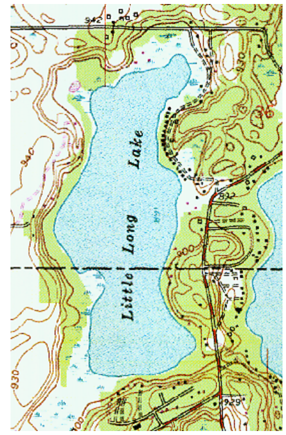

Carrying Capacity Study

Little Long Lake
Recreational and Environmental Carrying Capacity Study

Prepared for:
Four Township Water Resources Council
P.O. Box 634
Richland, MI 49083-0634

Prepared by:
Progressive AE
1811 4 Mile Road, NE
Grand Rapids, MI 49525-2442
616/361-2664

June 2005

Project No: 51830108

ProgressiveAE

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Introduction

The Four Township Water Resources Council was established in 1994 as a volunteer, non-profit group dedicated to protecting water quality in Barry and Prairieville Townships in Barry County and Richland and Ross Townships in Kalamazoo County (Figure 1). The Council's mission is to *assist with the development and implementation of land use strategies that retain the rural environment currently enjoyed by township residents, protecting lakes, streams, drinking water, agriculture, and open space*. In 1998 and 2002, the Council received grants from the U.S. Environmental Protection Agency under Section 319 of the Federal Clean Water Act to implement the Four Township Water Resources Project. As part of this project, the recreational and environmental carrying capacity of Little Long Lake has been evaluated.

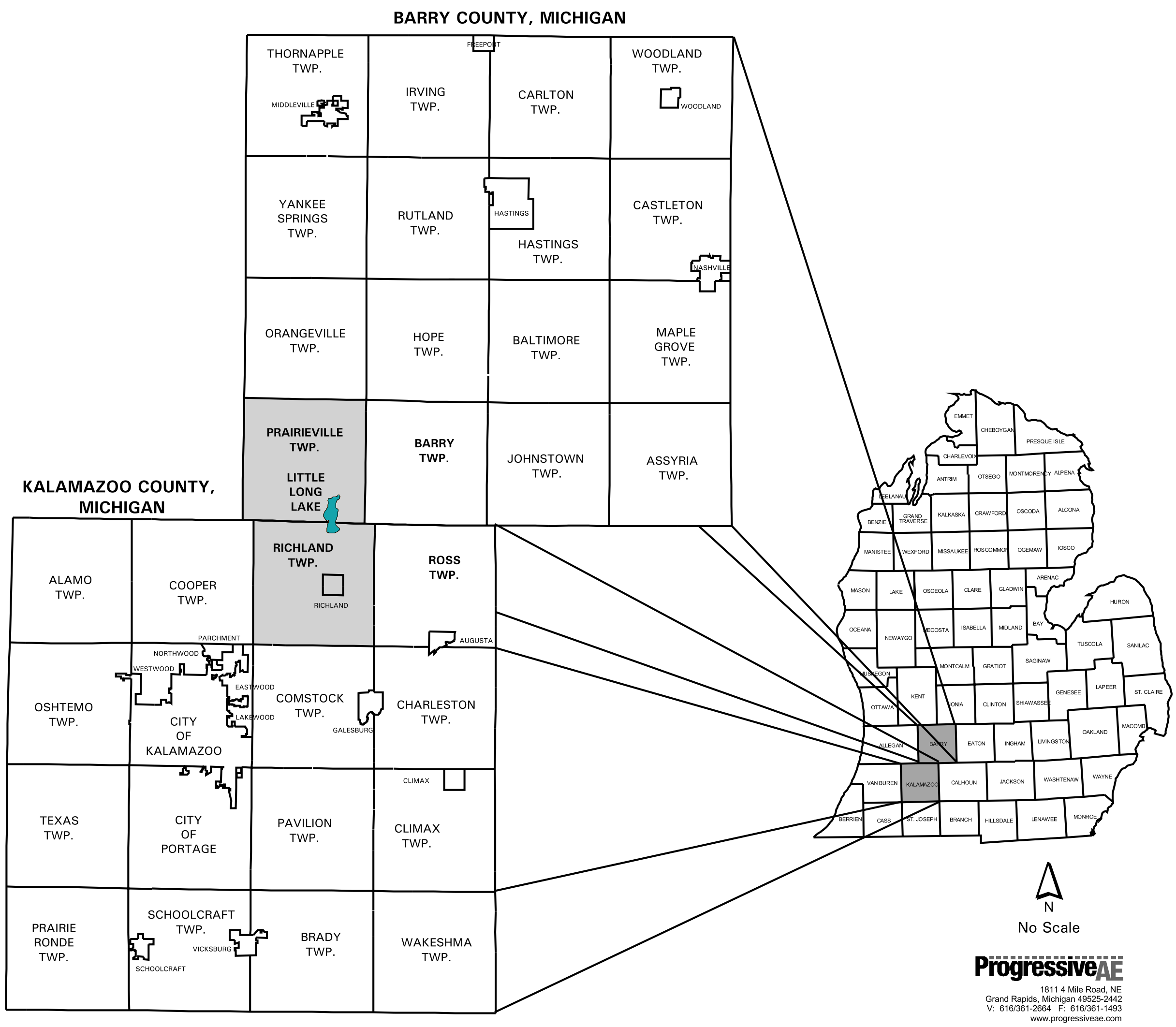

Figure 1. Project location map.

INTRODUCTION

For the purposes of this report, *recreational carrying capacity* refers to the number of boats that can be operated on a lake without compromising safe recreational use, aesthetic enjoyment, and/or environmental quality. *Environmental carrying capacity* refers to a lake's ability to sustain pollution inputs without degrading water quality. A key element of an environmental carrying capacity evaluation is an analysis of the watershed. A watershed is a geographic region within which water drains to a particular lake or stream. Watershed management is important since land use activities in a watershed directly impact water quality. Attempts to implement water quality protection strategies that do not focus on the watershed are often unsuccessful in that they fail to address problems and issues holistically.

The purpose of this report is to provide lake residents and local governmental decision makers with information that will help protect the water quality of Little Long Lake over the long term. The report includes a description of the physical characteristics of Little Long Lake and its watershed, a discussion of lake water quality, a recreational carrying capacity evaluation, an environmental carrying capacity evaluation, and recommendations to minimize the impacts of watershed development.

Lake and Watershed Characteristics

Little Long Lake is located on the border between Prairieville Township in Barry County and Richland Township in Kalamazoo County (T. 1N; R. 10W). Information regarding the physical characteristics of Little Long Lake and its watershed is provided in Table 1. A depth contour map of Little Long Lake is shown in Figure 2.

