COMMUNITY ASSISTANCE
PLANNING REPORT NO. 230

A LAKE MANAGEMENT PLAN FOR THE PHANTOM LAKES

WAUKESHA COUNTY WISCONSIN

volume two

ALTERNATIVES AND
RECOMMENDED PLAN

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COMMUNITY ASSISTANCE PLANNING REPORT
NUMBER 230

A LAKE MANAGEMENT PLAN FOR THE PHANTOM LAKES

WAUKESHA COUNTY, WISCONSIN

Volume Two

ALTERNATIVES AND RECOMMENDED PLAN

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Chapter I

BACKGROUND AND SUMMARY OF INVENTORY FINDINGS

INTRODUCTION

The Phantom Lakes are comprised of two connected waterbodies, Upper Phantom Lake and Lower Phantom Lake, on and adjacent to the Mukwonago River. Both lakes are located entirely within U.S. Public Land Survey Township 5 North, Range 18 East, Sections 26, 27, 34 and 35, Town and Village of Mukwonago, in Waukesha County. The Lakes, while exhibiting distinctly contrasting hydrographical characteristics, both offer a variety of water-based recreational opportunities and are the focus of the lake-oriented communities surrounding the Lakes. The shorelines of both lakes are well developed primarily for residential uses, although significant stretches of the shoreline of Lower Phantom Lake present a rural character among the changing land uses in an urbanizing area.

The Lakes provide a range of complementary recreational services to the lake-oriented municipalities and wider community, and are a popular destination for recreational users. Notwithstanding, continuing changes within both the direct and total drainage areas tributary to the Phantom Lakes have created a range of current concerns among this lake-centered community, including surface water use conflicts, siltation and abundant aquatic plant growths in the shallower portions of the lake basins. In addition, present and future residential and commercial growth within the drainage area tributary to the Lakes is perceived to have impacted the Lakes and their ecosystems. Other issues raised by lake residents and users include concerns over variable water quality conditions, contamination of lake waters by nonpoint source pollution, loss of riparian wetlands, and modifications of the shoreland, including proposed abstractions of groundwater upgradient from Upper Phantom Lake. These issues have been quantified to the extent possible and documented in the lake and watershed inventory, comprising Volume I of this lake management plan for the Phantom Lakes.

Based upon the documented issues identified in the aforementioned inventory, this plan sets forth alternative and recommended management actions for the Lake and its watershed.

This plan represents an ongoing commitment of the Phantom Lakes Management District, and the Village and Town of Mukwonago, to sound environmental planning with respect to the Lakes. This plan describes both watershed management and in-lake management measures that may be applied to enhance the water quality conditions, biological communities, and recreational opportunities in the Lake.

This plan is intended to provide the recommended means to: 1) contribute to the overall conservation and wise use of the Phantom Lakes through the environmentally sound management of vegetation, fishes, and wildlife populations in and around the Lakes; 2) provide the potential for ongoing, high-quality, water-based recreational experiences by residents and visitors to the Lakes; and 3) effectively control the severity of nuisances resulting

from the recurring excessive aquatic macrophyte and algal growths in portions of the Phantom Lakes basin to facilitate the conduct of water-based recreational activities, to improve the aesthetic value of the Lakes, and to enhance their resource value. This plan should serve as a practical guide over time for achieving these objectives in a technically sound manner.

The Phantom Lakes are typical hard-water, alkaline lakes within the Southeastern Wisconsin Region that are considered to have relatively good water quality. Physical and chemical parameters measured during the study period indicated that the water quality was within the "fair" to "very good" range, depending upon the parameters considered. Total phosphorus levels were found to be generally at a level consistent with a mesotrophic state, contributing to nuisance algal and macrophytic growths, which exert constraints on the recreational usage of the Lakes.

INVENTORY AND ANALYSIS FINDINGS

Population

- The 2000 resident population of the drainage area tributary to the Phantom Lakes was estimated to be 4,200 persons, an increase of about 400 over the 1990 population.

Land Use and Zoning

- As of 2000, approximately 330 acres, or about 30 percent of the direct tributary drainage area to Upper Phantom Lake, were in urban land use, with the dominant urban land use being residential, encompassing about 190 acres or about 60 percent of the urban lands in the drainage area.

- As of 2000, approximately 945 acres, or about 40 percent of the direct tributary drainage area to Lower Phantom Lake, were in urban land use, with the dominant urban land use being residential, encompassing about 515 acres or about 55 percent of the urban lands in the drainage area. Commercial, industrial, governmental and institutional, transportation, communications and utilities, and recreational lands comprised the balance of the urban lands.

- As of 2000, approximately 700 acres, or two-thirds of the direct tributary drainage area to Upper Phantom Lake, were in rural land use, with the dominant rural land use being agricultural, encompassing about 475 acres or about two-thirds of the rural lands in the drainage area.

- As of 2000, approximately 1,320 acres, or 60 percent of the direct tributary drainage area to Lower Phantom Lake, were in rural land use, with the dominant rural land use being agricultural, encompassing about 650 acres or about 50 percent of the rural lands in the drainage area. Woodlands, wetlands, surface water, and open lands comprised the largest portion of the balance of the rural lands.

Water Budget

- The long-term water budget for the Phantom Lakes was computed using the U.S. Geological Survey data for the Mukwonago River, as well as long term climatic data from the National Weather Service. It is estimated that, annually, 1,600 acre-feet of water enter Upper Phantom Lake, about 40 percent of which enters by surface runoff, about 40 percent by groundwater inflow, and about 20 percent through direct precipitation onto the lake surface. It is estimated that, annually, 39,250 acre-feet of water enters Lower Phantom Lake, about 90 percent of which enters by surface runoff and inflow of the Mukwonago River.

- Of these inflows, about 75 percent of the total inflow to Upper Phantom Lake is discharged to Lower Phantom Lake; about 97 percent of the total inflow to Lower Phantom Lake is discharged as outflow to the Mukwonago River.

Water Quality

- Physical and chemical characteristics of the Phantom Lakes were measured as part of the Wisconsin Department of Natural Resources Self-Help Monitoring Program from 1992 through 2004, and during 2003 and 2004 by the Lakes Program of the University of Wisconsin-Stevens Point, Water and Environmental Analysis Laboratory (WEAL, formerly known as the Environmental Task Force Laboratory) and the Phantom Lakes Management District.

- The Phantom Lakes were shown to be typical Southeastern Wisconsin hard-water, alkaline lakes having relatively good water quality.

- Upper Phantom Lake is dimictic, mixing completely twice per year during spring and fall. Temperature and dissolved oxygen concentrations indicate that complete mixing of Upper Phantom Lake is restricted during summer and winter by thermal stratification. Lower Phantom Lake does not thermally stratify for any significant period of time during summer. Winter kill is not a problem in the Phantom Lakes.

- Water clarity, as measured by a Secchi disc, in Upper Phantom Lake ranged from a minimum of about five feet to a maximum of about 14 feet, with an average Secchi-disc depth of about 10 feet in the spring, nine feet in summer and eight feet in fall. Water clarity in Lower Phantom Lake ranged from a minimum of about six feet to a maximum of about 12 feet, with an average of about 10 feet in spring, nine feet in summer and eight feet in fall.

- Chlorophyll-*a* concentrations in Upper Phantom Lake ranged from a minimum of 3.0 µg/l to a maximum of 14.5 µg/l; in Lower Phantom Lake, concentrations ranged from a minimum of 2.0 µg/l to a maximum of 7.0 µg/l. Concentrations above 10.0 µg/l generally result in a visible green coloration of the water, especially during spring when the maximum concentrations were recorded.

- The total phosphorus concentration in Upper Phantom Lake was about 12.0 mg/l during spring turnover; in Lower Phantom Lake the total phosphorus concentration during spring turnover was about 9.0 mg/l. These values do not exceed the Commission-recommended water quality standard of 20.0 mg/l for recreational use and maintenance of warmwater fish and aquatic life.

- Combined, these data indicate that the Phantom Lakes are mesotrophic lakes, being moderately fertile and capable of supporting abundant aquatic plant growths and productive fisheries. Mesotrophic conditions are typical of inland lakes in the Southeastern Wisconsin Region.

Pollutant Loadings

- The total phosphorus load to Upper Phantom Lake was estimated to be about 160 pounds per year, and the total phosphorus load to Lower Phantom Lake was estimated to be about 20,155 pounds per year.[1] The immediate shoreline of Lower Phantom Lake, within the Village of Mukwonago, is served by a public waterborne sanitary sewerage system.

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

Aquatic Plants

- Aquatic macrophyte growth in the Phantom Lakes was found to be diverse in composition and moderate to high in abundance. However, the increasing dominance of Eurasian water milfoil in the Lakes suggests that some interference with boat traffic and other water-based recreational uses may occur. Greater amounts of aquatic plant growth occurred in Lower Phantom Lake, which is consistent with the shallow nature of this Lake relative to the deeper, Upper Phantom Lake.

- During the 1993 aquatic plant survey, the aquatic plant flora in Upper Phantom Lake were dominated by muskgrass (*Chara* spp.); in Lower Phantom Lake the dominant aquatic plant was Northern water milfoil (*Myriophyllum sibiricum*), although Coontail (*Ceratophyllum demersum*) and Elodea ((*Elodea canadensis*) were both common.

- During the 2002 aquatic plant survey, Eurasian water milfoil (*Myriophyllum spicatum*) and muskgrass (*Chara* spp.) were the dominant aquatic plants in Upper Phantom Lake; Eurasian water milfoil (*Myriophyllum spicatum*) and Elodea ((*Elodea canadensis*) were the dominant aquatic plants in Lower Phantom Lake.

Fishery

- Wisconsin Department of Natural Resources fisheries surveys, conducted during 1966, 1978, and 1999, suggest a relatively diverse fish population in the Phantom Lakes, with 20 species of fishes being recorded. The Lakes are predominantly a bluegill, largemouth bass, and northern pike fishery, with walleyed pike also being an important sportfish.

Natural Resource Base

- In 1985, wildlife habitat covered about 20,600 acres, or 40 percent of the drainage area tributary to the Phantom Lakes. About 2 percent of the drainage area directly tributary to Upper Phantom Lake, and about 20 percent of the drainage area directly tributary to Lower Phantom Lake, were rated as high-value habitat capable of supporting a diverse population of wildlife, with adequate land area and appropriate vegetative cover for nesting, cover, and subsistence, and minimal levels of disturbance.

- Wetlands covered about 3 percent of the drainage area directly tributary to Upper Phantom Lake, and about 17 percent of the drainage area directly tributary to Lower Phantom Lake. Woodlands covered about 7 percent of the drainage area directly tributary to Upper Phantom Lake, and about 3 percent of the drainage area directly tributary to Lower Phantom Lake.

- Primary environmental corridors, or contiguous lands containing the majority of the high value woodlands, wetlands, and wildlife habitat and surface waters within the drainage area tributary to the Phantom Lakes, comprised about 10 percent of the drainage area directly tributary to Upper Phantom Lake, and about 20 percent of the drainage area directly tributary to Lower Phantom Lake.

Recreational Use

- As of 2004, there were numerous recreational boating access sites of the Phantom Lakes. Both Upper and Lower Phantom Lakes continue to be assessed as having adequate public recreational boating access pursuant to Chapter NR 1 of the *Wisconsin Administrative Code*.

- During 2002, approximately 250 watercraft were observed on and around Upper Phantom Lake. Of these, about 30 were power boats, about 35 craft were pontoon boats, about 35 were fishing boats, and six were personal watercraft. The balance was comprised of sailboats, rowboats, canoes, and similar nonmotorized watercraft. Of the approximately 175 watercraft observed on and around Lower Phantom Lake, about 20 were power boats, about 60 craft were pontoon boats, about 55 were fishing boats, and two were personal watercraft. The differences are consistent with the differences in lake depth, Lower Phantom Lake being a shallow waterbody, and with the different usages of the Lakes,

Lower Phantom Lake being utilized by anglers, while Upper Phantom Lake is utilized by more active recreational users including water skiers and power boaters.

- In a recreational rating technique developed by the Wisconsin Department of Natural Resources to characterize the recreational value of inland lakes, Upper Phantom Lake received 57 out of a possible total of 72 points and Lower Phantom Lake received 52 out of a possible total of 72 points. These scores indicate that both Lakes provide a wide range of recreational opportunities, including angling, swimming, boating, and aesthetic viewing opportunities.

Based upon these inventory findings, lake management actions appear warranted to maintain and preserve the aesthetic, recreational, and natural resource functions served by the Phantom Lakes. Consequently, Chapter II presents an overview of alternative lake management measures from which feasible alternatives are identified and set forth in the recommended lake management plan, which is formulated in Chapter III of this plan.

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Chapter II

ALTERNATIVE LAKE MANAGEMENT MEASURES

INTRODUCTION

Based upon review of the inventories and analyses set forth in Volume I, Chapters II through VI, issues were identified that require consideration in the formulation of alternative and recommended lake management measures. These issues are related to: 1) land use; 2) water quality; 3) aquatic biota including aquatic plants; and 4) water uses. The management measures considered herein are focused primarily on those measures which are applicable within the Phantom Lakes Management District, and to the Town and Village of Mukwonago, with lesser emphasis given to those measures which are applicable to others with jurisdiction within the broader total drainage area tributary to the Phantom Lakes.

WATERSHED MANAGEMENT ALTERNATIVES

Land Use Management

A basic element of any water quality management effort for a lake is the promotion of sound land use development and management in the tributary watershed. The type and location of future urban and rural land uses in the tributary drainage area to the Phantom Lakes will determine, to a large degree, the character, magnitude, and distribution of nonpoint sources of pollution; the practicality of, as well as the need for, stormwater management; and, to some degree, the water quality of the Lake.

Development in the Shoreland Zone

Existing year 2000 land use patterns and existing zoning regulations in the tributary area to the Phantom Lakes have been described in Volume I, Chapter III. If the recommendations set forth in the adopted Waukesha County development plan and regional land use plan are followed, under buildout conditions, some additional urban residential development would occur within the drainage area tributary to the Phantom Lakes. Much of this residential development is likely to occur on agricultural lands located within the total drainage area upstream of Lower Phantom Lake. Limited infilling of existing platted lots and some backlot development, as well as the redevelopment and reconstruction of existing single-family homes on lakefront properties, also may be expected to occur, with some portion of this redevelopment activity centered on the drainage area directly tributary to the Phantom Lakes. Recent surveillance indicates that this type of development is currently occurring. Accordingly, given the potential impact of lakeshore development on the lake resources, land use development or redevelopment proposals around the shoreline of Upper and Lower Phantom Lakes, as well as those generally within the drainage area directly tributary to the Lakes, should be evaluated for potential impacts on the Lake, as such proposals are advanced.

Recent studies of the potential impact of riparian landscaping activities on the nutrient loadings to lakes in Southeastern Wisconsin have suggested that urban residential lands can contribute up to twice the mass of

phosphorus to a lake when subjected to an active program of urban lawn care than similar lands managed in a more natural fashion.[1] The application of agrochemicals to such lands, in excess of the plant requirements, therefore, results in enhanced nutrient loading directly to the adjacent waterbodies. To address these concerns, a number of communities are debating the enactment of fertilizer control ordinances in addition to the public informational programming discussed below; some communities, such as the Big Cedar Lake Protection and Rehabilitation District, also have purchased bulk lots of phosphorus-free lawn and garden fertilizers for resale to riparian landowners. Given the increasing importance of urban land uses within the riparian area of the Phantom Lakes, and within its drainage area, consideration of programs to reduce phosphorus in urban agricultural practices may be of value. Further, other communities within the Region have adopted shoreland management guidelines and ordinances and encourage or require the use of vegetative shoreland buffers to intercept runoff and associated contaminant loads generated in the immediate lakeshore area. Application of the County shoreland zoning requirements within the Town of Mukwonago, and adoption and application of similar regulations within the Village of Mukwonago, as well as consideration of additional measures to protect and preserve the lakeshore environment of the Phantom Lakes, is recommended.

Development in the Tributary Drainage Area

The level of development envisioned in the Waukesha County development plan for the drainage basin tributary to the Phantom Lakes indicates continuing urban development, generally on large suburban-density lots. Careful review of applicable zoning ordinances to incorporate levels and patterns of development consistent with the plan within the drainage area tributary to the Phantom Lakes is considered a viable option for the management plan. Changes in the zoning ordinances could be considered to better reflect the land use patterns recommended in the County development plan. One feasible option would be giving consideration to minimizing the areal extent of development by providing specific provisions and incentives to cluster residential development on smaller lots while preserving portions of the open space on each property or group of properties considered for development, utilizing the principles of conservation development.[2]

While much of the new development foreseen in the adopted county development plan is anticipated in the total drainage area tributary to the Phantom Lakes, such development and redevelopment as may be proposed within the drainage areas directly tributary to the Phantom Lakes should be reviewed with the objective of ensuring implementation of sound shoreland management practices, effective stormwater controls, and good urban housekeeping practices, to the extent practicable. Application of such measures to the lands within the Town and Village of Mukwonago within the drainage area directly tributary to the Phantom Lakes is considered a viable option.

Stormwater Management on Development Site

With respect to stormwater management on development sites, the Village of Mukwonago, Town of Mukwonago and Waukesha County have adopted stormwater management ordinances. These ordinances reflect current best practices insofar as the determination of stormwater flows, mitigation of flooding potential, and the control of contaminants from land use activities are concerned. Periodic review of these ordinances and their provisions for consistency with best management practices, and to ensure their currency with the state-of-the-art, undertaken on a regular basis to facilitate control of urban-sourced contaminants that would likely be delivered to the Lake is considered a viable option. Where onsite detention/retention of stormwater is considered as a management practice, adoption of good shorescaping and shoreland management practices is recommended.[3]

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

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

[3]*See University of Wisconsin-Extension, Publication No. GWQ045,* Storm Water Basins: Using Natural Landscaping for Water Quality & Esthetics, *2005.*

Protection of Environmentally Sensitive Lands

Environmentally sensitive lands within the drainage area tributary to the Phantom Lakes include wetlands, woodlands, and wildlife habitat areas. Nearly all of these areas within the Phantom Lakes drainage area are included in the environmental corridors and isolated natural resource features delineated by the Regional Planning Commission. Upland areas, woodlands, and wildlife habitat areas, currently, are protected primarily through local land use regulation, while wetlands enjoy a wider range of protections set forth in State and Federal legislation.

Wetland protection can be accomplished through land use regulation and, in cases where land use regulations may not offer an adequate degree of protection, through public acquisition of sensitive sites. Wetland areas within the Phantom Lakes watershed are currently protected to a degree by current zoning and regulatory programs administered by the U.S. Army Corps of Engineers, Wisconsin Department of Natural Resources (WDNR), and County and municipal authorities under one or more of the Federal, State, County, and local regulations.

Notwithstanding, some of the wetland, woodland, and wildlife habitat areas within the drainage area tributary to the Phantom Lakes have been recommended for public acquisition in the adopted regional natural areas and critical species habitat management and protection plan. These lands include 20 acres of the Phantom Lakes Wetlands, 229 acres of the Mukwonago Fen, Sedge Meadow, and Tamarack Relict, and 159 acres along the Upper Mukwonago River.[4] Public acquisition of these lands, including acquisition by not-for-profit conservation organizations, as recommended in the adopted regional natural areas and critical species habitat protection and management plan is considered a viable option.

Wetlands adjacent to lakes and streams help enhance water quality conditions, while preserving desirable open space characteristics for residents of the area to participate in a wide range of resource-oriented recreational activities, and to avoid the creation of new environmental and developmental problems as urbanization proceeds within the watershed.

Pollution Abatement and Stormwater Management

All human activities upon the land surface result in some degree of mobilization of contaminants and modification of surface runoff patterns that can affect lakes and streams, their quality, and biotic condition. Many human activities can be mitigated to a large extent by the implementation of sound planning, appropriate nonpoint source pollution abatement measures, and the actions of an informed public. In the first instance, sound land use development and management in the tributary watershed, and protection of environmentally sensitive lands, are the fundamental building blocks for protecting lake and stream water quality and habitat, and preserving human use opportunities that will support a broadly-based recreational and residential community. In addition, specific nonpoint source pollution control and abatement measures should be integrated into land use regulations and promoted by a far-reaching informational and educational program within the drainage area tributary to individual lakes and streams

Nonpoint Source Pollution Abatement

Watershed management measures may be used to minimize nonpoint source pollutant loadings from the watershed by locating development within a drainage basin in accordance with sound planning. Beyond such actions, specific interventions may be required to control the mass of contaminants generated by various types of land use activity that are transported to the Lakes. Rural sources of contaminants arise as pollutants transported by runoff from cropland and pastureland; urban sources include contaminants transported by runoff from residential, commercial, industrial, transportation, and recreational land uses, and from construction activities. Alternative, watershed-based nonpoint source pollution control measures considered in this report are based upon the

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

recommendations set forth in the regional water quality management plan[5] and in the Waukesha County land and water resource management plan.[6]

The regional water quality management plan recommends that the nonpoint source pollutant loadings from the areas tributary to the Phantom Lakes be reduced by up to 25 percent in urban and rural areas, in addition to implementation of urban construction erosion controls, stream bank erosion controls, and onsite sewage disposal system management practices. In addition, the adopted plan recommends that the nonpoint source pollutant loadings from the areas tributary to the upstream Eagle Spring Lake be reduced by up to 50 percent in rural areas, with up to a 75 percent reduction in rural areas within the drainage area directly tributary to Eagle Spring Lake.[7] As described in Chapter IV, the most readily controllable loadings are associated primarily with runoff from urban lands within the direct drainage area tributary to the Lakes and from urbanizing lands throughout the total drainage area tributary to the Lakes that are linked to the Lakes by way of streams and stormwater drainage systems. These loadings constituted about 10 percent of the total phosphorus loadings to the Phantom Lakes, based upon year 2000 land uses. Phosphorus loadings from the remainder of the tributary area, and from direct deposition onto the Lake surface, contributed the balance of the total loadings.

While some proportion of the contaminant loads may be attenuated as a consequence of the wetland areas within the drainage area tributary to the Phantom Lakes, the ability of these wetlands to assimilate pollutants is wholly dependent upon the maintenance of their structure and function within their ecosystems. These features can be overwhelmed by inappropriate land uses that result in the degradation of the wetlands, diminishing their ability to capture contaminants, or creating contaminant loads of such magnitude that the wetlands are overloaded. Thus, the control of nonpoint sources of water pollution at their sources is an important consideration. Properly applied, such controls can reduce the pollutant loadings to a lake by about 25 percent or more.

Appendix A presents a list of alternative nonpoint source pollution management measures that could be considered for use in the Phantom Lakes area to reduce loadings from nonpoint sources of pollution. Information on the cost and effectiveness of the measures is also presented in Appendix A. It should be noted that appropriate public informational programming, described below, provides a means of disseminating information on various nonpoint source control measures that can be targeted to specific sectors of the community. Many of the measures are low-cost or no-cost measures that can be implemented by individual landowners. Selected measures are discussed below.

Rural Nonpoint Source Controls

Upland erosion from agricultural and other rural lands is a contributor of sediment and associated nutrients and other contaminants to streams and lakes. Estimated phosphorus loadings from croplands, woodlots, pastures, and grasslands in the drainage area tributary to the Phantom Lakes were presented in Chapter IV of Volume I. These data were utilized in determining the pollutant load reduction that could be achieved, the types of practices needed, and the extent of the areas to which the practices need to be applied within the drainage area tributary to the Phantom Lakes.

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[5]*SEWRPC Planning Report No. 30,* A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000, *Volume One,* Inventory Findings, *September 1978; Volume Two,* Alternative Plans, *February 1979; and Volume Three,* Recommended Plan, *June 1979; SEWRPC Memorandum Report No. 93,* A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report, *March 1995.*

[6]*Waukesha County,* Land and Water Resource Management Plan: 1999-2002, *January 1999.*

[7]*See SEWRPC Memorandum Report No. 93,* op. cit., *and SEWRPC Community Assistance Planning Report No. 226,* A Lake Management Plan for Eagle Spring Lake, Waukesha County, Wisconsin, *October 1997.*

Based upon the pollutant loading analysis set forth in Chapter IV of Volume I, a total annual phosphorus load of about 20,150 pounds is estimated to be contributed to the Phantom Lakes. Of that mass, it is estimated that about 18,750 pounds per year, or more than 90 percent of the total loading, were contributed by runoff from rural lands. As of 2000, such lands comprised about 40,000 acres, or about 75 percent of the drainage area tributary to the Phantom Lakes. While agricultural land uses are anticipated to be a declining form of land usage within the drainage area tributary to the Phantom Lakes, the agricultural operations that remain within the drainage area will continue to contribute a significant proportion of the nutrient load to the waterbody. Thus, detailed farm conservation plans are likely to continue to be required to adapt and refine erosion control and nutrient and pest management practices for individual farm units. Generally prepared with the assistance of staff from the U.S. Natural Resources Conservation Service or County Land Conservation Department, such plans identify desirable tillage practices, cropping patterns, and rotation cycles. The plans also consider the specific topography, hydrology, and soil characteristics of the farm; identify the specific resources of the farm operator; and articulate the operator objectives of the owners and managers of the land. Preparation of such plans is considered to be a viable option for the management of the Phantom Lakes.

Urban Nonpoint Source Controls

As of 2000, established urban land uses comprised about 12,200 acres, or about 25 percent, of the total drainage area tributary to the Phantom Lakes. The annual phosphorus loading from these urban lands was estimated to be about 1,400 pounds, or about 10 percent of the total load of phosphorus to the Lakes. This is anticipated to increase under buildout conditions. Those urban-sourced pollutant loadings that are most controllable include runoff from the residential lands adjacent to the Lakes, and urban runoff from areas with a high proportion of impervious surface. The potential also exists within the Phantom Lakes watershed for significant construction site erosion impacts if development continues in the tributary drainage area as has been the recent trend.

Potentially applicable urban nonpoint source control measures include stormwater management measures, wet detention basins, grassed swales, and good urban "housekeeping" practices. Generally, the application of low-cost urban housekeeping practices may be expected to reduce nonpoint source loadings from urban lands by about 25 percent. Public educational programs can be developed to encourage good urban housekeeping practices, to promote the selection of building and construction materials which reduce the runoff contribution of metals and other toxic pollutants, and to promote the acceptance and understanding of the proposed pollution abatement measures and the importance of lake water quality protection. Urban housekeeping practices and source controls include restricted use of fertilizers and pesticides, improved pet waste and litter control, the substitution of plastic for galvanized steel and copper roofing materials and gutters, proper disposal of motor vehicle fluids, increased leaf collection, and continued use of reduced quantities of street deicing salt.

Particular attention also should be given to reducing pollutant loadings from high pollutant loading areas, such as commercial sites, parking lots, and material storage areas. To the extent practicable, parking lot stormwater runoff should be diverted to areas covered by pervious soils and appropriate vegetation, rather than being directly discharged to surface waters. Material storage areas may be enclosed or periodically cleaned, and diversion of stormwater away from these sites may further reduce pollutant loadings. Street sweeping, increased catch basin cleaning, stream protection, leaf litter and vegetation debris collection, and stormwater storage and infiltration measures can enhance the control of nonpoint-sourced pollutants from urban and urbanizing areas, and reduce urban nonpoint source pollution loads by up to about 50 percent.

As has been noted above, the Village and Town of Mukwonago have adopted stringent stormwater management ordinances applicable to new development within the areas under their jurisdiction. While these measures limit the potential impacts of new development, they do not address impacts from existing land uses nor do they address the cumulative impacts of past development. Therefore, additional measures to reduce nonpoint source pollution from existing development would appear to be warranted. Proper design and application of structural urban nonpoint source control measures, such as grassed swales and detention basins, requires the preparation of a detailed stormwater management system plan that addresses stormwater drainage problems and controls nonpoint sources of pollution.

Developing Area Nonpoint Source Controls
Developing areas can generate significantly higher pollutant loadings than established areas of similar size. Developing areas include a wide array of activities, including urban renewal projects, individual site development within the existing urban area, and new land subdivision development. The regional land use and county development plans envision only limited new urban development within the drainage area directly tributary to the Lakes, although additional development is foreseen in the total drainage area. However, as previously noted, the potential for the redevelopment of existing, platted lakefront lots exists within the drainage area tributary to the Phantom Lakes.

Construction sites, especially, may be expected to produce suspended solids and phosphorus loadings at rates several times higher than established urban land uses. Control of sediment loss from construction sites can be provided by measures set forth in the model ordinance developed by Waukesha County within the context of the Wisconsin Department of Natural Resources Chapter NR 152 of the *Wisconsin Administrative Code*.[8] These controls are temporary measures taken to reduce pollutant loadings from construction sites during stormwater runoff events. Construction erosion controls may be expected to reduce pollutant loadings from construction sites by about 80 percent. Such practices are expected to have only a minimal impact on the total pollutant loading to the Lakes due to the relatively small amount of land proposed to be developed. However, such controls are important pollution control measures that can abate localized short-term loadings of phosphorus and sediment from the drainage area and the upstream tributary area. The control measures include such revegetation practices as temporary seeding, mulching, and sodding, and such runoff control measures as filter fabric fences, straw bale barriers, storm sewer inlet protection devices, diversion swales, sediment traps, and sedimentation basins.

The Waukesha County construction site erosion control ordinance is administered and enforced by the County in both the shoreland and nonshoreland areas of the unincorporated areas of the drainage area tributary to the Phantom Lakes. The provisions of this ordinance apply to all development except single- and two-family residential construction. Single- and two-family construction erosion control measures are to be specified as part of the building permit process. In the Town of Mukwonago, this function is performed by County staff, while in the Village this function is performed by Village staff. Because of the potential for development, some of it albeit unplanned, in the drainage area tributary to the Phantom Lakes, it is important that adequate construction erosion control programs, including enforcement, be in place.

Public Sanitary Sewerage System
Lands lying within the drainage area directly tributary to Upper Phantom Lake currently utilize onsite sewage disposal systems for the treatment of sewage. Lands lying within the drainage area directly tributary to Lower Phantom Lake are about equally divided between those utilizing onsite sewage disposal systems and those utilizing public sanitary sewage disposal systems. Consequently, application of management measures for both onsite and public sanitary sewerage systems are considered to be viable options.

Onsite Sewage Disposal System Management
The total phosphorus loads to the Lakes contributed by onsite sewage disposal systems is quantified in Chapter I of this volume and in Chapter IV of Volume I of this report. Those loads are anticipated to decline as public sanitary sewerage services are extended within the drainage area pursuant to the adopted regional water quality management plan[9] and sewer service area plan.[10] In addition to lake water quality considerations, sewage disposal

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[8]*Waukesha County Code, Chapter 14, Article VIII, "Stormwater Management and Erosion Control Ordinance," adopted March 22, 2005.* Wisconsin Administrative Code *Chapter NR 152, "Model Ordinances for Construction Site Erosion Control and Post-Construction Storm Water Management," September 2002.*

[9]*SEWRPC Memorandum Report No. 93,* op. cit.

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

options in the area have implications for groundwater quality and property values. Thus, onsite sewage disposal is an important consideration in the portions of the drainage area not within the planned public sanitary sewer service area. Two basic alternatives are available for abatement of pollution from onsite sewage disposal systems: continued reliance on, and management of, the onsite sewage disposal systems, and, alternatively, the expansion of the existing public sanitary sewer system.

Where onsite sewage disposal systems remain the primary wastewater treatment method, an onsite sewage disposal system management program, including the conduct of an ongoing informational and educational effort, is considered a viable option. Homeowners in areas served by onsite systems should be advised of the rules, regulations, and system limitations governing onsite sewage disposal systems, and should be encouraged to undertake preventive maintenance programs. Waukesha County currently has such a program in place, pursuant to Chapter Comm 83 of the *Wisconsin Administrative Code* for onsite sewage disposal systems installed after 1983, and consideration is currently being given by the Wisconsin Legislature to extending this inspection program to all onsite sewage disposal systems. The Phantom Lakes Management District currently contracts with Waukesha County for the conduct of septic tank inspections within its jurisdiction.

IN-LAKE MANAGEMENT ALTERNATIVES

The reduction of external nutrient loadings to the Phantom Lakes by the aforedescribed measures should help to prevent further deterioration of lake water quality conditions. These measures, however, may not completely eliminate existing water quality and lake-use problems. In mesotrophic and eutrophic lakes, the nutrients previously delivered to, and retained in, such lakes can continue to result in abundant macrophyte growth that can result in restricted water use potentials, even after the implementation of watershed-based management measures. Given that the Phantom Lakes fall within this trophic range, the application of in-lake rehabilitation techniques should be considered.

The applicability of specific in-lake rehabilitation techniques is highly dependent on lake-specific characteristics. The success of any lake rehabilitation technique can seldom be guaranteed, and because of the relatively high cost of applying most techniques, a cautious approach to implementing in-lake rehabilitation techniques is generally recommended. Certain in-lake rehabilitation techniques should be applied only to lakes in which: 1) nutrient inputs have been reduced below the critical level; 2) there is a high probability of success in applications of the particular technology to lakes of similar size, shape, and quality; and 3) the possibility of adverse environmental impacts is minimal. Finally, it should be noted that some in-lake rehabilitation techniques require the issuance of permits from appropriate State and Federal agencies prior to implementation.

Alternative lake rehabilitation measures include in-lake water quality management, water level management, aquatic plant and fisheries management, and water use management measures. Each of these groups of management measures is described further below.

Surface and Ground Water Management

As discussed in Chapter IV of Volume I, water quality information for the Phantom Lakes has been compiled from 1993 to the present for Upper Phantom Lake and from 1992 to 1999 for Lower Phantom Lake, mainly under the auspices of the Wisconsin Department of Natural Resources Self-Help Monitoring Program. Enrollment of volunteers in this program can be accomplished through the Southeast Region Office of the Wisconsin Department of Natural Resources. Volunteers enrolled in this program gather data at regular intervals on water clarity through the use of a Secchi disk. Because pollution tends to reduce water clarity, Secchi disk measurements are generally considered one of the key parameters in determining the overall quality of a lake's water as well as a lake's trophic status. Secchi disk measurement data is added to the Department-sponsored data base containing lake water quality information for most of the lakes in Wisconsin and is accessible on-line through the Department's website.

The Department also offers an Expanded Self-help Monitoring Program that involves collecting data on several key physical and chemical parameters in addition to the Secchi disk measurements. Under this program, samples of lake water are collected by volunteers at regular intervals and analyzed by the State Laboratory of Hygiene. Data collection is more extensive and, consequently, places more of a burden on volunteers. An alternative is the analytical services provided by the University of Wisconsin-Stevens Point. However, this program also requires volunteers to obtain and transmit the water quality samples to the laboratory. In both cases, the Wisconsin Department of Natural Resources offers Chapter NR 190 Small Grant funding that can be applied for to defray the costs for lab analysis and sampling equipment.

The U.S. Geological Survey offers an extensive water quality monitoring program, within which federal field personnel conduct a series of approximately five monthly samplings beginning with the spring turnover. Samples are analyzed for an extensive array of physical and chemical parameters. The U.S. Geological Survey also offers an array of other specialist services, including groundwater modeling and monitoring, which would be applicable in the Phantom Lakes watershed. The participation of the U.S. Geological Survey, Wisconsin Geological and Natural History Survey, and the University of Wisconsin-Madison in this project would permit extension and refinement for local conditions of the recently completed regional groundwater model.[11]

Ongoing water quality monitoring by volunteer monitors, supplemented by periodic more detailed water quality monitoring is considered to be a viable option for the Phantom Lakes. Conduct of detailed groundwater modeling is also considered viable in view of proposed additional demands to be placed upon the surfacial aquifers in the drainage area directly tributary to Upper Phantom Lake.

Water Quality Improvement Measures

This group of in-lake management practices includes a variety of measures designed to directly modify the magnitude of either a water quality determinant or biological response. Specific measures aimed at managing aquatic biota and water uses are separately considered below.

Phosphorus Precipitation and Inactivation

Nutrient inactivation is a restoration measure that is designed to limit the biological availability of phosphorus by chemically binding the element in the lake sediments using a variety of divalent or trivalent cations, highly positively charged elements. Aluminum sulfate (alum), ferric chloride, and ferric sulfate are commonly used cation sources. The use of these techniques to remove phosphorus from nutrient-rich lake waters is an extension of common water supply and wastewater treatment processes. Costs depend on the lake volume and type and dosage of chemical used. Approximately 100 tons of alum, costing about $150 per ton, can treat a lake area of about 40 acres. Effectiveness depends, in part, on the ability of the alum flocculent to form a stable “blanket” on the lakebed; to wit, on flushing time, turbulence, lake water acidity (pH) and rate of continued sedimentation. Impacts can include the release of toxic quantities of free aluminum into the water. The resulting improved water clarity can also encourage the spread of rooted aquatic plants.

Nutrient inactivation is not considered a viable option for the Phantom Lakes, and especially in Lower Phantom Lake, due to the generally soft sediments and shallow depth of management areas, the susceptibility to wind- and boat motor-induced mixing, and the overall pollutant loading which mediate against the effective use of nutrient inactivation.

Nutrient Load Reduction

Nutrient diversion is a restoration measure, which is designed to reduce the trophic state or degree of over-feeding of a waterbody and thereby control the growth response of the aquatic plants in the system. Control of nutrients in surface water runoff in the watershed is generally preferable to attempting such control within a lake. Many of the techniques presented in the watershed management section above are designed for this purpose.

[11]*SEWRPC Technical Report No. 37,* Groundwater Resources of Southeastern Wisconsin*, June 2002.*

In-lake control of nutrients generally involves removal of contaminated sediments or encapsulation of nutrients by chemical binding. Costs are generally high, involving an engineered design and usually some form of pumping or excavation. Effectiveness is variable, and impacts include the re-release of nutrients into the environment. The widespread use of in-lake nutrient load reduction measures is not considered feasible in the Phantom Lakes, especially given that internal loading from the lake sediments does not appear to be an important nutrient course to the water column. As noted in Chapter IV of Volume I, the good agreement between predicted and observed phosphorus concentrations in the Lakes strongly suggests that the external nutrient load to the Lakes accounts for the entire phosphorus concentration in the Lake water column.

Hydraulic and Hydrologic Management

This group of in-lake management measures consists of actions designed to modify the depth of water in the waterbody. Generally, the objectives of such manipulation are to enhance a particular class of recreational uses, to control the types and densities of organisms within a waterbody, or to minimize high water or flooding problems. Consideration can be given to outlet control modifications, drawdown, and dredging.

Outlet Control Operations

There is no dam or weir at the outflow of Upper Phantom Lake to regulate the outflow of water draining from Upper Phantom Lake to Lower Phantom Lake. Nevertheless, the navigational channel between Upper and Lower Phantom Lakes has been proposed for deepening to provide for enhanced passage of watercraft between the Lakes. While such a proposal would have little effect on Lake water levels during normal and high water periods, lake levels in Upper Phantom Lake may be adversely affected during periods of low precipitation and related periods of low water levels in the Lakes. Consequently, this type of water level manipulation is not recommended.

In contrast to Upper Phantom Lake, the outflow from Lower Phantom Lake is controlled by a concrete dam located in the Mukwonago River about two tenths of a mile downstream from the Lake in the Village of Mukwonago. The normal level of the Lakes is generally considered to be about 789 feet above National Geodetic Vertical Datum, 1929 adjustment (NGVD29). Any changes in this operating regime are subject to Wisconsin Department of Natural Resources Chapter 31, *Wisconsin Statutes*, permitting authority. No changes are currently recommended. As noted in Chapter V of Volume I, the presence of the control structure and upstream constructed lake have benefited the long-ear sunfish population located immediately downstream of the dam in the Mukwonago River by moderating the otherwise cold water temperatures in the Mukwonago River basin.

Drawdown

Drawdown refers to the manipulation of lake water levels, especially in impounded lakes, in order to change or create specific types of habitat and thereby manage species composition within a waterbody. Drawdown may be used to control aquatic plant growth and to manage fisheries. With regard to aquatic plant management, periodic drawdowns can reduce the growth of some shoreland plants by exposing the plants to climatic extremes, while the growth of others is unaffected or enhanced. Both desirable and undesirable plants are affected by such actions. Costs are primarily associated with loss of use of the waterbody surface area during drawdown, provided there is a means of controlling water level in place, such as a dam or other outlet control structure. Effectiveness is variable with the most significant side effect being the potential for increased plant growth.

