engine hours, fuel consumed and oil used, will be recorded in a harvester operations log.

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[16] *Winter storage of the aquatic plant harvesting equipment is recommended to be within doors; external storage can result in deterioration of the equipment, including its mechanical parts and hydraulic systems. Potential hydraulic failures may result that can disrupt implementation of aquatic plant management activities in the Lake, and can result in increased operational costs. Interior storage is preferred under the Chapter NR 7 Recreational Boating Facilities Grant Program that provides cost share funding for the acquisition of aquatic plant harvesting equipment.*

[17] *Periodic and annual reports on the aquatic plant management program, including aquatic plant harvesting operations, are provided to the City of Delafield Lake Welfare Committee, and annual reports are submitted to the WDNR as required pursuant to Chapters NR 107 and NR 109 of the* Wisconsin Administrative Code.

## SUMMARY

This plan, which documents the findings and recommendations of a study requested by the Nagawicka Lake Welfare Committee, is a refinement of the aquatic plant management measures recommended in the adopted lake management plan for Nagawicka Lake.

The refined Nagawicka Lake aquatic plant management plan, shown on Map 8 and summarized in Tables 10 and 11, recommends actions to be taken to limit further human impacts on the in-lake macrophyte beds and reduce human impacts on the ecologically valuable areas adjacent to the lake and in its watershed. The plan recommends continued reliance on aquatic plant harvesting as the primary aquatic plant management measure employed on Nagawicka Lake. In addition to aquatic plant harvesting, at this time the plan recommends only limited additional aquatic plant management actions, including selected manual removal, selected use of aquatic herbicides, and surveillance activities. The limited use of chemical treatments is recommended specifically to treat such species as purple loosestrife, curly-leaf pondweed and Eurasian water milfoil that are present in specific areas of the Lake. The supplemental use of aquatic herbicides in portions of the Lake subjected to ecosystem restoration activities could also be considered, with additional plantings of emergent and floating-leaved aquatic plants where appropriate. The plan also recommends the use of demarcated boating lanes to limit motorized boating traffic through macrophyte beds that contain Eurasian water milfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*) to attenuate the further proliferation of this plant. Support for the conservation of lands within the primary environmental corridors to ensure the protection and preservation of ecologically valuable areas within the drainage area tributary to Nagawicka Lake also is recommended.

Finally, the recommended plan includes the continuation of an ongoing program of public information and education being provided to both riparian residents and lake users. For example, additional options regarding household chemical usage, lawn and garden care, shoreland protection and maintenance, and recreational usage of the Lake should be made available to riparian householders, thereby providing riparian residents with alternatives to traditional alternatives and activities. Informational programming on the control of nonnative or exotic species, such as Eurasian water milfoil and zebra mussel, designed to limit their spread and onward transmission from Nagawicka Lake to other lakes within the Southeastern Wisconsin Region, also is recommended.

This recommended plan refines the adopted lake management plan for Nagawicka Lake, and seeks to balance the demand for high-quality residential and recreational opportunities at Nagawicka Lake with the requirements for environmental protection.