TABLE 1
LITTLE LONG LAKE
PHYSICAL CHARACTERISTICS[1]

Lake Surface Area	170	Acres
Maximum Depth	32	Feet
Mean Depth	10	Feet
Lake Volume	1,704	Acre-Feet
Shoreline Length	2.8	Miles
Shoreline Development Factor	1.5	
Lake Elevation	891	Feet
Watershed Area	1,633	Acres
Ratio of Lake Area to Watershed Area	1:9.6	

Watershed Land Uses	Acres	Percent of Total
Agriculture	1,101	67%
Residential Development	192	12%
Wooded/Undeveloped	225	14%
Wetlands	115	7%
Total	**1,633**	**100%**

The lake has a surface area of 170 acres, a maximum depth of 32 feet, and a mean or average depth of approximately 10 feet. Shallow shoals exist along the north and northwest portions of the lake. The lake contains 1,704 acre-feet of water, a volume that would cover an area of 1,704 acres or approximately 2.7 square miles to a depth of one foot. Little Long Lake has a shoreline length of 2.8 miles and a shoreline development factor of 1.5. Shoreline development factor is a measure of the degree of irregularity in the shape of the shoreline. A perfectly round lake would have a shoreline development factor of 1.0. The higher the shoreline development factor, the more convoluted the shoreline. The shoreline development factor of 1.5 for Little Long Lake indicates that the shoreline is 1.5 times longer than if the lake was perfectly round.

[1] Watershed area, shoreline length, lake elevation, and lake surface area were determined by examining United States Geological Survey topographic map (Delton, Michigan Quadrangle). Lake volume and maximum and mean depths were derived from a Michigan Conservation Department depth contour map of Little Long Lake (1964). Lake volume and shoreline development factor were calculated according to Lind (1974) using shoreline and contour areas derived from Microstation computer-aided design mapping. Land use acreage was derived from Michigan Department of Natural Resources' Michigan Resource Information System mapping, updated with 1994 aerial photography for Prairieville Township and 1996 aerial photography for Richland Township.

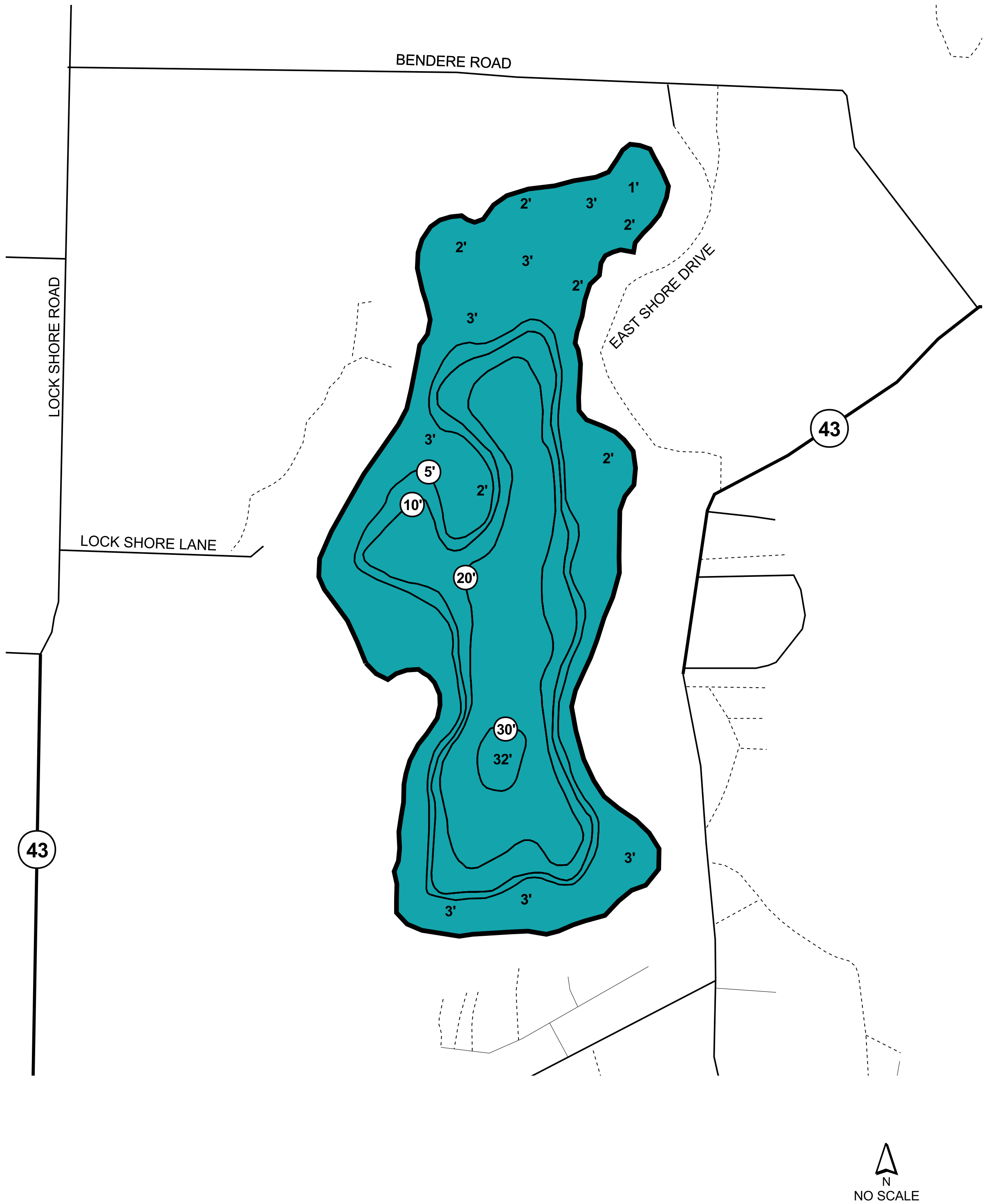

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Figure 2. Little Long Lake depth contour map.

Little Long Lake has an elevation of 891 feet above sea level. Water flows from Little Long Lake to Gull Lake which in turn drains into Gull Creek and ultimately into Lake Michigan via the Kalamazoo River. There is an elevation difference of approximately 310 feet between the level of Little Long Lake and Lake Michigan.

The watershed for Little Long Lake is 1,633 acres in area, a land area 9.6 times larger than the lake itself (Figure 3). Much of the shoreline of Little Long Lake has been developed for residential purposes. However, portions of the southwest and north shore contain contiguous wetland areas and are largely undeveloped (Figure 4). Currently, approximately 80 seasonal and year-round homes border directly on the lake. Much of the remainder of the watershed is composed of farmland, wetlands, and forested areas (Figure 5).

