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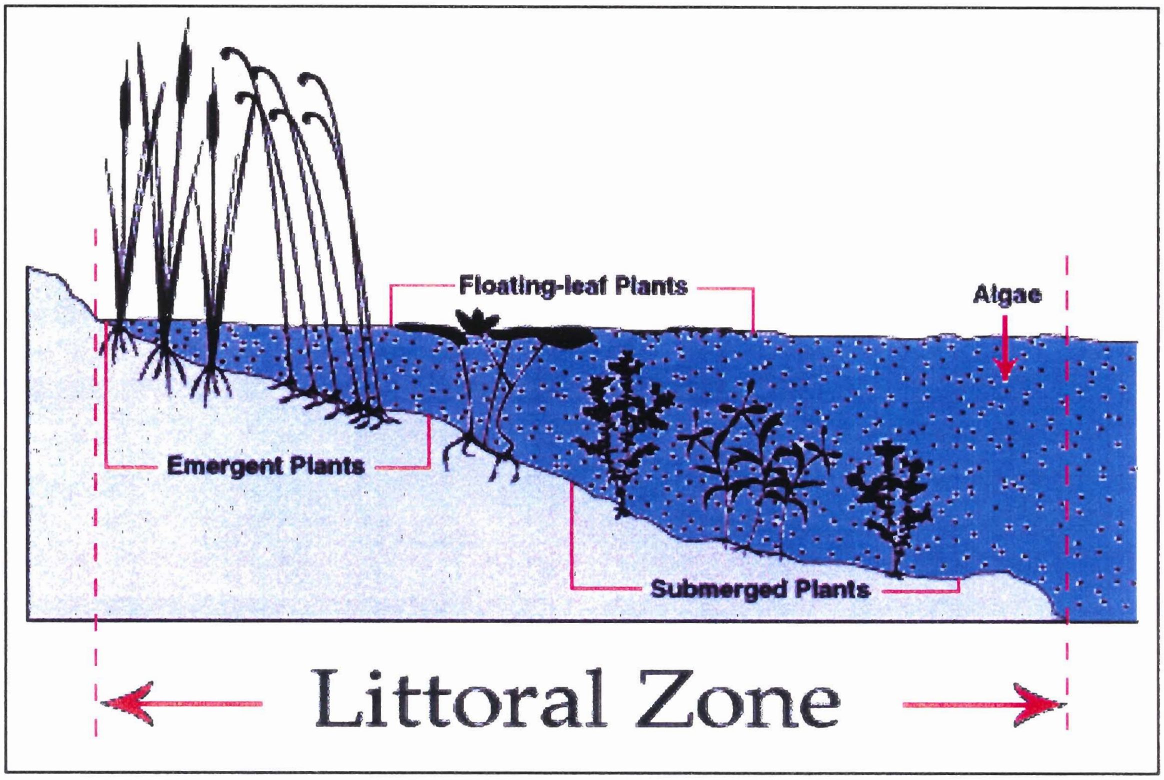
LITTLE GREEN LAKE
AQUATIC PLANT MANAGEMENT PLAN



PREPARED FOR:
LITTLE GREEN LAKE PROTECTION & REHABILITATION DISTRICT

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LPL-578

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EXECUTIVE SUMMARY

- Aquatic plant growth in shallow lakes like Little Green Lake is a natural occurrence, and provides the foundation for a healthy and balanced ecosystem. Plants protect water quality, stabilize the bottom sediment, oxygenate the water through photosynthesis, provide shelter and spawning habitat for fish, act as refuges for zooplankton (algae consumers), serve as food sources for wildlife, and offer a variety of other benefits. Unfortunately, the aquatic plant community found in Little Green Lake has undergone significant degradation. The aquatic plant community consequently lacks diversity, and is dominated by non-native, nuisance plant species such as Eurasian watermilfoil and curlyleaf pondweed. Because these species have few competitors and are tolerant to eutrophic conditions, they tend to grow to nuisance proportions to the detriment of native, beneficial species.

- Lake residents identified excessive aquatic plant and algae growth as the primary lake use impairments on Little Green Lake. The infestation of rooted aquatic weeds and algae growth is a biological consequence of an overly fertile lake due to nutrient-enrichment. This process is called eutrophication. It is also an indication of a disturbed ecosystem where human activities have managed to upset the lake's natural balance. Human-induced disturbances that foster algae blooms and the proliferation of undesirable plant species include soil erosion and polluted stormwater runoff from the adjacent watershed, as well as aggressive motor boat traffic that disrupts native plant beds and stirs up bottom sediments in shallow-water areas.

- Nuisance weed growth is negatively impacting multiple lake uses that are deemed a priority on Little Green Lake. Results of a 1997 lake resident survey revealed that fishing was the preferred lake use, followed closely by the enjoyment of scenic views and a peaceful, natural setting. Secondary priorities include motor boating and observing wildlife. The lake's water quality was viewed as the most important factor contributing to a desirable lake environment, followed by fishing success/habitat and overall ecosystem health. These findings were used to select management strategies that best support public interests and preferences, while taking into consideration any inherent recreational and/or ecological tradeoffs.

- The 1997 Little Green Lake Management Plan determined that a majority of desired lake uses and values will be supported if a reduction in algae growth is achieved in conjunction with a thriving, but well-managed <u>native</u> plant community. This is best accomplished by reducing nutrient inputs which are known to fuel algae blooms, while minimizing similar ecosystem "disturbances" that encourage the proliferation of <u>non-native</u> (exotic), rooted plant species. It is these exotic species (e.g. Eurasian watermilfoil and curlyleaf pondweed) that typically develop into extensive, monotypic stands of nuisance vegetation that cause most lake-use impairments. Therefore, the ideal strategy is to target exotic species whenever they become a nuisance in high traffic areas, and at the same time protect native plant communities that offer a number of water quality and wildlife habitat benefits. Attempting to significantly and indiscriminately reduce all rooted plant growth throughout the entire lake is likely to create conditions of increased turbidity and nutrient availability that would favor more frequent and larger scale algae blooms.

- Time and space zoning on the lake is recommended as an effective means of maximizing the lake's ability to support multiple, mutually exclusive activities. Recreational user zones can be designated to better manage conflicting activities, as well as to appropriately direct plant control techniques that would best serve these different lake uses. While some areas may require intensive management for recreational purposes, others may be best served if left protected from any type of disturbance. Management strategies will be most effective when implemented at specific times and in specific locations, depending on spatial and seasonal variations in plant growth, fish and wildlife behavior, recreational use of the water, and other factors.

- Mechanical harvesting is recommended as the primary plant control technique for Little Green Lake. It should be used on a conservative and targeted basis, and may be supplemented with other compatible strategies. Any attempt to aggressively manage plant growth in all areas of the lake regardless of circumstance is strongly discouraged, no matter what technique is used. Mechanical harvesting will be most effective when employed to: (1) clear motor boat navigation lanes perpendicular to public launch sites; (2) control nuisance vegetation that invades public swimming beaches; (3) maintain open water areas in high-intensity recreational user zones; and (4) create "fish-cruising lanes" (edge habitat) through weed-choked fishing areas. Mechanical harvesting is also effective at managing dense, monotypic stands of Eurasian watermilfoil following canopy formation at the water surface. Canopy removal eliminates the shading effect that prevents other rooted plant species from competing with the milfoil. When harvesting, all plant fragments must be removed from the water.

- No-wake zones are recommended in shallow water areas (e.g. less than 9 feet deep) to avoid the negative impacts associated with motor boat traffic. Aggressive motor boat traffic in these shallow, sensitive areas can re-suspend bottom sediment, destroy critical aquatic habitat, and promote the spread of exotic plant species. No-wake zones can also be established within a certain distance of the shoreline to help prevent shoreline erosion problems caused by wave action. State law currently prohibits motor boats from operating at speeds greater than "slow-no-wake" within 100 feet of the shore and other boats. This distance is expanded to 200 feet for personal watercraft such as jet skis. Local ordinances may be adopted to further expand no-wake times and areas if the restrictions are shown to be in the public's interest.

- A public information and education campaign is recommended to solicit the support and cooperation of all Lake Users. Lake Residents should fully understand the goals and objectives of aquatic plant management, as well as program limitations. They should also be encouraged to properly manage nuisance plant growth that occurs around their own piers, boatlifts and swimming rafts, as well as to remove floating plant debris when it washes onto their shorelines. It may prove beneficial to educate the public on the benefits of aquatic plants, and how to distinguish between native and exotic species. Signs could also be posted at launch sites explaining important lake rules and regulations.

- A monitoring program should be developed to document changes and evaluate the effect of different plant management strategies over time. It is recommended that the aquatic plant survey be repeated at least every few years for monitoring purposes. The information could then be used to evaluate and adjust various management approaches recommended in the Aquatic Plant Management Plan.

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SECTION 1
INTRODUCTION

1.1 BACKGROUND

Excessive algae and rooted aquatic plant growth are identified as the primary lake use impairments on Little Green Lake. These use impairments are biological symptoms of a much larger problem commonly referred to as accelerated eutrophication, or the rapid "aging" of a lake caused by nutrient-enrichment. The influx of too many nutrients such as phosphorus and nitrogen leads to elevated levels of primary productivity as evidenced by the overly abundant populations of plants and algae present in Little Green Lake. Nutrient sources include eroded soil, manure, lawn fertilizers, organic matter and similar non-point source pollutants that enter the lake from the surrounding watershed—called external nutrient loading. This is why lakes are considered reflections of their watersheds. Poor land use practices and watershed disturbances such as unmanaged residential and agricultural development only exacerbate the problem. Nutrients may also be released from aquatic organisms, plants and bottom sediments within the lake itself under certain situations—called internal nutrient loading, or in-lake nutrient recycling.

In an effort to appropriately address these issues, the Little Green Lake Protection & Rehabilitation District initiated a series of lake and watershed studies that were performed over a several year period. The studies were intended to collect the baseline data needed to characterize existing conditions, identify potential problem areas, and help direct management efforts accordingly. Initial studies included water quality monitoring (1991 – 1997), a watershed inventory (1994), and an aquatic plant survey (1994). A comprehensive lake management plan (1997) was then prepared to thoroughly evaluate this baseline information, and offer recommendations concerning the most appropriate, cost-effective management strategies that best support identified goals and objectives. The lake management plan was developed with two goals in mind; (1) to prevent further deterioration of the water quality, and (2) to implement those programs that will greatly improve the lake's entire ecosystem.

The lake management plan also attempted to factor in lake-use priorities when evaluating potential improvement strategies. Identifying and ranking preferred lake uses and values is important since lakes cannot be all things to all people. These rankings are also important since there are recreational and ecological tradeoffs associated with any ecosystem manipulation strategy that might be implemented in an attempt to achieve a desired outcome. Conflict is bound to arise whenever individuals place different values on the various attributes that attracted them to the lake in the first place, or differ on how those values should be maintained. Even the abundance of aquatic plants within a given lake can be valued or despised depending on individual lake-use preferences. Issue resolution can therefore be a difficult challenge, especially when conflicting values and priorities are at stake. For these reasons, it is essential that lake resident input play a significant role in dictating future management objectives and strategy selection.

Resident input was obtained through a 1997 survey of Little Green Lake residents. Completed as part of the lake management planning process, the survey indicated that the most valued lake use is fishing, followed closely by the enjoyment of scenic views and a peaceful, natural setting. Secondary priorities include activities such as motor boating and observing wildlife. A vast majority of the survey respondents felt that water quality is the most important factor contributing to a desirable lake environment, followed by fishing success/habitat and overall ecosystem health. The lake management plan revealed that most of the desired lake uses and values will be supported if a reduction in algae growth is achieved in conjunction with a flourishing, but carefully managed *native* plant community.

It is critical to recognize that algae growth and rooted aquatic plant growth often demonstrate an inverse relationship given that they each depend upon and compete for the same nutrients and available sunlight. Lakes frequently support a dominance of one of these biological components to the detriment of the other.

Therefore, the reverse of a lake that exhibits relatively good water clarity, abundant rooted plant cover and little algae growth is a lake with poor water clarity, little rooted plant cover and abundant algae growth. Every effort must be made to avoid trading a "weedy" lake for a turbid, algae dominated, weed-free lake with little nutrient buffering capabilities or fish habitat.

To carry out the objective of limiting algae production while promoting a healthy native plant community, the lake management plan recommended targeted mechanical harvesting in conjunction with nutrient-loading reduction strategies. The lake district was also encouraged to develop an Aquatic Plant Management Plan to ensure that mechanical harvesting and other plant control strategies are implemented using the most cost-effective and ecologically sound methodologies. The Aquatic Plant Management Plan was also recommended for the purpose of satisfying eligibility requirements set forth by the Recreational Boating Facilities grant program as administered through the State Waterways Commission. This competitive funding program currently provides cost-share dollars (50% match) that can be used toward the purchase of weed-harvesting equipment.

1.2 PROJECT GOALS & STRATEGY

The Aquatic Plant Management Plan is designed to guide the lake district in its efforts to control nuisance vegetation growth, while protecting native, beneficial plant communities that contribute to a healthy and stable aquatic environment. It is intended to offer a toolbox of potential management strategies that can be used separately or in combination to enhance preferred recreational attributes while limiting any possible negative repercussions. Public consensus and support is attained by establishing realistic goals, developing appropriate management objectives, and outlining control methodologies that support public interests and values. The plan is meant to help decision-makers avoid any negative impacts associated with the improper selection and implementation of plant management techniques. Consequently, it will reduce the likelihood of unintentionally exacerbating an existing problem or creating entirely new problems. Without a plan, objectives remain unclear, treatments become haphazard, and plant communities might be removed or damaged that did not require control in the first place.

Our goal is to promote the appropriate amount and types of aquatic plants while taking into account the effects of the different plants on fish communities, priority lake uses, nutrient cycles and overall ecosystem health. Aquatic plant growth is best managed using strategies that best support identified lake-use preferences and majority interests. However, every effort will be made to manage the aquatic environment in a manner that can support other conflicting and/or lower priority lake uses as well. Limiting the growth and proliferation of nuisance, exotic species, while maintaining a healthy community of native, beneficial species is the best approach in meeting stated goals and objectives. This approach is intended to facilitate reasonable boat access and navigation while restoring fish and wildlife habitat and improving water quality. Recommended plant control techniques will be most effective when implemented at specific times and in specific locations, depending on spatial and seasonal variations in plant growth, fish and wildlife behavior, recreational use of the water, and other factors.

Note: The Aquatic Plant Management Plan should be regularly consulted and updated to ensure its long-term effectiveness and applicability. As conditions change and new information or technologies become available, certain findings and recommendations contained in this report may need adjusting.

SECTION 2
ANALYSIS OF EXISTING CONDITIONS

2.1 LAKE & WATERSHED

The first step in addressing nuisance aquatic plant growth is to understand the underlying physical, chemical and biological characteristics and relationships that are unique to the larger ecosystem—the lake and its watershed. It is these factors that ultimately govern the type, amount and distribution of plant growth in the system.

Little Green Lake is a 466-acre groundwater seepage lake located approximately one mile north of the City of Markesan in Green Lake County, Wisconsin. The lake lies within a 3.33-square mile watershed dominated by agricultural land uses and fertile soils. As a landlocked water body, Little Green derives most of its water from precipitation and runoff, supplemented by groundwater from the immediate drainage area. The lake is described as a small, relatively shallow water body. Its water column may undergo weak thermal stratification during the late summer season as horizontal water layers of varying temperatures and densities develop under stable weather conditions. Little Green Lake is also polymictic, meaning that it completely mixes multiple times each year following the breakdown of thermal stratification. Lake trophic status ranges from mesotrophic to eutrophic, indicating a high level of primary productivity (i.e., algae and rooted aquatic plant growth) caused by nutrient enrichment. Tables 1 and 2 below provide a brief summary of the physical and water quality conditions of Little Green Lake.

