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SEWRPC Staff Memorandum

AN AQUATIC PLANT MANAGEMENT PLAN UPDATE FOR UPPER AND LOWER PHANTOM LAKES, WAUKESHA COUNTY, WISCONSIN: 2011

May 4, 2012

INTRODUCTION

The Phantom Lakes have been the subject of various lake-oriented planning efforts carried out by the Southeastern Wisconsin Regional Planning Commission (SEWRPC).[1] Among these planning efforts, SEWRPC staff prepared an aquatic plant management plan for Upper and Lower Phantom Lakes during the early 1990s. That plan provided the Phantom Lakes Management District (PLMD) with guidance related to the management of the aquatic plant communities in the Lakes through the early 2000s, at which time the SEWRPC staff developed a comprehensive lake management plan for Phantom Lakes which provided a refined survey and analysis of the aquatic plant communities of the Phantom Lakes and updated the management plan set forth in the original aquatic plant management plan.[2] The aquatic plant management plan update set forth in this SEWRPC Staff Memorandum forms an integral part of the 2006 comprehensive lake management plan, refining the recommendations set forth therein, and represents an important element of the ongoing commitment of the PLMD to sound environmental management of the Lakes.

The aquatic plant management element of the comprehensive lake management plan was prepared by SEWRPC based upon field surveys conducted by SEWRPC during July 2002. That survey was conducted by SEWRPC staff using the modified Jesson and Lound transect method then employed by the Wisconsin Department of Natural Resources (WDNR).[3] The current 2011 aquatic plant survey conducted by SEWRPC staff as the basis for this refined aquatic plant management plan for the Lakes differed from the previous surveys by employing a grid-

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

[2]*SEWRPC Community Assistance Planning Report No. 230,* A Lake Management Plan for the Phantom Lakes, Waukesha County, Wisconsin, *Volume One,* Inventory Findings, *and Volume Two,* Alternatives and Recommended Plan, *January 2006.*

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

based survey method.[4] This grid-based survey methodology reflects the current requirements of the WDNR relating to the conduct of aquatic plant inventories, and is used herein to further refine the aquatic plant management plan element for the Phantom Lakes. This refinement is based upon the results of an aquatic plant survey conducted in the Lakes during July 2011.

This SEWRPC Staff Memorandum follows the format adopted by the WDNR for aquatic plant management plans and is prepared pursuant to the requirements of Chapters NR 103 and NR 107 of the *Wisconsin Administrative Code*. Its scope is limited to an evaluation of those management measures which can be effective in the control of aquatic plant growths in the Phantom Lakes; those measures which can be readily undertaken by the PLMD in concert with the riparian residents; and, those measures which will directly affect the use of the Phantom Lakes. As noted, this SEWRPC Staff Memorandum refines the current aquatic plant management plan for the Lakes set forth in the comprehensive lake management plan.

This SEWRPC Staff Memorandum is comprised of seven main sections: 1) a statement of planning goals and objectives; 2) a brief description of the Lakes and their watersheds; 3) descriptions of past and current aquatic plant communities based on aquatic plant surveys, including a comparison of the previously reported aquatic plant communities with those currently reported to be present in the Phantom Lakes; 4) a statement of the current use restrictions and the need for aquatic plant management in the Phantom Lakes; 5) a description of past and present aquatic plant management practices utilized on the Phantom Lakes; 6) a review and evaluation of alternative methods of aquatic plant management; and 7) a description of the recommended plan.

STATEMENT OF AQUATIC PLANT MANAGEMENT GOALS AND OBJECTIVES

The goals and objectives for the Phantom Lakes were developed in consultation with the PLMD. The goals and objectives are to:

- Control effectively the quantity and density of aquatic plant growths in portions of the Phantom Lakes basins to improve the opportunities for water-related recreation, to improve the aesthetic value of the resource to the community, and to enhance the resource values of the two waterbodies;

- Effectively maintain the water quality of the Phantom Lakes to better facilitate the conduct of water-related recreation, improve the aesthetic value of the resource to the community, and enhance the resource value of the waterbodies;

- Protect and maintain public health and to promote public comfort, convenience, and welfare in concert with the natural resource through the environmentally sound management of native vegetation, fishes, and wildlife in and around the Phantom Lakes; and

- Promote a quality water-based experience for residents and visitors to the Phantom Lakes consistent with the policies and practices of the WDNR, as set forth in the regional water quality management

[4] *J. Hauxwell, S. Knight, K. Wagner, A. Mikulyuk, M. Nault, M. Porzky, and S. Chase. Wisconsin Department of Natural Resources, Bureau of Science Services, Publication No. PUB-SS-1068 201,* Recommended Baseline Monitoring of Aquatic Plants in Wisconsin: Sampling Design, Field and Laboratory Procedures, Data Entry and Analysis, and Applications, *March 2010.*

plan, SEWRPC Planning Report No. 30, *A Regional Water Quality Management Plan for Southeastern Wisconsin—2000*, as amended.[5]

PHANTOM LAKES AND THEIR WATERSHED CHARACTERISTICS

The Phantom Lakes are located within the Town and Village of Mukwonago, in Waukesha County, as shown on Map 1. Upper Phantom Lake is a drained lake which depends principally on precipitation falling directly on the Lakes' surfaces, surface water runoff from the immediate surface drainage areas, and groundwater flowing into the Lakes from inside and outside the immediate surface drainage areas, for its sources of water. Upper Phantom Lake has an outlet, in this case a navigable narrows at the eastern end of the Lake, which flows into Lower Phantom Lake. Lower Phantom Lake is a drainage, or through-flow, lake situated along the Mukwonago River. The Mukwonago River forms the principal inflow to and outflow from Lower Phantom Lake.

Upper Phantom Lake has a surface area of 107 acres, with a maximum depth of 29 feet and a mean depth of about 11 feet. Lower Phantom Lake has a surface area of 433 acres with a maximum depth of 12 feet and a mean depth of about four feet. The two lakes are quite different with respect to many of their physical features: Upper Phantom Lake is characterized by a clearly demarcated single, deep basin with a uniformly sloping bottom contour, while Lower Phantom Lake is an expansive, shallow waterbody with nearly 80 percent of the lake area being less than five feet deep.

The total drainage area of the Phantom Lakes is about 80 square miles, with the majority of the combined drainage area being comprised of the Mukwonago River watershed draining to Lower Phantom Lake.[6] The entire drainage area tributary to the Phantom Lakes extends into both Walworth and Waukesha Counties, and includes portions of the Towns of Eagle, East Troy, Genesee, LaGrange, Mukwonago, Ottawa, and Troy, and the Villages of Eagle, East Troy, Mukwonago, North Prairie, and Wales.

AQUATIC PLANT COMMUNITIES

The aquatic plant communities of the Phantom Lakes were surveyed historically by the WDNR staff during 1967,[7] and 1980,[8] in addition to the 1993,[9] 2002,[10] and 2011 surveys completed by SEWRPC staff noted above. Species lists compiled from the results of all of these aquatic plant surveys are set forth in Tables 1 and 2, with the 2011 survey detailed in Table 3. Key aspects of each survey are summarized chronologically below.

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

[6]*SEWRPC Community Assistance Planning Report No. 309,* Mukwonago River Watershed Protection Plan, *June 2010.*

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

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

[9]*SEWRPC Memorandum Report No. 81,* op. cit.

[10]*SEWRPC Community Assistance Planning Report No. 230,* op. cit.

1967 Survey
The 1967 survey of the Phantom Lakes identified 17 species of aquatic plants in Upper Phantom Lake, most of which were described as being scarce to common; the single species described as being abundant was the macro-alga, muskgrass (*Chara* spp.). In Lower Phantom Lake, 13 species of aquatic plants were reported, with native water milfoil (*Myriophyllum sibiricum*) being the single species described as being abundant.

1980 Survey
Fewer aquatic plants were observed in the Lakes during the 1980 survey, when only nine species of aquatic plants were recorded in Upper Phantom Lake. Four species of these species were described as being abundant: large-leaf pondweed (*Potamogeton amplifolius*), muskgrass, native water milfoil, and Sago pondweed (*Potamogeton pectinatus*). In Lower Phantom Lake, 13 species of aquatic plants were reported, with seven species described as abundant: bladderwort (*Utricularia* spp.), flat-stem pondweed (*Potamogeton zosteriformes*), floating-leaf pond-weed (*Potamoetong natans*), large-leaf pondweed, muskgrass, native water milfoil, and Sago pondweed.

1993 Survey
The 1993 survey was conducted by SEWRPC staff. Eight species of aquatic plants were observed in Upper Phantom Lake during the summer of that year, with muskgrass again being reported as being abundant. In Lower Phantom Lake, 14 species of aquatic plants were observed, with muskgrass and various-leaved milfoil (*Myrio-phyllum* spp.) being reported as being abundant. Nine other aquatic plant species were reported as being common. Various-leaved milfoil is considered to be a native form of the plant.

2002 Survey
SEWRPC staff again surveyed the Phantom Lakes during the summer of 2002. At that time, the survey of Upper Phantom Lake resulted in 19 species of aquatic plants being recorded, the most common being muskgrass and white-stem pondweed (*Potamogeton praelongus*). The distribution of these aquatic plants is shown on Map 2.

In Lower Phantom Lake, 20 species of aquatic plants were observed with eight species being noted as the most common: muskgrass, waterweed (*Elodea canadensis*), northern water milfoil, Eurasian water milfoil (*Myrio-phyllum spicatum*), bushy pondweed (*Najas* sp.), white-stem pondweed, clasping-leaf pondweed (*Potamogeton richardsonii*), and eel-grass (*Vallisneria americana*). The distribution of these aquatic plant species is shown on Map 3.

At the time of the 2002 survey, the data acquired from Upper Phantom Lake seemed to suggest a significant increase in Eurasian water milfoil abundance between 1993 and 2002. A similar increase was observed in the data for Lower Phantom Lake over the same time interval. In addition, there were accompanying increases in eel-grass, muskgrass, and waterweed, and a decrease in native northern water milfoil in Lower Phantom Lake. Changes in aquatic plant communities, such as these, often are related to a combination of factors, including the aquatic plant management practices, changes in land use (which affect nutrient supply and availability), lake use, climate, and natural biological processes, such as natural population cycles of specific plants. With regard to plant-specific population cycles, it is not uncommon for various forms of pondweed (*Potamogeton* spp.) to succeed each other during the growing season, with some species being more prevalent in cooler water, while others are more prevalent in warmer water. In contrast to such seasonal succession, aquatic plants, such as Eurasian water milfoil, are known to undergo interannual cycles of abundance and relative scarcity, possibly as a consequence of climatic factors and/or predation cycles related to the relative abundance of milfoil weevils (*Eurhychiopsis lecontei*) in a lake.

2011 Survey

Aquatic plant surveys were conducted by SEWRPC staff in the Upper and Lower Phantom Lakes during 2011. The distribution of the aquatic plant communities during these surveys is shown on Maps 4 and 5. Muskgrass and Eurasian water milfoil were the two most abundant species observed in Upper Phantom Lake, while muskgrass, Eurasian water milfoil, northern water milfoil, and eel-grass were the most common species observed in Lower Phantom Lake, as summarized in Table 3. Upper Phantom Lake contained a total of 20 observed species of submerged aquatic plants, while Lower Phantom Lake contained a total of 16 species.

Changes in the Observed Aquatic Plant Communities

From the aquatic plant survey data presented in Tables 1 and 2, muskgrass (*Chara*) has been a dominant species in Upper Phantom Lake for several decades. This macro-alga is considered to be an indicator of good water quality, and is frequently present in groundwater-fed lakes in southeastern Wisconsin. Also of note is the appearance of white-stem pondweed in both Upper and Lower Phantom Lakes, which is viewed as a sign of good water quality due to the intolerance of this species to turbidity. Both white-stem and large-leaf pondweeds seem to have declined in abundance since the 2002 surveys in both Lakes. Other changes in aquatic plant community composition reflected in the 2011 surveys include the apparent loss of coontail, curly-leaf pondweed, and water stargrass from the aquatic plant flora of Upper Phantom Lake.

While such changes in species composition may reflect sampling protocols and/or seasonality within the macrophyte community, the loss of a particular plant species may indicate changes in the underlying ecosystem. In part, the apparent loss of species may be related to an increase in abundance of Eurasian water milfoil. Shifts in the abundance of several native species, including coontail, several varieties of pondweed, and native water milfoil, appear to coincide with the increase in abundance of Eurasian water milfoil, and are consistent with changes in the aquatic plant community that occur as a result of the presence of Eurasian water milfoil in lakes.

Nevertheless, aquatic plant communities do undergo cyclical and periodic changes, which reflect, in part, changing climatic conditions on an interannual scale and, in part, the evolution of the aquatic plant community in response to changing hydroclimate conditions in a lake—these latter including factors, such as changes in long-term nutrient loading, sedimentation rates, and recreational use patterns.

Interannual changes in the aquatic plant communities of a lake occur over a period of three to seven years and may be temporary. Evolutionary changes occur over a decadal or longer period, and are longer-lasting. Some species, such as pondweeds, exhibit distinct seasonality, with individual species having well-defined growing periods that reflect water temperature, insolation, and other factors. Variations in the occurrence of pondweed species in lakes are not unusual. Such variations are frequently reported and reflect anticipated interannual variability within a lake. Such variability is related to weather conditions, insolation or the availability of sunlight, and related climatic factors, as well as sampling effort; rare species may be under-sampled. Consequently, variations in occurrences of pondweed species, in particular, rarely reflect long-term changes in a lake ecosystem. Similarly, changes in the Eurasian water milfoil population in a lake may reflect the results of aquatic management practices and/or may be a reflection of a periodicity the species naturally experiences. Such periodicity, especially in Eurasian water milfoil populations, has been observed elsewhere in southeastern Wisconsin, and potentially reflects the influences of a combination of stressors. These stressors include biological factors, such as the activities of naturally occurring Eurasian water milfoil weevils, as well as climatic and limnological factors, such as insolation, water temperature, and lake circulation patterns.

Comparison of the Transect- and Grid-Based Methodologies

To determine the nature of changes occurring in aquatic plant communities, successive surveys, utilizing similar methods, should to be conducted every three to five years. The modified Jesson and Lound transect method, as

promulgated by the WDNR and widely used throughout the Southeastern Wisconsin Region by SEWRPC staff prior to 2010, allows the statistical evaluation of changes in the aquatic plant community within a lake when utilized in successive aquatic plant surveys.[11] In 2010, the WDNR reverted to a grid-based sampling methodology,[12] and, consequently, the 2011 SEWRPC-conducted survey was accomplished using this methodology. In future years, as successive surveys are conducted at these same sampling points on the Phantom Lakes grids, more meaningful comparisons of empirical data may be possible.