# APPENDICES

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# Appendix A

# REPRESENTATIVE ILLUSTRATIONS OF AQUATIC PLANTS FOUND IN NAGAWICKA LAKE

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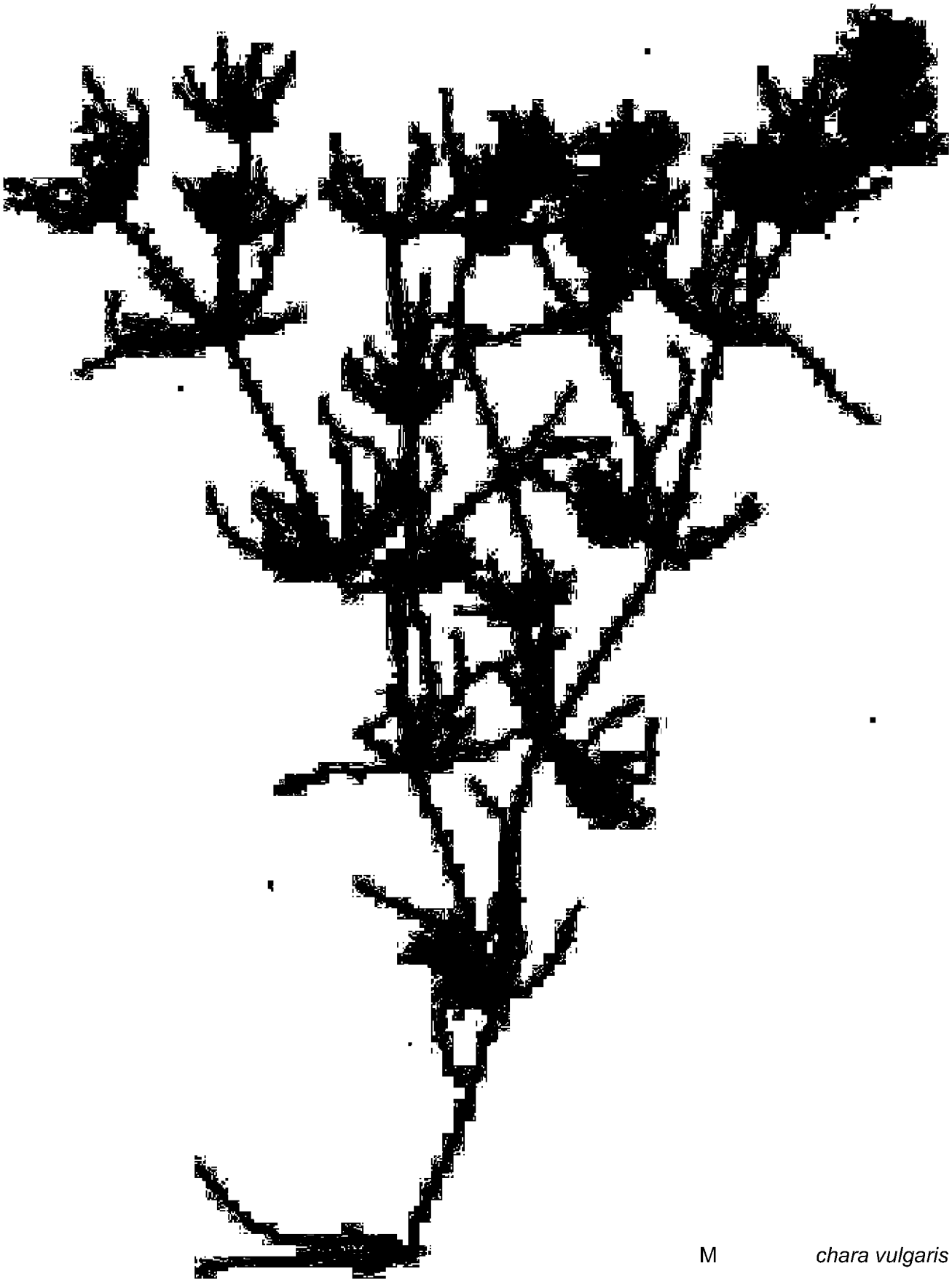
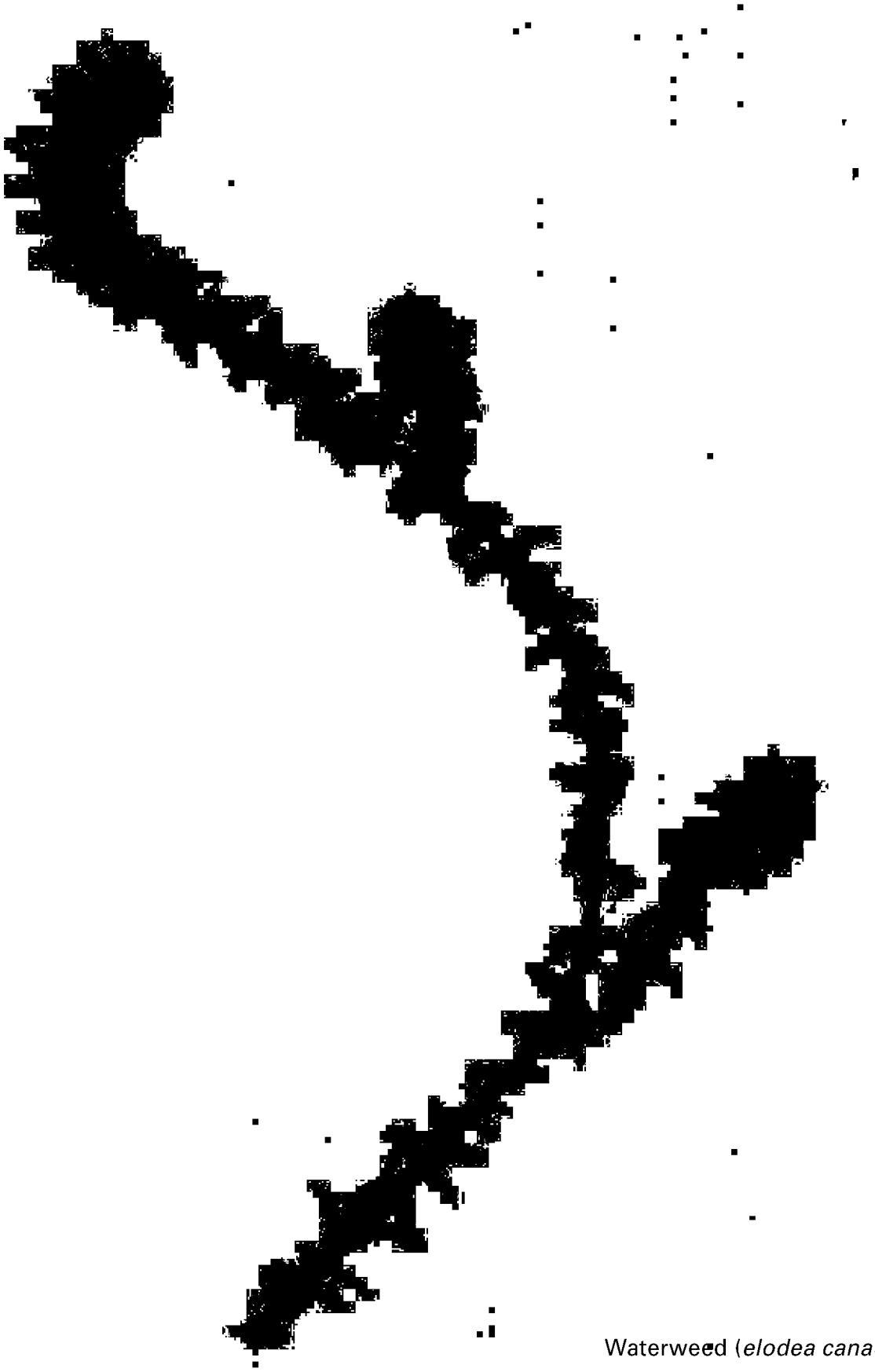
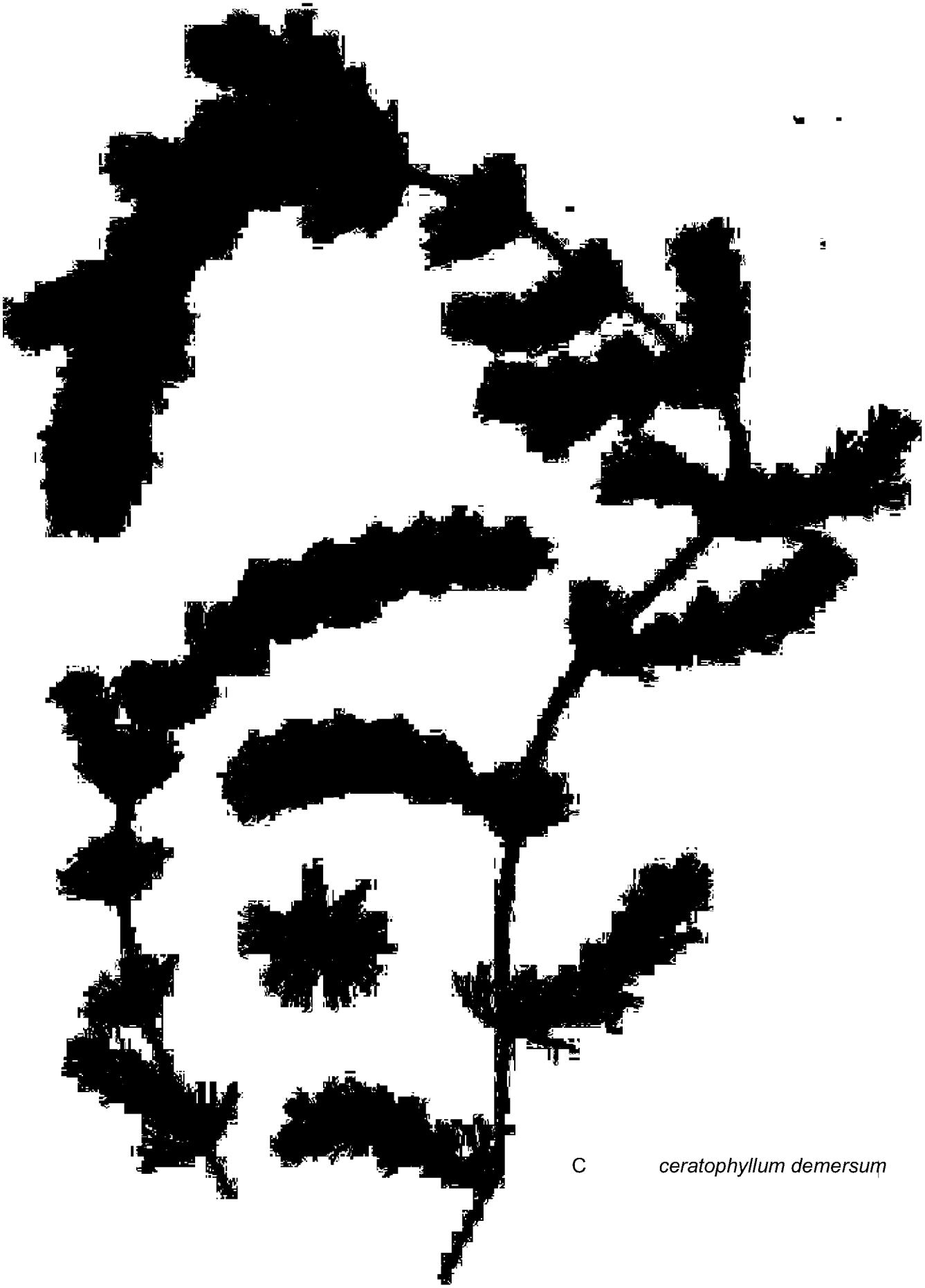