Table 1: Little Green Lake Physical Characteristics

Lake type	Groundwater seepage
Surface area	466 acres (0.728 square miles)
Watershed area (includes lake area)	2,131 acres (3.33 square miles)
Watershed-to-lake surface area ratio	3.57:1
Shoreline length	4.2 miles
Mean depth	10 feet
Maximum depth	26.5 feet
Littoral area (extent of rooted plant growth)	0-14 feet
Water volume	4,817 acre-feet
Hydraulic retention time	12.7 years
Inlets	2 intermittent inlets
Outlets	1 intermittent, dam-regulated outlet

Table 2: Little Green Lake Water Quality Characteristics

Trophic status	Mesotrophic – Eutrophic
Lillie & Mason Water quality index	Poor – very poor
Average pH range	7.2 – 8.8
Limiting nutrient (drives algae blooms)	Phosphorus
Nitrogen-to-phosphorus ratio	13:1 – 22:1
Bottom sediment phosphorus content (shallow – deep)	645 – 2,500 mg/kg
Summer anoxic zone	Bottom 15 – 27 feet

Shallow, nutrient-rich lakes like Little Green tend to exhibit greater levels of plant and algae growth in comparison to other lake systems. High plant biomass may be attributed to: (1) a large area of bottom sediments relative to water volume; (2) increased sunlight availability at the lake bottom; (3) more complete wind mixing of the water column; and (4) a greater shallow area extent along the lake perimeter that can be colonized by rooted aquatic plants. Because Little Green Lake is a shallow system, it has an extensive littoral zone in relation to its surface area. The littoral zone is the portion of the lake that is able to support rooted aquatic plant growth, and is defined by the depth at which sunlight is able to penetrate the water column in quantities sufficient to promote photosynthesis. The littoral zone in Little Green Lake ranges from 0-14 feet in depth. Submergent vegetation is most common in depths of less than 10 feet, while floating and emergent vegetation are most common at depths of less than five feet (Northern Environmental, 1994).

2.2 AQUATIC PLANT COMMUNITY

To build upon previous efforts and minimize costs, the Little Green Lake Aquatic Macrophyte Survey (1994) was used to estimate existing aquatic plant conditions. It provides a snapshot of what the aquatic plant community looked like at the time the survey was completed. The survey was performed in accordance with the methodology of Jensen and Lound's macrophyte evaluation technique, and provided baseline data on the distribution, types and densities of plant species found in Little Green Lake. It is important to realize that plant conditions can change dramatically on a seasonal and year-to-year basis. Therefore, plant conditions documented in the summer of 1994 are likely to have changed to some degree over the ensuing years. To account for these changes and evaluate the effectiveness of various management strategies, the macrophyte survey should be repeated on a recurring basis.

As part of the survey, a base map was created with 20, equally spaced transects around the lake perimeter. Transects extended perpendicular to the shoreline, and were spaced at a distance calculated by dividing the total shoreline length by the number of established transects. A 10-foot diameter circle was randomly selected along each transect in each of several depth ranges. The circle was divided into four quadrants, and a density rating was determined for each quadrant by visual observation or with a modified rake, depending on water clarity. A dragging test was necessary to correlate visual observations with rake density ratings. The density rating, water depth and visual assessment regarding substrate type were recorded.

The survey indicated that Little Green Lake is an ecosystem with low to moderate species diversity and a high amount of biomass, or species abundance. *Ceratophyllum demersum*, or coontail, was the single most abundant species sampled (relative frequency of 24%), followed by *Potamogeton crispus*, or curlyleaf pondweed (relative frequency of 21%), *Myriophyllum spicatum*, or Eurasian watermilfoil (relative frequency of 19%) and filamentous algae (relative frequency of 17%). No endangered or threatened plant species were identified during the survey.

The plant community in Little Green Lake is considered a fair food source for wildlife and waterfowl. It is also beneficial to the fishery by providing food, cover and spawning habitat. However, excessive plant growth is beginning to inhibit desired lake uses such as fishing, swimming and boating, and may be causing stunted fish populations by reducing predator success. For example, Eurasian watermilfoil and curlyleaf pondweed are non-native invasive species that, if left unchecked, have the potential to rapidly proliferate and out-compete native species. This phenomenon is already evident in Little Green Lake.

Table 3 below summarizes the results of the 1994 macrophte survey of Little Green Lake. Plant species are listed in descending order of relative frequency. Color maps showing the distribution of Little Green Lake's aquatic plants are contained in Appendix A (plant type), B (non-native species) and C (native species).

Table 3: Macrophyte Survey Results

Species	Common Name	Plant Type	Mean Density Rating	Frequency of Occurrence (%)	Relative Frequency (%)	Maxim. Rooting Depth (ft)
Ceratophyllum demersum	Coontail	S	2.7	53	24	14.4
Potamogeton crispus	Curlyleaf pondweed	S	2.5	49	21	11.3
Myriophyllum spicatum	Eurasian milfoil	S	3.3	42	19	7.5
*Filamentous algae***	None	F	2.9	40	17	---
Elodea canadensis	Common waterweed	S	2.8	9	4	3.9
*Lemna trisulca***	Forked duckweed	F	2.7	7.5	4	---
Scirpus validus	Great bulrush	E	1.7	4.2	2	1.5
Potamogeton pectinatus	Sago pondweed	S	1.0	2.5	1	4.3
*Lemna minor***	Small duckweed	F	2.5	2.5	1	---
Typha sp.	Cattail	E	2.0	2.5	1	1.2
Potamogeten zosteriformes	Flat-stem pondweed	S	1.5	2.5	1	1.5
Polygonum amphibium	Water smartweed	F	1.0	1.2	1	0.9
*Spirodela polyrhiza***	Great duckweed	F	1.0	1.2	1	---
*Scirpus spp.**	Bulrush	E	---	---	---	---
*Nuphar microphyllum**	Yellow water lily	F	---	---	---	---

Source: Northern Environmental, 1994

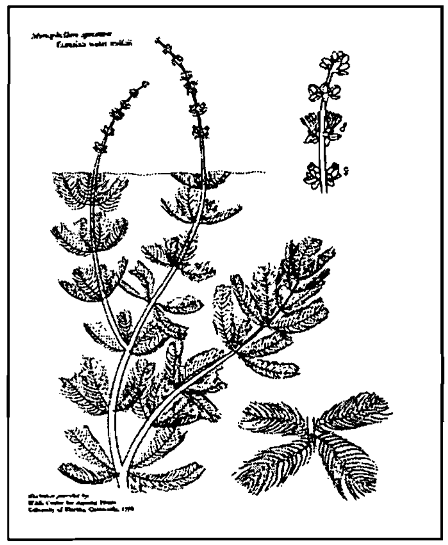
* = Species encountered in the initial collection of plants, but were not observed along the transects
** = Not a rooted plant species
S = Submergent
F = Floating
E = Emergent
Gray shading = Non-native, exotic species

SECTION 3
AQUATIC PLANT DESCRIPTIONS

3.1 NON-NATIVE PLANT SPECIES

Non-native (exotic), rooted aquatic plant species are to blame for most lake use impairments. These weeds are known to aggressively out-compete native species once they invade a lake. They are consequently able to form large, monotypic weed beds that grow unchecked until they cause nuisance conditions. The two exotic plant species found in Little Green Lake, Eurasian watermilfoil and curlyleaf pondweed, have already managed to dominate the system and create a host of problems. A map showing the distribution of exotic species in Little Green Lake is presented in Appendix B. These plants are described in greater detail below.

SUBMERGENT VEGETATION



Eurasian watermilfoil: ***#1 target species for control.***
This plant is not native to the U.S., and is a nuisance weed in many lakes. It is a submersed perennial, and is known as a "disturbance" species. Sediment deposition, plant removal, water level changes and other ecosystem disturbances encourage colonization by this plant species. Many eutrophic lakes in Wisconsin are dominated by Eurasian watermilfoil, which can grow to the surface in waters up to about 20 feet deep, forming dense beds of leafy canopies over strong, spaghetti-like stems. Broken stems and plant fragments are able to regenerate into new plants if they are not removed from the water. Fragments may be created as a result of severe weather, boat traffic, or through auto-fragmentation. These plants can provide limited cover for bluegills, crappies, perch, walleye and muskellunge when poor water clarity prevents other species from growing. They also support various macroinvertebrates that fish feed upon.

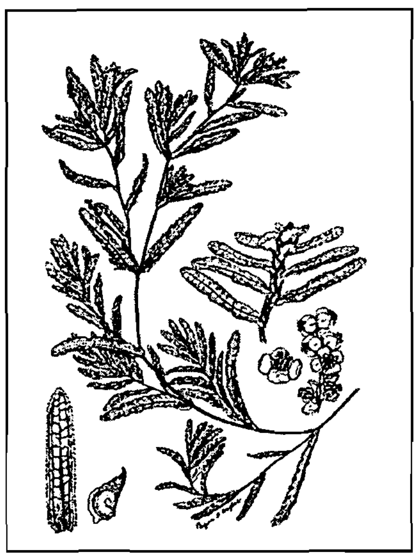
Eurasian watermilfoil is a pioneer species that commonly invades disturbed areas, quickly out-competing native vegetation. Past experience has shown that milfoil tends to invade and dominate lakes quickly. In some lakes it persists, while in others it subsides after about 10+ years. The reasons for the plant's eventual decline are unknown. Milfoil boom and bust growth cycles are well documented in other lakes, and are characteristic of ecosystems dominated by only a few species. These extreme growth cycles illustrate why it is important to maintain biodiversity for ecological stability. Excessive Eurasian watermilfoil growth primarily affects recreation by interfering with swimming and boating following canopy formation, by reducing the quality of sport fisheries, and by reducing the aesthetic appeal of water bodies.

In the spring, shoots begin to grow rapidly in response to rising water temperatures. As shoots grow, lower leaves drop off in response to shading. When the plant reaches the surface, shoots branch profusely to form a dense canopy above leafless vertical stems. Plants then reproduce by flowering at the surface and through fragmentation. Dominance by this species is often established early in the growing season, owing to a combination of high over-wintering biomass and rapid spring growth. In general, conditions of low light and high water temperature, characteristics of many eutrophic environments, stimulate shoot elongation and canopy formation. This plant grows most poorly on highly organic sediments and coarse substrates (sand and gravel), and best in finely textured, inorganic sediment. Shallow, moderately turbid bodies of water with widespread areas of nutrient-rich sediments will experience the most severe problems.

Table 4: Factors Influencing Growth and Morphology of Eurasian Watermilfoil

Factor	Affect on Milfoil Growth
Water Clarity	• Low water clarity limits watermilfoil to shallow rooting depths, and leads to canopy formation. • High water clarity allows milfoil growth at greater depths.
Temperature	• Plants photosynthesize and grow over a broad temperature range (15-35° C). • Maximum growth rates occur at relatively high water temperatures (30-35° C). • Growth is initiated in the spring once the water temperature reaches approximately 15° C.
Inorganic Carbon	• Plants grow best in relatively alkaline lakes. • Plants can grow in lakes of low alkalinity, but not as vigorously as elsewhere
Mineral Nutrients	• Nuisance growths of the plant are primarily restricted to moderately fertile lakes, or fertile locations in less fertile lakes. • Uptake of nutrients from sediments by roots is a very important sources of mineral nutrients, particularly P and N. • Major cations and bicarbonate are taken predominantly from the water.
Sediment Texture	• Plants grow best on fine-textured inorganic sediments of intermediate density since nutrient availability is greatest there.
Water Movement	• Water currents encourage the spread plant fragments. • The plant does not usually grow in high-energy environments.
Ice Scour	• Ice scour may exclude the plant from shallow areas of lakes in cold climates.
Desiccation & Freezing	• Desiccation during a water level drawdown is a viable control measure, particularly when accompanied by freezing during the wintertime.

Eurasian watermilfoil is commonly treated with aquatic herbicides such as 2,4-D early in the summer before plants flower. However, there are a number of negative consequences that can occur following chemical treatments. These include dissolved oxygen depletion and nutrient releases from the resulting plant decay, as well as the creation of "disturbance" areas that can be re-colonized by milfoil or other exotic species. Most control efforts have been directed toward maintenance, since eradication of this particular species is rarely if ever likely to succeed due to its aggressive growth and propagation characteristics. Since growth usually covers large areas, treatment efforts should be directed at well-defined areas where they will produce the greatest benefits.



Curlyleaf pondweed: ***#2 target species for control.***
This plant is not native to the U.S., and has a tendency to become a nuisance weed in many lakes. It is usually one of the first plants visible in the spring, and may cause temporary problems due to its early, rapid growth. The plant can grow under the ice while most plants are dormant, but declines by early to mid-July when other species are realizing peak growth. It typically grows in soft sediments in water depths up to 12 feet. It can tolerate cool temperatures and low light, and will grow in turbid water. Curlyleaf pondweed provides limited cover for bluegills, largemouth bass, northern pike and muskellunge, although broad-leaved pondweeds are preferred by these fish species.

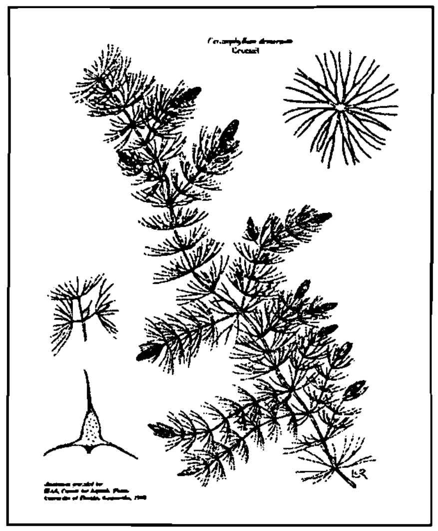
Young curlyleaf plants emerge from the sediments during fall, remain dormant during winter, and grow rapidly after ice-out, forming dense surface mats over expansive meadows. This growth cycle allows curlyleaf pondweed to out-compete other species for nutrients, sediment area and light. It grows especially well in areas where mechanical harvesting or herbicides were used inappropriately and without careful planning. The curlyleaf population collapses naturally by the first week of July (Pullman, 1992). The dead vegetation tends to either wash onto the lakeshore or sink to the lake bottom. Plant decay can deplete dissolved oxygen levels, eliminating habitat and causing the internal release of phosphorus from sediments on the lake bottom.

Pullman (1992) recommends early seasonal control during the initial stages of growth, so the plants can be controlled before the population collapses after full growth. Chemical treatment of the young plants during fall or spring may prevent formation of nuisance mats and depletion of oxygen while allowing other native macrophyte species to re-vegetate those areas. Protection and restoration of native species, and improving water clarity can help keep this plant in check without the use of aquatic herbicides.

3.2 NATIVE PLANT SPECIES

A diversity of native aquatic plants provides the foundation of a healthy and stable lake ecosystem. Moderate amounts of these plant species are necessary for protecting water quality and providing valuable fish and wildlife habitat. Unfortunately, Little Green Lake's native aquatic plant community is being rapidly replaced by exotic, nuisance species. The protection and restoration of native plant species that remain in Little Green Lake is critically important if Eurasian watermilfoil, curlyleaf pondweed and other exotics are to be controlled over the long run. A map showing the distribution of native species in Little Green Lake is presented in Appendix C. Each of these species is described in greater detail below.

SUBMERGENT VEGETATION



Coontail: Coontail is a native species that typically grows in clear water up to 20 feet deep below the water surface. It is the most abundant species in Little Green Lake. Although coontail has the capacity to grow at nuisance levels, it should not be entirely eliminated from a water body since it offers good habitat for fish and invertebrates. Coontail is also effective at removing phosphorus from the water column. This plant does not have any real roots, and can tolerate cool temperatures and low light conditions. The upper leaves may reach the surface in shallower areas. It over-winters as an evergreen plant, and resumes vigorous growth in the spring. Cut plant fragments can regenerate into new plants. This plant is often found on drop-offs, producing tree-like cover for bluegills, perch, largemouth bass and northern pike. Coontail also supports insects valuable as food for fish and ducklings, while its shoots are a food source for many waterfowl.

