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AQUATIC PLANT MANAGEMENT PLAN

NEENAH LAKE
MARQUETTE COUNTY, WISCONSIN

March 12, 2008

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1.0 EXECUTIVE SUMMARY

In 1970 Neenah Lake property owners formed the Oxford Conservation Club (OCC) to address resource management concerns on Neenah Lake. The Club has been active in a number of lake management activities on Neenah Lake. The Oxford Conservation Club contracted Northern Environmental to help develop an Aquatic Plant Management (APM) plan for Neenah Lake. The APM plan includes a review of available lake information, an aquatic plant survey, and an evaluation of feasible physical, mechanical, biological, and chemical management alternatives and recommended specific management activities for the aquatic invasive species (AIS) on Neenah Lake, which are discussed below.

Northern Environmental completed an aquatic plant survey on Neenah Lake in August, 2007, which identified seventeen aquatic plant species. The most abundant aquatic plants identified during the survey were wild coontail (*Ceratophyllum demersum*), elodea or common waterweed (*Elodea canadensis*), and large duckweed (*Spirodela polyrhiza*). The Floristic Quality Index (FQI) is an index that uses the aquatic plant community as an indicator of lake health. Plants sensitive to disturbances in the lake ecosystem are assigned a higher value than plants which can tolerate disturbances. The values of all species present are used in a formula to determine the plant community's FQI. Neenah Lake exhibited an FQI of 21.95, comparable to the state average (22.2) indicating average water quality.

Eurasian water-milfoil (*Myriophyllum spicatum* – EWM) was confirmed in Neenah Lake in 1995 and was found during the survey along with curly-leaf pondweed (*Potamogeton crispus* – CLP). Both are aquatic invasive species (AIS). CLP was found at approximately 3.12 acres with EWM covering 5.35 acres

Excessive aquatic plant growth on Neenah Lake has become a concern among lake residents and users. This growth not only limits recreational opportunities, but hampers aesthetic value too. This problem is caused by an excessive amount of coontail and the presence of two AIS. The overall aquatic plant management plan is to reduce presence of CLP and EWM while improving recreational and aesthetic values of Neenah Lake through coontail reduction and control. An achievable and quantitative goal for AIS reduction is to reduce the acreage within five years to small-scale herbicide treatments on the system. Wisconsin Administrative Code NR 107.04(3) defines small-scale as any treatment less than ten total acres or 10 percent (%) of the water body less than ten feet deep. This overall goal correlates to a reduction of AIS acres by 30% over the next five years to a total of 5.93 acres by 2012. The 30% reduction is focused equally throughout, aiming at reducing the acreage by 6% each year. The following table depicts this reduction by year. The table also assumes no major re-growth or expansion of AIS on a yearly basis.

Year	EWM	CLP	Total	% Acreage Reduction
2007	5.35	3.12	8.47	---
2008	5.03	2.93	7.96	6
2009	4.71	2.75	7.45	6
2010	4.39	2.56	6.95	6
2011	4.07	2.37	6.44	6
2012	3.75	2.18	5.93	6
			TOTAL	30

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Highly used recreational areas and public boat launches or access points should be given priority when considering treatment locations due to a greater potential for AIS spread from these areas. The APM plan should be updated in 2012-2013 to evaluate the aquatic plant community and to assess the current management strategies. Reduction numbers are based solely on chemical treatments. If the 30% reduction goal is met, then AIS chemical treatments should be considered maintenance activities instead of restoration.

Although coontail is a native species, it is currently growing at nuisance levels in Neenah Lake. Management of this species may include increased harvesting, water-level drawdowns, and/or chemical treatments in conjunction with any proposed AIS treatment.

Increasing sediment depth has also become a concern among lake users. Compaction and decay of mucky sediments can be achieved through a water-level drawdown.

The APM plan involved evaluating physical, mechanical, biological, and chemical management alternatives and outlines specific management activities for AIS and coontail on Neenah Lake.

Recommended APM Plan

Proposed management of EWM, CLP, and coontail should include manual removal in isolated shallow locations. No permit is required to remove EWM along a landowner's shoreline property, but removal of native plants is restricted to a 30-foot wide recreation zone (for pier, boatlift, or swim raft access). Additional native plant removal is not recommended and would require a permit from the WDNR.

Larger CLP and EWM areas should be treated with an herbicide in accordance with a WDNR issued permit under NR 107 Wisconsin Administrative Code. EWM and CLP treatments should be completed in the spring when native plant growth is minimal to increase the selectivity of the herbicide. Pre- and post-treatment monitoring should be included for all aquatic plant treatments and is typically a permit requirement.

Large scale, early season harvesting of CLP should be considered an alternative to chemical treatments. If increased harvesting for CLP and/or coontail is wanted, it is recommended to obtain a newer, more efficient mechanical harvester than what is currently in use. An increase in harvesting areas is recommended for coontail control and will require a change in permit conditions.

Water level manipulation or drawdown should also be considered as an alternative to large-scale chemical treatments or used in conjunction with chemical treatment. The type of drawdown is dependent on what results are desired. A winter drawn down will freeze out the CLP and EWM roots and reducing their occurrence the following growing season. A summer drawdown will have greater effect on sediment depth than a winter drawdown, but less of an effect on plant populations. The third alternative is a year-long period of drawdown that would essentially combine both the summer & winter versions, but would severely limit lake use opportunities. If successful, a water level drawdown could achieve results beyond the 30% reduction goal in one treatment and eliminate the need for any chemical treatments.

The APM Plan also includes prevention efforts; assigns responsibilities for APM activities; and outlines a monitoring protocol to evaluate the EWM and CLP treatment effectiveness, changes in the lake's aquatic plant community, and water quality.

2.0 INTRODUCTION

Neenah Lake is a 61 acre drainage lake located in western Marquette County with a 24,672 acre (38.55 square mile) watershed. Neenah Lake exhibits moderate water clarity and according to the Wisconsin Trophic State Index is a eutrophic lake. Both EWM and CLP, aquatic invasive species (AIS), were confirmed on Neenah Lake during the 2007 survey.

Lake residents have become concerned about excessive aquatic plant growth and the presence of EWM and other CLP in the aquatic plant community of Neenah Lake.

This document is the APM Plan for Neenah Lake and discusses the following:

- Lake morphology and lake watershed characteristics
- Historical aquatic plant management activities
- Stakeholder's goals and objectives
- Aquatic plant ecology
- 2007 baseline aquatic plant survey
- Feasible aquatic plant management alternatives
- Selected suite of aquatic plant management options

3.0 BACKGROUND INFORMATION

3.1 Lake History and Morphology

Neenah Lake is located near the city of Oxford in the western Marquette County, Wisconsin. Figure 1 depicts the lake location. The lake was created by construction of a dam on Neenah Creek. The following summarizes the lake's physical attributes:

Lake Name	Neenah Lake
Lake Type	Drainage
Surface Area (acres)	61
Maximum depth (feet)	15
Mean depth (feet)	NA
Shoreline Length (miles)	NA
Public Landing	Yes

Source: Wisconsin Lakes, WDNR 2005

Figure 2 illustrates the lake bathymetries. Neenah Lake provides year-round recreation activities ranging from, fishing, swimming, slow-no-wake boating, snowmobiling, and more.

3.2 Watershed Overview

The Neenah Lake watershed encompasses approximately 24,672 acres in Marquette and Adams Counties with the vast majority attributed to the Neenah Creek upstream of Neenah Lake. The watershed is primarily agricultural land (15,278 acres). Landuse within the watershed is as follows:

Landuse	Acres	% Watershed Coverage
Urban / Developed	428	1.74%
Agriculture	15278	61.92%
Forest	7892	31.99%
Open Water	433	1.76%
Wetland	590	2.39%
Barren	51	0.20%
TOTAL	**24672**	**100%**

Land listed as barren within the watershed is attributed to gravel or other open-air pits.

The Neenah Lake area is in the Delton-Briggsville-Mundelein soil type association. These are well drained to poorly drained silty clay soils with a silt, clay, or sand underlining deposited by glacial lakes. These soils range from level to steep with the majority of them having been cleared for cultivation. (USDA, 1975)

3.3 Water Quality

There is no available water quality data for Neenah Lake.

3.4 Summary of Lake Fishery

The following table identifies the fish species present in Neenah Lake.

Fish Species	Present	Common	Abundant
Trout	X		
Muskellunge			
Northern Pike		X	
Walleye			
Largemouth Bass		X	
Smallmouth Bass			
Panfish	X		

Source: WDNR Wisconsin Lakes Publication # PUB-FH-800, 2005

The only WDNR stocking of fish in Neenah Lake occurred in 2001 when 4,360 brown trout were stocked. (WDNR Fish stocking website, 2007).

3.5 Lake Management History

Aquatic plant management on Neenah Lake currently consists of the operation of a single aquatic plant cutter. This has been in operation for approximately 15 years, but lately has been in a state of disrepair. Currently, the WDNR has permitted three acres of cutting. Other lake management efforts include WDNR fish stocking and a non-point source pollution control plan for the Neenah Creek watershed. The Neenah Creek Watershed was a Priority Watershed Project starting in 1992. The goal of the project was to reduce sediment delivery to the creek, reduce the overall phosphorus load and restore degraded wetlands. Partners included the Wisconsin Department of Natural Resources, Adams, Columbia and Marquette Counties, and the Village of Oxford, among others.