M *chara vulgaris*



Waterweed (*elodea canadensis*)



C *ceratophyllum demersum*

Lesser Duckweed (*lemna minor*)

NOTE: P

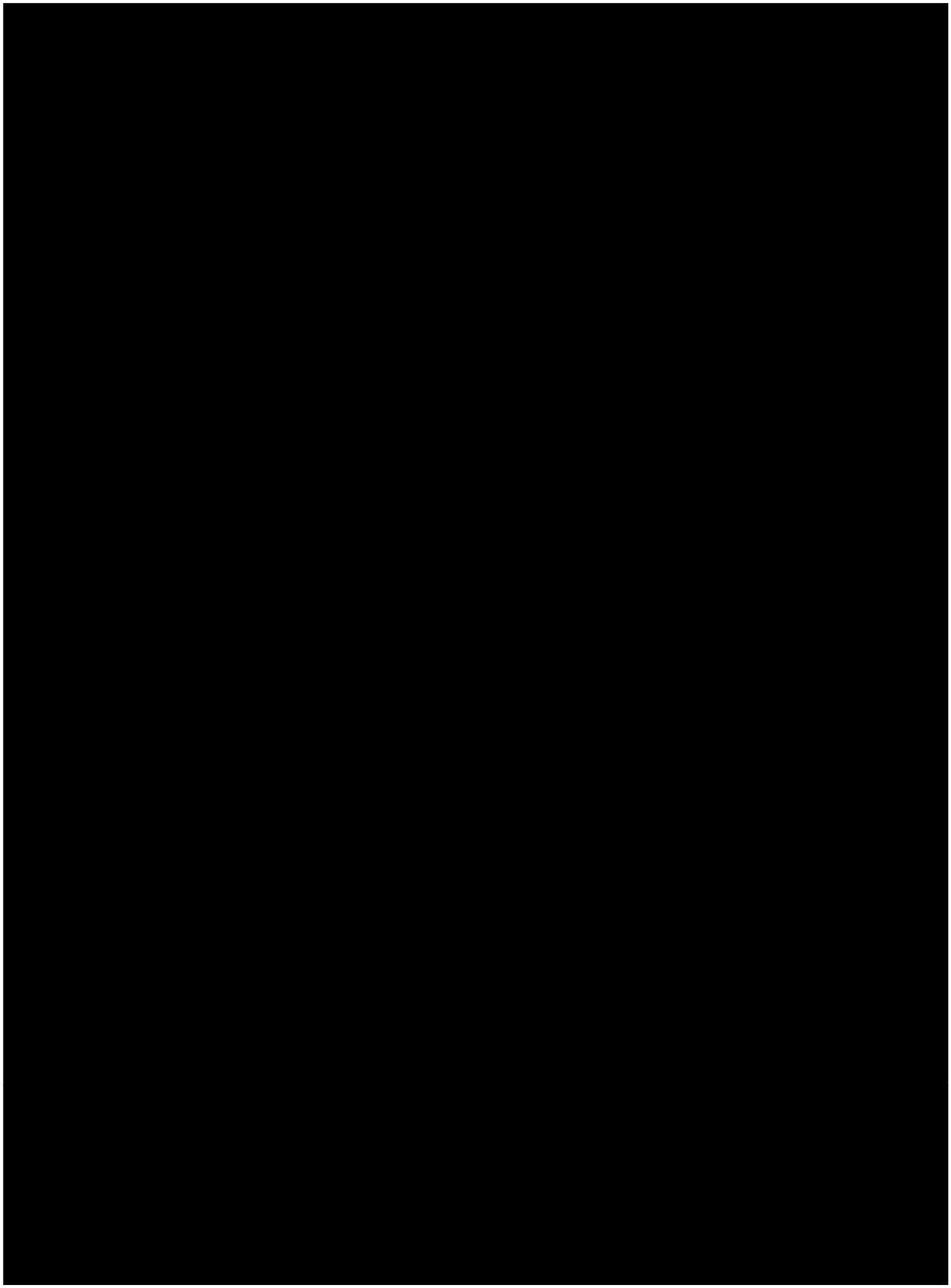
*Source: Steve D. Eggers and Donald M. Reed,* Wetland Plants and Plant Communities of Minnesota & Wisconsin, *2nd Edition, 1997*