That the two methodologies provide somewhat differing levels of information about the aquatic plant community should be anticipated. The transect method, adapted from terrestrial ecology and adopted to overcome the limitations inherent in a grid-based system, uses four aquatic plant samples collected at each sampling point to determine if a plant species is "present" or "absent" in each sample. This methodology provides an objective means of determining the abundance of a plant species; subsequently, the various other statistical measures—relative density, frequency of occurrence, and importance value—can be used in analyzing aquatic plant communities, since they are based on this initial objective observation. The method provides a fairly reliable and objective assessment of plant community composition. Further, since the "present" or "absent" determination is objectively made, the accuracy of this method is unlikely to be affected by different observers. Quite simply, the species is either in the sample, or it is not, and any errors made are due to either misidentification or inadvertently overlooking a small fragment of a species present in the sample.

The grid-based methodology, in which only one sample is collected at each sampling point and field staff make subjective evaluations as to the abundance of each species using a five-point scale without the benefit of objective descriptors for assigning these values, objectively notes only presence or absence data. Other data, such as relative density, importance value, and the like, are less objective since they are dependent on the initial subjective field assessment of abundance. Simply put, different observers may assign differing scores for density. The WDNR staff, themselves, note that "the presence/absence data cannot be used to estimate biomass or percent cover, [and] it is less sensitive to interannual or seasonal variations in plant abundance."[13] The WDNR staff also note that "the method is relatively rapid and cost-effective and can be used on the large scale to collect baseline data and statistically compare communities over time,"[14] which seems to be its principal attribute when compared with the transect-based methodology.

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

[12]*J. Hauxwell, S. Knight, K. Wagner, A. Mikulyuk, M. Nault, M. Porzky, and S. Chase,* op. cit.

[13]*See also J.D. Madsen, "Point Intercept and Line Intercept Methods for Aquatic Plant Management," U.S. Army Corps of Engineers Waterways Experiment Station Aquatic Plant Control Technical Note No. MI-02, 1999; and L. Dodd-Williams, G.O. Dick, R.M. Smart, and C.S. Owens, "Point Intercept and Surface Observation GPS (SOG): A Comparison of Survey Methods—Lake Gaston, NC/VA," U.S. Army Corps of Engineers Research and Development Center Report No. ERDC/TN APCRP-EA-19, 2008.*

[14]*Wisconsin Department of Natural Resources, Publication No. PUB-SS-1068 2010,* op. cit.

In 2010, a comparative study of the transect-based and grid-based methodologies was conducted on Powers Lake in Kenosha County, Wisconsin.[15] Results of this study suggested that both the grid-based and transect-based methodologies provided essentially the same information with regard to the numbers and types of aquatic plant species observed in Powers Lake during that year. Both sampling methods resulted in muskgrass being identified as the dominant aquatic plant species in that Lake, with bladderwort being the next most frequently encountered species. The two methodologies, however, differed in terms of identifying the third most frequently encountered species, with the transect method identifying coontail, while the grid method identified eel-grass (wild celery). Both aquatic plants are considered to be of high value for fishes and other aquatic organisms, so these differences were not considered to be significant for purposes of aquatic plant management in Powers Lake. Other minor differences in the aquatic plant data produced by the two methodologies, such as frequency of occurrence and pattern of distribution, from the point of view of aquatic plant management, were not considered to be significant in the Powers Lake study.

The agreement with respect to the dominant aquatic plant species and their relative areas of distribution indicated by both methodologies is important. An important objective of aquatic plant management practices is to address recreational and other use impairments that arise as a result of certain aquatic plants being dominant in a lake to the point where their abundance reaches nuisance levels.[16] This is especially significant when the plants that dominate are nonnative species, such as Eurasian water milfoil; oftentimes the nonnative species flourish at the expense of native species. As a consequence, whole ecosystems within a lake can be disrupted as native plant species, which normally provide the food, shelter, and other things which native aquatic animal life are adapted to and depend upon for survival, become replaced with nonnative species that do not fulfill these same requirements. Aquatic plant management works to develop strategies aimed at restoring the balance between desirable native aquatic plant species and other species as a basis for supporting and sustaining a wide range of lake uses that include recreational activities, such as swimming, fishing, and recreational boating, among others.

Aquatic Plant Diversity in the Phantom Lakes

A critical element of the ability of an ecosystem, such as a lake, to maintain its ecological integrity is *biological diversity*. Conserving the biological diversity, or biodiversity, of an ecosystem helps not only to sustain the system, but preserves a spectrum of options that can be support future decisions regarding the management of that system. Generally, both Upper and Lower Phantom Lakes exhibit moderate to good biodiversity in their aquatic plant communities, especially since 1993. It is possible that the modest increase in the reported numbers of aquatic plant species in both Lakes during the period since 1993 may be a function of more rigorous surveying methodologies, rather than a reflection of any significant changes in the communities themselves. Nevertheless, it is not uncommon for aquatic plant community diversity to vary between years in response to drivers, such as weather/climate, predation, and external stimuli, such as nutrient supply. This is especially true in the case of individual species of pondweeds in a lake, which, in general, tend to vary throughout the growing season in response to temperature, insolation, and other ecological factors.

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[15]*SEWRPC Memorandum Report No. 193,* A Lake Protection Plan for Powers Lake, Kenosha and Walworth Counties, Wisconsin, *November 2011.*

[16]*The presence of "nuisance" is an important determinant in the issuance of permits for the application of chemical herbicides in lakes, as stated in Section NR 107.05(3)(c) of the* Wisconsin Administrative Code.

Aquatic Plant Species of Special Significance

Native Aquatic Plants

Several native plant species have been observed during the various surveys of the aquatic plant communities in the Lakes that are of exceptionally high-ecological value, as summarized in Table 4.[17] These species include muskgrass (*Chara* spp.), large-leaf pondweed (*Potamogeton amplifolius*), and white-stem pondweed (*Potamogeton praelongus*).

Muskgrass is a favorite waterfowl food source and, as an effective bottom sediment stabilizer, benefits water quality. Its prevalence in the plant communities of a lake may be a significant contributing factor to establishing and maintaining good water quality in a lake and, consequently, in establishing water quality conditions that are conducive to native plant species successfully competing with nonnative species. Muskgrass has been reported as being common to abundant in both Lakes since the earliest surveys.

Large-leaf pondweed, also known as musky weed or bass weed, is another native species of high value in natural communities. Like muskgrass, this plant has been observed in abundance since the earliest surveys, although it appears to have experienced a decline in abundance since 1980. It has not been observed in Upper Phantom Lake since the 1980 survey. In the 2002 survey, it was observed in Lower Phantom Lake, but was described as being scarce. This plant, as fishermen well know, enjoys a reputation as a highly valuable component of fish habitat. Consequently, this plant has been (re-)introduced into Lac La Belle and Okauchee Lake, in Waukesha County, Wisconsin, making it a potentially valuable plant for use in littoral zone restoration projects.[18]

White-stem pondweed, because of its sensitivity to changes in water quality and intolerance of turbidity, is considered to be an excellent indicator species. Its disappearance from water systems is frequently an indication of declining water quality in disturbed systems. In contrast, its presence in a lake is usually an indicator of very-good water quality. Encouragingly, this species, described as scarce or totally absent during the 1967 and 1980 surveys of both Lakes, seemed to be increasing in numbers in both Lakes through 2002, being described as common in both Lakes at the time of the 2002 surveys. Since 2002, however, the plant has been described as being scarce in Lower Phantom Lake and not observed in Upper Phantom Lake.

Nonnative Species

During the 2011 and earlier aquatic plant surveys of the Phantom Lakes, several nonnative aquatic plant species of significance were observed. Two of these species, Eurasian water milfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*), are considered detrimental to the ecological health of lakes and have been declared to be nuisance species as defined in Chapter NR 109 of the *Wisconsin Administrative Code*.

Eurasian water milfoil is one of eight milfoil species found in Wisconsin and the only one known to be exotic or nonnative. Because of its nonnative nature, Eurasian water milfoil has few natural enemies that can inhibit its growth, which can be explosive under suitable conditions. The plant exhibits this characteristic growth pattern in lakes with organic-rich sediments, or where the lake bottom has been disturbed. It frequently has been reported as a colonizing species following dredging, unless its growth is anticipated and controlled. Eurasian water milfoil populations can displace native plant species and interfere with the aesthetic and recreational use of the water-bodies. This plant has been known to cause severe recreational use problems in lakes within the Southeastern Wisconsin Region. It has become an increasingly dominant element of the aquatic plant flora of the Phantom Lakes since the 1990s.

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[17]*See N.C. Fassett,* A Manual of Aquatic Plants*, Appendix, The University of Wisconsin Press, 1985.*

[18]*Wisconsin Lakes Partnership,* Through the Looking Glass…A Field Guide to Aquatic Plants, Wisconsin Lakes Partnership, University of Wisconsin-Extension, *1999.*

Eurasian water milfoil reproduces by the rooting of plant fragments. Consequently, some recreational uses of lakes can result in the expansion of Eurasian water milfoil communities, especially when boat propellers fragment Eurasian water milfoil plants. These fragments, as well as fragments that occur for other reasons, such as wind-induced turbulence or fragmentation of the plant by fishes, are able to generate new root systems, allowing the plant to colonize new sites. The fragments also can cling to boats, trailers, motors, and/or bait buckets, and can stay alive for weeks contributing to the transfer of milfoil to other lakes. For this reason, it is very important to remove all vegetation from boats, trailers, and other equipment after removing them from the water and prior to launching in other waterbodies.

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

USE RESTRICTIONS IMPOSED BY AQUATIC PLANTS

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.[19] 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.

Heavy aquatic plant growths have the potential to restrict recreational boating traffic to all but areas of open water. In particular, excessive plant growth in the riparian zone can make access to open water difficult. Dense growths also severely restrict shoreline angling and swimming. The abundance of aquatic plants in the Lower Phantom Lake, especially, given the shallow depth of that waterbody, has the potential to adversely affect riparian property values and the aesthetic enjoyment of the residents, and can have significant impact in terms of tourism and the aesthetic enjoyment of visitors to the Lakes. In addition to these human lake use restrictions, the abundant growths of aquatic plants such as the nonnative Eurasian water milfoil, reduce available quality aquatic habitat, impair predation of panfish by visually feeding game fish, and promote stunted panfish populations. These conditions in the Phantom Lakes have been mitigated in part by an ongoing aquatic plant management program conducted by the PLMD, fisheries management actions by the PLMD and WDNR, and the actions of the riparian homeowners, among others.

PAST AND PRESENT AQUATIC PLANT MANAGEMENT PRACTICES

Recorded WDNR-approved aquatic plant control measures have been undertaken on the Phantom Lakes since the 1950s, when records of such control programs began to be kept by the WDNR. However, aquatic plant control programs on the Lakes probably predate the WDNR recordkeeping system. Currently, all forms of aquatic plant management are subject to permitting by the WDNR pursuant to authorities granted the WDNR under Chapters NR 107 and NR 109 of the *Wisconsin Administrative Code.* The most common forms of aquatic plant management are briefly reviewed below insofar as they apply to the management of the Phantom Lakes aquatic plant communities.

Prior to the mid-1980s, the aquatic plant management program on the Phantom Lakes consisted mainly of the application of chemical herbicides and algicides. This program initially involved the chemical treatment of aquatic plant growths with sodium arsenite. Applications of sodium arsenite were discontinued in 1969 after arsenic accumulations were found in bottom sediments of some treated Wisconsin lakes, and concerns were expressed over possible human health impacts. The amount of sodium arsenite applied to the Phantom Lakes, and years of application during the period from 1950 through 1969, are listed in Table 5. The total amount of sodium arsenite applied over this period was about 3,876 pounds.

More recently, as shown in Table 5, the aquatic herbicides diquat, endothall, and 2,4-D have been applied to the Phantom Lakes to control aquatic macrophyte growth. In addition to the chemical herbicides, algicides, such as copper sulfate (primarily in its chelated form marketed as Cutrine Plus™), have also been applied to the Phantom Lakes.

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

As reported in the initial aquatic plant management plan,[20] aquatic plant management activities in the Phantom Lakes since the mid-1980s can be categorized as primarily mechanical macrophyte harvesting. Records of amount of plant material harvested are presented in Table 6.

ALTERNATIVE METHODS FOR AQUATIC PLANT CONTROL

Various aquatic plant management techniques, including manual, mechanical, physical and chemical techniques, are potentially viable on the Phantom Lakes.[21] Consideration has been given to each of these techniques, and a number of these methods have been employed with varying success on the Phantom Lakes in the past. As previously noted, all aquatic plant management measures are subject to State of Wisconsin permitting requirements, with limited exceptions. Physical control measures may be governed by requirements set forth in Chapter 30 of the *Wisconsin Statutes* and specific requirements governing placement of structures set forth in, among others, Chapters NR 115 and NR 328 of the *Wisconsin Administrative Code*. Chemical controls are governed by the requirements set forth in Chapter NR 107 of the *Wisconsin Administrative Code*, while manual, mechanical, and biological control measures are governed by the requirements set forth under Chapter NR 109 of the *Wisconsin Administrative Code*, among others.

Physical Controls

Physical methods, such as drawdown, are not feasible because of the heavy recreational demands placed on the Lakes throughout the year. Although an approximately eight- to ten-foot drawdown could be achieved by removal of the dam at the lake outlet of Lower Phantom Lake, the impact upon recreation and the uncertainty surrounding its effects, combined with the limited duration of such effectiveness, necessitating frequent repeat treatments, makes this type of control expensive and problematical. Drawdown can also encourage the growth of some plant species. In addition, a drawdown could be feasible for use only on Lower Phantom Lake, as Upper Phantom Lake would become isolated from the Lower Phantom Lake after a drawdown of only about three feet. Outflow from Upper Phantom Lake is governed by the elevation of the sand sill that separates the two waterbodies.[22] For these reasons, drawdown is not a recommended technique for the Phantom Lakes at this time.

