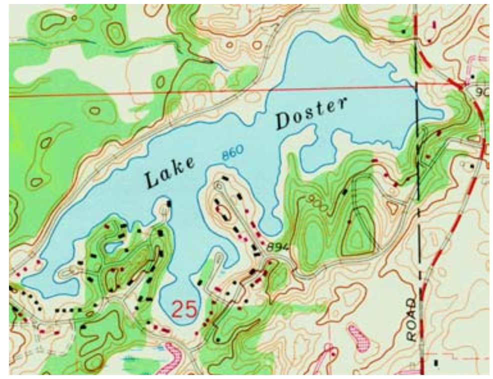

Lake Doster
Management Plan Report

Prepared for:

Lake Doster Property Owner's Association
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December 2002 (Revised)

Project No: 55790101

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PROJECT BACKGROUND

Lake Doster is located in Sections 24 and 25 of Gun Plain Township in Allegan County, and in Section 30 of Prairieville Township in Barry County (T1N, R10-11W; Figure 1). In January of 2002, Progressive AE was retained by the Lake Doster Property Owner's Association to conduct a lake improvement feasibility study. The primary objective of the study was to develop and define a management plan for Lake Doster. The purpose of this report is to discuss study findings and recommendations.

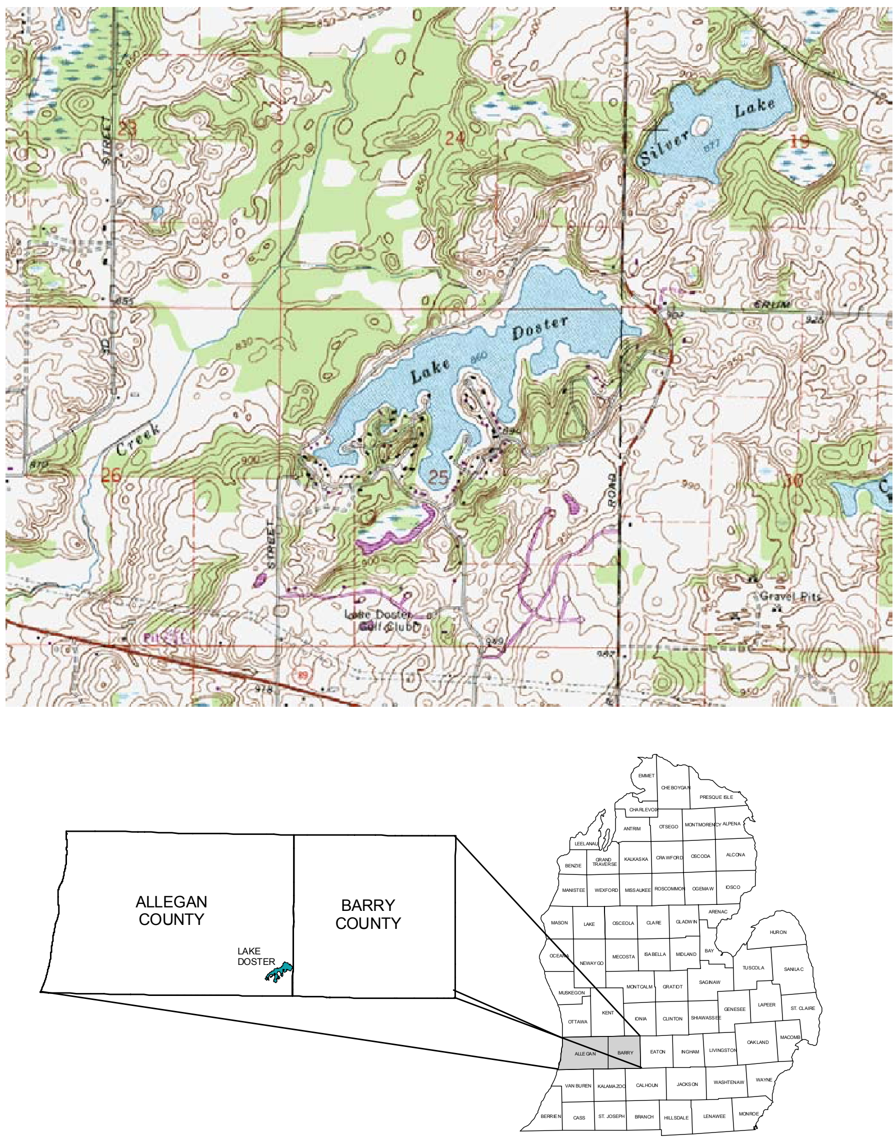


Figure 1. Project location map. (Source: Michigan Department of Natural Resources (MDNR) Michigan Resource Information System (MIRIS) and US Geological Survey topographic map, Kalamazoo NE 1973.)

LAKE AND WATERSHED CHARACTERISTICS

A summary of the physical characteristics of Lake Doster and its watershed is provided in Table 1. Lake Doster was created in 1961 with the construction of a 30-foot-high dam that impounded the headwaters of Silver Creek. As indicated in Figure 2, much of the existing bottomland in Lake Doster was formerly wetland that was inundated when the dam was constructed. Lake Doster has a surface area of 126 acres, a maximum depth of approximately 20 feet, and a mean or average depth of about 8 feet. A map depicting approximate depth contours in Lake Doster is shown in Figure 3. Lake Doster contains just over 1,000 acre-feet of water, or about 332 million gallons. The lake has a shoreline 4.7 miles long and a shoreline development factor of 3.0. The shoreline development factor indicates the degree of irregularity in the shape of the shoreline. That is, compared to a perfectly round lake with the same surface area as Lake Doster (i.e., 126 acres), the shoreline of Lake Doster is 3 times longer because of its irregular shape. Currently, approximately 160 homes border the lake.

The normal level of Lake Doster is maintained at 860 feet above mean sea level by an outlet structure located along the northwest end of the lake. The lake appears to be largely dependent on groundwater springs to sustain its level. Lake Doster flows into Silver Creek and eventually into Lake Michigan via the Kalamazoo River.

The land area surrounding a lake that drains to the lake is called its watershed or drainage basin. Lake Doster's watershed is approximately 449 acres in area (Figure 4). Much of the watershed is wooded or undeveloped land; however, most of the shorelands immediately adjacent to Lake Doster have been developed for single-family residential use (Figures 5 and 6).

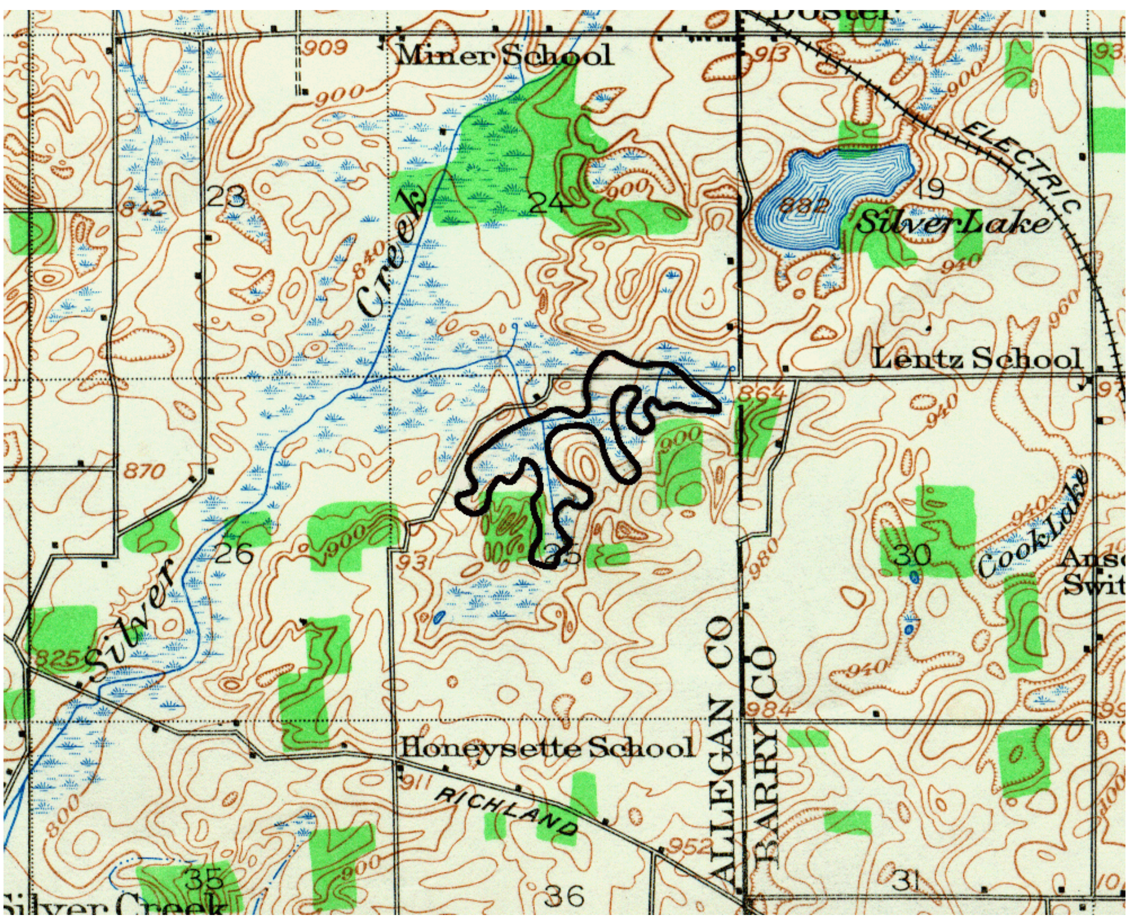


Figure 2. Lake Doster area before dam construction. (Source: US Geological Survey 1916.)

TABLE 1
LAKE DOSTER
PHYSICAL CHARACTERISTICS [1]

Lake Surface Area	126	Acres
Approximate Maximum Depth	20	Feet
Approximate Mean Depth	8.1	Feet
Approximate Lake Volume	1,020	Acre-Feet
Shoreline Length	4.7	Miles
Shoreline Development Factor	3.0	
Watershed Area	449	Acres
Ratio of Lake Area to Watershed Area	1:3.6	

Watershed Land Uses	Acres	Percent of Total
Agriculture	51	11
Residential Development	158	35
Wooded/Undeveloped	216	48
Wetlands	24	6
Total	449	100

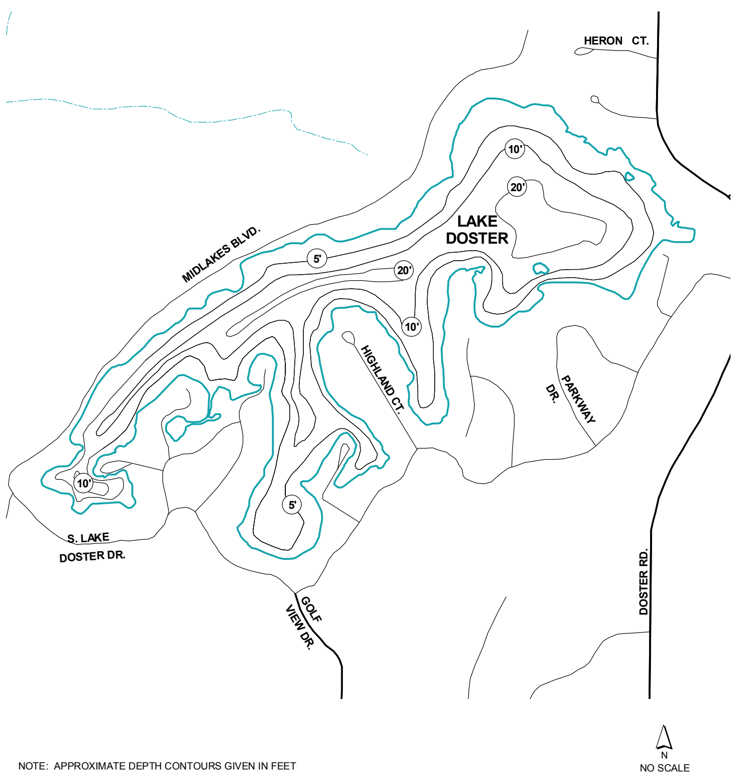


Figure 3. Lake Doster depth contour map. (Source: Base map provided by Lake Doster Property Owners Association.)

[1] Shoreline length, watershed, and lake areas were determined by examining a United States Geological Survey topographic map of the Lake Doster area (scale: 1" = 2000'). Lake volume and maximum and mean depths were derived from a field-verified depth contour map of Lake Doster. Land uses were derived from the Department of Natural Resources' Michigan Resource Information System (MIRIS) and 2001 aerial photography provided by the Allegan County Geographic Information System Department.

Figure 4. Lake Doster watershed map. (Source: Topographic map prepared by US Geological Survey; Kalamazoo NE, 1973.)

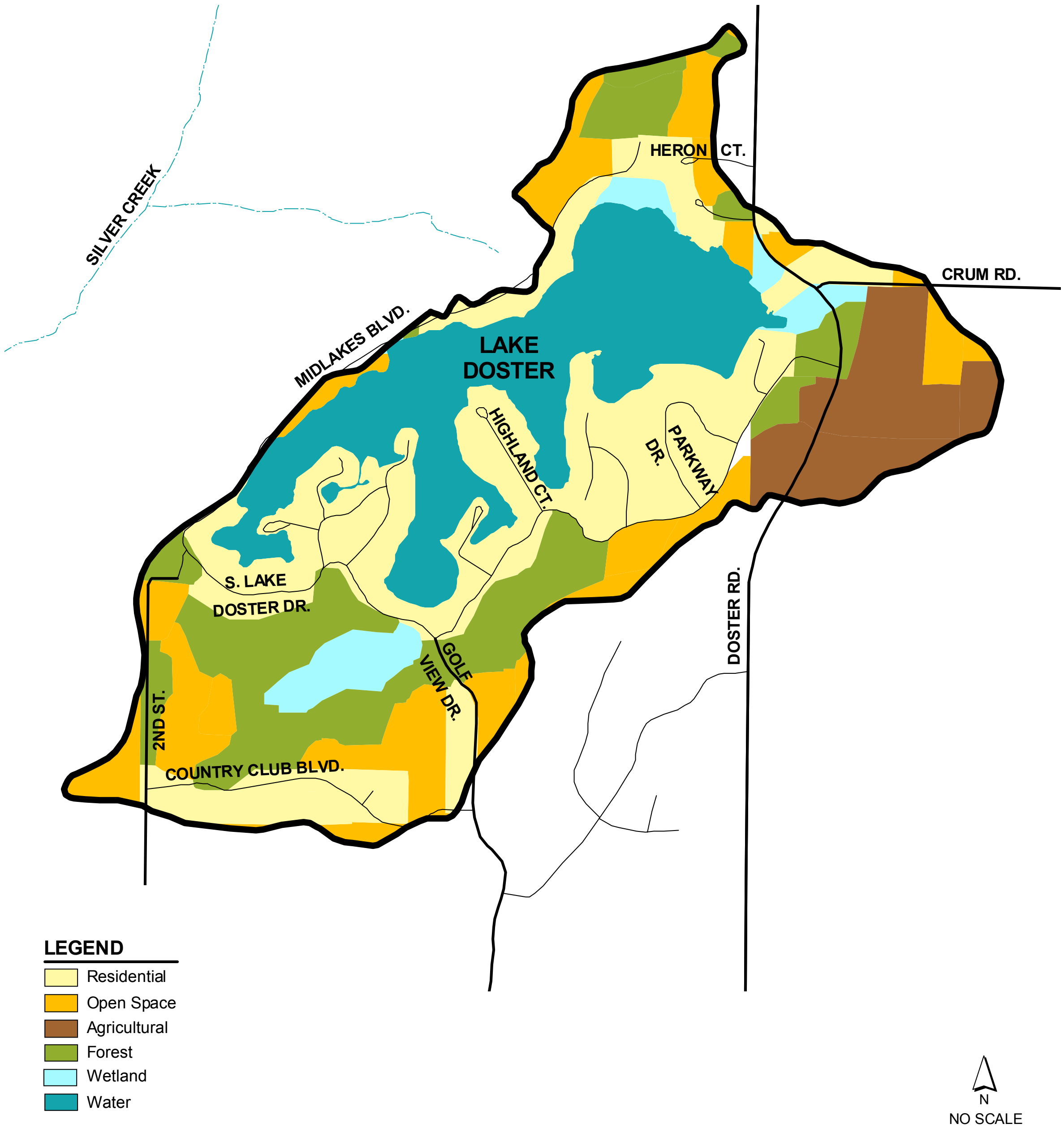


Figure 5. Lake Doster watershed land use map. (Source: Base map and land use information provided by MIRIS and Allegan County Geographic Information System Department.)