N W M *myriophyllum*

E W M *myriophyllum spicatum*

B P *najas flexilis*

S N *najas marina*



White Water Lily (*nymphaea odorata*)

Yellow Water Lily (*nuphar variegatum*)

Large-Leaf Pondweed (*potamogeton amplifolius*)

C -L P *potamogeton crispus*

Illinois Pondweed (*potamogeton illinoensis*)

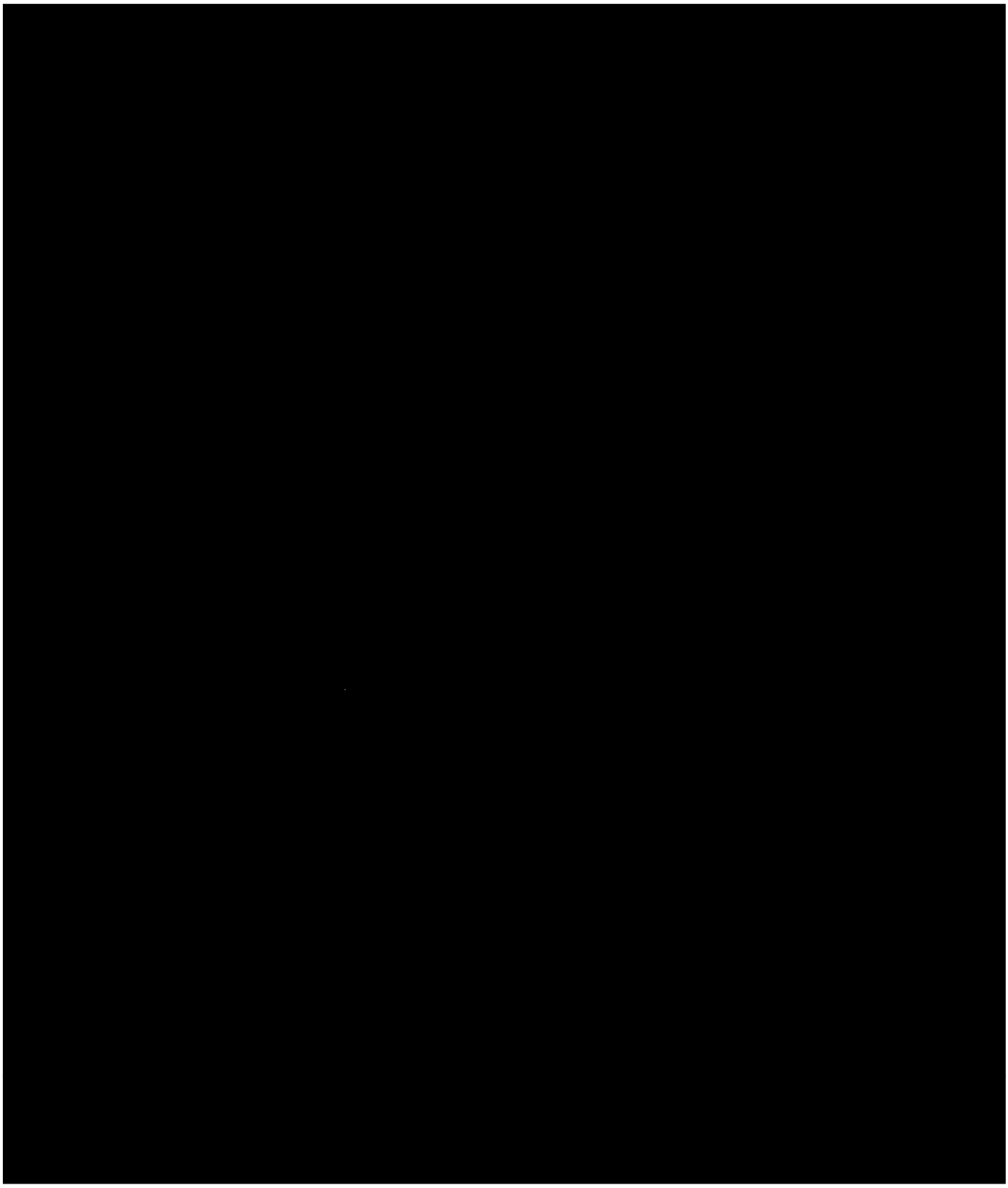
S P *potamogeton pectinatus*

S P *potamogeton pusillus*

C -L P

*potamogeton richardsonii*

F -S P *potamogeton zosteriformis*



Yellow Water Crowfoot (*ranunculus flabellaris*)

NOTE: Plant species in photograph are not to scale.

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

Cattail (*typha latifolia*)

Bladderwort (*utricularia* sp.)

E G W C *valisneria americana*

Water Stargrass (*zosterella dubia*)

## Appendix B

# CITY OF DELAFIELD LAKE USE ORDINANCES APPLICABLE TO NAGAWICKA LAKE

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# Chapter 19 PARKS AND PUBLIC WATERS

19.01 Park Curfew.
19.02 Lake Access Regulations.
19.03 Boat Livery and Launching Licenses.
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19.06 Dogs Prohibited in City Parks.
19.07 Horses Prohibited in Parks and Other Public Areas.
19.08 Regulation of Water Traffic on Upper Nashotah Lake.
19.09 Pierhead Line.
19.10 Penalty.

## 19.01 Park Curfew. (Am. #238)

(1) *Hours restricted.* All City owned parks shall be closed between 1/2 hour after sunset and 7 a.m. each day.

(2) *Exception.* The City Council may, upon written application of any group desiring to organize an athletic, recreational or social function, grant a permit waiving the restrictions of sub. (1) for a specified number of days.

(3) *Ice skating exception.* Ice skating on the City pond on Genesee St. shall be permitted until 10 p.m.