3.6 Goals and Objectives

Oxford Conservation Club identified the following goals for aquatic plant management on Neenah Lake.

- Manage EWM and CLP in accordance with the best available technologies
- Maintain and improve recreational opportunities
- Protect and improve fish and wildlife habitat
- Preserve native aquatic plants
- Prevent the introductions of new AIS
- Identify and protect sensitive areas
- Identify and discuss various sources of financial assistance for aquatic plant management activities
- Coordinate sound aquatic plant management practices where needed within Neenah Lake
- Educate the Neenah Lake community
- Increase citizen participation in lake management

4.0 PROJECT METHODS

To accomplish the project goals, the Oxford Conservation Club (OCC) needs to make informed decisions regarding APM on the lake. To make informed decisions, OCC proposed to:

- Collect, analyze, and interpret basic aquatic plant community data
- Recommend practical, scientifically-sound aquatic plant management strategies

Offsite and onsite research methods were used during this study. Offsite methods included a thorough review of available background information on the lake, its watershed and water quality. An aquatic plant community survey was completed onsite to provide data needed to evaluate aquatic plant management alternatives.

4.1 Existing Data Review

A variety of background information resources were researched to develop a thorough understanding of the ecology of the Lake. Information sources included:

- Local and regional geologic, limnologic, hydrologic, and hydrogeologic research
- Discussions with lake members
- Available topographic maps and aerial photographs
- Data from WDNR files
- Past lake study reports (if available)

These sources were essential to understanding the historic, present, and potential future conditions of the lake, as well as to ensure previously completed studies were not unintentionally duplicated. Specific references are listed in Section 8.0 of this report.

4.2 Aquatic Plant Survey and Analysis

The aquatic plant community of the lake was surveyed on August 28, 2007 by Northern Environmental. The survey was completed according to the point intercept sampling method described by Madsen (1999), as outlined in the WDNR draft guidance entitled “Aquatic Plant Management in Wisconsin” (WDNR, 2005).

WDNR research staff determined the sampling point resolution in accordance with the WDNR guidance and provided a base map with the specified sample point locations. The sample resolution was a 30 meter grid with 242 pre-determined intercept points (Figure 4). Latitude and longitude coordinates and sample identifications were assigned to each intercept point on the grid (Appendix A). Geographic coordinates were uploaded into a global positioning system (GPS) receiver. The GPS unit was then used to navigate to intercept points. At each intercept point, plants were collected by tossing a specialized rake on a rope and dragging the rake along the bottom sediments. All collected plants were identified to the lowest practicable taxonomic level (e.g., typically genus or species) and recorded on field data sheets. Visual observations of aquatic plants were also recorded. Water depth and, when detectable, sediment types at each intercept point were also recorded on field data sheets.

The point intercept method was used to evaluate the existing emergent, submergent, floating-leaf, and free-floating aquatic plants. If a species was not collected at a given point, the data field was left blank. For the survey, the data for each sample point was entered into the WDNR "Worksheets" (i.e., a data-processing spreadsheet) to calculate the following statistics:

- **Taxonomic richness** (the total number of taxa detected)
- **Maximum depth of plant growth**
- **Community frequency of occurrence** (number of intercept points where aquatic plants were detected divided by the number of intercept points shallower than the maximum depth of plant growth)
- **Mean intercept point taxonomic richness** (the average number of taxa per intercept point)
- **Mean intercept point native taxonomic richness** (the average number of native taxa per intercept point)
- **Taxonomic frequency of occurrence within vegetated areas** (the number of intercept points where a particular taxon (e.g., genus, species, etc.) was detected divided by the total number of intercept points where vegetation was present)
- **Taxonomic frequency of occurrence at sites within the photic zone** (the number of intercept points where a particular taxon (e.g., genus, species, etc.) was detected divided by the total number of intercept points which are equal to or shallower than the maximum depth of plant growth)
- **Relative taxonomic frequency of occurrence** (the number of intercept points where a particular taxon (e.g., genus, species, etc.) was detected divided by the sum of all species' occurrences)
- **Mean density** (the sum of the density values for a particular species divided by the number of sampling site)
- **Simpson Diversity Index (SDI)** is an indicator of aquatic plant community diversity. SDI is calculated by taking one minus the sum of the relative frequencies squared for each species present. Based upon the index of community diversity, the closer the SDI is to one, the greater the diversity within the population.

- **Floristic Quality Index (FQI)** (This method uses a predetermined Coefficient of Conservatism (C), that has been assigned to each native plant species in Wisconsin, based on that species' tolerance for disturbance. Non-native plants are not assigned conservatism coefficients. The aggregate conservatism of all the plants inhabiting a site determines its floristic quality. The mean C value for a given lake is the arithmetic mean of the coefficients of all native vascular plant species occurring on the entire site, without regard to dominance or frequency. The FQI value is the mean C times the square root of the total number of native species. This formula combines the conservatism of the species present with a measure of the species richness of the site.

4.3 Shoreline Characterization

The point intercept method described above may not accurately identify emergent and floating leaved aquatic plants in near shore areas. Therefore, a boat tour was completed traveling the entire perimeter of the lake's shoreline. During the boat tour, visual observations of the emergent and floating leaved plant communities were located and recorded. The boat tour also included a shoreline characterization, which provides an evaluation of shoreline development on the Lake. The following scale was used to rate the level of shoreline development.

- **1: Undeveloped** (i.e. Forested or wetland)
- **2: Minor development** (i.e. Properties may have mostly natural shoreline, sparse structures set further away from the lake, one pier, and little or no clearing of natural vegetation).
- **3: Moderate development** (i.e. Properties may exhibit additional clearing and/or manipulation to the shore and lawn areas but not to waters edge. More elaborate piers or boathouses may be present).
- **4: Major development** (i.e. Properties may include larger lawn areas extending to the shoreline, which contains little or no natural shoreline vegetation. Increased building density, possibly close to the shore, multiple docks or boathouses, and significant shoreline alteration such as seawalls or rip rap may be present).

5.0 DISCUSSION OF PROJECT RESULTS

5.1 Aquatic Plant Ecology

Aquatic plants are vital to the health of a water body. Unfortunately, people all too often refer to rooted aquatic plants as "weeds" and ultimately wish to eradicate them. This type of attitude, and the misconceptions it breeds, must be overcome in order to properly manage a lake ecosystem. Rooted aquatic plants (macrophytes) are extremely important for the well being of a lake community and possess many positive attributes. Despite their importance, aquatic macrophytes sometimes grow to nuisance levels that hamper recreational activities. This is especially prevalent in degraded ecosystems. The introduction of certain aquatic invasive species (AIS), such as EWM, often can exacerbate nuisance conditions, particularly when they compete successfully with native vegetation and occupy large portions of a lake.

When "managing" aquatic plants, it is important to maintain a well-balanced, stable, and diverse aquatic plant community that contains high percentages of desirable native species. To be effective, aquatic plant management in most lakes must maintain a plant community that is robust, species rich, and diverse. Appendix B includes a discussion about aquatic plant ecology, habitat types and relationships with water quality.

5.2 Aquatic Invasive Species

Aquatic invasive species (AIS) are aquatic plants and animals that have been introduced by human action to a location, area, or region where they did not previously exist. AIS often lack natural control mechanisms they may have had in their native ecosystem and may interfere with the native plant and animal interactions in their new "home". AIS have aggressive reproductive potential and contribute to ecological lake declines and interfere with recreation on lakes. Common AIS include:

- Eurasian water-milfoil
- Curly leaf pondweed
- Zebra mussels
- Rusty crayfish
- Spiny water flea
- Purple loosestrife

Appendix C provides additional information on these AIS.

5.3 2007 Aquatic Plant Survey

The survey included sampling at 242 intercept points. The aquatic macrophyte community of the Lake included 17 floating leaved, emergent, and submerged aquatic vascular plant species during 2007. Table 2 lists the taxa identified during the 2007 aquatic plant survey. Figures 5a through Figure 5e illustrate the locations of each species identified.

Vegetation was identified to a maximum depth of 17 feet (photic zone). Aquatic vegetation was detected at 100 percent (%) of photic zone intercept points. A diverse plant community inhabited the lake during 2007. The Simpson Diversity Index value of the community was 0.85. The taxonomic richness was 17 species and there was an averages of 3.35 species identified at sample points. When using only native species, this average drops to 3.15 per sample point. Table 3 summarizes these overall aquatic plant community statistics. Table 4 includes the abundance statistics for each species.