Sago pondweed: This plant grows below the water surface up to eight feet deep. It grows in a variety of sediment types and a wide range of water conditions. In fact, it is often the last remaining rooted plant in very turbid water. Sago's rapid growth rate allows it to quickly occupy large areas and smother potential competitors. It is also very pollution tolerant and can rapidly colonize unoccupied habitats. This may be one reason why the plant is typically not found with a diversity of other species, but tends to occur in discrete beds in stressed environments.

Sago pondweed is firmly rooted and has branched, slender stems and grass-like narrow leaves. This plant provides limited cover for bluegills, perch, northern pike and muskellunge, and is good cover for walleye. It supports insects valuable as food for fish and ducklings, and is considered one of the top food producers for waterfowl. Both the fruit and tubers are heavily grazed and are considered critical for a variety of migratory waterfowl. Sago communities also provide escape cover for macroinvertebrates, thus allowing them to thrive in the presence of small fish. Removing narrow-leafed pondweeds may allow less desirable species like curlyleaf pondweed to take over.

Common waterweed: This plant grows in both shallow and deep-water areas, and is most abundant on fine sediments enriched with organic matter. Common waterweed generally over-winters as an evergreen. Since seeds are rarely produced, the plant reproduces primarily through the spread of stem fragments. The branching stems of this plant provide excellent habitat for fish and invertebrates. However, dense stands can obstruct fish movement. The plant provides food for muskrats and waterfowl. Common waterweed is tolerant to low-light conditions.

Water smartweed: Water smartweed grows in shallow, quiet water and in a variety of sediment types. It is a perennial that reproduces by seeds and over-wintering rhizomes. Plants provide seeds for waterfowl, upland game birds, deer and muskrat. The leaves offer shade and habitat for fish and invertebrates.

Flat-stemmed pondweed: This plant grows in soft sediment below the water surface and in a variety of water depths. It is firmly rooted with branched, slender stems and grass-like narrow leaves. Flat-stemmed pondweed provides limited cover for bluegills, perch, northern pike and muskellunge. It also provides good cover for walleye, and supports insects valuable as food for fish and ducklings. Flat-stemmed pondweed is a food source for waterfowl, muskrat, deer and beaver. Removing narrow-leafed pondweeds may allow less desirable species like curlyleaf pondweed to take over.

FLOATING VEGETATION

Filamentous algae: This type of macro-algae consists of single cells that are connected end-to-end. It appears as green-colored thin threads, branched filaments or an interwoven net. Filamentous algae do not have roots, stems or leaves. It begins growing along the shoreline or on the lake bottom, and later buoys to the surface forming green mats that frequently attach to rocks or other plants. Abundant growth identifies lakes polluted with excessive nutrients. Although filamentous algae provide cover for insects valuable as fish food, it is often viewed as an unsightly nuisance. Preventative actions that reduce the flow of nutrients into the lake are the best means of control.

Duckweed (Small, Forked and Great): These free-floating small green plants grow in bays and quiet areas protected from wind and wave action. Some varieties are smaller than a pinhead while others are up to one-half inch long. Because it is free-floating, it drifts with the wind or current and is not dependent on depth, sediment type or water clarity. Duckweed is often associated with eutrophic waters since it must acquire all of its nutrients from the water through small roots on the underside of the plant. It has the ability to rapidly reproduce, doubling in population within three to five days. This floating plant provides cover for largemouth bass and northern pike. It is a food source for waterfowl and marsh birds (providing up to 90% of the dietary needs for a variety of ducks and geese), and supports insects valuable as food for fish. It is also consumed by muskrat, beaver and fish. These plants are too small for conventional physical removal. Control using chemicals is often ineffective, as it is difficult to contact all the plants with herbicide.

Yellow water lily: This plant usually grows in shallow, soft sediment areas of ponds or slow-moving streams. In addition to their aesthetically pleasing yellow flowers, water lilies provide good habitat for fish. They supply shade and cover for panfish, largemouth bass and northern pike. The insects that grow under the leaves are a food source for fish. These plants are also food for waterfowl, marsh birds and muskrat. Yellow water lily has been documented in Little Green Lake, but was not observed during the 1994 aquatic plant survey. Areas that support this species should be protected for water quality and fish habitat purposes.

EMERGENT VEGETATION

Bulrush: Bulrush grows above the water surface along moist and marshy shorelines, sand and gravel bars, and in water up to six feet deep. It prefers a firm bottom with little muck. The plant consists of a round or triangular stem that often appears leafless, but has slender green leaves and a loose cluster of flowers and seeds located near the tip of the stem. Bulrush is a valuable aquatic plant. Its rigid stems survive the winter and provide important spawning areas for northern pike and cover for other fish in early spring. Muskellunge fingerlings rely heavily on bulrush for cover during their first year. Bulrush also attracts marsh and song birds, and provides food for ducks, geese and swans. Dense stands of this emergent plant provide an excellent barrier that prevents shoreline erosion. Cutting stems underwater or raking works well to control nuisance growth if it occurs.

Cattail: This plant grows above the water surface in marshes, along shorelines, and in quiet water up to four feet deep, often in disturbed areas. It has long, well rooted, grass-like stalks that are 3-10 feet tall. The flower consists of a sausage-shaped "cattail" which is green during the early summer and turns brown and fuzzy by summer's end. Cattail helps stabilize marshy borders of lakes, protects shorelines from wave erosion, provides spawning sites for northern pike, and provides cover and nesting sites for marsh birds and waterfowl. Muskrat and beaver eat the stalks and roots. The plant should only be removed in limited areas, and only when necessary to provide access to deeper lake water. Cutting stalks under water during the early summer before the "cattail" appears works best to control growth. Cutting under water just before the lake freezes is also effective.

SECTION 4
AQUATIC PLANT ECOLOGY

4.1 INTRODUCTION

Little Green Lake is naturally going to be a productive system in terms of plant abundance, especially given that it is a shallow body of water located in a region characterized by fertile soils. Fortunately, the presence of aquatic vegetation is critical to a healthy and flourishing lake ecosystem. Plants protect water quality, stabilize the bottom sediment, oxygenate the water through photosynthesis, provide shelter and spawning habitat for fish, act as refuges for zooplankton (algae consumers), serve as food sources for wildlife, and offer a variety of other benefits. An absence of aquatic vegetation usually leads to poor water quality conditions, more algae and a less desirable fishery. Therefore, aggressively attempting to eradicate aquatic plants under any circumstance is strongly discouraged. These shortsighted actions will almost certainly result in outcomes that are contradictory to the lake management district's goals and objectives.

There are instances, however, when aquatic plants can become overly abundant. Nuisance vegetation growth may interfere with certain recreational uses, stunt fish growth, and release nutrients while depleting dissolved oxygen levels during decomposition. Most of this nuisance growth is due to the spread of non-native (exotic) plant species. These species are able to aggressively out-compete native, beneficial plant species until they reach densities that cause numerous problems. Excessive plant growth is prevalent in Little Green Lake, and should be controlled through careful and well-planned management. Aquatic plant management is most effective when specific areas and plant species are targeted. Control methods should be employed that do not significantly disrupt native, beneficial plant communities that provide critical fish and wildlife habitat and water quality protection benefits. Maintaining these more desirable, native plant communities should prevent the continued spread of the more aggressive, nuisance species such as Eurasian watermilfoil. In most instances, the control of native aquatic plants should be discouraged or limited to high use recreational areas like navigation channels.

A healthy native aquatic plant community...

- Produces oxygen, structural habitat and organic material that are essential to the survival of aquatic organisms.
- Absorbs nutrients such as phosphorus and nitrogen that are responsible for algae growth.
- Slows the velocity of runoff entering the lake, reducing turbidity as sediment is filtered and allowed to settle to the bottom.
- Provides surface habitat for insects and small, attached plants that are an important food source for fish and wildlife.
- Creates spawning areas, food and protective cover for fish.
- Stabilizes the lake bottom through extensive root system development.
- Prevents shoreline erosion by absorbing the energy from wave action.
- Offers a food source for waterfowl and other wildlife.
- Provides aesthetic values for those who prefer a natural-looking lake ecosystem with a thriving underwater plant community.
- Discourages the spread of non-native, exotic plant species.

Conversely, a sparse native aquatic plant community...

- Encourages more frequent algae blooms due to decreased competition for nutrients.
- Fails to prevent the re-suspension of bottom sediments from wind, wave and boat action.
- Fails to dampen wave energy that leads to the erosion of unprotected shorelines.
- Reduces available food and habitat for macroinvertebrates, fish and other wildlife.

- Limits the natural sediment filtration capacity of the lake, increasing the level of turbidity and decreasing water clarity.
- Lowers daytime oxygen concentrations due to decreased levels of photosynthesis.
- Allows for the easy invasion and spread of exotic, nuisance plant species.

However, an over abundance of nuisance, exotic vegetation…

- Limits recreational activities such as boating, swimming and fishing.
- Reduces the aesthetic appeal of the lake for those who prefer open water views.
- Restricts boat navigation lanes.
- Causes the deterioration of water quality following senescence and decay (e.g. dramatic fluctuations in dissolved oxygen levels, phosphorus releases, etc.).
- Causes the deterioration of gamefish habitat by providing too much structural refuge for prey fish.
- Displaces native, beneficial plant communities through aggressive competition.

4.2 PLANT TYPES

Aquatic plants, also known as macrophytes, include all macroscopic plants (observable with the naked eye) found in aquatic environments. Macrophytes are represented by a diverse group of aquatic and wetland plants, including flowering vascular plants, mosses, ferns and macroalgae. This form of vegetation is naturally present to some extent in all lakes, and represents an important component of aquatic ecosystems. However, nuisance macrophyte growth often occurs following the invasion of non-native (exotic) species, such as Eurasian watermilfoil or curlyleaf pondweed. Since exotic species have few natural predators, they tend to out-compete native species, forming large monotypic colonies. As a result, animal and plant biodiversity decreases, water quality conditions deteriorate, and recreational limitations are imposed.

Emergent, free-floating, floating-leafed and submergent vegetation represents the four categories of macrophytes. Emergents (e.g. cattail and bulrush) are rooted in water-saturated or submerged soils, but have stems that grow above the water surface. These plants most often grow in shallow areas found near the lakeshore. While emergents may sometimes cause problems for boat access, they offer a number of benefits, such as providing shoreline protection from wave action and waterfowl nesting habitat. Free-floating plants (e.g. duckweed) are not rooted in the lake bottom, but have an extensive root system that hangs beneath floating leaves. They obtain most of their required nutrients from the surrounding water column. These plants are often quite small, and may completely cover the water surface in small, stagnant water bodies. Floating-leafed macrophytes (e.g. water lilies) have leaves that float on the lake surface with a long rooted stem anchored to the lake bottom. Because the leaves of these plants are delicate and easily torn by wave action, they are typically found only in quiet, sheltered bays. Submergents (e.g. sago and curlyleaf pondweed) grow entirely under the water surface in areas where there is sufficient sunlight penetration. These plants may muffle wave action and water currents, limiting shoreline erosion and sediment re-suspension. They also accelerate the removal of suspended solids from turbid water by trapping the particles on leaf and stem surfaces.

4.3 GROWTH DETERMINANTS

Important factors affecting the abundance and distribution of aquatic macrophytes in Little Green Lake are light availability, nutrient availability, water chemistry, sediment type and wind energy. Each of these factors is discussed briefly below.

<u>Light availability</u>: Light availability, which is directly linked to water clarity, is often considered the single most crucial factor regulating the maximum depth of plant growth. The amount and spectral quality of light at the lake bottom diminishes as water clarity decreases, generally as a result of increasing water depth. Submersed macrophytes typically grow to a depth of two to three times the Secchi depth, or the depth at which an eight-inch, black and white disk is no longer visible below the water surface. Other factors that

influence light availability are phytoplankton (algae) concentrations, watercolor, and the concentration of organic/inorganic suspended particles (turbidity). Turbidity may be caused by runoff entering the lake, or through sediment re-suspension caused by boat traffic, wind mixing and biotic factors such as carp activity. The extent of the littoral zone, or the area that can support rooted aquatic plant growth, will fluctuate based on these and other photosynthesis-limiting factors.

Nutrient availability: Plant growth can be limited if at least one nutrient that is critical for growth (e.g. phosphorus or nitrogen) is in short supply. However, nutrients supplied from bottom sediments combined with those in solution are generally adequate to meet nutritional demands of rooted aquatic plants, even in oligotrophic, or nutrient poor systems. Rooted macrophytes usually fulfill most of their phosphorus and nitrogen requirements by direct uptake from sediments, although the preferred source of some nutrients such as potassium, calcium, magnesium, sulfate and sodium appears to be the open water. Oligotrophic lakes generally maintain less total biomass of aquatic plants and usually different species than eutrophic, or nutrient-rich lakes.

Water chemistry: Water chemistry is another environmental factor that can control plant growth. For instance, some species are very tolerant of acidic conditions while other species are very intolerant of these conditions, and vice versa. Most plants prefer slightly alkaline water chemistries as opposed to acidic environments. Little Green Lake is considered an alkaline environment.

Sediment type: Variations in the quality and quantity of bottom sediment play a significant role in controlling the distribution and growth of rooted aquatic vegetation. Rocky, sandy, silty and mucky substrates will each favor different plant communities. The distribution of various substrates along the lake bottom is dictated by a number of factors. For instance, wave action and currents cause coarse material to remain in shallow water (a higher energy environment) while finer materials are transported and deposited in deep water. The strength and direction of the wind in conjunction with the morphology of the lake basin will play a large role in determining where the substrates will move. In general, points and shallows where wind and wave energy are highest tend to be swept clean, while bays and deep areas in a lake tend to fill with sediment. This process is known as sediment focusing.

Wind energy: Finally, high-energy environments caused by wind, water current and/or wave action can significantly limit plant growth. These and similar disturbances, if frequent, will prevent vegetation from being able to take root in the substrate, especially if the substrate is unsuitable for most plants due to scouring. As noted in the paragraph above, wind, current and wave action are usually greatest in unprotected, near-shore areas.

4.4 PLANT-INDUCED, ECOSYSTEM IMPACTS

The preceding section dealt with some of the factors that can control the amount and type of plant growth in a particular lake. This section describes how the resulting plant growth (or lack thereof) can impact the surrounding ecosystem. The presence or absence of plant growth can have a dramatic effect on the aquatic environment. A number of these plant-induced, ecosystem impacts are discussed briefly below.

Littoral Zone Productivity: As explained earlier, the littoral zone is the shallow area of a lake that is able to support rooted aquatic plant growth. Small lakes usually have more miles of shoreline per acre of lake surface area, so they have greater potential for a more productive littoral zone in comparison to open water algae productivity. The accumulation of organic sediments from the decay of excessive plant matter causes expansion of this littoral zone and filling in of the lake.

Turbidity: Rooted aquatic plant growth exhibits an inverse relationship with water clarity. As rooted plant abundance increases in a lake, the abundance of suspended solids (e.g. algae cells, dead organic matter and clay particles) decreases. This relationship exists because aquatic plants act as water quality filters, stabilize bottom sediments, and compete for the same nutrients that fuel algae blooms. Plant management efforts that do not take this relationship into consideration may end up trading one problem for another even less desirable problem.

Water Temperature/Circulation: Shading and reduced water circulation caused by dense stands of aquatic plants affects the lake environment by producing vertical temperature gradients as steep as 18° F over three feet of water depth. Reduction in water flow through macrophyte beds also enhances trapping and deposition of fine sediment and organic matter. This process improves water clarity and increases the accumulation of sediments or organic material in shallow areas. The reduction in water circulation, if significant, can limit the ability of the lake to naturally aerate.