Drawdown can also affect the lake fisheries both indirectly, by reducing the numbers of food organisms, and directly, by reducing available habitat and desiccating (drying out) eggs and spawning habitat. In contrast, increasing water levels, especially during spring, can provide enhanced fish breeding habitat for some species, such as pike and muskellunge, and increase the food supply for opportunistic feeders, such as bass, by providing access to terrestrial insects, for example. Costs are primarily associated with loss of use. Effectiveness is better than for aquatic plant control, but the potential for side effects remains high given that undesirable fish species may also benefit from water level changes.

Sediment exposure and desiccation by means of lake drawdown has been used as a means of stabilizing bottom sediments, retarding nutrient release, reducing macrophyte growth, and reducing the volume of bottom sediments. During the period of drawdown, the exposed sediments are allowed to oxidize and consolidate. It is believed that

by reducing the sediment oxygen demand and increasing the oxidation state of the surface layer of the sediments, drawdown may retard the subsequent movement of phosphorus from the sediments. Sediment exposure may also curb sediment nutrient release by physically stabilizing the upper flocculent, sediment-water interface zone of the sediments which plays an important role in the exchange reaction and mixing of the sediments with the overlying water. Drawdown may thus increase the volume of the lake by dewatering and compacting the bottom sediments. The amount of compaction depends upon the organic content of the sediment, the thickness of sediment exposed above the water table, and the timing and duration of the drawdown.

Possible improvements resulting from a lake drawdown include reduced turbidity from wind action, improved game fishing, an opportunity to collect fish more effectively in fish removal programs, an opportunity to improve docks and dams, and an opportunity to clean and repair shorelines and deepen areas using conventional earth-moving equipment. Limited, over-winter drawdowns, conducted pursuant to the dam operating permit, are designed to limit shoreland damage by ice and ice movements during the winter months.

In contrast, depending on the timing and duration of the drawdown, drawbacks include loss of fish breeding habitat, loss of benthic food organisms, and disruption of waterfowl feeding and roosting patterns. Increased turbidity and unpleasant odors from rotting organic matter may occur during the period of the drawdown. Other adverse impacts of lake drawdown include algal blooms after reflooding, loss of use of the lake during the drawdown, changes in species composition, and a reduction in the density of benthic organisms following drawdown and reflooding. In some drawdown projects, it has been found that several years after reflooding, flocculent sediments began to reappear because of algae and macrophyte sedimentation. Therefore, to maintain the benefits of a drawdown project, the lake may have to be drawn down every five to 10 years to recompact any new sediments. At this time, drawdown is not considered a viable option for inclusion in the management plan.

Water Level Stabilization
While water level management in a lake is a common technique for managing fish and aquatic macrophytes, the consequences of manipulating lake water levels can be both beneficial and deleterious. The major impacts from the riparian owners standpoint is that the fluctuating water levels affect shoreline erosion, interfere with proper pier height and placement, as well as the correct placement of shoreline protection structures.

Periodic changes in precipitation and weather patterns between years often result in fluctuation of water loads to the lake. These fluctuations in turn can affect lake levels. Most plant and animal species can cope with this level of water surface fluctuation without experiencing the consequences, both positive and negative, noted above. Nevertheless, while artificial stabilization of the water surface is not considered a feasible option, it is desirable from the point of view of aquatic habitat that water level fluctuations be maintained within these natural limits.

Dredging
Sediment removal is a restoration measure that is carried out using a variety of techniques, both land-based and water-based, depending on the extent and nature of the sediment removal to be carried out. For larger-scale applications, a barge-mounted hydraulic or cutter-head dredge is generally used. For smaller-scale operations a shore-based drag-line system is typically employed. Both methods are expensive, especially if a suitable disposal site is not located close to the dredge site. Costs for removal and disposal begin at between $10 and $15 per cubic yard, with the cost of sediment removal alone beginning at between $3.00 and $5.00 per cubic yard. Effectiveness of dredging varies with the effectiveness of watershed controls in reducing or minimizing the sediment sources. Federal and State permits are required for use of this option.

Dredging in the Phantom Lakes could be accomplished using several different types of equipment, including a hydraulic cutterhead dredge mounted on a floating barge in deeper water areas; a bulldozer and backhoe equipment in the shoreland area, especially if the Lakes were drawn down; and a clamshell, or bucket, dragline dredge from the shoreline. While the use of conventional earth-moving equipment and shore-based draglines has some advantages over hydraulic dredging, particularly since these methods would not require large disposal and dewatering sites in close proximity to the project area, these methods would be dependent, to some extent, on the drawdown of the Lake. Reducing the water level in the Lake would be especially advantageous for dragline

dredging because it would not require the removal of shoreland trees, resulting in less disturbance of the shoreline to provide access for trucks and equipment. Likewise, reduced water levels would allow conventional construction equipment access to the littoral portions of the waterbody. Nevertheless, given the potential recreational use impacts of a drawdown during both summer and winter recreational seasons, use of these methods is not considered feasible for inclusion in the management plan.

Aquatic Plant and Fisheries Management

Fisheries Management Measures

The Phantom Lakes provide a quality habitat for a healthy, warmwater fishery. Currently, adequate water quality, dissolved oxygen levels, sand and gravel shorelines, and diverse plant communities exist for the maintenance of a sportfish population in the Lakes. The Lakes support a largemouth bass and northern pike fishery, along with a wide range of panfish. Measures to ensure the continuation of such favorable conditions are considered viable for inclusion in the lake management plan for the Phantom Lakes.

Habitat Protection

Habitat protection refers to a range of conservation measures designed to maintain existing fish spawning habitat, including measures such as restricting recreational use and other intrusions into gravel-bottomed shoreline areas during the spawning season. For bass this is mid-April to mid-June. Use of natural vegetation in shoreland management zones and other "soft" shoreline protection options aids in habitat protection. Costs are generally low, unless the habitat is already degraded. Modification of aquatic plant harvesting operations may be considered to support restoration and protection of native aquatic plant beds and maintenance of fish breeding habitat during the early summer period. Effectiveness is variable depending in part on community acceptance and enforcement. Generally, it is more effective to maintain a good habitat than to restore a habitat after it is degraded.

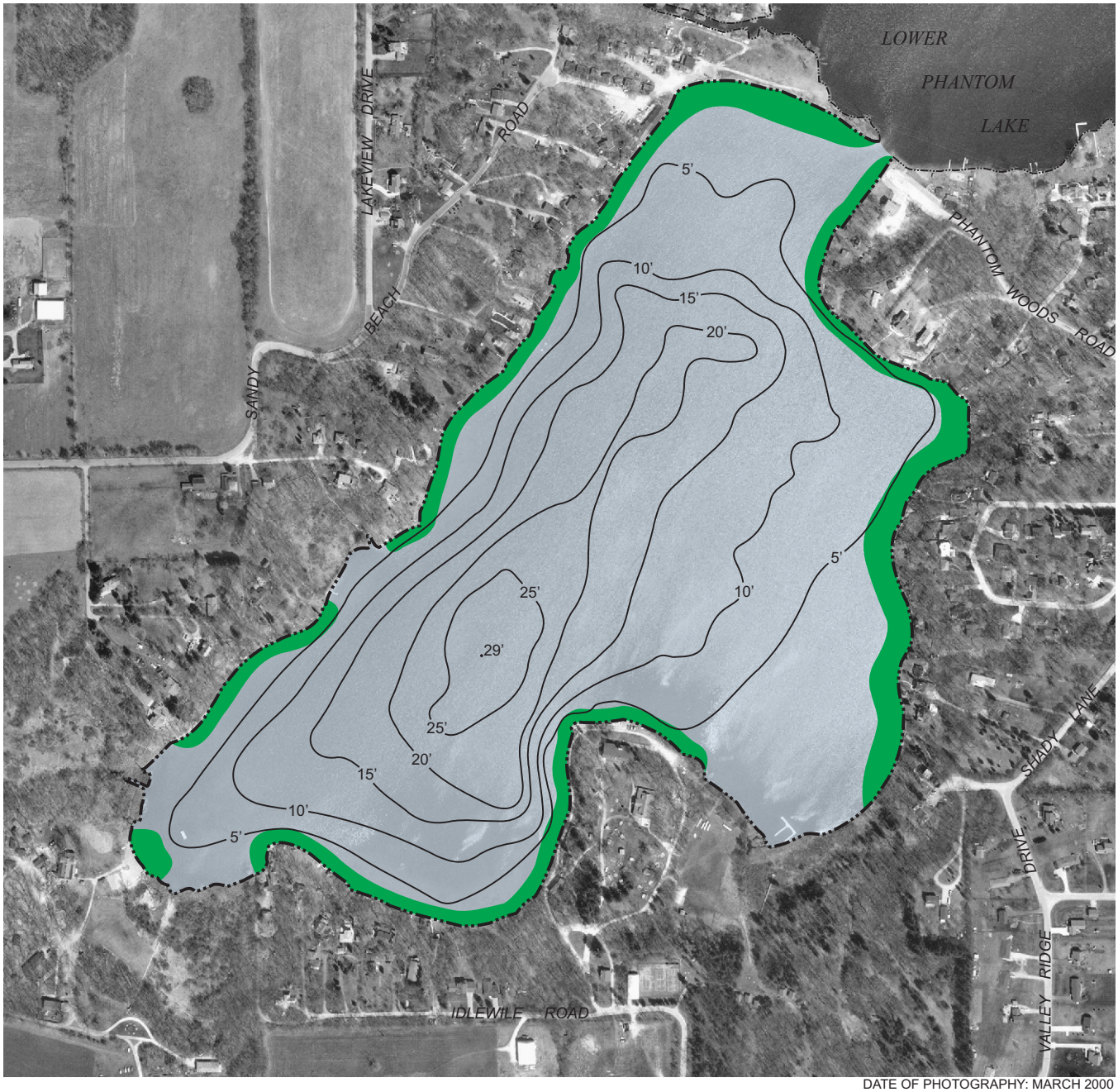
Loss of habitat should be a primary concern of any fisheries management program. The environmentally valuable areas identified within the Lakes and their watersheds are the most important areas to be protected. In addition, limiting or restricting certain activities in sensitive areas of the Lakes will prevent significant disturbance of fish nests and aquatic plant beds. The areas currently designated by the WDNR as sensitive areas within the Phantom Lakes, pursuant to authorities granted under Chapter NR 107 of the *Wisconsin Administrative Code*, are shown on Map 1. Within these areas, aquatic plant management measures are restricted, and dredging, filling, and the construction of piers and docks should be discouraged. It also should be noted that water level fluctuations other than those consequent to natural climatic variability and water quality conditions can affect fish habitat and the breeding success of fishes. In this regard, the maintenance of Lake water levels within natural limits, and the maintenance of good water quality, cannot be overemphasized as fish habitat protection measures.

Shoreline Maintenance

Shoreline maintenance refers to a group of measures designed to reduce and minimize shoreline loss due to erosion by waves, ice, or related actions of the water. Currently, about 25 percent of the shoreline of the lake basins of the Phantom Lakes is protected by some type of structural measure, as shown on Map 2. Four shoreline erosion control techniques were in use in 2002: vegetative buffer strips, rock revetments, wooden and concrete bulkheads, and beach. Maintenance of a vegetated buffer strip immediately adjacent to the Lakes is the simplest, least costly, and most natural method of reducing shoreline erosion. This technique employs natural vegetation, rather than maintained lawns, within five to 10 feet of the lakeshore and the establishment of emergent aquatic vegetation from two to six feet lakeward of the shoreline. Desirable plant species that may be expected and encouraged to invade a buffer strip, or which could be planted, include arrowhead (*Sagittaria latifolia*), cattail (*Typha* spp.), common reed (*Phragmites communis*), water plantain (*Alisma plantago-aquatica*), bur-reed (*Sparganium eurycarpum*), and blue flag (*Iris versicolor*) in the wetter areas; and jewelweed (*Impatiens biflora*), elderberry (*Sambucus canadensis*), giant goldenrod (*Solidago gigantea*), marsh aster (*Aster simplex*), red-stem aster (*Aster puniceus*), and white cedar (*Thuja occidentalis*) in the drier areas. In addition, trees and shrubs such as silver maple (*Acer saccharinum*), American elm (*Ulmus americana*), black willow (*Salix nigra*), and red-osier dogwood (*Cornus stolonifera*) could become established. These plants will develop a more extensive root system than the lawn grass and the aboveground portion of the plants will protect the soil against the erosive forces of

Map 1

WISCONSIN DEPARTMENT OF NATURAL RESOURCES-DELINEATED SENSITIVE AREAS IN UPPER PHANTOM LAKE



DATE OF PHOTOGRAPHY: MARCH 2000

—20'— WATER DEPTH CONTOUR IN FEET

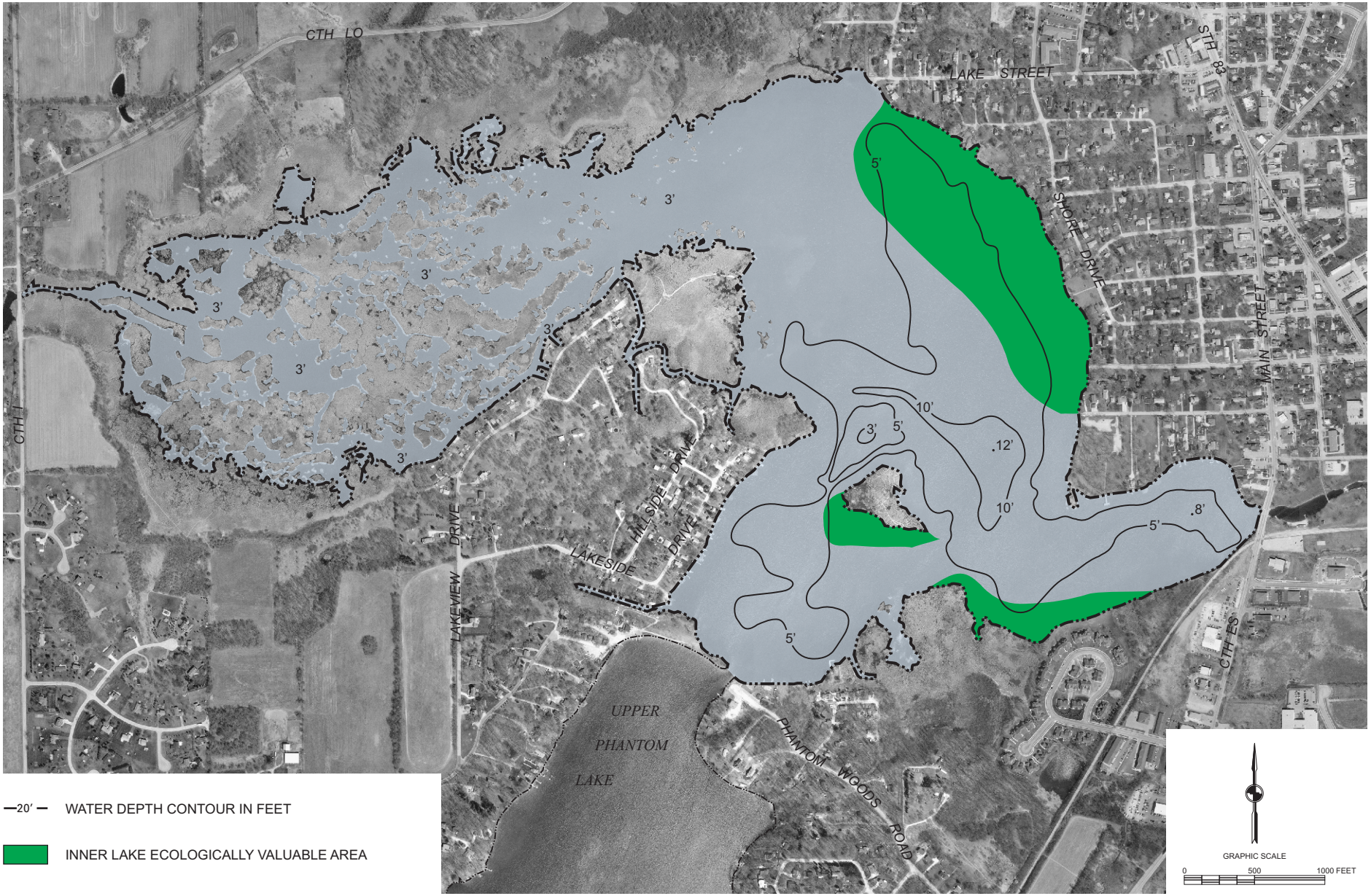
INNER LAKE ECOLOGICALLY VALUABLE AREA

GRAPHIC SCALE
0 300 600 FEET

Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 1 (continued)

WISCONSIN DEPARTMENT OF NATURAL RESOURCES-DELINEATED SENSITIVE AREAS IN LOWER PHANTOM LAKE



Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 2

SHORELINE PROTECTION STRUCTURES ON UPPER PHANTOM LAKE: 2002

DATE OF PHOTOGRAPHY: MARCH 2000

RIPRAP

BEACH

NATURAL

BULKHEAD

GRAPHIC SCALE

0 300 600 FEET

Source: SEWRPC.

Map 2 (continued)

SHORELINE PROTECTION STRUCTURES ON LOWER PHANTOM LAKE: 2002

Source: SEWRPC.

DATE OF PHOTOGRAPHY: MARCH 2000

rainfall and wave action. A narrow path to the lake can be maintained as lake access for boating, swimming, fishing, and other activities. A vegetative buffer strip would also serve to trap nutrients and sediments washing into the Lakes via direct overland flow. This alternative would involve only minimal cost.

Rock revetments, or riprap, are a highly effective method of shoreline erosion control applicable to many types of erosion problems, especially in areas of low banks and shallow water. These structures are already in place along limited stretches of the shoreline at the Phantom Lakes. The technique involves the shaping of the shoreline slope, the placement of a porous filter material, such as sand, gravel, or pebbles, on the slope and the placement of rocks on top of the filter material to protect the slope against the actions of waves and ice. The advantages of rock revetments are that they are highly flexible and not readily weakened by movements caused by settling or ice expansion, they can be constructed in stages, and they require little or no maintenance. The disadvantages of rock revetments are that they limit some uses of the immediate shoreline. The rough, irregular rock surfaces are unsuitable for walking; require a relatively large amount of filter material and rocks to be transported to the lakeshore; and can cause temporary disruptions and contribute sediment to the lake. If improperly constructed, revetments may fail because of washout of the filter material. A rock revetment is estimated to cost $25 to $35 per linear foot.

Vegetated buffer strips and riprap, as shown in Figure 1, are considered as viable options for achieving shoreline maintenance, especially in those areas of the Phantom Lakes subject to significant wind-wave, boat wake, and ice scour erosion. In those portions of the Lakes subject to direct action of wind waves and ice scour, the use of riprap would provide a more robust means of stabilizing shorelines, while elsewhere along the lakeshore creation of vegetated buffer strips would provide not only shoreline erosion protection but also enhanced shoreland habitat for fish and wildlife. In this regard, it should be noted that the selection of appropriate shoreland protection structures is subject to the provisions of Chapter NR 328 of the *Wisconsin Administrative Code*.

Modification of Species Composition

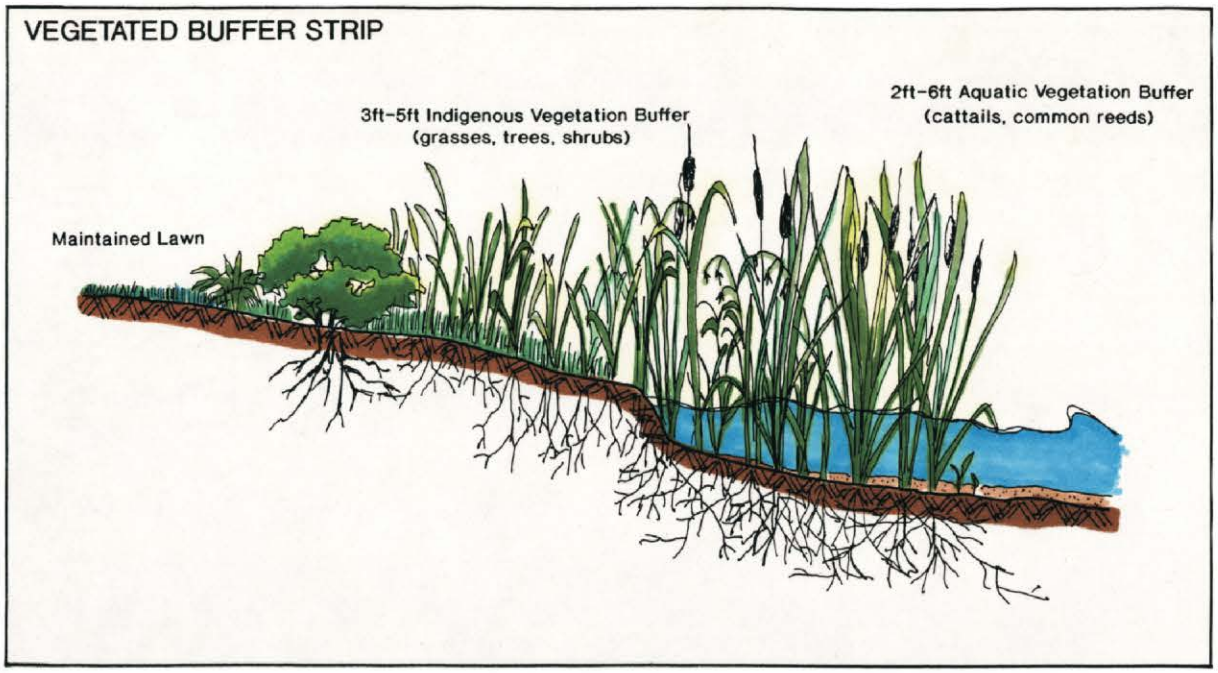
Species composition management refers to a group of conservation and restoration measures that include selective harvesting of undesirable fish species and stocking of desirable species designed to enhance the angling resource value of a lake. These measures also include water level manipulation both to aid in the breeding of desirable species, for example, increasing water levels in spring to provide additional breeding habitat for pike, and to disadvantage undesirable species, for example, drawing a lake down to concentrate forage fish and increase predation success and also to strand juveniles and desiccate the eggs of undesirable species. Costs, as with water level management above, are primarily associated with loss of use; effectiveness is good, but by no means certain; and side effects include collateral damage to desirable fish populations.

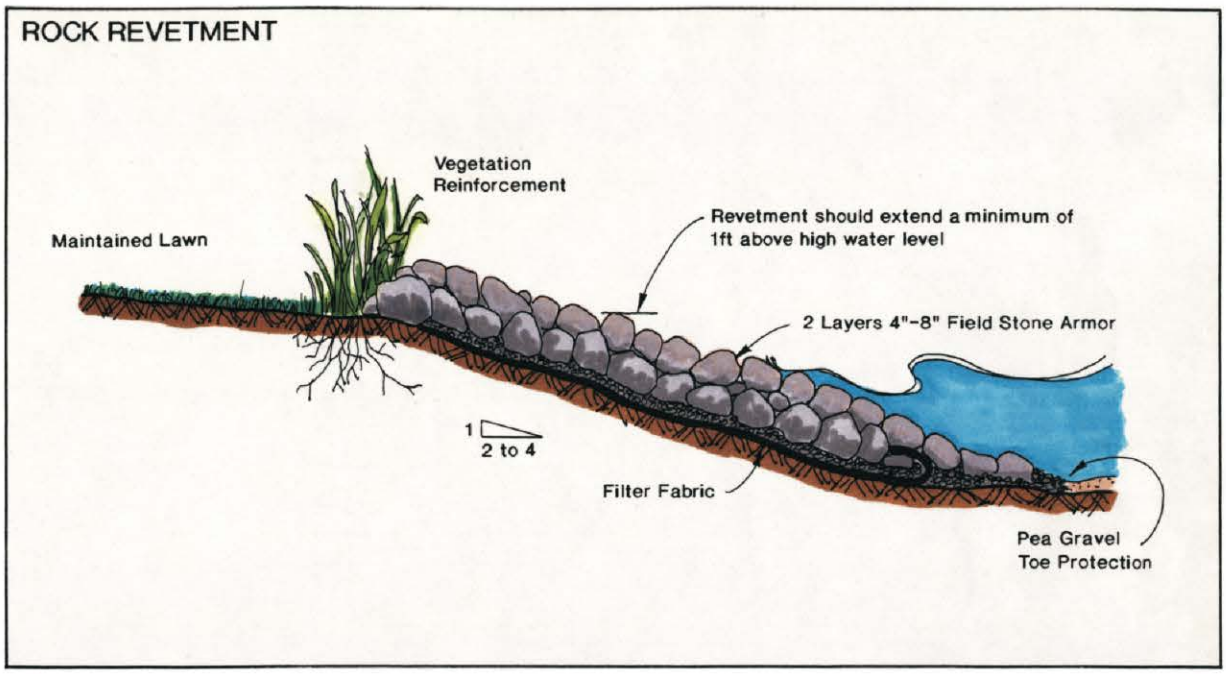
More extreme measures include organized fishing events and selective cropping of certain fish species, poisoning, and enhancement of predation by stocking. In lakes with an unbalanced fishery, dominated by carp and other rough fish, chemical eradication has been used to manage the fishery. Lake drawdown is often used along with chemical treatments to expose spawning areas and eggs and concentrate fish in shallow pools, thereby increasing their availability to anglers, commercial harvesters, or chemical eradication treatments. Fish barriers are usually used to prevent reintroduction of undesirable species from up- or downstream, and the habitat thus created will benefit the desired gamefish populations. Chemical eradication is a drastic, costly measure and the end result may be highly unpredictable. Although effectiveness is generally good, such extreme measures are not considered a feasible option for the Phantom Lakes.

As noted in Chapter V of Volume I, the Phantom Lakes are currently managed for warmwater sportfish. Periodic supplemental fish stocking by the Wisconsin Department of Natural Resources or by private organizations is considered a viable option for the Phantom Lakes, subject to monitoring and creel and other surveying data collected from the Lakes by the Wisconsin Department of Natural Resources. Additional fish population control measures do not appear to be warranted at this time, although rough fish populations should continue to be monitored.

Figure 1

PLAN ALTERNATIVES FOR SHORELINE EROSION CONTROL





NOTE: Design specifications shown herein are for typical structures. The detailed design of shoreline protection structures must be based upon analysis of local conditions.

Source: SEWRPC.

Regulations and Public Information
To reduce the risk of overharvest, the Wisconsin Department of Natural Resources has placed restrictions on the number and size of certain fish species caught by anglers. The open season, size limits, and bag limits for the fish species of the Phantom Lakes are given in Table 25 in Volume I. Enforcement of these regulations is critical to the success of any sound fish management program.

Aquatic Plant Management Measures
Aquatic plant management 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. Generally, aquatic plant management measures are classified into three groups: physical measures, which include lake bottom coverings and water level management; mechanical removal measures, which include harvesting and manual removal; and chemical measures, which include using aquatic herbicides and biological control measures, which in turn include the use of various organisms, including insects. Of these, chemical and biological measures are stringently regulated and require a State permit.

Costs of aquatic plant management measures range from minimal for manual removal of plants using rakes and hand-pulling to upwards of $100,000 for the purchase of a mechanical plant harvester and ancillary equipment, the operational costs for which can approach $10,000 to $20,000 per year depending on staffing and operating policies. Harvesting is probably the measure best applicable to larger areas while chemical controls may be best suited to use in confined areas and for initial control of invasive plants. Planting of native plant species is largely experimental in lakes, but can be considered a specialized shoreland management zone at the water's edge. Physical controls and mechanical harvesting may have side effects in the expansion of plant habitat and the spread of reproductive vegetative fragments.

Aquatic Herbicides
Chemical treatment with aquatic herbicides is a short-term method of controlling heavy growths of aquatic macrophytes and algae. Chemicals are applied to the growing plants in either liquid or granular form. The advantages of using chemical herbicides to control aquatic macrophyte growth are the relative ease, speed, and convenience of application. Herbicides also offer a degree of selectivity, targeting specific types of aquatic plants. However, the disadvantages associated with chemical control include the following:

1. The short-term, lethal effects of chemicals are relatively well known. However, properly applied, chemical applications should not result in such effects. Potential long-term, sublethal effects, especially on fish, fish-food organisms, and humans, are relatively unknown.

2. The elimination of macrophytes eliminates their competition with algae for light and nutrients. Algal blooms may then develop unless steps are taken simultaneously to control the sources of nutrient input.

3. Since much of the dead plant materials are left to decay in the lake, nutrients contained in them are rapidly released into the water and fuel the growth of algae. The decomposition of the dead plant material also consumes dissolved oxygen and increases the potential for fish kills. Accretion of additional organic matter in the sediments as a result of decomposition also increases the organic content of the soils and predisposes the sediments toward reintroduction of other (or the same) nuisance plant species. Long-term deposition of plant material may result in the need for other management measures, such as dredging.

4. The elimination of macrophyte beds destroys important cover, food sources, and spawning areas for desirable fish species.

5. Adverse impacts on other aquatic organisms may be expected. At the concentrations used for macrophyte control, Diquat has been known to kill the zooplankton *Daphnia* and *Hyalella*, both

important fish foods. *Daphnia* is the primary food for the young of nearly all fish species found in the Region's lakes.[12]

6. Areas generally must be treated again in the following season and weedbeds may need to be treated more than once in a summer, although certain herbicides may give relief over a period of up to three years in some lakes.

7. Many of the chemicals available often affect nontarget, desirable species, such as water lilies, as well as the "weeds," such as Eurasian water milfoil, as both species share similar biological characteristics, being dicotyledons.

The advantages and disadvantages of chemical macrophyte control also apply to the chemical control of algae. Copper, the active ingredient in algicides, may accumulate in the bottom sediments, where excessive amounts are toxic to fish and benthic animals. Fortunately, copper is rapidly eliminated from human systems and few cases of copper sensitivity among humans are known.[13]

Costs of chemical treatments vary widely. Large, organized treatments are more efficient and tend to decrease unit costs for commercial applications compared to individual treatments. Other factors, such as the type of chemical used and the number of treatments needed, are also important. Estimated costs for lakes in Southeastern Wisconsin range from $240 to $480 per acre. Chemical treatments must be permitted by the State under Chapter NR 107 of the *Wisconsin Administrative Code*.

In the absence of a demonstrated need to control aquatic plants in the Phantom Lakes, especially in Upper Phantom Lake, chemical treatment is considered to be a viable management option only in limited, nearshore areas of the Lakes, around piers and structures, or in order to control nuisance aquatic plants, especially nonnative species such as purple loosestrife and Eurasian water milfoil. Widespread use of chemical herbicides is not considered a feasible option for inclusion in the management plan at this time, although localized use around piers and docks, and in the control of nonnative shoreland and aquatic plants, could be considered viable.

Aquatic Plant Harvesting

Aquatic macrophytes are mechanically harvested with specialized equipment consisting of a cutting apparatus which cuts up to five feet below the water surface and a conveyor system that picks up the cut plants and hauls them to shore. Advantages of macrophyte harvesting include the following:

1. Harvesting removes the plants from the lake. The removal of this plant biomass decreases the rate of accumulation of organic sediment. A typical harvest of submerged macrophytes from eutrophic lakes in Southeastern Wisconsin can yield between 140 and 1,100 pounds of biomass per acre per year.[14]

2. Harvesting removes plant nutrients, including nitrogen and phosphorus, which would otherwise "refertilize" the lake as the plants decay. A typical harvest of submerged macrophytes from eutrophic lakes in Southeastern Wisconsin can remove between four and 34 pounds of nitrogen and 0.4 to 3.4 pounds of phosphorus per acre per year. In addition to the physical removal of nutrients, plant

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[12]*P.A. Gilderhus, "Effects of Diquat on Bluegills and Their Food Organisms,"* The Progressive Fish-Culturist, *Vol. 2, No. 9, 1967, pp. 67-74.*

[13]*J.A. Thornton, and W. Rast, "The Use of Copper and Copper Compounds as an Algicide,"* Copper Compounds Applications Handbook, *H.W. Richardson, ed., Marcel Dekker, New York, 1997.*

[14]*James E. Breck, Richard T. Prentki, and Orie L. Loucks, editors,* Aquatic Plants, Lake Management, and Ecosystem Consequences of Lake Harvesting, *Proceedings of Conference at Madison, Wisconsin, February 14-16, 1979.*

harvesting may reduce internal nutrient recycling. Several studies have shown that aquatic macrophytes can act as nutrient pumps, recycling nutrients from the bottom sediments into the water column. Ecosystem modeling results have indicated that a harvest of 50 percent of the macrophytes in Lake Wingra, Wisconsin, could reduce instantaneous phosphorus availability by about 30 percent, with a maximum reduction of 40 to 60 percent, depending on the season.

3. Repeated macrophyte harvesting may reduce the regrowth of certain aquatic macrophytes. The regrowth of milfoil has been reported to have decreased as harvesting frequency was increased.

4. Where dense growths of filamentous algae are closely associated with macrophyte stands, they may be harvested simultaneously.

5. The macrophyte stalks remaining after harvesting provide cover for fish and fish-food organisms, and stabilize the bottom sediment against wind erosion.

6. Selective macrophyte harvesting may reduce stunted populations of panfish in lakes where excessive cover has adversely influenced predator-prey relationships. By allowing an increase in predation on young panfish, both gamefish and the remaining panfish may show increased growth.[15]

7. The cut plant material can be used as mulch.

The disadvantages of macrophyte harvesting include the following:

1. Harvesting is most effective in water depths greater than two feet. Large harvesters cannot operate in shallow water or around docks and buoys. Operation of harvesting equipment in shallow waters can result in significant increases in turbidity and disruption of the lake bottom and lake bottom-dwelling fauna.

2. The reduction in aquatic macrophytes by harvesting reduces their competition with algae for light and nutrients. Thus, algal blooms may develop.

3. Fish, especially young-of-the-year bluegills and largemouth bass, as well as fish-food organisms, are frequently caught in the harvester. As much as 5 percent of the juvenile fish population can be removed by harvesting. A Wisconsin Department of Natural Resources study found that four pounds of fish were removed per ton of plants harvested.[16]

4. The reduction in aquatic macrophyte biomass by harvesting or chemical control can reduce the diversity and productivity of macroinvertebrate fish-food organisms feeding on the epibiota. Bluegills generally move into the shoreline area after sunset, where they consume these macroinvertebrates. After sunrise they migrate to open water, where they graze, primarily on zooplankton. If harvesting or chemical control shifts the dominance of the littoral macroinvertebrate fauna to sediment dwellers, the macroinvertebrate component of the bluegill diet could be restricted.[17] This would increase predation pressure on zooplankton and reduce the growth rate of the panfish; it could eventually lead to undesirable ramifications throughout the food web in a lake.

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[15]*James E. Breck, and J.F. Kitchell, "Effects of Macrophyte Harvesting on Simulated Predator-Prey Interactions," edited by Breck* et. al.*, 1979, pp. 211-228.*

[16]*Wisconsin Department of Natural Resources,* Environmental Assessment Aquatic Nuisance Control (NR 107) Program*, 3rd Edition, 1990, 213 pp.*

[17]*James E. Breck, et. al.,* op. cit.

5. Macrophyte harvesting may influence the community structure of macrophytes by favoring such plants as milfoil (*Myriophyllum* spp.) that propagate from cut fractions. This may allow these plants to spread into new areas through the rerooting of the cut fractions.

6. Certain species of plants, such as coontail, are difficult to harvest due to lack of root system.

7. The efficiency of macrophyte harvesting is greatly reduced around piers, rafts, and buoys because of the difficulty in maneuvering the harvesting equipment in those restricted areas. Manual methods have to be used in these areas.

8. High capital and labor costs may be associated with harvesting programs.

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 utilize these dense beds.[18] 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. "Clear cutting" of aquatic plants and denuding the lake bottom of flora should be avoided. However, top cutting of plants such as Eurasian water milfoil, as shown in Figure 2, can be an effective control measure for these plants. The harvest of water lilies and emergent native plants, however, should be avoided. Mechanical harvesting is considered a feasible option for inclusion in the plan. Mechanical harvesting of aquatic plants must be permitted by the State under Chapter NR 109 of the *Wisconsin Administrative Code*.

Native aquatic plant communities contribute most effectively to the maintenance of good water quality by providing suitable habitat for desirable fish and other aquatic organisms which promote stable or increased property values and quality of life.[19] Protecting native aquatic plant communities from disturbances can help prevent Eurasian water milfoil from spreading within a lake. Recent studies show that native plants can effectively compete with Eurasian water milfoil. However, the exotic species tends to outcompete native plants when the lake's ecosystem is stressed.[20] Stress can be brought on by watershed pollution, shoreline development, changing water levels, boating activity, carp, and aquatic nuisance controls. The maintenance of a healthy aquatic plant community has been found to be the most efficient way of managing aquatic plants, as opposed to other means of managing problems once they occur.

Manual Harvesting

Due to water depth limitations imposed by the size and maneuverability of the harvesters, it is not always possible for harvesters to reach the shoreline of every property. Likewise, because of the cost and other concerns relating to the use of chemical herbicides, alternative measures for the control of aquatic plant growth in specific areas of the Lakes should be considered. A number of specially designed rakes are available from commercial outlets to assist lakefront homeowners in manually removing aquatic plants from the shoreline area. The advantages of these rakes are that they are easy and quick to use, and result in an immediate result, in contrast to chemical treatments that involve a waiting period. This method also removes the plants from the lake avoiding the

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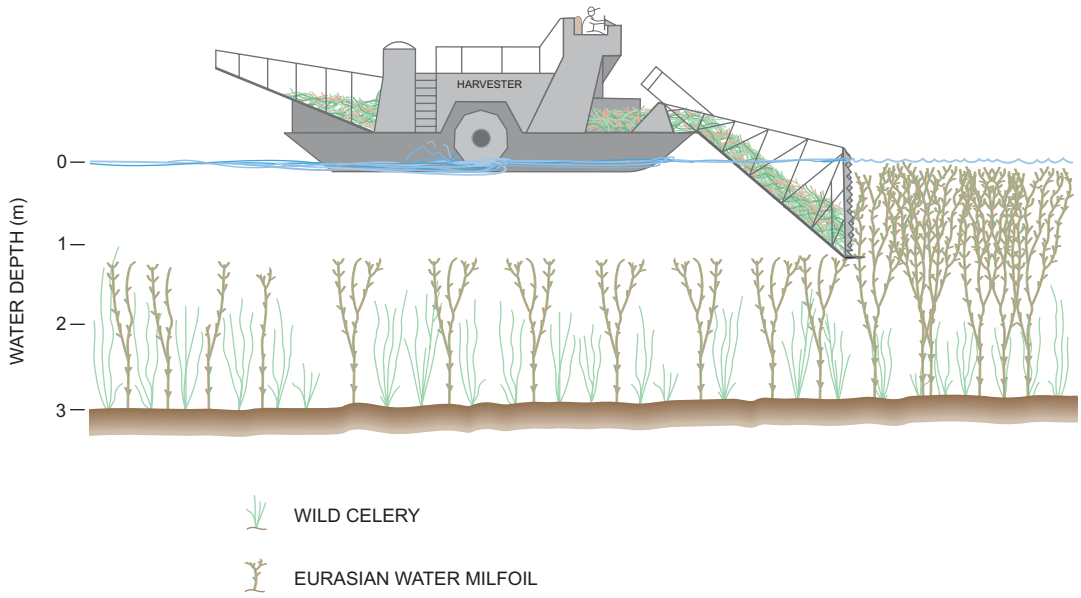
[18]*S. Nichols, Wisconsin Department of Natural Resources Technical Bulletin No. 77,* Mechanical and Habitat Manipulation for Aquatic Plant Management: A Review of Techniques, *1974.*

[19]*Roy Bouchard, Kevin J. Boyle, and Holly J. Michael,* Water Quality Affects Property Prices: A Case Study of Selected Maine Lakes, *Miscellaneous Report 398, February 1996.*

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

Figure 2

PLANT CANOPY REMOVAL WITH AN AQUATIC PLAN 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.

accumulation of organic matter on the lake bottom. Unfortunately, manual harvesting is feasible in only very limited areas and is not practical for large-scale use. Nevertheless, manual harvesting does offer a reasonable level of aquatic plant control in the vicinity of docks and piers, and is therefore considered a viable option. Manual harvesting beyond a 30-feet wide recreational corridor, or within a Wisconsin Department of Natural Resources-delineated environmentally sensitive area, must be permitted by the State under Chapter NR 109 of the *Wisconsin Administrative Code*. Pursuant to the provision of this Chapter, piers and other recreational areas must be placed within the 30-feet wide recreational corridor.