The most abundant aquatic plant identified during the aquatic plant survey was coontail *(Ceratopyllum demersun)*. It was present at 85.3% of sample sites and had a 25.4% relative frequency of occurrence

Coontail
Source: UW Herbarium Website

Ceratophyllum demersum (coontail) is one of the most widely distributed aquatic plants within Wisconsin. The plant lacks true roots and can be found in water up to 16 feet deep. The leaves are arranged in a whorled fashion and are stiff and located closer together at the tip of the plant, giving it the appearance of a raccoon tail. Coontail is excellent habitat for invertebrates, especially in the winter when most other plants have died. The plant itself is food for waterfowl and provides shelter and foraging opportunities for fish (Borman, et al., 1997). Coontail may be mistaken for EWM.

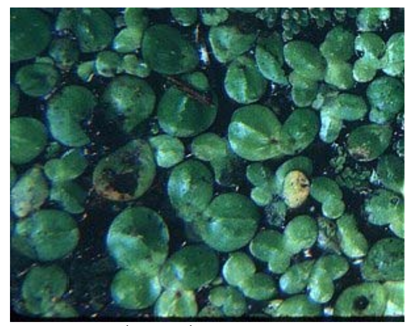
Elodea or common waterweed (*Elodea canadensis*) was the second most abundant vascular plant species. It was present at 81.5% of the sites and had a 24.4% relative frequency of occurrence.

Elodea
Source: UW Herbarium Website

Elodea canadensis (Elodea or common waterweed) is an abundant native plant species that is distributed statewide. It prefers soft substrate and water depths to 15 feet (Nichols, 1999). Elodea reproduces by seed and sprigs (USDA, 2002). The stems of elodea offer shelter and grazing to fish, but very dense elodea can interfere with fish movement. Elodea can be considered invasive at times and out-competes other more desirable plants.

Large duckweed *(Spirodela polyrhiza)* was the third most abundant vascular plant species occurring at 27.7% of the sample sites and had an 8.3% relative frequency of occurrence.

Spirodela polyrhiza (Large duckweed) is a common free-floating plant. The simple, flattened "leaf body" or frond has an irregular oval shape (3-10mm long, 2.5-8 mm wide). The plant multiplies mainly by budding. The green upper surface of each frond has about 5-15 faint nerves radiating from a nodal point. The underside is magenta with a cluster of 5-12 roots dangling down like the tentacles of a miniature jellyfish. (Borman, et al., 1997).



Large Duckweed
Source: UW Herbarium Website

Curly-leaf pondweed (*Potamogeton crispus*) and Eurasian water-milfoil (*Myriophyllum spicatum*) are both AIS and were found during the 2007 aquatic plant survey. CLP occurred at 14 sample points and was found at 7.61% of the sites and had a relative frequency of occurrence of 2.27%. EWM occurred at 24 sample points and was found at 12.5% of the sites, and had a relative frequency of occurrence of 3.73%. Based on the data collected, CLP covers approximately 3.12 acres while EWM covers 5.35 acres. See appendix C for additional information regarding these AIS.

5.3.1 Free-floating Plants

The following two free-floating aquatic plant species were also identified during the 2007 aquatic plant survey.

- Lemna trisulca (forked duckweed)
- *Wolffia columbiana* (common water-meal)

5.3.2 Floating-Leaf Plants

There were no floating-leaf plants identified during the 2007 aquatic plant survey.

5.3.3 Submergent Plants

The following fourteen submergent aquatic plant species were identified during the 2007 aquatic plant survey.

- *Ceratophyllum demersum* (coontail)
- *Chara sp.* (chara or muskgrass) [algal]
- *Elodea canadensis* (elodea)
- *Heteranthera dubia* (water star-grass)
- *Myriophyllum sibiricum* (northern water-milfoil)
- ***Myriophyllum spicatum* (Eurasian water-milfoil)**
- *Potamogeton alpinus* (alpine pondweed)
- ***Potamogeton crispus* (curly-leaf pondweed)**
- *Potamogeton natans* (floating-leaf pondweed)
- *Potamogeton praelongis* (white-stem pondweed)
- *Potamogeton pusillus* (small pondweed)
- *Potamogeton zosteriformis* (flat-stem pondweed)
- *Ranunculus aquatilis* (stiff water crowfoot)
- *Stuckenia pectinata* (sago pondweed)

5.3.4 Emergent Plants

The following emergent aquatic plant specie was identified during the 2007 aquatic plant survey.

- *Sagittaria latifolia* (common arrowhead)

Table 1 lists the species identified. Appendix D includes brief descriptions of all aquatic plants identified.

5.4 Floristic Quality Index

Higher FQI numbers indicate higher floristic quality and biological integrity and a lower level of disturbance impacts. FQI varies around the state of Wisconsin and ranges from 3.0 to 44.6 with the average FQI of 22.2 (WDNR, 2005). The FQI calculated from the 2007 aquatic plant survey data was 21.94. This FQI value is comparable to Wisconsin's median of 22.2 and suggests Neenah Lake exhibits average water quality when using aquatic plants as an indicator. Table 4 summarizes the FQI values.

5.5 Shoreline Characterization

Emergent and floating leaved plants identified along the shoreline outside of formal grid sample points included: *Carex sp*. (sedge species), *Typha sp.* (cattail), and *Schoenoplectus tabernaemontani* (soft-stem bulrush). Refer to Appendix D for descriptions of some of these plants. Figure 6 illustrates the floating leaved and emergent plant locations identified during the boat survey. Plants identified during the shoreline survey but not during the point-intercept method were not included in the community statistics or calculation of the FQI.

The level of shoreline development was noted and recorded around the lake. The majority of the shoreline showed minor to moderate development with patches of no development scattered around the lake. Figure 6 illustrates the level of shoreline development.

6.0 MANAGEMENT ALTERNATIVES

Already dense aquatic plant growth and the presence of EWM and CLP prompted increased APM efforts on Neenah Lake. WDNR informed OCC that an APM Plan should be developed for Neenah Lake to obtain future permits for plant management. A necessary component of an APM Plan is an evaluation of chemical, mechanical, biological, and physical aquatic plant control methods. While there may be additional AIS control measures used elsewhere (e.g. grass carp, or alternative herbicides), only those options approved for use in Wisconsin are discussed here. Appendix E includes a comprehensive description of available APM techniques, including descriptions about the technology, benefits, and drawbacks.

6.1 Manual Removal

Manual removal efforts include hand raking or hand pulling individual unwanted plants from the water. Specialized rakes are available for this purpose. All aquatic plant material must be removed from the water. Portions of roots may remain in the sediments, so removal may need to be repeated periodically. This technique is well suited for small areas in shallow water. Scuba divers can be contracted to remove unwanted vegetation in deeper areas. Benefits of manual removal include low cost compared to other control methods. The drawback of this alternative is raking or pulling aquatic plants can be quite labor intensive. Hiring laborers to remove aquatic vegetation is an option, but also increases cost and requires a permit.

Manual removal of aquatic vegetation by individual landowners can be completed to a maximum width of 30 feet to provide pier, boatlift or swimming raft access (recreation zone). A permit is not required for hand pulling or raking if the maximum width cleared does not exceed this 30-foot recreation zone. Removal of AIS only beyond the 30-foot recreation zone does not require a permit. Manual removal of any native aquatic vegetation beyond the 30-foot area would require a permit from the WDNR that satisfies the requirements of Chapter NR 109, Wisconsin Administrative Code. Appendix F includes a copy of NR 109.

6.1.1 Suction Assisted Manual Harvesting

Suction assisted harvesting is considered manual harvesting even though the use of a powered device is involved. The system is run off a barge or modified pontoon boats with steps in this process completed as follows:

- Plants are fed into a suction tube by a diver making sure to follow the plant to its base and remove the roots.
- The plant mass is transported to a capture device (barrel) where the transport water is drained returned to the lake and the plants remain.
- Plants are removed from the barrel, bagged, and properly disposed of.

A great benefit of this method is, if plants are identified properly, it exhibits a high degree of selectivity towards exotic species. However, the process is very labor intensive, expensive and is still in the early stages of development. As of this writing, the process is under review by the WDNR and awaiting approval as a management alternative.

6.2 Mechanical Harvesting

Mechanical harvesting is the removal of aquatic plants from a lake using a harvester machine that cuts the plants and collects them on the harvester for transport to the shoreline for off-site disposal. Harvesters have a cutting head that can be raised or lowered to a desired depth up to 5 feet. Large scale harvesting operations may involve additional equipment including a transport barge and shore conveyor. Harvesting is often used for large areas with dense monotypic AIS plant growth that significantly impedes boating or recreation on the lake. Advantages of this technology include: immediate results; removal of plant material and nutrients; and the flexibility to move to problem areas and at multiple times of the year "as needed". Disadvantages of this method include the limited depth of operation in shallow areas; possible need to repeat harvest an area throughout the summer; high initial equipment costs; maintenance, labor, and insurance costs; disposal site requirements; and a need for trained staff. A WDNR permit is required by NR 109 for aquatic plant harvesting.

6.3 Biological Controls

The use of aquatic weevils (*Euhrychiopsis lecontei*) is a biological control option that has shown effective EWM control in some Wisconsin lakes. The aquatic weevil is native to Wisconsin and normally is present in healthy stands of northern water-milfoil. The weevils however, prefer to feed on EWM plants. The weevil burrows into the plant's stem, destroying plant tissue. Increasing a natural population of weevils can be a costly endeavor but EWM reductions can be observed if the weevil population is maintained. This management alternative is best suited for lakes with limited shoreline development because the insects need to over-winter on a shoreline with vegetation and adequate leaf litter.