Other physical controls, such as the placement of bottom barriers and use of shoreline protection structures such as riprap, may be more practicable for the Phantom Lakes. Lake bottom covers and light screens provide limited control of rooted plants by creating a physical barrier which reduces or eliminates the sunlight available to the plants. Sand and gravel are usually readily available and relatively inexpensive to use as cover materials, but plants readily recolonize areas so covered in about a year. Synthetic materials, such as polyethylene, polypropylene, fiberglass, and nylon, can provide relief from rooted plants for several years. However, these structures must be placed and removed annually, and these barriers should not be used in areas of strong surf, heavy angling, or shallow water where motorboating occurs. Because of the limitations involved, lake bottom covering as a method to control aquatic plant growth is not recommended for the Phantom Lakes.

Maps 6 and 7 show the various methods of shoreline protection in use on the Phantom Lakes during 2011. These structures have been installed primarily to control erosion of the shoreline. Because of the uniqueness of each shoreline situation, these control methods are recommended for the Phantom Lakes only for installation by homeowners on a site-specific basis. Nevertheless, use of natural vegetation at the water's edge provides signifi-

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[20] *SEWRPC Memorandum Report No. 81,* op. cit.

[21] *The various methods referred to in the text are described in more detail in U.S. Environmental Protection Agency Report No. EPA-440/4-90-006,* The Lake and Reservoir Restoration Guidance Manual, *August 1990.*

[22] *See SEWRPC Community Assistance Planning Report No. 230,* op. cit.

cant benefit not only in terms of water quality protection, limiting shoreline erosion and runoff of contaminants into the waterway from the land surface, but also additional benefit in terms of habitat for fishes, aquatic organisms, amphibians, and birds.[23]

Chemical Controls

Chemical controls can be viewed by the community as having uncertain long-term environmental impacts as well as possible consequences for human health. While all the herbicides used on the Phantom Lakes have met applicable U.S. Environmental Protection Agency standards,[24] and are applied by registered applicators, the use of chemical control techniques can contribute to an ongoing aquatic plant problem by augmenting the natural rates of accumulation of decaying organic matter in the Lake, contributing to the oxygen demand may cause anoxia. The use of herbicides can also potentially damage or destroy nontarget plant species that provide needed habitat for fish and other aquatic life. As a result, less-desirable, invasive, introduced plant species may outcompete the more beneficial, native species. Hence the use of chemical herbicides is not a feasible option to be used on a large scale in the Phantom Lakes.

However, chemical control is the recommended technique for the control of the Eurasian water milfoil populations found in the Lakes, and purple loosestrife, which grows in some areas along the Lakes' shorelines. Control of curly-leaf pondweed and algal populations in the Lakes generally will not be necessary, given the early spring growing season of the former and the typically limited biomass of the latter. Chemical applications should be conducted in accordance with current WDNR administrative rules, under the authority of the appropriate permit, by a licensed applicator working under the supervision of WDNR staff.

Biological Controls

An alternative approach to controlling nuisance plants, particularly Eurasian water milfoil, is biological control. Classical biological control techniques have been successfully used to control both nuisance plants and herbivorous insects. Recent evidence shows that *Galerucella pucilla* and *Galerucella calmariensis*, beetle species, and *Hylobius transversovittatus* and *Nanophyes brevis*, weevil species, have potential as biological control agents for purple loosestrife. Extensive field trials conducted by the WDNR in the Southeastern Wisconsin Region since 1999 have indicated that these insects can provide effective management of large infestations of purple loosestrife.[25]

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[23]*SEWRPC,* Managing the Water's Edge: Making Natural Connections, *May 2010.*

[24]*See, for example, Wisconsin Department of Natural Resources PUBL-WR-236 90,* Chemical Fact Sheet: 2,4-D, *May 1990; see also Wisconsin Department of Natural Resources PUBL-WR-237 90,* Chemical Fact Sheet: Endothall, *May 1990; Wisconsin Department of Natural Resources PUBL-WR-239 90,* Chemical Fact Sheet: Glyphosate, *May 1990; and, Wisconsin Department of Natural Resources PUBL-WR-238 90,* Chemical Fact Sheet: Copper Compounds, *May 1990.*

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

In contrast, recent studies of *Eurhychiopsis lecontei*, an aquatic weevil, have resulted in widely differing experiences of its potential as a biological control agent for Eurasian water milfoil.[26] Consequently, as very few studies have been completed using *Eurhychiopsis lecontei* as a means of aquatic plant management control, [27] it is not recommended for use in the Lakes at this time. Use of biological control agents, with the exception of grass carp, is subject to State permitting requirements pursuant to Chapter NR 109 of the *Wisconsin Administrative Code*. The use of grass carp, *Ctenopharyngodon idella*, an alternative biological control used elsewhere in the United States, is not permitted in Wisconsin. Grass carp are a designated invasive species pursuant to Chapter NR 40 of the *Wisconsin Administrative Code.*

Manual Controls

Manual methods, such as raking or hand-pulling, 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 the least efficient of the aquatic plant control methods. While manual means will be needed to control nearshore plant growths and collect floating plant material from mechanical harvesting operations, this method is too inefficient and time-consuming to employ on the scale need to manage aquatic plant problems over the entire basins of Upper and Lower Phantom Lakes.

In the nearshore area, specially designed rakes are available to assist in the manual removal of nuisance aquatic plants, such as Eurasian water milfoil. The use of such rakes also provides a safe and convenient method of controlling aquatic plants in deeper nearshore waters around piers and docks. The advantage of the rakes is that they are relatively inexpensive, easy and quick to use, and immediately remove the plant material from the lake, without a waiting period. Hand-pulling of stems, where they occur in isolated stands, provides an alternative means of controlling plants, such as Eurasian water milfoil, in the lake, and purple loosestrife, on the lakeshore. Harvested material must be removed from the lake. Removal of the plants from the lake avoids the accumulation of organic matter on the lake bottom, which adds to the nutrient pool that favors further plant growth. State permitting requirements for manual aquatic plant harvesting pursuant to Chapter NR 109 of the *Wisconsin Administrative Code* apply, although individual landowners are allowed to clear 30 feet along the shoreline as a viewing and access corridor without a permit.

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

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[26]*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.*

[27]*Contrast the experiences, for example, reported on Whitewater Lake in SEWRPC Memorandum Report No. 177,* An Aquatic Plant Management Plan for Whitewater and Rice Lakes, Walworth County, Wisconsin, *March 2010, with those reported on Spring Lake in SEWRPC Memorandum Report No. 149,* A Lake Protection Plan for Spring Lake and Willow Spring Lake, Waukesha County, Wisconsin, *August 2004, which yielded widely differing results: Spring Lake, with limited motorized watercraft traffic, achieved a significant level of control as a result of a naturally occurring weevil population, although this control was several years in the making.*

Mechanical Controls

On the basis of previous use of mechanical harvester technologies on the Phantom Lakes, mechanical harvesting of aquatic plants appears to be a practicable and efficient means of controlling plant growth in an environmentally sensitive manner. Harvesting removes the plant biomass and nutrients from a lake. While mechanical harvesting can potentially impact fish and other aquatic life, disturb loosely consolidated lake bottom sediments, and result in the fragmentation and spread of some aquatic plants, it has been shown to benefit in ultimately reducing the regrowth of other plants. Harvesting also removes attached, epiphytic algal growths with the harvested plant material, and leaves sufficient plant material in a lake to provide forage and shelter for fish and other aquatic life and to stabilize sediments. For these reasons, mechanical harvesting continues to be the recommended primary method for control of aquatic plants in the Phantom Lakes.

Information and Education

In addition to these inlake rehabilitation methods, an ongoing campaign of community information will support the aquatic plant management program by encouraging the use of shoreland buffer strips, responsible use of household and garden chemicals, and environment-friendly household and garden practices to minimize the input of nutrients from these riparian areas. This information program will also remind riparian residents of the value of the lacustrine (lake) habitat and other benefits, such as shoreline stabilization, provided by the aquatic flora of the Lakes, and will promote the preservation of a healthy aquatic flora in the Lakes.

RECOMMENDED AQUATIC PLANT MANAGEMENT PLAN

Harvesting Plan

The recommended aquatic plant management plan for the Phantom Lakes is set forth in Maps 8 and 9. As indicated, it is proposed that aquatic plant management activities be restricted in certain ecologically valuable areas of the Lakes. Aquatic plant management operations will be concentrated in the main basin of Lower Phantom Lake, near the recreational boating access ramp, areas adjacent to populated portions of the shoreline, and in the principal boating and fishing areas. With the exception of the nearshore areas of Lower Phantom Lake within the Village of Mukwonago, the majority of Lower Phantom Lake falls within a delineated sensitive area defined by the WDNR pursuant to authorities granted the Department under Section NR 107.05(3)(i) of the *Wisconsin Administrative Code*.[28] An additional environmentally sensitive area was delineated within Upper Phantom Lake.[29] This area comprises the embayment located along the southeastern shoreline of the Lake. The delineation reports for these environmentally sensitive areas are reproduced as Appendix 1 of this SEWRPC Staff Memorandum.

Within Upper Phantom Lake Sensitive Area No. 1, the WDNR has recommended the use of limited applications of aquatic herbicides to control nonnative plants, prohibited mechanical harvesting and physical aquatic plant control measures such as placement of aquatic plant screens and dredging, and restricted the placement of piers and other shoreline structure, subject to permits. In the upper reaches of Lower Phantom Lake, in the vicinity of the debouchment of the Mukwonago River, aquatic plant management measures in Lower Phantom Lake Sensitive Area No. 3 are required to focus on the provision of navigational access and the preservation of native plant communities. Use of aquatic herbicides is prohibited, although selective harvesting and dredging for navigational access can be permitted.

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[28]*See Appendix D of SEWRPC Community Assistance Planning Report No. 230, Volume Two,* op. cit.

[29]Ibid.

Within Lower Phantom Lake Sensitive Area No. 1, which comprises the major portion of the main basin of Lower Phantom Lake but excluding the easternmost shoreline zone, aquatic plant management measures also focus on provision of navigational access and preservation of native vegetation through the full range of aquatic plant management measures, subject to permit requirements. Within Lower Phantom Lake Sensitive Area No. 2, which comprises the southernmost portion of the main basin of Lower Phantom Lake, use of aquatic herbicides is not generally recommended. Limited mechanical harvesting is suggested, subject to permitting.

As noted above, the goal of the management program is to accommodate recreational uses of the Lakes without inflicting irreparable damage on the ecosystems of the Lakes, their structure and functioning. To accomplish this goal, specific control measures will be applied in various zones of the Lakes identified on Map 6. Generally, aquatic plant management treatments, required to promote specific lake uses and functions, will be applied for the following purposes:

- Access Channels: Narrow channels, about 10-feet or approximately two harvester widths wide, are intended to provide recreational boating access to the main bodies of the two Lakes. Cutting depths will vary from about three feet to about eight feet, where depths allow. Clear-cutting of access channels should be avoided, and sufficient plant material should left on the Lake bottoms to minimize resuspension of lake bottom sediments and maintain desirable plant communities, such as those dominated by the low-growing *Chara* spp. Chemical herbicide use is not anticipated in these areas.

- Boating Transit Areas: Channels of about 50-feet or approximately ten harvester widths wide are intended to provide travel lanes for recreational watercraft, extending perpendicular to the shore, to the areas of open water. Cutting depths will vary from about three feet to about eight feet, where depths allow. Clear-cutting of access channels should be avoided, and sufficient plant material should left on the Lake bottoms to minimize resuspension of lake bottom sediments and maintain desirable plant communities. Chemical herbicide use is expected to be restricted to pier and dock areas within 50 feet of the shoreline, or limited to the control of Eurasian water milfoil, curly-leaf pondweed if necessary, and purple loosestrife.

- Fishing Areas: Narrow channels, about 10-feet or approximately two harvester widths wide, are intended to facilitate predation of panfish by visual-feeding game fish and enhance angling opportunities by harvesting lanes perpendicular to the shoreline of the main basin at roughly 100-foot intervals. Cutting depths will vary from about three feet to about eight feet, where depths allow. Clear-cutting of access channels should be avoided, and sufficient plant material should left on the Lake bottoms to minimize resuspension of lake bottom sediments and maintain desirable plant communities. Chemical herbicide use is expected to be limited to the control of Eurasian water milfoil, curly-leaf pondweed if necessary, and purple loosestrife.

- Habitat Areas: Areas of the Lakes having a predominantly wetland-like character, such as the upper reaches of Lower Phantom Lake in the vicinity of the debouchement of the Mukwonago River (WDNR Sensitive Area No. 3) and the western shorelands of Lower Phantom Lake (within WDNR Sensitive Area No. 2) are recommended to be preserved from any intervention except where necessary to control purple loosestrife infestations. Additional litter collection efforts will probably be required in these areas to maintain their aesthetic appeal.

- Open Water Areas: Deep-water areas of the Lakes, principally Upper Phantom Lake, are intended to be linked to boating transit areas and recreational access channels by about 30-feet-wide or five harvester width lanes. No chemical herbicides are anticipated to be used outside of pier and dock areas within 50 feet of the shoreline, except for the control of Eurasian water milfoil and curly-leaf pondweed, if necessary.

- Shoreland Areas: The area immediately adjacent to piers and docks along the shorelines of the Lakes 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. Individual chemical applications in this area, 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.

Application of aquatic plant management measures in each of these areas, as has been noted above, is subject to State of Wisconsin permitting requirement pursuant to Chapters NR 107 and NR 109 of the *Wisconsin Administrative Code,* and the specific recommendations set forth in this SEWRPC Staff Memorandum.

Depth of Harvesting and Treatment of Fragments
The Aquamarine H5-200/Aquarius 420 Series aquatic plant harvesters have a maximum cutting depth of about five feet; the Aquarius 820 Series 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.

Buoys
Temporary marker buoys may be used to direct harvesting operations in the lake basin by marking the areas to be cut. However, the size of the Lakes and the presence of numerous shoreline landmarks generally preclude the need for such buoys except as may be required for the control of boating traffic on the Lake. The harvester operators will be provided with a laminated copy of the harvesting plan and made familiar with the plan and local landmarks to the degree necessary to carry out the plan without the use of buoys. Harvesting operations are regularly supervised by PLMD staff.

Harvested Plant Material Transfer Site(s)
Off-loading of harvested plant material will take place at Wahl Avenue, as shown on Map 6. Plant material will be removed from the harvester on a transporter and conveyed to the off-loading area, where it will be transferred to a dump truck using a conveyor and transported to disposal sites identified by the PLMD. 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 launching site. The operators will stringently police the off-loading site to ensure minimal disruption of boating and of the activities of people using the riparian areas of the Lake.