Biological Controls

Another alternative approach to controlling nuisance weed conditions, in this particular case Eurasian water milfoil, is biological control. Classical biological control has been successfully used to control both weeds and herbivorous insects.[21] Recent documentation states that *Eurhychiopsis lecontei*, an aquatic weevil species, has the potential as a biological control agent for Eurasian water milfoil. In 1989, the weevil was discovered during a study investigating a decline of Eurasian water milfoil growth in a Vermont pond. *Eurhychiopsis* proved to have significant negative effects on Eurasian water milfoil in the field and in the laboratory. The adult weevil feeds on the milfoil causing lesions which make the plant more susceptible to pathogens, such as bacteria or fungi, while the weevil larvae burrows in the stem of the plant causing enough tissue damage for the plant to lose buoyancy

[21]*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.*

and collapse.[22] The few studies that have been done since that time have indicated the following potential advantages to use of this weevil as a means of Eurasian water milfoil control:

1. *Eurhychiopsis lecontei* is known to cause fatal damage to the Eurasian water milfoil plant and over a period of time has the potential to cause a decrease in the milfoil population.

2. *Eurhychiopsis lecontei* larvae are easy to produce.

3. *Eurhychiopsis lecontei* are not known to cause damage to existing native aquatic plants.

The potential disadvantages of using *Eurhychiopsis lecontei* include:

1. The studies done on *Eurhychiopsis* are very recent and more tests are necessary to determine if there are significant adverse effects.[23]

2. Since the upper portion of the Eurasian water milfoil plant is preferred by the weevil, harvesting would have to be extremely limited or not used at all in conjunction with this type of aquatic plant management control.

Relatively few studies have been completed using *Eurhychiopsis lecontei* as a means of aquatic plant management control. These have resulted in variable levels of control, and, while priced competitively with aquatic herbicides, are not considered a viable option for the Phantom Lakes at this time. Use of biological control agents must be permitted by the State under Chapter NR 109 of the *Wisconsin Administrative Code*. While the use of biological control agents such as the Eurasian water milfoil weevil and the beetles, *Hylobius transversovittatus, Galerucella pusilla, Galerucella calmariensis, Nanophyes brevis,* and *Nanophyes marmoratus,* used to control infestations of purple loosestrife in wetlands and along shorelands has been shown to be beneficial in certain circumstances, the use of other biological control agents is prohibited in Wisconsin; the use of the grass carp, *Ctenopharyngodon idella*, for aquatic plant control is expressly prohibited.

Lake Bottom Covering

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 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. The screens are flexible and can be anchored to the lakebed in spring or draped over plants in summer.

The advantages of bottom covers and screens are that control can be confined to specific areas, the covers and screens are usually unobtrusive and create no disturbance on shore, and the covers are relatively easy to install over small areas. The disadvantages of bottom covers and screens are that they do not reduce eutrophication of the lake, they are expensive, they are difficult to spread and anchor over large areas or obstructions, they can slip on steep grades or float to the surface after trapping gases beneath them, and they may be difficult to remove or relocate.

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[22]*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.*

[23]*The use of* Eurhychiopsis *sp. on an experimental basis to control Eurasian water milfoil was monitored in selected Wisconsin lakes by the Wisconsin Department of Natural Resources and the University of Wisconsin-Stevens Point from 1995 through 1998. These results indicated mixed success, suggesting that this organism has specific habitat requirements that limit its utility as a Eurasian water milfoil control agent within Wisconsin.*

Screens and covers should not be used in areas of strong surfs, heavy angling, or shallow waters where motorboating occurs. They should also not be used where aquatic vegetation is desired for fish and wildlife habitat. To minimize interference with fish spawning, screens should be placed before or after spawning. A permit from the Wisconsin Department of Natural Resources is required for use of sediment covers and light screens. Permits require inspection by the Department staff during the first two years, with subsequent permits issued for three-year periods. Annual removal of such barriers is generally required as a permit condition.

The estimated cost of lake bottom covers that would control plant growth along a typical shoreline property, an area of about 700 square feet, ranges from $100 for burlap to $300 for aqua screen. Placement of lake bottom screens requires a WDNR permit pursuant to Chapter 30 of the *Wisconsin Statutes*. Because of the limitations involved, placement of lake bottom covers as a method to control aquatic plant growth is not considered a viable option for the Phantom Lakes.

Use of sand blankets and pea gravel deposits has also been proposed as a physical barrier to aquatic plant growth in certain situations. Placement of materials on the bed of a navigable lake or waterway also requires a WDNR permit pursuant to Chapter 30 of the *Wisconsin Statutes*, and the use of these materials is generally confined to the creation and augmentation of swimming beaches. Use of these materials for aquatic plant management purposes is not considered feasible as deposition of sediments above the sand or gravel layer limits the longer term viability of this technique.

Aquatic Plant Monitoring

A separate aquatic plant management plan is considered a viable option for inclusion in the management plan. Reconnaissance surveys of the aquatic plant communities on a regular basis, either annually or every two to four years, is considered a feasible option for inclusion into the management plan. Results of such surveys could indicate the necessity for the development of an aquatic plant management plan with subsequent updates every three to five years.

Public Informational Programming

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. As shown in Table 17 in Volume I, many aquatic plants have positive ecological value within the lake ecosystem, and most native aquatic plants rarely interfere with human water uses. Thus, public information is an important component of an aquatic plant management program and should include informational programming on:

1. The types of aquatic plants in the Phantom Lakes and their value to water quality, fish, and wildlife.

2. The preservation of existing stands of desirable plant species.

3. The identification of nuisance species and the methods of preventing their spread.

4. Alternative methods for controlling existing nuisance plants including the positive and negative aspects of each method.

An organized aquatic plant identification/education day is one method of providing hands-on education to lake residents. Other sources of information and technical assistance include the Wisconsin Department of Natural Resources and the University of Wisconsin-Extension Service. The aquatic plant species lists provided in Appendix C of this volume, and the illustrations of common aquatic plants present in that appendix, may serve as a checklist for individuals interested in identifying the plants near their residences. Residents can observe and record changes in the abundance and types of plants in their part of a lake on an annual basis.

Of the submerged floating and free-floating aquatic plant species found in the Phantom Lakes, Eurasian water milfoil is one of the few species likely to cause lake-use problems. Eurasian water milfoil, unlike most aquatic plants, can reproduce from fragments and often forms dense, monotypic beds with little habitat value for fish or waterfowl. Lakeshore residents should be encouraged to collect fragments that wash ashore after storms and, especially, from weekend boat traffic. The plant fragments can be used as mulch on flower gardens or ornamental planting areas. Likewise, lake users should be encouraged to inspect boats and trailers both prior to launch and following recovery as Eurasian water milfoil and other aquatic plants can be transported between lakes as fragments on boats and boat trailers. This effort also limits the likelihood of transporting zebra mussel, *Dreissena polymorpha*, between lakes and into new areas of the Lakes.

To prevent unwanted introductions of plants and invasive aquatic animals into lakes, boaters should remove all plant fragments from their boats and trailers when exiting a lake, and allow wet wells, engine water jackets, and bilges to dry thoroughly for up to one week—alternatively, boaters can run their vessels through a car wash, where high pressure, high temperature water sprays can remove and destroy organisms such as the zebra mussel juveniles (veligers).[24] Providing the opportunity for the removal of plant fragments at the boat landing on the Phantom Lakes, and provision of signage at boat landings, including provision of disposal containers at boat landings, may help motivate boaters to utilize this practice. Posters and pamphlets are available from the Wisconsin Department of Natural Resources and University of Wisconsin-Extension Service that provide information and illustrations of milfoil, zebra mussel, and other nonnative aquatic species; discuss the importance of removing plant fragments from boats; and, remind boaters of their duty in this regard.

In accordance with measures to prevent unwanted introductions and spread of invasive aquatic biota, as well as to monitor native aquatic plant populations, periodic reconnaissance and surveying updates of aquatic plant species, especially in proximity to the public recreational boating access sites, are considered viable options in this management plan.

Water Use Management

Regulatory measures provide a basis for controlling lake use and use of the shorelands around a waterbody. On land, shoreland zoning, requiring set backs and shoreland buffers can protect and preserve views both from the water and from the land, controls development around a lake to minimize its environmental impacts and manages public and private access to a waterbody. On water, recreational use zoning can provide for safe and multiple-purpose use of lakes by various groups of lake users and protect environmentally sensitive areas of a lake. Use zoning can take the form of allocating times of use, such as the annual fishing season established by the State, or areas of use, wherein the types or rate of use is controlled, as in the case of shallow water, slow-no-wake speed limits.

A key issue in zoning a waterbody for use is equity; the same rules must apply to both riparian owners/residents and off-lake users. This condition is usually met in situations where use zoning is motivated by the protection of fish habitat, for example, as both on- and off-lake users would appreciate an enhanced fishery. Costs are relatively low, associated with creating and posting the ordinance, and effectiveness can be good with regular/consistent enforcement. Costs increase for measures requiring buoyage.

Currently, watercraft are restricted to slow-no-wake speeds within approximately 200 feet of shore or 150 feet of pierheads. These areas typically coincide with water depths of less than five feet in depth. Demarcation of Wisconsin Department of Natural Resources-delineated sensitive areas, Eurasian water milfoil control areas, and similar environmentally valuable or sensitive areas of the Lakes are considered a viable option for inclusion in the management plan. Governmental bodies surrounding the Phantom Lakes should continue to enforce recreational boating ordinances and winter lake use ordinances appended hereto as Appendix B.

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[24]*See Wisconsin Department of Natural Resources Publication No. PUBL-WR-383 95-REV.,* Zebra Mussel Boater's Guide, *1995; Wisconsin Department of Natural Resources Publication No. PUBL-WR-463 96-REV.,* The Facts...On Eurasian Water Milfoil, *February 1996.*

ANCILLARY MANAGEMENT MEASURES

Public Informational and Educational Programming

Educational and informational brochures and pamphlets, of interest to homeowners and supportive of the recreational use and shoreland zoning regulations, are available from the University of Wisconsin-Extension Service, the Wisconsin Department of Natural Resources, and the Waukesha County Department of Parks and Land Use. These latter cover topics, such as beneficial lawn care practices and household chemical use guidelines. These brochures could be provided to homeowners through local media, direct distribution, or targeted school or public library displays. Other Waukesha County lake organizations, in cooperation with the Waukesha County Department of Parks and Land Use, have compiled and distributed information packets to landowners on water quality protection measures and residential "good housekeeping" practices. Many of these ideas can be integrated into ongoing, larger-scale municipal activities such as anti-littering campaigns, recycling drives, and similar pro-environment activities.

In addition to public informational programming, or informal educational programming, discussed above, there are a number of school-based educational opportunities that the community can utilize. A number of these programs are currently being implemented at the middle school level throughout the region. Extension of these educational opportunities at the high school level is recommended. Programs and curricula such as Project WET, Adopt-A-Lake, and the Waukesha Water Walk program are available from and supported by the University of Wisconsin-Extension and Waukesha County, respectively. Through these programs, youth have an opportunity to experience "hands on" the aquatic environment and become better informed about current and future lake issues and concerns.

Finally, the participation of the Phantom Lakes community in the Wisconsin Department of Natural Resources Self-Help Monitoring Program should be continued. Volunteer monitoring under the auspices of the Wisconsin Department of Natural Resources "Self-Help Monitoring Program" involves citizens in taking Secchi-disc transparency readings in the Lakes at regular intervals. The Lake Coordinator of the Wisconsin Department of Natural Resources-Southeast Region can assist in enlisting volunteers in this program. The information gained at first hand by the public during participation in this program increases the credibility of the proposed changes in the nature and intensity of use to which the Lakes are subjected.

SUMMARY

This chapter has described options that could be employed in managing the types of problems recorded as occurring in the Phantom Lakes and which could, singly or in combination, assist in achieving and maintaining the water quality and water use objectives set forth in Chapter VI of Volume I. Selected characteristics of these measures are summarized in Table 1.

An evaluation of the potential management measures for improving the Phantom Lakes' water quality was carried out on the basis of the effectiveness, cost, and technical feasibility of the measures. Those alternative measures not considered further at this time include: phosphorus precipitation and inactivation, drawdown by water level control modifications, dredging, biological control of aquatic plants, lake bottom covering, and development of alternative institutions. The measures to be considered further for incorporation into the recommended plan are described in Chapter III.

Table 1

SELECTED CHARACTERISTICS OF ALTERNATIVE LAKE MANAGEMENT MEASURES FOR THE PHANTOM LAKES

Plan Element	Subelement	Alternative Management Measures	Estimated Costs: 2000		Considered Viable for Inclusion in Plan
			Capital	Operation and Maintenance	
Land Use	Zoning	Implement regional land use and county development plans within watershed	- -	- -	Yes
		Maintain existing density management in lakeshore areas; consider conservation development principles	- -	- -	Yes
		Develop and implement consistent stormwater management ordinances in all riparian communities; periodic review of stormwater ordinances	- -	- -	Yes
	Protecting environmentally sensitive lands	Implement regional natural areas and critical species habitat protection and management plan recommendations within watershed	- -	- -	Yes
Pollution Abatement	General nonpoint source pollution abatement	Implement regional water quality management plan, and county land and water resource management plan recommendations within watershed	- -	- -	Yes
	Rural nonpoint source controls	Develop farm conservation plans that encourage conservation tillage, contour farming, contour strip cropping, crop rotation, grassed waterways, and pasture and streambank management in agricultural areas of the watershed	- -[a]	- -[a]	Yes
	Urban nonpoint source controls	Promote urban housekeeping practices, public educational programming, and grassed swales	- -[a]	- -[a]	Yes
		Implement additional urban nonpoint source controls, including street sweeping, catch basin cleaning, leaf litter and garden refuse collection, materials storage facility protection, and stormwater management measures in urban areas of the watershed	- -[a]	- -[a]	Yes
	Developing area nonpoint source controls	Enforce construction site erosion control ordinances requiring soil stabilization, surface roughening, barriers, diversion swales, sediment traps and basins	$250 per acre	$25 per acre	Yes
	Onsite sewage disposal system management	Implement onsite sewage disposal system management, including inspection and maintenance	- -	$100[b]	Yes

Table 1 (continued)

Plan Element	Subelement	Alternative Management Measures	Estimated Costs: 2000		Considered Viable for Inclusion in Plan
			Capital	Operation and Maintenance	
Water Quality	Phosphorus and nutrient load management	Conduct alum treatment to achieve phosphorus inactivation in lake sediments	- -	$30,000[c]	No
		Promote nutrient load reduction within the Lake basin through sediment management	- -	Variable	No
	Hydraulic and hydrologic management	Modify outlet control operations	- -	- -	No
		Drawdown	- -	- -	No
		Water level stabilization	- -	- -	No
		Dredging	- -	- -	No
Aquatic Biota	Fisheries management	Protect fish habitat	- -	- -	Yes
		Maintain shoreline and littoral zone fish habitat by maintaining existing shoreline structures and repair as necessary using vegetative means insofar as practicable; recon-struction may require WDNR Chapter 30 permits	- -	- -	Yes
		Continue stocking of selected game fish species and monitor rough fish populations	- -	- -	Yes
		Enforce size and catch limit regulations	- -	$1,200	Yes
	Aquatic plant management	Limited use of aquatic herbicides for control of nuisance plants such as Eurasian water milfoil and purple loosestrife	- -	Variable	Yes[d]
		Mechanical harvesting of aquatic macrophytes to control nuisance plants and maintain navigational channels	$100,000[e]	$10,000-$25,000[f]	Yes
		Manually harvest aquatic plants from around docks and piers	$100	$100	Yes
		Employ biological controls using inocula of Eurasian water milfoil weevils	- -	Variable	No
		Use sediment covers to shade out aquatic plant growth around piers and docks	- -	$40 to $220 per 700 square feet	No
		Conduct public informational and educational programming on aquatic plants and options for their management	- -	$100 to $300	Yes
		Collect floating plant fragments from shoreland areas to minimize rooting of Eurasian water milfoil	- -	- -	Yes
		Encourage methods of preventing unwanted intrusions of invasive biota at public recreational boat access	$500	$100	Yes

Table 1 (continued)

Plan Element	Subelement	Alternative Management Measures	Estimated Costs: 2000		Considered Viable for Inclusion in Plan
			Capital	Operation and Maintenance	
Water Use	Recreational use management	Enforce boating regulations to maximize public safety; improve signage	$500	$100[g]	Yes
		Develop time and/or space zoning schemes to limit surface use conflicts	- -	- -	No
Ancillary Management Measures	Public informational and educational programming	Conduct public informational programming utilizing seminars and distribution of informational materials	- -	$1,200	Yes
		Support participation of schools in Project WET, Adopt-A-Lake, etc.	- -	- -	Yes
		Continue participation in Self-Help Monitoring Program	- -	$200	Yes
	Institutional development	Create a private lake association for Phantom Lakes	- -	- -	No

[a]*Cost of nonpoint source management practices to be determined by detailed farm plans and stormwater management plans.*

[b]*Onsite sanitary sewage disposal systems installed after 1983 are subject to regular inspection and maintenance requirements under Waukesha County Code; the cost shown represents an average pumping cost per property. (Note: the lakeshore areas of Ashippun Lake are served by onsite sewage disposal systems.)*

[c]*Based on a one-time application of 200 tons to treat 80 acres at an estimated cost of $150 per ton.*

[d]*In limited areas when necessary to control exotic, invasive species.*

[E]*Cost-share available through the Wisconsin Department of Natural Resources may lower capital cost.*

[f]*Dependent upon staffing needs and cost-share availability through the Wisconsin Department of Natural Resources.*

[g]*Cost for improved signage.*

Source: SEWRPC.

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Chapter III

RECOMMENDED MANAGEMENT PLAN FOR THE PHANTOM LAKES

INTRODUCTION

This chapter presents a recommended management plan for the Phantom Lakes. The plan is based upon inventories and analyses of land use and land and water management practices, pollution sources in the drainage area tributary to the Phantom Lakes, the physical and biological quality of the waters of the Lakes, and recreational use and population forecasts set forth in Volume I, and an evaluation of alternative lake management measures set forth in Chapter II of this volume. The recommended plan sets forth means for: 1) providing water quality conditions suitable for full-body contact recreational use and the maintenance of healthy communities of warmwater fish and other aquatic life, 2) reducing the severity of existing or perceived problems which constrain or preclude desired water uses, 3) improving opportunities for water-based recreational activities, and 4) protecting environmentally sensitive areas. The elements of the recommended plan were selected from among the alternatives described in Chapter II, and evaluated on the basis of those feasible alternatives, set forth in Table 1, that may be expected to best meet the foregoing lake management objectives. Ancillary actions to address emerging community concerns over, among others, groundwater are also included.

CURRENT STATUS OF THE PHANTOM LAKES AND RATIONALE FOR MANAGEMENT

Analyses of water quality and biological conditions indicate that the general condition of the water of the Phantom Lakes is good. There appear to be few impediments to water-based recreation, although access by recreational watercraft is limited in some portions of the Lakes by water depths and growths of aquatic macrophytes. Nevertheless, based upon a review of the inventory findings and consideration of planned developments within the drainage area tributary to the Lakes, as set forth in the adopted Waukesha County development plan and summarized in Volume I, measures will be required to continue to protect and maintain the high quality of the Lakes for future lake users. Therefore, this plan sets forth recommendations for: land use management in the drainage area tributary to the Phantom Lakes, protection of environmentally sensitive lands, nonpoint source pollution controls, water quality improvement, hydraulic and hydrologic management, aquatic plant and fisheries management, recreational use management, and informational programming. These measures complement and

refine the watershedwide land use controls and management measures recommended in the adopted regional water quality management plan[1] and the Waukesha County land and water resource management plan.[2]

The recommended management measures for the Phantom Lakes are graphically summarized on Map 3, and are listed in Table 2. The recommended plan measures are more fully described in the following paragraphs. The recommended management agency responsibilities for watershed land management also are set forth in Table 2.

WATERSHED MANAGEMENT RECOMMENDATIONS

Land Use Management

A fundamental element of a sound management plan and program for the Phantom Lakes is the promotion of a sound land use pattern within the drainage area tributary to the Lakes. The type and location of rural and urban land uses in the drainage area will determine, to a considerable degree, the character, magnitude, and distribution of nonpoint sources of pollution; the practicality of, as well as the need for, various land management measures; and, ultimately, the water quality of the Lakes. In addition, urban growth will modify the demand for water, recreational facilities, and waste management services that can affect the aquatic environment of the Phantom Lakes.

The recommended land use plan for the drainage area tributary to the Phantom Lakes under buildout conditions is described in Chapter III of Volume I. The framework for the plan is the regional land use plan as prepared and adopted by the Southeastern Wisconsin Regional Planning Commission (SEWRPC), as refined through the Waukesha County development plan.[3] The recommended land use and county development plans envision that urban land use development within the drainage area tributary to the Phantom Lakes will occur primarily at low densities and only in areas which are covered by soils suitable for the intended use; which are not subject to special hazards such as flooding; and which are not environmentally sensitive, that is, not encompassed within the Regional Planning Commission-delineated environmental corridors described in Chapter V of Volume I.

Development in the Shoreland Zone

A major land use issue which has the potential to affect the Phantom Lakes is the redevelopment of existing lakefront properties, replacing lower-density uses with higher-density, multi-family dwellings with potential for increased roof areas, parking areas, and other areas of impervious surfaces. Replacement of a pervious land surface with an impervious surface will increase the rate of stormwater runoff to the Lakes, increase pollutant loadings on the Lakes, and will reduce groundwater recharge. While these effects can be moderated to some extent through structural stormwater management measures, there is likely to be an adverse impact on the Lakes from significant redevelopment in the drainage area tributary to the Lakes involving conversion to higher-density land uses. For this reason, maintenance of the historic low- and medium-density residential character of the shoreline of the Phantom Lakes to the maximum extent practical is recommended.

It is further recommended that lakefront developments, as well as setback and landscaping provisions, be carefully reviewed by Waukesha County, the Town and Village of Mukwonago and the Wisconsin Department of

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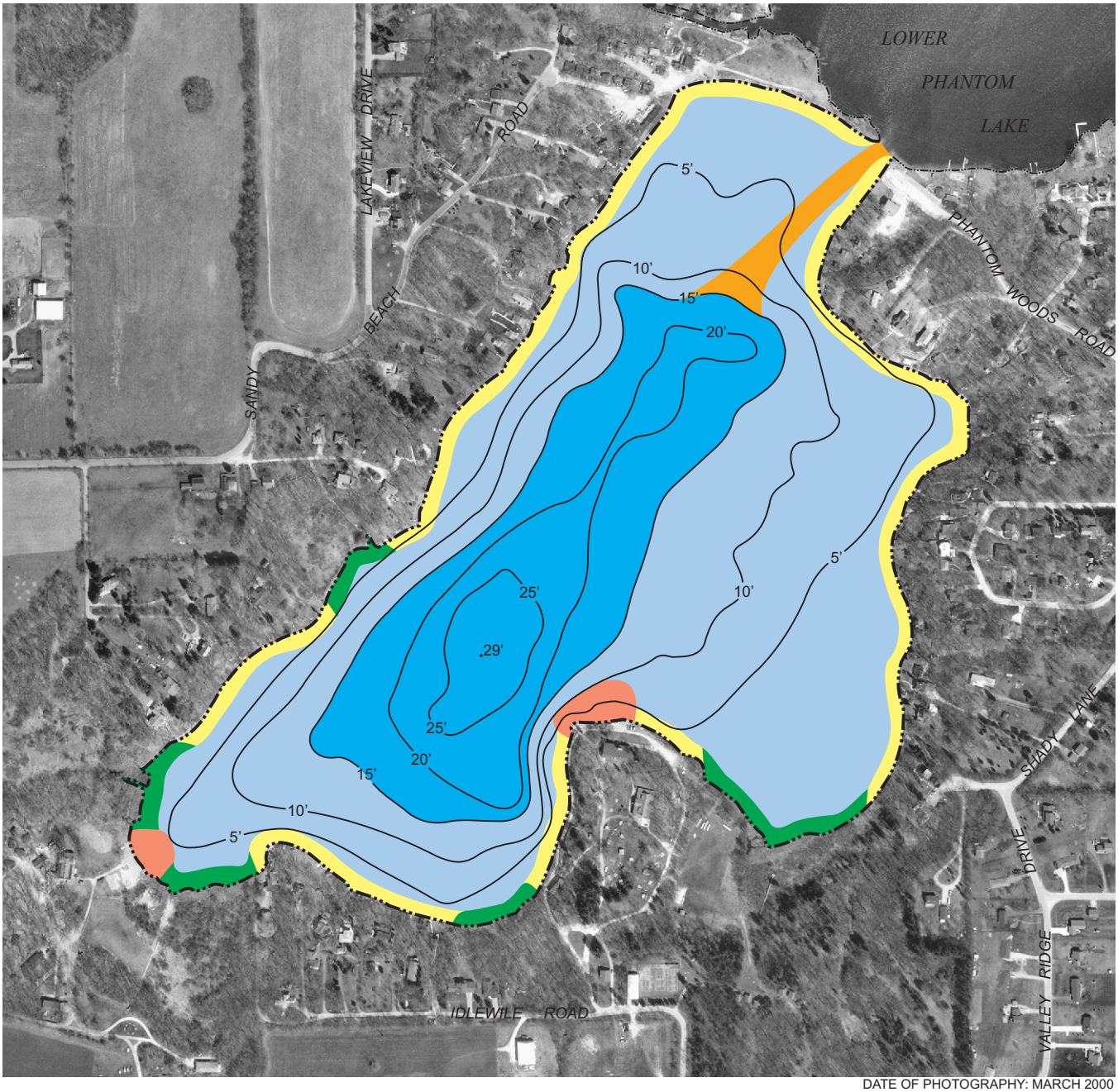
[1]SEWRPC Planning Report No. 30, *A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000*, Volume One, *Inventory Findings*, September 1978; Volume Two, *Alternative Plans*, February 1979; and Volume Three, *Recommended Plan*, June 1979. See also SEWRPC Memorandum Report No. 93, *A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report*, March 1995.

[2]*Waukesha County*, Land and Water Resource Management Plan: 1999-2002, *December 1998.*

[3]*SEWRPC Community Assistance Planning Report No. 209,* A Development Plan for Waukesha County, Wisconsin, *August 1996.*

Map 3

RECOMMENDED AQUATIC PLANT MANAGEMENT PLAN FOR UPPER PHANTOM LAKE



DATE OF PHOTOGRAPHY: MARCH 2000

—20′— WATER DEPTH CONTOUR IN FEET

OPEN WATER
- NO CONTROL

ENVIRONMENTALLY VALUABLE AREA
- NO CONTROL

SWIMMING AREA
- MANUAL HARVEST NEAR SHORE
- MECHANICAL HARVEST OFF SHORE
- LIMITED HERBICIDE USE TO CONTROL NONNATIVE SPECIES AND ALGAE

HABITAT AND MIXED USE AREA
- MONITOR NONNATIVE SPECIES
- HARVEST AS NECESSARY TO MAINTAIN BOATING ACCESS

SHORELAND AREA
- MAINTAIN SHORELINE VEGETATION
- MANUAL HARVEST AROUND PIERS AND DOCKS
- MONITOR SHORELINE AND NEAR SHORE AREA FOR NONNATIVE SPECIES

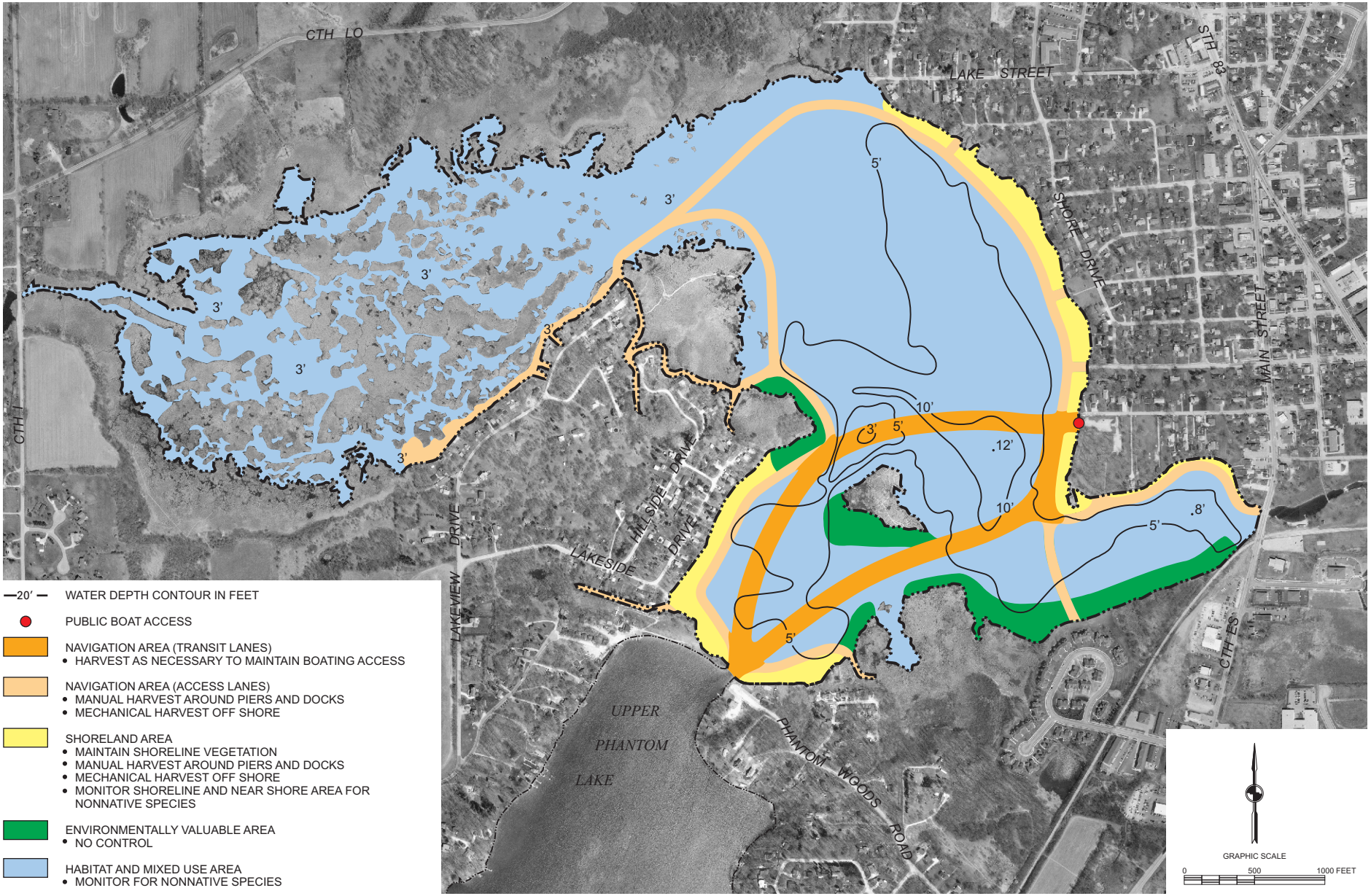
NAVIGATION AREA
- HARVEST AS NECESSARY TO MAINTAIN BOATING ACCESS

GRAPHIC SCALE
0 300 600 FEET

Source: SEWRPC.

Map 3 (continued)

RECOMMENDED AQUATIC PLANT MANAGEMENT PLAN FOR LOWER PHANTOM LAKE



Source: SEWRPC.

Table 2

RECOMMENDED MANAGEMENT PLAN ELEMENTS FOR THE PHANTOM LAKES

Plan Element	Subelement	Location	Recommended Management Measures	Management Responsibility
Land Use	Zoning	Entire watershed	Observe guidelines set forth in the regional land use plan and Waukesha County development plan	Waukesha County, Town of Mukwonago, Village of Mukwonago
		Lakeshore areas	Maintain historic lake front residential dwelling densities to extent practicable and continue to enforce setback requirements; consider conservation development principles	Waukesha County, Town of Mukwonago, Village of Mukwonago
		Entire watershed	Develop and periodically review ordinances especially in regard to stormwater management in development areas; adoption of common stormwater ordinances by all riparian municipalities	Waukesha County, Town of Mukwonago, Village of Mukwonago
		Groundwater recharge areas	Consider development of a groundwater recharge area protection ordinance and zoning overlay district, especially adjacent to Upper Phantom Lake	Waukesha County, Town of Mukwonago, Village of Mukwonago
	Protecting environmentally sensitive lands	Phantom Lakes, Mukwonago Fen, Sedge Meadow, and Tamarack Relict, Phantom Lake Wetlands, Mukwonago River undeveloped shoreline	Establish adequate protection of wetlands and shorelands, and other environmental corridor lands and isolated natural features, and consider public or private acquisition of features of local or greater significance, as set forth in the regional natural areas and critical species habitat protection and management plan	Waukesha County, Town of Mukwonago, Village of Mukwonago, Phantom Lakes Management District
Pollution Abatement	General nonpoint source pollution abatement	Entire watershed	Implement recommendations made in the county and regional plans for management of land and water resources	Waukesha County, Town of Mukwonago, Village of Mukwonago
	Rural nonpoint source controls	Entire watershed	Promote sound rural land management practices to reduce soil loss and contaminant loadings through preparation of farm conservation plans in accordance with the county land and water resource management plan	USDA, WDATCP, Waukesha County
	Urban nonpoint source controls	Entire watershed	Promote sound urban housekeeping and yard care practices through informational programming	Waukesha County, Town of Mukwonago, Village of Mukwonago, Phantom Lakes Management District
			Implement various urban nonpoint source controls including stormwater management measures	Waukesha County, Town of Mukwonago, Village of Mukwonago
	Developing area nonpoint source controls	Entire watershed	Develop and enforce construction site erosion control and stormwater management ordinances; review ordinances for concurrence with NR 152	Waukesha County, Town of Mukwonago, Village of Mukwonago

Table 2 (continued)

Plan Element	Subelement	Location	Recommended Management Measures	Management Responsibility
Pollution Abatement (continued)	Developing area nonpoint source controls (continued)	New clustered developments in conservation subdivisions	Develop stormwater management systems where appropriate densities exist	Waukesha County, Town of Mukwonago, Village of Mukwonago
	Onsite sewage disposal system management	Unsewered portions of the watershed	Inspect and maintain onsite sewage disposal systems and provide system maintenance information to residents	Waukesha County, Town of Mukwonago, Phantom Lakes Management District, private landowners
	Public sanitary sewer system management	Sewered portions and urbanizing portions of the watershed	Periodically review and refine the sewer service area with the Village of Mukwonago and environs	Village of Mukwonago, Town of Mukwonago, Phantom Lakes Management District
Water Quality	Surface water quality management	Main lake basin	Continue participation in Expanded WDNR Self-Help Monitoring Program Consider periodic participation in U.S. Geological Survey or University of Wisconsin-Stevens Point Environmental Task Force TSI monitoring program	WDNR, USGS, UW-SP, Phantom Lakes Management District
Aquatic Biota	Fisheries management	Entire lake	Conduct fish survey to determine management and stocking needs; conduct periodic creel census Continue stocking of selected game fish species and monitor populations of rough fish Enforce size and catch limit regulations	WDNR, Phantom Lakes Management District, private sports organizations
		Lakeshore areas	Protect and maintain fish habitat in shoreline and littoral zone areas, and especially in sensitive areas Encourage shoreline restoration projects and promote consistency in application of landscaping practices in sensitive shoreland areas, through informational programming and demonstration sites Maintain existing shoreline structures and repair as necessary using vegetative means insofar as practicable; reconstruction may require WDNR Chapter 30 permits	WDNR, Phantom Lakes Management District, private landowners
	Aquatic plant management	Entire lake	Conduct periodic reconnaissance surveys of aquatic plant communities Update aquatic plant management plan every three to five years Provide and conduct programming and information on aquatic plants and various management measures	WDNR, Phantom Lakes Management District

Table 2 (continued)

Plan Element	Subelement	Location	Recommended Management Measures	Management Responsibility
Aquatic Biota (continued)	Aquatic plant management (continued)	Selected areas of the Lake	Manually harvest aquatic plants from around docks and piers Limited use of chemical aquatic herbicides to control nuisance aquatic plants such as purple loosestrife and Eurasian water milfoil where necessary Harvest aquatic plants as required to facilitate recreational boating access; restrict harvesting in spring and autumn to avoid disturbances in fish breeding areas and WDNR-delineated sensitive areas	WDNR, Phantom Lakes Management District
		Lakeshore areas	Collect floating plant fragments from shoreland areas to minimize rooting of Eurasian water milfoil and deposition of organic materials in Lake	Private landowners
Water Use	Recreational use management	Entire lake	Enforce regulations governing the operation of watercraft and improve posting and notification of regulations and ordinances, including signage and materials at public recreational access site to aid in the identification and control of exotic species	Waukesha County, Town of Mukwonago, Village of Mukwonago, WDNR, Phantom Lakes Management District
Ancillary Management Measures	Public informational and educational programming	Entire watershed	Conduct informational and educational seminars and programs and distribute informational and educational materials	Waukesha County, Town of Mukwonago, Village of Mukwonago, WDNR, Phantom Lakes Management District
		Entire lake	Support the participation of local schools in Project WET, Adopt-A-Lake, etc.	Waukesha County, Town of Mukwonago, Village of Mukwonago, WDNR, Phantom Lakes Management District

Source: SEWRPC.

Natural Resources (WDNR). Such review would address specific shoreland zoning requirements, and could consider the stormwater and urban nonpoint source pollution abatement practices proposed to be included in shoreland development activities. Provision for shoreland buffers, use of appropriate and environmentally friendly landscaping practices, and inclusion of stormwater management measures that provide water quality benefits are practices to be encouraged. Similarly, given that Upper Phantom Lake is a groundwater-fed drained lake, consideration should be given by the County, Town and Village to the formulation of appropriate groundwater protection ordinances that guide development in critical recharge areas tributary to Upper Phantom Lake. Such critical areas should be identified by the relevant agencies in cooperation with the Regional Planning Commission, U.S. Geological Survey, Wisconsin Geologic and Natural History Survey and the University of Wisconsin-Madison, compilers of the regional ground water management model[4] that could be utilized as a basis for the local refinement necessary to underpin any future ordinance.

[4] *SEWRPC Technical Record No. 37,* Groundwater Resources of Southeastern Wisconsin*, June 2002.*

Development in the Tributary Drainage Area

Another land use issue which has the potential to affect the Lakes is the potential development for urban uses of the agricultural and other open space lands in the tributary drainage area. As previously noted, large-lot residential development is occurring in areas of the lake watershed in which such development was not envisioned in the adopted regional land use plan. If this trend continues, much of the open space areas remaining in the drainage area will be replaced over time with large-lot urban development. This may significantly increase the pollutant loadings to the Lakes and increase the pressures for recreational use of the Lakes. Under the full buildout condition envisioned under the Waukesha County development plan,[5] a significant portion of the undeveloped lands outside of the environmental corridors and other environmentally sensitive areas, could potentially be developed for low-density urban uses.

The existing zoning in the drainage basin permits development, generally on large suburban-density lots, over much of the remaining open lands other than the environmental corridors. Control of shoreland redevelopment, and the related intensification of use, is not specifically addressed in the existing zoning codes. It is recommended that the impact of future land use development on the Phantom Lakes be minimized through review and modification of the applicable zoning ordinance regulations and zoning district maps to address the concerns noted. Changes in zoning ordinances are recommended to minimize the areal extent of development by providing specific provisions and incentives for the clustering of residential development on smaller lots within conservation subdivisions, thus preserving significant portions of the open space within each property or group of properties considered for development.

Further, development and adoption of a groundwater protection ordinance for the lands within the ground-watershed of Upper Phantom Lake is recommended. Given the significant proportion of the hydrological budget of this waterbody that is supplied by the surfacial aquifer within the Regional groundwater system, detailed groundwater modeling should be undertaken in assessing the potential consequences of land use changes within the approximately 600-acre groundwatershed tributary to this Lake. While the outputs of such detailed modeling may not necessarily result in decisions that differ from those currently being made, such outputs would lead to better-informed decisions, made with full recognition of the potential consequences of such decisions on the water resources that form such a central focus of this lake-oriented community and its local economy. Notwithstanding, the essential features of sound groundwater protection are recommended to be embodied in a groundwater protection ordinance, jointly agreed by both the Town and Village of Mukwonago, insofar as the provision of such an ordinance affect the shared water resources of the Phantom Lakes.