Additional biological controls, such as grass carp, are commonly used in other states. Wisconsin law does not allow for the use of such controls; therefore they are not discussed in this APM plan.

6.4 Drawdown

A drawing down is a management option that is sometimes avalible to water bodies where water level is controled by a dam. Lowering the water level to expose near shore lake bed (areas where plants grow) can be an effective management tool for aqutic plant control, although results vary. A drawdown is completed over a relativly long period to allow sediments to dry (summer drawdown), plants to freeze out (winter drawdown), and/or sediment to compact (year long) to prevent plant growth. This method can be used in any of the abovementioned seasons or over the course of a year. Benefits of a water level drawdown include the relative inexpense of the proposed action, compaction of sediment (making lake bed less "mucky" and hindering plant reestablishment), large area affected with single action, and the draw down provides an opportunity for dam maintainence. Drawdowns have the capability to significantly impact populations of aquatic plants and are sometimes used during lake wide restoration efforts, inlcuding multiple year or periodic drawdowns to simulate drought and promote emergent plant growth. Disadvantages include adverse affects on non-target aquatic plants, the controversy associated with shoreline landowners, and temporary destruction of habitat for invertebrates and herptiles (repitiles and anphibians). The drawdown may be largely successful if there is a cold winter with relatively little snow cover. Conversely, mild winters and increased snow limit the drawdown's effectiveness in killing aquatic plants.

6.5 Selective Aquatic Herbicides

Chemical herbicides or pesticides designed for aquatic use can be used to eliminate or significantly reduce the abundance of unwanted aquatic plant species. The United States Environmental Protection Agency

(EPA) researches aquatic pesticides and determines what product can be registered for aquatic use. Aquatic pesticides registered for use in Wisconsin require a strict registration process and most demonstrate they are safe for the environment and do not pose a risk to human health when used according to label requirements. Numerous aquatic herbicides are registered for aquatic use and are designed to target specific plant types. Herbicides can be grouped into two general categories, contact and systemic. A contact herbicide will kill any part of the plant it contacts. Plant tissue not exposed to the chemical may survive. A systemic herbicide is taken up within the plant tissue, transferred throughout the plant, and destroys the entire plant. Herbicides are also categorized as broad based, ones that can kill many different plant species, and selective, ones that can kill a targeted plant species if applied correctly. The WDNR requires a permit (Chapter NR 107. Wis. Adm. Code) for aquatic herbicide applications in public waters. Appendix F includes a copy of NR 107. The product must be approved for aquatic use in Wisconsin and the applicator must be certified with the Wisconsin Department of Agriculture, Trade, and Consumer Protection (WDATCP) and licensed by WDNR. Advantages of herbicides include better control in confined areas (e.g. around docks) than harvesters can achieve. Disadvantages include negative public perception of chemicals, the potential to affect non-target plant species (if not applied at an appropriate application rate and/or time of year) and water use restrictions after application may be necessary.

7.0 RECOMMENDED ACTION PLAN

To accomplish the APM Plan goals, OCC will develop an action plan. This plan will select appropriate aquatic plant management techniques for EWM, CLP, and nuisance coontail growth on Neenah Lake based on the recommendations in this section. Implementation of the management recommendations, including monitoring, responsibilities, protection of native aquatic plants, education of lake users, prevention efforts and funding for future work, are discussed in the following subsections.

The overall aquatic plant management objective is to reduce the acreage of CLP and EWM on Neenah Lake to restore the native plant community. Management efforts should focus on CLP and EWM reduction and allow the natural restoration of native aquatic plants as they are minimized. This objective can be achieved by utilizing a combination of the following aquatic plant management alternatives.

7.1 Management Recommendations

7.1.1 Manual Removal of AIS and Coontail

Manual Removal is intended for riparian landowners to provide a small recreational clearing. Individual property owners can manually remove nuisance aquatic plants in the lake offshore from their property up to a maximum 30 foot width (measured along the shoreline) to provide pier, swim raft, or boat hoist access. A permit is not required for hand pulling or raking aquatic plants within this 30-foot recreation zone. Manual removal beyond the 30-feet zone is only allowed for EWM and CLP. Individuals removing EWM and CLP must remove all of the plant material and fragments from the water. Removal of any native vegetation beyond 30 feet would require a permit under NR 109, Wis. Adm. Code. Native plant removal is not recommended because it could actually facilitate the spread of EWM and CLP.

Landowners removing plants manually should learn to identify EWM and CLP and other look-alike native species. If an individual has questions about a particular aquatic plant or what level of manual removal is allowed , they should talk to OCC representative. Appendix F includes additional resources for plant identification.

7.1.2 Mechanical Harvesting

Current aquatic plant management on Neenah Lake is limited to mechanical harvesting. The objective of the harvesting is to maintain navigation and recreational areas. Due to the lake's shallow nature, nuisance aquatic plant growth, mainly coontail, is a common occurrence.

It is recommended OCC continue the mechanical harvesting program in accordance with this APM plan and WDNR permits. EWM is easily spread by harvesting so every effort should be made to restrict harvesting in these areas. Harvester operators should be trained to identify EWM and should report any locations to the WDNR and OCC. Harvesting should be limited to areas of high recreational and navigation use.

Large-scale early season mechanical harvesting of CLP should be considered as an alternative to large-scale chemical treatments. The objective is to harvest the CLP before the formation of turions. Turions are seed-like buds that drop off the mature plant and form the seed bank for the following year. The harvesting would be conducted in early spring when the CLP is beginning to grow. Intensive monitoring of the CLP would begin immediately upon ice-out to verify the turions have not yet formed. If the turions are not present, the harvesting should begin immediately and continue until turion formation. Once the turions have formed, intensive harvesting of CLP should be discontinued and harvesting should be limited to areas of high recreational and navigational use.

Advantages of the CLP harvesting include the reduction of the seed bank for the following growing season and the removal of large amount of plant biomass which leads to the addition of phosphorus in the lake. CLP dies in mid-summer and releases its nutrients into the water. Other aquatic plants and algae use these nutrients, often causing algae blooms. An additional advantage is OCC already owns two harvesters so the capital expenses would be eliminated. Disadvantages include the need for intensive plant monitoring to determine turion formation and the expense of operating the harvesters. Some lake groups use harvesters in tandem so that the second harvester can pick up the floating portion of plants missed by the initial cutting. An additional disadvantage is the need to have trained volunteers to conduct the plant monitoring.

Coontail has become present in nuisance levels on Neenah Lake while the current harvester in use is in disrepair and less efficient than desired. It is recommended OCC invest in a newer, more efficient harvester or contract with a harvesting company for periodic aquatic plant harvesting. OCC should consider increasing the acreage of harvesting targeting coontail areas. This increase in harvesting acreages would require a revised WDNR permit under NR 109.

7.1.3 Biological Controls

It is not recommended milfoil weevils be considered a management alternative for EWM control. Supplemental stocking of weevils is also not recommended due to the small EWM acreage, limited native milfoil and the presence of developed shorelines. This observation and the lack of natural shorelines both indicate natural populations or weevil augmentation may not be a suitable EWM management option for Neenah Lake.

7.1.4 Water Level Manipulation (Drawdown)

Water level manipulation of Neenah Lake can be achieved if the dam has a control structure. Water level manipulation or drawdown should also be considered as an alternative to large-scale chemical treatments or used in conjunction with chemical treatment. The objective is to freeze or dry out the CLP and EWM roots and reducing their occurrence the following growing season. Additionally, nuisance levels of coontail may be affected and reduced by a drawdown.

Advantages of this alternative include relatively low costs in comparison to other management alternatives, reduction in EWM and CLP, and consolidation of the exposed sediments. Disadvantages include unpleasant aesthetics during the drawdown, reduced recreational use during the drawdown, loss of fish downstream and the unpredictability of weather conditions.

It is recommended that a drawdown with a minimum of four feet be conducted, potentially affecting 68.4% of all AIS acreage within Neenah Lake (Figure 8). A drawdown of six feet is a second option with a potential affect on 79% of all AIS acreage (Figure 8). A drawdown beyond six feet may be possible, but is dependant on dam limitations and would severely limit recreational opportunities. The below table outlines potential affects of a drawdown by one foot intervals.

Drawdown Depth	Acres EWM Affected	Acres CLP Affected	Total Acres Affected	% AIS Affected
1	0.00	0.89	0.89	11
2	1.12	1.79	2.90	34
3	1.79	2.45	4.24	50
4	**3.12**	**2.68**	**5.80**	**68**
5	3.35	2.90	6.25	74
6	**3.79**	**2.90**	**6.69**	**79**
7	4.02	3.12	7.14	84
8	4.24	3.12	7.36	87
9	4.69	3.12	7.81	92
10	4.91	3.12	8.03	95
11	4.91	3.12	8.03	95
12	5.13	3.12	8.26	97
13	5.13	3.12	8.26	97
14	5.36	3.12	8.48	100

The type of drawdown required is dependant on what the desired results are (see below for drawdown descriptions). If the primary goal is to be control of EWM and CLP, then a winter drawdown is recommended. Conversely, if the primary goal is to increase lake depth, a summer drawdown is recommended. However, if both options are to be achieved to their maximum extent, a year-long drawdown would be best fit.