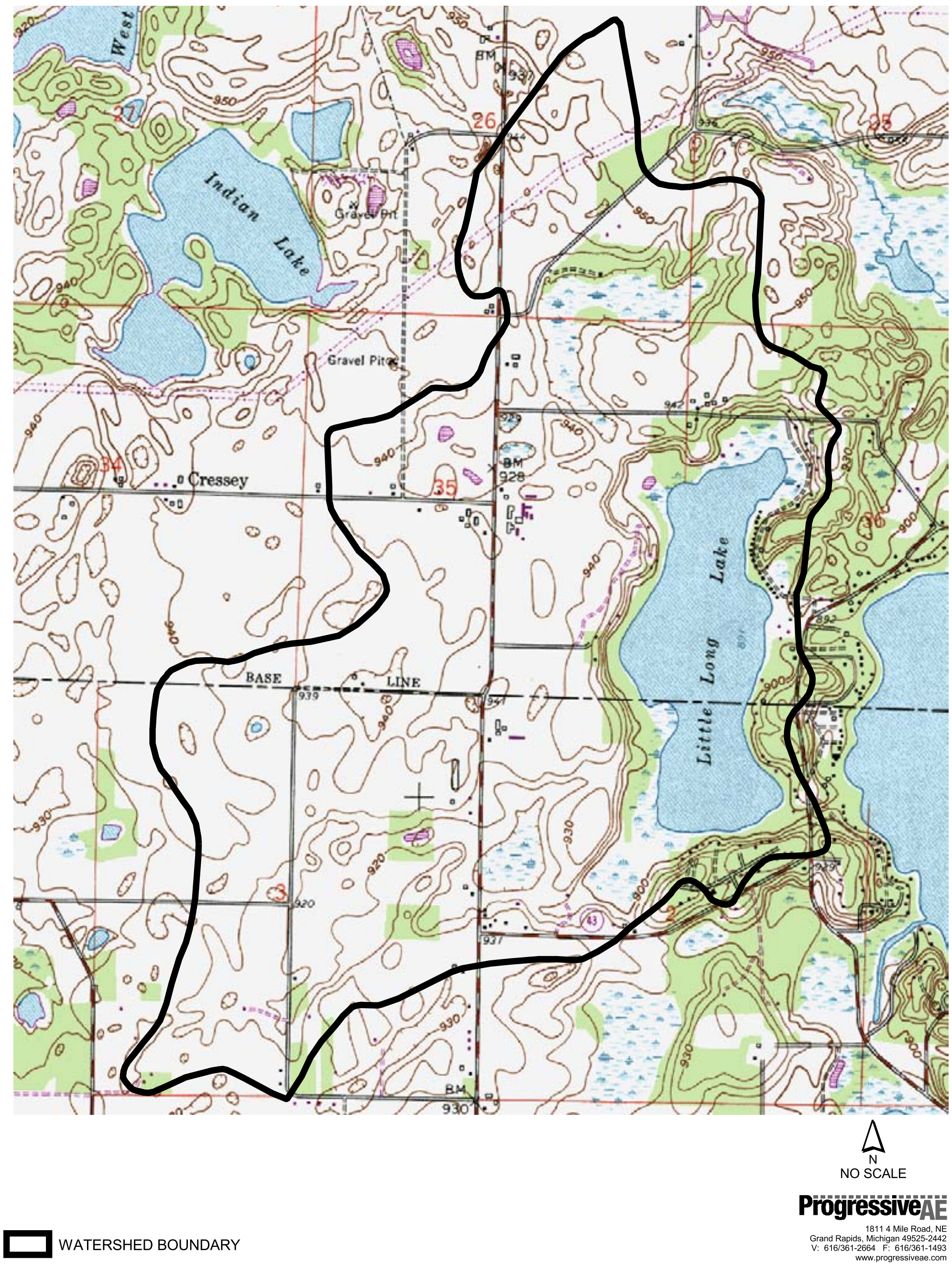


Figure 3. Little Long Lake watershed map.

Figure 4. Little Long Lake undeveloped shoreline area.

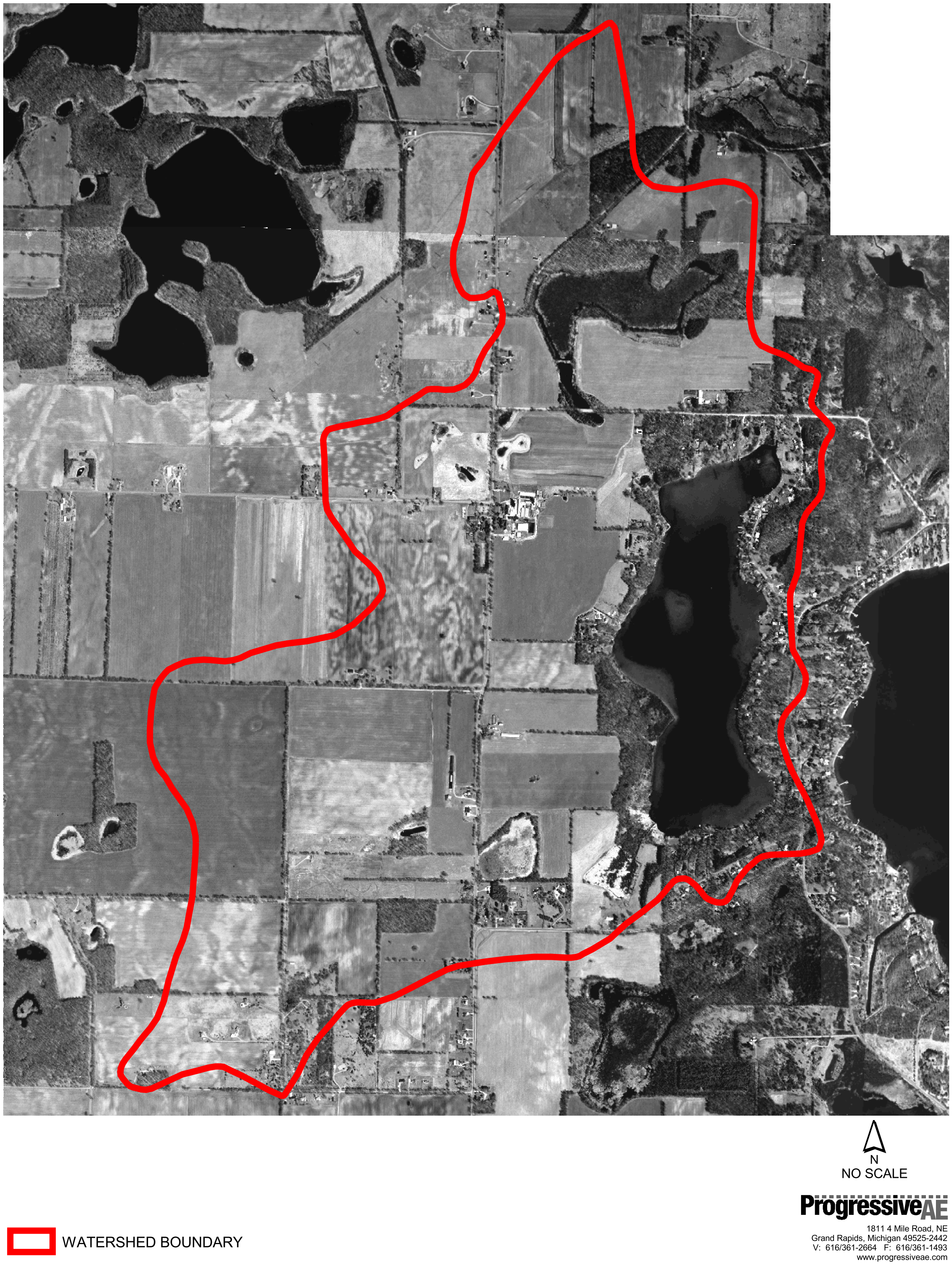
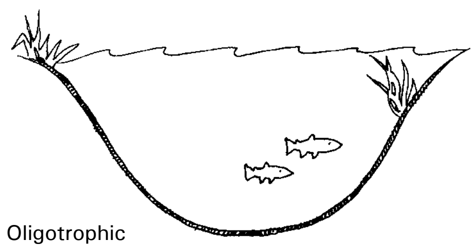


Figure 5. Little Long Lake watershed aerial photography.