Stormwater Management on Development Sites

It is recommended that Waukesha County, the Town of Mukwonago and the Village of Mukwonago take an active role in promoting urban nonpoint source pollution abatement. Actions to promote urban nonpoint source pollution abatement would include the conduct of specific stormwater management planning within specific portions of the drainage area located within each municipality where further urban development or redevelopment is anticipated. Such a planning program should include a review of the stormwater management ordinances, to ensure that the ordinance provisions reflect state-of-the-art runoff and water quality management requirements, and to ensure that there is harmony between the ordinances governing urban density development in each of the municipalities draining to the Phantom Lakes. Adoption by both riparian municipalities of common stormwater management ordinance provisions is strongly recommended.

Protection of Environmentally Sensitive Lands

Wetland, woodland, and groundwater recharge area protection can be accomplished through land use regulation and public land acquisition of critical lands. Both measures are recommended for the drainage area tributary to the Phantom Lakes. The wetland areas within the drainage area tributary to the Lakes are currently largely protected through the existing regulatory framework provided by the U.S. Army Corps of Engineers permit program, State shoreland zoning requirements, and local zoning ordinances. Nearly all wetland areas in the Phantom Lakes

[5]Ibid.

drainage area are included in the environmental corridors delineated by the Regional Planning Commission and protected under one or more of the existing Federal, State, County, and local regulations. Consistent and effective application of the provisions of these regulations is recommended.

Notwithstanding, some wetland and woodland areas have been identified for acquisition in the adopted regional natural areas and critical species habitat protection and management plan, including the Phantom Lakes Wetlands, Mukwonago Fen, Sedge Meadow, and Tamarack Relict, and the Upper Mukwonago river.[6] Public acquisition of these lands is recommended. In this regard, implementation of the recommendations of the adopted park and open space plan for Waukesha County[7] would complement the protection and preservation of these environmentally sensitive lands.

Pollution Abatement and Stormwater Management

The recommended watershed land management measures are specifically aimed at reducing the water quality impacts on the Phantom Lakes of nonpoint sources of pollution within the tributary drainage area. These measures are set forth in the aforereferenced regional water quality management plan and the Waukesha County land and water resource management plan. As indicated in the lake and watershed inventory, the only significant sources of phosphorus loading to the Lake that are subject to potential controls are rural and urban nonpoint sources, and onsite sewage disposal systems in the drainage area.

Nonpoint source control measures should be considered for the areas tributary to the Phantom Lakes, including the upstream tributary drainage area. The regional water quality management plan recommended a reduction of about 25 percent in urban and rural, nonpoint-sourced pollutants plus streambank erosion controls, construction site erosion controls, and onsite sewage disposal system management, where applicable, be achieved in the drainage area directly tributary to the Phantom Lakes. Greater nonpoint-sourced pollution load reductions were recommended for upstream areas of the Mukwonago River watershed within the drainage area directly tributary to Lulu and Eagle Spring Lakes. Such reductions in these headwater areas of the River would have concomitant benefit for the downstream Phantom Lakes and Fox River drainage system.

Nonpoint source pollution abatement controls in the drainage area are recommended to be achieved through a combination of rural agricultural nonpoint controls, urban stormwater management, and construction erosion controls. Included within this array of management measures are measures to protect and preserve the riparian wetlands and floodlands that form an essential buffer within the land and water ecotone. The implementation of the land management practices described below may be expected to result in a reduction in nonpoint-sourced pollutants that is considered to be the maximum practicable given the findings of the inventories and analyses compiled during the planning effort. These measures are consistent with the recommended measures set forth in the Waukesha County land and water resource management plan.

Rural Nonpoint Source Pollution Controls

The implementation of nonpoint source pollution controls in rural areas requires the cooperative efforts of the Town of Mukwonago, Waukesha County, and private landowners. Technical assistance can be provided by the U.S. Department of Agriculture Natural Resources Conservation Service; the Wisconsin Department of Agriculture, Trade and Consumer Protection; and the Waukesha County Department of Parks and Land Use. As discussed previously, it is recommended that the Town of Mukwonago, in coordination with the Wisconsin Department of Natural Resources, and Waukesha County, develop a strategy to address nonpoint source pollution. State and Federal soil erosion control and water quality management programs, individually or in combination, can be used to achieve pollutant reduction goals. Such programs include the U.S. Department of Agriculture

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

[7]*SEWRPC Community Assistance Planning Report No. 137,* A Park and Open Space Plan for Waukesha County, *December 1989.*

Environmental Quality Incentive Program (EQIP), the Wisconsin Department of Natural Resources runoff management and lake protection programs, and various local land acquisition initiatives.

Highly localized, detailed, and site-specific measures are required to effectively reduce soil loss and contaminant runoff in rural areas. These measures are best defined and implemented at the local level through the preparation of detailed farm conservation plans. Practices which are considered most applicable within the drainage area tributary to the Phantom Lakes include conservation tillage, integrated nutrient and pesticide management, and pasture management. In addition, it is recommended consideration be given to cropping patterns and crop rotation cycles, with attention to the specific topography, hydrology, and soil characteristics for each farm. A reduction of about 25 percent in the nonpoint source loading from rural lands could provide a similar reduction in total phosphorus loadings to Lower Phantom Lake, potentially reducing the nonpoint-sourced phosphorus load from agricultural and open lands from about 40 percent of the nutrient load to Lower Phantom Lake to about 30 percent of the load. Implementation of the recommendations and work planning activities set forth in the Waukesha County land and water resource management plan would constitute a major step toward implementation of these lake management recommendations.

The cost of the needed measures will vary depending upon the details of the recommended farm conservation plans. These costs may be expected to be incurred to a large extent for purposes of agricultural land erosion control in any case. As noted above, with the promulgation of Chapters NR 153 and NR 154 of the *Wisconsin Administrative Code*, which became effective during October 2003, cost-share funding may be available to encourage installation of appropriate land management measures. Likewise, cost-share funding may be available under the Chapter NR 120 nonpoint source pollution abatement program.

Urban Nonpoint Source Pollution Controls

The development of urban nonpoint source pollution abatement measures for the Phantom Lakes areas should be the primary responsibility of the Village of Mukwonago and the Town of Mukwonago to the extent that Town lands are developed at urban densities. Urban nonpoint source pollution abatement measures in the Town of Mukwonago are recommended to be supported by Waukesha County. In addition to the adoption of stormwater management ordinances, the most viable measures to control urban nonpoint sources of pollution appear to be good urban land management and urban housekeeping practices. Such practices consist of fertilizer and pesticide use management, litter and pet waste controls, and management of leaf litter and yard waste. The promotion of these measures requires an ongoing public informational program. It is recommended that the Phantom Lakes Management District, in cooperation with the Town, Village and County, take the lead in sponsoring such programming for the Phantom Lakes community through regular public informational meetings and mailings. The District should also ensure that relevant literature, available through the University of Wisconsin-Extension Service and the WDNR, is made available at these meetings and at the local Public Library and government offices.

As an initial step in carrying out the recommended urban practices, it is recommended that a fact sheet identifying specific residential land management measures beneficial to the water quality of the Phantom Lakes be prepared and distributed to property owners. This fact sheet could be distributed by the Village and Town of Mukwonago and the Phantom Lakes Management District, with the assistance of the University of Wisconsin-Extension. The recommended measures may be expected to provide about a 25 percent reduction in urban nonpoint source pollution runoff and a similar reduction in total phosphorus loadings to Lower Phantom Lake.

Developing Areas Nonpoint Source Pollution Controls

It is recommended that the Village of Mukwonago and Waukesha County and the Town of Mukwonago continue efforts to control soil erosion attendant to construction activities in accordance with existing ordinances. As noted in Chapter III of Volume I, Waukesha County has adopted construction erosion control ordinances. Enforcement of the ordinances by the County is generally considered effective. The provisions of these ordinances apply to all development within the unincorporated areas of the County except single- and two-family residential construction. The single- and two-family construction erosion control is to be carried out as part of the building permit process. Within the Village of Mukwonago, Village building and construction site ordinances apply.

Construction site erosion controls may include the use of silt fences, sedimentation basins, rapid revegetation of disturbed areas; the control of "tracking" from the site; and careful planning of the construction sequence to minimize the areas disturbed. Construction site erosion control is particularly important in minimizing the more severe localized short-term nutrient and sediment loadings to the Phantom Lakes that can result from uncontrolled construction sites. Consideration should be given to incorporating construction site erosion control measures into a formal stormwater management system serving larger developments following construction.

Construction site erosion control measures may be expected to reduce the phosphorus loading from that source by about 80 percent. Because of the potential for development in the tributary drainage area to the Phantom Lakes, it is important that adequate construction erosion control programs be in place.

The cost for construction site erosion control will vary depending upon the amount of land under construction at any given time. Typical costs are $250 to $500 per acre under development.

As aforementioned, the clustering of residential development on smaller lots within conservation subdivisions, thus preserving significant portions of the open space within each property or group of properties to be developed, is recommended to minimize impact of future land use on the Phantom Lakes. Concomitant with such zoning would be the development of stormwater management systems appropriate for such conservation development practices.

Onsite Sewage Disposal System Management

The lakeshore areas and entire drainage area tributary to Upper Phantom Lake and about half of the lakeshore areas and drainage area directly tributary to Lower Phantom Lake are served by onsite sewage disposal systems. Current County ordinance provisions requiring the regular inspection and maintenance of onsite sewage disposal systems should be enforced to minimize potential phosphorus loadings from this source. Such inspections are currently supplemented by a more comprehensive system of inspections carried out by Waukesha County under contract to the Phantom Lakes Management District for onsite sewage disposal systems located within the District's boundary. These latter inspections extend the state-mandated inspection to all onsite sewage disposal systems in the District. It should be noted that, based upon previous such inspections conducted within the recent past, the majority of onsite sewage disposal systems within the District are functioning properly. Few notices of exceptions have been issued.

It also is recommended that Waukesha County, in cooperation with the Town of Mukwonago, assume the lead in providing the public informational and educational programs to encourage affected property owners to have existing onsite systems inspected and any needed remedial measures undertaken, as appropriate. Homeowners should be advised of the rules and regulations governing, and the limitations of onsite sewage disposal systems, and should be encouraged to undertake preventive maintenance programs, especially of those older systems not yet subject to the inspection requirements of the County ordinance.

Typical costs for a basic inspection and maintenance service range from about $100 to $200 per year per property, although more extensive programs could be more expensive. The costs of the informational programming typically have been included within the operating budget of the County.

IN-LAKE MANAGEMENT RECOMMENDATIONS

The recommended in-lake management measures for the Phantom Lakes are summarized in Table 2 and are graphically summarized on Map 3. The major recommendations include water quality monitoring, fisheries management and habitat protection, shoreland protection, aquatic plant management, and recreational use management.

Surface Water Quality Management

Continued water quality monitoring of the Phantom Lakes is recommended. Enrollment of one or more lake residents as WDNR Self-Help Monitoring Program volunteers is recommended. Such enrollment can be

accomplished through the Southeast Region Office of the Wisconsin Department of Natural Resources. A firm commitment of time is required of the volunteers. In addition, participation in the trophic status index (TSI) Expanded Self-Help Monitoring Program, measuring phosphorus and chlorophyll-*a* concentrations, and temperature, is recommended. Such monitoring should be conducted five times a year at a central station in the deepest portion of each lake basin. Monitoring programs facilitated by the University of Wisconsin-Stevens Point Environmental Task Force Laboratory and the U.S. Geological Survey are also recommended to be given consideration. In this regard, it should be noted that the Phantom Lakes Management District has recently acquired a temperature and dissolved oxygen concentration meter and probe that will allow District volunteers to monitor these parameters with depth in the Lakes. Such data as may be acquired should be acquired at the same intervals as other Lake data, set forth above, and records maintained by the Lake Management District. It is strongly suggested that such data be featured at the annual meetings of the Phantom Lakes Management District so as to keep all lakefront property owners and District electors informed of evolving water quality conditions in the Lakes. Such knowledge is essential in order to encourage District property owners and electors to adopt appropriate land management and lake management practices, and to encourage general purpose units of government to adopt appropriate ordinances and informational programming in support of the water quality objectives established for the Phantom Lakes.

Fisheries Management

These specific actions are recommended with respect to fisheries management: the conduct of a fishery survey and/or periodic creel census with concomitant monitoring of rough fish populations; private stocking per recommendations based on fish surveys; and continued enforcement of size and bag limitations.

The fishery survey should be conducted by the WDNR at the request of the Phantom Lakes Management District and should have the following objectives:

1. To identify changes in fish species composition that may have taken place in the Lake since the previous surveys;

2. To permit any changes in fish populations, species composition and condition factors to be related to such known interventions as stocking programs, water pollution control activities, and aquatic plant management programs;

3. To refine and update information on fish spawning areas, breeding success, and survival rates;

4. To confirm the lack of disturbance by rough fish populations;

5. To determine the need for, and inform the timing of, any additional stocking of northern pike, and/or other game fish species, as appropriate, by the private entities and/or the WDNR, in order to maintain a continuing, viable sport fishery;

6. To provide data to determine the intensity of public use of the Phantom Lakes fishery through creel surveys, citizen reporting activities, and evaluation of the fish survey data; and

7. To provide data to assess the impact of harvesting of fishes from the Lake, relative to the bag limits established for the Phantom Lakes.

These actions are recommended to provide a sound basis for the District, the WDNR and sport fishing groups to consider developing a stocking program and to revise, as may be found necessary, the current fishing regulations regarding the size and number of fish to be taken seasonally.

Habitat Protection

The habitat protection measures recommended for the Phantom Lakes are designed to provide for habitat protection by avoiding disturbances in fish breeding areas during spring and autumn and maintaining stands of native aquatic plants. In particular, this recommendation extends to, and includes, the WDNR NR 107 sensitive

areas located in the drainage area of the Lakes as shown on Map 1 in this volume. As of late 2005, the WDNR had proposed amending the designated NR 107 sensitive areas. The proposed requirements are shown on Maps D-1 and D-2 in Appendix D. In addition, it is recommended that environmentally sensitive lands, including wetlands, be preserved.

Shoreland Protection

About one-half of the Phantom Lakes shoreline is protected and no major areas of erosion, which require additional protection against wind, wave, and wake erosion, were identified during the planning effort. Notwithstanding, various protection options were described in Chapter II for consideration in the repair or replacement of existing protection structures. Adoption of the vegetated buffer strip method is recommended to be used in lakeshore areas and on tributary waterways wherever practical in order to maintain habitat value and the natural ambience of the lakeshore. Continued maintenance of existing revetments and other protection structures is also recommended. Conversion of bulkheads to revetments or natural vegetated shoreline or combinations is recommended to be considered where potentially viable at such time as major repairs are found necessary. Guidance provided in the Chapter NR 328 of the *Wisconsin Administrative Code* sets forth a methodology for determining appropriate shoreline protection structures for inland lakes based upon wind wave action and fetch, substrate, and likely boat wake action.

In addition to the foregoing measures, it is also recommended that the Village of Mukwonago and Waukesha County and the Town of Mukwonago continue to enforce existing shoreland setback requirements, and construction site erosion control and stormwater management ordinances. Provision of informational materials to shoreland property owners is recommended, as set forth in the informational and educational programming element of this plan.

Aquatic Plant Management

The aquatic plant management strategy set forth below and in Appendix C recognizes the importance of fishing as a recreational use of the Phantom Lakes. Integral to the aquatic plant management strategy is the protection and preservation of fish breeding habitat. In addition, this strategy recognizes the ecosystem values and functions provided within the Phantom Lakes by a healthy and diverse aquatic plant community, and seeks to maximize these ecosystem level benefits necessary to ensure a balanced lake ecosystem capable of supporting a variety of diverse recreational uses and economic activities.

Recommended Aquatic Plant Management Measures

Various aquatic plant management techniques—manual, mechanical, and chemical—are potentially applicable on the Phantom Lakes. A number of these methods have been employed with varying success on the Phantom Lakes in the past. Currently, the aquatic plant management program is focused on Lower Phantom Lake and is based upon aquatic plant harvesting to maintain boating lanes and predatory fish "cruising" lanes. All aquatic plant management measures are subject to WDNR permitting authority pursuant to Chapters NR 107 and NR 109 of the *Wisconsin Administrative Code*.

Periodic Aquatic Plant Reconnaissance Surveys

It is recommended that the aquatic plant community be monitored through reconnaissance surveys on either an annual basis or every several years, depending upon the observed degree of change in the aquatic plant communities. In addition, information on the aquatic plant communities should be recorded and should include descriptions of major areas of nuisance plant growth and species identified. It is further recommended that should it be warranted, an aquatic plant management plan be developed and updated every three to five years. This will allow evaluation of the effectiveness of an aquatic plant management program over time and allow adjustments to be made in the program to maximize its benefit. Comprehensive aquatic plant surveys should be completed at approximately five-yearly intervals as recommended by the WDNR pursuant to their permitting authorities set forth in Chapter NR 109 of the *Wisconsin Administrative Code*.

Chemical Controls

It is recommended that the use of chemical herbicides be limited to controlling nuisance growth of exotic species such as Eurasian water milfoil and purple loosestrife. Large-scale application of aquatic herbicides is not recommended. Maintenance of shoreland areas around docks and piers remains the responsibility of individual property owners. It is recommended that chemical applications, if required, be made by licensed applicators in early spring subject to State permitting requirements 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. 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 and fluridone, should be used.[8] Algicides, such as Cutrine Plus, are not recommended because there are few reported significant, recurring filamentous algal or planktonic algal problems in the Phantom Lakes and valuable macroscopic algae, such as *Chara* and *Nitella* are killed by this product.

Manual Controls

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 for small-scale application—for example, under and around docks and piers—manual techniques are generally not practical for large-scale plant control methods. Manual means are recommended on the Phantom Lakes to control nearshore plant growths, especially around piers and docks, and are encouraged by the Phantom Lakes Management District.

Shoreline Cleanup Crew

Decomposing, floating vegetation can build up along the shorelines, and, together with terrestrial leaf litter, can limit the use of shoreline areas. Not only is this material unsightly and potentially foul smelling, but it also contributes to the organic and mucky substrates favored by invasive plant species, such as Eurasian water milfoil. Shoreline cleanup is a laborious job that can require substantial amounts of labor and time. However, in situations where a significant number of lake homeowners are seasonal or elderly, it is not always feasible for the riparian owners to clean their shoreline when needed. To alleviate this problem, some lake organizations, such as the Lake Pewaukee Sanitary District together with the Village of Pewaukee, have incorporated a shoreline cleanup crew into their harvesting program.[9] Currently, these shoreline cleanup crews remove nearly as much vegetation as do the harvester operators. While this operation continues to leave the control of rooted vegetation between the piers to the riparian owners, a shoreline clean up program is recommended. Efforts should continue to be made with the harvester operators to ensure that the area around the harvester off-load site is maintained free of debris. Harvested plant material should be moved offsite in an efficient manner to limit the potential for leaching of plant nutrients from the harvested material back into the Lake.

Informational and Educational Programming

In addition to the in-lake rehabilitation methods, an ongoing campaign of community informational programming can support the aquatic plant management program by encouraging the use of shoreland buffer strips, responsible use of household and garden chemicals, and environmentally friendly household and garden practices to minimize the input of nutrients from these riparian areas. In addition, a community information campaign should emphasize the need to clean boats and motors/propellers when removing boats from the Lakes and upon launching boats into the Lakes to limit the redistribution of invasive organisms. Plants removed from boats and motors should be retained onboard and/or disposed of by composting at the boat launch or homestead to avoid their being

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[8]*As of 2005, the use of fluridone remains experimental in Wisconsin and any proposed use of this herbicide should be predicated upon the ability of the waterbody to sustain the long contact period necessary for this herbicide to effectively control aquatic plant growth. Given the rapid flushing rate of Lower Phantom Lake, use of this product is not indicated, although it may be considered for isolated embayments and channels adjacent to the Lake.*

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

reintroduced into the water. An informational program can also remind riparian residents and others of the habitat and ecological benefits, such as shoreline stabilization, provided by the aquatic flora of the Lakes, thereby promoting the preservation of a healthy aquatic flora in the Lakes.

In addition to informational programming, educational programs such as Project WET, Adopt-A-Lake, and other school-based programs can help to build community awareness of the value of lake ecosystems, and the need for vigilance on the part of individual citizens and households within the drainage area tributary to the Lakes. School groups and other community service organizations also form a cadre of volunteers that can assist in shoreland management programs and in the dissemination and conduct of community informational programs.

The Phantom Lakes community has consistently supported informational and educational programming within their community. Efforts by the Phantom Lakes Management District staff have encouraged environmentally sound behaviors within the tributary drainage areas of the Lakes, and have worked cooperatively with their sister lake organizations—especially the Eagle Spring Lake Management District and Beulah Lake Management District—to promote coordinated actions for Lake protection along the length of the Mukwonago River. Thus, ongoing informational and educational programming is recommended.

Water Use Management Recommendations

Recreational Use

With respect to boating ordinances applicable to the Phantom Lakes, it is recommended that current levels of enforcement be maintained. In addition, recreational boating access users should be made aware of the presence of exotic invasive species, including zebra mussel and Eurasian water milfoil. Appropriate signage should be placed at the public recreational boating sites, and supplemental materials on the control of invasive species should be made available to the public. These materials could be provided to riparian householders by means of mail drops or distribution of informational materials at public buildings, such as municipal buildings and the public library, and to nonriparian users by means of informational materials provided at the entrance to the Village of Mukwonago Phantom Lakes public recreational boating access site and other Town of Mukwonago access sites. In addition, it is recommended that the Village of Mukwonago, Town of Mukwonago and Waukesha County make disposal bins available at their public recreational boating access sites for disposal of plant materials and other refuse removed from watercraft using the public recreational boating access sites.[10]

ANCILLARY LAKE MANAGEMENT RECOMMENDATIONS

Public Informational and Educational Programs

It is recommended that the Phantom Lakes Management District assume the lead in the development of a public informational and educational program. Participation by the Village of Mukwonago and Town of Mukwonago should be encouraged. This programming should deal with various lake management-related topics, including onsite sewage disposal system management (where applicable), water quality management, land management, groundwater protection, aquatic plant management, fishery management, and recreational use. Educational and informational brochures and pamphlets, of interest to homeowners and supportive of the recreational use and shoreland zoning regulations, are available from the WDNR and the University of Wisconsin-Extension Service. These cover topics such as beneficial lawn care practices and household chemical use. Such brochures should be provided to homeowners through local media, direct distribution or targeted library and civic center displays. Such distribution can also be integrated into ongoing, larger-scale activities, such as lakeside litter collections, which can reinforce anti-littering campaigns, recycling drives, and similar environmental protection activities.

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[10]*The Town and Village of Mukwonago and Waukesha County Department of Parks and Land Use should continue to monitor experience with the use of high pressure washing stations for the control of zebra mussel currently being gained within the Laurentian Great Lakes Basin and consider adoption of those measures proven to be successful in limiting the spread of zebra mussel within the Region. The U.S.-Canadian International Joint Commission regularly provides informational materials on this and related subjects.*

Given the extent of public interest in the Phantom Lakes, it is recommended that the Phantom Lakes Management District and the local municipalities consider offering regular informational programs on the Lakes and issues related thereto. Such programming can provide a mechanism to raise awareness of Lake issues, and provide a focal point from which to distribute the informational materials referred to above.

The Phantom Lakes Management District and the municipalities are also encouraged to take an active role in encouraging the local school districts to adopt and utilize lake-related educational programs, such as Adopt-A-Lake and Project WET, as means of more closely linking students to the lake environment.

The cost for conducting this informational and educational program is estimated to be $1,200 per year.

PLAN IMPLEMENTATION AND COSTS

The actions recommended in this plan largely represent an extension of ongoing actions being carried out by the Phantom Lakes Management District, in cooperation with neighboring municipalities, and county and state agencies. The recommended plan introduces few new elements, although some of the plan recommendations represent refinements of current programs. This is particularly true in the case of the fisheries and aquatic plant management programs, where the field surveys recommended in this plan will permit more efficient management of these resources.

Generally, aquatic plant and fisheries management practices, such as monitoring and public awareness campaigns, are recommended to continue with refinements as proposed herein. Some aspects of these programs lend themselves to citizen involvement through participation in the Wisconsin Department of Natural Resources Self-Help Monitoring Program, and identification with environmentally sound owner-based land management activities. It is recommended that the Phantom Lakes Management District, in cooperation with the local municipalities, assume the lead in the promotion of such citizen actions, with a view toward building community commitment and involvement. Assistance is generally available from agencies such as the WDNR, the County University of Wisconsin-Extension Service office, and SEWRPC. Additional lake and watershed management measures may be cost-shared through the Chapter NR 191 Lake Protection Grant Program, Chapter NR 120 Nonpoint Pollution Abatement Program, or NR 153/NR 154 runoff management programs.

The suggested lead agency or agencies for initiating program-related activities, by plan element, are set forth in Table 2, and the estimated costs of these elements, linked to possible funding sources where such are available, are summarized in Table 3. In general, it is recommended that the Phantom Lakes Management District continue to provide a coordinating role for community-based lake management actions, in cooperation with the appropriate local government units.

The Phantom Lakes are a valuable natural resource in the Southeastern Wisconsin Region, providing an abundance of natural vistas, good quality wildlife habitat, and opportunities for recreational activities that provide for an enriched quality of life. Increases in population, urbanization, income, leisure time, and individual mobility forecast for the Region may be expected to result in additional pressure for development in the drainage area tributary to the Lakes and for water-based recreation on the Lakes. Adoption and administration of an effective lake management program for the Phantom Lakes, based upon the recommendations set forth herein, will provide the water quality protection needed to maintain conditions in the Phantom Lakes suitable for recreational use and for fish and other aquatic life.

Table 3

ESTIMATED COSTS OF RECOMMENDED LAKE MANAGEMENT MEASURES FOR THE PHANTOM LAKES

Plan Element	Recommended Management Measures	Estimated Cost 2000-2020[a]		Potential Funding Sources[b]
		Capital	Annual Operation and Maintenance	
Land Use	Observe regional and county land use plan guidelines	- -	- -	County, Town, Village
	Density management in the shoreland zone	- -	- -	County, Town, Village
	Stormwater management plan development	- -	- -	County, Town, Village
	Protection of environmentally sensitive lands and environmental corridors	- -	- -	WDNR Lake Protection Grant and Stewardship Grant Programs, Waukesha County Land Conservancy, Phantom Lakes Management District
Pollution Abatement	Implement county and regional plans for land and water resource management	- -[c]	- -[c]	County, USDA EQIP, WDNR/WDATCP Runoff Management Program
	Rural nonpoint source controls	- -[c]	- -[c]	County, USDA EQIP, WDNR/WDATCP Runoff Management Program
	Urban nonpoint source controls	- -[c]	- -[c]	County, WDNR/WDATCP Runoff Management Program
	Construction site erosion controls and stormwater management ordinances	$250 per acre[c]	$25-$50 per acre[c]	County, municipalities, private firms, individuals
	Onsite sewerage system management	- -[c]	$100-$200[c] per property	County, Phantom Lakes Management District, private firms, individuals
Water Quality	Continue in expanded WDNR Self-Help Program; conduct ongoing depth profile monitoring, consider periodic participation in U.S. Geological Survey or University of Wisconsin-Stevens Point Environmental Task Force TSI monitoring	- -	- -[d]	WDNR Self-Help and Ambient Lakes Monitoring Programs, USGS, UW-SP Environmental Task Force Laboratory, Phantom Lakes Management District
Water Quantity	Consider preparing a local groundwater model to assist municipalities and county in land use decision making	- -	- -[e]	WDNR, USGS, WGNHS, UW System, SEWRPC, Waukesha County, Town and Village of Mukwonago, Phantom Lakes Management District
Aquatic Biota-Fisheries	Conduct fish survey to determine management/stocking needs	$16,000[d]	- -[d]	WDNR
	Continue stocking of selected game fish species and monitor populations of rough fish	- -	- -	WDNR, sporting groups
	Enforce size and catch limits	- -	$1,200	WDNR
	Protect and maintain fish habitat in shoreline and littoral zone and in sensitive areas	- -	- -	County, municipalities, private firms, individuals, WDNR, Phantom Lakes Management District
	Maintenance of shoreline protection structures and repair as necessary using vegetative means insofar as practicable	- -	- -	Private firms, individuals

Table 3 (continued)

Plan Element	Recommended Management Measures	Estimated Cost 2000-2020[a]		Potential Funding Sources[b]
		Capital	Annual Operation and Maintenance	
Aquatic Biota–Aquatic Plants	Conduct periodic aquatic plant reconnaissance and consider aquatic management plan as deemed necessary	- -	$1,500[f]	Phantom Lakes Management District, WDNR Lake Management Planning Grant Program
	Continue aquatic plant harvesting, especially in Lower Phantom Lake	$100,000	$25,000	Phantom Lakes Management District, Wisconsin Waterways Commission
	Limited use of chemical herbicides to control nuisance aquatic plants such as Eurasian water milfoil and purple loosestrife where necessary	- -	$1,000 per acre[h]	Wisconsin Waterways Commission, Phantom Lakes Management District, individuals
	Manually harvest aquatic plants from around docks and piers	$100	$100	Phantom Lakes Management District, individuals
	Collect floating plant fragments from shoreland areas to minimize rooting of Eurasian water milfoil	- -	- -	Phantom Lakes Management District, individuals
Water use	Enforce regulations governing the operation of watercraft; improve posting of regulations and ordinances and signage concerning control of exotic nuisance species	$500	$100[h]	Phantom Lakes Management District, Town of Mukwonago, Village of Mukwonago, WDNR
Ancillary Management Measures	Public informational and educational programming: seminars, programs, Project WET, Adopt-A-Lake, expanded TSI monitoring, etc.	- -	$1,200	Phantom Lakes Management District, UWEX/WDNR/WAL Lakes Partnership, school districts
Total	- -	$116,8500	$30,250	- -

[a] *All costs expressed in January 2005 dollars.*

[b] *Unless otherwise specified, USDA is the U.S. Department of Agriculture, USGS is the U.S. Geological Survey, WDNR is the Wisconsin Department of Natural Resources, WDATCP is the Wisconsin Department of Agriculture, Trade and Consumer Protection, WGNHS is the Wisconsin Geological and Natural History Survey, UW System is the University of Wisconsin, County is Waukesha County, Town is the Town of Mukwonago, Village is the Village of Mukwonago, SEWRPC is the Southeastern Wisconsin Regional Planning Commission, UWEX is the University of Wisconsin-Extension, and WAL is the Wisconsin Association of Lakes.*

[c] *Costs vary with the amount of land under development during any given year.*

[d] *The WDNR Self-Help Monitoring Program and proposed creel survey involves no cost but does entail a time commitment from the volunteer; monitoring by the USGS can be cost-shared between the Federal agency and local cooperators.*

[e] *Water quantity monitoring should be conducted in conjunction with a hydraulic and hydrologic analysis of the entire Mukwonago River system; USGS hydrological monitoring is proposed.*

[f] *Cost-share assistance may be available for lake management planning studies under the NR 190 Lake Management Planning Grant Program.*

[g] *Costs are based on the assumption that the existing harvester and ancillary equipment may eventually need replacement; cost-share assistance for harvester purchase may be available from the Wisconsin Waterways Commission Recreational Boating Facilities Grant Program. Planning costs assume that plan revisions will be completed at a cost of $6,000 every four years.*

[h] *Cost-share assistance may be available from the Wisconsin Waterways Commission Recreational Boating Facilities Grant Program.*

[i] *Costs exclude costs to the Village of Mukwonago and Town of Mukwonago related to land use planning and zoning, and exclude costs related to herbicide treatments.*

Source: SEWRPC.

APPENDICES

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Appendix A

NONPOINT SOURCE POLLUTION CONTROL MEASURES

Nonpoint, or diffuse, sources of water pollution include urban sources such as runoff from residential, commercial, industrial, transportation, and recreational land uses; construction activities; and onsite sewage disposal systems and rural sources such as runoff from cropland, pasture, and woodland, atmospheric contributions, and livestock wastes. These sources of pollutants discharge to surface waters by direct overland drainage, by drainage through natural channels, by drainage through engineered stormwater drainage systems, and by deep percolation into the ground and subsequent return flow to the surface waters.

A summary of the methods and estimated effectiveness of nonpoint source water pollution control measures is set forth in Table A-1. These measures have been grouped for planning purposes into two categories: basic practices and additional. Application of the basic practices will have a variable effectiveness in terms of control level of pollution control depending upon the subwatershed area characteristics and the pollutant considered. The additional category of nonpoint source control measures has been subdivided into four subcategories based upon the relative effectiveness and costs of the measures. The first subcategory of practices can be expected to generally result in about a 25 percent reduction in pollutant runoff. The second and third subcategory of practices, when applied in combination with the minimum and additional practices, can be expected to generally result in up to a 75 percent reduction in pollutant runoff, respectively. The fourth subcategory would consist of all of the preceding practices, plus those additional practices that would be required to achieve a reduction in ultimate runoff of more than 75 percent.

Table A-1 sets forth the diffuse source control measures applicable to general land uses and diffuse source activities, along with the estimated maximum level of pollution reduction which may be expected upon implementation of the applicable measures. The table also includes information pertaining to the costs of developing the alternatives set forth in this appendix.[1] These various individual nonpoint source control practices are summarized by group in Table A-2.

[1]*Costs are presented in more detail in the following SEWRPC Technical Reports: No. 18,* State of the Art of Water Pollution Control in Southeastern Wisconsin, *Volume Three,* Urban Storm Water Runoff, *July 1977, and Volume Four,* Rural Storm Water Runoff, *December 1976; and No. 31,* Costs of Urban Nonpoint Source Water Pollution Control Measures, *June 1991.*

Table A-1

GENERALIZED SUMMARY OF METHODS AND EFFECTIVENESS OF NONPOINT SOURCE WATER POLLUTION ABATEMENT

Applicable Land Use	Control Measures[a]	Summary Description	Approximate Percent Reduction of Released Pollutants[b]	Assumptions for Costing Purposes
Urban	Litter and pet waste control ordinance	Prevent the accumulation of litter and pet wastes on streets and residential, commercial, industrial, and recreational areas	2 to 5	Ordinance administration and enforcement costs are expected to be funded by violation penalties and related revenues
	Improved timing and efficiency of street sweeping, leaf collection and disposal, and catch basin cleaning	Improve the scheduling of these public works activities, modify work habits of personnel, and select equipment to maximize the effectiveness of these existing pollution control measures	2 to 5	No significant increase in current expenditures is expected
	Management of onsite sewage treatment systems	Regulate septic system installation, monitoring, location, and performance; replace failing systems with new septic systems or alternative treatment facilities; develop alternatives to septic systems; eliminate direct connections to drain tiles or ditches; dispose of septage at sewage treatment facility	10 to 30	Replace one-half of estimated existing failing septic systems with properly located and installed systems and replace one-half with alternative systems, such as mound systems or holding tanks; all existing and proposed onsite sewage treatment systems are assumed to be properly maintained; assume system life of 25 years. The estimated cost of a septic tank system is $5,000 to $6,000 and the cost of an alternative system is $10,000. The annual maintenance cost of a disposal system is $250. An in-ground pressure system is estimated to cost $6,000 to $10,000 with an annual operation and maintenance cost of $250. A holding tank would cost $5,500 to $6,500, with an annual operation and maintenance cost of $1,800
	Increased street sweeping	On the average, sweep all streets in urban areas an equivalent of once or twice a week with vacuum street sweepers; require parking restrictions to permit access to curb areas; sweep all streets at least eight months per year; sweep commercial and industrial areas with greater frequency than residential areas	30 to 50	Estimate curb-miles based on land use, estimated street acreage, and Commission transportation planning standards; assume one street sweeper can sweep 2,000 curb-miles per year; assume sweeper life of 10 years; assume residential areas swept once weekly, commercial and industrial areas swept twice weekly. The cost of a vacuum street sweeper is approximately $120,000. The cost of the operation and maintenance of a sweeper is about $25 per curb-mile swept
	Increased leaf and clippings collection and disposal	Increase the frequency and efficiency of leaf collection procedures in fall; use vacuum cleaners to collect leaves; implement ordinances for leaves, clippings. and other organic debris to be mulched, composted, or bagged for pickup	2 to 5	Assume one equivalent mature tree per residence, plus five trees per acre in recreational areas; 75 pounds of leaves per tree; 20 percent of leaves in urban areas not currently disposed of properly. The cost of the collection of leaves in a vacuum sweeper and disposal is estimated at $180 to $200 per ton of leaves
	Increased catch basin cleaning	Increase frequency and efficiency of catch basin cleaning; clean at least twice per year using vacuum cleaners; catch basin installation in new urban development not recommended as a cost-effective practice for water quality improvement	2 to 5	Determine curb-miles for street sweeping; vary percent of urban areas served by catch basins by watershed from Commission inventory data; assume density of 10 catch basins per curb-mile; clean each basin twice annually by vacuum cleaner. The cost of cleaning a catch basin is approximately $10
	Reduced use of deicing salt	Reduce use of deicing salt on streets; salt only intersections and problem areas; prevent excessive use of sand and other abrasives	Negligible for pollutants addressed in this plan, but helpful for reducing chlorides and associated damage to vegetation	Increased costs, such as for slower transportation movement, are expected to be offset by benefits, such as reduced automobile corrosion and damage to vegetation

Table A-1 (continued)

Applicable Land Use	Control Measures[a]	Summary Description	Approximate Percent Reduction of Released Pollutants[b]	Assumptions for Costing Purposes
Urban (continued)	Improved street maintenance and refuse collection and disposal	Increase street maintenance and repairs; increase provision of trash receptacles in public areas; improve trash collection schedules; increase cleanup of parks and commercial centers	2 to 5	Increase current expenditures by approximately 15 percent
	Parking lot stormwater temporary storage and treatment measures	Construct gravel-filled trenches, sediment basins, or similar measures to store temporarily the runoff from parking lots, rooftops, and other large impervious areas; if treatment is necessary, use a physical-chemical treatment measure, such as screens, dissolved air flotation, or a swirl concentrator	5 to 10	Design gravel-filled trenches for 24-hour, five-year recurrence interval storm; apply to off-street parking acreages. For treatment, assume four-hour detention time. The capital cost of stormwater detention and treatment facilities is estimated at $40,000 to $80,000 per acre of parking lot area, with an annual operation and maintenance cost of about $200 per acre
	Onsite storage—residential	Remove connections to sewer systems; construct onsite stormwater storage measures for subdivisions	5 to 10	Remove roof drains and other connections from sewer system wherever needed; use lawn aeration, if applicable; apply dutch drain storage facilities to 15 percent of residences. The capital cost would approximate $500 per house, with an annual operation and maintenance cost of about $25
	Stormwater Infiltration—urban	Construct gravel-filled trenches for areas of less than 10 acres or basins to collect and store temporarily stormwater runoff to reduce volume, provide groundwater recharge and augment low stream flows	45 to 90	Design gravel-filled trenches or basins to store the first 0.5 inch of runoff; provide at least a 25-foot grass buffer strip to reduce sediment loadings. The capital cost of stormwater infiltration is estimated at $12,000 for a six-foot-deep, 10-foot-wide trench, and at $70,000 for a one-acre basin, with an annual maintenance cost of about $10 to $350 for the trench and about $2,500 for the basin
	Stormwater storage—urban	Store stormwater runoff from urban land in surface storage basins or, where necessary, subsurface storage basins	10 to 35	Design all storage facilities for a 1.5-inch runoff event, which corresponds approximately to a five-year recurrence interval event, with a storm event being defined as a period of precipitation with a minimum antecedent and subsequent dry period of from 12 to 24 hours; apply subsurface storage tanks to intensively developed existing urban areas where suitable open land for surface storage is unavailable; design surface storage basins for proposed new urban land, existing urban land not storm sewered, and existing urban land where adequate open space is available at the storm sewer discharge site. The capital cost for stormwater storage would range from $35,000 to $110,000 per acre of basin, with an annual operation and maintenance cost of about $40 to $60 per acre
	Stormwater treatment	Provide physical-chemical treatment which includes screens, microstrainers, dissolved air flotation, swirl concentrator, or high-rate filtration, and/or disinfection, which may include chlorination, high-rate disinfection, or ozonation to stormwater following storage	10 to 50	To be applied only in combination with stormwater storage facilities above; general cost estimates for microstrainer treatment and ozonation were used; some costs were applied to existing urban land and proposed new urban development. Stormwater treatment has an estimated capital cost of from $900 to $7,000 per acre of tributary drainage area, with an average annual operation and maintenance cost of about $35 to $100 per acre