Winter Drawdown:
During this option, water will be drawn down before October 1, giving time for over-wintering amphibians and reptiles to adjust. Once drawn-down, water levels will remain constant throughout the winter and should be checked at least weekly to maintain proper water levels. Normal pool elevation will be resumed in late March when spring melt has begun, supplying ample water to return water levels to normal.

This process is not species specific and freezing must occur for a minimum of six weeks to be effective. Some sediment compaction may occur, but significant increase in lake depth is not expected. This process should be repeated every three to five years, when AIS may again be approaching nuisance levels.

Summer Drawdown:
For a summer drawdown, the goal is to dry out the roots and biomass of the plants. The drawdown should begin in early June. This will allow for the plants to begin growing, which allows them to be targeted. The drawdown should continue until late August or early September to allow ample drying time. Normal pool elevation will be restored at this time.

This process is not species specific and significant drying must occur to be effective. With the summer drawdown, higher rates of sediment compaction and decay of mucky materials will increase lake depth more compared to a winter drawdown. However, this type will have less of an effect on the plants and will have a greater limitation of recreational opportunities by limiting or preventing boat access. This process should be repeated every three to five years, when AIS may again be approaching nuisance levels. Less water will be available to re-fill the lake when compared to the winter draw-down and care should be taken not to dry out Neenah Creek below the dam.

Year Long Drawdown:

This option is essentially a combination of the summer and winter drawdowns. It will begin in early June once plants have begun growing. The water will be drawn down to the chosen level and held there until mid August. Normal water level will be established for about a month, allowing for any additional AIS seed bank or plants to re-grow to be targeted during the winter. In late September, but before October 1, the water will again be drawn down to the selected level and remain there until late March, when ample water will be available to resume normal levels.

This process is not species specific, but will provide the most effective combination to achieve both the sediment and AIS goals. However, this type will have the greatest affect on recreational activities by limiting them throughout the year.

7.1.5 Aquatic Herbicides

The WDNR requires a permit (Chapter NR 107. Wis. Adm. Code) for aquatic herbicide applications in public waters. Appendix F includes a copy of NR 107. The product must be approved for aquatic use in Wisconsin and the applicator must be certified with the Wisconsin Department of Agriculture, Trade, and Consumer Protection (WDATCP) and licensed by WDNR. Advantages of herbicides include better control in confined areas (e.g. around docks) than harvesters can achieve. Disadvantages include negative public perception of chemicals, the potential to affect non-target plant species (if not applied at an appropriate application rate and/or time of year) and water use restrictions after application may be necessary.

All chemical treatments will need to be completed in accordance with a permit issued under NR 107, Wis. Adm. Code. No nuisance levels of native plants should be treated on a large scale. A commercial aquatic pesticide applicator, certified with the Wisconsin Department of Agriculture and Consumer Protection (DATCP) and licensed by the WDNR should be hired to treat nuisance EWM and CLP beds as local funding allows. The applicator shall specify in the NR 107 permit application the chemical application size, rate, and location of proposed treatment areas. A list of licensed applicators may be available from DATCP or on the "Lake List" located at UW Extension Lakes Program website at http://www.uwsp.edu/cnr/uwexlakes/lakelist/ where people can search for companies offering select APM services by company name or area of expertise.

7.1.5.1 Herbicide Treatment

CLP was found to be at approximately 3.12 acres in Neenah Lake. Because of the growth cycle of this AIS, this number is likely to increase in spring when CLP is actively growing.
A few herbicides have demonstrated CLP control. The three WDNR-approved herbicides are Diquat, Endothall and Fluridone. Endothall and Diquat are both fast acting contact herbicides. Diquat binds to sediments readily and its effectiveness is reduced by turbid waters. Endothall is not readily transferred to other plants tissue, therefore re-growth can be expected and repeated treatments may be needed. Fluridone is capable of killing the roots of plants, producing a longer lasting effect. Fluridone and Endothall are effective for both EWM and CLP, both present in Neenah Lake. Endothall is the recommended herbicide because of CLP's high susceptibility to this chemical, allowing for greater reduction in CLP coverage after the first treatment.

EWM was also found on Neenah Lake at twenty-three sample points covering approximately 5.35 acres. EWM beds present beyond the 30 foot manual removal zone or too dense for effective hand removal efforts should be treated with an aquatic herbicide containing 2,4-D registered with the State of Wisconsin for use on public waters. 2,4-D products have demonstrated selective control of EWM if applied correctly (in early spring)..

The overall aquatic plant management plan is to reduce presence of CLP and EWM while improving recreational and aesthetic values of Neenah Lake through coontail reduction and control. An achievable and quantitative goal for AIS reduction is to reduce the acreage within five years to small-scale herbicide treatments on the system. Wisconsin Administrative Code NR 107.04(3) defines small-scale as any treatment less than ten total acres or 10 percent (%) of the water body less than ten feet deep. This overall goal correlates to a reduction of AIS acres by 30% over the next five years to a total of 5.93 acres by 2012. The 30% reduction is focused equally throughout, aiming at reducing the acreage by 6% each year. The following table depicts this reduction by year. The table also assumes no major re-growth or expansion of AIS on a yearly basis.

Year	EWM	CLP	Total	% Acreage Reduction
2007	5.35	3.12	8.47	---
2008	5.03	2.93	7.96	6
2009	4.71	2.75	7.45	6
2010	4.39	2.56	6.95	6
2011	4.07	2.37	6.44	6
2012	3.75	2.18	5.93	6
			TOTAL	30

Highly used recreational areas and public boat launches or access points should be given priority when considering treatment locations due to a greater potential for AIS spread from these areas. The APM plan should be updated in 2012-2013 to evaluate the aquatic plant community and to assess the current management strategies. Reduction numbers are based solely on chemical treatments. If the 30% reduction goal is met, then AIS chemical treatments should be considered maintenance activities instead of restoration.

Because coontail is a native plant species, large scale treatments are not an option on Neenah Lake. However, smaller treatments to control nuisance levels around private docks and highly used recreational areas are recommended as a control option. Coontail has shown susceptibility to the chemical 2,4-D which is also used to treat EWM. Therefore, coontail can be treated at the same time as EWM if nuisance growth is evident. However, higher application rates are required in order for 2,4-D to show effect on coontail.

7.1.5.2 Herbicide Treatment Monitoring

Pre- and post-treatment species specific mapping is typically recommended for most herbicide treatment programs. Reported EWM and CLP bed locations should be noted on a base map such as Figure 7 and recorded with a GPS if possible, preferably one with sub-meter accuracy. Reported EWM and CLP beds can then be verified by a WDNR or a hired professional if necessary prior to applying for permits or funding.

The above mentioned verification of EWM beds should preferably occur in late summer or early fall, when EWM would be at its maximum growth. A permit application process should begin in the fall prior to the year of the proposed treatment. This mapping effort will be used to determine potential treatment acreages. A spring EWM and CLP assessment or "pre-treatment survey" should be completed each year to modify the permit application prior to the actual EWM and CLP treatment. This pre-treatment survey allows the permit application to be modified to accurately reflect proposed treatment areas and current EWM and CLP locations/acreages. This modification request should be submitted in writing to WDNR along with a map of proposed treatment areas.

One major EWM and CLP treatment per season should be completed. This treatment should occur once water temperatures reach approximately 60°F. However, one potential follow up "spot treatment" may also be needed which will be determined by completing a post-treatment aquatic plant survey one month after the initial treatment. All NR 107 public notice and water use restriction posting requirements should be followed. A public notice must be filed in the local newspaper if the treatment is greater than 10 acres or the treatment area is greater than 10 % of the lake's area 10 feet deep or less, and a public hearing held if requested. All property owners within or adjacent to treatment areas should be notified with a copy of the permit application and map indicating the proposed treatment areas. A yellow sign describing the treatment must be posted by the dock or shoreline of any properties being treated. Post-EWM and CLP treatment assessments should be completed annually to document success or new infestation areas

7.2 Schedule of Events

The following table describes a schedule of required activities for the EWM and CLP treatment program on Neenah Lake.

Activity	Frequency	Date
Mapping of EWM and/or CLP or post-treatment survey	Annually	CLP-No later than May 31st EWM-No later than September 30th
Establish Priority Treatment Areas	Annually	October 30th

Prepare NR 107 Permit Application for grant and conditional permit purposes	Annually	December 1st
Prepare DRAFT WDNR AIS Control Grant Application	Annually/Multi-year	January 1st
Submit WNDR AIS Control Grant Application	Annually	February 1st
Pre-treatment survey	Annually	2 weeks after ice-out or when EWM plants are approximately 6 inches tall or prior to CLP turion formation
EWM and/or CLP treatment or CLP intensive harvesting	Annually	Before May 31st or before water temperatures reach 60°F
OCC Budget Voting	Annually	??
Town Budget Voting	Annually	??
Lake wide Aquatic Plant Survey	Every 5 years	July, 2012
Update APM Plan	Every 5 years	December 1, 2012

7.3 Designation of Responsibility

The following table assigns responsibility for the EWM and CLP treatment program events listed above. When the OCC is identified as a responsible party, these entities should identify which individual, or committee should complete the specified activity.