Dissolved Oxygen & pH: Daily dissolved oxygen concentration changes are heavily regulated by dense submersed macrophyte stands. The water column can become supersaturated with dissolved oxygen when peak photosynthesis occurs during daylight hours. This can be followed by anoxia, or the absence of oxygen as respiration exceeds photosynthesis during non-daylight hours, especially in the absence of sufficient water circulation, or when microbial decomposition increases as a result of a plant die-off. Whenever anoxic conditions are produced, the survivability of oxygen-dependent aquatic organisms is compromised. Dense growths of floating vegetation can exacerbate the situation by restricting atmospheric oxygen exchange at the water surface. Changes in pH of up to two units are also known to occur within a 24-hour period due to the metabolic processes of submersed plants.

Phosphorus Availability: Macrophytes influence nutrient cycles by assimilating phosphorus from the sediments during the growing season, and releasing phosphorus during death and decay. This means fewer nutrients are available for algae growth during the warm season, resulting in better water clarity. If nutrients are then released in the fall during decomposition of plant matter, water temperatures are usually cool enough so noxious algae blooms do not occur. Those that do occur will generally pose fewer problems since the peak recreational period has passed. If anoxic conditions are caused as a result of plant decomposition, phosphorus may be released from the bottom sediment into the surrounding water column, fueling additional algae blooms.

Habitat & Water Quality: Too few plants generally do not provide enough cover for fish, while too many plants may lead to stunted panfish populations and poor predator growth. The latter is caused by an overabundance of structural habitat for small fish, allowing them to escape predation and achieve high population densities. This means there is not enough food available for the existing fish, so both panfish and predators become small or stunted.

The Trophic Cascade Hypothesis predicts that water quality is linked to the success of certain fish species, which can cause a "cascading" effect down the food chain. Simply stated, water quality improves as larger gamefish (piscivores) become more successful at feeding on the smaller panfish (planktivores). As planktivore populations are diminished, there is less consumption of the microscopic animals (zooplankton) that graze on algae (phytoplankton). The amount and quality of the vegetative habitat usually plays a sizeable role in determining the outcome of this process. A moderate amount of high quality aquatic vegetation with plenty of edge habitat is generally the most conducive to larger fish populations and better water quality.

SECTION 5
AVAILABLE PLANT MANAGEMENT TECHNIQUES

5.1 INTRODUCTION

There are a number of techniques commonly used to manage nuisance plant growth in aquatic environments. Management categories include mechanical, chemical, biological, habitat manipulation (i.e., altering the lake environment through deepening, shading, water level drawdown, etc.), and an integrated approach that combines two or more categories. Most of these techniques are described in detail below. The various merits and drawbacks of each strategy are discussed to allow the lake management district to select the most appropriate course of action based on the particular situation. Evaluation criteria include effectiveness, potential positive and negative environmental impacts, costs, lake-use restrictions, and permit requirements.

5.2 SEDIMENT & NUTRIENT CONTROL

Controlling the amount of excess sediment and nutrients that enter the lake is a long-term management approach for nuisance plant growth. Plants require nutrients such as phosphorus and nitrogen to grow. However, when these nutrients are overly abundant in the lake, vegetation can grow to nuisance proportions. Soil erosion, manure, fertilizer, and organic debris such as leaves or grass clippings all contain nutrients. Preventing this material from getting into the lake will help alleviate nuisance conditions by addressing the problem at its source.

Most aquatic plants derive a majority of their nutrient requirements from the bottom sediment. As a result, nutrient-rich bottom sediment can support dense stands of vegetation for years. This suggests that even if nutrient inputs from the watershed (external nutrient loading) are significantly reduced, nuisance plant growth may still occur for a considerable period of time.

Table 5: Evaluation of Sediment/Nutrient Control as a Management Technique

Species controlled	All species, but especially exotics that are tolerant to nutrient-rich, eutrophic water quality conditions.
Effectiveness	Long-term effectiveness. However, observable results may not be evident for up to several years since lake sediments are already nutrient-rich as a result of previous sediment loading.
Benefits	Attacks the major source of the problem
Drawbacks	Even if sediment and nutrient loading to the lake are significantly reduced, nuisance plant growth can continue for many years given the high nutrient content of the existing lake bottom.
Lake-use restrictions	None
Land-use restrictions	Installation of Best Management Practices (e.g. erosion-control measures) on farms and construction sites along the shoreline and within the watershed. Adoption and enforcement of land use controls designed to mitigate erosion and stormwater runoff.
Permit requirements	NA
Costs	Highly variable depending on type and cost of actions taken in the watershed
Recommendation	Control sediment/nutrient sources in the watershed prior to and in conjunction with in-lake management efforts. This recommendation is already being implemented in the form of stormwater detention basins and barnyard runoff control systems. Additional measures may be required.

5.3 LAKE USE ZONING

Dividing a lake into distinct recreational user zones is an effective technique used to coordinate plant management efforts. This strategy recognizes that certain hours of the day and certain areas on the lake are best suited for particular activities. By regulating when and where these activities can occur, the lake management district can plan for better lake use and avoid problems that would otherwise develop. The manner in which aquatic plant life is distributed throughout the lake can help dictate the locations of specific user zones. For example, deeper, open water areas with little nuisance plant growth are probably best suited for motor boat enthusiasts. On the other hand, shallower areas with dense stands of native vegetation might be more appropriate for fishing and canoeing. Plant control strategies can then be more effectively directed, depending on how a particular user zone would best be managed.

Table 6: Evaluation of Lake Use Zoning as a Management Technique

Species controlled	None (this is a lake use modification strategy)
Effectiveness	NA (does not actually control plant growth)
Benefits	Conflicting lake uses can be better managed while protecting critical, sensitive areas. Plant control techniques can be more appropriately targeted depending on the needs of those recreating within a defined user zone.
Drawbacks	Recreational use of the lake may become more regulated. Monitoring and enforcement may be a challenge. Additional regulatory buoys will probably need to be purchased and installed to help define established user zones.
Lake-use restrictions	Recreational activities are either voluntarily or legally regulated through time and space zoning ordinances.
Land-use restrictions	NA
Permit requirements	Permits for the placement of marker or regulatory buoys will be needed.
Estimated costs	Costs would be associated with the extent of public education programs and enforcement activities. Buoys may need to be purchased to help delineate certain zones.
Recommendation	Divide the lake's surface area into recreational user zones that best reflect lake use preferences and priorities. It should be specified what activities are permitted in each zone and at what times. Marked buoys can delineate swimming areas, no-wake areas, etc. Volunteer lake watch patrols can be set up to assist with education and enforcement. Plant control techniques should be implemented that best support the goals and objectives of the particular user zone that is being managed.

5.4 MECHANICAL HARVESTING

Mechanical harvesting is a method of cutting aquatic vegetation a few feet below the water surface, where it is then collected and transported to a disposal site. Plant root systems remain in place after harvesting, allowing plants to quickly regenerate. Mechanical harvesting exhibits both selective and non-selective impacts on aquatic plants. Non-selectivity is demonstrated by the removal of all vegetation that falls within the reach of the cutter bars, regardless of plant type. A certain degree of selectivity is achieved since taller growing and free-floating species are removed along cutting routes. This plant selectivity can alter the composition of a plant community by encouraging the success of shorter-growing species while opening the understory up to additional sunlight.

Table 7: Evaluation of Mechanical Harvesting as a Management Technique

Species controlled	The top portion of all rooted plants that grow within five feet of the water surface, and are within reach of the mechanical harvester's cutter bars.
Effectiveness	Instantly effective at removing vegetation growing within five feet of the

	surface, but for short time periods due to plant regeneration. Up to one acre of lake surface can typically be harvested per hour. Relief can last as little as several days or up to three months depending on the situation. This technique is not as effective on fast growing and non-rooted aquatic plants species.
Benefits	Immediate relief from nuisance aquatic plants with minimum health and safety risk, and without significantly restricting water use during harvesting operations. Plant material and associated nutrients are removed from the lake. Some species selectivity is achieved by targeting monotypic stands of nuisance vegetation, operating at different times during the growing season, and altering the depth of cut. Community composition can be shifted to slower-growing species. Effective at opening boat navigation lanes, clearing swimming areas, and creating fish cruising lanes for edge habitat. The costs and environmental impacts associated with herbicides, dredging and other less desirable control techniques are avoided.
Drawbacks	Plants are only removed if located in deeper, open areas within reach of the cutting arm. Nuisance vegetation may grow back within a few weeks after harvesting. Non-selectivity of species in mixed plant communities. May encourage the spread of exotic species if plant fragments are not effectively collected from the water. Re-suspension of bottom sediment may occur if the harvester is used in shallow, mucky areas. Small fish, turtles and other aquatic organisms will be harvested along with the plants. Harvesting can be overused, destroying critical habitat.
Lake-use restrictions	Use of the lake should be restricted within at least a couple hundred feet of an operating weed harvester.
Land-use restrictions	Harvested plants will require temporary storage near the shoreline, as well as a final disposal site.
Permit requirements	No permits are required. However, harvested plant material must be removed from the lake by law.
Estimated costs	High initial capital investment for machinery. A mechanical harvester, shore conveyor and dump truck can run between $100,000 and $200,000. Annual operating costs may exceed several thousand dollars. These costs involve equipment maintenance and repair, storage, operator wages, insurance, etc.
Recommendation	Mechanical harvesting is one of the most viable options for Little Green Lake. It should be used as a primary measure for nuisance plant control, and can be used in combination with other recommended strategies.

5.5 AQUATIC PLANT SCREENS

Aquatic plant screens are synthetic barriers constructed of fiberglass mesh or polyvinyl fabric that are placed on the lake bottom in near-shore areas to smother existing vegetation, inhibit light penetration and prevent new plants from rooting. Installation requires securely anchoring the screens to the substrate in the spring before plants begin growing. Aquatic plant screens work well in small, shallow areas or where other methods are not viable. These barriers will need to be periodically removed and cleaned as sediment deposits on the screen surface. They should be applied in the spring and removed every 1-3 years in the fall for cleaning. The barriers do not effectively control algae or free-floating plants.

Aquascreen, a commercially available fiberglass screen coated with polyvinyl chloride, has been proven effective in controlling rooted aquatic plant growth. Burlap is also used, but typically rots within one or two seasons. The most effective materials are gas-permeable screens constructed of fiberglass, polypropylene or nylon. Commercially available screens have a high initial cost, but can last 5-10 years. This technique may be most appropriate in shallower areas around public swimming beaches where mechanical weed harvesting is inappropriate.

Table 8: Evaluation of Aquatic Plant Screens as a Management Technique

Species controlled	All rooted plant species (non-selective)
Effectiveness	Instantaneous, but a relatively short-term control technique. Aquatic plant screens require cleaning and reapplication every 1-3 years, depending on sediment accumulation rates.
Benefits	Immediate control of all rooted vegetation in small, shallow areas where mechanical harvesters cannot reach. Effective technique at controlling nuisance plant growth around piers and boat lifts.
Drawbacks	Not a species-specific control technique, and may destroy high quality plant communities and fishery habitat. Very labor intensive, and cost-effective only in small, shallow areas. May be difficult to install on steep slopes or uneven substrates, and trapped gases may cause lifting of the barrier. Routine cleaning and reapplication is necessary.
Lake-use restrictions	None
Land-use restrictions	None
Permit requirements	A DNR permit is needed prior to installation.
Estimated costs	Expensive to purchase initial materials. Costs vary depending on type of materials used and size of treatment area.
Recommendation	Use only in small areas (less than 200 square feet) around piers, docks, and at public swimming beaches that are infested with nuisance plant growth. Recommended as a potential technique for lakefront property owners who may need to control nuisance plant growth around piers and boatlifts.

5.6 SHADING

Shading is a technique that involves the use of soluble dyes, artificial structures, or overhanging terrestrial vegetation to limit plant growth by inhibiting light penetration. Dyes are used to temporarily color the water to reduce sunlight penetration and spectral quality needed for photosynthesis. Dyes offer very short-term control, may be difficult to apply in larger bodies of water, and are not species specific. They require repeated treatments and are easily diluted by wave action, precipitation, or in-flowing water. Dyes are most commonly used in small ornamental ponds. Manmade structures and overhanging vegetation will partially inhibit light penetration, but shade tolerant species may still grow. By planting the appropriate shade trees along the shoreline, near-shore aquatic vegetation can be naturally controlled. These shoreline plantings also provide a vegetative buffer strip that acts as a natural water quality filter and offers wildlife habitat benefits.

Table 9: Evaluation of Shading as a Management Technique

Species controlled	All species (with the exception of some shade tolerant species)
Effectiveness	Not as effective and generally not recommended on larger bodies of water. Dyes are very short-term, while manmade structures and overhanging vegetation are longer-term control measures. Shade from overhanging vegetation will only inhibit aquatic plant growth that occurs in close proximity to the shoreline.
Benefits	The use of shoreland vegetation is a natural means of controlling near-shore plant growth. These upland vegetative "buffers" are also aesthetically pleasing, act as nutrient and pollutant filters, and create riparian wildlife habitat.
Drawbacks	Shading using shoreline vegetation is not a species-specific control technique, and is difficult to implement on a lake-wide basis. It requires the cooperation of lakefront property owners who often prefer turf grass up to the water's edge.
Lake-use restrictions	None
Land-use restrictions	Shoreline vegetation may partially obstruct lake views and reduce open lawn areas.

Permit requirements	The placement of artificial structures on the bed of a lake or within the shoreland zone will require a DNR permit.
Estimated costs	Inexpensive. Costs depend on the type and quantity of plants and trees that are purchased from a local nursery, as well as the amount of labor needed for planting.
Recommendation	Dyes and manmade structures are not recommended. However, lakefront property owners are to be encouraged to work with local nurseries to establish native vegetative buffers along their shorelines.

5.7 WATER LEVEL MANIPULATION

This strategy refers to the raising or lowering of water levels to control aquatic plant growth. By raising water levels, sunlight availability is reduced, as light must penetrate to greater depths. Plant growth is thereby limited due to the reduction in sunlight that is able to penetrate to the lake bottom. Unfortunately, raising water levels often exacerbates shoreline erosion problems. It may also cause previously dry areas to flood, allowing these areas to become susceptible to the infestation of nuisance aquatic plant growth.

The lowering of water levels (referred to as a drawdown) is used to expose the root systems of shallow-water plants to the effects of freezing, drying and sediment compaction. A four to six-month drawdown period is typically required to be effective. Partial drawdowns of a few inches to several feet to expose small, near-shore areas are often used to allow some ongoing use of the lake. However, any summer drawdown will impact lake use, may stress certain fish species, and may allow emergent plants to colonize the lakebed. A winter drawdown, on the other hand, permits lake use in the summer, but may affect fish survival and lead to dominance by submergent plants resistant to drawdown.

Water level manipulations are often not physically possible on certain lakes. The technique is limited to lakes that have adequate water control structures, and the ability to refill within a reasonable amount of time following a drawdown. Dam controlled flowages are usually targeted for this type of plant control technique. Some nuisance species are tolerant to this method of control, or may be favored as a result of habitat disturbances that eliminate competing native species. Because water level manipulations are not very species sensitive, native communities may be inadvertently damaged or eliminated in the process. Although the composition of aquatic vegetation may be altered as a result of this technique, desirable changes are not always produced. The responses of various aquatic plant species to a water level drawdown vary widely and sometimes unpredictably.