Table A-1 (continued)

Applicable Land Use	Control Measures[a]	Summary Description	Approximate Percent Reduction of Released Pollutants[b]	Assumptions for Costing Purposes
Rural	Conservation practices	Includes such practices as strip cropping, contour plowing, crop rotation, pasture management, critical area protection, grading and terracing, grassed waterways, diversions, woodlot management, fertilization and pesticide management, and chisel tillage	Up to 50	Cost for Natural Resources Conservation Service (NRCS) recommended practices are applied to agricultural and related rural land; the distribution and extent of the various practices were determined from an examination of 56 existing farm plan designs within the Region. The capital cost of conservation practices ranges from $3,000 to $5,000 per acre of rural land, with an average annual operation and maintenance cost of from $5.00 to $10 per rural acre
	Animal waste control system	Construct streambank fencing and crossovers to prevent access of all livestock to waterways; construct a runoff control system or a manure storage facility, as needed, for major livestock operations; prevent improper applications of manure on frozen ground, near surface drainageways, and on steep slopes; incorporate manure into soil	50 to 75	Cost estimated per animal unit; animal waste storage (liquid and slurry tank for costing purposes) facilities are recommended for all major animal operations within 500 feet of surface water and located in areas identified as having relatively high potential for severe pollution problems. Runoff control systems recommended for all other major animal operations. It is recognized that dry manure stacking facilities are significantly less expensive than liquid and slurry storage tanks and may be adequate waste storage systems in many instances. The estimated capital cost and average operation and maintenance cost of a runoff control system is $100 per animal unit and $25 per animal unit, respectively. The capital cost of a liquid and slurry storage facility is about $1,000 per animal unit, with an annual operation and maintenance cost of about $75 per unit. An animal unit is the weight equivalent of a 1,000-pound cow
	Base-of-slope detention storage	Store runoff from agricultural land to allow solids to settle out and reduce peak runoff rates. Berms could be constructed parallel to streams	50 to 75	Construct a low earthen berm at the base of agricultural fields, along the edge of a floodplain, wetland, or other sensitive area, design for 24-hour, 10-year recurrence interval storm; berm height about four feet. Apply where needed in addition to basic conservation practices; repair berm every 10 years and remove sediment and spread on land. The estimated capital cost of base-of-slope detention storage would be $500 per tributary acre, with an annual operation and maintenance cost of $25 per acre
	Bench terraces	Construct bench terraces, thereby reducing the need for many other conservation practices on sloping agricultural land	75 to 90	Apply to all appropriate agricultural lands for a maximum level of pollution control. Utilization of this practice would exclude installation of many basic conservation practices and base-of-slope detention storage. The capital cost of bench terraces is estimated at $1,500 per acre, with an annual operation and maintenance cost of $100 per acre
Urban and Rural	Public education programs	Conduct regional and county-level public education programs to inform the public and provide technical information on the need for proper land management practices on private land, the recommendations for management programs, and the effects of implemented measures; develop local awareness programs for citizens and public works officials; develop local contract and education efforts	Indeterminate	For first 10 years, includes cost of one person, materials, and support for each 25,000 population. Thereafter, the same cost can be applied for every 50,000 population. The cost of one person, materials, and support is estimated at $55,000 per year

Table A-1 (continued)

Applicable Land Use	Control Measures[a]	Summary Description	Approximate Percent Reduction of Released Pollutants[b]	Assumptions for Costing Purposes
Urban and Rural (continued)	Construction erosion control practices	Construct temporary sediment basins; install straw bale dikes; use fiber mats, mulching, and seeding; install slope drains to stabilize steep slopes; construct temporary diversion swales or berms upslope from the project	20 to 40	Assume acreage under construction is the average annual incremental increase in urban acreage; apply costs for a typical erosion control program for a construction site. The estimated capital cost and operation and maintenance cost for construction erosion control is $250 to $5,500 and $250 to $1,500 per acre under construction, respectively
	Materials storage and runoff control facilities	Enclose industrial storage sites with diversion; divert runoff to acceptable outlet or storage facility; enclose salt piles and other large storage sites in crib and dome structures	5 to 10	Assume 40 percent of industrial areas are used for storage and to be enclosed by diversions; assume existing salt storage piles enclosed by cribs and dome structures. The estimated capital cost of industrial runoff control is $2,500 per acre of industrial land. Material storage control costs are estimated at $75 per ton of material
	Stream protection measures	Provide vegetative buffer zones along streams to filter direct pollutant runoff to the stream; construct streambank protection measures, such as rock riprap, brush mats, tree revetment, jacks, and jetted willow poles, where needed	5 to 10	Apply a 50-foot-wide vegetative buffer zone on each side of 15 percent of the stream length; apply streambank protection measures to 5 percent of the stream length. Vegetative buffer zones are estimated to cost $21,200 per mile of stream and streambank protection measures cost about $37,000 per stream mile
	Pesticide and fertilizer application restrictions	Match application rate to need; eliminate excessive applications and applications near or into surface water drainageways	0 to 3	Cost included in public education program
	Critical area protection	Emphasize control of areas bordering lakes and streams; correct obvious erosion and other pollution source problems	Indeterminate	Indeterminate

[a] *Not all control measures are required for each subwatershed. The characteristics of the watershed, the estimated required level of pollution reduction needed to meet the applicable water quality standards, and other factors will influence the selection and estimation of costs of specific practices for any one subwatershed. Although the control measures costed represent the recommended practices developed at the regional level on the basis of the best available information, the local implementation process should provide more detailed data and identify more efficient and effective sets of practices to apply to local conditions.*

[b] *The approximate effectiveness refers to the estimated amount of pollution produced by the contributing category (urban or rural) that could be expected to be reduced by the implementation of the practice. The effectiveness rates would vary greatly depending on the characteristics of the watershed and individual diffuse sources. It should be further noted that practices can have only a "sequential" effect, since the percent pollution reduction of a second practice can only be applied against the residual pollutant load which is not controlled by the first practice. For example. two practices of 50 percent effectiveness in series would achieve a theoretical total effectiveness of only 75 percent control of the initial load. Further, the general levels of effectiveness reported in the table are not necessarily the same for all pollutants associated with each source. Some pollutants are transported by dissolving in water and others by attaching to solids in the water; the methods summarized here reflect typical pollutant removal levels.*

[c] *For highly urbanized areas which require retrofitting of facilities into developed areas, the costs can range from $400,000 to $1,000,000 per acre of storage.*

Source: SEWRPC.

Of the sets of practices recommended for various levels of diffuse source pollution control presented in Table A-2, not all practices are needed, applicable, or cost-effective for all watersheds, due to variations in pollutant loadings and land use and natural conditions among the watersheds. Therefore, it is recommended that the practices indicated as needed for nonpoint source pollutant control be refined by local level nonpoint source control practices planning, which would be analogous to sewerage facilities planning for point source pollution abatement. A locally prepared plan for nonpoint abatement measures should be better able to blend knowledge of current problems and practices with a quickly evolving technology to achieve a suitable, site-specific approach to pollution abatement.

Table A-2

ALTERNATIVE GROUPS OF DIFFUSE SOURCE WATER POLLUTION CONTROL MEASURES PROPOSED FOR STREAMS AND LAKE WATER QUALITY MANAGEMENT

Pollution Control Category	Level of Pollution[a] Control	Practices to Control Diffuse Source Pollution from Urban Areas[b]	Practices to Control Diffuse Source Pollution from Rural Areas[a]
Basic Practices	Variable	Construction erosion control; onsite sewage disposal system management; streambank erosion control	Streambank erosion control
	25 percent	Public education programs; litter and pet waste control; restricted use of fertilizers and pesticides; construction erosion control; critical areas protection; improved timing and efficiency of street sweeping, leaf collection, and catch basin cleaning; material storage facilities and runoff control	Public education programs; fertilizer and pesticide management; critical area protection; crop residue management; chisel tillage; pasture management; contour plowing; livestock waste control
Additional Diffuse Source Control Practices[c]	50 percent	Above, plus: Increased street sweeping; improved street maintenance and refuse collection and disposal; increased catch basin cleaning; stream protection; increased leaf and vegetation debris collection and disposal; stormwater storage; stormwater infiltration	Above, plus: crop rotation; contour strip-cropping; grass waterways; diversions; wind erosion controls; terraces; stream protection
	75 percent	Above, plus: An additional increase in street sweeping, stormwater storage and infiltration; additional parking lot stormwater runoff storage and treatment	Above, plus: Base-of-slope detention storage
	More than 75 percent	Above, plus: Urban stormwater treatment with physical-chemical and/or disinfection treatment measures	Bench terraces[b]

[a]*Groups of practices are presented here for general analysis purposes only. Not all practices are applicable to, or recommended for, all lake and stream tributary watersheds. For costing purposes, construction erosion control practices, public education programs, and material storage facilities and runoff controls are considered urban control measures and stream protection is considered a rural control measure.*

[b]*The provision of bench terraces would exclude most basic conversation practices and base-of-slope detention storage facilities.*

[c]*In addition to diffuse source control measures, lake rehabilitation techniques may be required to satisfy lake water quality standards.*

Source: SEWRPC.

Appendix B

BOATING ORDINANCES APPLICABLE TO THE PHANTOM LAKES

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STATE OF WISCONSIN
TOWN OF MUKWONAGO
WAUKESHA COUNTY
ORDINANCE NO. 2005-5

AN ORDINANCE TO REPEAL AND RE-CREATE SECTION 2.04(b)(5) OF THE BOATING CODE IN THE TOWN OF MUKWONAGO.

WHEREAS, the Town of Mukwonago has within its corporate boundaries a waterway (hereinafter "channel") that connects Upper and Lower Phantom Lake; and

WHEREAS, said channel is heavily used by anglers, canoeists, and boaters; and

WHEREAS, said channel is approximately 150 feet in length, and only about 40 feet in width; and

WHEREAS, people who swim, wade, or otherwise loiter is said channel are at risk of injury from passing watercraft, and they obstruct and create a hazard for said watercraft; and

WHEREAS, parents who do not prevent their minor children from swimming, wading, or otherwise loitering in said channel similarly expose their children to risks of injury from passing watercraft, and obstruct and create a hazard for said watercraft; and

WHEREAS, the Town of Mukwonago Town Board, in the best interest of the public health safety, and welfare, deems it necessary that special regulations be adopted regarding the use of said channel.

NOW, THEREFORE, the Town Board of the Town of Mukwonago, Waukesha County, State of Wisconsin, **DO ORDAIN AS FOLLOWS:**

Section 1: Section 2.04(B)(5) of the Boating Code in the Town of Mukwonago is hereby repealed and re-created to read as follows:

5. SWIMMING, WADING, OR OTHERWISE LOITERING IN A CHANNEL BETWEEN UPPER PHANTOM LAKE AND LOWER PHANTOM LAKE.

No person shall swim, wade, or otherwise loiter in any way, in the channel between Upper Phantom Lake and Lower Phantom Lake, at any time except as expressly authorized in writing by the Town of Mukwonago Chief of Police. No parent shall allow or fail to prevent their minor child from, swimming, wading or otherwise loitering in any way in the channel between Upper Phantom Lake and Lower Phantom Lake, at any time.

Section 2: SERERABILITY.

The several sections of this ordinance are declared to be severable. If any section or portion thereof shall be declared by a court of competent jurisdiction to be invalid, unlawful or unenforceable, such decision shall apply only to the specific section or portion thereof directly specified in the decision, and shall not affect the validity of any other provisions, sections or portions thereof of the ordinance. The remainder of the ordinance shall remain in full force and effect. Any other ordinances whose terms are in conflict with the provisions of this ordinance are hereby repealed as to those terms that conflict.

Section 3: EFFECTIVE DATE.

This ordinance shall take effect immediately upon passage and posting or publication as provided by law.

Dated this 19th day of October, 2005.

TOWN OF MUKWONAGO
David Dubey, Town Chair

ATTEST:

Katherine Wilson, Town Clerk
Published and/or posted this 21st day of October 2005.

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Appendix C

AN AQUATIC PLANT MANAGEMENT PLAN FOR THE PHANTOM LAKES, WAUKESHA COUNTY, WISCONSIN

INTRODUCTION

This aquatic plant management plan was prepared by the Southeastern Wisconsin Regional Planning Commission staff as an integral part of the Lakes management plan for the Phantom Lakes.[1] It represents an important element of the ongoing commitment of the Phantom Lakes Management District, and the Village and Town of Mukwonago, to sound environmental management with respect to the Lakes. The plan is based upon field surveys conducted by Commission staff during the summer of 2002, and subsequent field reconnaissance surveys conducted during the 2004 summer season. The 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*. Its scope is limited to such management measures as can: 1) be effective in the control of aquatic plant growth; 2) be readily undertaken by the Lake District, Village of Mukwonago, and Town of Mukwonago, in concert with the riparian residents; and, 3) directly affect the recreational uses of the Phantom Lakes. The aquatic plant management plan for the Phantom Lakes is comprised of eight elements:

1. A set of aquatic plant management objectives;
2. A brief description of the Lakes and their watershed;
3. A statement of perceived use restrictions and need for aquatic plant management in the Phantom Lakes;
4. A review of past and present aquatic plant management measures utilized on the Phantom Lakes;
5. An evaluation of alternative means of aquatic plant management and a recommended plan for such management;
6. A description of the recommended plan;
7. A description of the equipment needs for the recommended plan; and
8. A recommended means of monitoring and evaluating the efficacy of the plan.

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[1]*SEWRPC Community Assistance Planning Report No. 230,* A Lakes Management Plan for the Phantom Lakes, Waukesha County, Wisconsin, *in preparation.*

STATEMENT OF AQUATIC PLANT MANAGEMENT GOALS AND OBJECTIVES

The aquatic plant management program objectives for the Phantom Lakes were developed in consultation with the Phantom Lakes Management District and the Phantom Lakes community. The primary goal of the aquatic plant management program is to provide a full range of recreational access opportunities for all Lake users, focused on those areas of the Lakes within which aquatic plants can become overly abundant, in a manner that preserves and maintains the underlying natural resource base of the Lakes. Pursuant to the current aquatic plant management plan for the Phantom Lakes,[2] this overarching goal is to be achieved through the accomplishment of a number of practical objectives, including:

1. Provision of boating access and access for sport anglers: by harvesting access channels and shoreline areas to provide cruising lanes for visually feeding gamefish to increase yields in these formerly inaccessible areas and to allow access for sport anglers in these areas.

2. Protection of the Lakes environment: by harvesting and, thereby, removing from the Lakes plant material, nutrients and organic matter that otherwise would be added to the Lake bottom sediments through the decay process, spurring further aquatic plant growths and encouraging the growth of invasive plant species.

3. Enhancement of the native aquatic plant communities: by harvesting the canopy of invasive plant species such as Eurasian water milfoil to allow for deeper penetration of sunlight into the Lakes to promote the competitive success of generally low-growing native aquatic plants and a greater diversity of aquatic plant species.

4. Maintenance of the ecological balance: by encouraging the competitive success and diversity of native plant communities, leading to a more balanced aquatic system better able to support the array of recreational uses to which the Lakes are subjected.

5. Cooperation with Lake residents: by providing lakeshore residents with appropriate information on how to maintain their pier areas, manage their lawns and gardens, and utilize the natural resources of the Lakes in a sustainable and environmentally friendly manner.

6. Collaboration with the residents of the drainage basin tributary to the Lakes: by providing all residents of the drainage area tributary to Phantom Lakes with appropriate information on how their actions affect the waterways tributary to the Lakes, their local environment, and the natural resource base of the Lakes and watershed.

This goal and its concomitant objectives remain unchanged.

UPPER AND LOWER PHANTOM LAKES AND THEIR WATERSHED CHARACTERISTICS

The Phantom Lakes are located within the civil division limits of the Village and Town of Mukwonago, all within Waukesha County. Surface water enters the Lakes primarily through the Mukwonago River that flows into Lower Phantom Lake from the west. Upper Phantom Lake is primarily groundwater fed. Water drains from Upper Phantom Lake to Lower Phantom Lake and from Lower Phantom Lake, over a low-head dam located within the Village of Mukwonago, into the Mukwonago River, flowing in a southeasterly direction and ultimately discharging into the Fox River. A bathymetric map of the Lakes is set forth as Maps C-1 and C-2.

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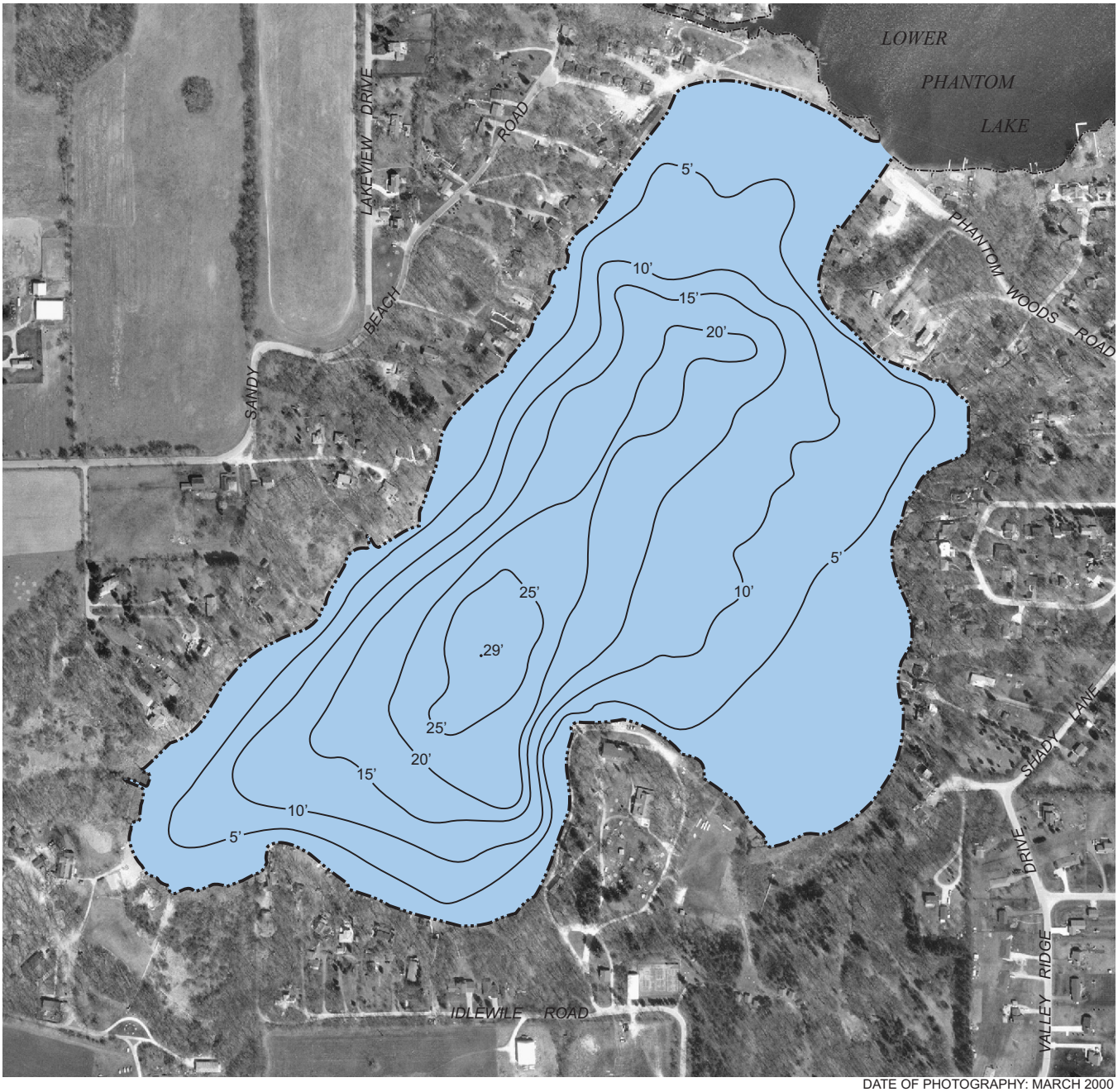
[2]*SEWRPC Memorandum Report No. 81,* An Aquatic Plant Management Plan for the Phantom Lakes, Waukesha County, Wisconsin, *July 1993.*

Map C-1

BATHYMETRIC MAP OF UPPER PHANTOM LAKE



DATE OF PHOTOGRAPHY: MARCH 2000

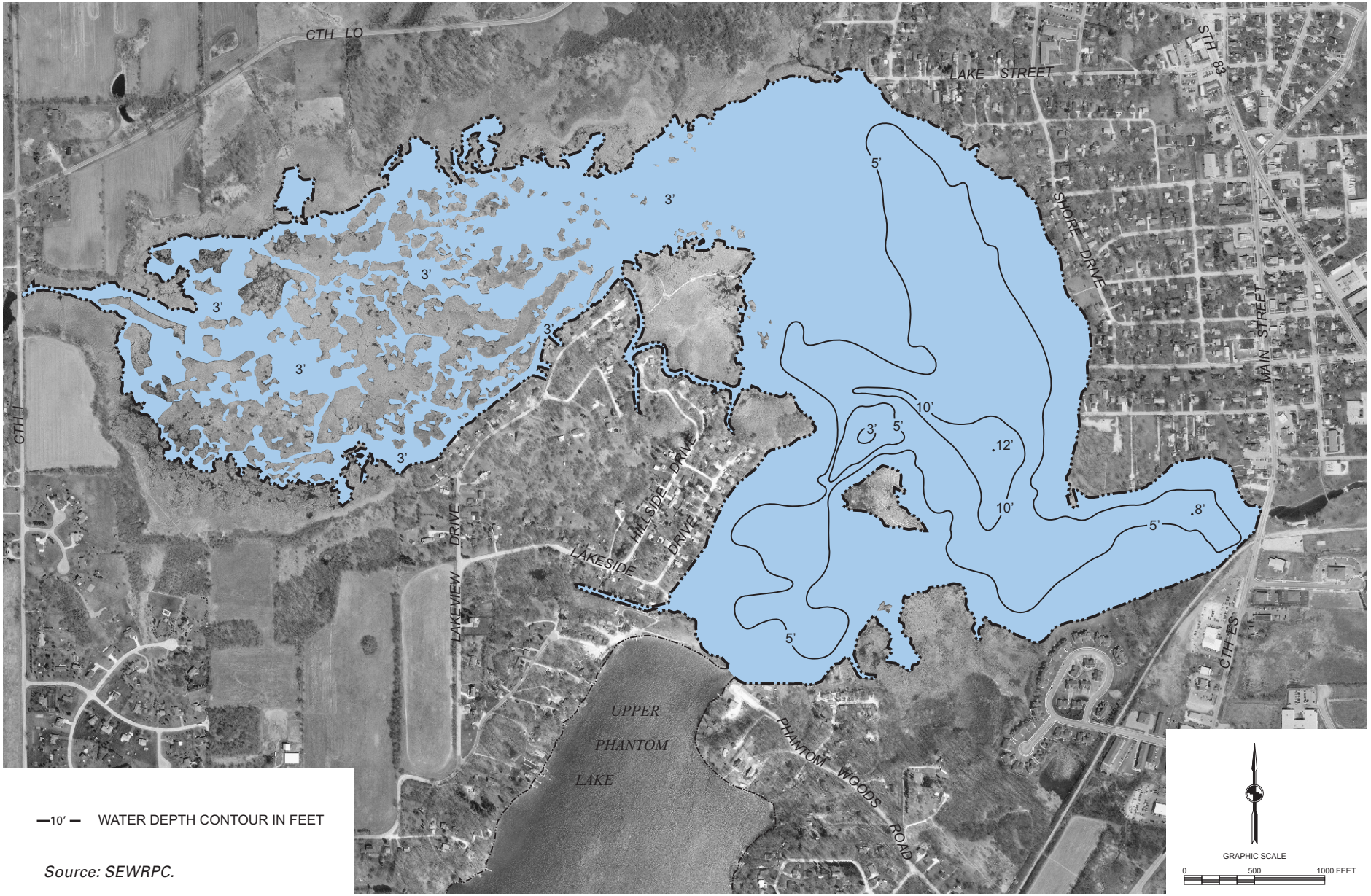
—20′— WATER DEPTH CONTOUR IN FEET

GRAPHIC SCALE
0 300 600 FEET

Source: SEWRPC.

Map C-2

BATHYMETRIC MAP OF LOWER PHANTOM LAKE



—10′— WATER DEPTH CONTOUR IN FEET

Source: SEWRPC.

DATE OF PHOTOGRAPHY: MARCH 2000

The total watershed area draining to Phantom Lakes is approximately 87 square miles in areal extent. Portions of the watershed extend from Waukesha County into Jefferson and Walworth Counties. Lulu, Eagle Spring, Peters, Swift, and Beulah Lakes are included within this watershed boundary. Lulu Lake and the stretch of the Mukwonago River between Eagle Spring Lake and Upper Phantom Lake, which includes the portion of Lower Phantom Lake characterized in large part by emergent aquatic plant communities, have been designated as Outstanding Resource Waters by the WDNR pursuant to Chapter NR 102 of the *Wisconsin Administrative Code*.

Upper Phantom Lake is a 110-acre natural drained lake, roughly circular in aspect. This Lake has a well-defined "deep hole" with a maximum depth of about 29 feet, a mean depth of approximately 10 feet, and a volume of about 1,100 acre-feet. Upper Phantom Lake drains across a shallow, sandy sill to Lower Phantom Lake, with the outflow of Upper Phantom Lake entering Lower Phantom Lake from the southwest. This connection is maintained, in part, by the passage of recreational boating traffic between the waterbodies. Insofar as the water level of Upper Phantom Lake remains above this sandy sill, the lake levels of both Lakes are controlled artificially by the dam located at the outlet of Lower Phantom Lake. The drainage area directly tributary to Upper Phantom Lake is approximately 270 acres in areal extent.

Lower Phantom Lake is a through-flow drainage Lake, augmented by impoundment with a low-head dam. This impoundment creates a Lake with a surface area of about 500 acres, approximately 218 acres of which are characterized as wetland. This Lake is elongate in aspect, having a maximum depth of approximately 12 feet, a mean depth of about 3.5 feet, and a volume of approximately 1,800 acre-feet. The drainage area directly tributary to Lower Phantom Lake is approximately 20,800 acres in areal extent.

Land Use and Shoreline Development

The importance of the Phantom Lakes area as an attractive setting for residential development within a reasonable commuting distance of major commercial and industrial centers in Southeastern Wisconsin has increased steadily since 1850, as shown on Map C-3. Initial urban density development around the Phantom Lakes centered in the Village of Mukwonago, and, later, beginning in the 1930s, extended into the drainage area directly tributary to Upper Phantom Lake. Many summer cottages, over the years, have been converted into year-round homes. By 2000, about 11,800 acres, or about 22 percent of the total drainage area tributary to the Phantom Lakes, were in urban land uses, with residential uses being the dominant urban land use. As of 2000, about 40,370 acres, or about 78 percent of the total drainage area tributary to the Phantom Lakes, remained in rural land uses. Of these uses, about 63 percent of the rural lands and about 50 percent of the total drainage area was in agricultural use.

The shorelands of the Lakes may be generally considered to be fully developed, although some limited infilling, backlot development, and redevelopment of platted lots may be expected to occur. Under planned year 2020 conditions, urban lands may be expected to increase to about 14,330 acres, or about 28 percent of the total drainage area tributary to the Phantom Lakes. Rural lands, and especially agricultural lands, are anticipated to proportionately decline in areal extent. Agricultural lands are estimated to comprise about 21,900 acres, or about 40 percent of the total drainage area.

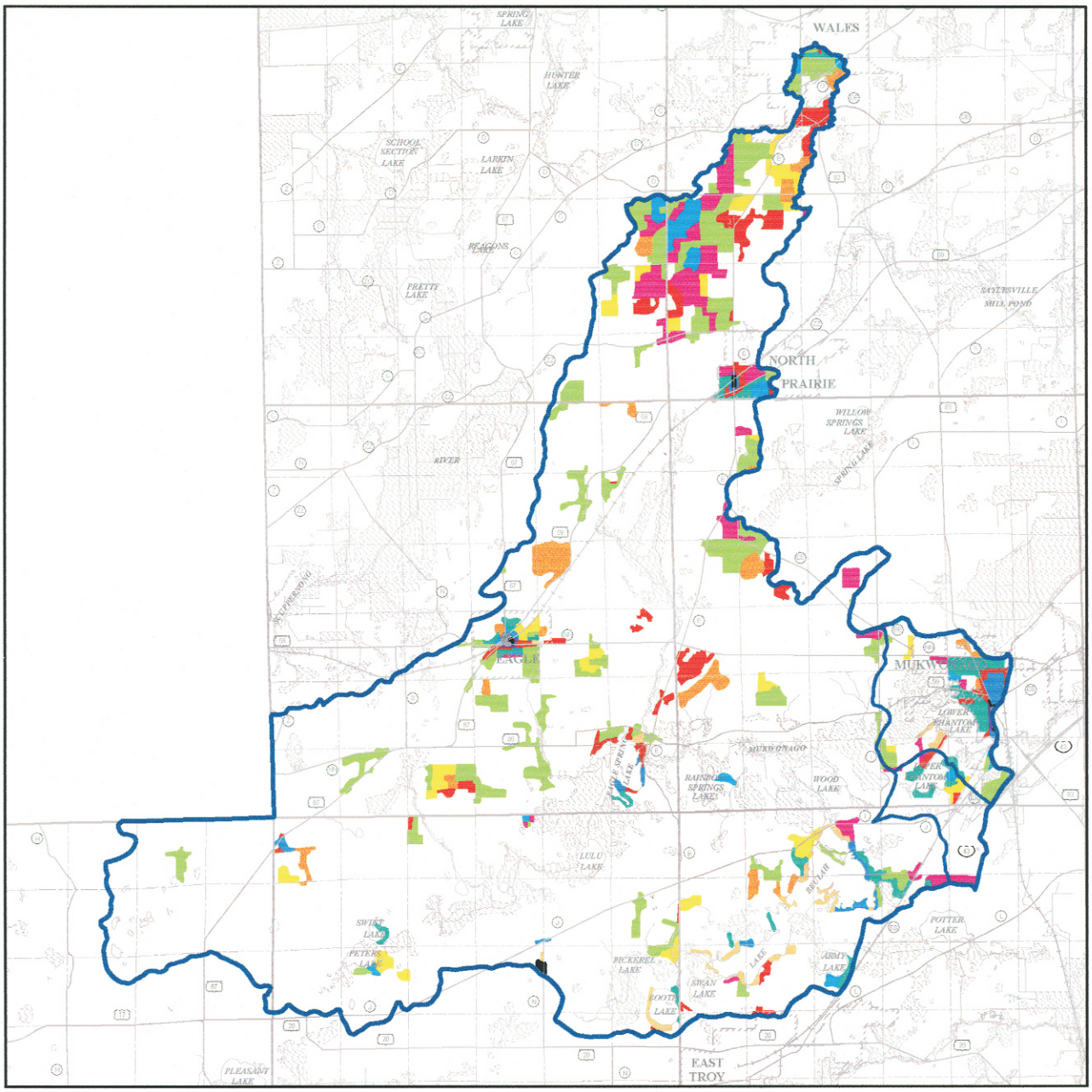
Nearly all of the shoreland around the Phantom Lakes has some form of shoreline protection. Maps C-4 and C-5 show current shoreline conditions as of the year 2002.

Aquatic Plants, Distribution and Management Areas

Several aquatic plant surveys have been conducted on the Phantom Lakes. The initial aquatic plant survey of the Phantom Lakes was conducted by the WDNR during 1967, with a subsequent survey having been conducted by the WDNR during 1980. The WDNR conducted a further, abbreviated aquatic plant survey off the Whispering Bay development on the western shore of Lower Phantom Lake during July 1992. The comprehensive surveys reported some 17 species of plants, about half of which were common to abundant, while 19 species were reported during the abbreviated aquatic plant survey conducted within the western portion of Lower Phantom Lake during 1992.

Map C-3

HISTORIC URBAN GROWTH WITHIN THE DRAINAGE AREA TRIBUTARY TO THE PHANTOM LAKES: 1850-2000



Source: SEWRPC.

Map C-4

SHORELINE PROTECTION STRUCTURES ON UPPER PHANTOM LAKE: 2002

DATE OF PHOTOGRAPHY: MARCH 2000

RIPRAP

BEACH

NATURAL

BULKHEAD

GRAPHIC SCALE

0 300 600 FEET

Source: SEWRPC.

Map C-5

SHORELINE PROTECTION STRUCTURES ON LOWER PHANTOM LAKE: 2002

Source: SEWRPC.

DATE OF PHOTOGRAPHY: MARCH 2000

More recently, surveys of the aquatic plant species present within the Phantom Lakes were conducted by Regional Planning Commission staff during July 1993 and July 2002. Lower Phantom Lake contained an abundant and diverse aquatic plant flora due to its uniform shallow depth, with Upper Phantom Lake containing an impoverished aquatic plant flora in contrast. A total of 19 species of aquatic plants were recorded in both Lakes during the 1993 survey and 22 species were recorded during the 2002 survey. All of the observed aquatic plants commonly observed within the Lakes typically are found throughout the Southeastern Wisconsin Region.

Aquatic Plants in the Phantom Lakes

Species lists, compiled by the WDNR and Regional Planning Commission staff from data gathered during the four aquatic plant surveys conducted on the Phantom Lakes between 1967 and 2002, are set forth in Tables C-1 and C-2, for Upper and Lower Phantom Lakes, respectively, with the information on aquatic plant community composition from the partial survey of Lower Phantom Lake also being included. An overall total of 26 species of submergent and floating-leaved aquatic plants were identified in the Phantom Lakes during these surveys. Notes on the ecological significance of each plant are set forth in Table C-3. The greatest diversity of aquatic plants was found to be in the shallower, Lower Phantom Lake. The areas in which aquatic plant growth was found are shown in Maps C-6 and C-7, and representative illustrations of these aquatic plants can be found at the end of this appendix.

Plant growth occurred in both of the Lakes where the water depth was less than about 12 feet. In Lower Phantom Lake, this included the majority of the lakebed. Species that interfere with the recreational and aesthetic use of the Lakes, such as *Myriophyllum spicatum*, *Ceratophyllum demersum*, and *Potamogeton crispus*, were found to be present in both Lakes. Eurasian water milfoil was first reported to be present in the Lakes during the 1993 survey, although the WDNR noted the presence of this nonnative invasive plant in Whispering Bay in Lower Phantom Lake during their 1992 partial aquatic plant survey. This plant has increased steadily in abundance in both Lakes, with the plant becoming co-dominant in Lower Phantom Lake with elodea (*Elodea canadensis*), and in Upper Phantom Lake with muskgrass (*Chara* spp.). As of 2002, however, in Upper Phantom Lake, muskgrass remained the most frequently observed species, while in Lower Phantom Lake, the increase in abundance of Eurasian water milfoil appears to have occurred at the expense of the native or northern water milfoil, which has decreased proportionately in abundance. Healthy populations of pondweeds (*Potamogeton* spp.) appeared to be present in Lower Phantom Lake, but these plants were less commonly found in Upper Phantom Lake. In general, the Phantom Lakes continue to support a healthy and diverse aquatic macrophyte community. Changes in the aquatic macrophyte species distribution and abundance in the Phantom Lakes, between 1993 and 2002, are summarized in Tables C-4 and C-5.

Year 2002 Aquatic Plant Distribution

The aquatic plant community in Lower Phantom Lake observed during the year 2002 aquatic plant survey was comprised of 20 species of submergent aquatic plants. These plants were found at a majority of the 87 sites sampled. Plant growth occurred throughout the Lake basin, given the shallow nature of Lower Phantom Lake. Eurasian water milfoil growths were observed to be most dense within the littoral zone, defined by the five foot depth contour. Of the six most common aquatic plant species present in Lower Phantom Lake, most were present with a relative density rating of about 3.0, out of a maximum density rating of 4.0 at the sites where the plants were found. Because not all plants were found at all locations, the whole Lake densities ratings of these species ranged from about 1.5 to 2.9, with Eurasian water milfoil and elodea being most abundant, as previously noted. These densities suggest a more abundant aquatic plant community within Lower Phantom Lake, compared with the plant community reported during the 1993 survey. During that previous survey, the six most abundant aquatic plants were present with a relative density of about 2.0 out of 4.0 where the plants were found, resulting in a whole Lake density that averaged about 1.0. Consequently, it would appear that not only did aquatic plant growth in Lower Phantom Lake increase in density, but it also increased in diversity, with nine species being reported at more than about one-half of the sites sampled.

In Upper Phantom Lake, 18 species of submergent aquatic plants were recorded during the year 2002 aquatic plant survey. These plants were found at a majority of the 87 sites sampled, but no plants were reported at depths

Table C-1

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

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

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

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

Source: SEWRPC.

in excess of 11 feet. In contrast to Lower Phantom Lake, Eurasian water milfoil growths in Upper Phantom Lake were most abundant at depths of greater than five feet, up to the maximum depth of observed aquatic plant growth of 11 feet. Of the four most common aquatic plant species in Upper Phantom Lake, most were present with a relative density rating of about 2.0 out of a maximum density rating of 4.0 at the sites where the plants were found. Because not all plants were found at all locations, the whole Lake densities ratings of these species ranged from about 0.7 to 2.6, with muskgrass being most abundant, as previously noted. These density ratings were not inconsistent with those reported during the 1993 survey, although Eurasian water milfoil and eelgrass did appear to be somewhat more dense and widespread during 2002. As in Lower Phantom Lake, the diversity of submergent aquatic plants appears to have increased between these surveys, with three species being reported at more than one-half of the sites surveyed during 2002, in contrast to the single species observed during 1993.

In both Lakes, the frequency of occurrence of Eurasian water milfoil, as well as the density of the plant within the submergent aquatic plant communities, has increased, suggesting that the plant has become more widespread in the Lake system. Consequently, this plant should remain a target species for control within the overall aquatic plant management program being conducted on the Phantom Lakes.

Eurasian Water Milfoil

At the time of the year 2002 Commission survey, the dominant aquatic plant within Lower Phantom Lake was Eurasian water milfoil, *Myriophyllum spicatum*, and the plant was increasing in abundance in Upper Phantom Lake. Eurasian water milfoil is one of eight milfoil species found in Wisconsin and the only one that is known to be exotic or nonnative. Because of its nonnative nature, Eurasian water milfoil has few natural enemies and can

Table C-2

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

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

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

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

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

Source: Wisconsin Department of Natural Resources and SEWRPC.

exhibit “explosive” growth under suitable conditions, such as the presence of organic-rich sediments, or in areas where the lake bottom has been disturbed. It can displace native plant species and disrupt the ecosystem functioning of lakes as it lacks many of the positive ecological values of native aquatic plants. This particular species of milfoil has been known to become the dominant plant present in lakes with its ability to regenerate, to replace native vegetation, and to reduce the quality of fish and wildlife habitat.