Figure 6. Lake Doster aerial photograph. (Source: Allegan County GIS Department, April 1999.)

Lake Water Quality

INTRODUCTION

Lake water quality is determined by a unique combination of processes that occur both within and outside of the lake. In order to make sound management decisions, it is necessary to have an understanding of the current physical, chemical, and biological condition of the lake, and the potential impact of drainage from the surrounding watershed.

Lakes are commonly classified as **oligotrophic**, **mesotrophic**, or **eutrophic** (Figure 7). Oligotrophic lakes are generally deep and clear with little aquatic plant growth. These lakes maintain sufficient dissolved oxygen in the cool, deep bottom waters during late summer to support cold water fish such as trout and whitefish. By contrast, eutrophic lakes are generally shallow, turbid, and support abundant aquatic plant growth. In deep eutrophic lakes, the cool bottom waters usually contain little or no dissolved oxygen. Therefore, these lakes can only support warm water fish such as bass and pike. Lakes that fall between these two extremes are called mesotrophic lakes.

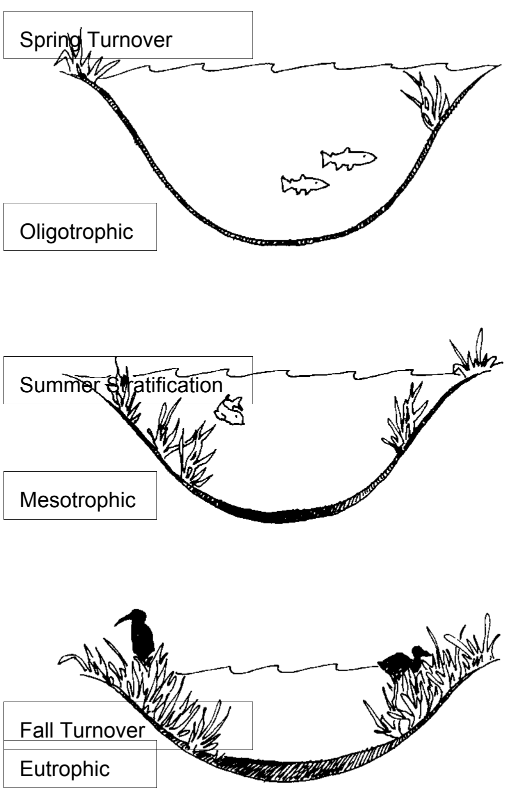


Figure 7. Lake classification.

Under natural conditions, most lakes will ultimately evolve to a eutrophic state as they gradually fill with sediment and organic matter transported to the lake from the surrounding watershed. As the lake becomes shallower, the process accelerates. When aquatic plants become abundant, the lake slowly begins to fill in as sediment and decaying plant matter accumulate on the lake bottom. Eventually, terrestrial plants become established and the lake is transformed to a marshland. The aging process in lakes is called "**eutrophication**" and may take anywhere from a few hundred to several thousand years, generally depending on the size of the lake and its watershed. The natural lake aging process can be greatly accelerated if excessive amounts of sediment and nutrients (which stimulate aquatic plant growth) enter the lake from the surrounding watershed. Because these added inputs are usually associated with human activity, this accelerated lake aging process is often referred to as "**cultural eutrophication**." The problem of cultural eutrophication can be managed by identifying sources of sediment and nutrient loading (i.e., inputs) to the lake and developing strategies to halt or slow the inputs. Thus, in developing a management plan, it is necessary to determine the limnological (i.e., the physical, chemical, and biological) condition of the lake and the physical characteristics of the watershed as well.

Winter Stratification

Key parameters used to evaluate the limnological condition of a lake include temperature, dissolved oxygen, total phosphorus, chlorophyll-*a*, and Secchi transparency. A brief description of these water quality measurements is provided as an introduction for the reader. Particular attention should be given to the interrelationship of these water quality measurements.

TEMPERATURE

Temperature is important in determining the type of organisms that may live in a lake. For example, trout prefer temperatures below 68EF. Temperature also determines how water mixes in a lake. As the ice cover breaks up on a lake in the spring, the water temperature becomes uniform from the surface to the bottom. This period is referred to as "spring turnover" because water mixes throughout the entire water column. As the surface waters warm, they are underlain by a colder, more dense strata of water. This process is called thermal stratification. Once thermal stratification occurs, there is little mixing of the warm surface waters with the cooler bottom waters. The transition layer that separates these layers is referred to as the "thermocline." The thermocline is characterized as the zone where temperature drops rapidly with depth. As fall approaches, the warm surface waters begin to cool and become more dense. Eventually, the surface temperature drops to a point that allows the lake to undergo complete mixing. This period is referred to as "fall turnover." As the season progresses and ice begins to form on the lake, the lake may stratify again. However, during winter stratification, the surface waters (at or near 32EF) are underlain by slightly warmer water (about 39EF). This is sometimes referred to as "inverse stratification" and occurs because water is most dense at a temperature of about 39EF. As the lake ice melts in the spring, these stratification cycles are repeated (Figure 8). Shallow lakes do not stratify. Lakes that are 15 to 30 feet deep may stratify and destratify with storm events several times during the year.

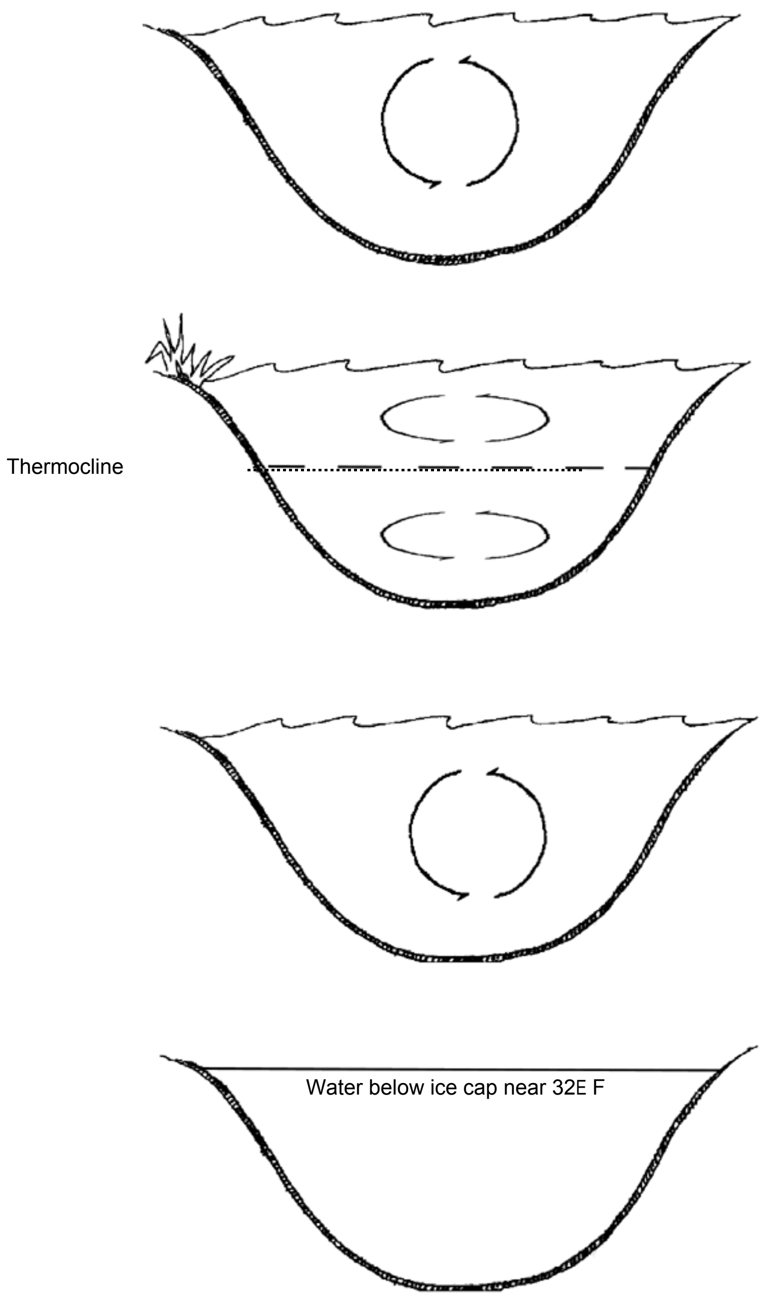


Figure 8. Seasonal thermal stratification cycles.

DISSOLVED OXYGEN

An important factor influencing lake water quality is the quantity of **dissolved oxygen** in the water column. The major inputs of dissolved oxygen to lakes are the atmosphere and photosynthetic activity by aquatic plants. An oxygen level of about 5 mg/L (milligrams per liter, or parts per million) is required to support warm water fish. In lakes deep enough to exhibit thermal stratification, oxygen levels are often reduced or depleted below the thermocline once the lake has stratified. This is because deep water is cut off from plant photosynthesis and the atmosphere, and oxygen is consumed by bacteria that use oxygen as they decompose organic matter (plant and animal remains) at the bottom of the lake. Bottom-water oxygen depletion is a common occurrence in eutrophic and some mesotrophic lakes. Thus, eutrophic and most mesotrophic lakes cannot support cold water fish because the cool, deep water (that the fish require to live) does not contain sufficient oxygen.

PHOSPHORUS

The quantity of **phosphorus** present in the water column is especially important since phosphorus is the nutrient that most often controls aquatic plant growth and the rate at which a lake ages and becomes more eutrophic. In the presence of oxygen, lake sediments act as a phosphorus trap, retaining phosphorus and thus making it unavailable for aquatic plant growth. However, if bottom-water oxygen is depleted, phosphorus will be released from the sediments and may be available to promote aquatic plant growth. In some lakes, the internal release of phosphorus from the bottom sediments is the primary source of phosphorus loading (or input).

By reducing the amount of phosphorus in a lake, it may be possible to control the amount of aquatic plant growth. In general, lakes with a phosphorus concentration greater than 20 μg/L (micrograms per liter, or parts per billion) are able to support abundant plant growth and are classified as nutrient-enriched or eutrophic.

CHLOROPHYLL-*A*

Chlorophyll-*a* is a pigment that imparts the green color to plants and algae. A rough estimate of the quantity of algae present in lake water can be made by measuring the amount of chlorophyll-*a* in the water column. A chlorophyll-*a* concentration greater than 6 μg/L is considered characteristic of a eutrophic condition.

SECCHI TRANSPARENCY

A **Secchi disk** is often used to estimate water clarity. The measurement is made by fastening a round, black and white, 8-inch disk to a calibrated line (Figure 9). The disk is lowered over the deepest point of the lake until it is no longer visible, and the depth is noted. The disk is then raised until it reappears. The average between these two depths is the Secchi transparency. Generally, it has been found that aquatic plants can grow at a depth of approximately twice the Secchi transparency measurement. In eutrophic lakes, water clarity is often reduced by algae growth in the water column, and Secchi disk readings of 7.5 feet or less are common.

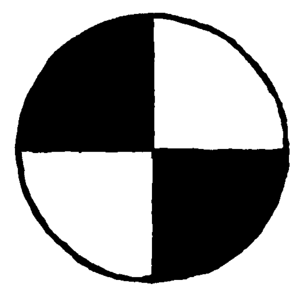


Figure 9. Secchi disk.

LAKE CLASSIFICATION CRITERIA

Ordinarily, as phosphorus inputs (both internal and external) to a lake increase, the amount of algae will also increase. Thus, the lake will exhibit increased chlorophyll-*a* levels and decreased transparency. A summary of lake classification criteria developed by the Michigan Department of Natural Resources is shown in Table 2.

TABLE 2
LAKE CLASSIFICATION CRITERIA

Lake Classification	Total Phosphorus (µg/L)[2]	Chlorophyll-a (µg/L)	Secchi Transparency (feet)
Oligotrophic	Less than 10	Less than 2.2	Greater than 15.0
Mesotrophic	10 to 20	2.2 to 6.0	7.5 to 15.0
Eutrophic	Greater than 20	Greater than 6.0	Less than 7.5

SAMPLING METHODS

Water quality sampling was conducted in the spring and summer of 2002 at the deep basin within Lake Doster (Figure 10). Temperature and dissolved oxygen content were measured using a YSI Model 95 probe. Approximately five percent of the total number of measurements were verified with the modified Winkler method (Standard Methods procedure 4500-O C). Samples were collected at the surface, mid-depth, and just above the lake bottom with a Kemmerer bottle to be analyzed for pH, total alkalinity, and total phosphorus. pH was measured in the field using a Hach pH Pal. Total alkalinity and total phosphorus samples were placed on ice and transported to Progressive AE and to Summit Laboratory[3], respectively, for analysis. Total alkalinity was titrated at Progressive AE using Standard Methods procedure 2320.B, and total phosphorus was analyzed at Summit Laboratory using Standard Methods (19th edition). In addition to the depth-interval samples at each deep basin, Secchi transparency was measured and composite chlorophyll-*a* samples were collected from the surface to a depth equal to twice the Secchi transparency. Chloropyll-*a* samples were analyzed by Summit Laboratory using Standard Methods.