PLMD staff should investigate a possible second harvester off-loading site on the southern sides of the Lakes in order to maximize efficiency and minimize fuel consumption. Should a suitable off-loading site be identified, the use of this site is incorporated into this plan.

Disposal of Harvested Plant Material
Harvested plant material will be land-spread on area farms.

Precautions to Protect Wildlife, Fisheries, and Ecologically Valuable Areas
Operators will be provided with a laminated copy of the approved harvesting plan maps showing the limits of the harvesting operations. A copy of these maps will be kept on the harvester at all times. Operations will be prohibited in the upper reaches of Lower Phantom Lake, except for the access channels and boating transit areas described above, to prevent disturbance of the wetland areas, as well as in those areas of both Lakes where the water depth is three feet or less to protect sport fish habitat and spawning areas. Harvesting operations in the areas identified as suitable for sport fish spawning will be restricted until early- to mid-June to permit undisturbed spawning.

Public Information
It is the policy of the PLMD to maintain an active dialogue with the community. This dialogue is carried out through the medium of the public press and through various public meetings and other scheduled events. In addition, the PLMD holds regular public meetings which are appropriately noticed. Where necessary, personal contacts with homeowners could be made.

Harvesting Schedule
The harvesting season will begin no earlier than May 15 and will end no later than October 15 of each year. Harvesting generally will average about 40 hours per week over a five-day week, depending on weather conditions and plant growth, to minimize recreational conflicts. In addition, harvesting will be confined to daylight hours to minimize public disturbances resulting from harvester and plant removal operations. Additional harvesting time may be warranted in order to effectively manage populations of Eurasian water milfoil in the open water areas of the Lakes, especially Lower Phantom Lake where such growths have occurred with increasing frequency in recent years. As described above, harvesting operations will also be modified to protect fish spawning areas and other ecologically valuable areas of the Lake as set forth on Map 6.

EQUIPMENT NEEDS AND OPERATION

Equipment Needs and Total Costs
The PLMD currently owns and operates an Aquarius Systems model H-420 harvester, an Aquarius Systems 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 by the PLMD staff in accordance with the manufacturer's recommended maintenance schedule. Maintenance costs will be borne by the PLMD.

Winter storage of the harvesting equipment will be the responsibility of the PMLD. The PLMD owns a facility constructed for this purpose.

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

Operators, Training, and Supervision
The harvester will be owned and operated by the PLMD, which will be responsible for day-to-day operations of the equipment. The PLMD will provide operator training as required. PLMD staff have extensive experience in the operation of this type of machinery. Initial training will be provided by Aquarius Systems/Aquamarine on delivery of the machinery. Day-to-day supervision will be by the PLMD staff, with oversight by the PLMD Board of Commissioners.

EVALUATION AND MONITORING

Daily Recordkeeping Relating to the Harvesting Operation
A record of daily harvesting activities will be recorded by the operator in a harvester operations log. An annual summary of the harvesting program will be presented to the PLMD Board of Commissioners, and at the annual meeting of the property owners and electors of the PMLD.

It is the intention of the PLMD to undertake a periodic, formal review of the harvesting program as set forth in the comprehensive lake management plan for the Phantom Lakes, a copy of which has been lodged with the WDNR Southeast Region Office, as refined by this SEWRPC Staff Memorandum.

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

SUMMARY

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 PLMD of the existing harvesters and transport equipment.

2. Maintenance of shared boating transit and 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, in addition to the fishing areas, would benefit piscivorous, visual predators such as the northern pike.

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 1, should be focused, primarily, on boating access channels and transit areas 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, and to controlling growths of Eurasian water milfoil, and curly-leaf pondweed if necessary, throughout the Lake basins. 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 PLMD 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 PLMD 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 WDNR and the University of Wisconsin-Extension (UWEX). The aquatic plant illustrations provided in this SEWRPC Staff Memorandum 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 8 and 9. 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.

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SEWRPC Staff Memorandum

AN AQUATIC PLANT MANAGEMENT PLAN UPDATE FOR UPPER AND LOWER PHANTOM LAKES, WAUKESHA COUNTY, WISCONSIN: 2011

TABLES

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Table 1

AQUATIC PLANT SPECIES OBSERVED IN UPPER PHANTOM LAKE: 1967-2011

Aquatic Plant Species	1967	1980	1993	2002	2011
Ceratophyllum demersum (coontail)	Common	Scarce	- -	Present	- -
Chara spp. (muskgrass)	Abundant	Abundant	Abundant	Common	Common
Elodea canadensis (waterweed)	Scarce	Common	- -	Present	Scarce
Myriophyllum sibiricum[a] (northern water milfoil)	Scarce	Abundant	- -	Present	Scarce
Myriophyllum heterophyllum (various-leaved milfoil)	- -	- -	Common	- -	- -
Myriophyllum spicatum (Eurasian water milfoil)	- -	- -	Scarce	Present	Common
Najas flexilis (bushy pondweed)	Common	Common	Scarce	Present	Present
Najas marina (spiny naiad)	- -	- -	- -	Present	Present
Nitella spp. (stonewort)	Common	- -	- -	Present	Present
Potamogeton amplifolius (large-leaf pondweed)	Scarce	Abundant	- -	- -	- -
Potamogeton crispus (curly-leaf pondweed)	Scarce	Scarce	- -	Scarce	- -
Potamogeton foliosus (leafy pondweed)	- -	- -	- -	Present	Scarce
Potamogeton gramineus (variable pondweed)	- -	- -	- -	Present	Present
Potamogeton illinoensis (Illinois pondweed)	- -	- -	- -	- -	Present
Potamogeton natans (floating-leaf pondweed)	Scarce	- -	- -	- -	- -
Potamogeton oakesianus (Oakes pondweed)	Scarce	- -	- -	- -	- -
Potamogeton pectinatus (Sago pondweed)	Common	Abundant	- -	Present	Scarce
Potamogeton praelongus (white-stem pondweed)	- -	- -	Scarce	Common	- -
Potamogeton pusillus (small pondweed)	- -	- -	- -	Scarce	Present
Potamogeton richardsonii (clasping-leaf pondweed)	Scarce	- -	- -	Present	Scarce
Potamogeton zosteriformis (flat-stem pondweed)	Scarce	- -	Scarce	Present	Present
Utricularia vulgaris (bladderwort)	Scarce	- -	Scarce	Scarce	Scarce
Vallisneria americana (eel-grass/wild celery)	Common	Common	Scarce	Present	Scarce
Zosterella dubia (water stargrass)	- -	- -	- -	Scarce	- -

NOTE: In general, species identified as “abundant” had a density value of 3.5 to 4.0; “common” had a density value of 2.5 to 3.4; “present” had a density value of 1.5 to 2.4; and, “scarce” had a density value of less than 1.5. The density value is the sum of density ratings for a species divided by the number of sampling points with vegetation. The maximum density possible of 4.0 is assigned to plants that occur at all four points sampled at a given depth and is an indication of how abundant a particular plant is throughout a lake. Such determination is made possible through the Jesson-Lound transect method where four samples are taken at each pre-determined depth along each transect line. In 2010, the WDNR revised the methodology for aquatic plant surveys to a grid-based point-intercept method. The 2011 survey was conducted by SEWRPC staff using the point-intercept method utilizing 271 sample sites. For purposes of comparison, the following descriptors were used for the 2011 survey based on the relative density of each species: “abundant” had a relative density of 4.0 to 5.0; “common” had a density value of 3.0 to 3.9; “present” refers to a density value of 2.0 to 2.9; “scarce” refers to a density of 1.0 to 1.9; “very scarce” refers to a density of 0.1 to 0.9.

[a]*Formerly known as* Myriophyllum exalbescens.

Source: SEWRPC.

Table 2

AQUATIC PLANT SPECIES OBSERVED IN LOWER PHANTOM LAKE: 1967-2011

Aquatic Plant Species	1967	1980	1992	1993	2002	2011
Ceratophyllum demersum (coontail)	Common	Common	Present	Common	Present	Present
Chara spp. (muskgrass)	Common	Abundant	Present	Abundant	Common	Abundant
Elodea canadensis (waterweed)	Common	Common	Present	Common	Common	Present
Myriophyllum sibiricum[a] (northern water milfoil)	Abundant	Abundant	- -	- -	Common	Common
Myriophyllum heterophyllum (various-leaved milfoil)	- -	- -	- -	Abundant	- -	- -
Myriophyllum spicatum (Eurasian water milfoil)	- -	- -	Present	Scarce	Common	Common
Najas flexilis (bushy pondweed)	Common	Common	- -	- -	Common	Scarce
Najas guadalupensis (southern pondweed)	- -	- -	Present	Scarce	- -	- -
Najas marina (spiny naiad)	- -	- -	- -	- -	Scarce	Present
Nitella spp. (stonewort)	- -	- -	- -	- -	Scarce	Scarce
Potamogeton amplifolius (large-leaf pondweed)	Common	Abundant	Present	Common	Scarce	- -
Potamogeton crispus (curly-leaf pondweed)	Scarce	Scarce	Present	Scarce	Present	Scarce
Potamogeton filiformis (narrow-leaf pondweed)	- -	- -	Present	- -	- -	- -
Potamogeton gramineus (variable pondweed)	- -	- -	- -	- -	Scarce	Scarce
Potamogeton illinoensis (Illinois pondweed)	- -	- -	Present	- -	Scarce	Present
Potamogeton natans (floating-leaf pondweed)	Common	Abundant	Present	Common	Scarce	Present
Potamogeton nodosus (long-leaf pondweed)	- -	- -	- -	- -	- -	Scarce
Potamogeton pectinatus (Sago pondweed)	Scarce	Abundant	Present	Common	Present	Present
Potamogeton praelongus (white-stem pondweed)	Scarce	- -	Present	Common	Common	Scarce
Potamogeton richardsonii (clasping-leaf pondweed)	- -	Common	Present	- -	Common	Present
Potamogeton zosteriformis (flat-stem pondweed)	Common	Abundant	Present	Common	Present	Present
Utricularia vulgaris (bladderwort)	Scarce	Abundant	Present	Common	Present	Present
Vallisneria americana (eel-grass/wild celery)	Common	Common	Present	Common	Common	Common
Zosterella dubia (water stargrass)	- -	- -	- -	- -	Present	Scarce

NOTE: In general, species identified as “abundant” had a density value of 3.5 to 4.0; “common” had a density value of 2.5 to 3.4; “present” had a density value of 1.5 to 2.4; and, “scarce” had a density value of less than 1.5. The density value is the sum of density ratings for a species divided by the number of sampling points with vegetation. The maximum density possible of 4.0 is assigned to plants that occur at all four points sampled at a given depth and is an indication of how abundant a particular plant is throughout a lake. Such determination is made possible through the Jesson-Lound transect method where four samples are taken at each pre-determined depth along each transect line. In 2010, the WDNR revised the methodology for aquatic plant surveys to a grid-based point-intercept method. The 2011 survey was conducted by SEWRPC staff using the point-intercept method utilizing 271 sample sites. For purposes of comparison, the following descriptors were used for the 2011 survey based on the relative density of each species: “abundant” had a relative density of 4.0 to 5.0; “common” had a density value of 3.0 to 3.9; “present” refers to a density value of 2.0 to 2.9; “scarce” refers to a density of 1.0 to 1.9; “very scarce” refers to a density of 0.1 to 0.9.

[a]*Formerly known as* Myriophyllum exalbescens.

Source: SEWRPC.

Table 3

FREQUENCY OF OCCURRENCE, RELATIVE DENSITY, AND IMPORTANCE VALUE OF AQUATIC PLANT SPECIES OBSERVED IN UPPER AND LOWER PHANTOM LAKES: 2011

Aquatic Plant Species	Upper Phantom Lake			Lower Phantom Lake		
	FREQ	ADEN	IV	FREQ	ADEN	IV
Ceratophyllum demersum (coontail)	1.0	3.0	3	40.1	2.4	18
Chara spp. (muskgrass)	80.5	3.3	263	51.2	3.3	30
Elodea canadensis (waterweed)	9.5	1.7	16	73.4	3.2	43
Myriophyllum sibiricum[a] (northern water milfoil)	40.4	1.7	70	52.1	3.1	29
Myriophyllum spicatum (Eurasian water milfoil)	59.6	2.3	138	74.9	3.1	43
Najas flexilis (bushy pondweed)	55.3	1.8	100	58.7	3.1	33
Najas marina (spiny naiad)	45.7	2.2	100	0.9	1.5	1
Nitella spp. (stonewort)	3.2	1.7	5	0.3	1.0	1
Potamogeton amplifolius (large-leaf pondweed)	- -	- -	- -	1.2	1.0	1
Potamogeton crispus (curly-leaf pondweed)	2,.1	1.0	2	3.6	2.0	1
Potamogeton foliosus (leafy pondweed)	6.4	1.7	10	- -	- -	- -
Potamogeton gramineus (variable pondweed)	40.4	1.9	75	1.5	1.3	1
Potamogeton illinoensis (Illinois pondweed)	- -	- -	- -	3.0	1.4	1
Potamogeton natans (floating-leaf pondweed)	- -	- -	- -	0.9	1.0	1
Potamogeton pectinatus (Sago pondweed)	36.2	1.6	59	15.3	1.5	4
Potamogeton praelongus (white-stem pondweed)	8.5	2.5	21	8.4	1.6	2
Potamogeton richardsonii (clasping-leaf pondweed)	21.3	1.7	36	41.6	2.6	19
Potamogeton zosteriformis (flat-stem pondweed)	11.7	1.5	17	31.4	2.2	12
Utricularia vulgaris (bladderwort)	5.3	1.0	5	22.2	1.9	7
Vallisneria americana (eel-grass/wild celery)	47.8	2.1	102	54.5	3.2	32
Zosterella dubia (water stargrass)	3.2	1.0	3	9.6	1.7	3

FREQ = Frequency of Occurrence = the number of occurrences of a species divided by the number of samples with vegetation, expressed as a percentage.

ADEN = Average (or Relative) Density = the sum of the density ratings for a species divided by the number of sampling points with vegetation.

IV = Importance Value = the product of the relative frequency and the average density, expressed as a percentage.

[a] *Formerly known as* Myriophyllum exalbescens.

Source: SEWRPC.