Eurasian water milfoil is especially abundant in Lower Phantom Lake where depths rarely exceed 10 feet, as well as within the littoral zone of Upper Phantom Lake. The abundant growths of Eurasian water milfoil are known to cause extreme problems in the Phantom Lakes due to the ability of the plant to grow to the lake surface, making certain recreational uses less enjoyable, if not dangerous, and impairing the aesthetic qualities of the waterbody. When Eurasian water milfoil is fragmented by boat propellers, or by other means, the fragments are able to sprout new roots and potentially colonize new sites. These fragments can also cling to boats, trailers, motors, propellers, and bait buckets, among other things, and stay alive for weeks, facilitating their transfer to other lakes.[3]

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

Table C-3

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

Aquatic Plant Species Present	Ecological Significance
Ceratophyllum demersum (coontail)	Provides good shelter for young fish and supports insects valuable as food for fish and ducklings
Chara vulgaris (muskgrass)	Excellent producer of fish food, especially for young trout, bluegills, small and largemouth bass, stabilizes bottom sediments, and has softening effect on the water by removing lime and carbon dioxide
Decodon verticillatus (swamp loosestrife, water-willow)	Seeds provide food for waterfowl; food and cover for muskrat
Elodea canadensis (waterweed)	Provides shelter and support for insects which are valuable as fish food
Lemna minor (small duckweed)	Important food source for ducks and geese; food source also for muskrat and beaver; provides shade and shelter for fish
Lythrum aslicaria (purple loosestrife)	Invasive species considered a threat to native ecosystems; has little wildlife value
Myriophyllum sibiricum (northern water milfoil)	Provides food for waterfowl, insect habitat and foraging opportunities for fish
Myriophyllum spicatum (Eurasian water milfoil)	None known
Najas flexilis (bushy pondweed)	Stems, foliage, and seeds important wildfowl food and produces good food and shelter for fish
Najas marina (spiny naiad)	Important food source for ducks
Nitella spp. (stonewarts)	Sometimes eaten by waterfowl; provides foraging for fish
Nymphaea tuberose (white water lily)	Provides food for waterfowl, deer, muskrat and beaver; provides shade and shelter for fish
Nymphaea variegate (yellow water lily/spadderdock)	Provides food for waterfowl, deer, muskrat and beaver; provides shade and shelter for fish
Phalaris arundinacea (reed canary grass)	An effective shoreline stabilizer with little wildlife value; a Eurasian strain has become a threat to native species
Potamogeton amplifolius (large-leaf pondweed)	Offers shade, shelter and foraging for fish; valuable food for waterfowl
Potamogeton crispus (curly-leaf pondweed)	Provides food, shelter and shade for some fish and food for wildfowl
Potamogeton foliosis (leafy pondweed)	Provides food for geese and ducks; food for muskrat, beaver and deer; good surface area for insects and cover for juvenile fish
Potamogeton gramineus (variable pondweed)	Provides habitat for fish and food for waterfowl, muskrat, beaver and deer
Potamogeton illinoensis (Illinois pondweed)	Provides shade and shelter for fish; harbor for insects; seeds are eaten by wildfowl
Potamogeton natans (floating-leaf pondweed)	Provides food for waterfowl, muskrat, beaver and deer; good fish habitat
Potamogeton pectinatus (Sago pondweed)	This plant is the most important pondweed for ducks, in addition to providing food and shelter for young fish
Potamogeton praelongus (white-stem pondweed)	Good food provider for waterfowl, muskrat, and some fish species; valuable habitat for musky. Considered an indicator species for water quality due to its intolerance of turbid water conditions

Table C-3 (continued)

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

Source: SEWRPC.

Environmentally Sensitive Areas

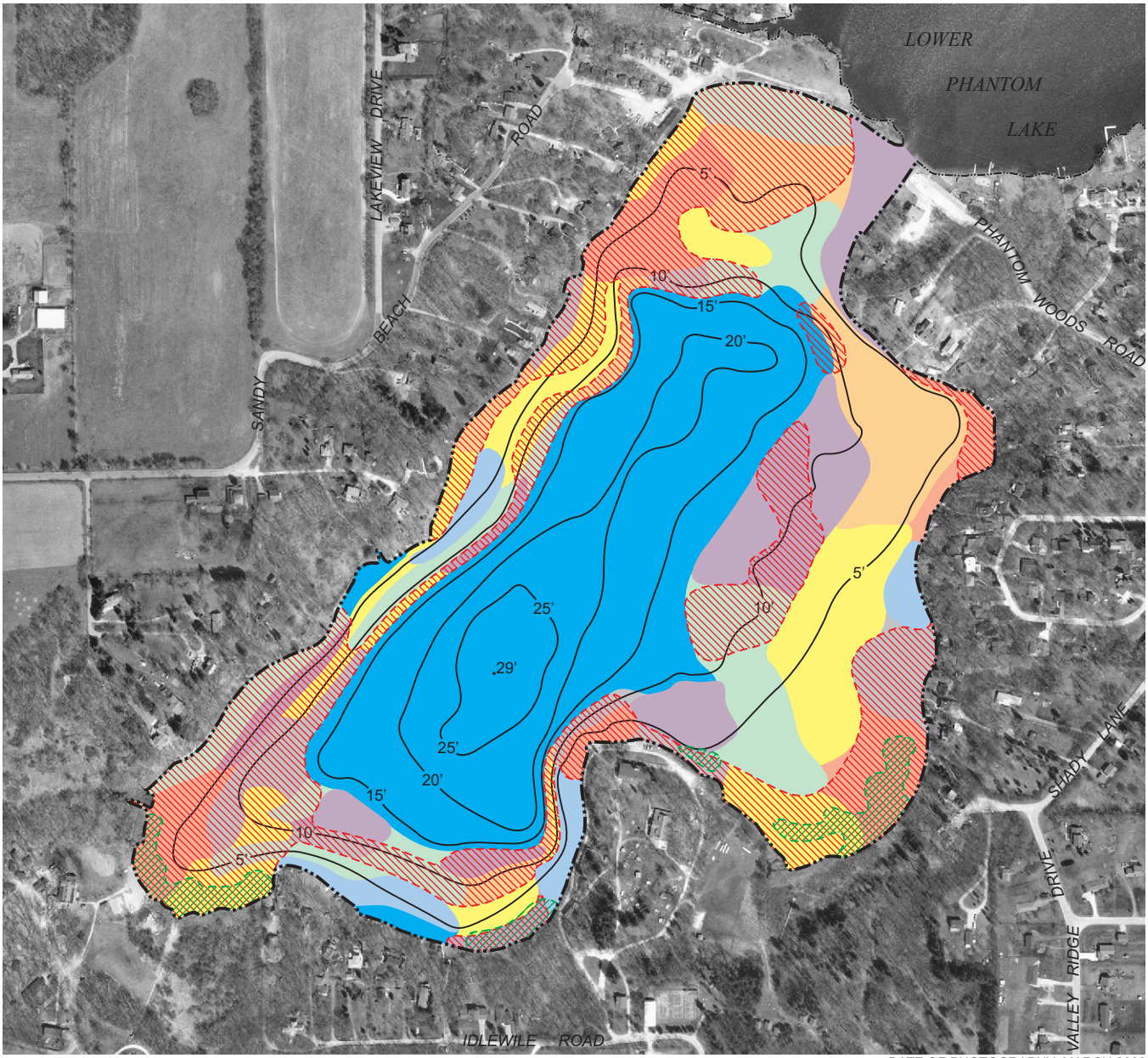
The Wisconsin Department of Natural Resources can designate environmentally sensitive areas within lakes pursuant to Chapter NR 107 of the *Wisconsin Administrative Code*. Such designations can be made because of the importance of specific areas within a lake to the maintenance of good water quality conditions and the biological integrity of a lake. There are no environmentally sensitive areas designated on the Phantom Lakes.

Fisheries, Wildlife and Waterfowl

The Phantom Lakes are well known for their bass and panfish fishing. The Wisconsin Department of Natural Resources Publication PUB-FH-800, *Wisconsin Lakes*, indicates that northern pike and largemouth bass are common, and that walleyed pike and panfish are present in both Lakes. No stocking has been carried out on the Lakes since 1972, when the last introductions of record were made. Good bass breeding habitat exists almost exclusively in Upper Phantom Lake.

Map C-6

AQUATIC PLANT COMMUNITY DISTRIBUTION IN UPPER PHANTOM LAKE: 2002



DATE OF PHOTOGRAPHY: MARCH 2000

—20′— WATER DEPTH CONTOUR IN FEET

OPEN WATER

WATER LILIES

EURASIAN WATER MILFOIL

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

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

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

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

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

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

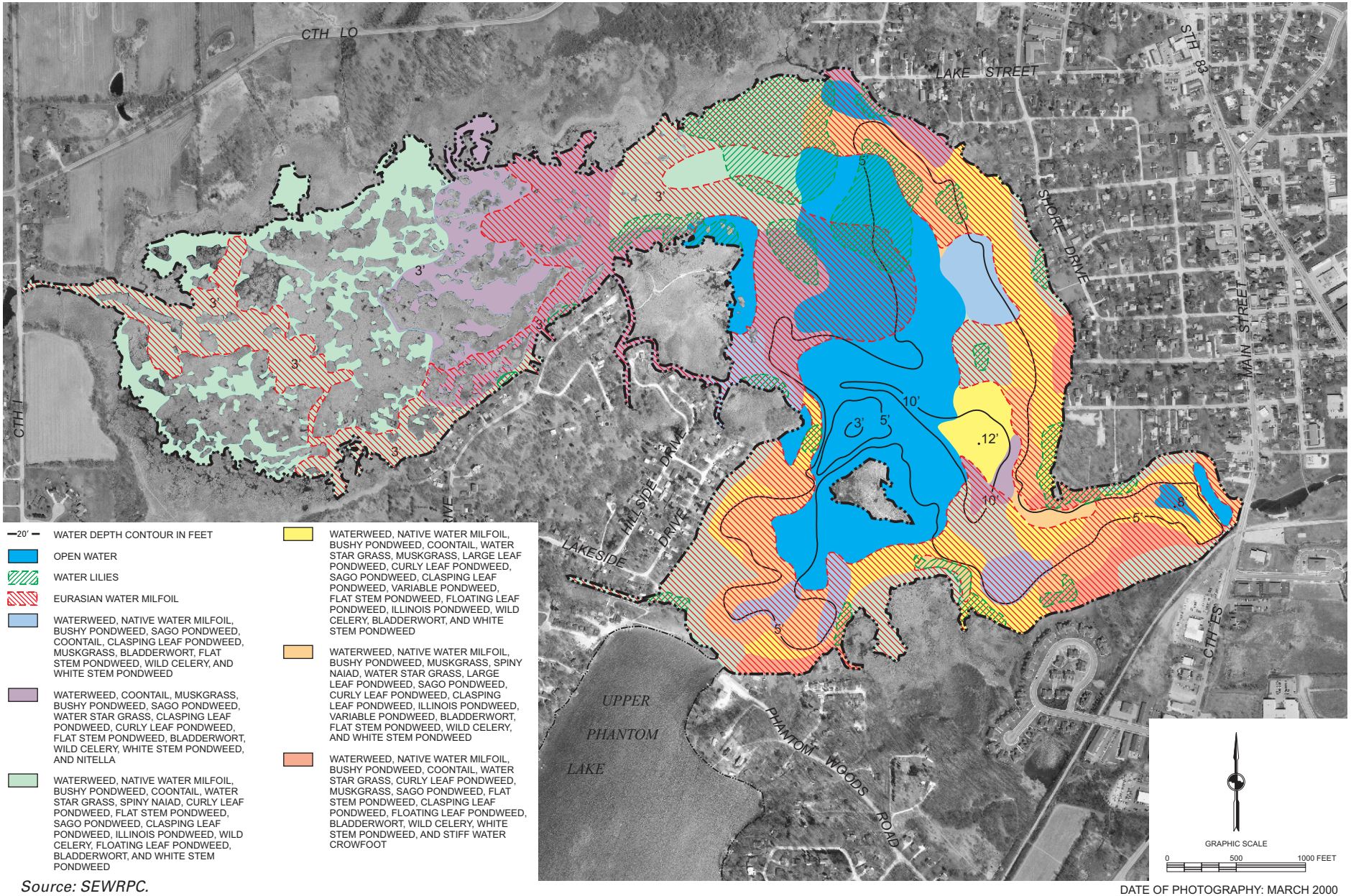
WILD CELERY, BUSHY PONDWEED, NATIVE WATER MILFOIL, CLASPING LEAF PONDWEED, FLAT STEM PONDWEED, SPINY NAIAD, WATERWEED, SAGO PONDWEED, WHITE STEM PONDWEED, VARIABLE PONDWEED, WATER BULRUSH, AND NITELLA

GRAPHIC SCALE
0 300 600 FEET

Source: SEWRPC.

Map C-7

AQUATIC PLANT COMMUNITY DISTRIBUTION IN LOWER PHANTOM LAKE: 2002



—20′— WATER DEPTH CONTOUR IN FEET

OPEN WATER

WATER LILIES

EURASIAN WATER MILFOIL

WATERWEED, NATIVE WATER MILFOIL, BUSHY PONDWEED, SAGO PONDWEED, COONTAIL, CLASPING LEAF PONDWEED, MUSKGRASS, BLADDERWORT, FLAT STEM PONDWEED, WILD CELERY, AND WHITE STEM PONDWEED

WATERWEED, COONTAIL, MUSKGRASS, BUSHY PONDWEED, SAGO PONDWEED, WATER STAR GRASS, CLASPING LEAF PONDWEED, CURLY LEAF PONDWEED, FLAT STEM PONDWEED, BLADDERWORT, WILD CELERY, WHITE STEM PONDWEED, AND NITELLA

WATERWEED, NATIVE WATER MILFOIL, BUSHY PONDWEED, COONTAIL, WATER STAR GRASS, SPINY NAIAD, CURLY LEAF PONDWEED, FLAT STEM PONDWEED, SAGO PONDWEED, CLASPING LEAF PONDWEED, ILLINOIS PONDWEED, WILD CELERY, FLOATING LEAF PONDWEED, BLADDERWORT, AND WHITE STEM PONDWEED

WATERWEED, NATIVE WATER MILFOIL, BUSHY PONDWEED, COONTAIL, WATER STAR GRASS, MUSKGRASS, LARGE LEAF PONDWEED, CURLY LEAF PONDWEED, SAGO PONDWEED, CLASPING LEAF PONDWEED, VARIABLE PONDWEED, FLAT STEM PONDWEED, FLOATING LEAF PONDWEED, ILLINOIS PONDWEED, WILD CELERY, BLADDERWORT, AND WHITE STEM PONDWEED

WATERWEED, NATIVE WATER MILFOIL, BUSHY PONDWEED, MUSKGRASS, SPINY NAIAD, WATER STAR GRASS, LARGE LEAF PONDWEED, SAGO PONDWEED, CURLY LEAF PONDWEED, CLASPING LEAF PONDWEED, ILLINOIS PONDWEED, VARIABLE PONDWEED, BLADDERWORT, FLAT STEM PONDWEED, WILD CELERY, AND WHITE STEM PONDWEED

WATERWEED, NATIVE WATER MILFOIL, BUSHY PONDWEED, COONTAIL, WATER STAR GRASS, CURLY LEAF PONDWEED, MUSKGRASS, SAGO PONDWEED, FLAT STEM PONDWEED, CLASPING LEAF PONDWEED, FLOATING LEAF PONDWEED, BLADDERWORT, WILD CELERY, WHITE STEM PONDWEED, AND STIFF WATER CROWFOOT

Source: SEWRPC.

DATE OF PHOTOGRAPHY: MARCH 2000

Table C-4

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

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

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

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

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

Source: SEWRPC.

Table C-5

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

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

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

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

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

Source: SEWRPC.

Given the urban nature of much of the shorelands of the Lakes only smaller urban tolerant mammals are generally present. A somewhat more diverse animal community, and greater number of waterfowl, makes use of the extensive outlying wetland and other habitat areas located throughout the tributary drainage area to the Phantom Lakes. Muskrats 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 area tributary to the Lakes.

The Phantom Lakes drainage area supports a significant population of waterfowl including mallards and geese. There are several pairs of swans on Lower Phantom Lake, and geese are especially abundant in the parkland areas adjacent to, and upstream of, Lower Phantom Lake. Active breeding colonies of waterfowl inhabit both the Lakes and their surrounding wetlands during the spring and early summer, while, during migration seasons, a greater variety of waterfowl may be present and in greater numbers.

Recreational Uses and Facilities

The Phantom Lakes are multipurpose waterbodies serving numerous forms of recreation, including both active and passive recreational uses. Boating, waterskiing, swimming, and fishing are popular activities during open water periods, and ice fishing and snowmobiling are common during closed water periods. Two youth camps exist along the shores of Upper Phantom Lake, and a major community park exists on the eastern shore of Lower Phantom Lake within the Village of Mukwonago. The Lakes are utilized year round as a visual amenity, with walking, bird watching, and picnicking being popular passive recreational uses of the waterbody and its surroundings. Given the shallow nature of Lower Phantom Lake, less use is made of that Lake for waterskiing relative to Upper Phantom Lake and other waterbodies in Southeastern Wisconsin.

Boat traffic on the Phantom Lakes is variable throughout the season. During 2002, commission staff conducted recreational use surveys on the Upper and Lower Phantom Lakes during both weekdays and weekend days. These data confirm significantly different recreational uses of the two Lakes. Users of Upper Phantom Lake utilize that waterbody most frequently for nonfishing recreational activities, such as swimming, water skiing, canoeing, kayaking and paddle boating. Of the recreational use activities occurring on Upper Phantom Lake, swimming accounted for about 42 percent of the observed use; pleasure boating of various types, including water skiing, accounted for about 39 percent of the observed use; and fishing accounted for the balance. In contrast, recreational users of Lower Phantom Lake favored fishing over other categories of recreational water uses. During both weekday and weekend surveys conducted on Lower Phantom Lake, fishing, from either shore or boat, accounted for over 90 percent of all recreational uses.

The distribution of watercraft types on the two Lakes reflected, to some degree, the dominant recreational uses of the two Lakes. On Upper Phantom Lake, where about 80 percent of recreational uses were of nonfishing uses, fishing boats accounted for only about 15 percent of the more than 250 watercraft observed. On Lower Phantom Lake, where there was an observed preference for fishing, over 30 percent of the approximately 180 watercraft were fishing boats, with a further 30 percent being pontoon boats, which can, and often do, serve dual purposes as both pleasure craft and fishing platforms. A boating survey, conducted by the Commission staff during the current planning program period, indicated that about 113 watercraft of all descriptions were in use on the Lakes on a typical weekend day, August 12, 2000, with about 20 watercraft of all descriptions being in use during a typical weekday, on August 15, 2000. The density of powerboats and ski boats on Lower Phantom Lake were consistent with the recreational boating guidelines set forth in the adopted regional park and open space plan. On Upper Phantom Lake, however, the numbers of powerboats and ski boats exceeded this guideline.

There is one public recreational boating access site located on Lower Phantom Lake, and a number of private recreational facilities offering boating access to the general public on both Upper and Lower Phantom Lakes. The Lakes have adequate public recreational boating access as set forth pursuant to Chapter NR 1 of the *Wisconsin Administrative Code*. There also were other facilities that provided a range of services for recreational users of the Phantom Lakes, including several local retail outlets within the Village of Mukwonago in close proximity to the Lakes. A public beach is located near the outlet of Lower Phantom Lake, on the east side of CTH ES.

Local Ordinances

The comprehensive zoning ordinance represents one of the most important and significant tools available to local units of government in directing the proper use of lands within their area of jurisdiction. Local zoning regulations include general, or comprehensive, zoning regulations and special-purpose regulations governing floodland and shoreland areas. The Village of Mukwonago and the Town of Mukwonago, in Waukesha County, within the drainage area directly tributary to the Phantom Lakes have adopted local zoning ordinances. In the Village of Mukwonago, these ordinances include shoreland, floodland, and shoreland-wetland zoning ordinances,

subdivision control ordinances, and erosion control and stormwater management ordinances, while the Town of Mukwonago utilizes the County ordinances in conjunction with a Town subdivision control ordinance. Recreational boating uses of Lakes are governed by a joint Town and Village recreational boating ordinance applicable to Lower Phantom Lake and a Town ordinance applicable to Upper Phantom Lake. These ordinances specify hours for watercraft operation and water-based recreational activities such as waterskiing.

USE RESTRICTIONS IMPOSED BY AQUATIC PLANTS

Aquatic plant growth in the Phantom Lakes is perceived to have reached densities in portions of the Lakes that interfere with recreational usage of the Lakes, impeding boat traffic and making some areas of the Lakes impassable without aquatic plant control. At numerous sample sites, plant growths recorded by the Commission staff exceeded a density rating of 3.0, indicating a moderate to abundant density. As noted above, Eurasian water milfoil is a major contributor to these higher densities, especially in Lower Phantom Lake. Excessive plant growth in the littoral zone makes access to the open water extremely difficult, and severely restricts shoreline angling and swimming. The abundance of aquatic plants in the Phantom Lakes also reportedly adversely affects the aesthetic appeal of residing on, or visiting, the Lakes. The result is heightened public concern and complaints particularly during open water periods.

PAST AND PRESENT AQUATIC PLANT MANAGEMENT PRACTICES

Records of aquatic plant management efforts on Wisconsin Lakes were not maintained by the Wisconsin Department of Natural Resources prior to 1950. Notwithstanding, previous interventions were likely to have taken place. On the Phantom Lakes, the first recorded efforts to manage the aquatic plants took place during 1941. At that time, aquatic plant management involved a WDNR-approved “Nuisance Weed Control Program” utilizing aquatic herbicides as the primary management measure. Since 1987, however, the mode of aquatic plant management has shifted to a program based on mechanical harvesting of aquatic plants. Consequently, aquatic plant management activities in the Phantom Lakes can be categorized as chemical macrophyte and algal control, and macrophyte harvesting, with aquatic plant harvesting being the primary control measure implemented since 1987. Other aquatic plant management techniques, including lake bottom covering, shoreland riprap and, in Lower Phantom Lake, limited drawdowns have been employed to a lesser extent, these measures being perceived by the community as being less successful than the alternatives.

Chemical Controls

Perceived excessive macrophyte growths on the Phantom Lakes have historically resulted in application of a chemical control program. Since 1950, the use of chemicals to control aquatic plants has been regulated in Wisconsin. Chemical herbicides are known to have been applied to the Phantom Lakes from at least 1950 through 1975, as set forth in Table C-6.

In 1926, sodium arsenite, an agricultural herbicide, was first applied to Lakes in the Madison area, and, by the 1930s, sodium arsenite was widely used throughout the State for aquatic plant control. No other chemicals were applied in significant amounts to control macrophytes until recent years, when a number of organic chemical herbicides came into general use. The amounts of sodium arsenite applied to the Phantom Lakes during the period 1959 through 1962 are listed in Table C-6 the total amount of sodium arsenite applied over this four-year period being about 3,876 pounds. When it became apparent that arsenic was accumulating in the sediments of treated Lakes, presenting potential health hazards to both humans and aquatic life, the use of sodium arsenite was discontinued in the State in 1969.

As shown in Table C-6, the aquatic herbicides diquat, endothall, and 2,4-D have also been applied to the Phantom Lakes to control aquatic macrophyte growth. Diquat and endothall (Aquathol) are contact herbicides and kill plant parts exposed to the active ingredient. Diquat use is restricted to the control of duckweed (*Lemna* sp.), milfoil (*Myriophyllum* spp.), and waterweed (*Elodea* sp.). However, this herbicide is nonselective and will kill many other aquatic plants, such as pondweeds (*Potamogeton* spp.), bladderwort (*Utricularia* sp.), and naiads (*Najas*

Table C-6

HISTORIC CHEMICAL CONTROLS ON THE PHANTOM LAKES: 1950-2003

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

Source: Wisconsin Department of Natural Resources and SEWRPC.

spp.). Endothall primarily kills pondweeds, but does not control such nuisance species as Eurasian water milfoil (*Myriophyllum spicatum*). The herbicide 2,4-D is a systemic herbicide that is absorbed by the leaves and translocated to other parts of the plant; it is more selective than the other herbicides listed above and is generally used to control Eurasian water milfoil. However, it will also kill species such as water lilies (*Nymphaea* sp. and *Nuphar* sp.). The present restrictions on water use after application of these herbicides are given in Table C-7.

In addition to the chemical herbicides used to control large aquatic plants, algicides have also been applied to Phantom Lakes. As shown in Table C-6, copper sulfate has been applied to the Phantom Lakes, on occasion. Like arsenic, copper, the active ingredient in many algicides, may accumulate in the bottom sediments. Excessive levels of copper may be toxic to fish and benthic organisms, but, generally, have not been found to be harmful to humans.[4] Restrictions on water uses after application of copper sulphate are also given in Table C-7.

Macrophyte Harvesting

Since the mid-1980s, the excessive macrophyte growths on the Phantom Lakes have been managed using a control program that is based upon manual and mechanical harvesting. The existing macrophyte control program

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

Table C-7

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

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

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

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

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

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

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

Source: Wisconsin Department of Natural Resources.

follows an aquatic management plan developed for the Lakes in 1993, summarized on Maps C-8 and C-9.[5] The harvesting program emphasizes removal of nuisance plants necessary to facilitate recreational uses and enhance the Lakes fisheries, rather than 100 percent plant removal. Under this program, the Phantom Lakes Management District conducts harvesting operations using Aquarius Systems H-420 and H-820 harvesters, a transport barge, and shore conveyer for off-loading. Typically, harvesting is conducted 40 hours per week, weather permitting, during spring and summer primarily in Lower Phantom Lake, or from May 15 to September 15, annually. This program results in approximately 200 truckloads of harvested aquatic plant material being removed from the system during the three-month period between July and August. In addition, residents individually remove aquatic plants from around piers and docks using rakes or other manual harvesting techniques. The harvested plant material also is removed from the Lakes.

ALTERNATIVE METHODS FOR AQUATIC PLANT CONTROL

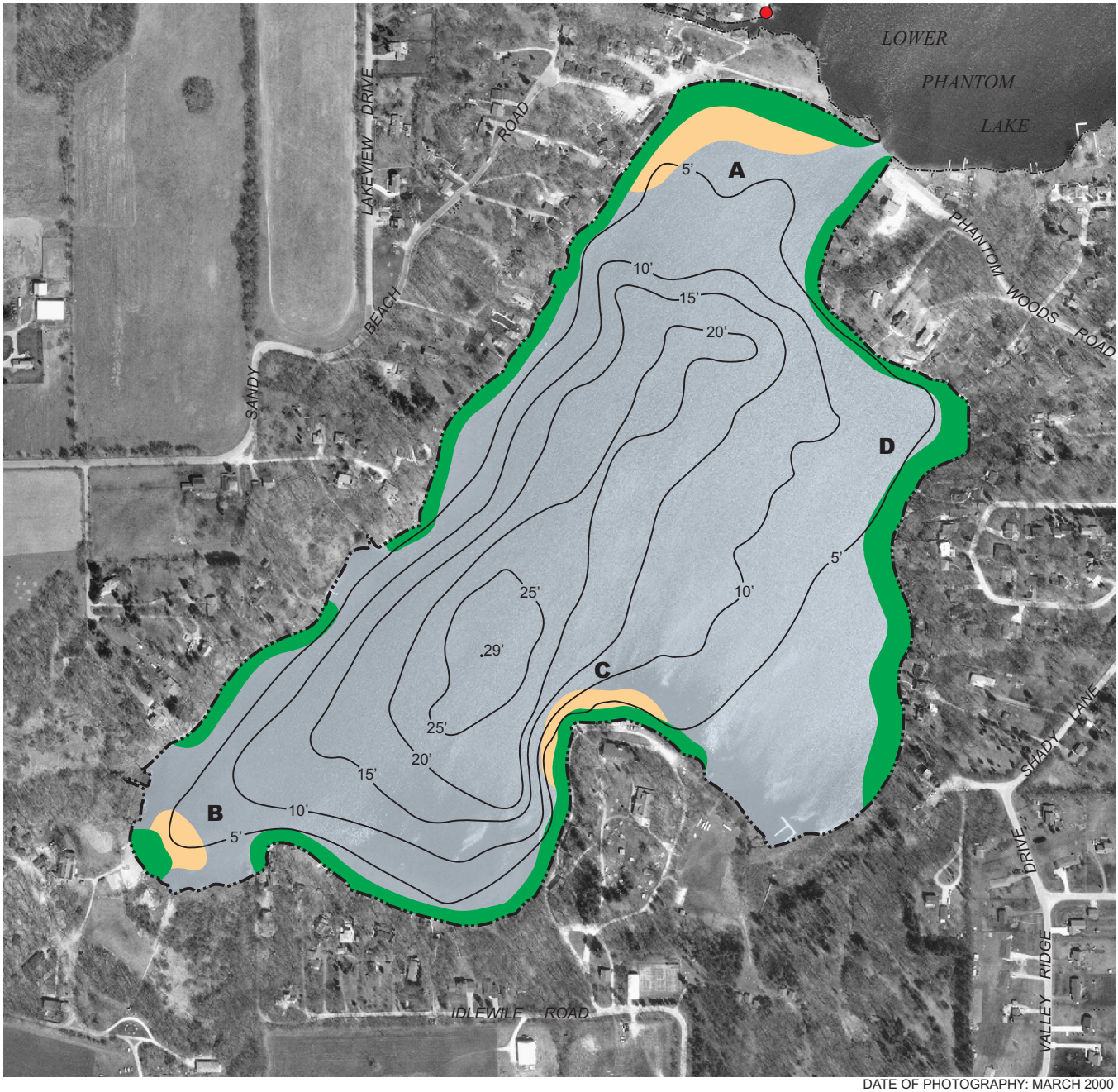
Background

Various aquatic plant management techniques, manual, mechanical, physical, biological, and chemical, are potentially applicable on the Phantom Lakes. A number of these methods have been employed with varying success on the Phantom Lakes, as noted above, although aquatic plant harvesting has been the major control measure utilized throughout the Lakes in recent years.

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

Map C-8

AREAS OF UPPER PHANTOM LAKE RECOMMENDED TO BE HARVESTED BY THE PHANTOM LAKES MANAGEMENT DISTRICT: 1993



DATE OF PHOTOGRAPHY: MARCH 2000

NOTE: Harvesting period July 1 through September 1

—20'— WATER DEPTH CONTOUR IN FEET

HARVESTING AREA FOR SWIMMING AND MAINTENANCE

INNER LAKE ECOLOGICALLY VALUABLE AREA

UNLOADING SITE

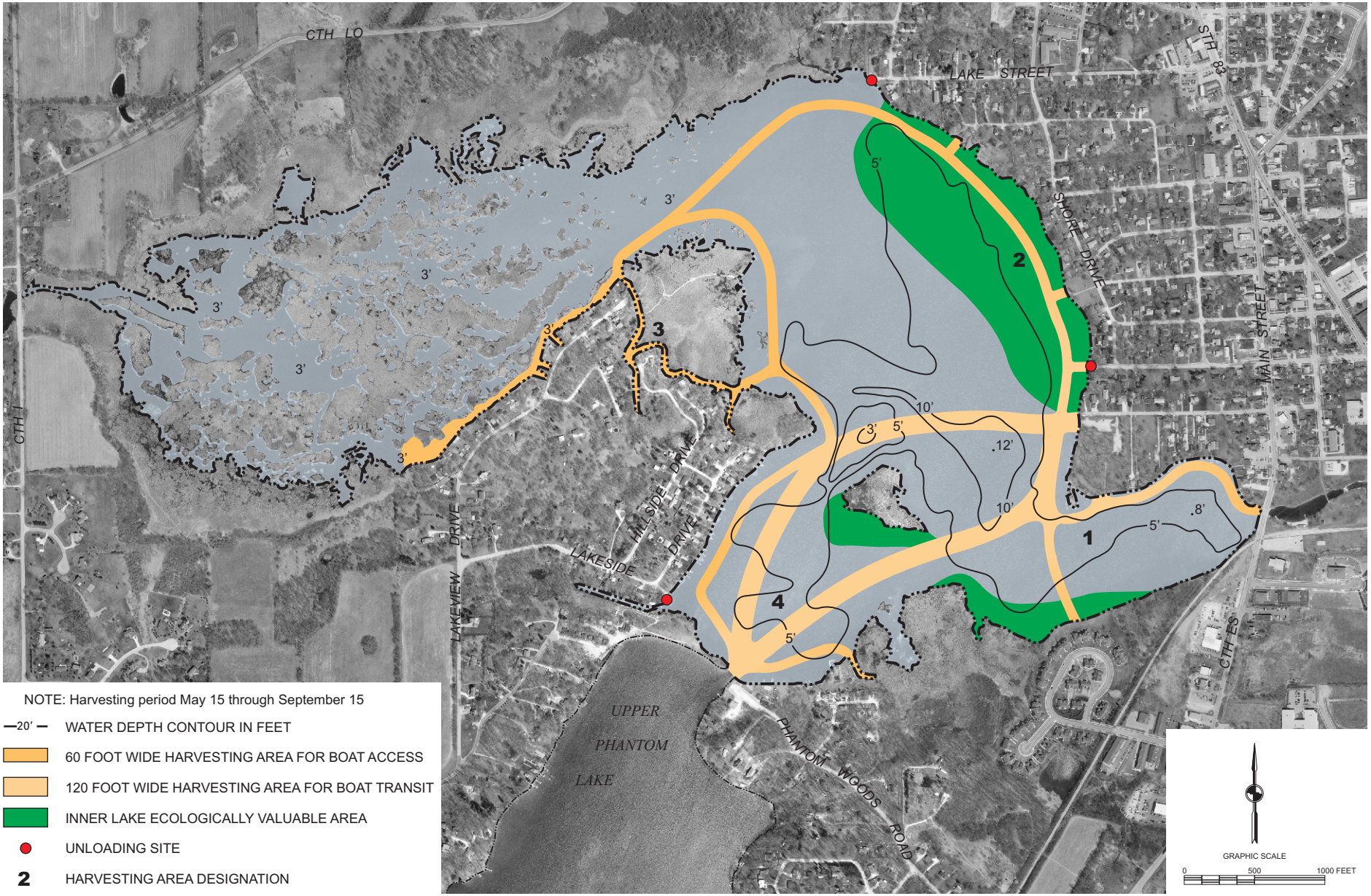
A HARVESTING AREA DESIGNATION

GRAPHIC SCALE
0 300 600 FEET

Source: SEWRPC.

Map C-9

AREAS OF LOWER PHANTOM LAKE RECOMMENDED TO BE HARVESTED BY THE PHANTOM LAKES MANAGEMENT DISTRICT: 1993



Source: SEWRPC.

Physical Controls
Physical methods of aquatic plant control involve water level manipulation, placement of bottom barriers, and use of shoreline protection structures.

Water level manipulations generally focus on drawdowns that reduce the surface level of a waterbody, or on inducing variations in water levels, in order to change or create specific types of habitat and thereby manage species composition within the waterbody. Drawdowns, or periodic lake level fluctuations, were not considered practical for the Phantom Lakes due to the heavy recreational demands placed on the Lakes throughout the year. In addition, the ability to reduce the water level of Upper Phantom Lake is limited by the depth of the sandy sill that separates Upper Phantom Lake from Lower Phantom Lake. Further, because the lake levels can only be controlled to any significant extent on Lower Phantom Lake, and because drawdowns can encourage algal blooms and increase the growths of certain rooted aquatic plant species, such as cattails, for example, that already grow in proliferation in the upper portions of Lower Phantom Lake, the use of water level manipulation as an aquatic plant management technique entails significant potential risk, especially in the shallow Lower Phantom Lake. Likewise, raising or frequently changing the lake levels for the control of certain nuisance species has limited practicality on the Phantom Lakes, again for reasons of the intensity of year round lake usage. The ability to raise water levels for aquatic plant management purposes is limited by the topography of the lake basins, which would create unacceptable risks of flooding of residential properties and infrastructure. For these reasons, drawing down, raising or frequently changing the water levels of the Lakes is not a recommended aquatic plant management technique for the Phantom Lakes at this time.

Other physical controls, such as the placement of bottom barriers, which may be comprised of grids made of nylon or other synthetic fabric mesh or the placement of sand or pea gravel blankets, are likewise considered to be of limited utility in the Phantom Lakes. The lack of depth, especially in Lower Phantom Lake, and requirements typically included in permits for the placement of synthetic fabric grids that require that such structures be removed annually, as well as the propensity of such structures to be disturbed by recreational boating traffic in shallow water areas, suggests that such structures are not feasible for use in the Phantom Lakes. In contrast, however, the use of shoreline protection structures such as vegetated buffer strips, may be more practicable for the Phantom Lakes. Extensive use of shoreline protection structures has occurred adjacent to the residential areas of the Phantom Lakes, primarily to control shoreline erosion. Depending upon the nature of the measures used, certain structures, such as vegetated buffer strips and enhanced littoral vegetation, can serve to filter out agro-chemicals, including residential lawn care products, which can stimulate aquatic plant growth. Consequently, increasing the extent of shoreline buffers around the Lakes provides an important and ready means of moderating the nutrient loads that stimulate the growth of aquatic plants.

One further physical control option, dredging, is a technique that may be used on a limited scale to manage aquatic macrophyte growths and accumulations of nutrient-rich, organic sediments that frequently sustain and promote the growths of nuisance aquatic plant species in lakes. However, extensive dredging to alleviate excessive macrophyte growths is not recommended due, in part, to the potential presence of arsenic residues in the Lakes sediments from the extensive sodium arsenite applications conducted on the Lakes during the 1950s and 1960s.

Chemical Controls
Chemical controls, in the form of herbicides and algicides, have been used on the Phantom Lakes. However, an important goal of the Phantom Lakes Management District has been to manage the aquatic plant communities of the Lakes without the use of chemicals. Currently, the use of herbicides on the Lakes has been limited to individual applications around piers and docks.

As noted above, the aquatic herbicides diquat, endothall, and 2,4-D have been applied to the Phantom Lakes to control aquatic macrophyte growth, and the use of fluridone has been proposed. Diquat is a nonselective herbicide that will kill many aquatic plants, such as the pondweeds, bladderwort, and naiads that occur in the Phantom Lakes and that provide significant habitat value for the fishes and wildlife of the Lakes. Endothall primarily kills pondweeds, but does not control such nuisance species as Eurasian water milfoil, while 2,4-D and fluridone are

systemic herbicides that are considered to be more selective at recommended dosage rates and generally used to control Eurasian water milfoil. However, 2,4-D also will kill high value species such as water lilies, and fluridone will also affect coontail and elodea. In addition, the use of chemical control techniques may contribute to an ongoing aquatic plant problem by augmenting the natural rates of accumulation of decayed organic matter in the Lakes' sediments, releasing the nutrients contained in the plants back into the water column where they can be reused by new plants, inducing biomass production. The use of chemical control measures may also contribute to the oxygen demand that produces anoxic conditions in the Lakes, damaging or destroying nontarget plant species that provide needed habitat for fish and other aquatic life. Hence, this option is not feasible on the scale required to control the infestations of aquatic plants in the Phantom Lakes.

Chemical control may be a suitable technique for the control of relatively small-scale infestations of Eurasian water milfoil. Chemical applications in early spring, and, potentially, in late fall, have been found to be effective in controlling such infestations of milfoil and facilitating the resurgence of growth of native plant species in Lakes in Southeastern Wisconsin. Chemical applications should be conducted in accordance with current Department of Natural Resources administrative rules, under the authority of a State permit, and by a licensed applicator working under the supervision of WDNR staff. Records accurately delineating treated areas and the type and amount of herbicide used in each area, should be carefully documented and used as a reference in applying for permits in the following year. A recommended checklist is provided as Figure C-1.

Manual Controls

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 for small-scale application, for example, in and around docks and piers, manual techniques are generally not practical for large-scale plant control methods. Manual means are considered a viable option on the Phantom Lakes to control nearshore plant growths, especially around piers and docks, and are encouraged by the Phantom Lakes Management District.

Mechanical Controls

Based on previous experience of the use of mechanical harvester technologies on the Phantom Lakes, mechanical harvesting of aquatic plants appears to be a practical and environmentally sensitive method of controlling plant growth and associated filamentous algae. The most significant impact of mechanical harvesting is the removal of the organic plant biomass, decreasing nutrient inputs (recycling) to the Lakes. Potential negative impacts of mechanical harvesting, as outlined by the U.S. Environmental Protection Agency,[6] include: the removal of small fish, limited depths of operation, propagation of plant fragments, and time needed to treat specific areas of a waterbody. However, mechanical harvesting does offer temporary relief from nuisance aquatic plant growths, especially when conducted in accordance with a management plan designed to optimize benefits and minimize adverse impacts.

In addition to controlling nuisance aquatic plant growth conditions, harvesting has been shown to promote better balance within the in-Lakes fishery by providing access for larger game fish, such as the largemouth bass, to smaller prey fishes and organisms that can utilize the dense plant beds. Narrow channels harvested to provide navigational access also provide "cruising lanes" for predator fish to migrate into the macrophyte beds to feed on smaller fish. These cruising lanes can be combined, in part, with the creation of shared access lanes, allowing several residences to use the same recreational boating traffic lane. The increased use of these shared lanes can help to 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 the Phantom Lakes, and because the current Lakes uses continue to indicate a need for aquatic plant harvesting, harvesting is considered a viable management option that should be continued by the Phantom Lakes Management District.

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[6]*Environmental Protection Agency,* The Lakes and Reservoir Restoration Guidance Manual, *2nd Edition, August 1990, p. 146.*

Figure C-1

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.