Table 10: Evaluation of Water Level Manipulation as a Management Technique

Species controlled	Variable
Effectiveness	This strategy is relatively short-lived, and requires one full season of implementation.
Benefits	When conditions are feasible, it is an inexpensive process. Secondary benefits include sediment oxidation and consolidation that may help deepen near-shore areas.
Drawbacks	Not a very species-specific control technique. There may be increases in undesirable plant species, and decreases in desirable species. This technique can dramatically impact recreational use of the lake.
Lake-use restrictions	Numerous lake-use limitations caused by the lowering of water levels.
Land-use restrictions	If water levels are raised, previously dry areas may become flooded.
Permit requirements	Permits are generally from the DNR and U.S. Army Corps of Engineers to artificially manipulate water levels on navigable bodies of water.
Estimated costs	Inexpensive if suitable conditions prevail
Recommendation	Not recommended since Little Green Lake is not a flowage, and does not have a suitable outlet control structure. It will also take a considerable amount of time to refill the lake in the event of a drawdown. This type of control measure

	is likely to destroy the few remaining plant communities of high quality while favoring the proliferation of non-native, nuisance species.

5.8 DREDGING

Dredging involves the physical removal of sediment and associated rooted plants. In extreme cases of overgrown aquatic vegetation, conventional or specially adapted dredging machines may be used to remove vegetation and underlying sediments. The resulting depth increase, if sufficient, will reduce or eliminate the potential for rooted vegetation to become re-established by inhibiting light penetration.

Dredging operations are very expensive to implement, and the disposal of sediments can be difficult if a nearby disposal site is not available. This strategy commonly causes an increase in turbidity due to sediment re-suspension, destroys habitat, and may permit deeper water plant species to spread. It is not species-specific, and is usually a short-lived treatment method unless sediment is removed from within the photic (light-penetrating) zone. Spot dredging to create boat channels is a cheaper compromise to dredging an entire lakebed.

Table 11: Evaluation of Dredging as a Management Technique

Species controlled	All rooted species (not species-specific)
Effectiveness	Instantaneous and long-term effectiveness if nutrient-rich sediment is removed to a depth that inhibits further sunlight penetration.
Benefits	Removes both plants and sediment while increasing water depths
Drawbacks	This technique is not species-specific, is expensive, requires a suitable disposal site, and increases the potential for negative environmental impacts (e.g. increased turbidity, loss of habitat, etc.).
Lake-use restrictions	Lake uses would be restricted near active dredging operations
Land-use restrictions	A large area of land will have to be used to de-water and dispose of plant material and associated sediment.
Permit requirements	Multiple permits related to the excavation and disposal of sediment are required.
Estimated costs	Very expensive
Recommendation	Not recommended unless a motorboat access channel needs to be deepened to allow for public access of the lake.

5.9 BIOLOGICAL CONTROL

Biological controls involve the use of plant species, insects, pathogens or herbaceous fish to out-compete or consume nuisance plant species. Once a biological control is introduced into a particular ecosystem, it is usually extremely difficult to predict where and how it will grow and proliferate. It is also difficult to determine whether there will be negative environmental repercussions as a result of the introduction. On the positive side, biological controls have the potential to be permanent, self-perpetuating, and inexpensive over the long run. The following are some examples of biological controls.

Insects: Native beetles called weevils (*Euhrychiopsis lecontei*) are increasingly used as a biological control for Eurasian watermilfoil. Weevils are shown to feed on this nuisance plant without damaging other native plants or animals. The adult weevil is only 2-3 millimeters, or slightly smaller than a grain of rice. The adult lays eggs on the growing tips of milfoil which hatch within a week into larvae that feed upon the plant. While the adults and larvae both feed on milfoil leaves, the larvae do the most destruction by eating the conductive tissue inside the stem. Eventually, damaged plants loose buoyancy, fall to the bottom of the lake and slowly decay. It generally takes from one to three years for the beetles to permanently stabilize Eurasian watermilfoil below problematic levels (depending on application densities). As milfoil decreases, the beetle population gradually declines to a self-sustaining level. The introduction of weevils to control milfoil is a new technique that has shown positive results.

Pathogens: Restrictions regarding the importation of plant pathogens from abroad tend to prohibit this approach and limit the scope to native pathogens. Pathogens also tend to be environmentally sensitive, and populations do not remain high enough for sustained suppression of weed populations.

Herbaceous fish: Adult grass carp are commonly used in many parts of the world to control plant growth through consumption. Native to China and the Soviet Union, grass carp are known to decimate entire plant communities as a result of their voracious appetites. There are many potential problems associated with the introduction of grass carp. They are difficult to control and may cause increased turbidity, algae blooms, and nutrient recycling. They can also facilitate oxygen depletion, destroy vegetative habitat, and consume beneficial plant species. Grass carp introductions are currently prohibited in Wisconsin.

Information provided in the table below is specific only to the weevil, a native beetle that feeds on Eurasian watermilfoil. The weevil was selected independently for evaluation as a biological control technique since it is the most feasible option available for Little Green Lake.

Table 12: Evaluation of Biological Control as a Management Technique

Species controlled	Weevils are shown to be effective against Eurasian watermilfoil.
Effectiveness	Observable results are not immediate, and may not occur within the first few years following introduction. Medium-term to long-term effectiveness depending on application rates and survivability of the weevil once introduced.
Benefits	This technique is low maintenance, and should minimize the potential for negative environmental consequences. It should not interfere with the recreational use of the lake. Current research suggests that use of the weevil may be a permanent, self-perpetuating control agent.
Drawbacks	Eurasian watermilfoil will not be completely eradicated. Once a biological agent is introduced, it is difficult to control its growth or target its effectiveness. The use of weevils to control milfoil is still experimental. The effect of the weevil may be compromised if other plant control methods are implemented following introduction.
Lake-use restrictions	None
Land-use restrictions	None
Permit requirements	A DNR permit may be required
Estimated costs	Costs will vary depending on the size of treatment area, and number of biological agents introduced. A similarly sized lake in southeastern Wisconsin spent about $15,000 for a recent weevil introduction.
Recommendation	Experimental use of the weevil is recommended to help control Eurasian watermilfoil populations. Treated areas should not be harvested or exposed to herbicides.

5.10 CHEMICAL CONTROL

Aquatic herbicides are often used in problematic areas to aggressively control small pockets of nuisance, pioneer species before they have spread throughout the lake. Preferred treatment areas are small, confined and absent of high quality native species. Herbicides can be either broad spectrum or fairly species-specific. Contact and systemic herbicides are both available and commonly employed, but each leaves plants in the water to die and decay. Application rates and frequencies depend upon physical conditions (e.g. wave action, currents, dilution, water temperature, etc.). Plants differ considerably in their susceptibility to chemical treatment. Chemical treatment should be viewed as a last resort when other methods fail or prove infeasible.

This treatment method may limit certain water uses, and chemical drift can potentially damage or destroy desirable plant beds.

A WDNR permit is required for chemically treating aquatic plants in waters of the State. In many cases, only a licensed applicator certified by DATCP can apply chemicals to lakes. Currently, only eight herbicides are labeled for use in aquatic environments. Two of these, xylene and acrolein, are highly toxic and used only in irrigation systems in 17 western states. This leaves six active ingredients (copper, 2,4-D, dichlobenil, diquat, endothal, fluridone and glyphosphate) that are contained in herbicide formulations that are currently labeled for use in aquatic sites in most states. Endothall, diquat and copper are contact aquatic herbicides (not effective on perennials). Dichlobenil, 2,4-D, fluridone and glyphosphate are systemic aquatic herbicides (effective on perennials, and more species selective).

The herbicide 2, 4-D (2,4-dichlorophenoxyacetic acid) is one of the most common and most effective chemicals used to systemically control Eurasian watermilfoil. Although effective against Eurasian watermilfoil, it cannot control curlyleaf pondweed. This particular herbicide has been shown in certain situations to shift community composition from watermilfoil and coontail, to beneficial pondweeds and wild celery. Proper timing of herbicide applications is extremely important for both effective control and to avoid other potential problems. Timing involves knowing water temperatures, waiting until vigorous plant growth is present, but not waiting until plants are fully grown which would result in large amounts of weeds decomposing and robbing the water of oxygen.

Table 13: Evaluation of Chemical Control as a Management Technique

Species controlled	Dependent upon type of herbicide used. Difficult to not impact non-target plant species.
Effectiveness	Certain species may be controlled within a short timeframe, but the effect may be relatively short term. This strategy will need to be repeated as treatment areas are re-colonized by new plants.
Benefits	Chemical applications can clear an area of vegetation within a short period of time. Fish toxicity is generally not a problem when used in recommended doses.
Drawbacks	Chemical applications may cause dissolved oxygen problems as plants are left in the water to decay. Herbicides may harm sensitive aquatic organisms, and can potentially damage non-targeted plant species. Treated areas may be prone to re-colonize with more aggressive, pioneer species. Chemical introductions are prone to be publicly contentious due to negative health and environmental effects (both real and perceived).
Lake-use restrictions	A waiting period for certain lake uses may be required following application.
Land-use restrictions	None
Permit requirements	A DNR permit is required
Estimated costs	Relatively expensive in many cases. Costs depend on type of chemical used and size of treatment area among other factors.
Recommendation	Not recommended unless "spot" herbicide treatments are used strictly to control small pockets of invasive species in fairly confined areas.

5.11 MANUAL HARVESTING

Manual harvesting is a labor-intensive method used to cut and/or remove emergent, floating or submergent aquatic plants from the substrate. This is usually the simplest, most species-selective method for small, shallow water areas. Plants should be pulled from the sediment by the base so the root systems are removed in their entirety. The frequency and practicality of continued hand harvesting depend on the availability of labor, the re-growth or re-introduction potential of the vegetation, and the level of control desired.

Manual harvesting techniques include dragging, raking, cutting and pulling. Dragging is an inexpensive method that involves pulling "draglines" through weed beds. Draglines are constructed of rope, wire or chains that can be placed into the water from either shore or boat, and then pulled in manually or towed. They are often used in water that is greater than six feet deep, but are not effective at removing root systems. Raking can be done in shallow water with a long-handled steel garden rake or pitchfork. The root systems of certain plant species will be removed, while others will remain in place. Hand-held weed cutters are specially designed rakes or cutters that are manually thrown out into the lake and slowly retrieved. While rakes can remove the entire root systems, cutters usually leave root systems to regenerate. Hand pulling is the most labor-intensive method, but it is also the most effective and species-specific.

Table 14: Evaluation of Manual Harvesting as a Management Technique

Species controlled	Hand harvesting is very species specific. Dragging, raking and cutting are not as species specific, but can be focused within specific areas.
Effectiveness	Instantaneous control. Medium to longer-term effectiveness is possible when root systems are removed.
Benefits	Excellent method of selectively controlling nuisance plant growth around piers and boatlifts with few negative environmental impacts.
Drawbacks	This method is very labor intensive and slow. Only small, shallow areas can be treated effectively.
Lake-use restrictions	None
Land-use restrictions	Harvested plants will require temporary storage and final disposal sites.
Permit requirements	None
Estimated costs	Very inexpensive in terms of materials. Most costs are incurred through contracted labor.
Recommendation	Lakefront property owners should be encouraged to use manual harvesting techniques on nuisance plant growth that occurs around private piers and boatlifts.

5.12 NATIVE PLANT RESTORATION

The restoration of native aquatic plant communities is ideal whenever feasible as a plant control method. Maintaining and facilitating the propagation of native plants in lakes is often the most effective and ecologically responsible means of nuisance plant control. The right types of native plants can be used to attract waterfowl, promote fish spawning, retard shoreline erosion, improve water clarity, and prevent the spread of exotic species. Short species can be planted to compete with taller ones that disrupt boating. Broad-leaved species can be grown to diversify monotonous stands of finely branched plants. Aquatic plants can be grown from seed or transplanted as cuttings, winter buds, tubers or whole plants. Nails or clay can be attached to sink the plants to the lake bottom.

Table 15: Evaluation of Native Plant Restoration as a Management Technique

Species controlled	Any nuisance, pioneering plant species that would otherwise invade and occupy a given space on the lakebed.
Effectiveness	This is an ecologically sound strategy that can have a very positive, long-term effect. Newly transplanted areas should be protected from further disturbance (e.g. motorboat traffic) while the plants struggle to become established.
Benefits	Increases the number and diversity of native species. Helps prevent the spread of nuisance species through natural competition.
Drawbacks	Success rate of newly transplanted plants can be very low. Recently restored areas will need to be actively protected and monitored to avoid the re-infestation of exotic species.
Lake-use restrictions	Newly planted areas should be protected from motorboat traffic for at least a

	full growing season.
Land-use restrictions	None.
Permit requirements	None.
Estimated costs	Generally not very expensive. Actual costs will depend on size of treatment area, as well as the number and types of plants used.
Recommendation	Attempts could be made to transplant native species on exposed portions of the lake bottom where nuisance, pioneer species threaten to re-colonize.

SECTION 6
COMPREHENSIVE ACTION PLAN

6.1 STEP 1: ADDRESS PROBLEM SOURCE

The first step is to attack the nuisance weed problem through preventative measures that reduce the amount of sediment and nutrients that enter the lake. Nuisance aquatic plant conditions are typically a biological consequence of accelerated eutrophication. Shallow, nutrient-rich lakes like Little Green are prime candidates for heavy plant growth, especially following the influx of sediment caused by watershed disturbances. Because lakes are a reflection of their watershed, water bodies located in fertile soil regions with high erosion rates will support more plant life than those situated in areas with less fertile soils and lower erosion rates. In fertile lakes like Little Green, aquatic plant management must be viewed as a long-term commitment.

Preventative actions that target the source of a problem rather than the symptoms are the best means of achieving a long-term reduction in excessive plant growth. Reducing the influx of surplus nutrients and sediments into the lake, for example, can limit the extent of a nuisance plant problem and prevent it from worsening. Adopting and enforcing zoning and land use ordinances that protect the shoreline and lakeshore wetlands, reduce construction site erosion, and control stormwater runoff are effective means of controlling this external nutrient and sediment loading. After the impacts of watershed disturbances are minimized to the greatest extent possible, the implementation of in-lake management techniques can begin. The Little Green Lake Management Plan (1997) should be consulted for detailed descriptions of nutrient-reduction strategies and advice on the proper implementation of these strategies.

6.2 STEP 2: MANAGE LAKE USE VIA TIME/SPACE ZONING

The second step is to plan better lake use through the implementation of time and space zoning. This behavioral measure is intended to regulate the use of the lake in a manner that best supports majority interests without ignoring minority interests. It is a means of maximizing the enjoyment of conflicting and mutually exclusive lake-use activities through the development of time and space parameters. As a result, situations are avoided that allow one type of activity to occur to the detriment of another. Enjoyment of the lake is maximized by simply designating the most appropriate times and places for certain activities to take place.

By dividing a lake into separate and distinct user zones, conflicting recreational uses can occur with limited interference. The lake surface is essentially delineated into multiple recreational user zones based on any number of criteria. Criteria to be considered include identified lake-use priorities, time/location preferences for certain activities, and the locations of sensitive areas such as high quality fishery habitat or important waterfowl nesting sites.

This technique is commonly used to avoid conflicts between anglers, boaters, swimmers and wildlife by prohibiting certain uses during a specified time of the day or in selected areas. Specific management strategies can then be tailored to each zone, and unnecessary treatments (e.g. applying herbicides to areas best left for fish spawning or endangered species) can be avoided. Allowing water skiing and jet skiing between 10:00 a. m. and 5:00 p.m. is an example of time zoning. For space zoning, specific shore areas of the lake could be limited to swimming or fishing, while motorboating and water skiing is confined to deep, open water areas. If necessary, certain zones such as senitive areas can be cordoned off and marked using special buoys. A map illustrating potential user zones on Little Green Lake is presented in Appendix D.

As a sidebar, it is well documented that motorboat traffic can have a detrimental impact on native plant communities. Prop wash from boat motors causes scouring of the lake bottom in shallower areas, while propeller blades inflict physical damage to any plant within reach. These disturbances are conducive to the spread of exotic, invasive species that are able to tolerate harsher environments and exploit recently disturbed areas. Whenever possible, no-wake zones should be designated in shallow water areas (e.g. less than 9 feet deep). No-wake zones should also be established within a certain distance of the shoreline to help prevent shoreline erosion problems caused by wave action. State law currently prohibits the operation of motor boats at speeds greater than slow-no-wake within 100 feet of the shore and other boats on the lake. This distance is expanded to 200 feet for personal watercraft such as jet skis.