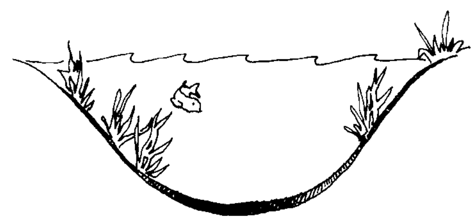
Lake Water Quality

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.

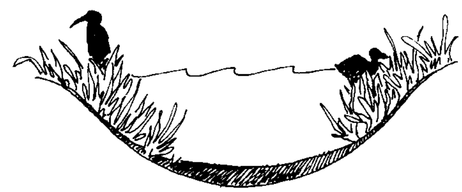
Lakes are commonly classified as oligotrophic, mesotrophic, or eutrophic. Oligotrophic lakes are generally deep and clear with little aquatic plant growth. These lakes maintain sufficient dissolved oxygen in the cool, deep bottom waters during late summer to support cold water fish such as trout and 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.



Oligotrophic



Mesotrophic



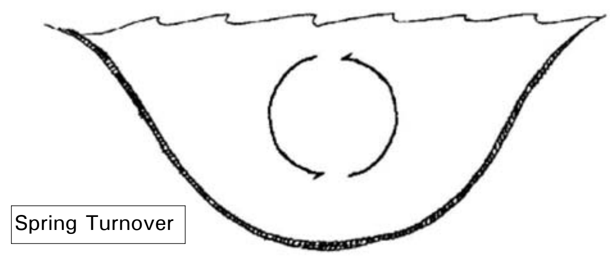
Eutrophic

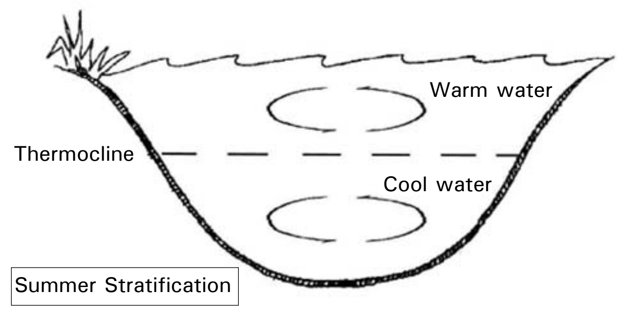
Under natural conditions, most lakes will ultimately evolve to a eutrophic state as they gradually fill with sediment and organic matter transported to the lake from the surrounding watershed. As the lake becomes shallower, the process accelerates. When aquatic plants become abundant, the lake slowly 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.

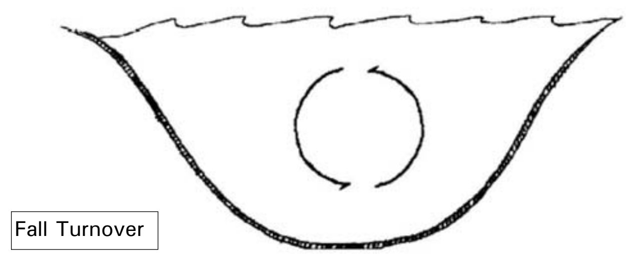
Key parameters used to evaluate the limnological condition of a lake include temperature, dissolved oxygen, total phosphorus, chlorophyll-*a*, and Secchi transparency. A brief description of these water quality measurements is provided as an introduction for the reader. Particular attention should be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

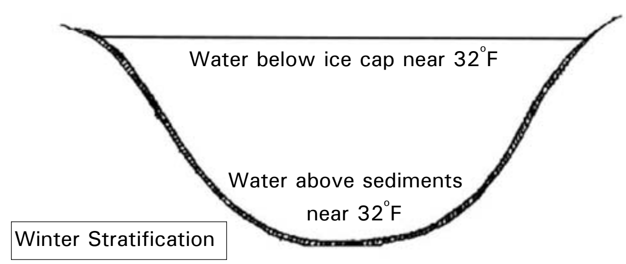
TEMPERATURE

Temperature is important in determining the type of organisms that may live in a lake. For example, trout prefer temperatures below 68°F. 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 32°F) are underlain by slightly warmer water (about 39°F). This is sometimes referred to as "inverse stratification" and occurs because water is most dense at a temperature of about 39°F. As the lake ice melts in the spring, these stratification cycles are repeated. 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.









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).

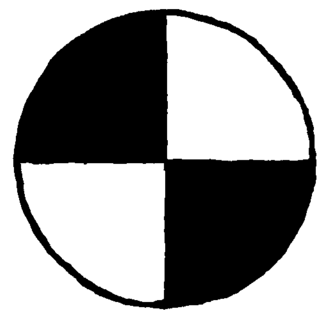
By reducing the amount of phosphorus in a lake, it may be possible to control the amount of aquatic plant growth. In general, lakes with a phosphorus concentration greater than 20 µg/L (micrograms per liter, or parts per billion) are able to support abundant plant growth and are classified as nutrient-enriched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



Secchi disk.

Ordinarily, as phosphorus inputs (both internal and external) to a lake increase, the amount of algae the lake can support 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 Environmental Quality is shown in Table 2.

TABLE 2
LAKE CLASSIFICATION CRITERIA

Lake Classification	Total Phosphorus (µg/L)[1]	Chlorophyll-*a* (µg/L)[1]	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

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

LITTLE LONG LAKE WATER QUALITY

In order to evaluate baseline water quality conditions in Little Long Lake, samples were collected from over the deepest portion of the lake on April 8 and July 22, 2004 (Figure 6). A summary of data collected is presented in Table 3 and Table 4.