Shoreline Cleanup

Decomposing, floating vegetation can build up along the shorelines, and, together with terrestrial leaf litter, can limit the use of shoreline areas. Not only is this material unsightly and potentially foul smelling, but it also contributes to the organic and mucky substrates favored by invasive plant species, such as Eurasian water milfoil. Shoreline cleanup is a laborious job that can require substantial amounts of labor and time. Given that a significant number of Lakes homeowners are seasonal or elderly, it is not always feasible for the riparian owners to clean their shoreline when needed. To alleviate this problem, the Phantom Lakes Management District could consider incorporating a shoreline cleanup crew into the harvesting program, while continuing to leave the control of rooted vegetation between the piers to the riparian owners.

Biological Controls

An alternative approach to controlling nuisance aquatic plant conditions is biological control. Recent WDNR studies have shown that *Eurhychiopsis lecontei*, an aquatic weevil species, has potential as a biological control agent for the control of Eurasian water milfoil. In 1989, the weevil was "discovered" during a study of the decline of Eurasian water milfoil growth in a Vermont pond. *Eurhychiopsis* subsequently proved to have significant impacts on Eurasian water milfoil both in the field and in the laboratory, and has been found to be far more widespread than previously thought. The adult weevil feeds on the milfoil plant, causing lesions which make the plant more susceptible to pathogens such as bacteria or fungi. During its feeding process, the weevil burrows into

the stem of the plant, causing tissue damage to the plant such that its will lose buoyancy and collapse.[7] However, like all predator-prey relationships, the effectiveness of this organism as a Eurasian water milfoil control agent is limited by its numbers at any given time. While these numbers can be artificially enhanced by stocking, the use of these insects is highly labor-intensive and is subject to failure if the insects are exposed to the level of disturbances by boating traffic as might be expected in the Phantom Lakes. Thus, this type of control remains largely experimental in Wisconsin and, because of the sensitivity of the weevils to disturbance and heavy predation by native fishes, is not recommended for widespread application at this time.

Informational and Educational Programming

In addition to the in-lake rehabilitation methods, an ongoing campaign of community informational programming can support the aquatic plant management program by encouraging the use of shoreland buffer strips, responsible use of household and garden chemicals, and environmentally friendly household and garden practices to minimize the input of nutrients from these riparian areas. In addition, a community information campaign should emphasize the need to clean boats and motors/propellers when removing boats from the Lakes and upon launching boats into the Lakes to limit the redistribution of invasive organisms. Plants removed from boats and motors should be retained onboard and/or disposed of by composting at the boat launch or homestead to avoid their being reintroduced into the water. An informational program can also remind riparian residents and others of the habitat and ecological benefits, such as shoreline stabilization, provided by the aquatic flora of the Lakes, thereby promoting the preservation of a healthy aquatic flora in the Lakes.

In addition to informational programming, educational programs such as Project WET, Adopt-A-Lakes, and other school-based programs can help to build community awareness of the value of lake ecosystems, and the need for vigilance on the part of individual citizens and households within the drainage area tributary to the Lakes. School groups and other community service organizations also form a cadre of volunteers that can assist in shoreland management programs and in the dissemination and conduct of community informational programs.

The Phantom Lakes community has consistently supported informational and educational programming within their community. Efforts by the Phantom Lakes Management District have not only encouraged environmentally sound behaviors within the Lakes, but have contributed to shoreland restoration efforts and Lake monitoring as well. Thus, ongoing informational and educational programming is recommended.

RECOMMENDED AQUATIC PLANT MANAGEMENT PLAN

The recommended aquatic plant management plan consists of the integrated use of mechanical and manual harvesting designed to minimize the negative impacts on the ecologically valuable areas of the Lakes, while providing a level of control needed to facilitate the desired recreational uses of the Lakes. In addition, such harvesting is recommended to be supplemented by an ongoing informational and educational program.

In order to implement the recommended aquatic plant management program, the following management actions are recommended:

1. The continued operation by the Phantom Lakes Management District of the existing harvesters and transport equipment.

2. Maintenance of shared access channels, especially in Lower Phantom Lake, which should be harvested in such manner as 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, while the presence of such lanes would benefit piscivorous, visual predators such as the northern pike.

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[7]*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.*

3. Use of shallow harvesting to remove the surface canopy of nonnative plants such as Eurasian water milfoil, to provide a competitive advantage to the low-growing native plants in the Lakes is recommended. By not disturbing these low-growing species, which generally grow within one to two feet of the Lakes bottom and in relatively low densities, and leaving the root stocks and stems of the cut plants in place, the resuspension of sediments in the Lakes will be minimized. This type of harvesting, illustrated in Figure C-2, should be focused, primarily, on boating channels around the perimeter of the main Lake basins, and, secondarily, on other areas with extensive growths of Eurasian water milfoil. Care is required to collect any fragments of Eurasian water milfoil that may be generated during the harvesting process to minimize the distribution of Eurasian water milfoil into other areas of the Lakes.

4. Chemical herbicides, if found to be necessary, should be limited to controlling nuisance growths of exotic species in shallow water around docks and piers. Maintenance of shoreland areas around docks and piers remains the responsibility of individual property owners. It is recommended that chemical applications, if required, should be made by licensed applicators in early spring subject to State permitting requirements to maximize their effectiveness on nonnative plant species, minimize their impacts on native plant species, and act as a preventive measure to reduce the development of nuisance conditions. Only herbicides that are selective in their control, such as 2,4-D and fluridone, should be used. Algicides, such as Cutrine Plus, generally are not recommended as algal blooms are not common in the Lakes, and valuable macroscopic algae, such as *Chara* and *Nitella*, may be killed by this product. During periods of intensive algal growth, limited use of copper-based algicides, such as Cutrine Plus, could be considered.

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. As an additional option it is recommended that the Phantom Lakes Management District obtain informational brochures regarding shoreline maintenance, such as information on hand-held specialty rakes made for this specific purpose and on various shoreland plants and planting arrangements, to be made available to these residents.

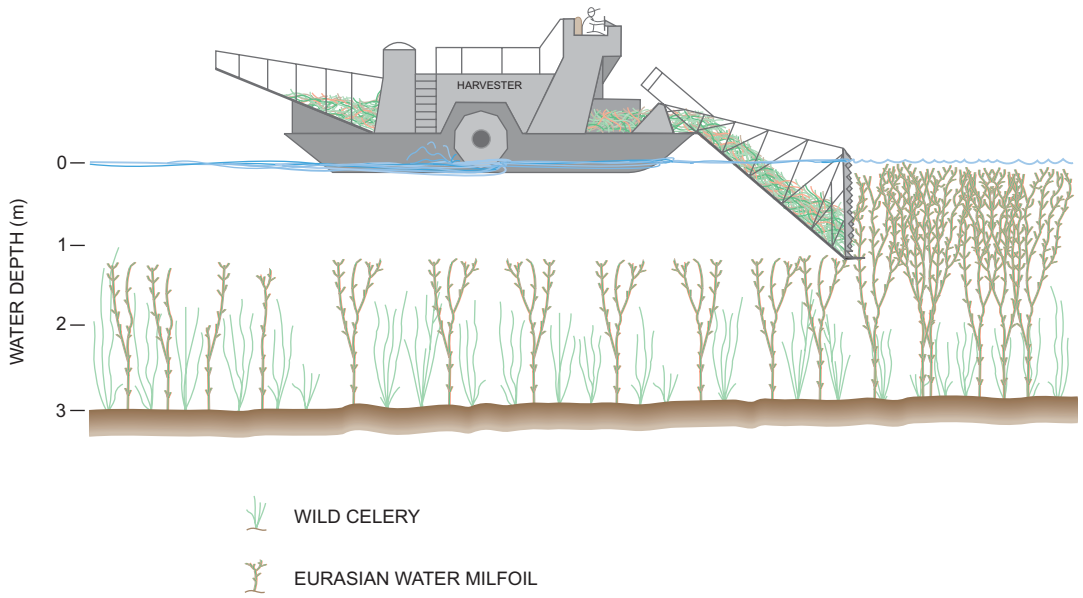
6. The incorporation by the Phantom Lakes Management District and riparian communities of educational and informational programming within the aquatic plant management program for the Lakes is recommended. Such programming can provide students and householders with information on the types of aquatic plants in the Phantom Lakes, and on the values and impacts of these plants on water quality, fish, and on wildlife; and on alternative methods for controlling existing nuisance plants, including the positive and negative aspects of each method. An organized aquatic plant identification day is one method of providing effective informational programming to Lake residents. Other sources of information and technical assistance include the Department of Natural Resources and the University of Wisconsin-Extension Service. The aquatic plant illustrations provided in this Appendix may assist individuals interested in identifying plants near their residences. Residents should be encouraged to observe and document changes in the abundance and types of aquatic plants in their parts of the Lakes on annual basis.

The recommended aquatic plant management plan for the Phantom Lakes is graphically summarized on Maps C-10 and C-11. As indicated on the maps, it is proposed that aquatic plant management activities be restricted in certain ecologically valuable areas of the Lakes. For this reason, aquatic plant management activities are recommended to be confined to zones related to access, boating, fishing, and habitat areas of the Lakes.

Harvesting should not take place in shallow waters, generally three feet or less, the major spawning areas of bass in Phantom Lakes during spring spawning season, May 1st to June 30th, annually, to avoid disturbance of fish spawning areas and beds of native aquatic plants.

Figure C-2

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.

The primary objective of the management program is to accommodate recreational uses of the Lakes, and to enhance the public perceptions of the Lakes, without inflicting irreparable damage to the structure and functioning of the Lakes ecosystem. To accomplish this objective, specific control measures should be applied in each of the Lakes within the zones as summarized in Table C-8 and shown on Maps C-10 and C-11. The recommended sequence of the harvester operations on the Phantom Lakes is set forth in Figure C-3.

Depth of Harvesting and Treatment of Fragments

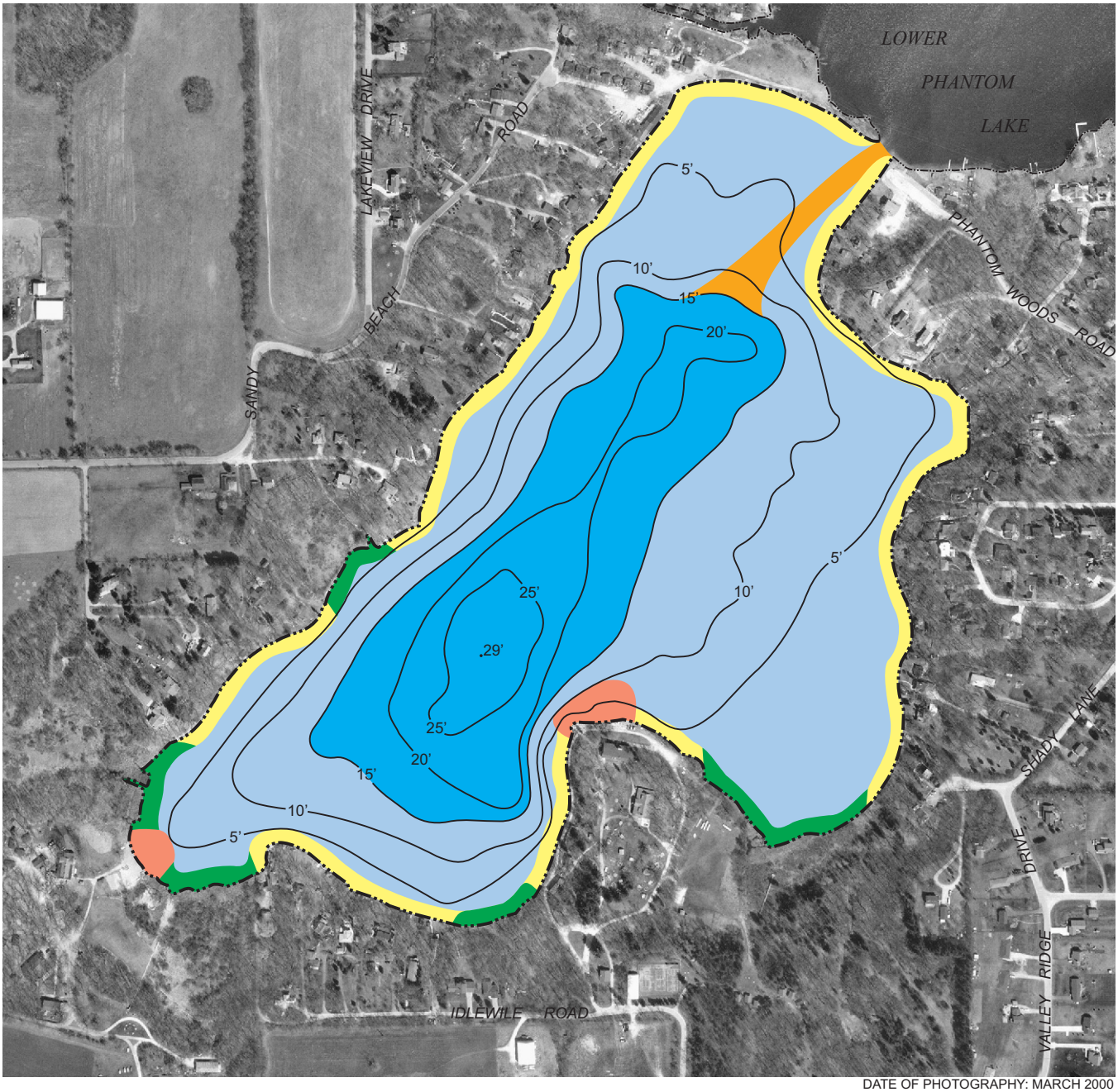
The H-420 aquatic plant harvester has a maximum cutting depth of about five feet; the H-820 aquatic plant harvester has a maximum cutting depth of about eight feet. While these cutting depths exceed the actual water depth in approximately 10 percent of Upper Phantom Lake and about 80 percent of Lower Phantom Lake, it is not the intention of the owners or operators of the equipment to denude the Lakes of aquatic plants. Maintenance of aquatic plant beds in the Lakes, especially those dominated by native aquatic plants, is warranted given the intensive angling use of the waterbodies, their morphology, in which portions may not be conducive to extensive motorized boat traffic, and the program goals. Sufficient plant materials will be retained in the Lakes to minimize resuspension of lake bottom sediments and to maintain desirable plant communities, such as those dominated by the low-growing *Chara* spp. All plant cuttings and fragments will be collected *in situ*, to the extent practicable, by the harvesters. Those fragments accumulating along the shoreland areas will be collected by the riparian homeowners. Fragments collected by the homeowners can be used as garden mulch and compost.

Buoyage

Temporary marker buoys may be used to direct harvesting operations in the Lake basins by marking the areas to be cut. The size of the Lakes may warrant the use of such buoyage. Notwithstanding, the harvester operators will

Map C-10

RECOMMENDED AQUATIC PLANT MANAGEMENT PLAN FOR UPPER PHANTOM LAKE



DATE OF PHOTOGRAPHY: MARCH 2000

—20′— WATER DEPTH CONTOUR IN FEET

OPEN WATER
- NO CONTROL

ENVIRONMENTALLY VALUABLE AREA
- NO CONTROL

SWIMMING AREA
- MANUAL HARVEST NEAR SHORE
- MECHANICAL HARVEST OFF SHORE
- LIMITED HERBICIDE USE TO CONTROL NONNATIVE SPECIES AND ALGAE

HABITAT AND MIXED USE AREA
- MONITOR NONNATIVE SPECIES
- HARVEST AS NECESSARY TO MAINTAIN BOATING ACCESS

SHORELAND AREA
- MAINTAIN SHORELINE VEGETATION
- MANUAL HARVEST AROUND PIERS AND DOCKS
- MONITOR SHORELINE AND NEAR SHORE AREA FOR NONNATIVE SPECIES

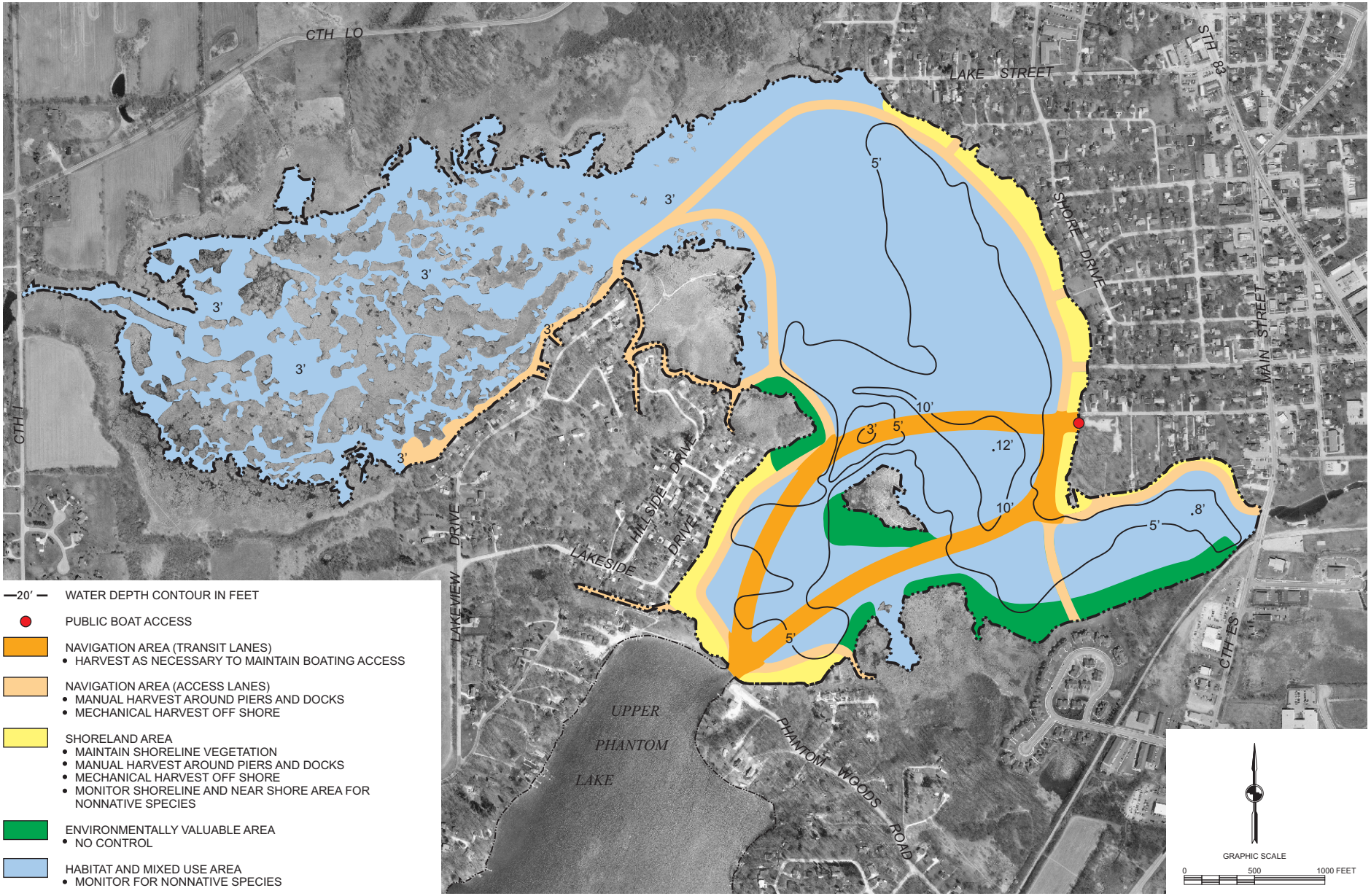
NAVIGATION AREA
- HARVEST AS NECESSARY TO MAINTAIN BOATING ACCESS

GRAPHIC SCALE
0 300 600 FEET

Source: SEWRPC.

Map C-11

RECOMMENDED AQUATIC PLANT MANAGEMENT PLAN FOR LOWER PHANTOM LAKE



DATE OF PHOTOGRAPHY: MARCH 2000

Source: SEWRPC.

Table C-8

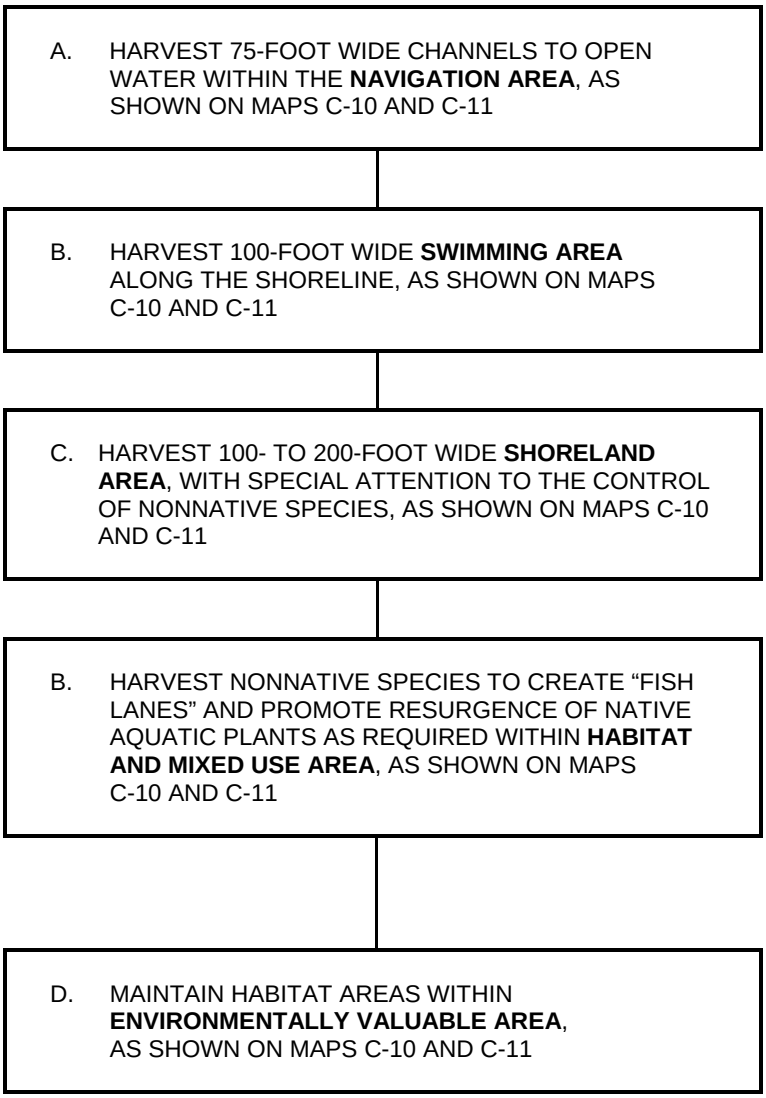
RECOMMENDED AQUATIC PLANT MANAGEMENT TREATMENTS FOR THE PHANTOM LAKES

Zone and Priority	Recommended Aquatic Plant Management Treatment
Habitat and Mixed Use Area Low-Priority Harvesting	Harvesting limited to maintaining 30-feet-wide navigational channels extending towards the center of the Lakes to allow boat access to the open water area of the Lakes, as necessary Limited late season harvesting, late August to early September, may be necessary to maintain adequate open water areas in the central portion of the Lakes Chemical use, if required, should be restricted to selective control of nuisance species near public access site Habitat and Mixed Use Area is intended to accommodate fishing from a boat
Environmentally Valuable Area No Harvesting	It is recommended that selected areas of the Lakes be preserved as high-quality habitat area This area and adjacent lands should be managed for fish habitat No harvesting or in-Lakes chemical application should be permitted, except in special instances where selective herbicide application may be allowed for the control of nuisance species Debris and litter cleanup would be needed in some adjacent areas; the immediate shoreline should be preserved in natural, open use to the extent possible
Open Water No Harvesting	This area should supplement those areas designated specifically for fishing and boating activities Includes areas greater than 15 feet in depth that require no harvesting.
Shoreland Area Moderate-Priority Harvesting	Nuisance aquatic macrophyte growth up to within 200 feet of the shoreline should be harvested to provide maximum opportunities for boating, fishing, and limited swimming The entire area may not require intensive plant management Areas between piers should not be harvested due to potential liability and maneuverability problems. Residents are encouraged to manually harvest aquatic plants in these areas Chemical use should be restricted to pier and dock areas and should not extend more than 100 feet from shore; subject to permit requirements
Navigation Area High-Priority Harvesting	Harvesting limited to maintaining 75-foot-wide navigational transit lanes extending towards the open water area of the Lakes to allow boat access, as necessary Harvesting limited to maintaining 30-foot-wide shared navigational access lanes parallel to the shoreline, connecting to the navigational transit lanes, to allow boat access to the open water area of the Lakes, as necessary Harvesting should be concentrated in areas of abundant macrophyte growth Patterns of harvesting will vary yearly dependant on macrophyte abundance Chemical use should be restricted to pier and dock areas and should not extend more than 100 feet from shore
Swimming Area High-Priority Harvesting Limited Herbicide Use	Areas between piers should not be harvested due to potential liability and maneuverability problems. Residents are encouraged to manually harvest aquatic plants in these areas Chemical use should be restricted to pier and dock areas and should not extend more than 100 feet from shore; subject to permit requirements
Approximate Total Area to Be Harvested	Upper Phantom Lake : 12 acres Lower Phantom Lake: 75 acres

Source: SEWRPC.

Figure C-3

HARVESTING SEQUENCE FOR THE PHANTOM LAKES



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

Source: SEWRPC.

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. Harvesting operations will be regularly supervised by Lake Management District Commissioners and staff.

Harvested Plant Material Disposal and Transfer Site(s)

Plant material will be removed from the harvesters at the off-loading area, where it will be transferred to a dump truck by conveyor and transported to disposal sites identified by the Phantom Lakes Management District. Plant material will be collected and disposed of daily to avoid leaching of nutrients back into the impoundment and to minimize the visual degradation of the environment near the boat launch site. The operators will stringently monitor the off-loading site to ensure minimal disruption of boaters and of the people using the riparian areas of the Lakes.

Precautions to Protect Wildlife and Ecologically Valuable Areas
As noted above, harvester operators will be provided with a laminated copy of the approved harvesting plan map and operational sequence chart, as set forth on Maps C-10 and C-11 and in Figure C-3, showing the limits and priorities of harvesting operations. A copy of these items will be kept on the harvesters at all times. Harvesting operations in the areas identified as suitable for bass spawning (shown on Maps C-10 and C-11 as environmentally valuable areas) will be restricted until the beginning of June to permit undisturbed spawning. Harvesting in all areas will be to a maximum depth of one foot above the Lake bottom in order to provide adequate protection for the Lake bottom, to minimize resuspension of the bottom sediments, and to allow low-growing native plants present within the system, such as *Chara* sp., to retain their competitive advantage over less-desirable invasive species, such as the Eurasian water milfoil.

Public Informational Programming
It is the policy of the Phantom Lakes Management District 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 District Commissioner meetings, public meetings, and other scheduled hearings. Further, the Phantom Lakes Management District holds occasional public informational meetings serving community members within their jurisdiction.

Harvesting Schedule
The harvesting season should begin no earlier than mid May and will end no later than mid October of each year. Harvesting is planned not to exceed 40 hours per week over a five-day week, depending on weather conditions and plant growth, to minimize recreational conflicts. Further, harvesting should be confined to daylight hours to minimize public disturbances resulting from harvester and plant removal operations. As provided for above, the harvesting operations should also be modified to protect fish spawning areas and other ecologically valuable areas of the Lakes as set forth on Maps C-10 and C-11.

EQUIPMENT NEEDS AND OPERATION

The Phantom Lakes Management District currently owns and operates a model H-420 harvester, a model H-820 harvester, and one shore conveyor, each with 10-year anticipated life spans. Replacement of two harvesters and one shore conveyor when necessary may be expected to cost about $227,500.

Harvester/Transporter:	Two Aquarius Systems Model H-820 or equivalent. One Aquarius Systems Model H-420 or equivalent.	
Shore Conveyor:	Two Aquarius Systems Model S/C-34 or equivalent.	
Costs:	One Aquatic Plant Harvester with 12,000 pound capacity	$112,000
	One Aquatic Plant Harvester with 10,500 pound capacity	$ 92,000
	One Shore conveyor	$ 23,500
	Total Costs	$227,500

Maintenance Schedule, Storage, and Related Costs
Routine maintenance will be performed on the respective harvesters by the Phantom Lakes Management District in accordance with the manufacturer's recommended maintenance schedule. Maintenance costs will be borne by the Phantom Lakes Management District. Winter storage of the harvesting equipment will be the responsibility of the Phantom Lakes Management District. The Phantom Lakes Management District owns a facility constructed for this purpose.

Insurance Coverage
Insurance coverage on the harvesters is incorporated into the policy held by the Phantom Lakes Management District on all capital equipment. Liability insurance for the operation of the harvesters will also be borne by the District. The relevant certificates of insurance will be held by the Phantom Lakes Management District.

Operators, Training, and Supervision
The harvesters will be owned and operated by the Phantom Lakes Management District, who will be responsible for day-to-day operations of the equipment. The District will provide operator training as required. Initial training will be provided by the manufacturer on delivery of the machinery.

Day-to-day supervision will be by the Phantom Lakes Management District Commissioners and staff.

MONITORING AND EVALUATION

Daily Record-Keeping Relating to the Harvesting Operation
Daily harvesting activities will be recorded by the operators of harvesting equipment in an operations log. An annual summary of the harvesting program will be submitted to the Phantom Lakes Management District Board of Commissioners at the annual meeting of the District, and made available to the public at that time.

It is the intention of the Phantom Lakes Management District to take the lead in a periodic, formal review of the harvesting program as set forth in the Aquatic Plant Management Plan for the Phantom Lakes, a copy of which has been lodged with the WDNR's Southeast District Office.

Daily Record-Keeping Relating to the Harvesters
Daily maintenance and service records showing engine hours, fuel consumed and oil used, will be recorded in a harvester operations log.

ILLUSTRATIONS OF COMMON AQUATIC PLANTS FOUND IN THE PHANTOM LAKES

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Coontail (*ceratophyllum demersum*)

Muskgrass (*chara vulgaris*)

Waterweed (*elodea canadensis*)

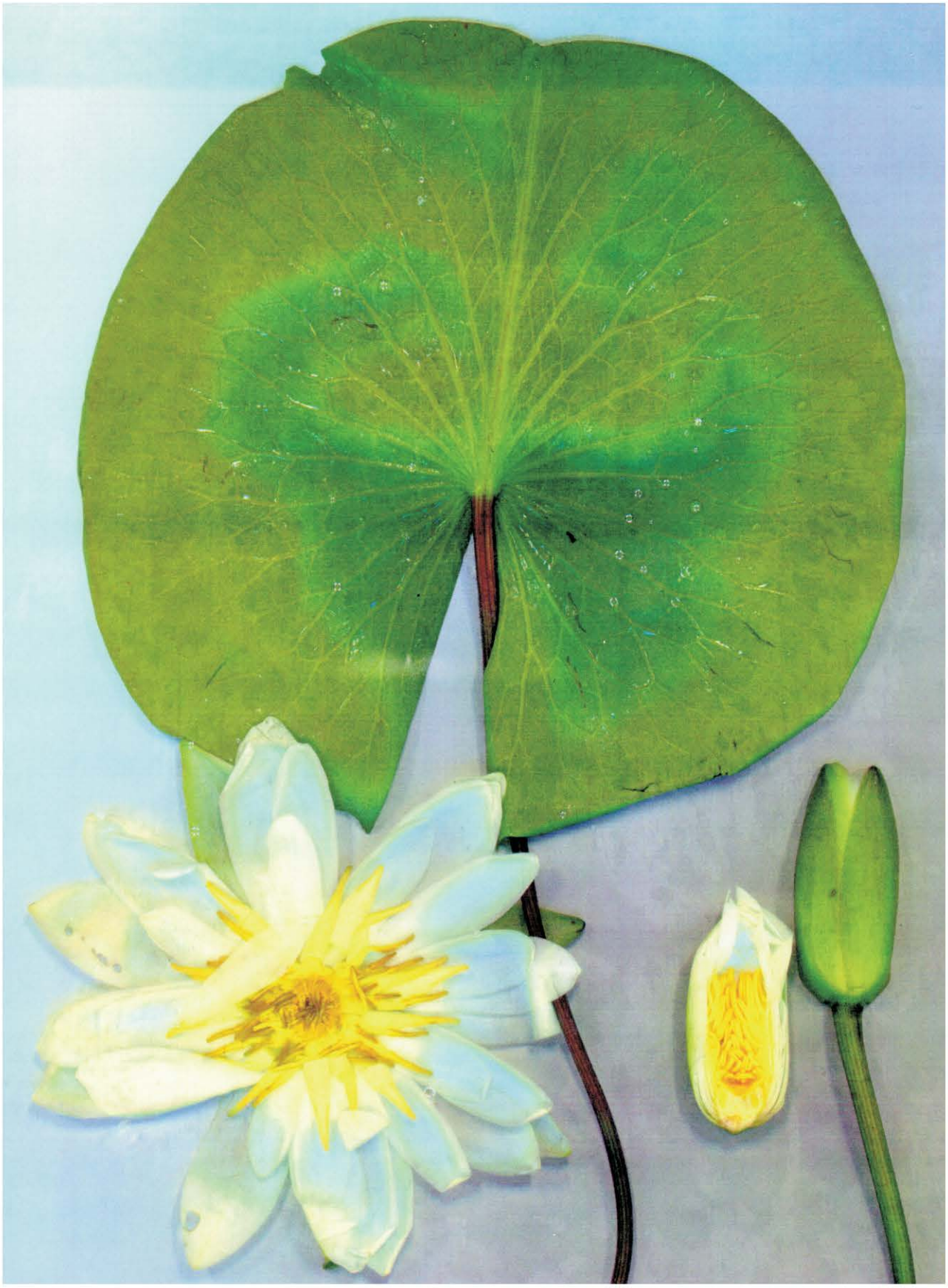
Native Water Milfoil (*myriophyllum* sp.)

Eurasian Water Milfoil (*myriophyllum spicatum*)

Bushy Pondweed (*najas flexilis*)

Spiny Naiad (*najas marina*)

Yellow Water Lily (*nuphar variegatum*)



White Water Lily (*nymphaea odorata*)

Large-Leaf Pondweed (*potamogeton amplifolius*)

Curly-Leaf Pondweed (*potamogeton crispus*)

Variable Pondweed (*potamogeton gramineus*)

Sago Pondweed (*potamogeton pectinatus*)

Clasping-Leaf Pondweed
(*potamogeton richardsonii*)

Flat-Stem Pondweed (*potamogeton zosteriformis*)

Eel Grass / Wild Celery (*valisneria americana*)

Water Stargrass (*zosterella dubia*)

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Appendix D

WISCONSIN DEPARTMENT OF NATURAL RESOURCES-DELINEATED CHAPTER NR 107 SENSITIVE AREAS PROPOSED FOR THE PHANTOM LAKES: 2005

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DRAFT

Phantom Lakes (Waukesha County, Wisconsin)
Integrated Sensitive Area Report

Assessment Dates:	July 30, 2001 July 26, August 23rd, September 1st, 2005
Number of Sensitive Areas Surveyed:	4
Site Evaluators:	Pam Schense, Water Management Specialist Sue Beyler, Fisheries Biologist Heidi Bunk, Lakes Biologist Jim Jackley, Wildlife Biologist Mike Hemmingsen, Water Resources Specialist
Authors:	Pat Campfield, Water Resources Specialist Heidi Bunk, DNR Lakes Biologist Mike Hemmingsen, Water Resources Specialist

General Lake Information

The Phantom Lakes consist of two lakes – Upper Phantom and Lower Phantom Lakes - located in south-central Waukesha County (Township 5 North, Range 18 East, Section 34 and Township 5 North, Range 18 East, Sections 26, 27, and 35). The surface area of Upper Phantom Lake is 118 acres, its maximum depth is 29 feet, and the average depth is 10 feet. Lower Phantom Lake has a surface area of 433 acres, a maximum depth of 12 feet, and an average depth of 4 feet. Upper Phantom is a drainage lake, fed primarily by precipitation, runoff, and groundwater. It has no major surface inlets. Lower Phantom is an impoundment located on the Mukwonago River, with depths of <5 feet in 80% of the lake. Lake level is controlled by a dam to the west of Highway 83 on the Mukwonago River, the single surface-water outlet from the Lakes (WDNR 1982).

The Phantom Lakes serve as “all sports” lakes. The main access site on Andrews Street meets the requirement of “adequate public access” defined by NR 1.91(11), Wis. Adm. Code.

The Phantom Lakes have multiple recreational uses. These include fishing, water skiing, swimming, canoeing, kayaking, pontoon boat site seeing and small craft sailing in summer months and ice fishing, cross-country skiing, ice-skating, and hunting during winter. Throughout the year, the lakes provide natural scenic beauty and opportunities for walking, jogging, bird watching, and picnicking.

Overall, the Phantom Lakes have a diverse fish population, including multiple forage, non-game and game species. 22 fish species were observed during fish surveys

conducted in 1994 and 1996. These include northern pike, grass pickerel, largemouth bass, yellow perch, warmouth, white crappie, rock bass, bluegill, pumpkinseed, green sunfish, sunfish hybrids, Johnny darter, blackchin shiner, blacknose shiner, bluntnose minnow, mudminnow, banded killifish, yellow bullhead, common carp, brook silverside, lake chubsucker, and starhead topminnow (Ehrlinger 1994; Nesta *et al.* 1996). The fish community is extremely diverse in the Mukwonago River downstream of the dam, consisting of 41 species. The Mukwonago River is one of the most pristine waterways in Wisconsin, requiring special attention and protection from development and habitat degradation.

The starhead topminnow (*Fundulus dispar*) is listed as an **endangered species** by the State of Wisconsin. Endangered species listing applies to any species whose continued existence as a viable component of the ecosystem is determined by the DNR to be in jeopardy on the basis of scientific evidence. *F. dispar* prefers quiet, shallow water with abundant aquatic vegetation. It has been found in clear to slightly turbid water (Becker 1983). This habitat type occurs throughout the Phantom Lakes and its preservation is highly recommended. Starhead topminnows spawn in late spring to early summer. Common food items include terrestrial and aquatic insects, crustaceans, mollusks, and delicate aquatic vegetation.

The lake chubsucker (*Erimyzon sucetta*) is listed as a State **species of special concern** (Lyons et al. 2000). The abundance or distribution of special concern species is likely reduced; however the designation has not been proven scientifically. The purpose of this category is to focus attention on certain species before they become threatened or endangered. The lake chubsucker relies on dense vegetation for cover throughout its life cycle. Low growing beds of aquatic plants (such as slender naiad) and filamentous algae are preferred for spawning between late March and early July. Young lake chubsuckers feed on copepods, cladocerans (e.g., *Daphnia*), and midge larvae. Adults prey upon these same items, as well as algae, molluscs, and both larval and adult insects. It is a valuable forage fish and fry are a preferred food of largemouth bass (Becker 1983). Preservation is highly recommended in areas where lake chubsucker habitat exists.

Fish habitat in the Phantom Lakes consists mostly of aquatic vegetation. Minimal woody debris, overhanging vegetation, and fallen trees exist along the developed shoreline. The remaining undeveloped shoreline provides critical habitat for fish, reptiles, amphibians, waterfowl, and both small and large mammals.

Prime wildlife habitat exists on the Phantom Lakes where shoreline and waterfront areas remain natural or in areas where waterfront owners kept “natural corridors” in place. During urbanization of the lakes, most developed properties retained some large trees, conserving the canopy. However, these owners also eliminated the sub-canopy and associated shrubbery. The sub-canopy provides important nesting, feeding, and cover habitat for multiple species. Consequently, most wildlife remaining in and around the Phantom Lakes consists of urban-tolerant species. Resident mammal populations include white-tailed deer, muskrats, cottontail rabbits, and some squirrels. Songbirds, wood ducks, mallards, and Canada geese are representative avian (bird)

species. The remaining undeveloped areas associated with the Lakes provide the only balanced cover for a number of wildlife species.

The Phantom Lakes Lake Management District is the primary sponsor for aquatic plant management goals/plans on the lakes, currently controlling nuisance plants by harvesting. In past aquatic plant studies of the Phantom Lakes (1967 and 1980), approximately 27 plant species were observed (WDNR 1982). In 1967, 25 native species occurred. Eighteen native species were observed in a 1980 survey. In both surveys, two exotic species were noted, Eurasian watermilfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*).