6.3 STEP 3: IMPLEMENT STRATEGIES APPROPRIATE FOR EACH USER ZONE

Plant control strategies should be selected and implemented that would most cost-effectively address the unique needs of each recreational user zone identified in Step 2. They should also be used in a manner that targets Eurasian watermilfoil and curlyleaf pondweed, while protecting native plant beds as much as possible. Manipulating habitat (e.g. substrate, sunlight availability, etc.), selectively removing undesired plants or plants that occur in undesired locations, and encouraging desired plant growth in desired locations are all ways of managing aquatic plants to improve the quality of a lake. Many of these techniques were discussed and evaluated in the previous section.

The aggressive use of a single, "silver bullet" strategy to manage all areas of the lake regardless of circumstance is strongly discouraged. For this reason, a number of different strategies will be discussed in this section. Selection will depend on the nature of the particular problem that is being addressed, as well as the desired outcome that is sought in terms of recreational enhancement. The effectiveness and benefits of each plant control method must be weighed against potential impacts on non-target plants and animals, as well as impacts on water uses such as swimming and fishing. If the lake has a mucky bottom and shore, controlling plant growth to create swimming areas does not mean people will swim there.

The following table lists each strategy, its potential uses, and the recreational user zone(s) where the strategy would be most appropriate. An integrated approach that uses mechanical harvesting in combination with one or more of the strategies listed below is recommended for Little Green Lake.

Table 16: Summary of Plant Control Techniques and Implementation Strategies

Technique	Recommended Use(s) & Applicable User Zone(s)
Mechanical harvesting (*Primary control strategy*)	Recommended as a primary control strategy in the following situations: • Public launch sites that require motorboat access channels as links to open water areas • Weed-choked areas designated as open-water boating sites, public swimming beaches, etc. • Prime fishing areas that are becoming overgrown with nuisance vegetation, and that could benefit from more edge habitat in the form of fish-cruising lanes
Aquatic herbicide treatments	Not recommended since the treatment areas would be too large and undefined. This strategy works best in small, confined areas of nuisance vegetation growth, and before the problem has spread throughout the lake.
Biological controls	Recommended as an experimental strategy on large control plots using native weevils (*Euhrychiopsis lecontei*) that feed on Eurasian watermilfoil.
Dredging	Not recommended given the high expense in relation to its limited effectiveness and ecological side effects.
Water level manipulations	Not recommended given the nature of the lake, its outlet structure, and water recharge rate.
Aquatic plant screens	Recommended in small, shallow, weed-choked areas around public swimming beaches, piers and rafts. Also recommended for similar uses by private lakefront property owners.

Shading	Recommended in near-shore areas where trees and other shade-producing vegetation can be planted. Lakefront property owners could be encouraged to install vegetative buffer strips in the shoreland area. The use of soluble dyes as a shading technique is not recommended given the extent and scale of the problem.
Manual harvesting	Recommended as a plant-control tactic for lakefront property owners who need to address weed-choked areas around piers, boat lifts and swimming rafts. SCUBA divers can also be employed to create relatively long-term access channels by cutting Eurasian watermilfoil (following canopy formation) a few inches from the lake bottom.
Planting/restoration	Recommended in small, sheltered areas following the eradication of nuisance plant species.
No action	Recommended in critical sensitive areas that require protection for fish spawning, wildlife habitat and native plant biodiversity purposes. Motorboat traffic and other disturbances should be prohibited in these areas. Critical sensitive areas might include waterlily beds for fisheries habitat, bulrush stands for shoreline protection, and wetland habitat for water quality protection. Diverse, native plant communities should also be protected whenever feasible.

6.4 STEP 4: COORDINATE PUBLIC INFORMATION & EDUCATION CAMPAIGN

The lake management district is advised to solicit the support and cooperation of all Lake Users by implementing a public information and education (I&E) campaign. This will increase the understanding of what can and cannot be done with a weed management program. For instance, the public should be informed as to why certain areas of the lake are harvested and others are not. The public should also know the harvesting timetable, and the possibilities and reasons for delay. I&E pamphlets, signs, press releases, newsletters, radio and television spots, and public meetings represent some of the methods used to communicate with the public. Communicating the goals and objectives of an aquatic plant management program is an excellent way of garnering community support through increased awareness and understanding.

Lake Residents should be encouraged to properly manage nuisance plant growth around their own piers, boatlifts and swimming rafts using approved methodologies. Given the shallow water depths and risk of property damage in near-shore areas, it is the lakefront property owner's responsibility to manage these areas as they see fit. They should therefore be educated on the benefits of aquatic plants, how to distinguish between native and exotic species, and approved methods for nuisance plant control. Lakefront property owners should also be encouraged to remove floating plant debris from the water when it washes onto their shorelines. It is important for people to realize that not all plant fragments are produced from harvesting operations. Severe weather, boat traffic and natural plant fragmentation are usually the main culprits. Finally, highly visible signs should be posted at launch sites that explain important boating ordinances, the location of no-wake zones, and other lake rules and regulations. Lake Residents should fully understand the damage they are likely to cause by aggressively operating their motorboats or personal watercraft in shallow, near-shore areas.

Information and education is an ongoing process as long as an aquatic plant management program is in place. New people moving into the area will need to be informed and educated, while others will require occasional reminders.

6.5 STEP 5: DEVELOP MONITORING PROGRAM

A monitoring program should be developed for the purpose of documenting changes in the type, abundance and distribution of the different plant species found in Little Green Lake. Knowing how the aquatic plant community responds to various management actions is essential in ensuring that the program remains cost-effective over the long-term. Because a plan is only as good as the information it is based upon, maintaining accurate and current plant survey data is very important. It is recommended that the lake management district repeat the aquatic plant survey at least every two to three years. The information can then be used to evaluate the success of the present management strategy and determine if modifications are appropriate.

It is also recommended that the lake management district form a Volunteer Lake Watch Patrol. The Lake Watch Patrol would operate similar to a neighborhood watch program. Volunteers would patrol the lake on certain days throughout the summer when local law enforcement officials are unable to maintain a presence on the lake. A non-confrontational approach would be used to inform boaters of alleged violations when they are observed. Repeat violators would then be documented and reported to the police. The Lake Watch Patrol could also be tasked with monitoring the aquatic plant community. Any observable changes would be reported on lake maps and/or log sheets. All Lake Watch participants should be trained in boating safety, applicable lake rules and regulations, and aquatic plant identification.

SECTION 7
MECHANICAL WEED HARVESTING STRATEGY

7.1 INTRODUCTION

Aquatic plant harvesting can do much to help improve the short and long-term quality of a lake. However, anyone who enters into a harvesting program must realize that there are no miracle cures for a shallow, eutrophic lake system, and that simply buying a harvester will not solve every problem. Mechanical harvesting should be viewed as a long-term commitment where operational intensity will vary from year to year depending on actual need. An effective harvesting program requires a great deal of work and a significant time commitment. It involves maintaining, storing and deploying multiple pieces of equipment. It also involves finding and training employees or volunteers; providing insurance; securing launching and unloading sites; locating disposal areas; record keeping; and maintaining public relations. However, once a program is established, significant cost savings and other benefits can be realized.

The lake management district should be aware of the possible impacts associated with plant harvesting. Harvesting theoretically removes nutrients from the lake in the form of plant tissue. Early concerns about cut "stumps" of aquatic plants pumping nutrients into the lake appears not to be the case, or at least the effects are so small that they cannot be measured (Carpenter and Gasith, 1978). Significantly reducing nutrient levels is extremely difficult, but could possibly occur if harvesting is continuously repeated. Weed harvesting is not recommended as a major nutrient-reduction strategy for Little Green Lake.

It is inconclusive whether harvesting stimulates plant growth. Apparently, the surface canopy of vegetation is removed which allows plants deeper in the water column to grow, or the terminal growth of a plant is removed which allows more energy for lateral growth. In effect, there appears to be more plants, but there may be little or no additional biomass created. Some studies suggest that intensive harvesting occurring two or three times a season can in fact reduce plant growth in subsequent years (Nichols and Ckottam, 1972).

There is little or no evidence that harvesting can be used to restructure plant communities. In fact, evidence points in the opposite direction (Nichols and Cottam, 1972). Many weedy species are disturbance tolerant, and harvesting is a disturbance. They thrive at the expense of disturbance intolerant species, or they are replaced by more disturbance tolerant species that may pose greater problems. Therefore, mechanical weed harvesting should be employed on a limited scale and only to target specific areas for specific purposes.

7.2 EQUIPMENT NEEDS

Mechanical harvesting typically employs a floating mechanical weed harvester, dump truck, trailer and shore conveyor. The harvester is most often constructed upon a low-draft barge controlled by paddle wheels, and is equipped with one horizontal and two vertical cutter bars. Traditional cutter bars harvest plant material that grows within a certain distance of the water surface (generally 3-5 feet). Once cut, hydraulic conveyors built into the harvester hoist the aquatic plants onto the deck of the barge where they can then be transported to shore to be off-loaded into an awaiting dump truck using another conveyor system. Depending on its size, a harvester can store between two and eight tons of wet plants before it must return to shore to empty its load.

New harvesters are being developed to cut aquatic plants off at root level, which prevents plants from rapidly re-growing. The drawback is that these new machines will be more likely to encounter underwater obstructions and disturb bottom sediments. Deep cutting harvesters are not recommended for Little Green Lake in most situations. Poor water clarity and a mucky substrate make it extremely difficult for these types of machines to operate without inadvertently disturbing bottom sediments and destroying aquatic habitat. Smaller-sized harvesters with a shallower draft and mechanical cutters that cut plants, but do not collect the plant fragments are also available. Smaller harvesters can be used to open lanes near shore and groom the edges of piers. A major drawback is that plant fragments cannot be left in the water, and it can be very labor intensive to gather all the plant fragments that are left behind by these types of harvesters. Finally, tiller barges (also known as rotovators) are available that are actually designed to cut into sediments to destroy the root systems of plants. These machines can cause turbidity problems through the re-suspension of bottom sediments. They also destroy aquatic habitat for bottom-dwelling fauna, and leave plants in the water to decay.

The following should be considered when purchasing an aquatic plant harvesting system: size and morphology of the lake, cost of the equipment, plant storage capacity, speed of operation (ranges from 0.5-1.5 acres/hour), depth of cut (generally 2-5 feet), width of cut (generally 5-10 feet), ease of transportation on land and water, and time required to complete a full cutting cycle. Appropriate machinery for Little Green Lake would include one larger-sized harvester, a harvester trailer, a dump truck, and a shore conveyor. A transport barge is optional, and may be considered to help improve overall efficiency.

7.3 OPERATIONAL SETUP

A number of steps will need to be taken before the lake management district can implement its own weed-harvesting program. The first step is to secure the appropriate equipment. A harvester that cuts and then collects the harvested plant material without disrupting the lake bottom will probably offer the most benefits for the cost. These harvesters work best in waters that are three to six feet deep, and where nuisance vegetation reaches the surface. They should never be used in shallow water areas less than three feet in depth, and will be most effective if used in specific locations and for specific purposes. Clearing navigation channels for motorboats, managing public swimming areas, and creating fish-cruising lanes for the purpose of establishing additional edge habitat are examples of targeting mechanical harvesting efforts where they will be most effective. The best times to harvest are mid-June and mid-July when plant growth reaches the surface and assuming no fish spawning is occurring. A conveyor system and dump truck will need to be obtained to off-load and dispose of the harvested plant material.

The next step is to identify a launching site and a storage location for the equipment. Keep in mind that weed-harvesting machines range from 32 to over 43 feet long, may exceed 17 feet in width, and can weigh over seven tons. The launch site must have a fairly extensive turnaround area and sufficient water depths to allow the harvester to be maneuvered into the lake. The public boat ramp at Kearly Bay is currently one of the most feasible options. A sheltered location along the shoreline will also be necessary to park the shore conveyor and weed harvester when they are not being used during the operating season. The selected shoreline must be easily accessed by a dump truck in which harvested plant material will be deposited and hauled away. If a public site is not available, shoreline space may need to be rented from a private property owner. Finally, equipment storage space during the off-season will need to be located. An indoor storage site of sufficient size to store all the equipment, and in close proximity to the launch site is preferred. Again, if a public site is not available, storage space may need to be rented from a private owner.

A disposal site is required for the ultimate disposal of the harvested plant material. Transportation may represent a large percentage of the total harvesting cost, so a disposal site in close proximity to the off-loading site is ideal. In most cases, local farmers can be persuaded to take the plants for fertilizer. Aquatic plants compare favorably with cow manure as a source of nutrients (2.5% nitrogen, 0.6% phosphorus, and 2.3% potassium) and can add valuable, seed-free organic matter to the soil. Another option is to find a composting facility that would accept the material. Harvested plants should not be disposed in the water or along the shoreline to avoid unsightly, smelly conditions where nutrients can leach back into the lake.

Before operations can commence, the lake management district must find individuals who would be able to operate and maintain the equipment on a semi-regular to regular basis. A minimum of two, well-trained individuals are needed, and would preferably be available on a year-to-year basis. One person would operate the harvester while the other would operate the shore conveyor and dump truck. Ideally, one or both of these individuals would also be qualified to maintain and repair the equipment when it is needed.

The dump truck driver may need to obtain a Commercial Drivers License before operating the vehicle, especially when towing the weed harvester back and forth from storage. Another person may be needed if the lake management district elects to use a transport barge to increase operational efficiency. Costs in terms of wages, benefits and insurance depend on how many people are employed and how often they are needed to operate the machinery each season. It is recommended that the lake management district board appoint a weed harvesting committee to oversee the program.

7.4 OPERATONAL IMPLEMENTATION

Before the operating season commences, the harvesting crew should be trained on the safe and effective use of the equipment. The crew should be responsible for properly maintaining the equipment and knowing what action to take in the event of a system malfunction or other emergency. Experience at identifying different plant species and being able to distinguish between native and exotic vegetation is a must. The operator should become familiar with the locations of potential underwater obstructions, shallow water depths, and protected areas (i.e., critical habitat, high quality plant beds, etc.). It may be helpful for the lake management district to provide waterproof lake maps showing the launch site, off-loading site, weed control target areas, underwater hazards, and protected areas. Color photos of Eurasian watermilfoil and curlyleaf pondweed could also be provided to assist the operator in properly targeting these two nuisance species.

Operations should begin no sooner than mid-June to allow time for the vegetation to grow within reach of the harvester, as well as to avoid most of the fish-spawning season. The harvesting season usually ends during the last week in August or the first week in September. Cutting will usually be carried out between the hours of 7:30 a.m. and 3:30 p.m. on weekdays during optimal weather conditions. The actual amount of time needed for harvesting each season can vary dramatically, making scheduling difficult at best. The amount of lake surface area covered, number of plant loads collected, or hours spent on the lake harvesting is irrelevant and should not be used to gauge success. Changes in plant abundance and rate of growth are dependent upon a number of variables independent of a harvesting program. The goal is simply to keep high-use recreational areas clear of nuisance vegetation, while protecting critical, sensitive areas. Therefore, control efforts should target nuisance stands of Eurasian watermilfoil and curlyleaf pondweed, while avoiding native plant beds. Native plant growth must be protected and even encouraged so that the lake remains healthy and able to continue to provide an environment that will support fish and wildlife.