RESULTS AND DISCUSSION

Water quality sampling results are provided in Tables 3 and 4. The March sampling of Lake Doster corresponded with the time of spring turnover when the lake was more or less uniform in temperature from the surface to bottom. At that time, the entire water column was mixed and well-oxygenated. Total phosphorus levels and algae growth in the open waters of the lake were low and water transparency was reasonably good.

The sampling in August corresponded with the period of summer thermal stratification. The temperature at the surface of the lake was substantially warmer than the bottom waters indicating there was little mixing of the surface and deeper water in the lake. The bottom waters of the lake were nearly devoid of oxygen, thus, fish were largely restricted to the upper, warmer strata of water. (This is why Lake Doster cannot support cold-water fish species such as trout. The cool, bottom water in the lake does not contain sufficient dissolved oxygen to sustain cold-water fish during the summer months.) Summer total phosphorus levels and open water algae growth increased and water transparency was somewhat reduced compared to the spring sampling period.

[2] µg/L = micrograms per liter = parts per billion.

[3] Summit Laboratory, 1435 Buchanan Avenue SW, Grand Rapids, MI.

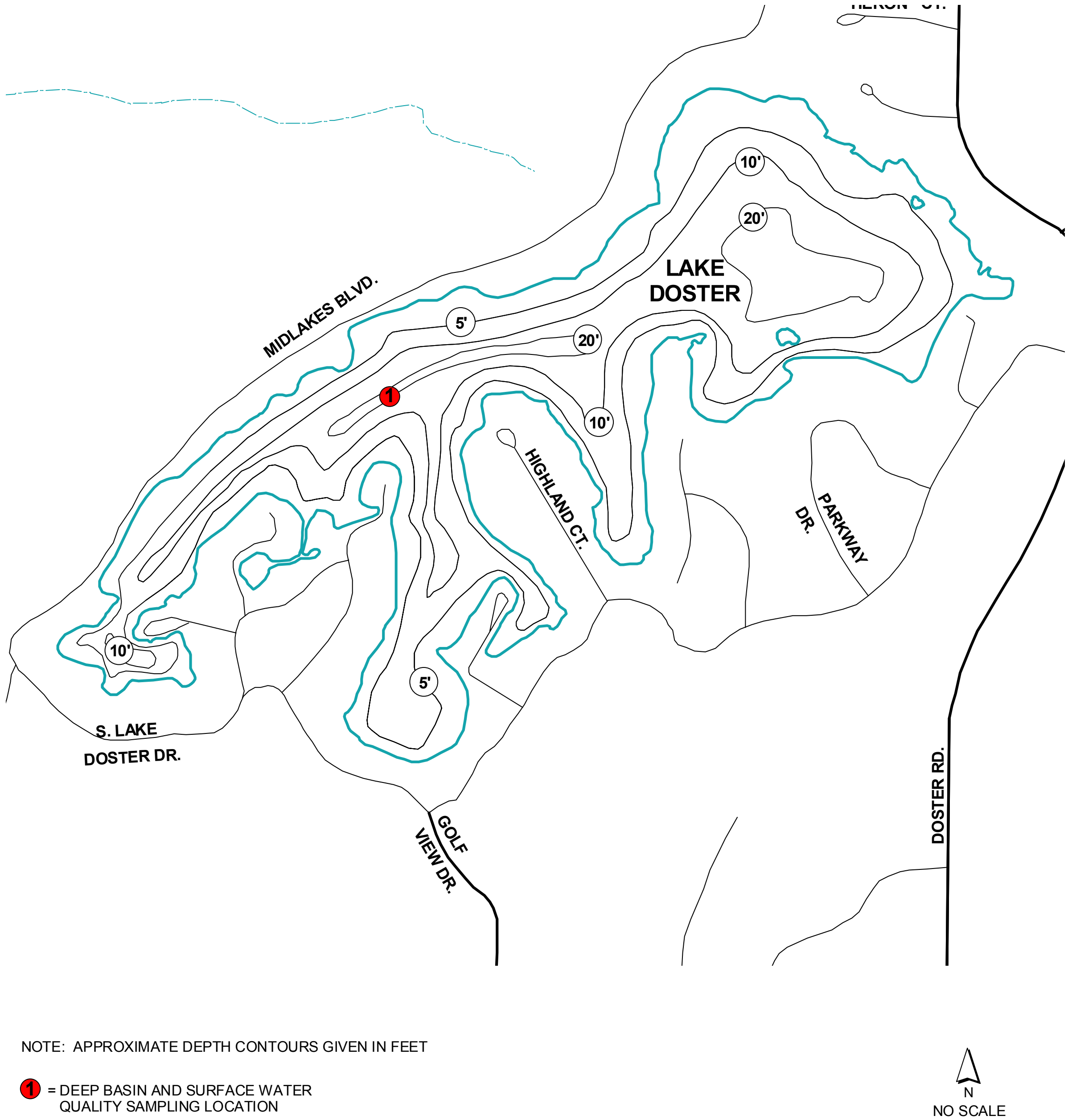


Figure 10. Lake Doster sampling location map. (Source: Base map provided by Lake Doster Property Owners Association.)

TABLE 3
LAKE DOSTER
DEEP BASIN WATER QUALITY DATA

Date	Sample Location	Sample Depth (feet)	Temp. (EF)	Dissolved Oxygen (mg/L)[1]	Total Phosphorus (μg/L)[2]	pH(S.U.)[3]	Total Alkalinity (mg/L as $CaCO_3$)[4]
3-2-02	1	1	38.0	10.2	8	8.7	188
3-2-02	1	9	37.5	10.4	8	8.8	194
3-2-02	1	18	37.5	10.5	6	8.7	197
8-1-02	1	1	82.0	8.9	12	9.0	174
8-1-02	1	9	80.5	7.6	14	8.8	182
8-1-02	1	18	71.0	0.9	19	8.6	197

TABLE 4
LAKE DOSTER
SURFACE WATER QUALITY DATA

Date	Sample Location	Secchi Transparency (feet)	Chlorophyll-*a* (μg/L)[1]
3-2-02	1	10.5	2
8-1-02	1	6.5	10

pH is a measure of the amount of acid or base in water. The pH scale ranges from 0 (acidic) to 14 (alkaline or basic) with neutrality at 7. The pH of most lakes generally ranges from 6 to 9 (Wetzel 1983). Alkalinity is the measure of the pH-buffering capacity of water in that it is the quantitative capacity of water to neutralize an acid. Often lakes with high alkalinity (such as Lake Doster) receive substantial water inputs via groundwater springs. Lake Doster is well buffered and therefore not susceptible to the effects of acid rain.

Temperature data collected from Clarksville and Ceresco by Michigan State University indicate the summer of 2002 was warmer than previous summers in the general vicinity of Lake Doster (Table 5). Warmer temperatures would tend to increase both rooted plant and algae growth. Increased algae growth can reduce water clarity.

[1] mg/L = milligrams per liter = parts per million.

[2] μg/L = micrograms per liter = parts per billion.

[3] S.U. = standard units.

[4] mg/L as $CaCO_3$ = milligrams per liter as calcium carbonate.

TABLE 5
AVERAGE MAXIMUM AIR TEMPERATURE IN CLARKSVILLE AND CERESCO, MICHIGAN
JUNE THROUGH AUGUST, 1999 - 2002

	Clarksville	Ceresco
1999	72.3	
2000	77.3	74.6
2001	80.3	81.7
2002	82.2	84.5

The data collected from Lake Doster are generally consistent with data that has been collected historically from Lake Doster (Appendix A). Based on these data, Lake Doster would be classified as mesotrophic in that it exhibits evidence of bottom-water oxygen depletion and moderate total phosphorus, chlorophyll-*a,* and transparency levels.

Aquatic Plants

The distribution and abundance of aquatic plants are dependent on several variables, including light penetration, bottom type, temperature, water levels, and the availability of plant nutrients. The term "aquatic plants" includes both the algae and the larger aquatic plants or macrophytes. The macrophytes can be categorized into four groups: The emergent, the floating-leaved, the submersed, and the free-floating.

In developing an effective aquatic plant control program, the type and distribution of nuisance plant growth must be evaluated so that a balanced, environmentally sound control strategy can be determined. Aquatic plant surveys of Lake Doster were conducted on May 24 and August 1, 2002. Plant types observed during the surveys are listed in Table 6, and the location of plants on the two sampling dates is shown in Figures 11 and 12. Diagrams of many of the plants listed are included in Figure 13.

TABLE 6
LAKE DOSTER
AQUATIC PLANTS

Common Name	Scientific Name	Group	Occurrence
Eurasian milfoil	*Myriophyllum spicatum*	Submersed	Sparse to Common
Curly-leaf pondweed	*Potamogeton crispus*	Submersed	Sparse to Common
Muskgrass	*Chara* sp.	Submersed	Common
Thin-leaf pondweed	*Potamogeton* sp.	Submersed	Sparse to Common
Variable-leaf pondweed	*Potamogeton gramineus*	Submersed	Sparse
Illinois pondweed	*Potamogeton illinoensis*	Submersed	Sparse
Southern naiad	*Najas guadalupensis*	Submersed	Sparse
Bladderwort	*Utricularia vulgaris*	Submersed	Rare
Yellow water lily	*Nuphar* sp.	Floating-leaved	Sparse
Cattail	*Typha* sp.	Emergent	Sparse to Common

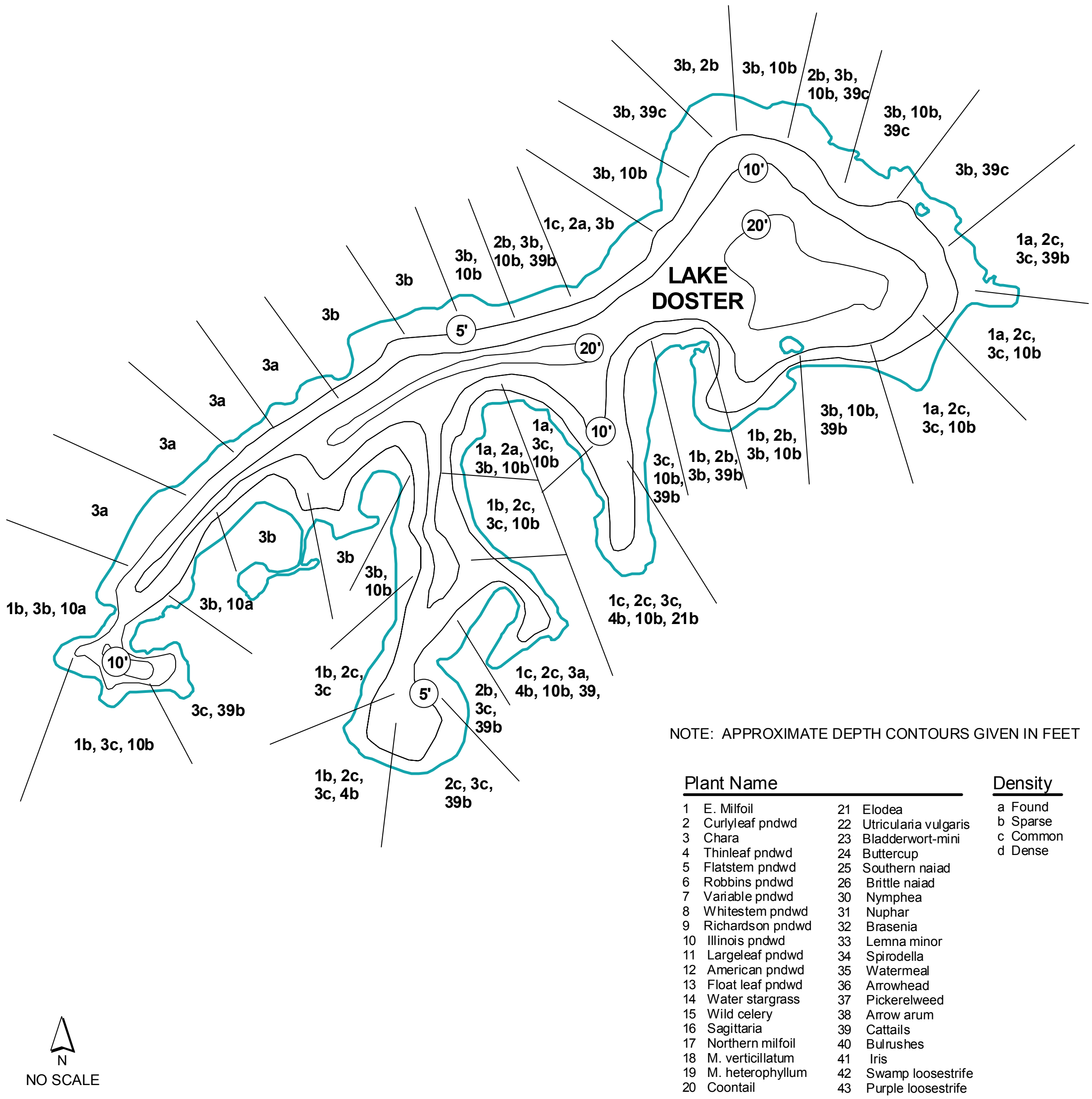


Figure 11. Lake Doster aquatic plant survey map, May 24, 2002. (Source: Base map provided by Lake Doster Property Owners Association.)