Activity	Responsible Party
Mapping of EWM and CLP or post-treatment survey	Aquatic Plant Professional with assistance from trained volunteers
Establish Priority Treatment Areas	OCC WDNR and aquatic plant professional
Prepare NR 107 Permit Application (*for grant purposes*)	Certified/Licensed Applicator or OCC
Prepare DRAFT WDNR AIS Control Grant Application	OCC
Submit WDNR AIS Control Grant Application	OCC
Pre-treatment EWM Survey	Aquatic Plant Professional
EWM/CLP treatment	Certified/Licensed Applicator
Lake District Budget Voting	OCC
Town Budget Voting	Town
Lake wide Aquatic Plant Survey	Aquatic Plant Professional hired by OCC or Town
Update APM Plan	Aquatic Plant Professional , OCC and WDNR

7.4 Prevention Efforts

The following sections discuss recommended activities to prevent the spread of new AIS into Neenah Lake. Prevention efforts can also prevent the spread of AIS from Neenah Lake into other area lakes.

7.4.1 Watercraft Inspection

A basic watercraft inspection program should be developed for Neenah Lake. Education of the public, property and resort owners about inspecting watercraft for AIS before launching the boat or leaving access sites on other lakes could help prevent new AIS infestations. Proper signage at popular boat entry locations can also be useful. Training and signage are available through the Clean Boat/ Clean Waters (CB/CW) Program developed by the University of Wisconsin Extension Lakes Program. The CB/CW efforts involves providing information to lake users about what invasive species look like and what precautions they should take to avoid spreading them. It also involves visual inspection of boats to make sure they are "clean" and demonstration to the public of how to take the proper steps to clean their boats and trailers. For more information see the following website:

http://www.uwsp.edu/cnr/uwexlakes/CBCW/default.asp

Any volunteer hours accrued with the CB/CW program or any other AIS monitoring done by OCC members can be counted towards matching grant funds up to a maximum of $8.00 an hour. Essentially, this allows for more grant money to be awarded at no additional cost to OCC. Accordingly, use of personal equipment (boat, GPS, etc.) or expenses (postage, printing, or supplies) may also count towards matching funds. However, to be eligible a write-up of expected donated hours must accompany the grant application and hours volunteered prior to the grant project are not eligible for matching funds. It is recommended the DNR Lake coordinator be contacted for proper forms and help in determining the value of donated, volunteer time.

7.4.2 Aquatic Plant Protection and Shoreline Management

Protection of the native aquatic plant community is needed to slow the spread of EWM and CLP. Therefore, riparian landowners should refrain from removing native vegetation. Additionally, EWM and CLP can thrive in nutrient (phosphorus and nitrogen) enriched waters or where nutrient rich sediments occur. Two simple actions by lakeshore residents can help prevent excessive nutrients and sediments from reaching the lake.

The first activity is the restoration of natural shorelines, which act as a buffer for runoff containing nutrients and sediments. Establishing natural shoreline vegetation can sometimes be as easy as not mowing to the waters edge. Native plants can also be purchased from nurseries for restoration efforts. Shoreline restoration has the added benefits of providing wildlife habitat and erosion prevention.

The second easy nutrient prevention effort is to use lawn fertilizers only when soil samples show a lack of nutrients. Phosphorus free fertilizers should be used when possible. The fertilizers commonly used for lawns and gardens have three major plant macronutrients - Nitrogen, Phosphorus, and Potassium. These are summarized on the fertilizer package by three numbers. The middle number represents the amount of phosphorus. Since most Wisconsin lakes are “Phosphorus limited”, meaning additions of phosphorus can cause increased aquatic plant or algae growth, preventing phosphorus from reaching the lake is a good practice. Landowners should be encouraged to use phosphorus free fertilizers on lakeshore lawns. Local retailers and lawn care companies can provide soil test kits to determine a lawn's nutrient needs. Appendix G includes resources for further information about these AIS Prevention efforts.

Additionally, the Neenah Creek Watershed was the subject of a Priority Watershed project because of excess sediment and phosphorus loads. The Oxford Conservation Club would benefit from review of the available information and Nonpoint Source Control Plan for Neenah Creek Priority Watershed Project by K. Rahmeier, 1994 (Watershed project #91-2). Watershed-wide efforts to lower excess nutrient inputs to Neenah Creek will help improve the lake.

7.5 Public Education and Involvement

Public involvement and education efforts included a presentation by Northern Environmental with OCC members on August 18, 2007 to discuss the APM Plan project. OCC should continue to keep abreast of current AIS issues throughout the County. The County Land and Water Resource Conservation Department and the WDNR Lakes Coordinator ,and the UW Extension are good sources of information. Many important materials can be ordered at the following website:

http://www.uwsp.edu/cnr/uwexlakes/publications/

Appendix G includes resources for further information about public education opportunities.
If the above hyperlink to web address becomes inactive, please contact Northern Environmental for appropriate program and contact information.

7.6 Monitoring

To evaluate the effectiveness of the APM Program, monitoring of multiple components should be completed. Some of these are discussed in the section(s) above related to a specific management activity, but are re-iterated here in the context of overall monitoring efforts.

7.6.1 Aquatic Plant Monitoring

In some lake systems, native aquatic plants "hold their own" and AIS never grow to nuisance levels, in others, however vigilant management is required. Areas that have not been treated or were treated in previous years should also be monitored to see if native plant communities have inhibited further spread of AIS. Additionally, the lake should be monitored for new or expanding AIS infestations.

Neenah Lake should complete pre-treatment and post-treatment EWM and Curly-leaf Pondweed monitoring to gauge the effectiveness of herbicide treatments. See section 7.2 for monitoring dates and assignment of responsibility for herbicide treatment monitoring.

To monitor for AIS, the lake should be split into sectors with 2 OCC members serving as monitors per sector. The monitors survey the sectors by boat from May through August looking for any sign and/or location of any AIS. If an AIS is located, the position is recorded via GPS and approximate size and density of the bed is taken as well. Monitors return to each recorded site during each survey period to check for any change in size or health of the located AIS. To assist in this monitoring, the table below outlines approximated dates for AIS monitoring split by species. Shaded cells indicate growth cycle period and best times to monitor for the respective species.

	April	May	June	July	August	September
Eurasian Water-Milfoil						
Sprout						
Growth						
Bloom						
Die Back						
Curly-Leaf Pondweed						
Sprout						
Growth						
Bloom						
Die Back						
Purple Loosestrife						
Sprout						
Growth						
Bloom						
Die Back						
Zebra Mussel						
Rusty Crayfish						
Spiny Water Flea						

Source: Aquatic Invasive Species – A Guide for Proactive and Reactive Management, 2006.

Northern Environmental also recommends completing complete aquatic plant surveys every 5 years (essentially repeating the 2007 point intercept aquatic plant survey) to monitor changes in the overall aquatic plant community and the effects of the APM activities. Aquatic plant communities may change with varying water levels, water clarity, nutrient levels, and aquatic plant management actions.

7.6.2 APM Technologies

The APM technologies listed in Appendix E should be re-visited periodically to evaluate if new or improved alternatives are available. The professional environmental science community includes universities, state natural resource agencies (e.g. WDNR), and federal agencies (e.g. EPA, United States Northern Environmental [USACE]) are excellent sources for information. Appendix G includes resources for further information about APM alternatives and current research. This activity should be completed in conjunction with an overall APM Plan update effort, which includes a lake wide aquatic plant survey.

7.6.3 Lake Users

Periodically, the lake users should be polled to evaluate their perception of APM activities on the lake. A questionnaire, telephone interviews, face to face interviews, web-based online surveys, and focus groups are examples of polling tools.

7.6.4 Water Quality

Currenty, no data regarding water quality exists for Neenah Lake. Lakeshore property owners or members of OCC should consider becoming an active Citizen Lake Monitor for water quality (secchi depth, total phosphorus and chlorophyll a). At a minimum, water clarity (secchi depth) monitoring is recommended. Secchi depth monitoring is an easy volunteer activity that yields useful information about lake health over the long term. Collection of all parameters will create a baseline water quality data base allowing for future monitoring against possible changes and disturbances.

For more information, please visit:

http://dnr.wi.gov/org/water/fhp/lakes/selfhelp/shlmhowto.htm

7.7 Funding

Since CLP was not identified on Neenah Lake prior to the 2007 survey, it can be considered a pioneer population. This allows OCC to apply for an Aquatic Invasive Species Rapid Response Grant to help in funding any CLP control methods. This grant has no deadline and may be applied for at any time of the year up to a maximum state share of $10,000 at a 75% cost-share.