Table 4

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; supports insects valuable as food for fish and ducklings; native
Chara spp. (muskgrass)	A favorite waterfowl food and fish habitat, especially for young fish; native
Elodea canadensis (waterweed)	Provides shelter and support for insects which are valuable as fish food; native
Myriophyllum heterophyllum (various-leaved milfoil)	Waterfowl utilize fruit and foliage as food source; foliage provides invertebrate habitat, as well as shade, shelter, and foraging for fish; native
Myriophyllum sibiricum (northern water milfoil)	Leaves and fruit provide food for waterfowl and shelter and foraging for fish; native
Myriophyllum spicatum (Eurasian water milfoil)	None known; nonnative
Najas flexilis (bushy pondweed)	Important food source for waterfowl, marsh birds, and muskrats; provides food and shelter for fish; native
Najas guadalupensis (southern naiad)	Important food source for waterfowl, marsh birds, and muskrats; provides food and shelter for fish; native
Najas marina (spiny naiad)	Important food source for waterfowl, marsh birds, and muskrats; provides food and shelter for fish; native
Nitella spp. (stonewort)	Sometimes grazed by waterfowl; forage for fish; native
Potamogeton amplifolius (large-leaf pondweed)	Also known as bass-weed or musky-weed, this plant is highly prized by fishermen as prime fish habitat; provides excellent shelter for small fish and foraging opportunities for predator fish; valuable waterfowl food; native
Potamogeton crispus (curly-leaf pondweed)	Nonnative
Potamogeton filiformis (narrow-leaf pondweed)	Provides shade and shelter for fish; harbor for insects; seeds are eaten by wildfowl; native
Potamogeton foliosus (leafy pondweed)	The fruit is an important food source for many waterfowl; also provides food for muskrat, deer, and beaver; native
Potamogeton gramineus (variable pondweed)	The fruit is an important food source for many waterfowl; also provides food for muskrat, deer, and beaver; native
Potamogeton illinoensis (Illinois pondweed)	Provides shade and shelter for fish; harbor for insects; seeds are eaten by wildfowl; native
Potamogeton natans (floating-leaf pondweed)	The late-forming fruit provides important food source for ducks; provides good fish habitat due to its shade and foraging opportunities; native
Potamogeton nodosus (long-leaf pondweed)	Fruit grazed by waterfowl; provides food for muskrat, beaver, and deer; habitat for invertebrates and forage opportunities for fish; native
Potamogeton oakesianus (Oakes pondweed)	Provides shade and shelter for fish; harbor for insects; seeds are eaten by wildfowl; native
Potamogeton pectinatus (Sago pondweed)	This plant is the most important pondweed for ducks, in addition to providing food and shelter for young fish; native
Potamogeton praelongus (white-stem pondweed)	Provides shade and shelter for fish; harbor for insects; seeds are eaten by wildfowl; the presence of white-stem pondweed in a lake is usually an indicator of good water quality due to this plant's intolerance of polluted conditions; native
Potamogeton pusillus (small pondweed)	Provides shade and shelter for fish; harbor for insects; seeds are eaten by wildfowl; native
Potamogeton richardsonii (clasping-leaf pondweed)	The fruit is an important food source for waterfowl; the stem and leaves supply food for muskrat, beaver, deer, and moose and provide forage and cover for fish; native
Potamogeton zosteriformis (flat-stem pondweed)	Provides some food for ducks; native
Utricularia vulgaris (bladderwort)	Stems provide food and cover for fish; native
Vallisneria americana (eel-grass/wild celery)	Provides good shade and shelter, supports insects, and is valuable fish food; native
Zosterella dubia (water stargrass)	Locally important food source for waterfowl and forage for fish; native

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

Source: SEWRPC.

Table 5

CHEMICAL CONTROL OF AQUATIC PLANTS IN THE PHANTOM LAKES: 1950-2010

Year	Algae Control		Macrophyte Control			
	Cutrine-Plus (gallons)	Copper Sulphate (pounds)	Sodium Arsenite (pounds)	2,4-D (pounds)	Diquat (gallons)	Endothall/Aquathol (gallons)
1950-1959	- -	- -	1,080	- -	- -	- -
1960-1969[a]	- -	245.0	2,796	2,280[b]	128.0 lbs.	30.0 lbs.
1970	8.0	103.5	- -	- -	31.5	24.0 + 1,117.0 lbs.
1971	- -	115.0	- -	- -	20.0	98.0
1972	- -	350.0	- -	- -	15.0	115.0
1973	- -	450.0	- -	- -	- -	160.0
1974	- -	285.0	- -	- -	- -	- -
1975	- -	150.0	- -	- -	- -	90.0
1976-2010[a]	- -	- -	- -	- -	- -	- -
Total	8.0	1,698.5	3,876	2,280	66.5 + 128.0 lbs.	Endothall 114.0 + 30.0 lbs. Aquathol 373.0 + 1,117 lbs.

[a]*Chemical records no chemical controls used during these years.*

[b]*Also, 40 pounds of 2,4,5-T in 1969.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 6

AMOUNT OF AQUATIC PLANT MATERIAL HARVESTED FROM PHANTOM LAKES

Year	Plant Material Removed (cubic yards)
2004	N/A
2005	1,362
2006	4,572
2007	6,730
2008	7,260
2009	10,764
2010	9,481
2011	N/A

NOTE: Information for 2004 and 2011 was not available at time of printing.

Source: Wisconsin Department of Natural Resources and SEWRPC.

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SEWRPC Staff Memorandum

AN AQUATIC PLANT MANAGEMENT PLAN UPDATE FOR UPPER AND LOWER PHANTOM LAKES, WAUKESHA COUNTY, WISCONSIN: 2011

FIGURES

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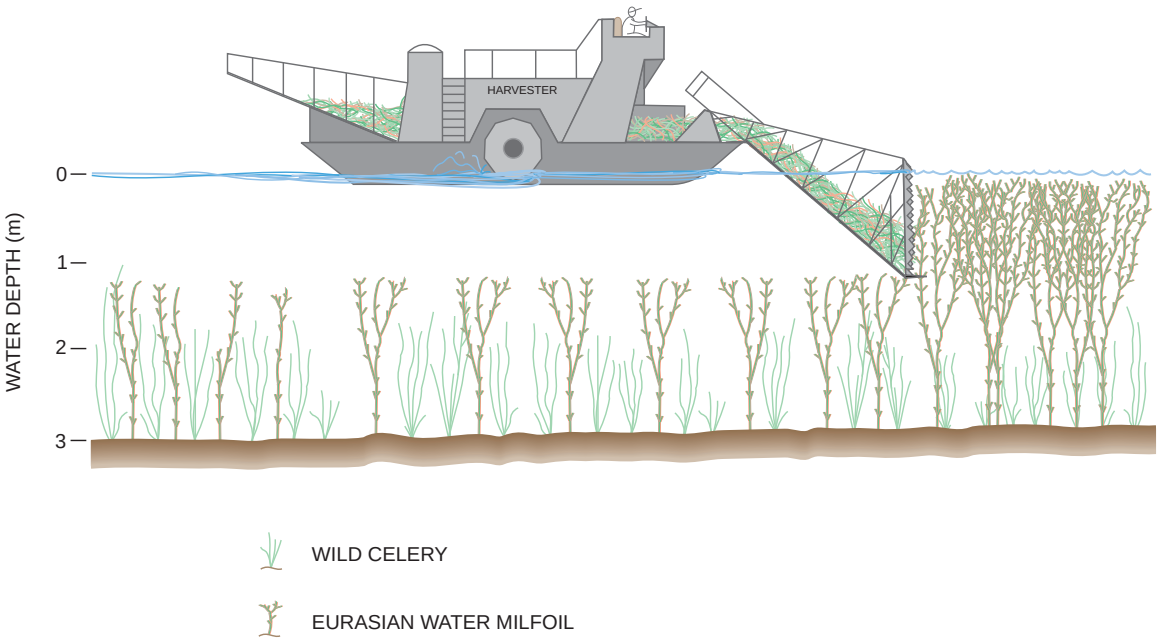
Figure 1

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.

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SEWRPC Staff Memorandum

AN AQUATIC PLANT MANAGEMENT PLAN UPDATE FOR UPPER AND LOWER PHANTOM LAKES, WAUKESHA COUNTY, WISCONSIN: 2011

MAPS

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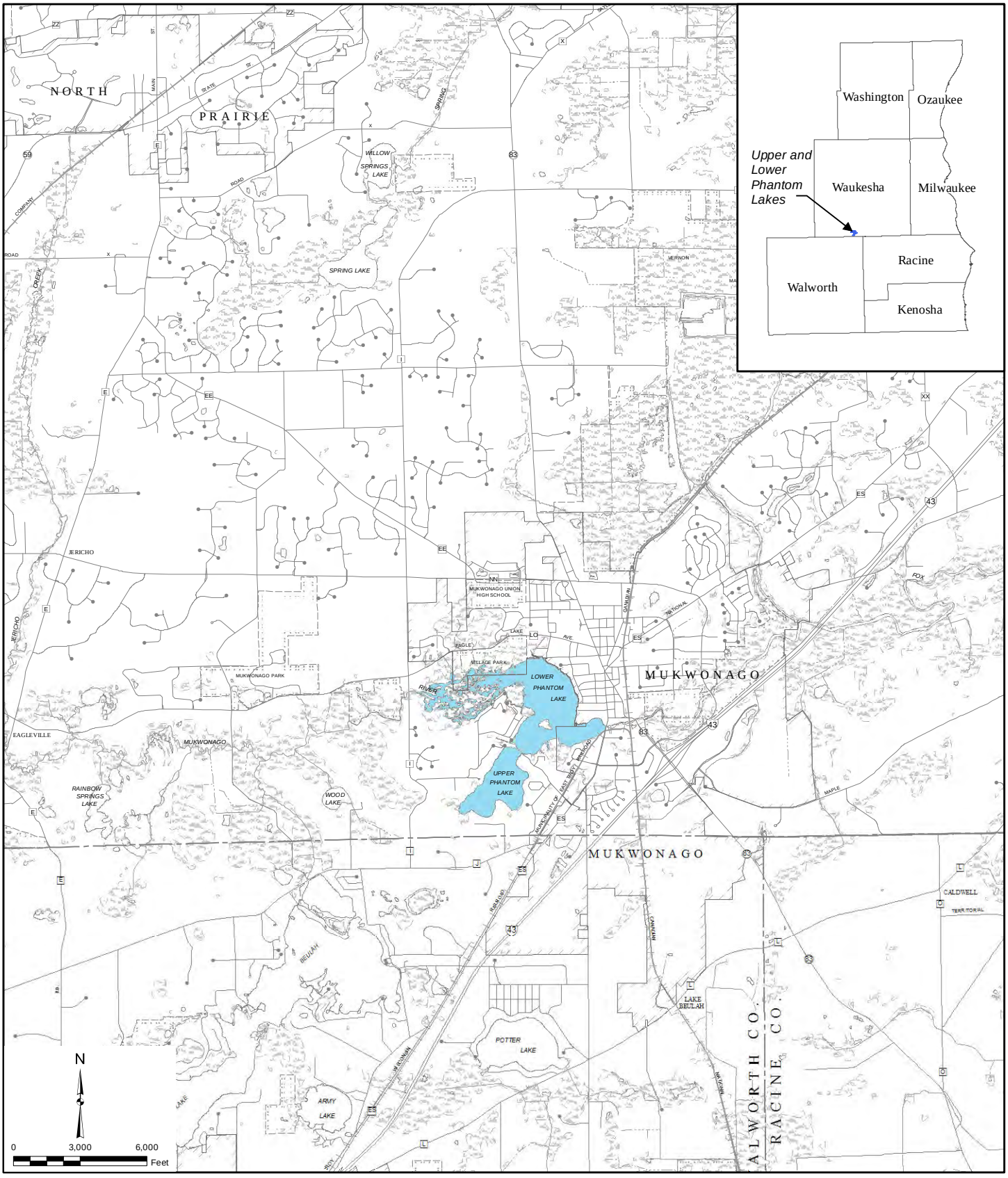
Map 1

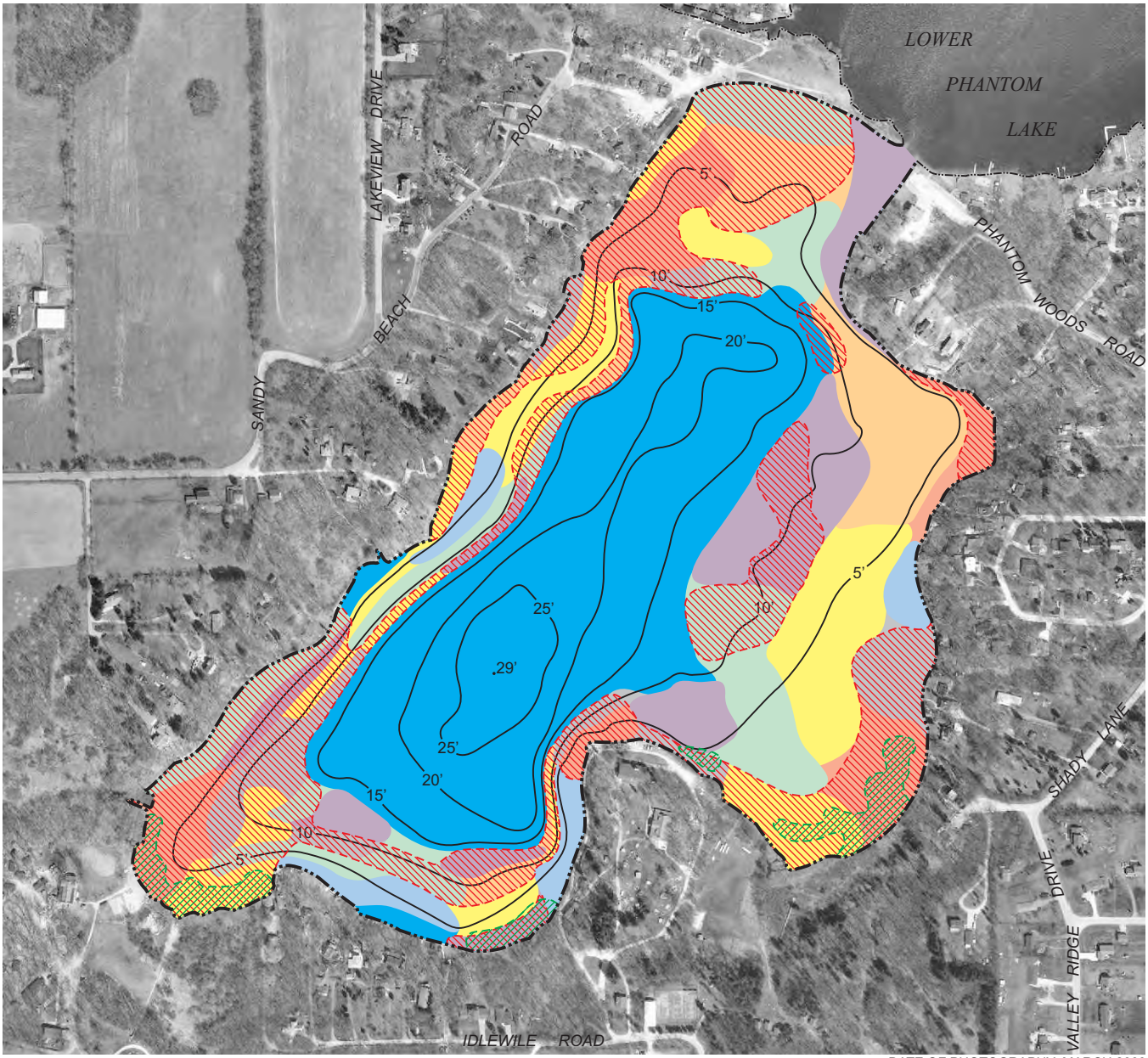
LOCATION OF UPPER AND LOWER PHANTOM LAKES



Source: SEWRPC.