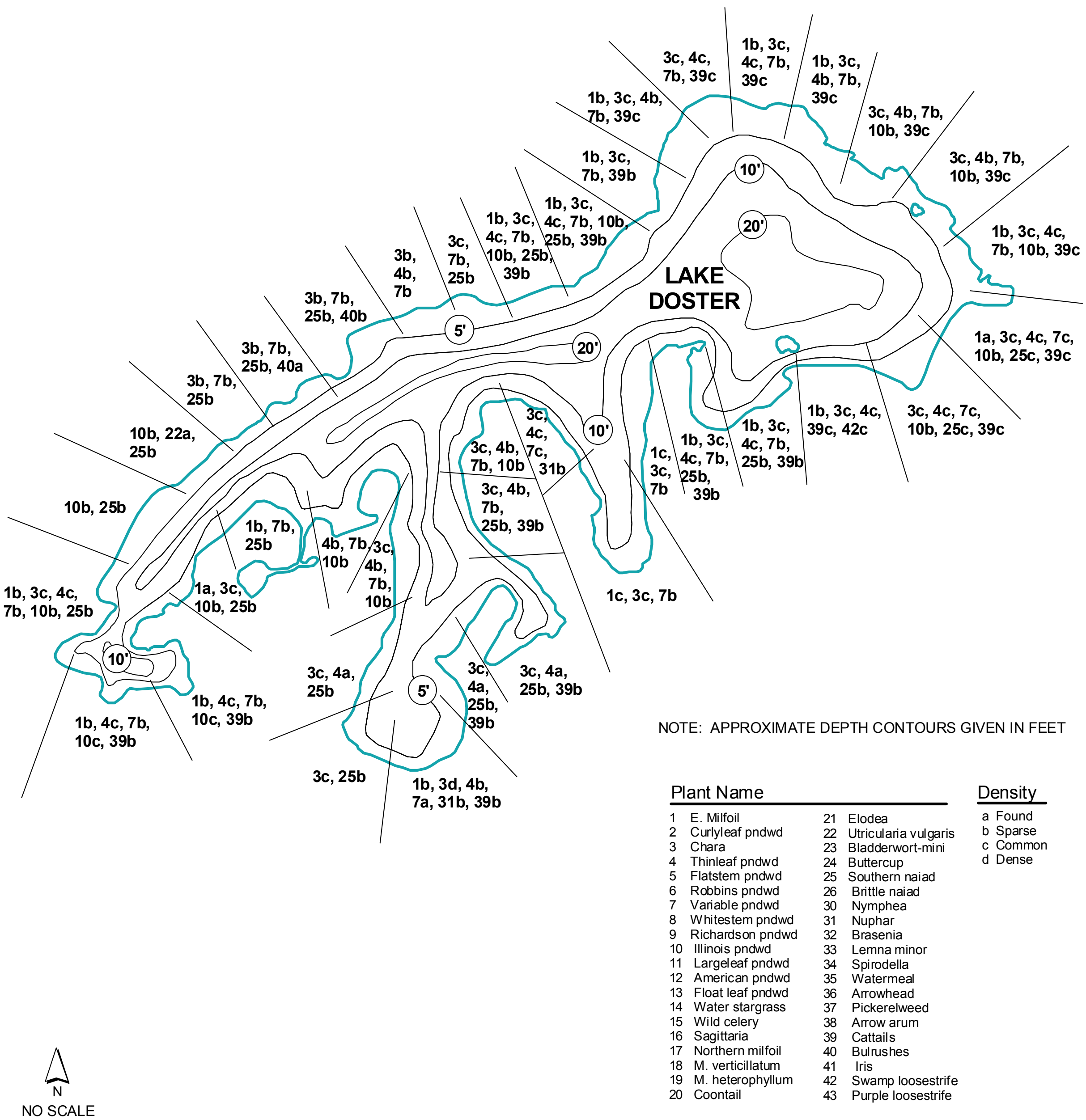


Figure 12. Lake Doster aquatic plant survey map, August 1, 2002. (Source: Base map provided by Lake Doster Property Owners Association.)

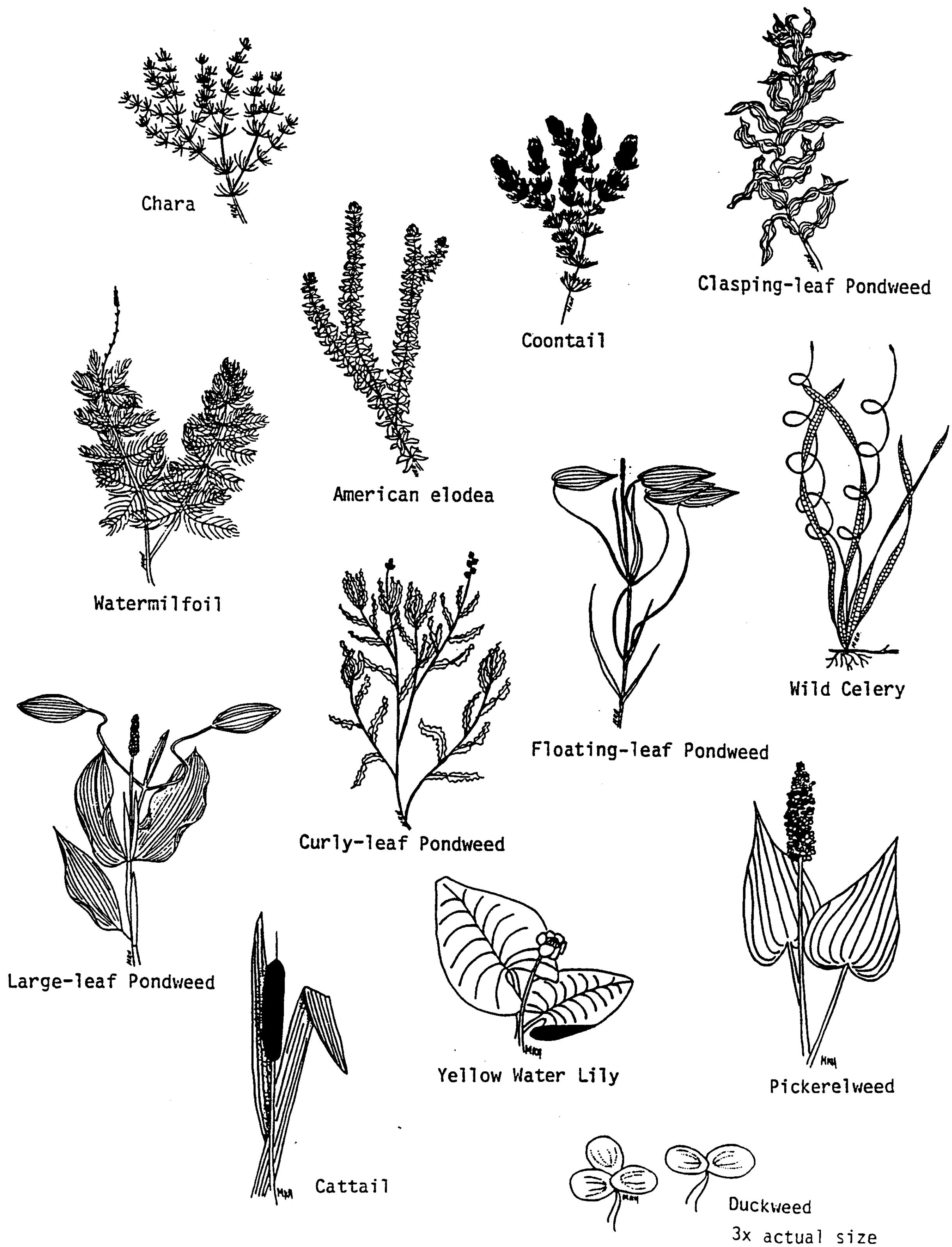


Figure 13. Common aquatic plants.

Lake Improvement Alternatives

INTRODUCTION

In order to effectively manage Lake Doster, steps must be taken in conjunction with in-lake improvements to minimize pollution inputs to the extent possible. This section of the report discusses both in-lake improvement alternatives and methods to reduce pollution inputs to the lake over the long term.

AQUATIC PLANT CONTROL

Although an overabundance of undesirable plants can limit recreational use and enjoyment of a lake, it is important to realize that aquatic plants are a vital component of aquatic ecosystems. They produce oxygen during photosynthesis, provide food and habitat for fish and other organisms, and help stabilize shoreline and bottom sediments. The objective of a sound aquatic plant control program is to remove plants only from problem areas where nuisance growth is occurring. Under no circumstance should an attempt be made to remove all plants from the lake.

Mechanical harvesting (i.e., plant cutting and removal) and chemical herbicide treatments are methods commonly employed to control aquatic plant growth. For large-scale aquatic plant control, harvesting may be advantageous over herbicide treatments since plants removed from the lake will not sink to the lake bottom and add to the buildup of organic sediments (Figure 14). In addition, some nutrients contained within the plant tissues are removed with the harvested plants. With the use of herbicides, treated plants die back and decompose on the lake bottom while bacteria consume dissolved oxygen reserves in the decomposition process. Since the plants are not removed from the lake, sediment buildup on the lake bottom continues, often creating a bottom substrate ideal for future aquatic plant growth.

Figure 14. Mechanical harvesting.

It should be noted, however, that attempts to control certain plant types by harvesting alone may not prove entirely effective. This is especially true with Eurasian milfoil (*Myriophyllum spicatum*) due to the fact that this plant may proliferate and spread via vegetative propagation (small pieces break off, take root, and grow) if the plant is cut (Figures 15 and 16). Eurasian milfoil is especially problematic in that it often becomes established early in the growing season and can grow at greater depths than most plants. Eurasian milfoil often forms a thick canopy at the lake surface that can degrade fish habitat and seriously hinder recreational activity (Figure 17). Once introduced into a lake system, Eurasian milfoil may out-compete and displace more desirable plants and become the dominant species. When Eurasian milfoil is present, it may be possible to control the growth and spread of the plant by treating the lake with a species-selective systemic herbicide. In Michigan, Act 368 of 1978 (the Public Health Code) requires that a permit be acquired from the Department of Environmental Quality before any herbicides are applied to inland lakes. The permit will include a list of herbicides that are approved for use in the lake, respective dose rates, use restrictions, and will show specific areas in the lake where treatments are allowed.

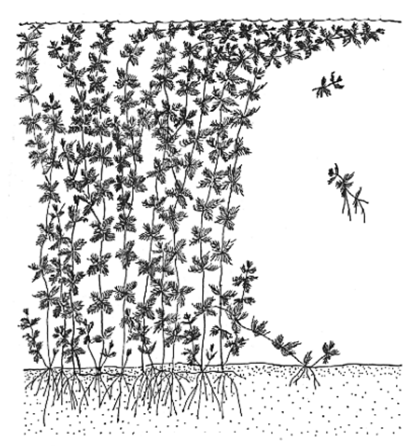


Figure 15. Milfoil fragmentation. (Source: Vermont Agency of Natural Resources.)

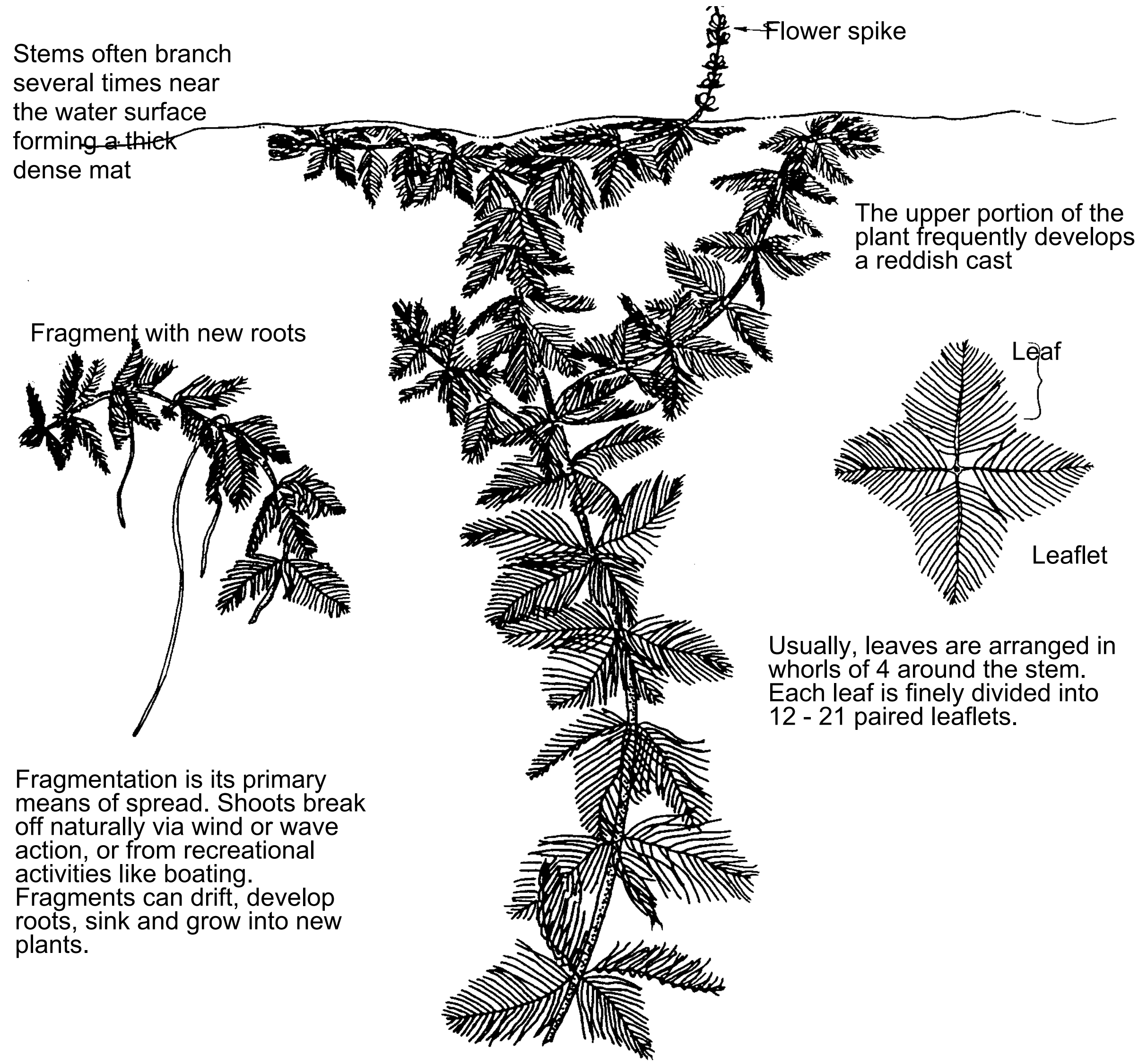


Figure 16. Eurasian milfoil.

Figure 17. Eurasian milfoil canopy.

Lake Doster has several beneficial native plant species, however, approximately 25 acres of the lake contain nuisance plant growth (Figure 18). Nuisance species of primary concern include Eurasian milfoil and curly-leaf pondweed. Initial plant control efforts should focus on the control of Eurasian milfoil with the select use of a systemic herbicide. Herbicide treatments are generally most effective when conducted early in the growing season (i.e., late May or June) when the plants are actively growing. As Eurasian milfoil is brought under control, consideration can be given to mechanically harvesting portions of the lake where nuisance plant growth other than Eurasian milfoil is occurring. To maximize the removal of plant biomass and to help minimize the potential for regrowth later in the season, harvesting should be conducted in late June or July. It should be noted that, given the limited maneuverability of harvesting equipment and the potential for damage to docks and boats, harvesting is generally not conducted between docks.