The OCC should evaluate if their existing and sustainable funding mechanisms are adequate for continued EWM and CLP management activities listed in this recommended action plan. First, all available volunteer roles should be filled if possible. Then, cost estimates or professional bids should be solicited for the remaining activities (e.g. monitoring and EWM/CLP) from professional firms. These cost estimates can be used to budget for needed activities.

One example of how funding APM efforts could work is individual lake association members can determine what individual property owners are willing to pay for AIS treatment and/or implementation of the suction assisted harvesting. This dollar amount can then be presented to the townships through a OCC/town liaison who can decide what the township may be willing to sponsor for additional management dollars. Collectively, these funds can then be used as local matching funds in combination with credit for volunteer activities to apply for cost sharing assistance from the WDNR AIS Control grant program. Qualified lake associations and local governments are both eligible applicants, but funding preference goes to local units of government. Eligible projects include monitoring, permit fees, and EWM treatment. The application deadlines are February 1st and August 1st annually. A proposed schedule and assignment of responsibility are provided in Section 7.2. For more detailed information about AIS Control grants, please visit:

http://www.dnr.state.wi.us/org/caer/cfa/Grants/Lakes/invasivespecies.html

A second source for EWM and CLP control projects is the WDNR Recreational Boating Facilities (RBF) grant program. Projects are presented to the Wisconsin Waterways Commission (WWC) which meets approximately four times per year to review project presentations. This program funds 50% of eligible activities.

http://www.dnr.state.wi.us/org/caer/cfa/Grants/recboat.html

If the above funding combinations appear woefully inadequate to fund the management activities, then additional sources should be considered. Other funding alternatives may include:

- Additional State grant assistance
- Private (landowner) funding
- Countywide sales or room tax
- Resource user fee (e.g. AIS boat sticker)

- Property tax or special assessment
- Federal invasive species management partnerships

These sources would require government action at the State and/or County levels

7.8 Closing

This APM Plan was prepared in cooperation with the OCC. It includes the major components outlined in the WDNR Aquatic Plant Management guidance. The recommended action plan section of this report can be used as a stand alone document to facilitate EWM and CLP management activities for the lake. This section outlines important monitoring and management activities. The greater APM Plan document and appendices provides a central source of information for the lake's aquatic plant community information, the overall lake ecology, and sources of additional information. If there are any questions about how to use this APM Plan or its contents, please contact Northern Environmental.

8.0 REFERENCES

While not all references are specifically cited, the following resources were used in preparation of this report.

Borman, Susan, Robert Korth, and Jo Temte, *Through the Looking Glass, A Field Guide to Aquatic Plants*, Wisconsin Lakes Partnership, 1997

Fassett, Norman C., *A Manual of Aquatic Plants*, The University of Wisconsin Press, Madison, Wisconsin, 1975

Getsinger, Kurt D., and H.E. Westerdahl, *Aquatic Plant Identification and Herbicide Use Guide, Volume II Aquatic Plants and Susceptibility to Herbicides*, U.S. Northern Environmental Waterways Experiments Station, Technical Report A-88-9, 1988

Jester, Laura, Bozek, Michael, Helsel, Daniel, and Sheldon, Sallie, *Euhrychiopsis lecontei Distribution, Abundance, and Experimental Augmentation for Eurasian water-milfoill Control in Wisconsin Lakes*, Journal Aquatic Plant Management, 38:88-97

Madsen, John, *Point Intercept and Line Intercept Methods for Aquatic Plant Management, Aquatic Plant Control Technical Note MI-02*, February 1999

Nichols, Stanley A. *Distribution and habitat descriptions of Wisconsin lake plants*, Wisconsin Geological and Natural History Survey Bulletin 96, 1999

North America Lake Management Society of Aquatic Plant Management Society (NALMS), *Aquatic Plant Management in Lakes and Reservoirs,* 1997

Prescott, G.W., *How to Know the Aquatic Plants,* Wm. C. Brown Publishers, Dubuque, Iowa, 1980

United States Department of Agriculture, *Soil Survey of Marquette County, Wisconsin*. 1975

United States Geological Survey, *Heafford Junction, Wisconsin Quadrangle, 7.5 minute (Topographic) Series*, 1982

United States Geological Survey, Nonindigenous Aquatic Species, (http://nas.er.usgs.gov/queries/collectioninfo.asp?), Accessed November 13, 2007

Welsh, Jeff, *Guide to Wisconsin Aquatic Plants,* Wisconsin Department of Natural Resources Publication WR 173, 1992 revised

Wetzel, Robert G., *Limnology*, 1983

Wisconsin Department of Natural Resources, *Aquatic Plant Management in Wisconsin DRAFT,* April 25 2005

Wisconsin Department of Natural Resources, *Aquatic Invasive Species Website* (http://dnr.wi.gov/invasives/aquatic/), Accessed April 2007

Wisconsin Department of Natural Resources, *Listing of Wisconsin Waters with Eurasian Water-Milfoil (current as of 01/02/2007)*, 2007

Wisconsin Department of Natural Resources, *Fish Stocking Website* (http://infotrek.er.usgs.gov/doc/wdnr_biology/Public_Stocking/StateMapHotspotsAllYears.htm), Accessed April, 2007

Wisconsin Department of Natural Resources, *Wisconsin Lakes,* Publication # PUB-FH-800, 2005

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FIGURES

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TABLES

APPENDIX A

POINT INTERCEPT SAMPLE COORDINATES

APPENDIX B

IMPORTANCE OF AQUATIC PLANTS TO LAKE ECOSYSTEM

Northern Environmental℠
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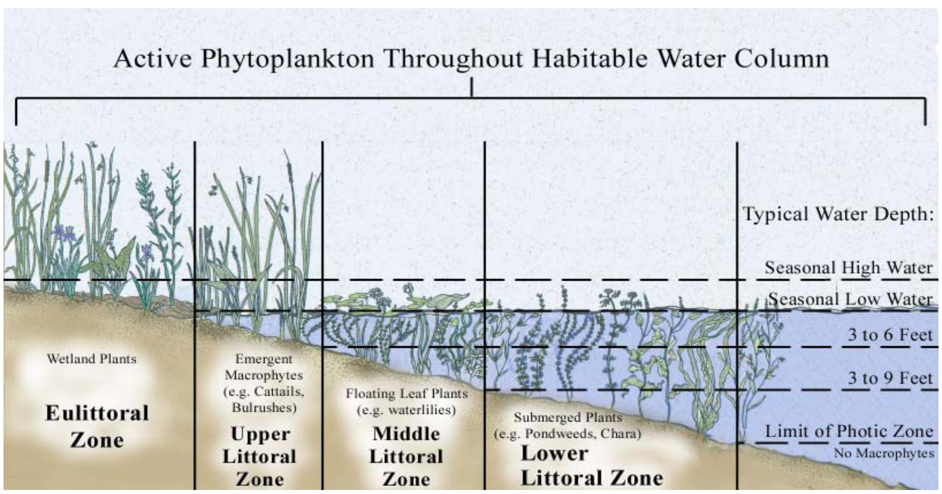
Aquatic Plant Types and Habitat

Aquatic plants can be divided into two major groups: microphytes (phytoplankton and epiphytes) composed mostly of single-celled algae, and macrophytes that include macro algae, flowering vascular plants, and aquatic mosses and ferns. Wide varieties of microphytes co-inhabit all habitable areas of a lake. Their abundance depends on light, nutrient availability, and other ecological factors.

In contrast, macrophytes are predominantly found in distinct habitats located in the littoral (i.e., shallow near shore) zone where light sufficient for photosynthesis can penetrate to the lake bottom. The littoral zone is subdivided into four distinct transitional zones: the eulittoral, upper littoral, middle littoral, and lower littoral (Wetzel, 1983).

Eulittoral Zone:	Includes the area between the highest and lowest seasonal water levels, and often contains many wetland plants.
Upper Littoral Zone:	Dominated by emergent macrophytes and extends from the shoreline edge to water depths between 3 and 6 feet.
Middle Littoral Zone:	Occupies water depths of 3 to 9 feet, extending deeper from the upper littoral zone. The middle littoral zone is often dominated by floating-leaf plants.
Lower Littoral Zone:	Extends to a depth equivalent to the limit of the photic zone, which is the maximum depth sufficient light can support photosynthesis. This area is dominated by submergent aquatic plant types.

The following illustration depicts these particular zones and aquatic plant communities.



Aquatic Plant Communities Schematic

The abundance and distribution of aquatic macrophytes are controlled by light availability, lake trophic status as it relates to nutrients and water chemistry, sediment characteristics, and wind energy. Lake morphology and watershed characteristics relate to these factors independently and in combination (NALMS, 1997).