In the 2001 sensitive area survey, Department staff observed 14 native aquatic plant species in sensitive area 1 of Upper Phantom Lake. In Lower Phantom Lake, 17 native plant species occurred in sensitive area 1 and 20 native species were observed in sensitive area 2. 17 aquatic plant species were observed in sensitive area 3. Two exotic species were observed. Eurasian watermilfoil (*Myriophyllum spicatum*) occurred in each area. Curly-leaf pondweed (*Potamogeton crispus*) was observed in Lower Phantom Lake in sensitive area 2.

Exotic Species

Southeastern Wisconsin lakes have been invaded by aquatic exotic species, most notably zebra mussels, Eurasian watermilfoil, and purple loosestrife. Most exotic species are introduced to a waterbody by transient boaters. The disturbance of lake substrate from human activity (boating, plant harvesting, chemical treatments, etc.) plays a significant role in the colonization and/or expansion of exotic species, particularly exotic plants.

Eurasian watermilfoil has established itself as one of the most common and abundant plants in the Phantom Lakes. It occurred in all of the sensitive areas, although at different densities. Eurasian watermilfoil is one of eight milfoil species currently found in Wisconsin. It is often misidentified as one of its seven native cousins, and vice versa. In many areas within the Lakes, this non-native milfoil has established large monocultures and outcompeted many native plants. These very dense beds of milfoil not only impede the growth of native plant species but also inhibit fish movement and create navigational problems for boaters.

The regenerative ability of Eurasian milfoil is another obstacle when attempting to control this species. Fragments of Eurasian watermilfoil detached by harvesting, boating, and other recreational activities can float to non-colonized areas of a lake or downstream to additional lakes in the drainage system and create new colonies. Chemical treatment is often used when an isolated stand of Eurasian watermilfoil is identified. A few lakes have successfully used the milfoil weevil to suppress milfoil populations. However, the most effective ‘treatment’ of exotic milfoil is <u>prevention</u> through public education.

Curly-leaf pondweed is another submerged, exotic species found in the Phantom Lakes. Like Eurasian watermilfoil, curly-leaf grows into large, homogenous stands. It also crowds out native vegetation, creates navigational problems, and limits fish movement. A unique characteristic of curly-leaf pondweed is that the plant dies off by the end of June each year, increasing nutrient availability in the water column. This often contributes to summer algal blooms and decreased water quality.

The unusual life cycle of curly-leaf pondweed makes management difficult. The plant germinates as temperatures decrease in the fall. Curly-leaf is highly tolerant of cold temperatures and reduced sunlight, continuing to grow under lake ice and snow cover. With ice-off and increasing water temperatures in the spring, the plant produces fruit, flowers, and buds (turions). Turions are the main reproductive mechanism of curly-leaf. To control the species in lakes, the plant must be combated before turions become viable. The majority of plant harvesters have not started cutting when curly-leaf is most susceptible and a small window of opportunity exists for chemical treatment.

Purple loosestrife, a hardy perennial native to Europe, was desirable primarily as an ornamental plant but also marketed for bee keeping. It was transported in soil used as ballast during shipping. Since its introduction to North America in the early 1800s, purple loosestrife has become common in gardens and wetlands, as well as around lakes, rivers, and roadways. The species is highly invasive and thrives in disturbed areas. Monotypic (dense) stands of purple loosestrife outcompete native plants, resulting in the destruction of food, cover, and nesting sites for wildlife and fish. Occasional small stands of purple loosestrife were noted throughout the Phantom Lakes.

Purple loosestrife most often spreads when seeds adhere to animals. Humans should be aware of picking up seeds on clothing and equipment when in the vicinity of the plant. Loosestrife can be controlled manually, biologically, or with a broad-leaf herbicide. Young plants can be pulled but adult plants have large root structures and must be excavated with a garden fork. Biological control is most effective on large stands of purple loosestrife. Five different insects are known to feed on this plant. Four of those have been used as control agents in the United States. Of the five species, *Galerucella pusilla* and *G. calmariensis* are leaf-eating beetles; *Nanophyes brevis* and *N. marmoratus* are flower-eating beetles; and *Hylobius trasversovittatus* is a root-boring weevil. Only *N. brevis* has not been released in the United States (WDNR 2003).

Shoreland Management

Wisconsin's Shoreland Management Program, a partnership between state and local governments, works to protect clean water, habitat for fish and wildlife, and natural scenic beauty. The program establishes minimum standards for lot sizes, structural setbacks, shoreland buffers, vegetation removal, and other activities within the shoreland zone. The shoreland zone includes land within 1000 feet of lakes, 300 feet of rivers, and floodplains. Current research shows that present standards are probably inadequate for the protection of water resources (Woodford and Meyer 2003, Garn 2002). Therefore, many communities have chosen to go beyond minimum standards to ensure protection of

our natural resource. This report provides management guidelines for activities within the lake and in the immediate shoreland areas. Before any recommendations in this report are completed, please check with the Department of Natural Resources and local units of government for required approvals.

A vital step in protecting our water resources is to maintain effective vegetative buffers. A shoreland buffer should extend from the water onto the land at least 35 to 50 feet. Studies have shown that buffers less than 35 feet are not very effective in reducing water pollution. Wider buffers of 50 feet or more can help provide important wildlife habitat for songbirds, turtles, frogs, and other animals, as well as filter pollutants from runoff. In general, no mowing should occur in the buffer area, except perhaps in a viewing access corridor. The plant composition of a buffer should match the flora found in natural Wisconsin lakeshores. A buffer should include three layers - herbaceous, shrub, and tree.

In addition, the reader also should investigate other innovative ways to reduce the impacts of runoff flowing into the lake while improving critical shoreline habitat (see Greene 2003). This may include the use of phosphorus-free fertilizers, installing rain gardens, setting the lawnmower at a higher mower height, decreasing the area of impervious surfaces, or restoring aquatic plant communities.

Introduction

Wisconsin Department of Natural Resources personnel conducted sensitive area designation surveys on the Phantom Lakes following the Department's sensitive area survey protocol. The main survey occurred on July 30, 2001. Follow up surveys were conducted on July 26th, 2005 and August 23, 2005. This study utilized an integrated team of DNR resource managers with input from multiple disciplines: water regulation, water chemistry, fisheries, lake biology, and wildlife.

Sensitive areas are defined in Wisconsin Administrative Code NR 107.05 (3)(i)(1) as *areas of aquatic vegetation identified by the department as offering critical or unique fish and wildlife habitat, including seasonal or life stage requirements, or offering water quality or erosion control benefits to the body of water*. Department resource managers determined that four areas met this definition. Their recommendations on the future management of these areas are included below.

Overview of Sensitive Area Designations

Sensitive areas often have aquatic or wetland vegetation, terrestrial (land) vegetation, gravel or rubble lake substrate, or areas that contain large woody cover (fallen trees or logs). These areas may provide water quality benefits to the lake, reduce shoreline erosion, and provide habitat necessary for seasonal and/or life stage requirements of fish, invertebrates, and wildlife. A designated sensitive area alerts interested parties (i.e., DNR personnel, county zoning personnel, lake associations, etc.) that the area contains critical habitat vital to sustaining a healthy lake ecosystem and/or

may feature an endangered plant or animal. Information presented in a sensitive area report may discourage certain permits from being approved within these sites.

Whole Lake Recommendations:

Several recommendations from Department staff pertain to the Phantom Lakes chain as a whole rather than to individual sensitive areas:

1. Native aquatic plant beds should be protected and maintained.

2. Prevent the spread of exotic species through sign postings, education, etc. and control exotic species where established.

3. Comply with State and Local Shoreland Zoning standards by maintaining no-cut buffers and setbacks, removing non-conforming structures, and limiting impervious surfaces.

4. Create shoreland buffers and maintain existing buffers.

5. Monitor water quality for early detection of changes and possible degradation.

Resource Value of Sensitive Area Site 1 – Upper Phantom Lake

Sensitive area 1 is located within a bay in the southeast portion of Upper Phantom Lake. Eurasian watermilfoil is less dense here than in other areas of Upper Phantom Lake and it is adjacent to a high quality wetland. Substrates in the bay include sand, clay, muck, and detritus. This area is not harvested. The average water depth in this bay is 4 to 6 feet. The shoreline is 90% wetland, 5 % wooded and 5 % developed. This is the only area of Upper Phantom Lake that is not heavily developed.

The bay acts as a sediment and nutrient trap for the lake, helping to protect water quality. Aquatic vegetation (Table 1) helps control shoreline erosion. It also provides walleye, northern pike, largemouth bass, bluegill, yellow perch, and forage fish (suckers and minnows) with spawning, nursery, and foraging habitats (Table 2).

The majority of the shoreline along Upper Phantom Lake does not provide much wildlife habitat. However, this sensitive area provides excellent habitat for ducks, geese, songbirds, muskrat, mink, reptiles, and amphibians, unique to Upper Phantom Lake. The combination of submersed aquatic plants and wetland edge plants provide cover, nesting and feeding areas for wildlife. Scattered woody material houses insect larvae that are in turn consumed by fish and wildlife.

Table 1. Plants observed in sensitive area 1 of Upper Phantom Lake.

	Emergent	Submergent	Free-floating	Exotic
PRESENT (0-25% Cover)		*Elodea* (waterweed) *P. illinoiensis* (Illinois pondweed)	*Nymphaea odorata* (white water lily) *Nuphar advena* (yellow water lily) *P. natans* (floating-leaf pondweed)	
COMMON (26-50% Cover)		*Utricularia* (bladderwort) *P. pectinata* (sago pondweed) *P. robbinsii* (fern) *P. ampliforius* (large-leaf pondweed)		*Myriophyllum spicatum* (Eurasian watermilfoil)
ABUNDANT (51-75% Cover)		*Chara* (muskgrass) *Vallisneria* (wild celery) *Myriophyllum* (native milfoil) *Najas* (bushy naiad) *P. richardsonii* (clasping-leaf pondweed)		
DOMINANT (76-100% Cover)				

Table 2. Sensitive area 1 habitat utilized by resident fish species of the Phantom Lakes.

Fish Species	Spawning	Nursery	Feeding	Protective Cover
Walleye		water lily, milfoil, sago	milfoil, sago	milfoil, sago
Northern Pike		water lily, milfoil, sago, pondweeds	water lily, milfoil, sago, pondweeds	water lily, milfoil, sago, pondweeds
Largemouth Bass	sand, milfoil	water lily, milfoil, sago, pondweeds	water lily, milfoil, sago, pondweeds	water lily, milfoil, sago, pondweeds
Bluegill and Pumpkinseed	sand	water lily, milfoil, sago, clasping leaf, pondweeds	water lily, milfoil, sago, clasping leaf, pondweeds	water lily, milfoil, sago, clasping leaf, pondweeds
Yellow Perch	milfoil, sago	water lily, milfoil, sago	sago, milfoil	sago, milfoil
Suckers		water lily, milfoil, sago, clasping leaf	water lily, milfoil, sago, clasping leaf	water lily, milfoil, sago, clasping leaf
Minnows		water lily, milfoil, sago, clasping leaf	water lily, milfoil, sago, clasping leaf	water lily, milfoil, sago, clasping leaf

Management Recommendations for Upper Phantom Lake Sensitive Area #1

1. Selective chemical treatment on a case-by-case basis for pioneer stands of non-native species.
    A. Post "Exotics Alert" sign(s) at boat landings.
    B. Protect native plant species.
    C. Seasonally protect fish spawning habitat.

2. No mechanical harvesting.

3. No filling of wetlands.

4. New piers are allowed to provide riparians with access, but the number of slips allowed will likely be less than "reasonable use" as defined by state law.

5. None of the following in-lake activities will be allowed:
   Dredging
   Filling
   Aquatic plant screens
   Wetland alterations
   Boardwalks
   Pea gravel/sand blankets
   Rip rap

6. The following in-lake activities are allowed with conditions:
   A. No alteration of the littoral zone except to improve fish habitat.
   B. No disturbance of shoreline unless actively eroding.

7. Strictly enforce shoreland and wetland ordinances.
   A. Use bioengineering for any necessary shoreland stabilization.
   B. Increase shrub/herbaceous cover.
   C. Expand width of existing wildlife corridor.

8. Efforts should be undertaken to create and enforce ordinances, and educate developers on preventing erosion.

Resource Value of Sensitive Area Site 1 – Lower Phantom Lake

Sensitive area 1 is the middle portion of Lower Phantom Lake. Substrates in this portion of the lake include gravel, sand, clay, and detritus. This area is heavily harvested. The shoreline is 85% developed and 15 % wetland.

The entire lake (Lower Phantom) is sensitive with the exception of the developed shoreline running from the public boat launch on Andrews Street, north along the shoreline up to Lake Street. This portion of the developed shoreline is not sensitive from the water's edge out 150 feet from shore.

This littoral (shallow) area acts as a nutrient trap for the lake, helping to protect water quality. Aquatic vegetation (Table 3) helps control shoreline erosion and is highly diverse, with several native pondweed species. Forage fish and the endangered starhead topminnow utilize the area for spawning, nursery, and foraging habitats (Table 4).

largemouth bass, panfish, perch and minnows. Northern pike and walleye fry utilize the area for nursery and feeding (Table 4). This area of Lower Phantom Lake is not critical to wildlife. The extensive residential development of the adjacent shoreline in this portion of Lower Phantom Lake has reduced available wildlife habitat.

Table 3. Plants observed in sensitive area 1 of Lower Phantom Lake.

PRESENT (0-25% Cover)	**Emergent** *Sparganium* (bur-reed)	**Submergent** *Elodea* (waterweed) *P. amplifolius* (large-leaf pondweed)	**Free-floating** *Nymphaea odorata* (white water lily) *Lemna* (duckweed) *Spirodela* (large duckweed) *P. natans* (floating-leaf pondweed)	**Algae** filamentous algae
COMMON (26-50% Cover)		*Ceratophyllum* (coontail) *Utricularia* (bladderwort) *P. nodosus* (long-leaf pondweed) *P. robbinsii* (fern) *P. richardsonii* (clasping-leaf pondweed)		
ABUNDANT (51-75% Cover)		*Myriophyllum* (native watermilfoil) *Najas* (bushy pondweed) *P. pectinatus* (sago pondweed)	**Exotic** *Myriophyllum spicatum* (Eurasian watermilfoil)	
DOMINANT (76-100% Cover)		*Vallisneria* (wild celery)		

Table 4. Sensitive area 1 habitat utilized by resident fish species of the Phantom Lakes.

Fish Species	Spawning	Nursery	Feeding	Protective Cover
Walleye		water lily, milfoil, sago	sago, milfoil	sago, milfoil
Northern Pike		water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds
Largemouth Bass	sand, milfoil	water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds
Bluegill and Pumpkinseed	sand	water lily, wild celery, milfoil	water lily, wild celery, milfoil	water lily, wild celery, milfoil
Yellow Perch	milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds	milfoil, pondweeds	milfoil, pondweeds
Suckers		water lily, milfoil, sago	water lily, milfoil, sago	water lily, milfoil, sago
Minnows		water lily, milfoil, sago	water lily, milfoil, sago	water lily, milfoil, sago
Starhead Topminnow		water lily, milfoil, sago	water lily, milfoil, sago	water lily, milfoil, sago

Management Recommendations for Lower Phantom Lake Sensitive Area # 1

1. Selective chemical treatment on a case-by-case basis for pioneer stands of non-native species.
   A. Post "Exotics Alert" sign(s) at boat landings.
   B. Protect native plant species.

2. Mechanical harvesting must follow the plan approved by the DNR. Harvesting is restricted to navigational channels after fish spawning activities have finished.
   A. Minimize native aquatic plant removal, managing selectively for non-native species and protecting pondweeds and emergent vegetation. Harvesting efforts should be concentrated on monotypic (dense) stands of Eurasian watermilfoil.
   B. No alteration of littoral zone except to improve fish habitat.
   C. Do not remove fallen trees along shoreline, except where navigation is impaired. If navigation is impaired by a fallen tree, cut into smaller pieces and place outside of boating lanes.

3. New piers are allowed to provide riparians with access, but the number of slips allowed will be equal to "reasonable use" as defined by state law.

4. Dredging, pea gravel, and rip rap will be permitted on a case-by-case basis.

5. None of the following in-lake activities allowed:
   Wetland Filling
   Aquatic plant screens
   Wetland alterations
   Boardwalks

6. Strictly enforce shoreland and wetland ordinances.
   A. Use bioengineering for any necessary shoreland stabilization.
   B. Create shoreline/bank vegetative buffers.
   C. Use non-chemical lawn care.

7. Efforts should be undertaken to create and enforce ordinances, and educate developers on preventing erosion.

Resource Value of Sensitive Area Site 2 – Lower Phantom Lake

This area is located near the outlet of the Lake where the Mukwonago River continues flowing eastward. The area consists of two bays, one located in the southeastern portion of Lower Phantom Lake and one located in the southwestern portion of Lower Phantom Lake. This area is developed along approximately 50% of the shoreline. 40 % of the frontage is wetland and 10% of the frontage is wooded. This area contains a high quality wetland complex. This area contains the greatest diversity of emergent, submergent, and floating plants within the Phantom Lakes, including wild rice.

Substrates in the bay are variable and include sand, gravel, clay, and muck. Navigation lanes are harvested in this area.

The area acts as a sediment and nutrient trap for the lake, helping to protect water quality. Aquatic vegetation (Table 5) helps control shoreline erosion and is highly diverse, with several native pondweed species. It also provides walleye, northern pike, largemouth bass, bluegill, yellow perch, and the endangered starhead topminnow with spawning, nursery, and foraging habitats (Table 6).

This area is a very valuable fish nursery and contains good habitat for amphibians and reptiles. The residential portion of this sensitive area provides little habitat for wildlife, but does contain an abundant and diverse collection of native pondweed species. This area is a very valuable fish nursery and contains good habitat for amphibians and reptiles.

The wetland portion of this sensitive area provides shelter, nesting and feeding areas for ducks, geese, herons, rails, bittern, songbirds, upland wildlife, muskrat, mink, reptiles, and amphibians. The abundance and diversity of native pondweed species provide essential cover for a variety of fish species. This area of the lake provides excellent spawning and nursery habitat for walleye as well.

Table 5. Plants observed in sensitive area 2 of Lower Phantom Lake.

	Emergents	**Submergents**	**Free-floating**	**Exotics**
PRESENT (0-25% Cover)	*Scirpus* (bulrush) *Sagittaria* (arrowhead)	*Utricularia* (bladderwort)	*Lemna* (duckweed) *P. natans* (floating-leaf pondweed)	*P. crispus* (curly-leaf pondweed)
COMMON (26-50% Cover)	***Zizania* (wild rice)**	*Elodea* (waterweed) *P. pectinatus* (sago pondweed) *P.illinoensis* (Illinois pondweed) *P. amplifolius* (large-leaf pondweed) *P. foliosus* (leafy pondweed)		*Myriophyllum spicatum* (Eurasian watermilfoil)
ABUNDANT (51-75% Cover)	*Decodon* (water-willow)	*Chara* (muskgrass) *Vallisneria* (wild celery) *Najas* (bushy naiad) *P. robinsii* (fern) *P. richarsonii* (clasping-leaf pondweed)	*Nuphar advena* (yellow water lily) *Nymphaea* (white water lily)	
DOMINANT (76-100% Cover)	*Typha* (cattail)			

Table 6. Sensitive area 2 habitat utilized by resident fish species of the Phantom Lakes.

Fish Species	Spawning	Nursery	Feeding	Protective Cover
Walleye	gravel	water lily, sago	sago	sago
Northern Pike	*Chara*	*Chara*, water lily, wild celery, pondweeds	water lily, wild celery, pondweeds	water lily, wild celery, pondweeds
Largemouth Bass		water lily, *Chara*, wild celery, pondweeds	water lily, wild celery, pondweeds	water lily, wild celery, pondweeds
Bluegill and Pumpkinseed		water lily, *Chara*, wild celery, pondweeds	water lily, wild celery, pondweeds	water lily, wild celery, pondweeds
Yellow Perch	pondweeds	water lily, *Chara*, wild celery, pondweeds	pondweeds	pondweeds
Starhead Topminnow		water lily, sago	water lily, sago	water lily, sago

Management Recommendations for Lower Phantom Lake Sensitive Area # 2

1. Chemical treatment is not recommended due to close proximities to Mukwonago River and swimming area.
   A. Post "Exotics Alert" sign(s) at boat landings.

2. Limited mechanical harvesting following management plan. Harvesting is restricted to a navigational channel along the developed shoreline but only after spawning activities have finished. One harvesting channel is allowed to provide ingress and egress to the condo pier off of Bay View Circle.
   A. Minimize aquatic plant removal, managing selectively for non-native species and protecting pondweeds, emergent vegetation, water celery, and aquatic wetland fringe area. Harvesting efforts should be concentrated on monotypic (dense) stands of Eurasian watermilfoil.
   B. No alteration of littoral zone except to improve fish habitat.
   C. Do not remove fallen trees along shoreline, except where navigation is impaired. If navigation is impaired by a fallen tree, cut into smaller pieces and place outside of boating lanes.

3. New piers are allowed to provide riparians with access, but the number of slips allowed will likely be less than "reasonable use" as defined by state law.

4. None of the following in-lake activities are recommended:
   Pea Gravel
   Rip Rap

5. None of the following in-lake activities are allowed:
   Filling of wetland
   Aquatic plant screens
   Cutting large expanses of wetland vegetation
   Rip rap on the undeveloped shoreline

6. The following in-lake activities allowed with conditions:
   Dredging only for navigational access, on a case-by-case basis
   Boardwalks on a case by case basis to provide open water access only for a riparian landowner

7. Strictly enforce shoreland and wetland ordinances.
   A. Use soft bioengineering for any necessary shoreland stabilization.
   B. Create shoreline/bank vegetative buffers.

8. Efforts should be undertaken to create and enforce ordinances, and educate developers on preventing erosion.
   A. Minimize swimming/wading area.
   B. Implement a "No-Wake Zone" along the undeveloped shoreline.

Resource Value of Sensitive Area Site 3 – Lower Phantom Lake

This sensitive area provides a buffer for runoff entering the lake. It traps sediment and nutrients, helping to protect water quality. Aquatic vegetation helps control shoreline erosion. This is a relatively shallow (≤ 5 feet) area that consists of the western half of Lower Phantom Lake extending from the inlet of the Mukwonago River. A navigational channel is harvested along the developed shoreline.

This sensitive area is very large and has been divided into five subsections A, B, C, D, and F so a more accurate plant survey could be conducted. See Appendix 1 for location of subsections. The majority of the shoreline is undeveloped.

Subsection A contains thirteen aquatic plant species. The water depth is approximately 3 feet near the water lilly bed. Songbirds and shorebirds were both observed and heard among the water willow beds. The dominate substrate is silt.

Subsection B contains eleven aquatic plant species and the water depth is approximately 1-3 feet deep. A harvested path through section B along the houses contains few plants. The wetland side of the path is dominated by cattails.

Subsection C is a large wetland complex containing five aquatic plant species. White water lilies and water willows dominate. Water depth in the harvested channel is approximately 3.5 to 4 feet deep. The dominate substrate is silt.

Subsection D borders a developed shoreline with a water depth of approximately 4 to 5 feet. A channel has been harvested. The channel area is dominated by Eurasian water milfoil. Outside the channel, water willow dominates in most places while cattails dominate in some. A total of thirteen aquatic plant species were observed in subsection D.

Subsection E contains seven aquatic plant species and is generally dominated by cattails. Water willows were the dominate plant in a few patches, interspersed with the cattails. The harvested channel is generally less than five feet deep.

This area of Lower Phantom lake provides high quality nesting, feeding and cover habitat for ducks, geese, herons, swans, bittern, a variety of songbirds, upland wildlife, muskrat, mink, reptiles, and amphibians. This area also provides high quality fish nursery and fish feed habitat.

Plant Species in Sensitive Area 3 (further divided into 5 sub-areas)					
Species	A	B	C	D	E
Decodon (water-willow)	Dominant	Present / Common	Dominant	Dominant	Dominant
Scirpus (bulrush)	Common				
Nymphaea odorata (white water lily)	Dominant	Common	Dominant	Common	Dominant
Utricularia (bladderwort)	Abundant				
Ceratophyllum (coontail)	Common				
P. zosteriformis (flat-stemmed pondweed)	Present			Present	
P. richardsonii (clasping-leaf pondweed)	Abundant				
Myriophyllum spicatum (Eurasian watermilfoil)	Abundant			Dominant in Channel	Abundant
Myriophyllum (native watermilfoil)	Common				
P. pectinatus (sago pondweed)	Abundant				Present
Nuphar advena (yellow water lily)	Common	Common		Common	Present
Lemna (duckweed)	Present				
Vallisneria (wild celery)	Yes				
Typha (cattail)		Dominant	Present	Dominant	Dominant
Carex stricta (Hummock Sedge)		Present		Common	
Eupatorium (joe pye weed)		Present		Common	
Lythrum (purple loosestrife)		Present	Present	Present	
Sagittaria (arrowhead)		Common		Common	
Cornus racemosa (Grey Dogwood)		Common			
Cornus sericea (Red Osier Dogwood)		Common			
V. vulpina ssp. Riparia (River Bank Grape)		Common / Abundant			
Eastwoodia elegans (Yellow aster)			Present	Present	
Solidago (Goldenrod)				Present	
Verbena hastata (Blue Vervain)				Present	
P. natans (floating-leaf pondweed)				Present	

Management Recommendations for Lower Phantom Lake Sensitive Area # 3

1. No chemical treatment allowed.

2. Mechanical harvesting is limited to one navigational channel along the developed shoreline out towards the main lake.

3. None of the following in-lake activities are allowed:
   Filling of wetland
   Aquatic plant screens
   Cutting large expanses of wetland vegetation
   Rip rap on the undeveloped shoreline
   Pea gravel/sand blankets

4. The following in-lake activities allowed with conditions:
   Dredging only for navigational access, on a case-by-case basis along the developed shoreline (adjacent to Lakeview Drive)
   Boardwalks on a case by case basis to provide open water access only for a riparian landowner
   Rip rap on a case by case basis on the developed shoreline along Lakeview Drive

5. Dredging is allowed to maintain the existing navigational channel along Lakeview Drive out to the main lake.

6. New piers are allowed along the developed shoreline (along Lakeview Drive) to provide riparians with access, but the number of slips allowed will likely be less than "reasonable use" as defined by state law. New piers along the undeveloped shoreline will not be permitted.

7. Strictly enforce shoreland and wetland ordinances.

8. Efforts should be undertaken to create and enforce ordinances, and educate developers on preventing erosion.

9. A "no-wake" zone should be created.

10. Do not remove fallen trees along shoreline, except where navigation is impaired. If navigation is impaired by a fallen tree, cut into smaller pieces and place outside of boating lanes.

Conclusion

Four sensitive areas have been identified at this time. The Phantom Lakes system is very sensitive to further development and loss of remaining habitat. This sensitive area report identifies the characteristics and management recommendations for each of these areas. In Wisconsin, lakes attract many users and water quality in these lakes affects many more. The Phantom Lakes attract a diversity of user groups, inevitably creating conflict. An integrated approach that includes the public and all of the Lakes' governing units is essential. The objective is to create and maintain a balance between recreational use and preservation of habitat, which is essential to the Lakes' health. Improving or at least maintaining water quality on Wisconsin lakes is critical. By protecting and restoring habitat these resources will continue to provide ecosystem functions and responsible recreational opportunities for years to come.

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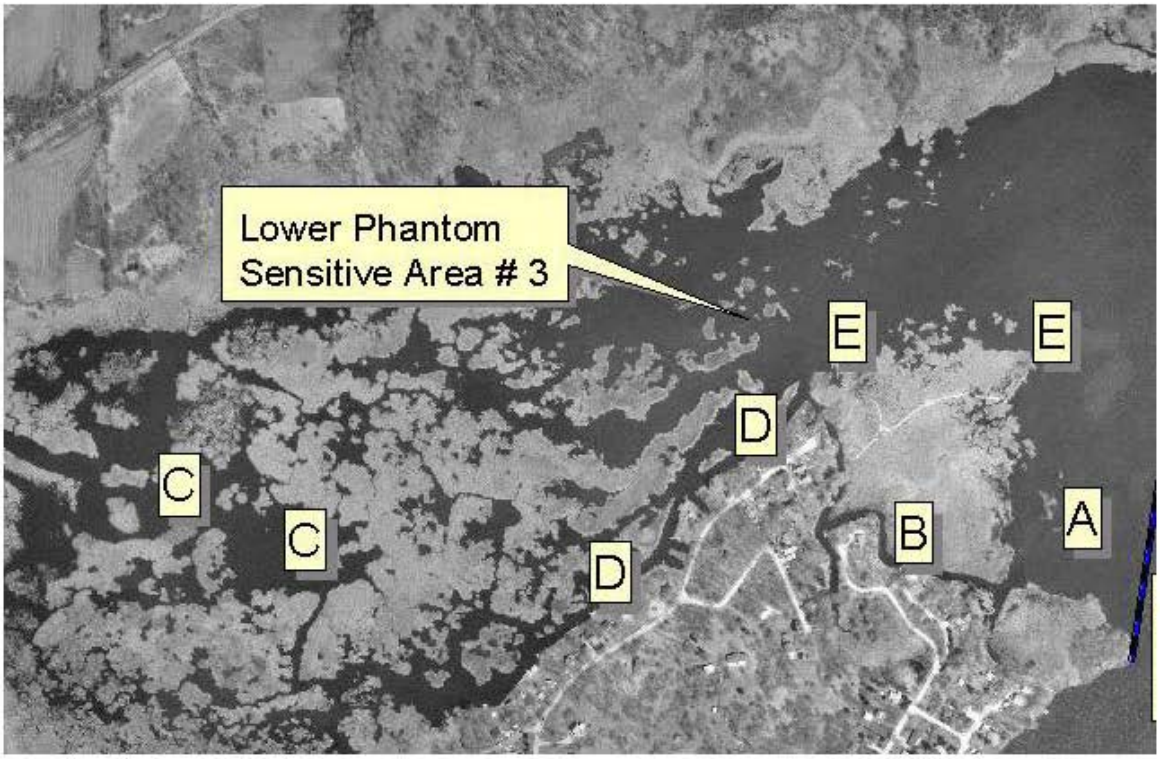
Appendix 1
Subsections of Sensitive Area # 3



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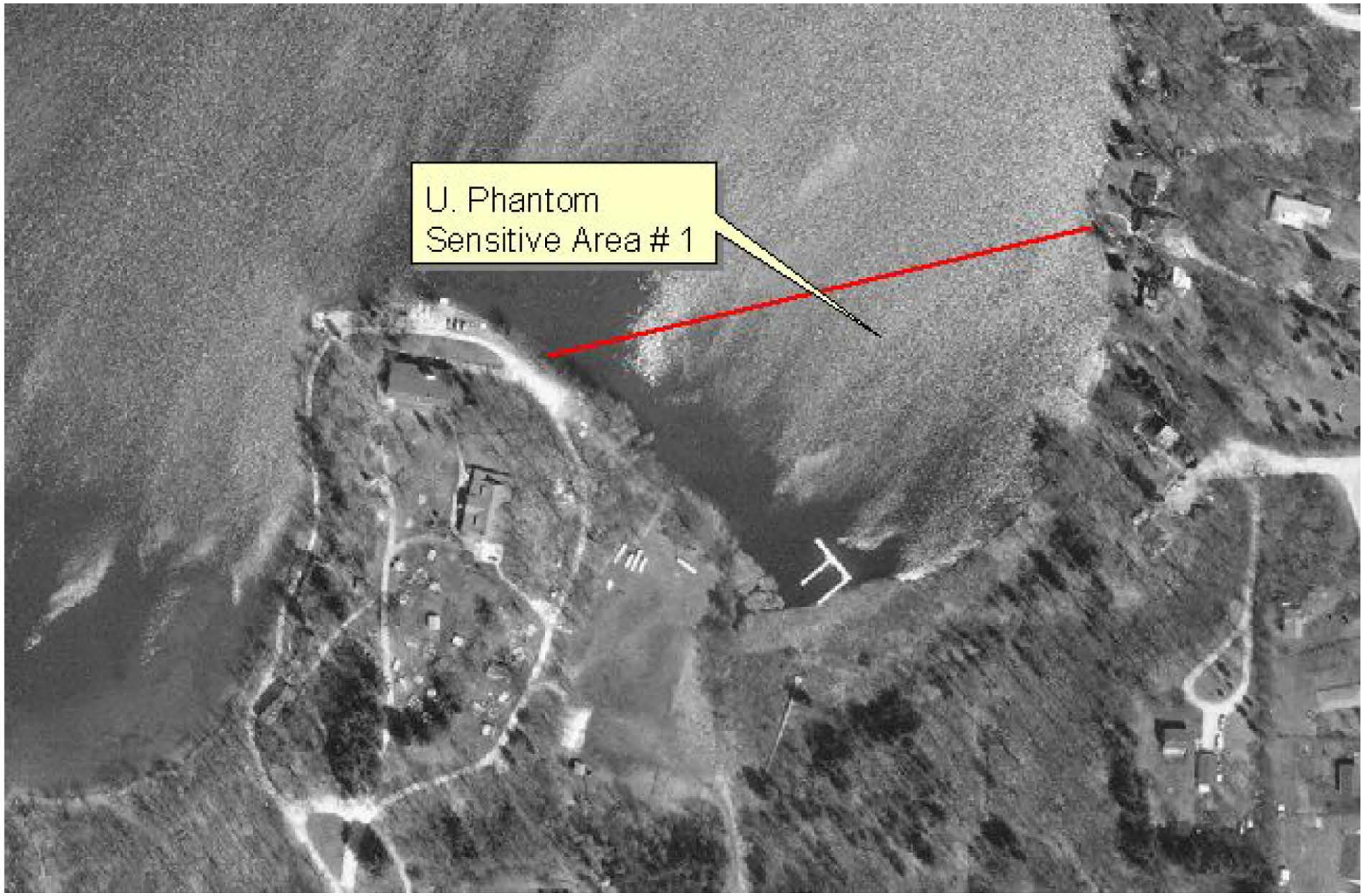
APPENDIX 2 - Aquatic plants within sensitive areas of the Phantom Lakes

	Upper Phantom	Lower Phantom		
	Area 1	Area 1	Area 2	Area 3
Emergent				
Zizania (wild rice)			X	
Typha (cattail)			X	X
Scirpus (bulrush)			X	X
Decodon (water-willow)			X	X
Sagittaria (arrowhead)			X	X
Sparganium (bur-reed)		X		
Cornus racemosa (Grey Dogwood)				X
Cornus sericea(Red Osier Dogwood)				X
V. vulpina ssp. Riparia (River Bank Grape)				X
Eastwoodia elegans (Yellow aster)				X
Solidago (Golden rod)				X
Eupatorium (joe pye weed)				X
Carex stricta (Hummock Sedge)				X
Verbena hastata (Blue Vervain)				X
Submergent				
Myriophyllum (native watermilfoil)	X	X		X
Chara (muskgrass)	X		X	
P. amplifolius (large-leaf pondweed)	X	X	X	
Elodea (waterweed)	X	X	X	
Utricularia (bladderwort)	X	X	X	X
Ceratophyllum (coontail)		X		X
P. pectinatus (sago pondweed)	X	X	X	X
Vallisneria (wild celery)	X	X	X	X
P. illinoensis (Illinois pondweed)	X		X	
Najas (bushy naiad)	X	X	X	
P. richardsonii (clasping-leaf pondweed)	X	X	X	X
P. robinsii (fern)	X	X	X	
P. nodosus (long-leaf pondweed)		X		
P. foliosus (leafy pondweed)			X	
P. zosteriformis (flat-stemmed pondweed)				X
Free-floating				
Nuphar advena (yellow water lily)	X		X	X
Nymphaea odorata (white water lily)	X	X	X	X
P. natans (floating-leaf pondweed)	X	X	X	X
Lemna (duckweed)		X	X	X
Spirodela (large duckweed)		X		
Exotic				
Myriophyllum spicatum (Eurasian watermilfoil)	X	X	X	X
P. crispus (curly-leaf pondweed)			X	
Lythrum (purple loosestrife)				X
Algae				
filamentous		X		

MAP D-1

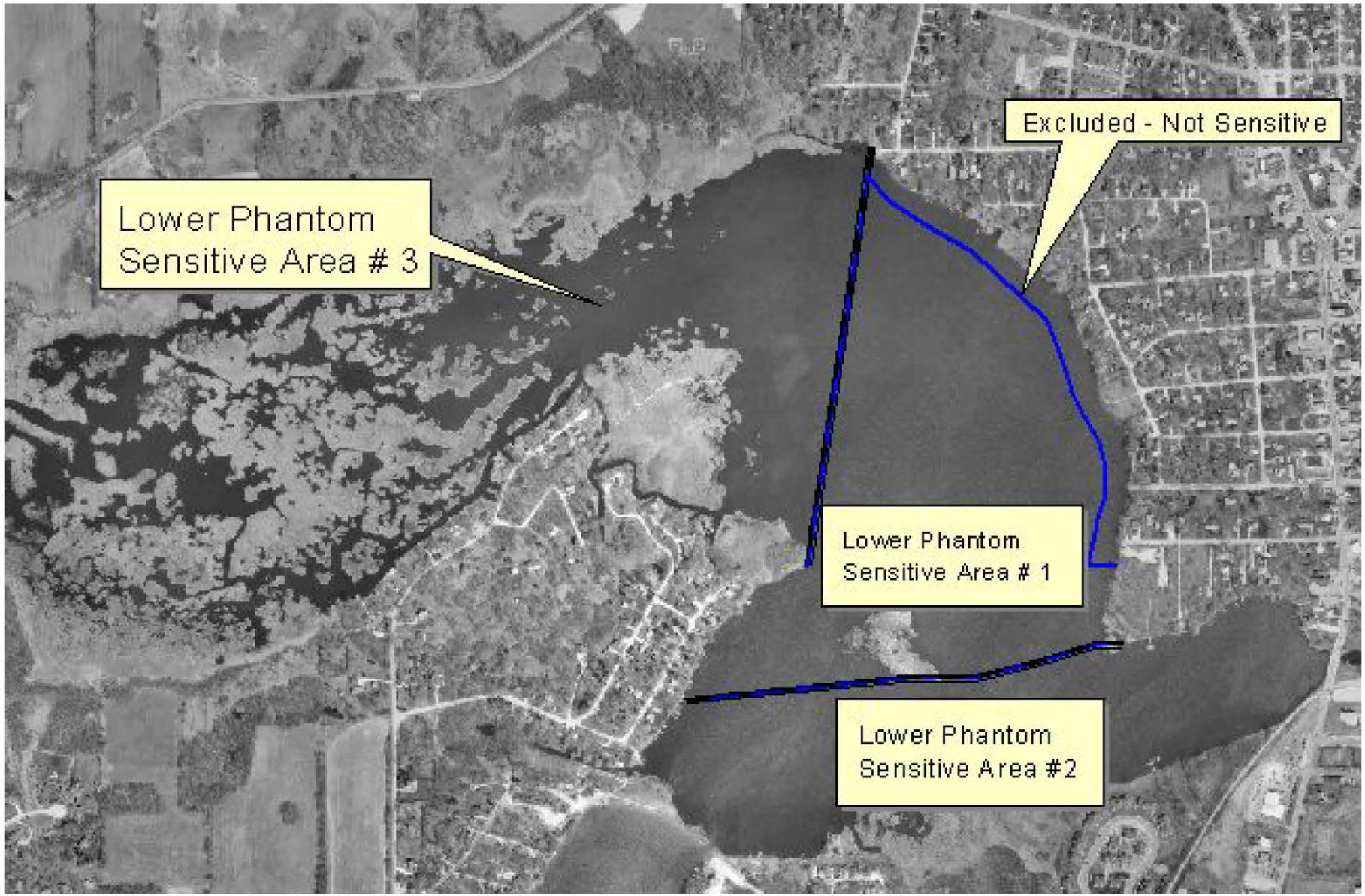
WISCONSIN DEPARTMENT OF NATURAL RESOURCES-DELINEATED CHAPTER NR 107 SENSITIVE AREA PROPOSED FOR UPPER PHANTOM LAKE: 2005



Source: Wisconsin Department of Natural Resources.

MAP D-2

WISCONSIN DEPARTMENT OF NATURAL RESOURCES-DELINEATED CHAPTER NR 107 SENSITIVE AREA PROPOSED FOR LOWER PHANTOM LAKE: 2005



Source: Wisconsin Department of Natural Resources.