## 19.02 Lake Access Regulations.

(1) Augmenting the provisions of § 236.16(3), Wis. Stats., no plat which includes any parcel of land dedicated or intended for use as either a public or private accessway to any lake or stream, where such way is intended to serve 5 or more parcels of building lots, and whether such access be created as an easement, license, privilege or concurrent estate, each and every parcel or building lot of such plat, by covenant of the subdivider or subdividers, a charge or assessment payable annually or more frequently to some resident of the City corporate or natural, who shall be designated in such covenant as trustee of such fund for the benefit of the public or private access holders. Such charge or assessment need not be stated in amount, but shall be sufficient in the aggregate to defray the expenses of such trustee in providing the facilities for safety, congestion control, property protection, health and public welfare.

(2) Every such trustee shall provide, upon or closely appurtenant to every such accessway, each of the following facilities:

(a) A supply of pure drinking water.

(b) Adequate sanitary facilities for each sex.

(c) Electric lighting sufficient to provide safe and adequate illumination in darkness until 10 p.m. and thereafter so long as any person may pass upon or over such accessway.

(d) Direct and adequate access for police and emergency vehicles from a dedicated public highway, road or street to a point on such accessway which is not more than 50' from the shoreline, which access shall be surfaced for all weather use by such vehicles.

(e) Launching and docking facilities sufficient to provide for the safe launching and docking of not less than one 12' outboard or rowboat for each parcel or building lot intended to share in such access or, in the case of a public access, for not less than 100 such boats.

(f) A regular inspection of the shore area, with provision for removal of debris and correction of hazardous conditions, not less than biweekly.

(g) Property liability insurance, with policy limits of not less than $20,000--$50,000, with a responsible insurer licensed to issue policies in this State, assuring the financial responsibility of such trustee to respond for damages arising out of the use and maintenance of such accessway.

(3) Wherever any such accessway is dedicated to the use of the public, and the City accepts the same for public use and agrees to operate, police and maintain the same, the provisions for private plat covenant, for operation by trustee, and for safety, health and welfare facilities may be dispensed with. But such dedication and acceptance must, in each such case, precede or be simultaneous with plat approval; and the approving authority of the City must determine, as a condition of such acceptance, that the accessway is reasonably adapted to public use for such purposes and will not disproportionately burden City revenues.

(4) At the present time there are sufficient public, private and quasi-public areas, which afford adequate access to the lake and river, so that there is no necessity for any further such access sites. Therefore, no division of land into separate tracts or parcels of land shall be permitted which creates or uses any site, tract, strip or piece of land lying on any lake or stream, any portion of which is within the City corporate limits for the use of, or access to, such lake or stream for the benefit of any tract, lot or parcel of land which is offshore, whether such use or access is by free title, reservation or easement.

## 19.03 Boat Livery and Launching Licenses.

(1) *Definitions.* For purposes of this Municipal Code, the following definitions shall apply:

(a) *Boat livery.* Any person or entity who furnishes boats, canoes, or other types of watercraft, boat lifts, boat slips or other mooring facilities for a rental fee.

(b) *Boat launching site or facility.* Any site or facility not operated by a governmental body which offers launching facilities for boats, canoes or other types of watercraft for a fee.

(2) *License required.* No person shall operate a boat livery or construct, maintain or operate within the City any site or facility for the launching of boats or other watercraft with charge to members of the general public without first obtaining a license therefor from the City Clerk-Treasurer.

(3) *Application.* Written application for such licenses, signed by the applicant, shall be submitted to the City Clerk-Treasurer for consideration by the City Council, and shall contain the following information regarding the proposed site or facility:

(a) A legal description of all the lands upon which the site or facility is to be located, including its appurtenant parking and sanitary facilities.

(b) The surface construction, drainage specifications, dimensions and location upon the proposed site of off-street areas in which vehicles and trailers may be parked, stopped or left standing incident to the proposed operation.

(c) A description of the location and construction specifications of drinking water facilities, restroom and waste disposal facilities.

(d) The minimum number of responsible persons over the age of 16 years who shall be kept on duty to supervise activities at all times while the facility is operated, open or available to patrons or the general public for use.

(e) The hours at which such facility shall be operated, open or available to patrons or the general public.

(f) The number of boats, canoes or other watercraft as well as boat lifts, boat slips or other mooring facilities that shall be available for rental during the license period.

(g) The number and approximate location of trash containers to be made available for the use of patrons or the general public.

(h) A description of and locational diagram of lighting facilities on the premises as well as appurtenant parking areas.

(i) The site proposed by the applicant for the erection and display of a sign to be furnished by the City displaying regulations of the City governing the lake and operation of the licensed premises.

(4) *Requirements.* No license shall be issued to construct, operate or maintain any boat livery or boat launching site unless the following conditions are met:

(a) *Location.* All proposed sites for these purposes shall be located in a zoning district or area of such classification that such site or facility shall be in substantial conformity therewith, in view of the ordinary nature of the respective uses; nor shall any such site or facility be licensed in any location where its operation shall result in material depreciation of the value of surrounding properties or which shall result in a public nuisance.

(b) *Parking area.* Such site shall include, within 200' of the licensed premises, an area upon which a number of vehicles and trailers not less than the maximum number of boat launchings to be made from such site in any one day may be parked, stopped and left standing and which area shall be exclusive of the area of any public street or alley. The parking areas furnished by the licensee pursuant to this subsection shall be of at least a 6" crushed stone base with proper drainage and shall be maintained so as to be free of standing water.

(c) *Water supply.* The licensed premises shall include an adequate supply of pure water for drinking and washing purposes, from a well or other source conformable to applicable standards of the Department of Health and Social Services for public facilities with such water to be made available at all times when the facility is open for business or use by its patrons.

(d) *Sanitary facilities.* (Am. #192) Unless otherwise required by State, County or City regulation, the licensee need only provide one restroom of permanent construction, utilizing indoor plumbing and connected to an approved septic or municipal sewage system. Doors of all restrooms shall be equipped with a lock to insure privacy. Restrooms shall be open and available for use by patrons during all times that the licensee is open for business. Restrooms shall be adequately lighted so as to be readily visible during all hours of darkness or periods of otherwise decreased visibility when any boat launched from such site is in use.

(e) *Supervision.* The licensee shall provide supervision of launching and parking facilities by not less than one responsible person over the age of 16 yrs. who shall be present on the site at all times while the facility is open or available for use by patrons or the general public.