Aquatic Plants and Water Quality

In many instances aquatic plants serve as indicators of water quality due to the sensitive nature of plants to water quality parameters such as water clarity and nutrient levels. To grow, aquatic plants must have adequate supplies of nutrients. Microphytes and free-floating macrophytes (e.g., duckweed) derive all their nutrients directly from the water. Rooted macrophytes can absorb nutrients from water and/or sediment. Therefore, the growth of phytoplankton and free-floating aquatic plants is regulated by the supply of critical available nutrients in the water column. In contrast, rooted aquatic plants can normally continue to grow in nutrient-poor water if lake sediment contains adequate nutrient concentrations. Nutrients removed by rooted macrophytes from the lake bottom may be returned to the water column when the plants die. Consequently, killing too many aquatic macrophytes may increase nutrients available for algal growth.

In general, a direct relationship exists between water clarity and macrophyte growth. That is, water clarity is usually improved with increasing abundance of aquatic macrophytes. Two possible explanations are postulated. The first is macrophytes and epiphytes out-compete phytoplankton for available nutrients. Epiphytes derive essentially all of their nutrient needs from the water column. The other explanation is aquatic macrophytes stabilize bottom sediment and limit water circulation, preventing re-suspension of solids and nutrients (NALMS, 1997).

If aquatic macrophyte abundance is reduced, then water clarity may suffer. Water clarity reductions can further reduce the vigor of macrophytes by restricting light penetration. Studies have shown if 30 percent or less of a lake areas occupied by aquatic plants is controlled, water clarity will generally not be affected. However, lake water clarity will likely be reduced if 50 percent or more of the macrophytes are controlled (NALMS, 1997).

Aquatic plants also play a key role in the ecology of a lake system. Aquatic plants provide food and shelter for fish, wildlife and invertebrates. Plants also improve water quality by protecting shorelines and the lake bottom, improving water quality, adding to the aesthetic quality of the lake and impacting recreational activities.

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APPENDIX C

AQUATIC INVASIVE SPECIES

Invasive Aquatic Plants

Invasive species have invaded our backyards, Ocontos, prairies, wetlands, and waters. Invasive species are often transplanted from other regions, even from across the globe. "A species is regarded as invasive if it has been introduced by human action to a location, area, or region where it did not previously occur naturally (i.e., is not native), becomes capable of establishing a breeding population in the new location without further intervention by humans, and spreads widely throughout the new location " (Source: WDNR website, Invasive Species, 2007). AIS include plants and animals that affect our lakes, rivers, and wetlands in negative ways. Once in their new environment, AIS often lack natural control mechanisms they may have had in their native ecosystem and may interfere with the native plant and animal interactions in their new "home". Some AIS have aggressive reproductive potential and contribute to ecological declines and problems for water based recreation and local economies. AIS often quickly become a problem in already disturbed lake ecosystems (i.e. one with relatively few native plant species). While native plants provide numerous benefits, AIS can contribute to ecological decline and financial constraints to manage problem infestations.

Eurasian Water-milfoill *(Myriophyllum spicatum)*

EWM is the most common AIS found in Wisconsin lakes. EWM was first discovered in southeast Wisconsin in the 1960's. During the 1980's, EWM began to spread to other lakes in southern Wisconsin and by 1993 it was common in 39 Wisconsin counties. EWM continues to spread across Wisconsin and is now found in the far northern portion of the state including Oconto and Oconto Counties.

Unlike many other plants, EWM does not rely on seed for reproduction. Its seeds germinate poorly under natural conditions. It reproduces vegetatively by fragmentation, allowing it to disperse over long distances. The plant produces fragments after fruiting once or twice during the summer. These shoots may then be carried downstream by water currents or inadvertently picked up by boaters. EWM is readily dispersed by boats, motors, trailers, bilges, live wells, or bait buckets, and can stay alive for weeks if kept moist (WDNR website, 2007).

Once established in an aquatic community, EWM reproduces from shoot fragments and stolons (runners that creep along the lake bed). As an opportunistic species, EWM is adapted for rapid growth early in spring. Stolons, lower stems, and roots persist over winter and store the carbohydrates that help milfoil claim the water column early in spring, photosynthesize, divide, and form a dense leaf canopy that shades out native aquatic plants. Its ability to spread rapidly by fragmentation and effectively block out sunlight needed for native plant growth often results in monotypic stands. Monotypic stands of EWM provide only a single habitat, and threaten the integrity of aquatic communities in a number of ways; for example, dense stands disrupt predator-prey relationships by fencing out larger fish, and reducing the number of nutrient-rich native plants available for waterfowl (WDNR website, 2007).

Dense stands of EWM also inhibit recreational uses like swimming, boating, and fishing. The visual impact that greets the lake user on milfoil-dominated lakes is the flat yellow-green of matted vegetation, often prompting the perception that the lake is "infested" or "dead". Cycling of nutrients from sediments to the water column by EWM may lead to deteriorating water quality and algae blooms of infested lakes (WDNR website, 2007).

Curly leaf pondweed *(Potamogeton crispus)*

Curly-leaf pondweed (CLP) spreads through burr-like winter buds (turions), which are moved among waterways. These plants can also reproduce by seed, but this plays a relatively small role compared to the vegetative reproduction through turions. New plants form under the ice in winter, making CLP one of the first nuisance aquatic plants to emerge in the spring.

The leaves of curly-leaf pondweed are reddish-green, oblong, and about 3 inches long, with distinct wavy, finely toothed edges. The stem of the plant is flat, reddish-brown and grows from 1 to 3 feet long. The plant usually drops to the lake bottom by early July.

CLP becomes invasive in some areas because of its tolerance for low light and low water temperatures. These tolerances allow it to get a head start on and out-compete native plants in the spring. CLP forms surface mats that interfere with aquatic recreation in mid-summer, when most aquatic plants are growing, CLP plants are dying off. Plant die-offs may result in a critical loss of dissolved oxygen. Furthermore, the decaying plants can increase nutrients which contribute to algal blooms, as well as create unpleasant stinking messes on beaches (WDNR website, 2007).

Purple Loosestrife (*Lythrum salicaria*)

Purple loosestrife is a perennial herb 3-7 feet tall with a dense bushy growth form. Showy flowers vary from purple to magenta, possess 5-6 petals aggregated into numerous long spikes, and bloom from July to September. Leaves are opposite, nearly linear, and attached to four-sided stems without stalks. It has a large, woody taproot with fibrous rhizomes that form a dense mat.

Purple loosestrife was first detected in Wisconsin in the early 1930's, but remained uncommon until the 1970's. It is now widely dispersed in the state, and has been recorded in 70 of Wisconsin's 72 counties. Low densities in most areas of the state suggest that the plant is still in the pioneering stage of establishment. Areas of heaviest infestation are sections of the Wisconsin River, the extreme southeastern part of the state, and the Wolf and Fox River drainage systems.

This plant's optimal habitat includes marshes, stream margins, alluvial flood plains, sedge meadows, and wet prairies. It is tolerant of moist soil and shallow water sites such as pastures and meadows, although established plants can tolerate drier conditions. Purple loosestrife has also been planted in lawns and gardens, which is often how it has been introduced to many of our wetlands, lakes, and rivers. Purple loosestrife spreads mainly by seed, but it can also spread vegetatively from root or stem segments. A single stalk can produce from 100,000 to 300,000

seeds per year. Seed survival is up to 60-70%, resulting in an extensive seed bank. Mature plants with up to 50 shoots grow over 2 meters high and produce more than two million seeds a year. Germination is restricted to open, wet soils and requires high temperatures, but seeds remain viable in the soil for many years. Even seeds submerged in water can live for approximately 20 months (WDNR website, 2007).

Other Aquatic Invasive Species

The following AIS are not plants, but are mentioned here because they also can significantly disrupt healthy aquatic ecosystems.

Rusty Crayfish *(Orconectes rusticus)* are large crustaceans that feed aggressively on aquatic plants, small invertebrates, small fish, and fish eggs. They can remove nearly all the aquatic vegetation from a lake, offsetting the balance of a lake ecosystem. More information about this invader can be found at http://dnr.wi.gov/invasives/fact/rusty.htm.

Zebra Mussels *(Dreissena polymorpha)* are small freshwater clams that can attach to hard substrates in water bodies, often forming large of thousands of individual mussels. They are prolific filter feeders, removing valuable phytoplankton from the water, which is the base of the food chain in an aquatic ecosystem. More information about this invader can be found at http://dnr.wi.gov/invasives/fact/zebra.htm.

Spiny Water Flea (*Bythotrephes cederstoemi)* are predatory zooplankton (tiny aquatic animals) that have a barbed tail making up most of their body length (one centimeter average). They compete with small fish for food supplies (zooplankton) and small fish cannot swallow the spiny water flea due to the long spiny appendage. More research is being completed to determine the potential impacts of the spiny water flea. More information about this invader can be found at
http://dnr.wi.gov/invasives/fact/spiny.htm.

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APPENDIX D

DESCRIPTONS OF AQUATIC PLANTS

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APPENDIX E

SUMMARY OF AQUATIC PLANT MANAGEMENT ALTERNATIVES

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APPENDIX F

NR 107 AND NR 109 WISCONSIN ADMINISTRATIVE CODE

APPENDIX G

RESOURCE FOR ADDITIONAL INFORMATION

AQUATIC PLANT MANAGEMENT PLAN

NEENAH LAKE MARQUETTE COUNTY, WISCONSIN

March 12, 2008