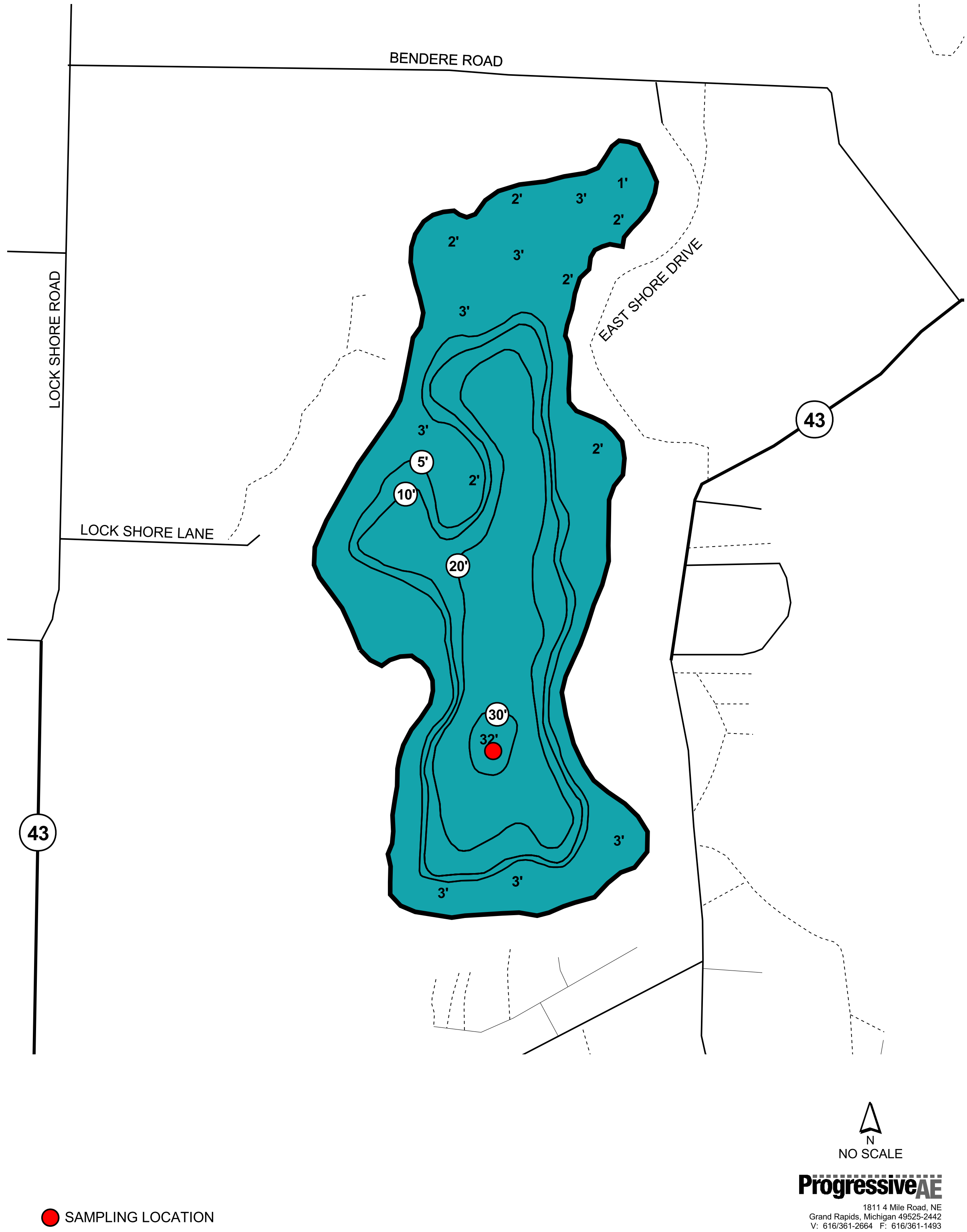


Figure 6. Little Long Lake sampling location map.

TABLE 3
LITTLE LONG LAKE
DEEP BASIN WATER QUALITY DATA

Date	Sampling Site	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)[1]	Total Phosphorus (µg/L)[2]
8-Apr-04	1	1	50.0	11.0	7
8-Apr-04	1	5	48.7	10.7	--
8-Apr-04	1	10	48.0	10.8	--
8-Apr-04	1	15	47.8	10.9	10
8-Apr-04	1	20	47.7	10.9	--
8-Apr-04	1	25	47.1	10.8	--
8-Apr-04	1	28	46.9	10.6	17
22-Jul-04	1	1	81.3	7.5	6
22-Jul-04	1	5	80.4	7.7	--
22-Jul-04	1	10	78.6	7.3	--
22-Jul-04	1	15	73.8	7.1	6
22-Jul-04	1	20	65.8	2.2	--
22-Jul-04	1	25	62.2	0.5	--
22-Jul-04	1	29	60.6	0.5	460

TABLE 4
LITTLE LONG LAKE
SURFACE WATER QUALITY DATA

Sampling Site	Date	Secchi Transparency (feet)	Chlorophyll-*a* (µg/L)[2]
8-Apr-04	1	24.5	0.50
22-Jul-04	1	6.5	0.50

During the April sampling period, the temperature of Little Long Lake was nearly uniform from surface to bottom indicating that the lake had not yet thermally stratified. However, by the July sampling period, the lake exhibited strong thermal stratification with relatively warm surface waters underlain by cooler deep waters. During the July sampling period, the surface was approximately 20 degrees warmer than the bottom waters in the lake.

[1] mg/L = milligrams per liter = parts per million.
[2] µg/L = micrograms per liter = parts per billion.

Dissolved oxygen levels in the lake were near saturation surface to bottom during the April sampling period. During the period of thermal stratification in July, dissolved oxygen below about 20 feet was less than the 5 mg/L level required to support warm water fish. At depths greater than 25 feet, dissolved oxygen was nearly depleted.

Total phosphorus levels in Little Long Lake were relatively low throughout the water column in April, and were low at the surface and mid-depth in July. A substantially elevated phosphorus level was measured in the bottom waters in July, indicating that phosphorus release from the sediments was occurring in the oxygen-deficient deep waters of the lake. However, given the relatively small volume of the oxygen-deficient bottom waters in the lake, it does not appear that internal phosphorus loading is significant in Little Long Lake.

Little Long Lake exhibits relatively low phosphorus levels, minimal algal growth, fair to excellent transparency, and deep water oxygen depletion during summer stratification.

Secchi transparency readings in Little Long Lake ranged from 24.5 feet in April to 6.5 feet in July. During the spring sampling, it was sunny, the wind was calm, and there was no boat traffic. In July, it was cloudy and hot, and several motorized boats were active on the lake, thus reducing water clarity in the lake. Chlorophyll-*a* readings from both April and July were very low, indicating algal growth was minimal in the lake during the period of sampling.

Based on the data collected during the course of study, Little Long Lake would be classified as mesotrophic in that it exhibits relatively low phosphorus levels, minimal algal growth, fair to excellent transparency, and deep water oxygen depletion during summer stratification.

A factor that may contribute to the good water quality in Little Long Lake is the presence of calcium carbonate (also known as "marl") in the lake. During spring and summer months when plants in the lake are actively growing, calcium carbonate will precipitate from the water column. It can often be seen as a white coating encrusted on submersed aquatic plants. In some cases, calcium carbonate will bind with phosphorus and remove it from the water column, making it unavailable to stimulate algae growth. This phenomenon appears to be occurring in Little Long Lake where marl deposits are present throughout much of the shallow-water portions of the lake (Figure 7).