(f) *Lighting.* Whenever any facility or site is to be open or available for public use during hours of darkness, such site shall provide adequate lighting of the launching, the parking and restroom areas. All lighting shall conform to City ordinances.

(g) *Identification symbols.* Every licensee shall prominently display alphabetical and numerical identification symbols on both sides of any boat, canoe or other craft which is held out for rental within the terms of this section. Such symbols shall be displayed at a point level with the State identification numbers but positioned so as to commence at not more than 12" from the stern of the boat, canoe or craft. Identification symbols shall be furnished by the City Clerk-Treasurer upon the presentation of any proper application and application fee within the terms of this section.

(5) *Posting of regulations.* The licensee shall furnish a site approved by the Building Inspector which is suitable for the erection and prominent posting of at least one sign to be furnished by the City displaying regulations of the City which govern the lake and the operation of the licensed premises.

(6) *Trash disposal.* The licensee shall furnish and maintain in a usable condition sufficient trash containers so as to prevent the accumulation of debris upon the licensed premises and appurtenant areas.

(7) *Annual report.* Each year the city council shall require a report from the County Health Department and the City Building Inspector regarding the continued suitability of any premises licensed under the terms of this section as well as other relevant City ordinances and State statutes. Such reports shall be received yearly prior to the issuance of any license under the provisions of this section, and no license shall be issued unless the site and the operator have complied with all provisions of this Municipal Code as well as any relevant State statutes.

(8) *Application fee.* Each application for a license hereunder shall be accompanied by an application fee of $25 which sum shall be in addition to any license fees required hereunder and shall reimburse the City for the cost of processing any applications made under this section as well as conducting the necessary investigations to determine if the applicant has complied with the terms of this section as well as other relevant City ordinances and State statutes. In addition thereto, the applicant shall tender a sum computed pursuant to the following tables which sum shall constitute the license fee for operating a public boat livery or public boat launching site within the City. Any license fee tendered shall be returned to the applicant if the application for the license is denied, however, no application fee may be returned to the applicant.

(9) [Effective 1/1/82] *License fees.* (Am. #101.02) In addition to the application fee, any applicant for a license within the terms of this section shall be required to tender the general license fee set forth below which is applicable to the particular operation of each location as anticipated by this section:

(a) Boat Rental (General), per license period: $50.

(b) Boat Launching (General), per license period: $50.

(c) Boat Livery (General), per license period: $50.

(10) *Notice required.* No application for a license pursuant to the terms of this section shall be granted until notice thereof has been published at least once in the City newspaper. Upon the request of any applicant, councilman or resident of the City, a public hearing upon such license application shall be held prior to the granting of any license pursuant to the terms of this section.

## 19.04 Delafield Water Safety Patrol Unit.

(1) *Designation.* Pursuant to the authority granted by §§ 30.77(2) and 30.79, Wis. Stats. the City shall designate a Water Safety Patrol Unit for the purpose of enforcing §§

30.50 to 30.80, Wis. Stats., and any rule or ordinances enacted pursuant thereto, upon the water of Nagawicka Lake and its tributaries to which the City is riparian.

(2) *Wisconsin Statutes.* The provisions of §§ 30.50 through 30.71, Wis. Stats. so far as applicable, and all acts amendatory thereof, and the rules of the Wisconsin Department of Natural Resources enacted pursuant to such sections, so far as applicable, are hereby adopted and enacted by reference, except that nothing herein contained shall be deemed to require local numbering, registration or licensing of boats.

(3) *Speed limit.*

(a) *Fixed limit.* The fixed speed limit on Nagawicka Lake shall be 45 mph.

(b) *Exceptions.* No person shall operate a motorboat at a speed in excess of 10 mph from 1/2 hour after sunset to 1/2 hour before sunrise. Because of increased boat traffic, the speed limit on Saturdays, Sundays and holidays between 11 a.m. and 4 p.m. shall be 25 mph during the months of June, July and August. No person shall operate any motorboat in any restricted area at a speed in excess of 3 mph nor in excess of a speed which creates a wake, whichever is less. A restricted area within the meaning of this section is defined as any waters lying within 300' of a shoreline and includes all channels along and in such shoreline and such other waters as shall from time to time be clearly marked as "SLOW - 3 MPH" by buoy markers or other clearly discernible sign or device by authority of the Police Department or governing bodies of the enacting municipalities acting for the protection of persons and property on account of hazards which may from time to time arise and exist. The Chief of Police or any police officer acting in his absence is hereby granted the right and authority to declare certain waters restricted and to mark them as such, upon the happening of any event or circumstances which, in his opinion, constitutes a hazard and renders it advisable so to restrict a water area or areas. The speed limitation contained in this section shall not apply in case of emergency to patrol or rescue craft nor to a normal and otherwise lawful starting or picking up of a water skier, aquaplaner or person engaged in a similar activity. (Am. #265)

(4) *Operator to sit or kneel.* Except for the purpose of anchoring, mooring, casting off or other necessary purpose, no person shall operate or ride in any motorboat while the same is under way, unless such person is in a sitting or kneeling position.

(5) *Towing persons.* No person may operate a motorboat towing a person on water skis, aquaplane or similar device, unless there is in the boat a competent person in addition to the operator in a position to observe the progress of the person being towed. An observer is hereby ordained to be competent if he is over the age of 12 years and can, in fact, observe the person being towed and is physically and mentally capable of relaying any signals to the operator and of rendering assistance to a water skier in distress.

(6) *Distance required from bathers, swimmers, channels or "kettle."* Except for normal and otherwise lawful ingress to and egress from the shore and except for tournaments, expositions or instructions conducted pursuant to specific permit previously granted by the Police Department or governing body of either of the enacting municipalities, no person engaged in water skiing, aquaplaning or similar activities and no operator of a motorboat towing such person shall pass within 150' of any bather or swimmer nor within the limits of any of the channels or "kettle" of Nagawicka Lake.

(7) *Jumps restricted.* No person shall place upon the waters of Nagawicka Lake a water ski jump or any other apparatus designed for the purpose of creating a jump for water skiers; provided, however, that with the explicit permission of the City Council of the City, upon recommendation of the Lake Welfare Committee and approval of the Village Board of the Village of Nashotah, a jump may be placed on the lake under the

following criteria:

(a) Liability insurance of $100,000 or more is obtained by the applicant for such jump and a certificate of this insurance is filed with the City and the Village of Nashotah and the Village of Nashotah shall be named as additional insured on such liability insurance policy.