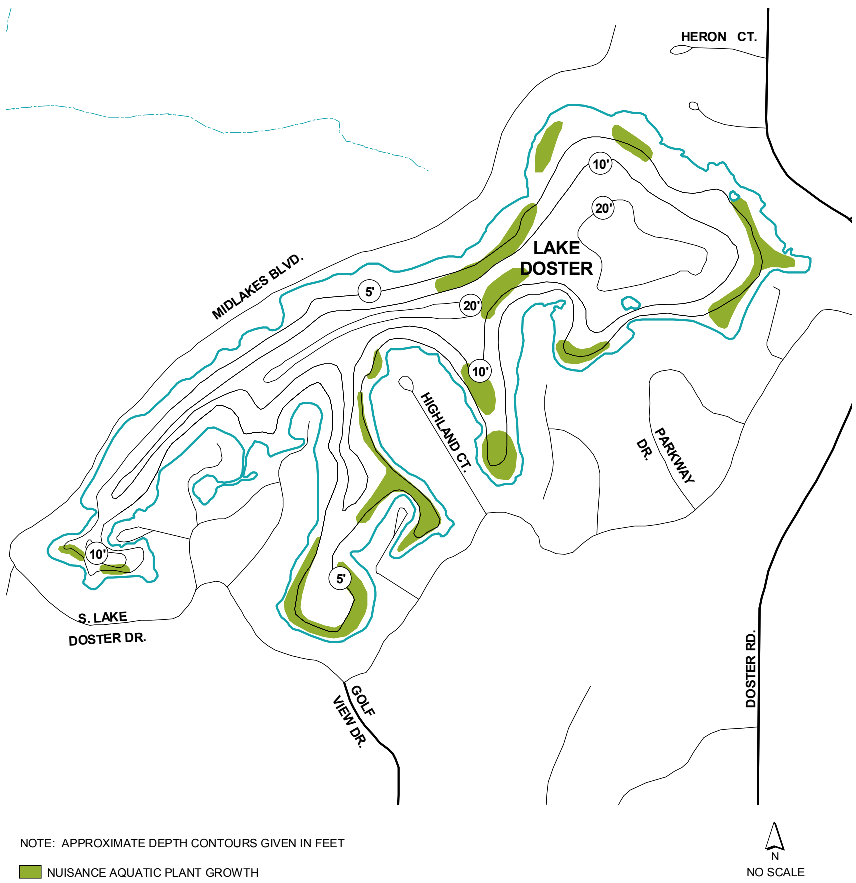


Figure 18. Lake Doster nuisance aquatic plant growth map. (Source: Base map provided by Lake Doster Property Owners Association.)

Although Chara is common throughout Lake Doster, this plant merits special consideration. Chara looks like a rooted plant but is actually an algae which forms a net-like mat on the lake bottom. Chara is considered to be beneficial in that it is low-growing (and generally does not interfere with recreational activities), it controls the resuspension of bottom sediments, and absorbs phosphorus. Thus, Chara helps to improve water clarity. If Chara is removed from Lake Doster, an invasive, nuisance species such as Eurasian milfoil will likely take its place. Based on these considerations, it is recommended that no attempt be made to control Chara growth in Lake Doster. Costs associated with the recommended plant control program for Lake Doster are contained in the Project Implementation and Financing section of this report.

SPOT DREDGING

Lake dredging is a lake management alternative that is often considered to improve navigation and to control aquatic plant growth. There are two major dredging methods: drag-line and hydraulic (Figures 19 and 20). Drag-line dredging involves excavation using a crane, backhoe or similar equipment. The crane is placed on shore or on a floating barge and excavates material with its "clamshell" or bucket. Excavated material is placed in an interim location to drain or "dewater" the dredged material, or, if a location is available nearby, dredge spoils can be placed directly in the final disposal location. Drag-line dredging is limited to areas that are within reach of the crane arm. With hydraulic dredging, excavated material is pumped in a slurry through a floating pipeline to the point of disposal. Most large-scale dredging projects are conducted with a hydraulic dredge.

Figure 19. Dredging with a backhoe.

Figure 20. Hydraulic dredging. The floating pipeline is visible behind the barge at the bottom of the photograph.

A primary consideration in a lake dredging project is identifying a suitable location (or locations) for the placement of dredged material. When a hydraulic dredge is used, disposal sites are usually constructed by excavating an area and creating an earthen dike to contain the dredged slurry (Figure 21). Given the flocculent nature of the organic sediments found in most lakes and the extended time frame for dredged material to dewater and consolidate, the disposal cell must be adequately sized to accommodate the large amount of dredged material produced. The disposal cell should be designed to maximize the settling of solids while allowing excess water to drain off. After dredged materials have been deposited and sufficiently drained and dried, the disposal area may be graded and seeded. Another disposal alternative for hydraulic dredging is pumping to sealed, permeable, geotextile tubes which are filled with dredged materials and allowed to dewater by percolation through the geotextile fabric walls (Figure 22). The drier sediments are retained inside the tube. The tubes can then be split open and the dried sediments hauled to the final disposal location, if necessary.

Pursuant to provisions of Part 301 of P.A. 451 of 1994, the Natural Resource and Environmental Protection Act, a permit must be acquired from the Michigan Department of Environmental Quality (MDEQ) before a dredging project can be initiated. Permit conditions will generally require that the dredge disposal site be located in an upland location and that steps be taken during the dredging operation to prevent excessive sediment transport to adjacent areas. Dredge spoils are not typically allowed to be placed in wetland areas.

MDEQ has recently developed testing procedures for sediments proposed for dredging that require non-sandy sediments to be tested for certain heavy metals, polychlorinated biphenyls (PCBs), and polynuclear aromatic hydrocarbons (PNAs). If sediment proposed for dredging is found to be contaminated, the MDEQ may require that sediments be placed in a licensed landfill. This requirement can substantially increase the cost of a dredging project.

Figure 21. Dredged sediment disposal cell (aerial view).

Figure 22. Geotextile tubes can be used to store and dewater hydraulically dredged sediments.

Currently, shallow water conditions limit full recreational use and enjoyment of portions of Lake Doster. This is especially true in the coves at the south end of the lake. To improve navigation and to help reduce nuisance plant growth in these areas, approximately 40,300 cubic yards of sediment would need to be removed from the lake. Dredged sediments (also known as dredge "spoils") could potentially be placed in a natural depression just south of the intersection of South Lake Doster Drive and Highland Court (Figure 23). A dredging project of this scope would involve deepening approximately 5 acres of the lake by 5 feet (Figure 24). Costs associated with spot-dredging in Lake Doster are included in the Project Implementation and Financing section of this report.

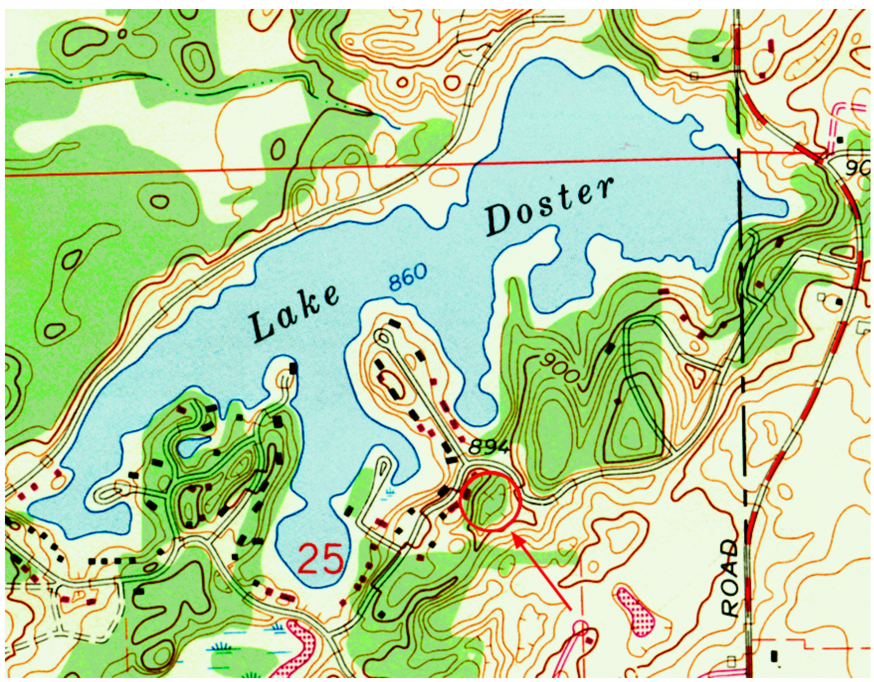


Figure 23. Potential dredge-spoil disposal location.

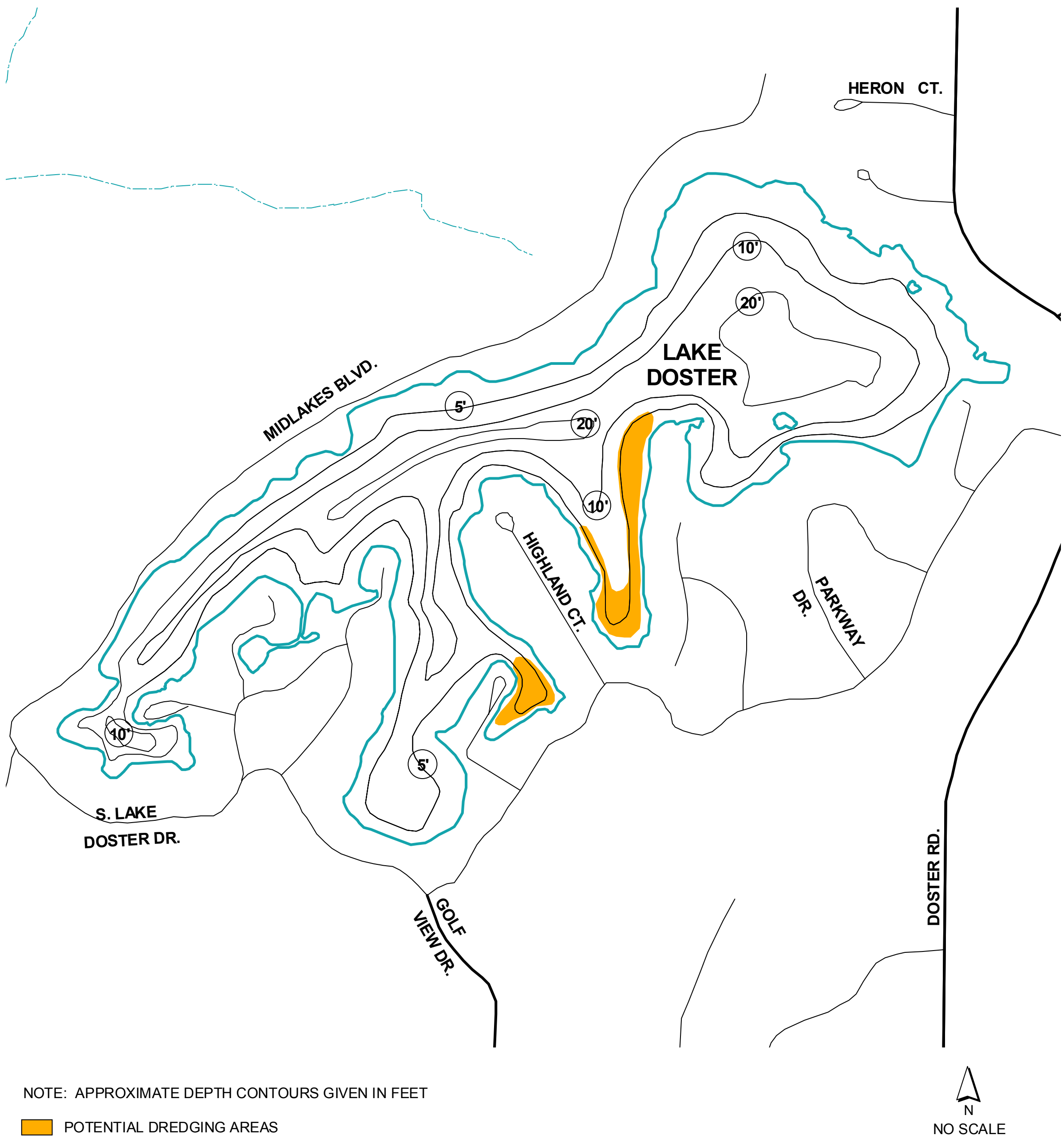


Figure 24. Lake Doster potential dredging areas map. (Source: Base map provided by Lake Doster Property Owners Association.)

STUMP REMOVAL

When the pre-existing wetland was flooded to create Lake Doster, some tree stumps were also inundated that now pose recreational difficulties and safety concerns. Most of the submerged stumps are located in the areas shown in Figure 25. It may be possible to remove stumps from below the water's surface using a shore-based winch. However, before removing stumps from Lake Doster, a permit must be acquired from the MDEQ pursuant to Part 301 of Act 451 of 1994, the Natural Resources and Environmental Protection Act. The MDEQ will likely require that tree stumps only be removed from areas where their presence creates a significant navigation or safety hazard. Because stumps provide fish cover, the Michigan Department of Natural Resources (MDNR) may request that some stumps be relocated elsewhere within the lake, or that suitable replacement cover be introduced to protect fishery habitat. Costs associated with stump removal from Lake Doster are presented in the Project Implementation and Financing section of this report.

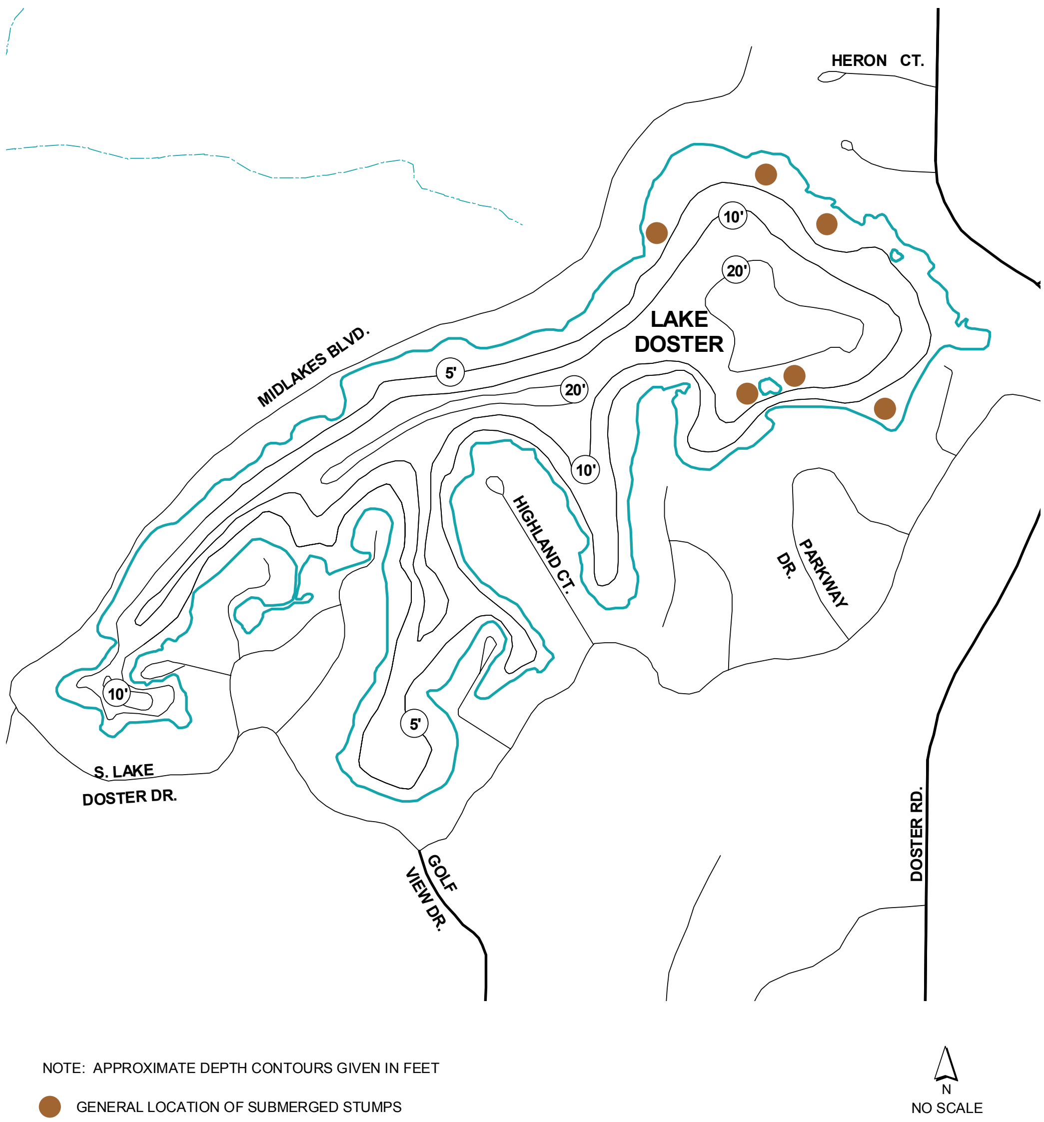


Figure 25. Lake Doster stump location map. (Source: Base map provided by Lake Doster Property Owners Association.)