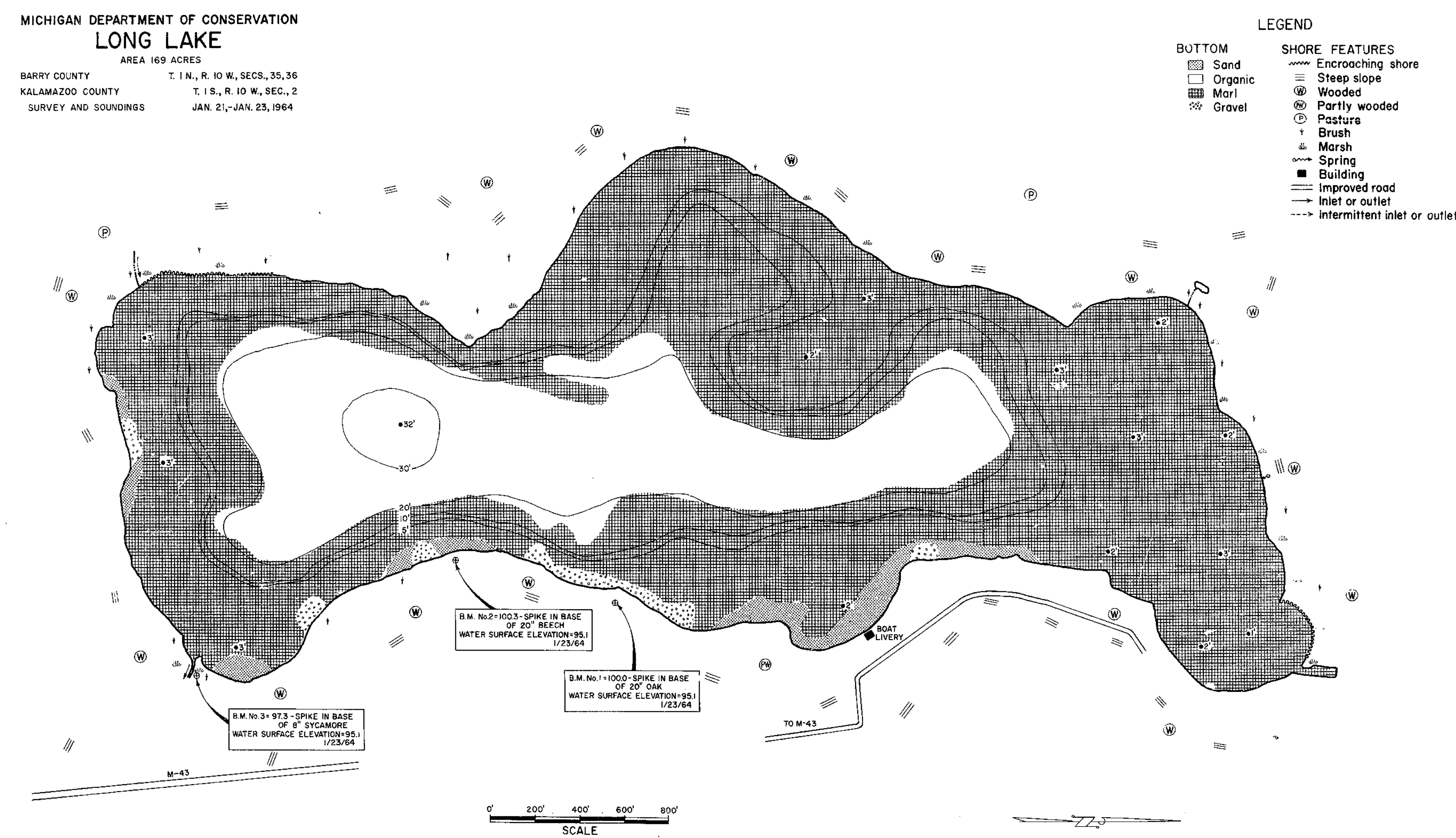


Figure 7. Little Long Lake marl deposits. Location of marl is shown as the grey cross-hatched areas of the lake.

Recreational Carrying Capacity

Lakes are a finite resource with seemingly unlimited demand. As more development occurs around lakes and more lakeside cottages are converted from seasonal to year-round use, boating and other recreational activities can be expected to increase accordingly. This fact, coupled with the tremendous increase in the number, size, and speed of today's watercraft, has brought the issues of lake access and overcrowding to the forefront in many communities.

THE CONCEPT OF RECREATIONAL CARRYING CAPACITY

It should be recognized that the concept of recreational carrying capacity is as much perception as science (Mahoney and Stynes 1995). Although research shows that a higher density of boats increases the potential for negative impacts, there have been no conclusive studies that answer the question: How many boats is too many? (Wagner 1991). Each lake is different, and various lake users will have different perspectives on what constitutes congestion. Thus, there is no single boating density standard that will satisfy all lake users in all situations.

Recreational carrying capacity refers to the number of boats that can be operated on a lake without compromising safe recreational use, aesthetic enjoyment, and/or environmental quality.

In light of these considerations, a recreational carrying capacity study should not be used as the sole determining factor limiting lake use or access. Rather, a recreational carrying capacity analysis should be used as a tool to evaluate the range of options that are available to help minimize multi-use conflicts, environmental concerns, and other problems associated with lake overcrowding. A recreational carrying capacity study can establish a framework for decision making and provide a basis for regulatory action.

At its core, the concept of recreational carrying capacity appears simplistic. The area of the lake that is suitable for boating is divided by the desired boating density. For example, if a lake is 250 acres, and the desired boat density is ten acres per boat, then the recreational carrying capacity would be a maximum of twenty-five boats:

250 acres) 10 acres per boat = 25 boats

However, in estimating recreational carrying capacity, a number of factors need to be considered. Key factors that should be evaluated include lake physical characteristics, use characteristics (i.e., the number of lakeside homes, moored boats, the number and type of access sites), environmental impacts, useable lake area, boating density, and lake use rate. These factors are discussed below.

LAKE PHYSICAL CHARACTERISTICS

Lake size, shape, and depth strongly influence recreational carrying capacity. As previously discussed, Little Long Lake has a surface area of 170 acres, a maximum depth of 32 feet, and a mean or average depth of approximately 10 feet. Shallow shoals exist along the north and northwest portions of the lake. The lake has a shoreline length of 2.8 miles and a shoreline development factor of 1.5. The shoreline development factor of 1.5 for Little Long Lake indicates that the shoreline is 50% longer than if the lake were perfectly round. Lakes with highly convoluted shorelines have the potential to support much more shoreland development per unit area of lake surface. In a study that assessed the impact of motorized watercraft on lakes, Wagner (1991) noted:

> The ratio of the length of shoreline around the lake to the circumference of a circle with the same area as the lake [shoreline development factor] provides a size-independent measure of lake shape and indicates much about how motorized watercraft could affect the water body. Higher ratios suggest irregular shorelines with more waterfront per unit area than smaller ratios. Numerous coves may serve to isolate impacts, but there is a greater potential for the shoreline to be affected. High ratios also imply greater safety risks as well as ecological consequences.

USE CHARACTERISTICS

Little Long Lake supports fishing, boating, swimming, and other recreational opportunities. It appears that in recent years, many of the original seasonal cottages around the lake were converted to year-round occupancy.