(b) Proper safety markings appropriately visible, appropriate for both night and daytime safety will be placed on such jump.

(c) The jump shall be so constructed as to restrict its use only to the applicant, its agents, servants and employees. Use of the jump by the general public shall not be permitted.

(d) The Lake Welfare Committee of the City, in cooperation with the party requesting such jump, will establish a location for such jump that is to be permanent for the boating season (except during times when the jump is needed in a different location for special shows or events. Such location shall be subject to the approval of the Village of Nashotah.)

(e) After the boating season, the permit for such jump will terminate. However, upon application made, such permit may be extended by the City Council and the Village Board of the Village of Nashotah for each subsequent boating season upon the aforesaid conditions and such new conditions as the City and Village of Nashotah shall deem necessary.

(f) The applicant shall agree to and shall subsequently execute a hold harmless agreement whereby he agrees to indemnify and hold the City and Village of Nashotah harmless from any loss, damages or expenses arising out of the operation of the jump or the placing of same upon Lake Nagawicka pursuant to this section.

(8) *Distance required from shoreline.* A person operating a motorboat having in tow a person on water skis, aquaplane or similar device shall not operate in waters within 300' of any shoreline which is hereby ordained to be the distance from shore under which a motorboat towing a person on water skis, aquaplane or similar device cannot operate without endangering the life and property of persons on or about the shoreline of Nagawicka Lake, unless such person is in the process of egress directly away from the shoreline at an angle of 90° to the shoreline as nearly as practicable in view of the circumstances then and there existing.

(9) *Refuse.* No person shall deposit, place or throw into any of the waters within the jurisdiction of the enacting municipalities, upon any of the shores thereof, upon any rafts or piers located on such waters or their shores or upon the ice of such waters any cans, bottles, debris, refuse or other waste material.

(10) *Violation of rules and regulations prohibited.* No operator, owner or person in charge of any motorboat shall permit any person in such boat to violate any of the rules and regulations pertaining to boat operation as contained in §§ 30.65, 30.66, 30.68 and 30.69, Wis. Stats., or as contained in this Municipal Code.

(11) *Applicability.* All of the provisions of this section, including those provisions of the Wisconsin Statutes enacted by reference, shall apply to the waters of Nagawicka Lake, its tributaries, bays and channels.

(12) *Penalty.*

(a) Any person found guilty of violating any provisions of §§ 30.50 through 30.71, Wis. Stats., which are herein enacted by reference, for which a penalty is not provided, and any person violating any other provisions of this section shall forfeit a sum not to exceed $50 plus the costs of prosecution or, in default of

such payment, shall be imprisoned in the county jail for not to exceed 30 days.

(b) Any person found guilty of violating the same provision of the sections of the Wisconsin Statutes enacted by reference or of the section for which a penalty is provided a second or subsequent time within one year of the first violation thereof shall forfeit a sum not to exceed $100 plus the costs of prosecution or, in default of such payment, shall be imprisoned in the county jail for not to exceed 90 days.

(c) Any person found guilty of violating §§ 30.67(1) or 30.68(1), Wis. Stats., by this section adopted by reference, shall forfeit a sum not to exceed $200 plus the costs of prosecution or, in default of such payment, shall be imprisoned in the county jail for not to exceed 6 months. Any person convicted of violating § 30.68, Wis. Stats., shall be required to obtain a certificate of satisfactory completion of a safety course under § 30.74(1), Wis. Stats.

(13) *Citations.* Citations for violations of any provision of this section and the deposits, stipulations and municipal court procedures that result therefrom shall be governed by the provisions of §§ 23.50 through 23.85; Wis. Stats.

(14) *Violation of subsection (7).* Any violation of sub. (7) shall be penalized as provided under sub. (12). However, each separate day that the violation occurs shall constitute a distinct separate offense. The City and the Village of Nashotah shall, in addition, have the right to remove such ski jump apparatus from the waters of Nagawicka Lake upon giving 10 days' notice to the owner or owners of such apparatus of their intention to do so.

## 19.05 Prohibiting Motor Vehicles on Nagawicka Lake When Icebound.

(1) No person shall operate, permit, or authorize, direct or control operation of any motor vehicle required to be registered by or under the provisions of Ch. 341, Wis. Stats., upon or over the bed or waters of Nagawicka Lake, unless such operation shall first have been authorized by permit as provided below.

(2) The Chief of Police, or either enacting municipality, upon application and payment of a license fee of $0.50, may issue a written permit upon being satisfied that ice conditions do and will permit operation of one or more motor vehicles upon a designated portion of the lake without material risk or hazard, authorizing operation of one or more such vehicles on the lake for particular purposes to be specified in such permit. Such permit shall expire 24 hours after issuance, unless sooner revoked by notice by the issuing authority of a hazardous change in the condition of the ice. No such permit shall authorize any motor vehicle speed or acrobatic contest, exhibition or performance; nor shall any such permit authorize joyriding, sightseeing or other activity not ancillary to the ordinary utilization of icebound lakes.

(3) No person shall ride as a passenger in any motor vehicle being operated in violation of sub. (1).

## 19.06 Dogs Prohibited in City Parks. (Cr. #139)

(1) No person who owns, harbors or keeps a dog, or has a dog under his control, shall bring it into or allow it to remain in any park within the city at any time.

(2) This shall not apply to registered Seeing Eye dogs when accompanied by their owners.

**19.07 Horses Prohibited in Parks and Other Public Areas.** (Cr. 140)

No person shall ride, lead, graze, tie up or drive a horse within any public park or parking lot within the City except while performing in authorized civic affairs or events.

**19.08 Regulation of Water Traffic on Upper Nashotah Lake.** (Cr. 175, Rep. & recr. #334)

(1) *Application.* The provisions of this section shall apply to the waters of Upper Nashotah Lake, within the jurisdiction of the Town of Summit and the City of Delafield, and shall be enforced by the officers of the Water Safety Patrol Unit and police of the jurisdiction of the Town of Summit.