LAKE DRAWDOWN

An alternative method for stump removal would be to draw down the lake level and remove the stumps with a chainsaw. The lake level could be lowered by either withdrawing water using the existing slide gate at the dam or by siphoning water from the lake (Figures 26 through 28). A 3-foot drawdown would be sufficient to expose most stumps that pose a safety hazard and interfere with recreational use of the lake.

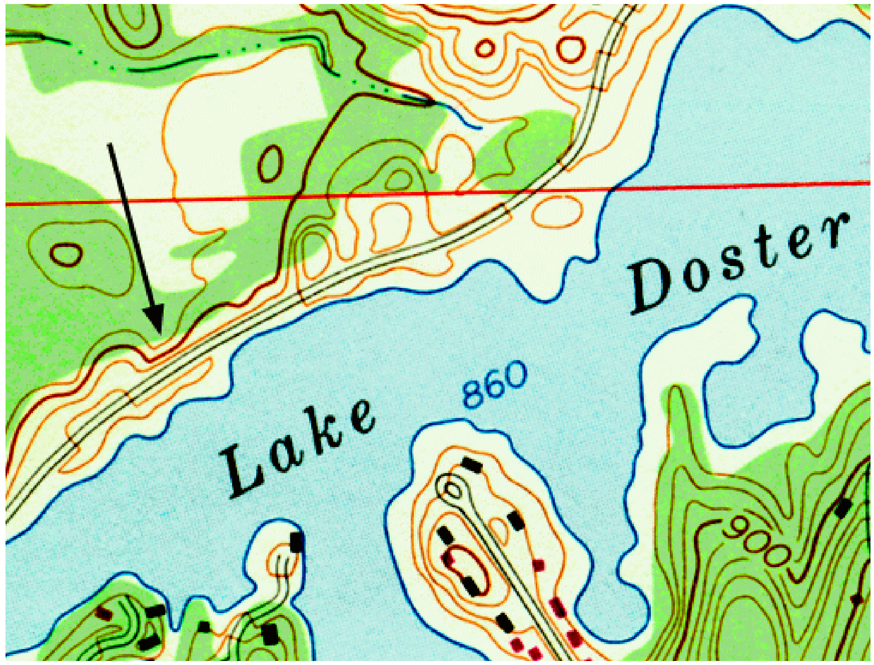


Figure 26. Lake Doster dam location.

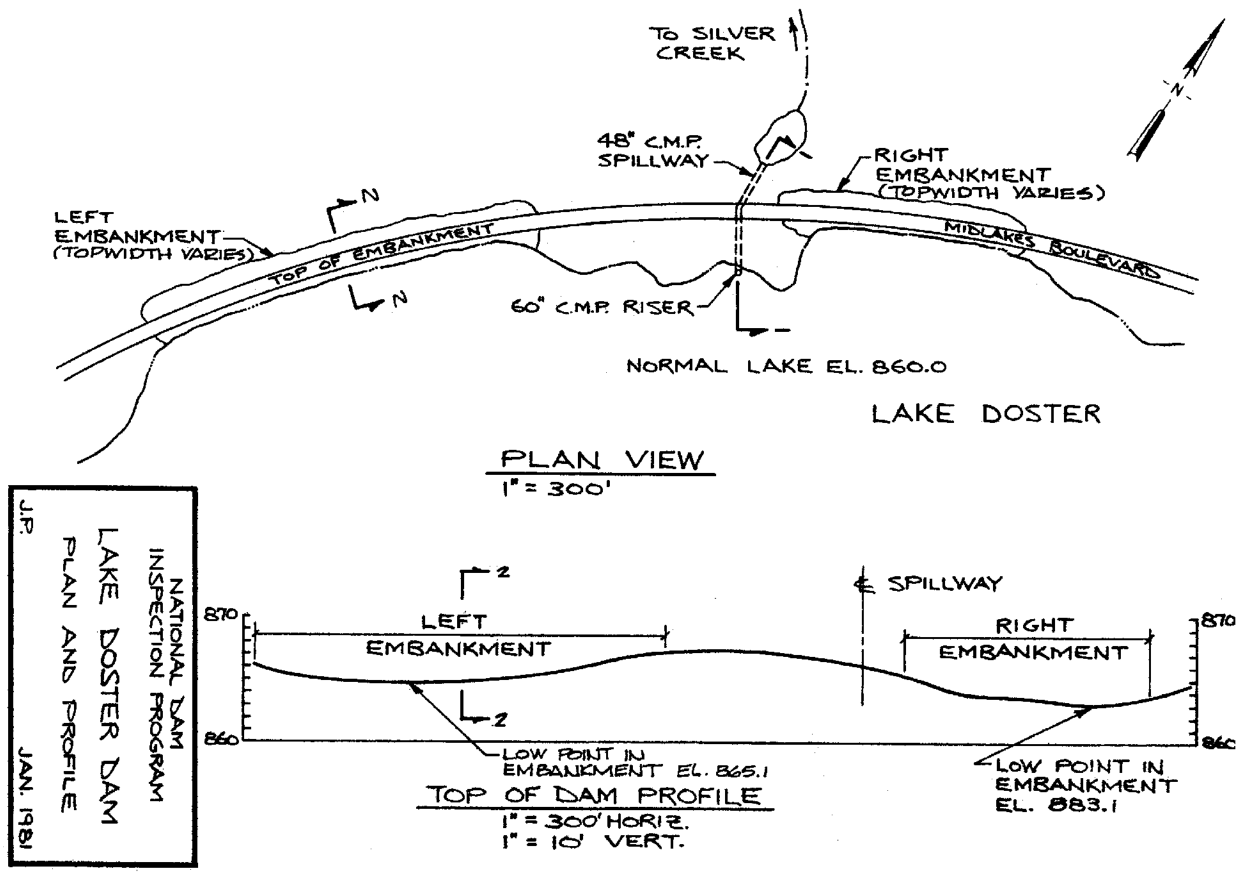


Figure 27. Lake Doster dam plan and profile. (Source: Owen Ayres and Assoc. 1981.)

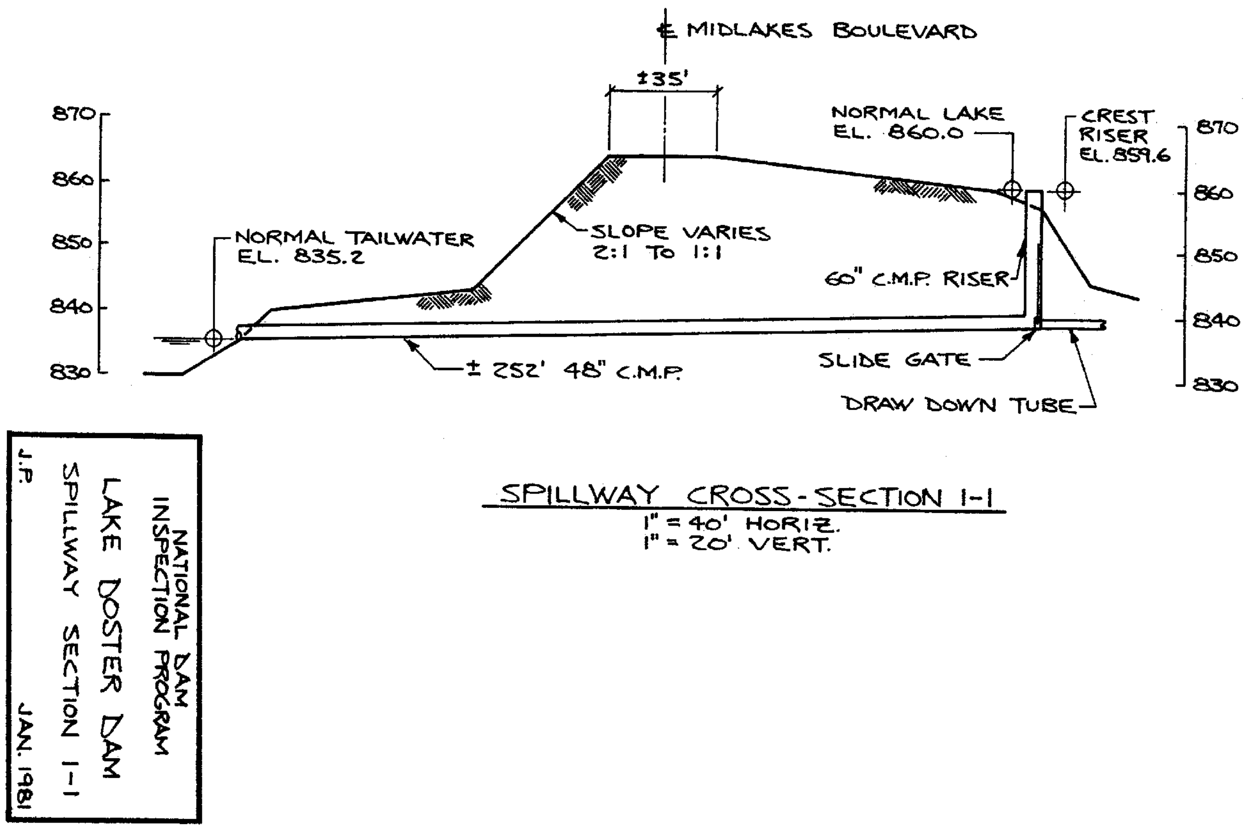


Figure 28. Lake Doster spillway cross-section. (Source: Owen Ayres and Assoc. 1981.)

In addition to stump removal, winter drawdown can provide an opportunity to clean accumulated debris from exposed bottomlands and to compact the exposed lake bottom which can help control aquatic plant growth. However, some plants such as Southern naiad are drawdown-resistant and can become more abundant following a drawdown. Other potential problems associated with drawdown include winter fish kill due to dissolved oxygen depletion under ice, exposure of fish spawning areas due to low spring water levels, downstream sediment transport and flooding, exposure of dangerous muck areas, and failure to refill.

To address these potential problems, any drawdown of Lake Doster would need to be timed so as to mitigate potential adverse impacts. This could be accomplished by slowly drawing down the lake level in fall (on or about October 15th, after the water temperature has cooled and most residents have removed their boats from the lake) and starting refill prior to the onset of winter ice cover. With this approach, the lake level could be slowly lowered over three to four weeks. Assuming work (i.e., stump removal and beach clean-up) could be completed in a two-week period, refill of the lake could begin in early December and continue until the normal 860-foot lake level is attained. This approach would minimize downstream impacts with respect to flooding or sediment scouring, reduce the potential for dissolved oxygen depletion under ice cover, and minimize the potential for impacts on spring fish spawning due to reduced water levels. To better gauge the response of Lake Doster to a drawdown, it may be prudent to conduct a drawdown in an incremental fashion. Initially, the lake level could be lowered 1.5 feet and the rate of refill measured to determine if there is adequate inflow to the lake to ensure timely refill under the 3-foot drawdown scenario. Prior to any drawdown, a newsletter should be circulated to all area residents informing them of the timing of the drawdown and noting that, during drawdown, some of the exposed bottomland areas may pose a safety hazard.

In order to conduct a lake drawdown, a permit must be acquired from the MDEQ pursuant to Part 301 of Act 451 of 1994, the Natural Resources and Environmental Protection Act. Typically, the MDEQ will require that dissolved oxygen monitoring be conducted during the course of drawdown to ensure sufficient dissolved oxygen levels are maintained to protect the fishery. Costs associated with drawdown are presented in the Project Implementation and Financing section of this report.

BEACH CONSTRUCTION

Currently, conditions along much of the near-shore bottomlands of Lake Doster are less than ideal for swimming and other recreational activities. Near-shore conditions and recreational activities afforded by the lake could be markedly improved if lakefront property owners opted to construct swimming beach areas adjacent to their respective properties. Beaches could be constructed by cleaning, stabilizing, and possibly placing sand at select swimming locations. It is important to remember that shoreline areas are vital for fish and wildlife. Residents should limit beach size in order to preserve and protect as much natural area as possible, both on shore and in the lake.

Areas being considered for beach construction should first be cleared to remove accumulated debris. Once adequately cleaned, the beach area can be overlain by a gas-permeable filter fabric to stabilize the bottom and to provide a relatively firm bottom substrate. (The filter fabric must be gas-permeable so that gasses naturally produced in the lake sediments do not float the fabric to the surface.) Once secured in place, the filter fabric may be covered with clean, washed beach sand; or, in some instances, the fabric is left uncovered to inhibit aquatic plant growth. Depending on the extent of use of the beach areas, periodic maintenance may be required to ensure optimum conditions are maintained.

Pursuant to provisions of Part 301, Inland Lakes and Streams, of P.A. 451 of 1994, the Natural Resource and Environmental Protection Act, a permit must be acquired from the MDEQ for beach construction. If the proposed beach area requires less than 300 cubic yards of clean fill sand, does not exceed a blanket depth of 6 inches, and is constructed in less than 4 feet of water, the MDEQ may classify the work as a minor activity. The minor activity classification can expedite the usual four- to six-month MDEQ permit acquisition process.

Cost estimates for the construction of beach areas as described above range from $2 to $3 per square foot. It is recommended that lake residents who desire to implement beach improvements develop site specific construction plans and submit the appropriate permit application to the MDEQ.

WATERSHED MANAGEMENT

The Lake Doster watershed is relatively small at just over 3-1/2 times the size of the lake and is readily amenable to management. Often, lakes with large watersheds are of poorer quality than those with small watersheds because of the greater quantity of runoff draining into the lake. In evaluating watershed management options, it is important to note that the type of land use in a watershed directly influences the quantity and quality of runoff. For example, the runoff from residential areas (with roof tops, roads, driveways, and other impermeable surfaces) will generally be of greater quantity and poorer quality in terms of sediment and nutrient content than runoff from a wooded area of equal size. In wooded areas, much of the potential pollution load is retained and assimilated by the vegetative ground cover. Thus, watershed management often focuses on protecting natural areas (such as wetlands and forested areas) from over-development while implementing practices to reduce pollution inputs from existing and new development.