To evaluate use characteristics on Little Long Lake, a field survey was conducted in July of 2004 to count the number of lakeside homes and moored boats. Moored boats included boats beached along the shore. Currently, approximately 80 seasonal and year-round homes border directly on Little Long Lake. Moored boat data is shown in Table 5.

TABLE 5
LITTLE LONG LAKE
MOORED BOAT COUNT DATA - July 22, 2004

Boats with Motors Greater Than 25 HP	65	37%
Boats with Motors Less Than or Equal to 25 HP	21	12%
Personal Watercraft	7	4%
Sailboats	8	5%
Non-Motorized Boats[1]	76	42%
Total	177	100%

Non-motorized boats represented the greatest percentage of boats moored on Little Long Lake (42%) followed by boats with motors greater than 25 horsepower (37%), boats with motors less than or equal to 25 horsepower (12%), and personal watercraft and sail boats, which represented less than 10% of moored boats. On average, each lakeside home has two boats. There is no public access site on Little Long Lake.

ENVIRONMENTAL IMPACTS

Several studies have been conducted to evaluate environmental impacts associated with boating (Bouchard 2000, Warrington 1999, Asplund and Cook 1997, Asplund 1996, Wagner 1991). Environmental impacts most commonly associated with boating activity include fuel emissions from boat motors, suspension of bottom sediments, decreased water transparency, shoreline erosion, destruction of fish spawning areas, and loss of fish and wildlife habitat.

Although fuel emissions from motor boats are often cited as a major source of pollution, recent technological advances have greatly reduced pollution inputs associated with outboard motor discharges. Wagner (1991) noted:

[1] Non-motorized boats include canoes, row boats, paddle boats, and other non-motorized watercraft, excluding sailboats.

> Until the mid-1970's, two-cycle outboard engines were considered to be inefficient users of fuel and major contributors to water pollution. . . The fuel crisis in the 1970s and increasing environmental awareness resulted in a number of engineering advances that greatly reduced the discharge of fuel; recycling of fuel that accumulated in the crankcase became a standard feature in 1972. Fuel waste is typically less than 1 percent in a well-tuned modern engine.

Most hydrocarbons in outboard motor exhaust are biodegradable and many components of gasoline volatilize and evaporate rapidly (Bouchard 2000, Warrington 1999). In a study of the impacts of outboard motors conducted on lakes in British Columbia, Warrington (1999) found that there are few well-designed studies that have measured the effect of outboard exhaust on water quality and aquatic organisms. However, he tentatively concluded that there does not appear to be a significant detrimental effect on most aquatic organisms at normal recreational use levels. Warrington also observed that there is no evidence to suggest that lead from fuel was a serious problem for fish or other aquatic life under normal boating activity levels. Warrington further concluded that outboard motor use has not been shown to cause significant hydrocarbon pollution of the bulk water column. However, in localized areas of heavy boating traffic, such as marinas, the impacts of fuel emissions on the aquatic environment may be more pronounced (Warrington 1999, Wagner 1991). Bouchard (2000) concluded that acute (short term) toxicity from outboard exhaust was probably not a problem in most lakes, but chronic (long term) exposure of sensitive aquatic organisms to outboard exhaust is harmful.

In addition to fuel emissions, other environmental impacts associated with boating activity will vary widely depending on a number of factors such as lake size, depth, and level of boat use. In general, the shallower portions of lakes (i.e., areas less than 5 feet deep) are most susceptible to adverse environmental impacts associated with motor boat activities (Wagner 1991). This is especially true with regards to sediment resuspension, reduced water transparency, and impacts to fish and wildlife habitat. Wagner (1991) observed that the shallowness ratio, which compares the area of the lake less than 5 feet deep to the total lake area, is indicative of the lake bottom area likely to be directly affected by motorized watercraft. Shallowness ratios range from low (<0.10) for lakes unlikely to be impacted to high (>0.50) for lakes with a high potential for impact. Little Long Lake's shallowness ratio is 0.52. Thus, Little Long Lake appears to be highly sensitive to sediment suspension and other environmental impacts associated with motor boat activity. Water quality monitoring conducted during the course of study indicates that motorboat activity appears to substantially reduce water clarity in Little Long Lake.

Little Long Lake appears to be highly sensitive to sediment suspension and other environmental impacts associated with motor boat activity.

USEABLE LAKE AREA

For every lake, there are portions of the lake where boating activity can create safety and/or environmental problems. Therefore, these areas should be subtracted from the total lake area and the remaining "useable lake area" should be retained for the carrying capacity calculation. In accordance with Part 801, Marine Safety, of the Natural Resources and Environmental Protection Act (PA 451 of 1994):

> A person shall not operate a motorboat on the waters of this state at a speed greater than slow no-wake speed or the minimum speed necessary for the motorboat to maintain forward movement *when within 100 feet of the shoreline where the water depth is less than 3 feet,* as determined by vertical measurement, except in navigable channels not otherwise posted (Section 80146 (3); emphasis added).
>
> Persons operating vessels on the waters of this state . . . *shall maintain a distance of 100 feet from any dock, raft, buoyed or occupied bathing area, or vessel moored or at anchor*, except when the vessel is proceeding at a slow-no wake speed or when water skiers are being picked up or dropped off . . . (Section 80149; emphasis added).

In light of these considerations and the fact that most environmental problems associated with motor boating activity occur in shallow waters, a minimum width of 100 feet from the shoreline of Little Long Lake is recommended as a shoreline safety and environmental protection zone. Thus, this portion of the lake has been excluded from the useable lake area for carrying capacity calculations. The remaining portion of the lake would be suitable for boating activity and would constitute the useable lake area. A 100-foot shoreline safety zone encompasses 34 acres acres of Little Long Lake's 170 total acres, leaving 136 acres of useable lake area.

BOATING DENSITY

Different types of boats have different spatial requirements. Despite widespread interest in lake carrying capacity, there have been very few scientific studies to determine optimum boating density (i.e., the number of acres of water surface required per boat). Most reported figures are based on the authors' personal opinions, though many may be considered expert.

In a study of carrying capacity controls for recreational water uses, Kusler (1972) noted:

> Water resource groups throughout the nation have prepared water space demand estimates for water sport uses based upon complex assumptions concerning acceptable limits for intrasport and intersport activity. However, these estimates vary widely and much work needs to be done to determine space demands of a particular use in isolation, or in combination with other uses, under particular conditions. For example, water skiing may require 40 acres per boat if the boat must run a complicated course around swimmers, power boaters, sailing craft, fisherman, and other ski craft moving at cross directions. However, only 20 acres of water might be required if other uses were excluded from the ski area. And perhaps only 15 acres would be needed if all ski boats were to move in the same direction, thereby preventing course conflicts.