(2) *State boating and water safety laws adopted.*

(a) Except as otherwise specifically provided in this section, the current and future statutory provisions describing and defining regulations with respect to water traffic, boats, boating and relating water activities in §§ 30.50 up to and including 30.71, Wis. Stats., exclusive of any provisions therein relating to the penalties to be imposed or the punishment for violation of such statutes, are hereby adopted and by reference made a part of this section as if fully set forth herein. Any act required to be performed or prohibited by any current or future statute incorporated herein by reference is required or prohibited by this section. Any further additions, amendments, revisions or modifications of the statute incorporated herein are intended to be made part of this section in order to secure uniform state-wide regulation of the waterways of the State.

(b) All rules and orders created by the Wisconsin Department of Natural Resources modifying or supplementing the foregoing provisions of State law or which may be adopted or made in the future are hereby incorporated in and made a part of this section by deferring to the same as if they are or were to be set out herein verbatim.

(3) *Operation of motorboats.* No motorboat shall be operated on Upper Nashotah Lake from sunset until sunrise at a speed in excess of slow no wake.

(4) *Swimming regulations.* No person, unless engaging in activities and subject to the provisions of § 30.70, Wis. Stats., entitled "Skin Diving," shall:

(a) Swim from any unmanned boat, unless such boat is anchored.

(b) Swim more than 150' from the shoreline unless it is a designated swimming zone or unless accompanied by a competent person in a boat.

(c) Swim more than 150' from the shoreline between sunset and sunrise.

(5) *Local regulation on icebound inland waters.*

(a) No person shall operate or park or permit, authorize, direct or control the operation or parking of, or ride as a passenger on any motorized vehicle or motor-driven vehicle, including but not limited to motor vehicles, snowmobiles or all-terrain vehicles, on the ice on any portion of Upper Nashotah Lake.

(b) The Chief of Police of the Town of Summit, upon application to him and payment of a license fee established by the Town Board, being satisfied that ice conditions do and will permit operation of a motorized vehicle or motor-driven vehicle upon a designated portion of the lake without material risk or hazard, may issue a written permit expiring within 24 hours after issuance authorizing operation of a motorized vehicle or motor-driven vehicle on the lake for particular purposes to be specified in such permit. Such particular purposes shall be limited

to: snowplowing of a portion of the lake for an ice skating rink, transporting of property to an island or conducting official lake studies. No such permit shall authorize speed or acrobatic contests, exhibitions or performances; racing; fishing; nor shall any such permit authorize joy-riding, sightseeing or any other activity not deemed necessary by the Chief of Police.

(6) *Penalty.*

(a) *State boating and water safety laws and all other violations.* Any forfeiture for violation of a State statute, rule or order adopted by reference in sub. (2) of this section shall conform to the forfeiture permitted to be imposed for violation of such statutes as set forth in the Uniform Wisconsin Deposit and Bail Schedule for Conservation, Boating, Snowmobile and ATV Violations, including any variations or increases for subsequent offenses, which schedule is adopted by reference.

(b) *Local boating laws.*

1. Any person 16 years or older violating the provisions of this section shall be subject to a forfeiture of not more than $500 plus court costs and penalty assessment. Failure to pay any forfeiture hereunder shall subject the violator to imprisonment in the County Jail or loss of license.

2. Any person 14 or 15 years of age shall be subject to a forfeiture of not less than $10 nor more than $25 plus court costs and penalty assessment per each offense or referred to the proper authorities as provided in Chapter 48, Wis. Stats. Failure to pay any forfeiture hereunder shall subject the violator to the provisions of § 48.17(2), Wis. Stats.

3. Any person under the age of 14 shall be referred to the proper authorities as provided in Ch. 48, Wis. Stats.

(7) *Enforcement.*

(a) *Enforcement procedure.* The statutory provisions of §§ 66.115, 66.119, 66.12, 30.29, 30.50 to 30.71, and Ch. 800, Wis. Stats., are adopted and by reference made a part of this section as if fully set forth herein. Any act required to be performed or prohibited by any statute incorporated herein by reference is required or prohibited by this section. Any future additions, amendments, revisions or modifications of the statutes incorporated herein are intended to be made part of this section in order to secure uniform state-wide regulation and enforcement of boating ordinance violations. Further, the Town of Summit and the City of Delafield specifically elect to use the citation method of enforcement.

(b) *Deposits.*

1. *Schedule of deposits.* The schedule of cash deposits shall be as follows:

a. *Subsection (2) violations.* Applicable sections of Uniform Wisconsin Deposit and Bail Schedule for Conservation, Boating, Snowmobile and ATV Violations plus current assessment fees and current court costs, if applicable.

b. *Subsection (3), (4) and (5) violations.* $50 plus court costs and assessments plus current assessment fees and current court costs, if applicable.

2. *Deposit for repeat offenses.* Any person found guilty of violating this section or any part thereof who was previously convicted of the same section within the last year shall forfeit twice the deposit delineated above

plus court costs and penalty assessment.

3. *Nonscheduled deposit.* If a deposit schedule has not been established for a specific violation, the arresting officer shall require the alleged offender to deposit not less than the maximum forfeiture permitted hereunder.

4. *Depository.* Deposits shall be made in cash, money order or certified check to the Clerk of Municipal Court, who shall issue a receipt therefor as required by the Wisconsin Statutes. If the deposit is mailed, the signed statement required by the Wisconsin Statutes shall be mailed with the deposit.

(c) *Nonexclusivity.*

1. *Other ordinances.* Adoption of this section does not preclude the Town Board or City Council from adopting any other ordinance or providing for the enforcement of any other law or ordinance relating to the same or other matter.

2. *Other remedies.* The issuance of a citation hereunder shall not preclude the Town Board or City Council or any authorized office from proceedings under any other ordinance of law or by any other enforcement method to enforce any ordinance, regulation or order.

**19.09 Pierhead Line.** (Cr. #244)

Pursuant to § 30.11, Wis. Stats., a pierhead line is hereby established 100' lakeward from the ordinary high water mark of all lakes within the City. Special exception to this pierhead line may be granted by the city council.

**19.10 Penalty.**

Except as otherwise provided herein, any person who shall violate any provision of this chapter or any regulation, rule or order made hereunder shall be subject to a penalty as provided by § 25.04 of this Municipal Code.