As with most lakes, development in the Lake Doster watershed is concentrated in close proximity to the lake. Fortunately, most of the residences around the lake are serviced by a sanitary sewer and pollution from septic systems is not an issue on Lake Doster. However, runoff from these developed shoreland areas has a direct and significant impact on water quality. Given the proximity of development around the lake and the topography that slopes to the lake, it is not possible to divert area runoff from the lake. Thus, in order to improve and protect the quality of Lake Doster over the long term, it is important for lake-area residents to reduce the nutrient and sediment content of runoff water to the extent possible. Pollution inputs from the surrounding shoreland areas in the Lake Doster watershed could be greatly reduced if area residents limit the application of lawn fertilizers, or used non-phosphorus fertilizer, and establish landscape greenbelts along the shoreline. Information on proper lakeside landscaping practices is included in Appendix B.

In addition, wetlands in the Lake Doster watershed trap sediment and nutrient pollutants and provide valuable water quality protection benefits. These vital wetlands should be protected. Pursuant to provisions of Part 303 of the Natural Resources and Environmental Protection Act (P.A. 451 of 1994), regulations exist that restrict the development and destruction of wetlands. However, lake residents should monitor development around the lake to prevent excessive encroachment of area wetlands and the loss of valuable wetland functions.

It is recommended that information on watershed management practices be disseminated to all area residents annually though lake association newsletters and publications.

Recommended Management Plan

Study findings indicate that Lake Doster exhibits relatively good water quality. The lake contains a healthy population of native aquatic plants but is threatened by nuisance exotic plant species, including Eurasian milfoil and curly-leaf pondweed. Steps should be taken to control the spread of these nuisance plants while sustaining beneficial, native plant species in the lake.

Currently, shallow water conditions limit full recreational use and enjoyment of portions of Lake Doster. In portions of the lake, submerged tree stumps pose a problem.

In order to effectively manage and improve conditions in Lake Doster over the long term, steps must be taken in conjunction with in-lake improvements to reduce nutrient runoff to the lake. The primary controllable source of nutrient input to Lake Doster appears to be the runoff of lawn fertilizer from the developed shoreland areas around the lake.

In light of these considerations, the management plan for Lake Doster is proposed to include the following:

- An aquatic plant control program consisting of herbicide treatments to selectively control Eurasian milfoil and mechanical harvesting of nuisance levels of native aquatic plants.
- Consideration of spot-dredging portions of the lake to improve navigation and to control nuisance plant growth.
- Consideration of drawdown to facilitate stump removal and shoreline clean-up.
- A watershed management program that focuses on the dissemination of information to area residents regarding proper lakeside landscaping, fertilizer management, and wetland protection.

Project Implementation and Financing

Improvements for Lake Doster could be implemented in either of three ways: 1) Using the Association's existing dues structure, or 2) by establishing a lake improvement board and assessment district in accordance with Part 309, Inland Lake Improvements, of P.A. 451 of 1994, the Natural Resources and Environmental Protection Act, or 3) by establishing an assessment district under Act 188 of 1954, the Township Public Improvement Act. Under Act 451, a lake board could be established to oversee the project. A lake board for Lake Doster would include the following members:

- A Lake Doster resident.
- A representative of Gun Plain Township.
- An Allegan County Commissioner.
- The Allegan County Drain Commissioner.
- A representative of the Michigan Department of Environmental Quality.

Under Act 188, the project could be implemented by the existing Gun Plain Township Board. Costs for the various project alternatives are presented in Table 7.

TABLE 7
LAKE DOSTER
PROJECT ALTERNATIVES COSTS

Improvement	Cost
Aquatic Plant Control[1] (25 acres at $400 per acre)	$10,000 per year
Engineering, Administration, and Inspections[2]	$3,000 per year
Contingency	$1,500 per year
Total Annual Plant Control Cost	$14,500 per year
Spot-Dredging (121,000 cubic yards at $15 per cubic yard)	$605,000
Engineering/Administration/Contingencies (20% of construction)	$121,000
Total Dredging Cost	$726,000
Stump Removal	$6,500
Drawdown and Stump Removal	$21,500

[1] The scope of herbicide treatments or harvesting in any given year will depend upon the type and distribution of aquatic vegetation.

[2] Plant control activities are proposed to be coordinated under the direction of the lake association's consultant. The consultant would be responsible for preparing bid documents for the plant control program, assisting the association with the selection of plant control contractors, conducting surveys of the lake to determine the scope of work to be performed by the plant control contractors, and performing follow-up inspections to ensure work is performed in a satisfactory manner. The consultant would report to the association regarding the performance of the plant control contractors and would make recommendations to the association regarding payments to the contractors.

Projects under Part 309 or Act 188 can be initiated by petition of area residents or by an action of the township, in which case a petition may not be required. Pursuant to provisions of these Acts, a public hearing would be required to determine if lake residents support the proposed improvements. If public support is demonstrated, a Special Assessment District could be established from which revenue would be generated to finance the improvements. A second public hearing is held to receive comment on the proposed assessments.

Generally, special assessment districts for lake improvement projects include all properties which border the lake and back lots which have deeded or dedicated lake access. It is these properties that would directly benefit from the project. Under this plan, lakefront properties are often assessed one unit of benefit and back lots with deeded or dedicated lake access are typically assessed 1/4 unit of benefit.

Applying these criteria to Lake Doster, approximately 200 assessment units would exist within the Special Assessment District. A breakdown of costs based on this approach is included in Table 8.

TABLE 8
LAKE DOSTER
PROJECT ALTERNATIVES ASSESSMENT COSTS

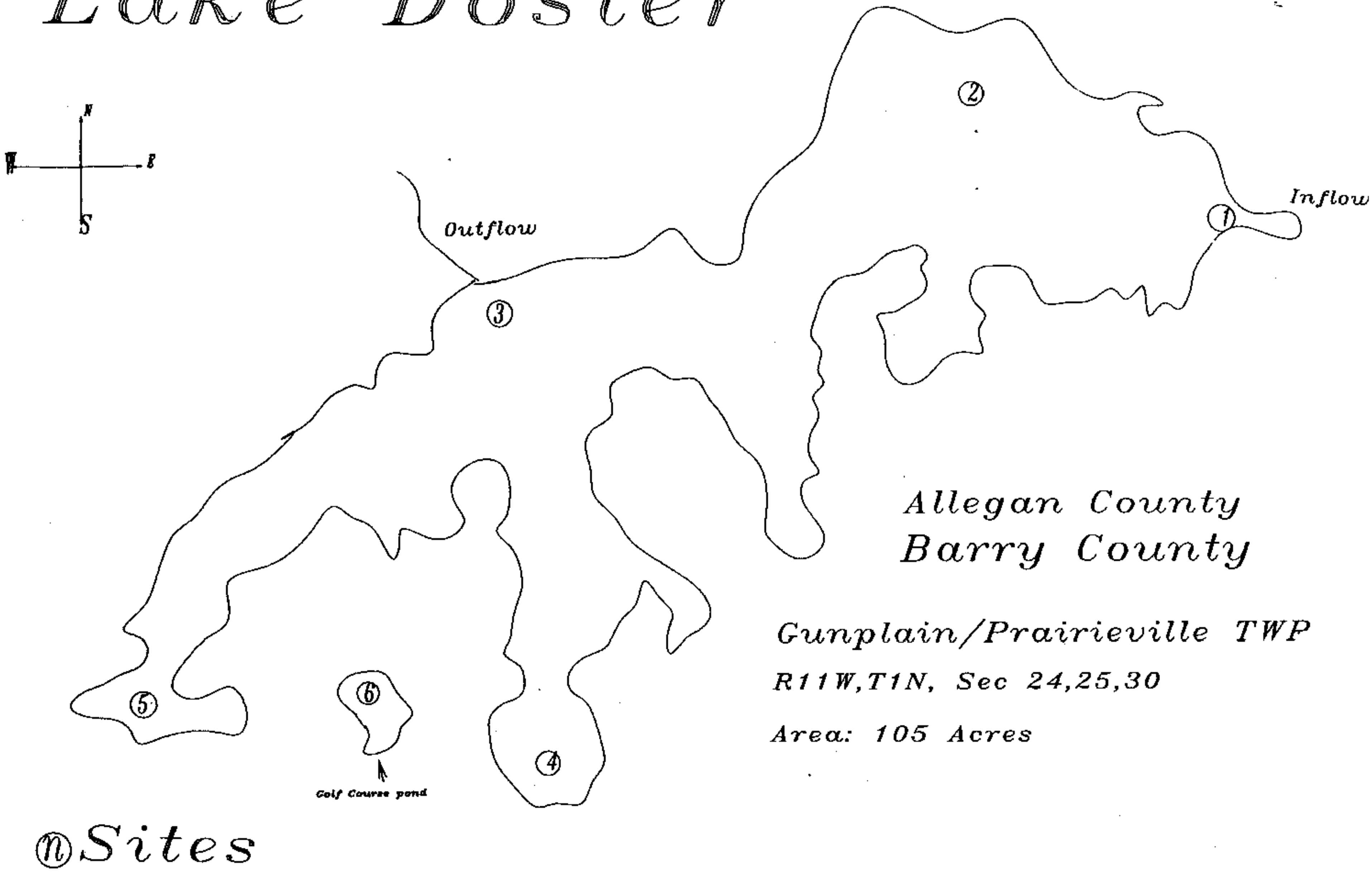
Project Alternative	Lakefront	Backlot
Annual Plant Control (2003 - 2007)	$73	$18
Spot Dredging (If Paid in One Lump Sum in 2003)	$3,653	$913
Spot Dredging (If Amortized Over 5 Years, 2003 - 2007)	$1,156	$289
Stump Removal (No Drawdown)	$33	$8
Drawdown and Stump Removal	$108	$27

The project could include any of the elements in Table 8, but would not need to include all of the elements. For example, based upon input from lake residents, the lake association may choose to undertake annual plant control and stump removal with drawdown. In that case, a lakefront property owner would pay $73 each year over 5 years for the plant control costs, and $108 in the first year only for drawdown and stump removal costs.

Appendix A

Lake Doster Historical Water Quality Data

Lake Doster


N
S
E
W
Outflow
Inflow
1
2
3
4
5
6
Golf Course pond
Allegan County
Barry County
Gunplain/Prairieville TWP
R11W,T1N, Sec 24,25,30
Area: 105 Acres
n Sites

2000 LAKE DOSTER WATER QUALITY DATA SUMMARY
ALLEGAN COUNTY, MICHIGAN

Date 06/30/00 **Air Temp:** 85 F

	Water Temp. F				Dissolved Oxygen				pH				Alkalinity	Phosphorous	Secchi
Site	Surface	1 m	2 m	3 m	Surface	1 m	2 m	3 m	Surface	1 m	2 m	3 m	Surface (mg/L)	Surface (mg/L)	(inches)
1	77	77	76	71	17.2	16.2	16.4	13.7	9.4	9.4	9.3	8.8	154	0.03	96
2	76	76	76	74	13.8	13.5	14.9	14.8	9.2	9.2	9.2	9.2	160	0.03	90
3	76	76	75	75	12.1	12.2	12.5	12.5	9.1	9.1	9	9	162	0.03	90
4	77	76	73	n/a	14.1	18.4	12.1	n/a	9.3	9.3	8.1	n/a	160	0.03	78
5	76	75	75	74	12.8	11.1	10.7	8.4	8.8	8.8	8.8	8.3	150	0.03	90

Date 08/17/00 **Air Temp:** 66 F

	Water Temp. F				Dissolved Oxygen				pH				Alkalinity	Phosphorous	Secchi
Site	Surface	1 m	2 m	3 m	Surface	1 m	2 m	3 m	Surface	1 m	2 m	3 m	Surface (mg/L)	Surface {mg/L)	(inches)
1	77	77	77	76	10.5	12	11.3	n/a	9	9	8.9	7.5	171	0.04	102
2	77	77	76	76	10.2	10	10.1	10.7	8.9	8.9	8.9	8.9	172	0.03	90
3	76	77	77	77	9.9	10.4	9.7	9.9	8.8	8.8	8.7	8.8	172	0.03	89
4	76	77	77	77	11.8	11.1	11.2	7.9	9	9	8.9	8.7	165	0.03	102
5	75	76	76	n/a	11.1	10.3	10	n/a	8.8	8.7	8.5	n/a	170	0.03	70

Date 09/10/00 **'Air Temp:** 71 F

	Water Temp. F				Dissolved Oxygen				pH				Alkalinity	Phosphorous	Secchi
Site	Surface	1 m	2 m	3 m	Surface	1 m	2 m	3 m	Surface	1 m	2 m	3 m	Surface (mg/L)	Surface (mg/L)	(inches)
1	75	75	74	71	11.9	11.4	11	n/a	9	9	8.9	8	172	0.02	84
2	74	74	74	73	10.7	10.9	11.5	3.2	8.9	8.9	8.9	8	172	< 0.02	102
3	74	74	74	73	10.9	10.9	11.3	8.7	8.9	8.9	8.8	8.6	168	0.02	108
4	72	73	73	73	11.9	11.6	9.5	n/a	8.9	8.9	8.6	8.1	165	0.03	108
5	75	76	76	n/a	11.1	10.3	10	n/a	8.8	8.7	8.5	n/a	165	0.03	78

Lake Doster Water Quality - 1998

		Site 1				Site 2				Site 3				Site 4				Site 5			
	Depth	5/31	6/30	9/14		5/31	6/30	9/14		5/31	6/30	9/14		5/31	6/30	9/14		5/31	6/30	9/14	
Temp.	Surf.	76	82	76	---	76	82	76	---	75	82	77	---	75	83	76	---	62	82	76	---
	1m	76	82	76	---	75	82	76	---	75	82	76	---	75	83	75	---	62	83	76	---
	2m	74	82	75	---	75	83	74	---	75	82	75	---	74	79	72	---	62	83	73	---
	3m	73	---	---	---	70	81	73	---	72	79	74	---	73	---	---	---	61	82	73	---
	4m	---	---	---	---	69	71	71	---	67	72	73	---	---	---	---	---	---	---	---	---
	5m	---	---	---	---	---	---	---	---	64	68	66	---	---	---	---	---	---	---	---	---
Diss. Oxygen	Surf.	14.8	19.3	17.5	---	15.5	15.3	17.1	---	15.6	13.4	16.8	---	16.7	15.4	17	---	13.7	14.8	9.5	---
	1m	14.5	17.8	14.2	---	14.5	15.6	16.7	---	15	13.3	16.3	---	16.2	17.2	16	---	13.3	14.3	16.2	---
	2m	11.5	8.7	10.3	---	14	15.5	15.1	---	14.9	13.6	15.7	---	5.2	4.5	7.1	---	12.8	14.7	15	---
	3m	2.6	---	---	---	12.1	6	12.2	---	12.6	9	13	---	---	---	---	---	9.5	3.1	1.6	---
	4m	---	---	---	---	---	---	3.7	---	4	7	8.6	---	---	---	---	---	---	---	---	---
	5m	---	---	---	---	---	---	---	---	0.5	1.3	1.1	---	---	---	---	---	---	---	---	---
pH	Surf.	NA	NA	NA	---	NA	NA	NA	---	NA	NA	NA	---	NA	NA	NA	---	NA	NA	NA	---
Secchi	NA	58	47	60	---	61	105	72	---	59	92	72	---	52	74	82	---	56	92	78	---
Alkalinity	Surf.	192	171	163	---	193	168	164	---	161	155	154	---	166	148	160	---	131	138	134	---
Phosp.	Surf.	0.03	0.02	0.02	---	0.02	0.02	<0.02	---	<0.02	0.02	<0.02	---	<0.02	0.03	0.02	---	<0.02	<0.02	0.02	---