Map 2

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

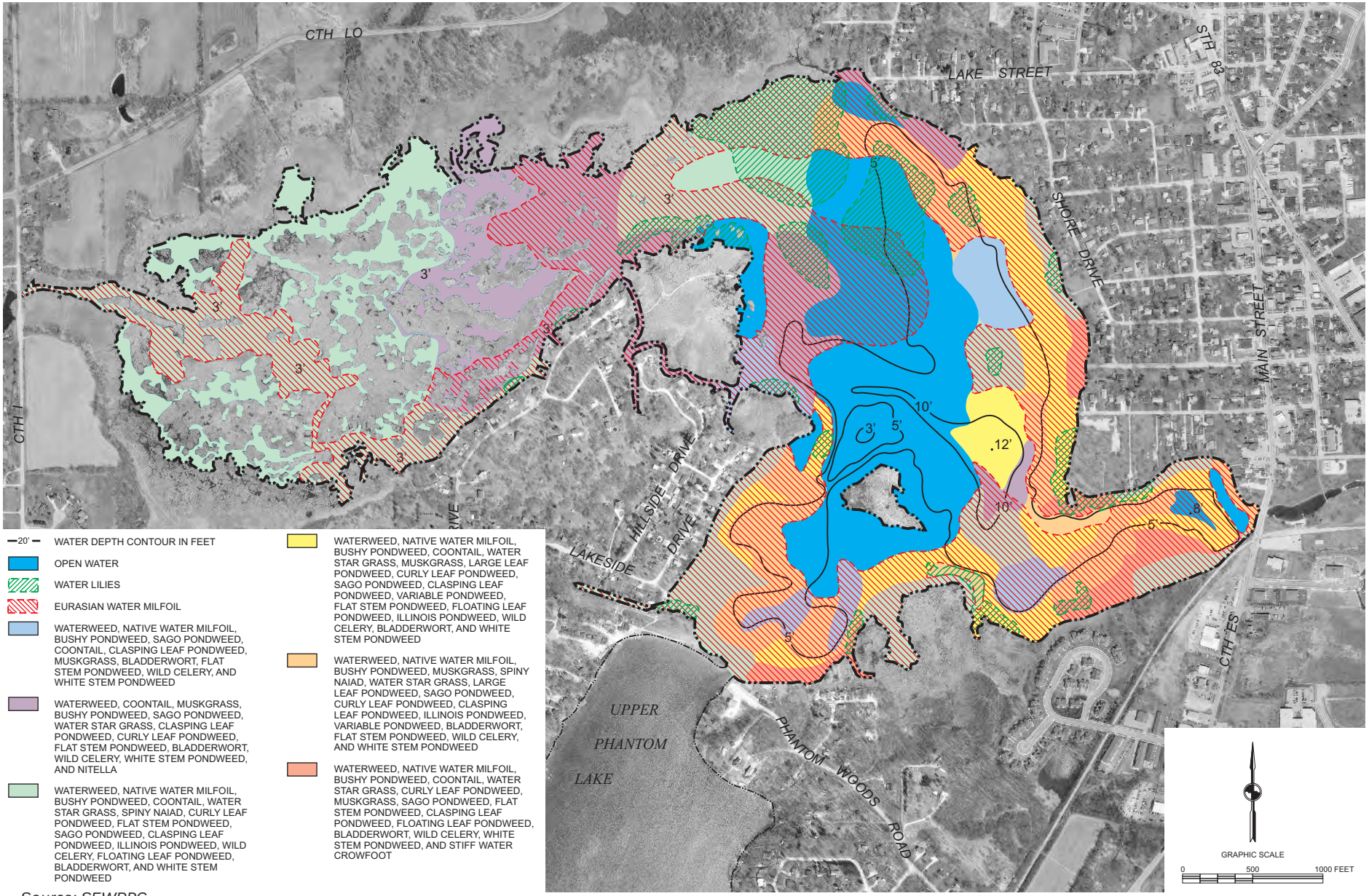
WILD CELERY, BUSHY PONDWEED, NATIVE WATER MILFOIL, CLASPING LEAF PONDWEED, FLAT STEM PONDWEED, SPINY NAIAD, WATERWEED, SAGO PONDWEED, WHITE STEM PONDWEED, VARIABLE PONDWEED, WATER BULRUSH, AND NITELLA

GRAPHIC SCALE
0 300 600 FEET

Source: SEWRPC.

Map 3

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

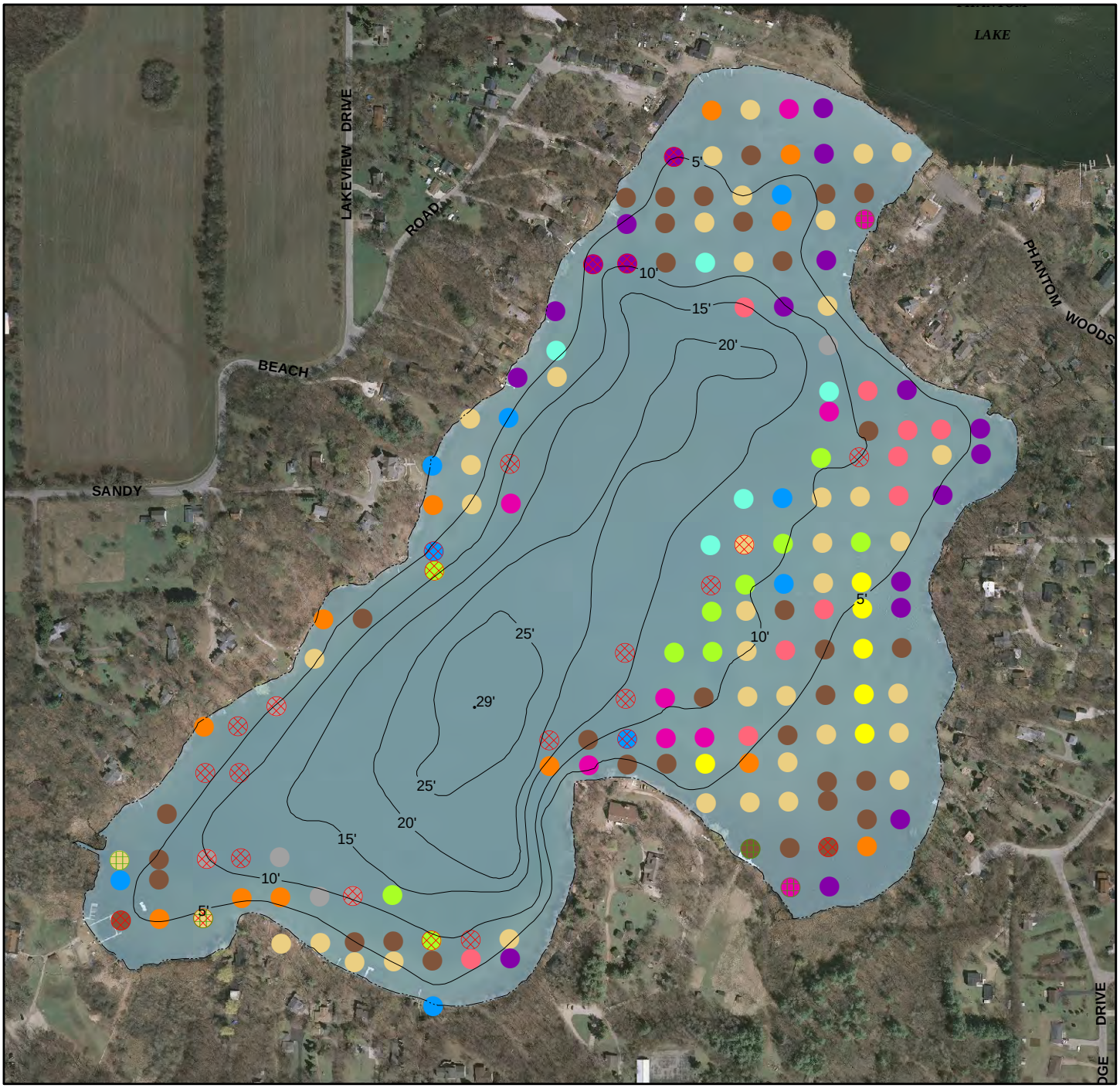
WATERWEED, NATIVE WATER MILFOIL, BUSHY PONDWEED, COONTAIL, WATER STAR GRASS, CURLY LEAF PONDWEED, MUSKGRASS, SAGO PONDWEED, FLAT STEM PONDWEED, CLASPING LEAF PONDWEED, FLOATING LEAF PONDWEED, BLADDERWORT, WILD CELERY, WHITE STEM PONDWEED, AND STIFF WATER CROWFOOT

Source: SEWRPC.

DATE OF PHOTOGRAPHY: MARCH 2000

Map 4

AQUATIC PLANT COMMUNITY DISTRIBUTION IN UPPER PHANTOM LAKE: 2011



DATE OF PHOTOGRAPHY: APRIL 2010

— 20' — WATER DEPTH CONTOUR IN FEET

OPEN WATER

WATER LILIES

EURASAIN WATER MILFOIL

NITELLA AND SPINY NAIAD

SPINY NAIAD

MUSKGRASS, SPINY NAIAD, AND BLADDERWORT

MUSKGRASS AND BLADDERWORT

MUSKGRASS

MUSKGRASS, SPINY NAIAD, NATIVE WATER MILFOIL, WILD CELERY, BLADDERWORT, SAGO PONDWEED, VARIABLE PONDWEED, ILLINOIS PONDWEED, BUSHY PONDWEED, AND WATERWEED

MUSKGRASS, SPINY NAIAD, NATIVE WATER MILFOIL, WILD CELERY, BLADDERWORT, SAGO PONDWEED, ILLINOIS PONDWEED, CLASPING LEAF PONDWEED, SMALL PONDWEED, AND LEAFY PONDWEED

MUSKGRASS, SPINY NAIAD, NATIVE WATER MILFOIL, WILD CELERY, BLADDERWORT, SAGO PONDWEED, NITELLA, CLASPING LEAF PONDWEED, AND FLAT STEM PONDWEED

MUSKGRASS, SPINY NAIAD, NATIVE WATER MILFOIL, NITELLA, AND BUSHY PONDWEED

MUSKGRASS, SPINY NAIAD, NATIVE WATER MILFOIL, WILD CELERY, BLADDERWORT, CLASPING LEAF PONDWEED, AND BUSHY PONDWEED

SPINY NAIAD, NATIVE WATER MILFOIL, WILD CELERY, BUSHY PONDWEED, BLADDERWORT, FLAT STEM PONDWEED, AND CLASPING LEAF PONDWEED

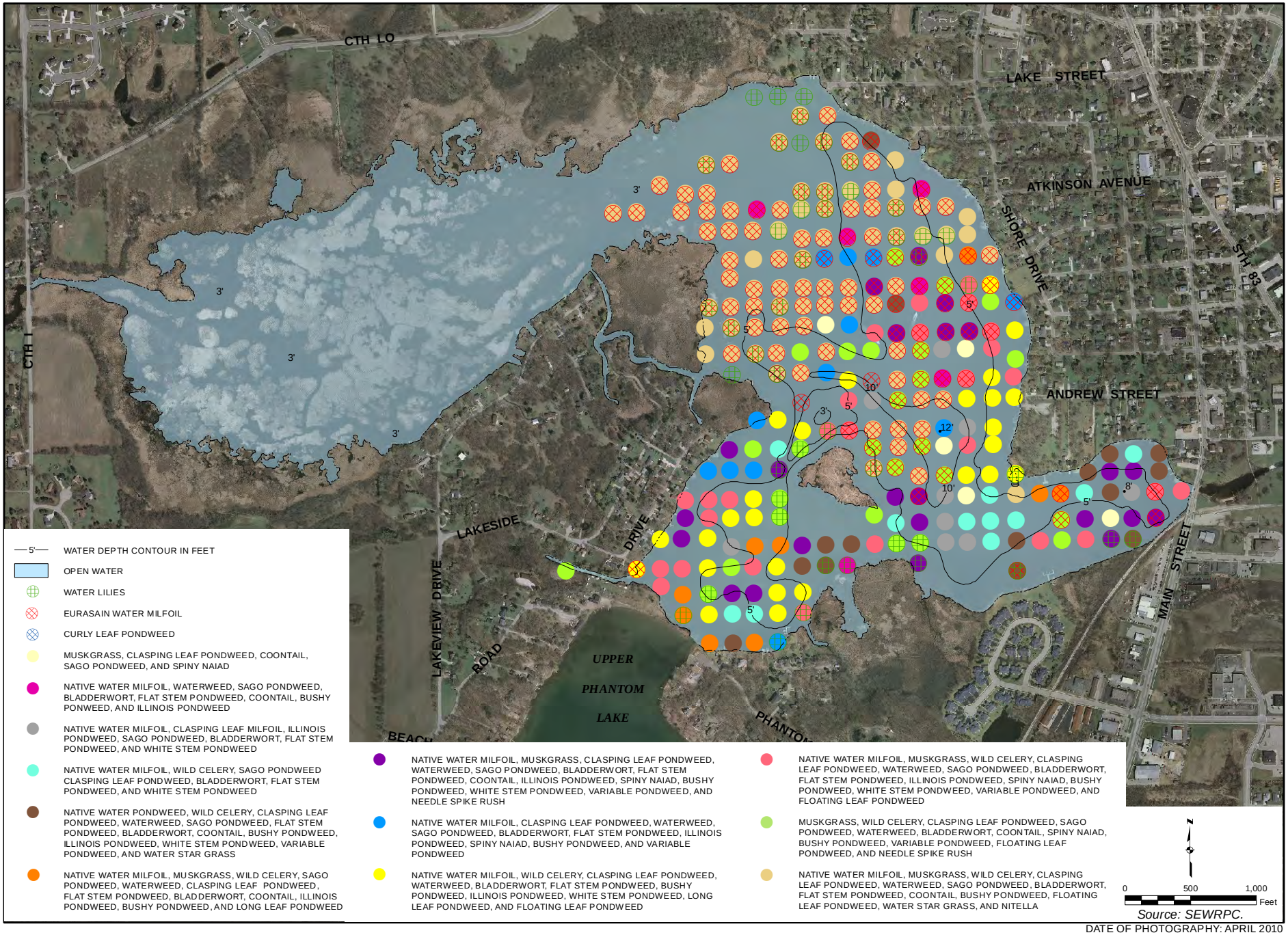
N

0 250 500 Feet

Source: SEWRPC.