Target areas include high-use, recreational areas that may need to be cut as often as two or three times per season during heavy growth. Some "hot spots" may occur because of rapid plant growth and may require cutting as many as 4-5 times during the summer. Cutting is done when plant densities are high and a nuisance condition exists. To avoid disturbing bottom sediments, no harvesting is performed any closer than one foot from the bottom of the lake or in water less than three feet deep. Loose, mucky or silty substrates and stump fields in shallow areas should be avoided to prevent the re-suspension of bottom sediments or damage to the machinery. Exotic plant species will be harvested when they are visible at the surface, and cut to a maximum depth of five feet below the water surface in these designated target areas.

Operators should be instructed to monitor the number and types of fish picked up by the harvester. Larger fish and turtles should be safely and expeditiously returned to the lake. When large numbers of fish are encountered, harvesting is temporarily stopped in that area until the fish have moved on. Spawning beds should be avoided during the early part of the season. The operator can return to these areas later in the season when spawning has ended. While harvesting, all floating plant debris must be immediately removed from the water. The operator should make every effort to pick up floating plant fragments when making turns and during trips to and from the loading site. Shoreline cleanup crews can be used to retrieve plant fragments that float into shore.

Mechanical harvesting strategies: Macro and micro harvesting are two different strategies used to control plant growth in a lake. Macro-harvesting aims to open as much area of water surface as machine, budget and daylight allow. This method is effective at opening large areas of the lake for water sports, removing exotic foliage that stymies less aggressive native plants, and reducing the level of stunting by plant-dwelling panfish.

However, if performed too aggressively, the clear-cutting strategy causes numerous problems with shoreline erosion, sediment re-suspension, loss of habitat, and the proliferation of undesirable species. Furthermore, recreational activities such as fishing and wildlife viewing will suffer while the lake becomes a haven for speed boating and other open water activities. Large scale harvesting also increases the chances of removing significant quantities of juvenile fish, turtles and other aquatic organisms that fail to escape the path of the harvester. Although nutrients are removed with harvested plants, macro-harvesting rarely offsets nutrient loading to lakes (Peterson et al., 1974).

Micro harvesting, on the other hand, involves selective cutting in certain areas. This method involves reshaping as much habitat as Lake Users need, leaving the rest for aquatic communities. It can be used to maximize the enjoyment of unique user zones on the lake that are delineated to support mutually exclusive activities. Clearing wading sites near shore, remove foliage around boat landings, and cutting boat channels out from piers are some examples of what can be achieved through micro harvesting. This particular approach is recommended for Little Green Lake as a planned approach to multiple lake use.

It is recommended that a daily log be completed by the machine operators and submitted every two weeks as a time sheet. Harvesting logs are a good way of documenting program activities, keeping track of costs, informing lake residents, tracking program effectiveness, identifying ecosystem changes over time, etc. It is important to understand that the areas harvested, methods used, and the intensity of harvesting will vary from season to season depending on nuisance plant growth. A typical harvesting log will ask for the date, name of operator; weather, areas harvested (delineated on map), number of loads collected, predominant plant types, nuisance growth areas, start/finish times, equipment maintenance, travel mileage, fuel consumption, and additional remarks. At the close of the season, the equipment is cleaned, inspected, lubricated and prepared for storage.

It is up to the individual property owner to manage nuisance weed growth that occurs around their own piers, boatlifts and swimming rafts. Operating a large weed harvester in these tight, shallow areas is hazardous given the risk of damaging the equipment or private property. Property owners should also be encouraged to groom their shorelines, removing any floating plant debris that might wash up to shore. Residents should understand that plant debris is not just produced by weed harvesting operations. Boat traffic, severe weather and auto-fragmentation of certain plant species may contribute to the problem. The lake management district may want to consider designating certain days during the operating season as weed collection days. Lakefront property owners could then pile plant debris in specified areas for later collection and disposal. It is also important that people understand factors that can interfere with the harvesting program such as bad weather, wind and recreational boaters. Boaters should be reminded to check for Eurasian waterfilfoil on boats and trailers before launching at a public boat ramp. A public information and education campaign is recommended (discussed in previous section).

Table 17: Harvesting Strategies According to Lake User Zones

Recreational User Zone	Harvesting Strategy
Designated sensitive areas (e.g. critical wildlife habitat, fish spawning areas, native plant beds, etc.)	No action.
Fishing areas	Harvest fish channels that are 6-10 feet wide and at least 20 feet apart through dense stands of nuisance vegetation. These channels will serve as edge habitat for gamefish, and may help alleviate stunted panfish populations. Channels cut perpendicular to the shoreline can serve as access channels for boats if they connect to open water areas.
Swimming areas	Harvest nuisance plant growth in water greater than three feet deep.
Boat launch areas	Harvest a navigation channel perpendicular to the

	launch site that connects to open water.
Water ski areas	Harvest all nuisance plant growth that reaches within five feet of the water surface.

A map showing the recommended harvester launch site location, potential harvest area, and shallow water hazard zones is presented in Appendix E.

7.5 PROGRAM COSTS

Costs can be categorized into two groups – capital costs and operating/maintenance costs. Capital expenditures may include the purchase of a weed harvester, dump truck, trailer, shore conveyor and an optional transport barge. Weed harvesters run anywhere from $30,000 to over $100,000. Actual costs will depend on the model, size and options chosen, as well as if the machinery is bought new or used. Add a harvester trailer, shore conveyor, dump truck and small transport barge and the costs could easily exceed $200,000. More detailed cost information for each piece of equipment was obtained from the local manufacturer Aquarius Systems, a division of D& D Products, Inc. Note that harvester costs were estimated based on a model that would be appropriate for managing a lake similar to Little Green. This information is presented in Table 18 below. Keep in mind that the purchase of weed harvesting machinery is eligible for 50% cost-sharing through a Recreational Boating Facilities Grant administered by the Wisconsin Waterways Commission.

Table 18: Capital Equipment Costs for Mechanical Harvesting

Item	Estimated Cost	Comments
HM-420 Weed Harvester	$66,000	This model is a mid-sized machine with a 7' harvesting width, 5.5' harvesting depth, 10.8-19.8" draft, and a 440 cubic feet capacity (8,500 lbs.). A number of options are available at an added cost. Options include a stainless steel barge ($8,000), stainless steel conveyor mesh ($2,900), and retractable paddle wheels ($4,250) among others.
Harvester Trailer (basic)	$8,000	The basic trailer is used strictly for transporting and launching the harvester.
Harvester Trailer (with conveyor and collapsible sides)	$20,500	The trailer with built in conveyor system may be used to transport and launch the harvester, as well as to haul collected plant material to the disposal site.
Shore Conveyor	$19,500	The shore conveyor is used to off-load harvested plant material from the harvester into an awaiting dump truck.
Small Transport Barge	$62,000	The transport barge is an optional piece of equipment used to increase the speed and efficiency of a harvesting program. The harvester can off-load plant material onto the transport barge in open water, reducing travel times back and forth from shore.
Dump Truck	NA	The cost of a dump truck is highly variable depending on model, size, age, etc. If purchasing your own dump truck, an older, used truck will probably make the most sense from an economic standpoint. Another option is to rent or borrow a truck on an as-needed basis.

Source: Aquarius Systems of D&D Products, Inc., 1999

To save on capital equipment costs, the lake management district may want to explore the possibility of renting or borrowing equipment from a neighboring lake management group. This option is viable only when the traveling distance between two cooperating lakes is reasonably short. Equipment sharing can become controversial when it comes to paying for machinery storage, repairs and maintenance. There may also be routine disagreement as to when the equipment is to be used on each particular lake. Little Green

Lake may want to explore this option by contacting representatives at Green Lake or Lake Puckaway. If this option proves viable, it is recommended that the cooperating lake management groups sign a contract that seeks to resolve issues related to insurance, scheduling and maintenance.

Operating costs are highly variable but generally average around several thousand dollars per year, with hired labor comprising from 20-65% of the total operating costs. Costs include fuel, equipment storage and maintenance, payroll and insurance. Actual operating expenses depend on the number of people employed to operate the machine and related equipment, the nature of their employment (volunteer, part-time or full-time), and the hours of operation (which affects the number of services required, fuel and oil consumed, and person hours consumed). The lake management district should recognize that it takes dedicated, skilled individuals to properly maintain and operate the equipment. Appropriate incentives must be provided to maintain a qualified operating crew and to avoid a high, annual staff turnover rate.

The lake management district also has the option of contracting with a private service provider, rather than implementing its own harvesting program. Contractors generally charge by the hour for harvesting, and take into consideration the amount of time it takes to deliver and set up the equipment. For example, the New London, Wisconsin firm of Midwest Aquatics charges $120 per hour for harvesting services. They require a one-time, 30-hour minimum commitment at a cost of approximately $3,600. Contract harvesting is attractive for its lower short-term costs and less need for a support network (e.g. program administration, storage facilities, operation and maintenance crews, etc.). However, potential problems include less conscientious plant collection, poor performance, and uncertain availability of the harvester when needed. Furthermore, a lake that requires extensive harvesting every year will generally save money over the long-term by implementing its own harvesting program.

7.6 OTHER CONSIDERATIONS

Potential insurance coverage needs include inland marine, commercial property, commercial general liability, automobile, errors and emissions for board members, and worker's compensation. It is important that the lake management district review its insurance coverage each year so that necessary adjustments can be made to meet any changes that occur in the value of the property or the equipment it owns and operates.

There are numerous safety precautions that should be taken when operating mechanical harvesting equipment. The following safety measures will help prevent personal injuries and damage to the machinery and other property. This list is not complete, and should be used only as a guide. A more complete list with detailed explanations can be obtained from the equipment manufacturer or local distributor.

- All equipment operators shall be experienced and have sufficient training on the safe and proper use of the machinery.
- The harvester operator shall wear a Coast Guard approved personal floatation device.
- The harvester operator shall not consume alcohol, smoke, wear headphones, or operate the machinery when tired or sick.
- The harvester operator shall be appropriately protected from the elements by wearing proper sun protection or rain gear.
- The harvester operator shall abide by all equipment safety and operational rules.
- No swimming or fishing shall be allowed to occur in the area of the harvester.
- No person shall be allowed within the immediate vicinity of the harvester during operations.
- Harvesting shall be postponed during inclement weather conditions.
- The equipment shall not be operated after dark or in high winds. Operations should also cease during times of excessive boat traffic.
- The harvester shall be equipped with the proper navigational equipment.
- The harvester shall be equipped with the proper safety equipment, including a first aid kit and fire extinguisher. Plenty of drinking water, polarized sunglasses, and a hat are also recommended.
- No pets or extra people shall be allowed on the harvester during operations.

- The harvester shall not be overloaded with plant material at any time.
- The harvester engine shall be shut off before any repairs are made, or before any obstructions are cleared.
- The harvester engine shall never be allowed to idle unattended.
- Regular equipment inspections shall be performed to ensure that all mechanical parts are in proper operating condition.

SECTION 8
RECOMMENDATIONS

- Do not lose site of your overall mission and management goals. It takes a great deal of effort to adhere to a plan, especially when faced with random complaints or special requests from district members. Deviating from the plan will not set a good precedent, and can negate the effects of earlier management efforts.

- Repeat the aquatic plant survey whenever feasible to document changes in plant types, densities and distributions. Regularly update the plan as plant conditions change or new information/technologies become available.

- Form a weed harvesting committee to supervise and coordinate aquatic plant management operations. The committee can consist of active board members and other volunteers. All committee members should be intimately familiar with the strategies and recommendations outlined in the plan.

- Decide whether the lake district prefers to: (1) purchase the necessary equipment and implement its own harvesting program, (2) implement its own program but share equipment with another local lake group, or (3) contract with a private service provider. See Section 7.5 for cost information and other details.

- If the Lake District decides to pursue the purchase of its own harvesting equipment, apply for grant money through the Wisconsin Waterways Commission to help finance a portion of the equipment costs. A Recreational Boating Facilities Grant will currently match 50% of the total cost for approved weed harvesting machinery.

- Follow the mechanical harvesting strategy outlined in Section 7 of this report.

- Implement time and space zoning on the lake to better support conflicting recreational activities. Select and target aquatic plant management efforts based on designated lake-user zones. Employ different methodologies and control intensities depending on type of user zone and management needed.

- Target nuisance stands of Eurasian watermilfoil and curlyleaf pondweed. Protect and promote the growth of native, beneficial plant communities whenever feasible.

- Adopt and/or enforce rules and regulations that help to minimize ecological disturbances that destroy native plant beds and encourage the spread of exotic species. Motor boating in shallow areas, improper plant control methods, and non-point source pollution all create ecological disturbances that may exacerbate existing problems.

- Set up a volunteer lake watch patrol to help educate lake users, enforce existing ordinances, and monitor plant community changes.

- Regularly participate in programs, seminars, workshops and discussion groups on plant management to keep abreast of new findings, strategies and technologies.

- Continue implementing a water quality-monitoring program to obtain long-term trends data. In addition, maintain good records on all aquatic plant management efforts.

- Implement an information and education campaign to solicit public support and cooperation.

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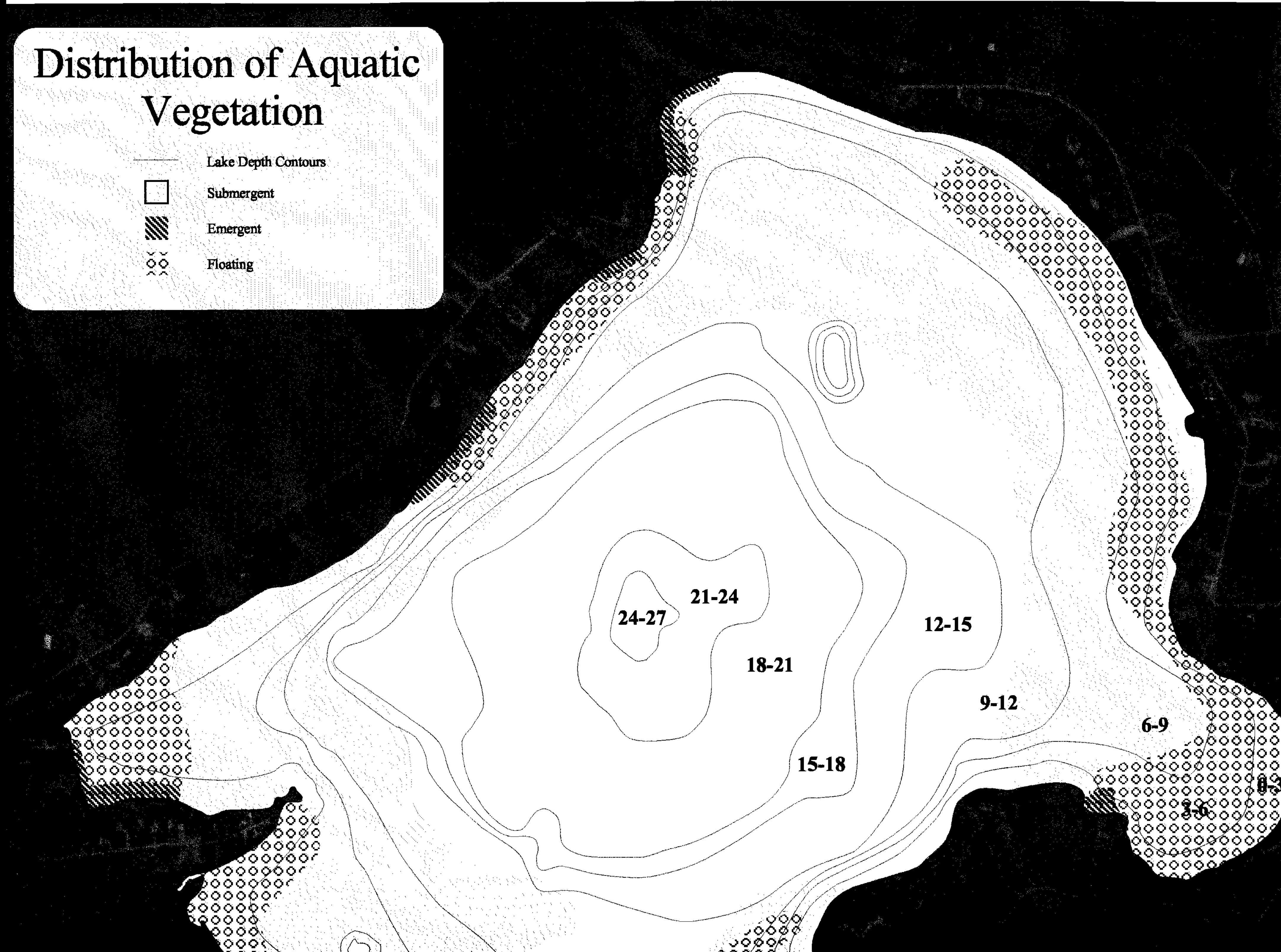