Lake Doster Water Quality - 1997

		Site 1				Site 2				Site 3				Site 4				Site 5			
	Depth	5/29	6/29	7/30	8/23	5/29	6/29	7/30	8/23	5/29	6/29	7/30	8/23	5/29	6/29	7/30	8/23	5/29	6/29	7/30	8/23
	Surf.	61	82	81	70	62	82	80	69	62	82	81	70	62	81	81	69	62	81	82	70
	1m	60	81	80	70	62	82	80	69	62	82	81	70	62	81	82	70	62	81	82	70
Temp.	2m	60	81	79	69	61	82	80	69	61	82	81	70	61	76	77	68	62	81	81	70
	3m	59	76	---	---	61	---	---	69	61	78	79	70	---	---	---	---	61	---	---	70
	4m	---	---	---	---	---	---	---	---	61	71	77	70	---	---	---	---	---	---	---	---
	5m	---	---	---	---	---	---	---	---	59	67	74	70	---	---	---	---	---	---	---	---
	Surf.	14.2	16.1	16.6	14.7	17	14.9	16.3	12.9	14.6	13.3	15.6	11.9	16.1	14.8	17.3	14.3	13.7	12.1	14.6	10.6
	1m	13.8	15.1	14.6	14.5	16.2	14.3	14.7	12.7	14.1	13.3	14.1	11.6	14.6	14.4	16.3	5.1	13.3	11.9	14.4	10
Diss.	2m	16.7	13.7	19.9	12.9	16	14.4	14.6	11.7	13.4	13.5	13.8	11.5	8.3	6	12	6.5	12.8	12.3	18.4	9.3
Oxygen	3m	16.9	6.3	---	---	17.7	---	---	8.8	13.5	9.9	13	11.5	---	---	---	---	9.5	---	---	8.7
	4m	---	---	---	---	---	---	---	---	12.3	2.3	4.2	11.2	---	---	---	---	---	---	---	---
	5m	---	---	---	---	---	---	---	---	6.7	4.4	0.7	10.5	---	---	---	---	---	---	---	---
pH	Surf.	8.3	9	8.9	8.9	8	9	9	8.9	7.9	9	9	8.6	8.2	8.9	9	8.9	8.3	9	9	8.7
Secchi	NA	90	NA	73	63	97	NA	79	97	133	NA	77	74	48	NA	82	66	102	NA	78	88
Alkalinity	Surf.	184	160	158	164	197	142	166	152	198	154	164	160	161	145	154	142	180	144	158	160
Phosp.	Surf.	NA	NA	NA	50	NA	NA	NA	50	NA	NA	NA	30	NA	NA	NA	30	NA	NA	NA	30

Water Quality Data Summary - 1996										
Lake Doster										
Allegan County										
Altitude 700-900 feet above sea level										
05/13/96		Daily Conditions: Partly Cloudy (52 degrees)								
Site	Surface Temp.	Temperature - 3'	Temperature - 5'	D.O. Surface	D.O. - 3'	D.O. - 5'	Ph	Secchi Disk	Total Phos.	Alkalinity
1	53	53	N/A	12	11.5	N/A	8.5	52"Bottom	14	130
2	53	53	N/A	12	12.25	N/A	8.2	38"Bottom	27	170
3	53	53	53	12	11.75	11.5	8.3	109"	23	185
4	53	53	53	12	12	12	8.4	83"Bottom	15	190
5	54	54	53	11.5	11.5	12.5	8.1	118"Bottom	32	190
6	53	N/A	N/A	12	N/A	N/A	8	N/A	28	105
7	53	N/A	N/A	9.25	N/A	N/A	8.2	N/A	29	125
06/06/96		Daily Conditions: Rain (68 degrees)								
Site	Surface Temp.	Temperature - 3'	Temperature - 5'	D.O. Surface	D.O. - 3'	D.O. - 5'	Ph	Secchi Disk	Total Phos.	Alkalinity
1	66	N/A	N/A	9.75	N/A	N/A	8.2	32" bot	18 ug/L	195
2	66	66	N/A	9.9	10	N/A	8.1	48" bot	22 ug/L	180
3	66	66	65	10.1	10.4	10.2	8.2	100"	20 ug/L	175
4	66	65	65	9.75	10	7	8.1	72" bot	18 ug/L	185
5	64	64	64	10.4	10.1	10.1	8.1	99"	31 ug/L	160
6	67	N/A	N/A	9.5	N/A	N/A	8.1	N/A	30 ug/L	115
7	67	N/A	N/A	7.5	N/A	N/A	8	N/A	29 ug/L	130

September 3, 1974

TO: Lake Doster Board of Directors

FROM: Ed Olson

SUBJECT: Lake Water Analysis

The analyses carried out on water samples gathered August 27, 1974 at 5:00 p.m. are given in Table I. These show no significant changes from previous values.

Samples were collected and have been submitted to a commercial testing laboratory for dissolved oxygen, BOD, and Coliform tests. The results of these tests will be reported as soon as they are returned to me.

The sampling sites are the same as previously used.

The clearity of the water remains excellent. Cooler weather and the use of less fertilizer make further testing unnecessary. I will resume testing in May of 1975.

TABLE I

Analysis Site	Temp °F	pH	Phosphate mg/L	Nitrate mg/L
1	76	8.0	0.01	<0.1
2	76	8.1	0.02	<0.1
3	75	8.0	0.02	<0.1
4	75	8.0	0.01	<0.1
5	76	8.1	0.01	<0.1

Table I

Water Analyses, Lake Doster

May 29, 1974

Analysis Site	Temp °F	pH	Phosphate mg/L	Nitrate mg/L
1	70	8.0	0.02	0.2
2	69	8.0	0.02	0.1
3	66	8.0	0.03	0.2
4	67	8.0	0.01	0.2
5	70	8.0	0.02	0.2

Appendix I

Cost of Water Analyses

5 Day BOD $20.00

Dissolved oxygen $7.50

Coliform Bacteria $7.50

LAKE DOSTER
Water Analysis Summary

Site	pH	Temp. (°F)	COD (mg/L)	P (mg/L)	N (mg/L)	DO (mg/L)	Jackson Turbidity	Bacterial (Colonies/ 100 ml) TC.	FC.	EC.
Date: June 24, 1972										
1	8.1	-	7.15	0.06	0.4	5.99	2	2	0	0
2	8.1	-	6.94	0.08	0.4	6.65	3	0	0	0
3	8.1	-	5.79	0.04	0.4	6.00	2	2	0	2
4	8.1	-	7.38	0.10	0.4	5.45	4	1	1	6
5	8.1	-	5.79	0.04	0.4	6.15	3	2	0	8
Date: May 29, 1974										
1	8.0	70	-	0.02	0.2	-	-	-	-	-
2	8.0	69	-	0.02	0.1	-	-	-	-	-
3	8.0	66	-	0.03	0.2	-	-	-	-	-
4	8.0	67	-	0.01	0.2	-	-	-	-	-
5	8.0	70	-	0.02	0.2	-	-	-	-	-
Date: August 27, 1974										
1	8.0	76	-	0.01	<0.1	-	-	-	-	-
2	8.1	76	-	0.02	<0.1	-	-	-	-	-
3	8.0	75	-	0.02	<0.1	-	-	-	-	-
4	8.0	75	-	0.01	<0.1	-	-	-	-	-
5	8.1	76	-	0.01	<0.1	-	-	-	-	-
Date: October 2, 1992										
1	7.8	56	6.89	0.05	0.5	7.44	2	1	0	1
2	7.8	56	6.45	0.04	0.6	7.89	2	1	0	2
3	7.9	56	7.68	0.04	0.4	7.64	2	1	0	1
4	7.8	57	5.23	0.08	0.7	5.22	4	2	2	4
5	7.9	58	5.66	0.04	0.5	6.89	2	1	1	2

Algal Associations include Dinoflagellates (Ceratium), Diatoms (Asterionella, Synedra), and Blue-Greens (Anacystis).

Comparative Lake Analysis:

Lake	pH	Temp.	COD	P	N	DO	Jackson Turbidity	TC.	FC.	EC.
Austin	8.0	-	-	0.02	0.5	9.2	-	-	-	-
Eagle	6.3	-	-	0.01	1.5	9.2	-	-	-	-
Gull	7.7	-	-	0.007	0.5	9.0	-	-	-	-
Long	7.4	-	-	0.01	0.6	10.0	-	-	-	-
Gourd-neck	7.4	-	-	-	0.6	9.6	-	-	-	-

COD = Chemical Oxygen Demand
DO = Dissolved Oxygen
P = Phosphorus
N = Nitrogen
TC = Total Coliform
FC = Fecal Coliform
EC = E. Coli

Appendix B

Lakefront Lawn Care and Lakeside Landscaping

Lakefront Lawn Care

Lakefront property owners should not apply fertilizer to lawns and shrubs unless absolutely necessary. When fertilizer is required, only fertilizers specially formulated for lakeside use should be applied, since excess fertilizer can wash into the lake and stimulate unwanted aquatic plant growth. Nutrients commonly found in commercial fertilizers are nitrogen, phosphorus, and potash. The relative content of nutrients in lawn fertilizer can be determined by examining the packaging label. For example, a fertilizer that contains 30 parts nitrogen, 15 parts phosphorus, and 10 parts potash would be labeled 30-15-10.

In most cases, phosphorus is the nutrient that stimulates plant and algae growth in lakes. Generally, most soils contain sufficient phosphorus to maintain a good grass cover and applying additional phosphorus as fertilizer saturates the soil, allowing phosphorus to wash into the lake. Once in the lake, phosphorus can generate several hundred times its weight in aquatic plants. In light of these considerations, lake residents should not use fertilizer containing phosphorus unless a soil test specifically indicates a need for this nutrient. Many fertilizer suppliers carry phosphorus-free fertilizers which are specially formulated to be "lake safe." These fertilizers will be labeled to indicate they are phosphorus-free, i.e., the second number on the label will be zero.

The following practices will help reduce phosphorus losses from lakefront lawns:

- When establishing a lawn, plant fescue rather than bluegrass. Fescue grass requires much less fertilizer.
- When fertilizing, use a fertilizer mix containing potash and a slow-release type of nitrogen, such as sulphur-coated urea, in combination with a more soluble form of nitrogen like ammonium nitrate or ammonium sulfate. Usually, a non-phosphorus fertilizer, such as 25-0-4 or 16-0-8, will contain sufficient nutrients to maintain a healthy lawn without polluting the lake.
- Use the smallest amount of fertilizer necessary to maintain a good grass cover. To reduce the amount of undissolved fertilizer washing into the lake, fertilize in the spring or early summer when the lawn is actively growing and can utilize the fertilizer. This will reduce the amount of undissolved fertilizer washing into the lake.
- Water sparingly to avoid washing or leaching nutrients into the lake.
- On lightly fertilized lawns, thatch probably will not need to be removed. It will decompose and provide part of the nutrients needed by the lawn.
- In the fall, rake and dispose of leaves away from the lake (compost if possible). Do not burn leaves near shore. Nutrients concentrate in the ash and are easily washed into the lake.
- Do not cut the lawn too close. Cutting height should be 2 to 2-1/2 inches so that adequate green area remains on the turf. Do not allow grass clippings to enter the lake.
- Do not feed geese or ducks near the lake. Bird droppings are high in phosphorus and bacteria.

Lakeside Landscaping

Lakeside landscaping involves planting or preserving a zone of natural vegetation (i.e., a greenbelt) around the lake's edge. This vegetation acts as a buffer, trapping runoff and absorbing nutrients (through vegetative uptake) before they can enter the lake.

The lakefront should be landscaped to allow full recreational use of the lake and still provide water quality protection. Lawns alone do not make good greenbelts. Plant varieties should be selected that are attractive, easily maintained, and effective buffers. To minimize the amount of leaves falling into the water, deciduous trees (i.e., trees that lose their leaves at the end of the growing season) should be planted as far from the water's edge as practical. Ideally, deciduous trees should be set back from the water's edge a distance equal to twice the mature height of the tree. Evergreens can be established closer to the lake shoreline. Some native greenbelt varieties include:

Ground Covers

Coronilla varia (Crown Vetch)
Vinca minor (Periwinkle)
Pachysandra terminalis (Pachysandra)
Ajuga reptans (Ajuga or Bugleweed)

Deciduous Shrubs

Lonicera spp. (Honeysuckle)
Elaeagnus umbellata (Autumn-Olive)
Philadelphus coronarius (Mockorange)
Viburnum spp. (Viburnum)
Forsythia spp. (Forsythia)
Syringa spp. (Lilac, shrub form)
Hibiscus syriacus (Rose-of-Sharon)
Physocarpus opulifolius (Ninebark)
Ligustrum spp. (Privet)
Cornus spp. (Dogwood, shrub form)
Cotoneaster spp. (Cotoneaster)

Evergreen Shrubs

Juniperus spp. (Juniper)
Kalmia angustifolia (Sheep Laurel)

Deciduous Trees

Cercis canadensis (Redbud)
Malus spp. (Crabapple)
Amelanchier spp. (Serviceberry)
Quercus rubra (Red Oak)
Quercus alba (White Oak)
Betula spp. (Birch)
Fagus spp. (Beech)
Populus tremuloides (Quaking Aspen)
Tilia americana (Basswood)
Acer rubrum (Red Maple)
Acer saccharum (Sugar Maple)
Acer saccharinum (Silver Maple)
Fraxinus spp. (Ash)
Populus balsamifera (Balsam Poplar)
Robinia pseudoacacia (Black Locust)

Evergreen Trees

Tamarix spp. (Tamarix)
Cedrus spp. (Cedar)
Pinus resinosa (Red Pine)
Pinus strobus (White Pine)
Taxodium spp. (Baldcypress)
Tsuga canadensis (Canadian Hemlock)
Juniperus virginiana (Eastern Red Cedar)

References

Wetzel, R.G. 1983. Limnology. 2nd edition. Saunders College Publishing, Philadelphia, Pennsylvania.