Map 5

AQUATIC PLANT COMMUNITY DISTRIBUTION IN LOWER PHANTOM LAKE: 2011

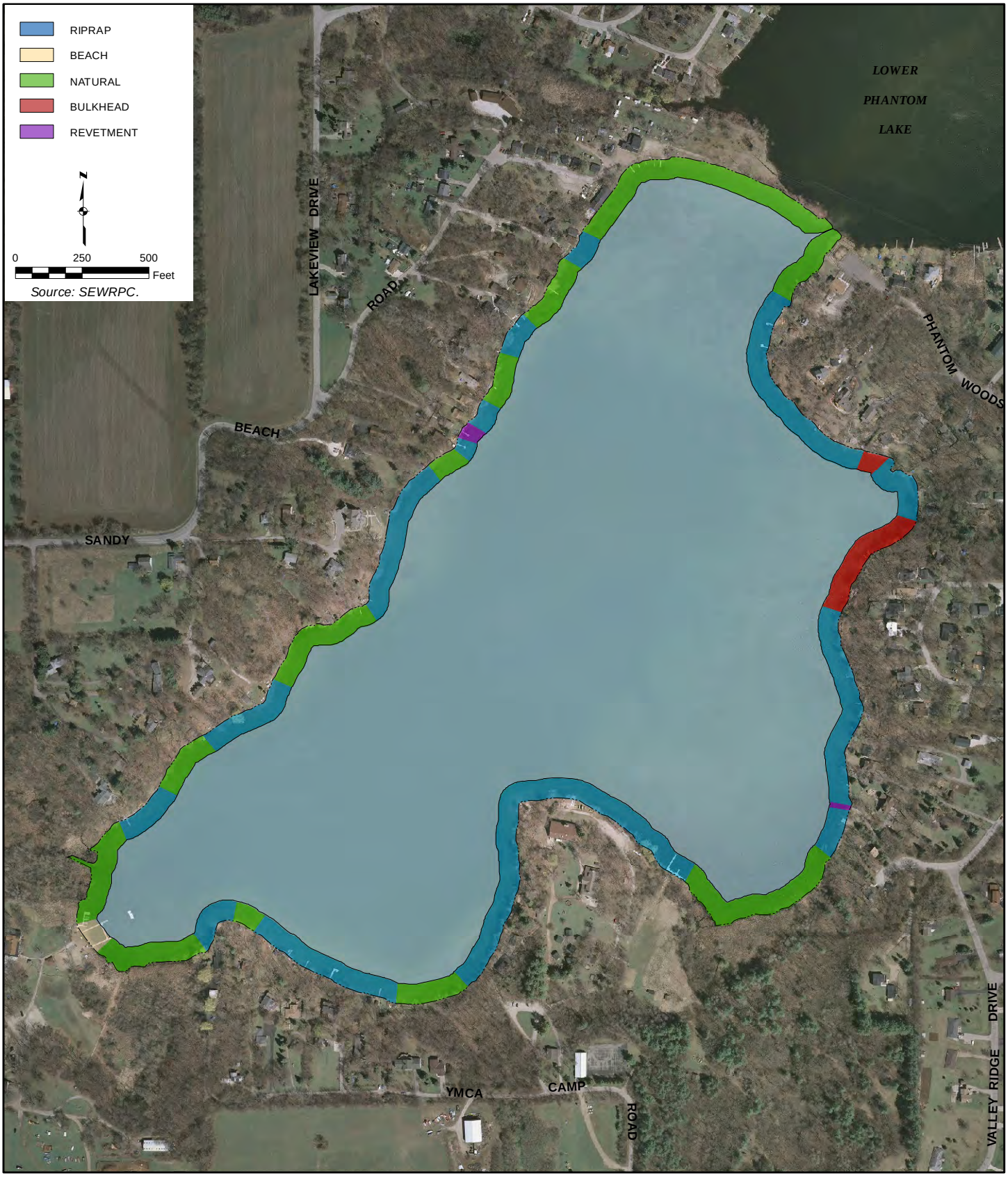


Source: SEWRPC.

DATE OF PHOTOGRAPHY: APRIL 2010

Map 6

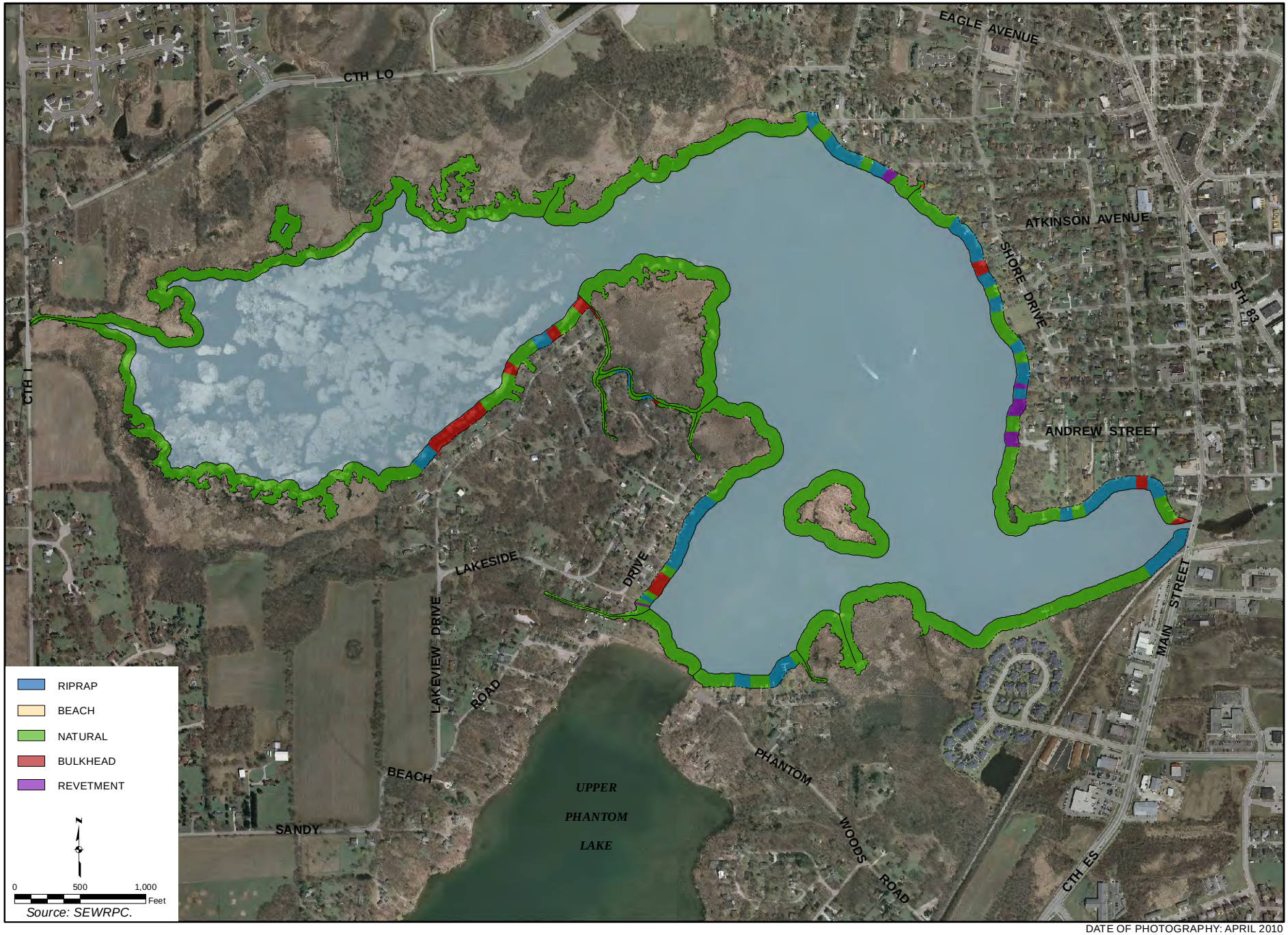
SHORELINE PROTECTION STRUCTURES ON UPPER PHANTOM LAKE



DATE OF PHOTOGRAPHY: APRIL 2010

Map 7

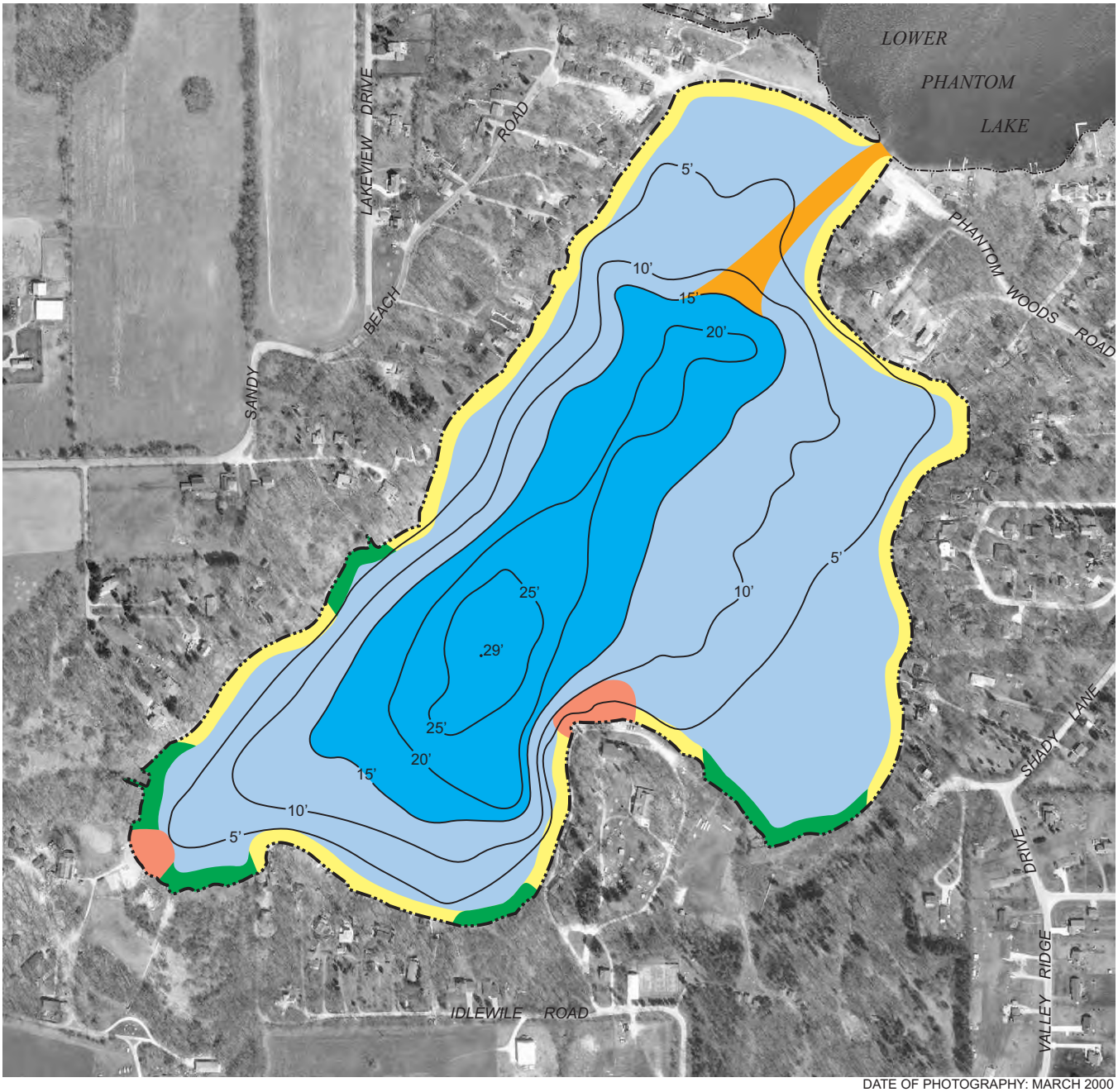
SHORELINE PROTECTION STRUCTURES ON LOWER PHANTOM LAKE