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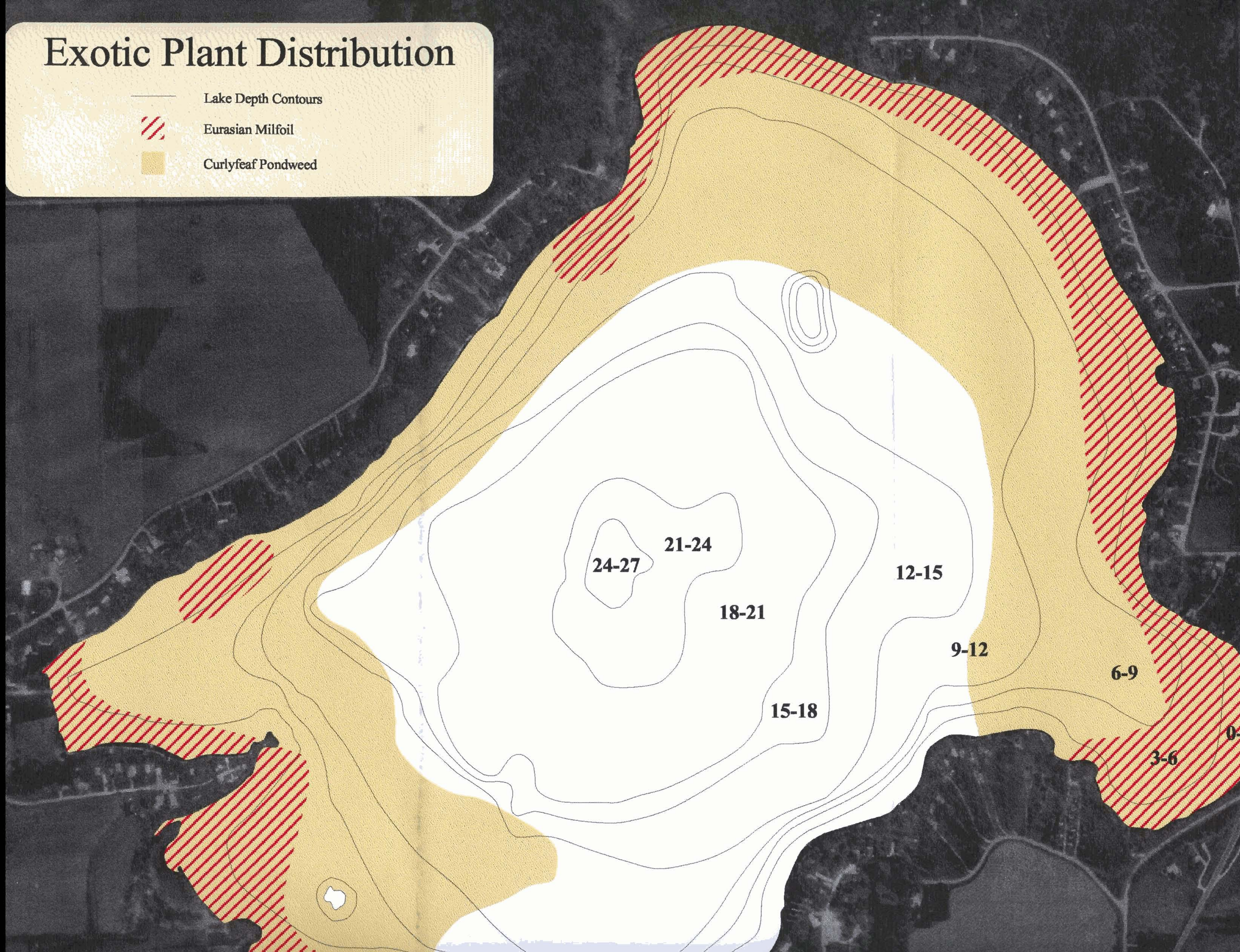

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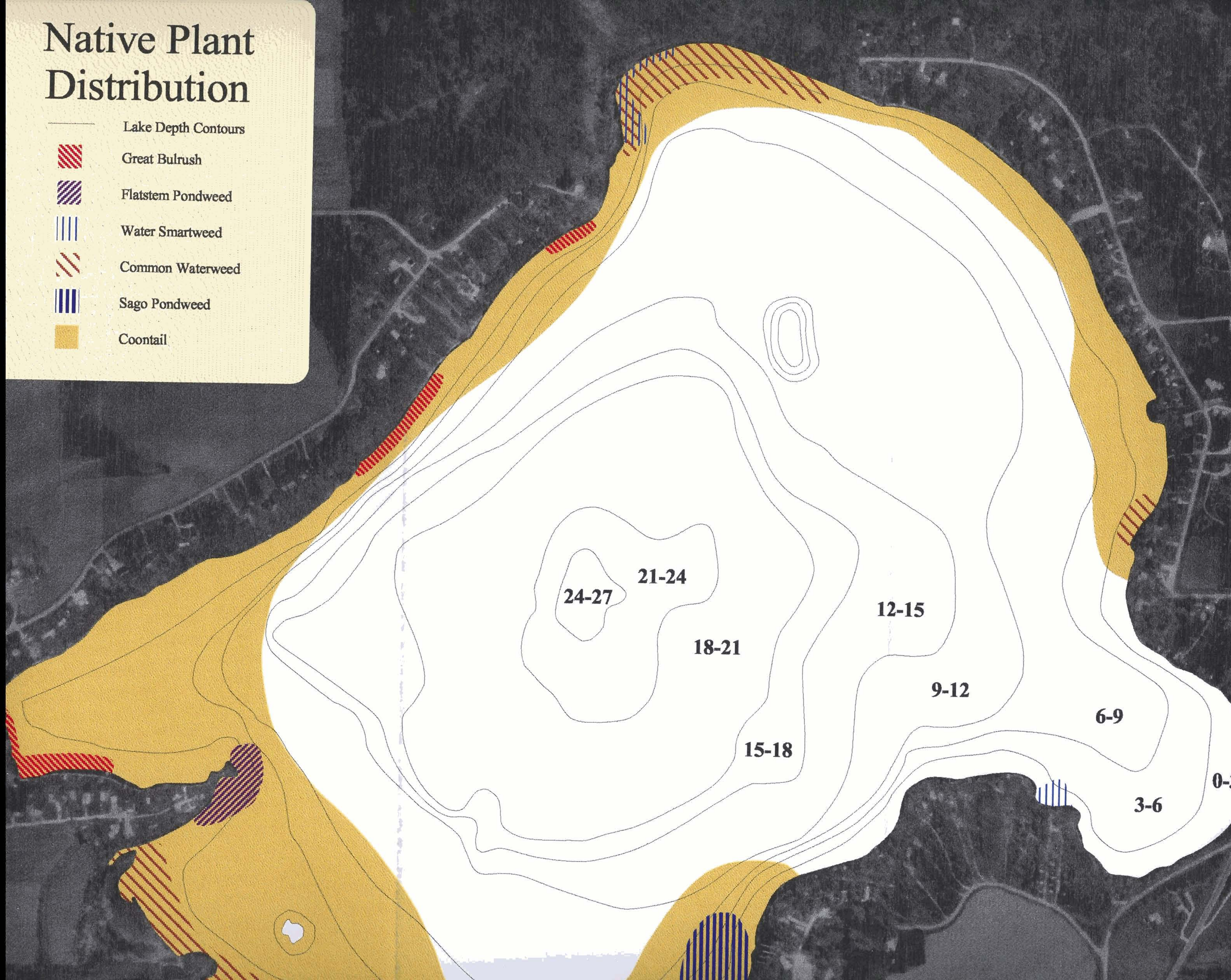

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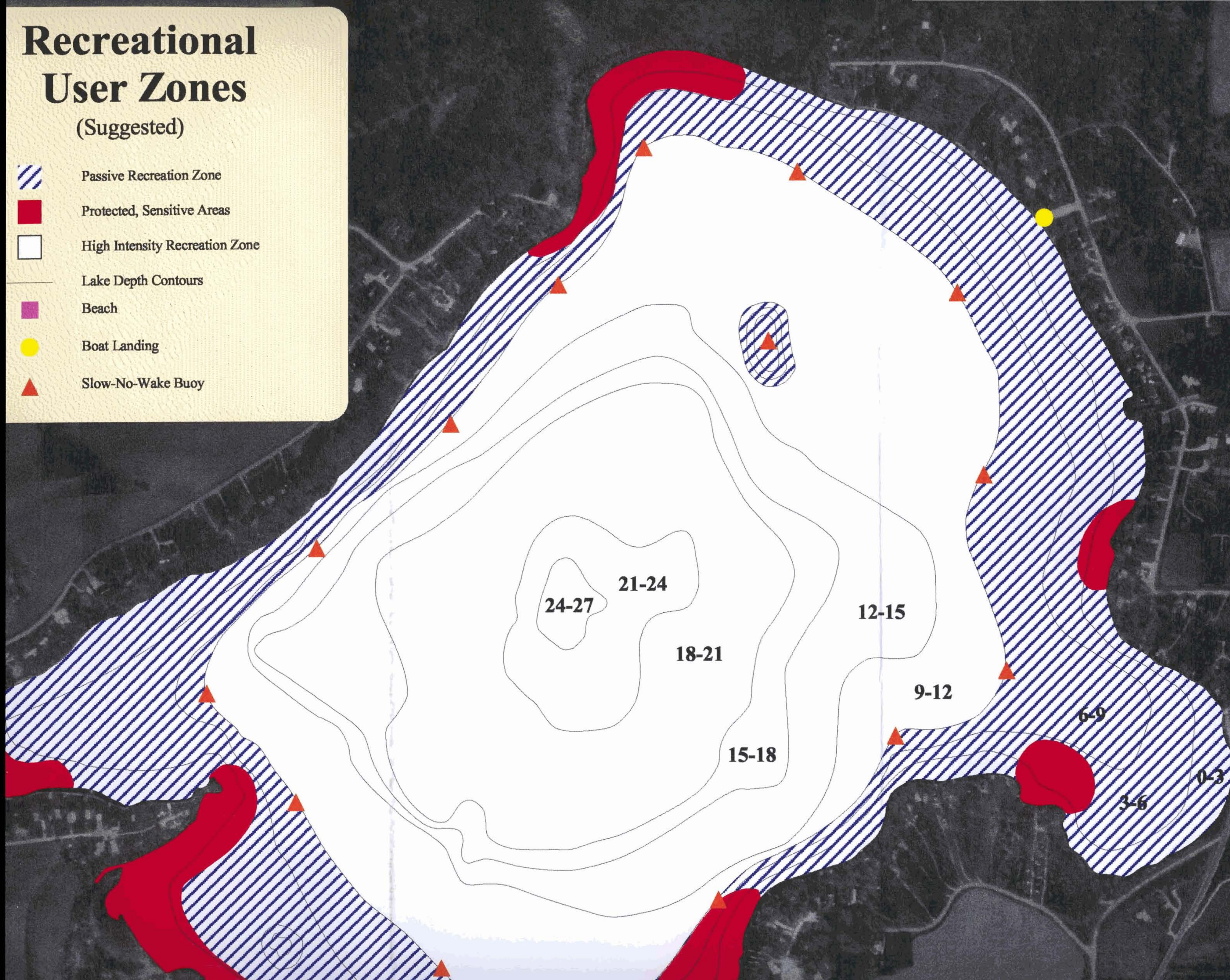

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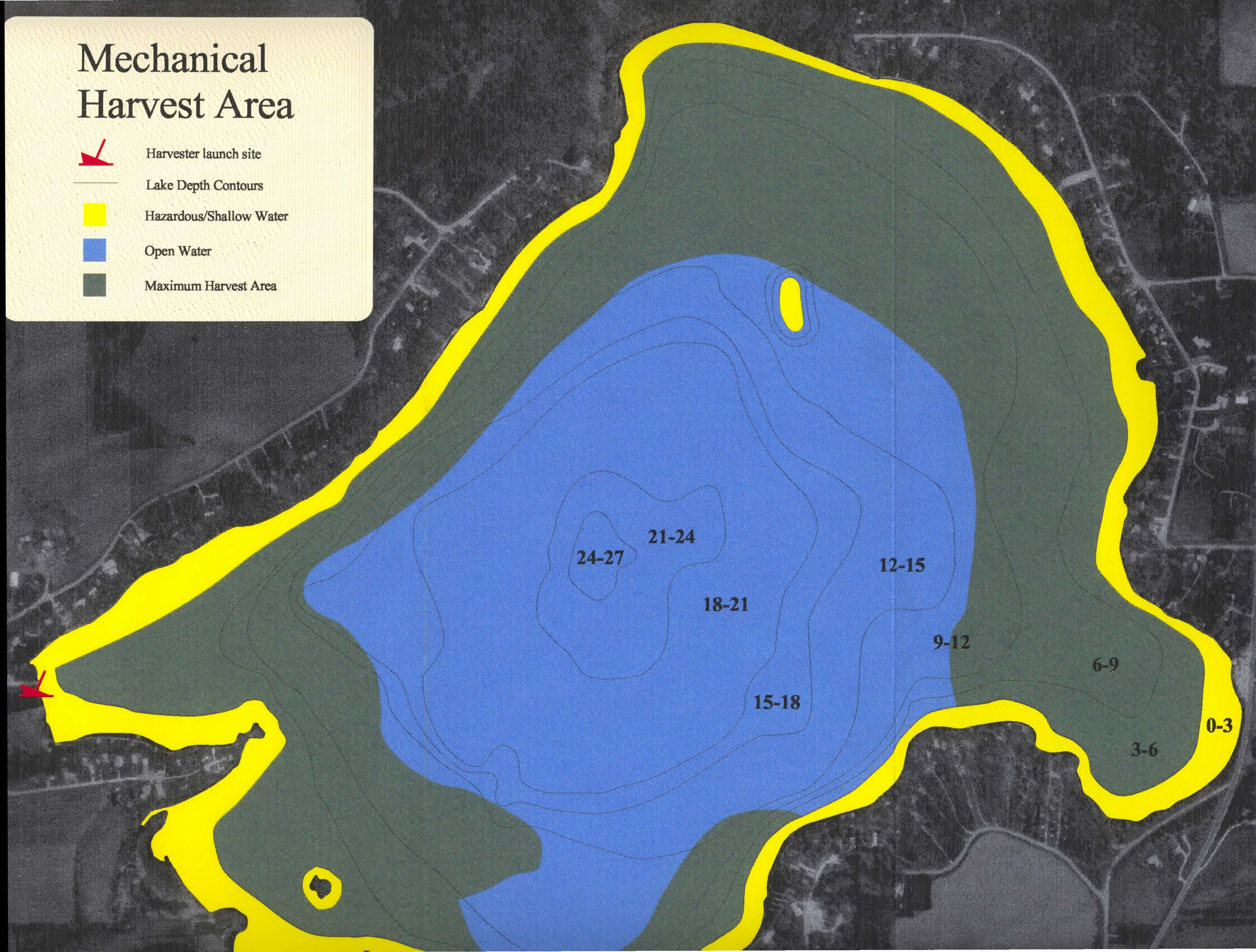

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