DATE OF PHOTOGRAPHY: APRIL 2010

Map 8

RECOMMENDED AQUATIC PLANT MANAGEMENT PLAN FOR UPPER PHANTOM LAKE: 2011



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

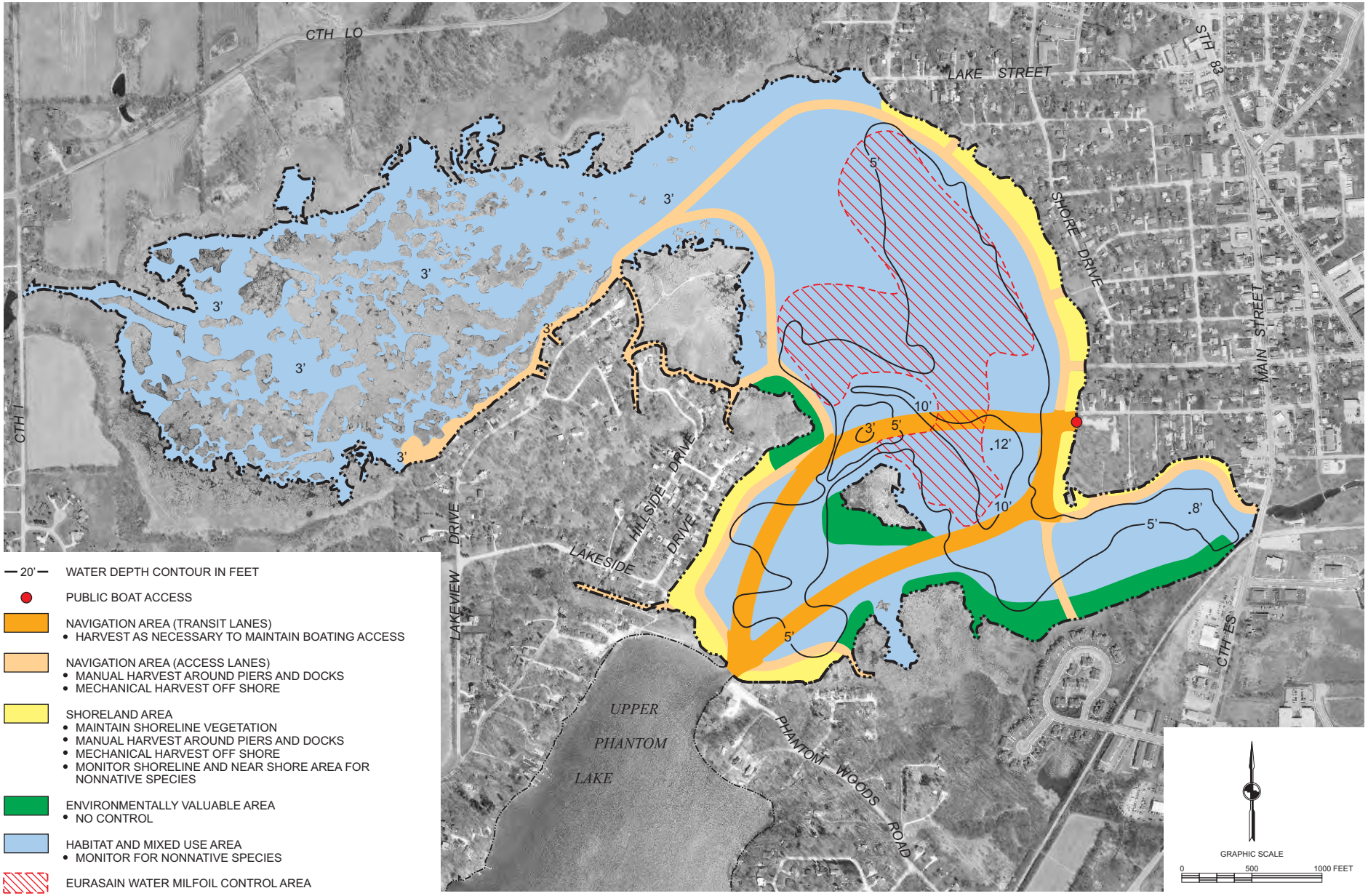
NAVIGATION AREA
- HARVEST AS NECESSARY TO MAINTAIN BOATING ACCESS

GRAPHIC SCALE
0 300 600 FEET

Source: SEWRPC.

Map 9

RECOMMENDED AQUATIC PLANT MANAGEMENT PLAN FOR LOWER PHANTOM LAKE: 2011



— 20' — WATER DEPTH CONTOUR IN FEET

PUBLIC BOAT ACCESS

NAVIGATION AREA (TRANSIT LANES)
- HARVEST AS NECESSARY TO MAINTAIN BOATING ACCESS

NAVIGATION AREA (ACCESS LANES)
- MANUAL HARVEST AROUND PIERS AND DOCKS
- MECHANICAL HARVEST OFF SHORE

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

ENVIRONMENTALLY VALUABLE AREA
- NO CONTROL

HABITAT AND MIXED USE AREA
- MONITOR FOR NONNATIVE SPECIES

EURASAIN WATER MILFOIL CONTROL AREA

DATE OF PHOTOGRAPHY: MARCH 2000

Source: SEWRPC.

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SEWRPC Staff Memorandum

AN AQUATIC PLANT MANAGEMENT PLAN UPDATE FOR UPPER AND LOWER PHANTOM LAKES, WAUKESHA COUNTY, WISCONSIN: 2011

APPENDIX 1

WISCONSIN DEPARTMENT OF NATURAL RESOURCES CHAPTER NR 107 SENSITIVE AREA DELINEATIONS FOR UPPER AND LOWER PHANTOM LAKES

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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
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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

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 <u>not sensitive</u> 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.

	Emergent	**Submergent**	**Free-floating**	**Algae**
PRESENT (0-25% Cover)	*Sparganium* (bur-reed)	*Elodea* (waterweed) *P. amplifolius* (large-leaf pondweed)	*Nymphaea odorata* (white water lily) *Lemna* (duckweed) *Spirodela* (large duckweed) *P. natans* (floating-leaf pondweed)	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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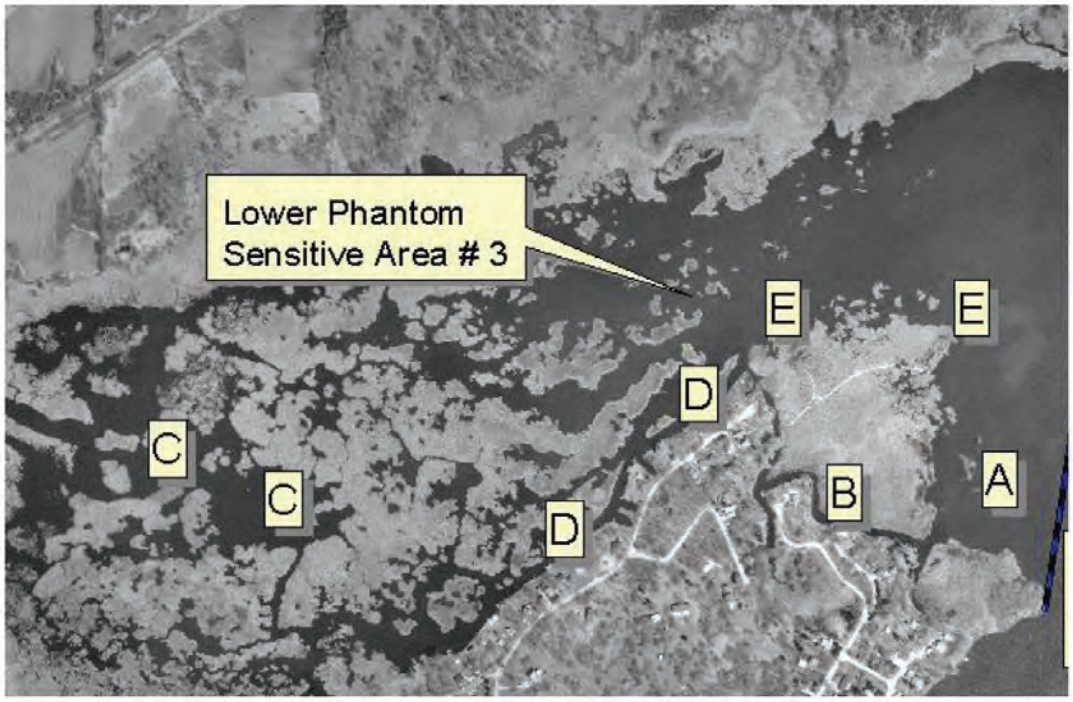
Appendix 1
Subsections of Sensitive Area # 3



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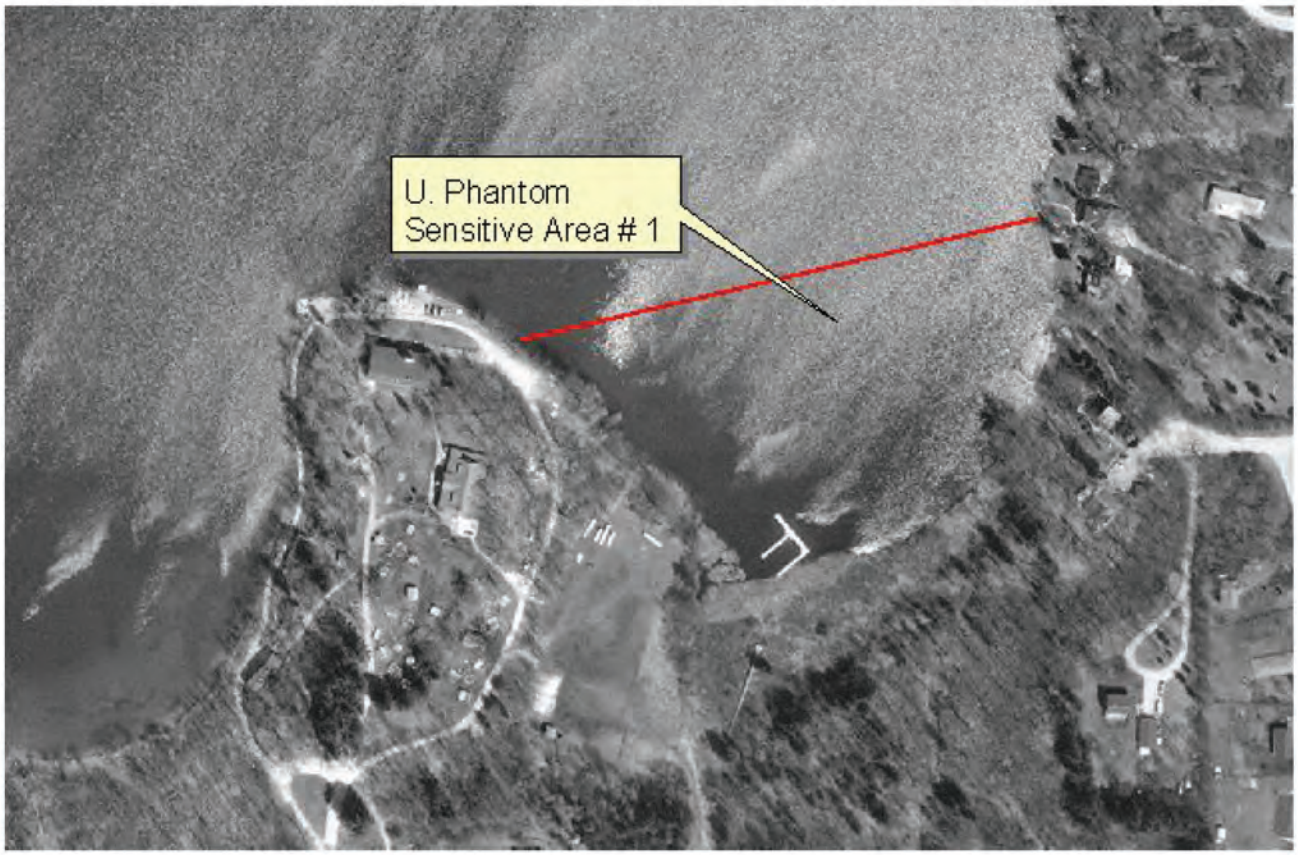
APPENDIX 2 - Aquatic plants within sensitive areas of the Phantom Lakes

	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

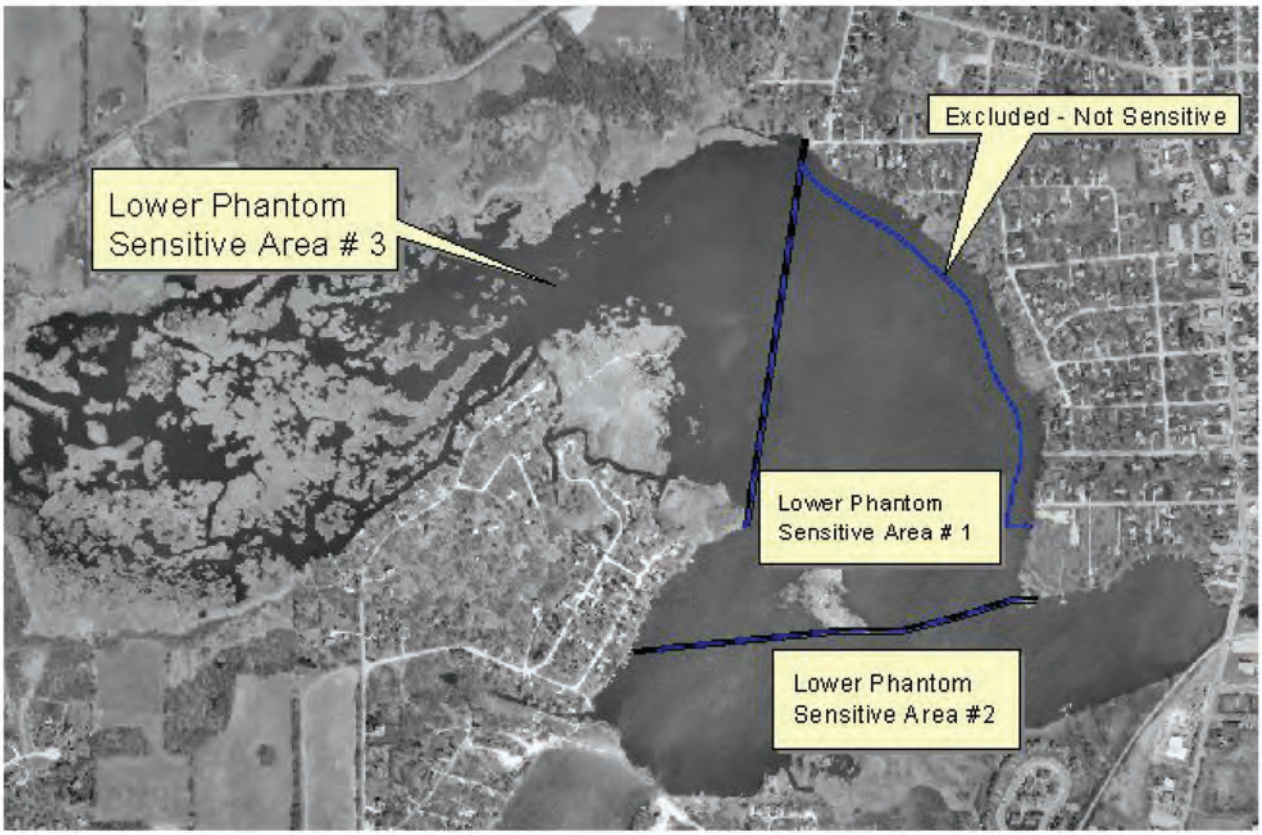
WISCONSIN DEPARTMENT OF NATURAL RESOURCES-DELINEATED CHAPTER NR 107 SENSITIVE AREA PROPOSED FOR UPPER PHANTOM LAKE: 2005



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.