In a study of carrying capacity and lake user attitudes for Cass, Orchard, and Union Lakes in Oakland County, Ashton (1971) determined optimum boating density ranges of 5 to 9 acres per boat, 4 to 9 acres per boat, and 6 to 11 acres per boat for the three lakes, respectively. Jaakson et al. (1989) studied three lakes in north-central Saskatchewan and determined the following boating densities: 20 acres each for motorboat cruising and water skiing; 10 acres for fishing (from a boat); and 8 acres each for canoeing, kayaking, and sailing. Jaakson et al. (1989) assumed an average of 10 acres per boat for acceptable safe boating. Wagner (1991) reported that, based on the viewpoints of many boaters, one boat per 25 acres of water surface is considered sufficient for all recreational boating activities (racing, fishing, and skiing). Racers and water skiers feel restricted at less than 10 acres per boat and nearly all motorized watercraft users feel crowded at less than 5 acres per boat. Warbach et al. (1994), concluded that approximately 30 acres per motor boat (greater than five horsepower) is an appropriate boat density. A summary of optimum boating density statistics is presented in Table 6.

In recent years, increased use of personal watercraft has raised safety concerns state-wide. The rate of injuries attributed to the use of personal watercraft is about 8.5 times higher than those from motorboats (Branche et al. 1997).

Based on these various criteria and considerations, 10 acres of water surface per boat is recommended for Little Long Lake as an aggregate density for all types of boating activities. A boating density greater than 10 acres per boat would create a potential for safety problems, multi-use conflicts, or environmental degradation. This would be especially true for high-speed boating activities.

TABLE 6
SUMMARY OF BOATING DENSITY STATISTICS

Source	Suggested Density	Boating Uses
Ashton (1971)	5 to 9 acres/boat	All uses combined in Cass Lake
	4 to 9 acres/boat	All uses combined in Orchard Lake
	6 to 11 acres/boat	All uses combined in Union Lake
Kusler (1972)	40 acres/boat	Waterskiing - All uses combined
	20 acres/boat	Waterskiing
	15 acres/boat	Coordinated waterskiing
Jaakson et al. (1989)	20 acres/boat	Waterskiing and motorboat cruising
	10 acres/boat	Fishing
	8 acres/boat	Canoeing, kayaking, sailing
	10 acres/boat	All uses combined
Wagner (1991)	25 acres/boat	All recreational activities
Warbach et al. (1994)	30 acres/boat	All motorized (>5 HP) uses

LAKE USE RATE

Although it is possible to determine an optimum boating density, as described above, it is important to consider that only a fraction of moored boats are on the lake at any given time. For example, on peak use days, such as the Fourth of July, a large percentage of the boats moored at the lake may be on the lake at the same time. Or, on weekdays, the lake may be utilized by only a small fraction of boats at a given time. Thus, in evaluating carrying capacity, the lake use rate must be considered.

According to a 1987 study by the Lake Charlevoix County Planning Commission, an estimated 10 percent of the total number of riparian boats may be on the lake at any given time during high-use periods such as summer weekends. Similarly, Threinen (1964) observed that a common level of use at a peak activity period is 10 percent of the boats present. An analysis of use rates on Lake Lansing found an overall use rate of about 8 percent of the moored boats (Progressive Architecture Engineering 2001). In the absence of empirical data to the contrary, Warbach et al. (1994) recommended that a peak use rate of 15 percent be used for planning purposes.

In light of these observations, a peak use rate of 10 percent has been assumed for Little Long Lake. Based on these criteria, the potential number of boats on Little Long Lake during peak-use periods is estimated to be 18 (i.e., 177 moored boats x 0.10 = 17.8).

LITTLE LONG LAKE RECREATIONAL CARRYING CAPACITY

It is now possible to determine if sufficient useable lake area is available to accommodate the number of boats anticipated on Little Long Lake during periods of peak use. With 136 acres of useable lake area, the recreational carrying capacity of Little Long Lake is 136 acres divided by 10 acres per boat, or 13.6 boats. This compares to an estimated peak use of 18 boats on Little Long Lake. Thus, under peak use conditions, the recreational carrying capacity of Little Long Lake has the potential to be exceeded by 32% which indicates that there is a potential for overcrowding and unsafe boating conditions and/or adverse environmental impacts to the lake.

Environmental Carrying Capacity

Lakes have a limited ability to sustain pollution inputs. Eventually the pollution input, or load, becomes so large that water quality in the lake begins to decline. The ability of a lake to withstand pollution inputs is a function of several variables including lake size and depth, flushing rate, and water chemistry. In general, lakes in highly urbanized areas that receive large inputs of pollutants from their watersheds tend to be of poorer quality than lakes in less urbanized watersheds. In this section of the report, an estimate is made of the potential pollution load being transported to Little Long Lake, and the lake's response to this load is evaluated to gauge the sensitivity of the lake to future development pressures.

Environmental carrying capacity refers to a lake's ability to sustain pollution inputs without degrading water quality.

THE LITTLE LONG LAKE WATERSHED

As previously discussed, the Little Long Lake watershed is approximately 1,633 acres in area, a land area about 9.6 times larger than the lake itself. Much of the shoreline of Little Long Lake has been developed for residential purposes. However, portions of the southwest and north shore contain contiguous wetland areas and are largely undeveloped. Land uses in the Little Long Lake watershed are graphically depicted in Figure 8 and Figure 9.

For the most part, residential development in the Little Long Lake watershed is concentrated in close proximity to the lake. Much of this residential development has occurred on relatively small lots that directly abut the lake. Concentrated development of this nature can be problematic in that it increases the amount of imperviousness (i.e., hard surfaces such as roof tops, roads, driveways) and allows water to run directly into the lake. Often, runoff from residential areas contains fertilizers, oil, and grease residues that can significantly degrade water quality. A major potential source of pollution input to Little Long Lake was eliminated with the construction of a sanitary sewer system which services the northeast portion of the lake. However, a total of about 48 homes remain on septic systems.

Much of the Little Long Lake watershed is farmland. In many cases, runoff from agricultural lands contains fertilizer residues and other potential pollutants. However, in the Little Long Lake watershed, there are several factors that mitigate the impact of agricultural activities. Soils in the Little Long Lake watershed consist primarily of Oshtemo sandy loams, Kalamazoo loams, and Dowagiac loams (U.S. Department of Agriculture Soil Conservation Service). These soil types tend to be moderately to highly permeable and well-drained. Thus, water tends to infiltrate into the ground after rain events which eliminates the need to construct farm drains. No significant agricultural drains appear to discharge directly to Little Long Lake. In addition, several natural depressions exist within the watershed that act to store and infiltrate water. Also, many of the agricultural lands in the watershed are separated from the lake by wetland and/or wooded areas. These natural areas filter agricultural fertilizers and other potential contaminants and prevent them from washing directly to the lake.

To a large extent, the quality of water in a lake mirrors land use activities in the surrounding watershed.

Approximately 7% of the Little Long Lake watershed is wetland. In addition to providing fish and wildlife habitat, wetlands in the Little Long Lake watershed afford a number of important benefits and functions including pollution prevention, flood control, and groundwater recharge. Preservation of these wetlands is vital to maintaining the quality of Little Long Lake.

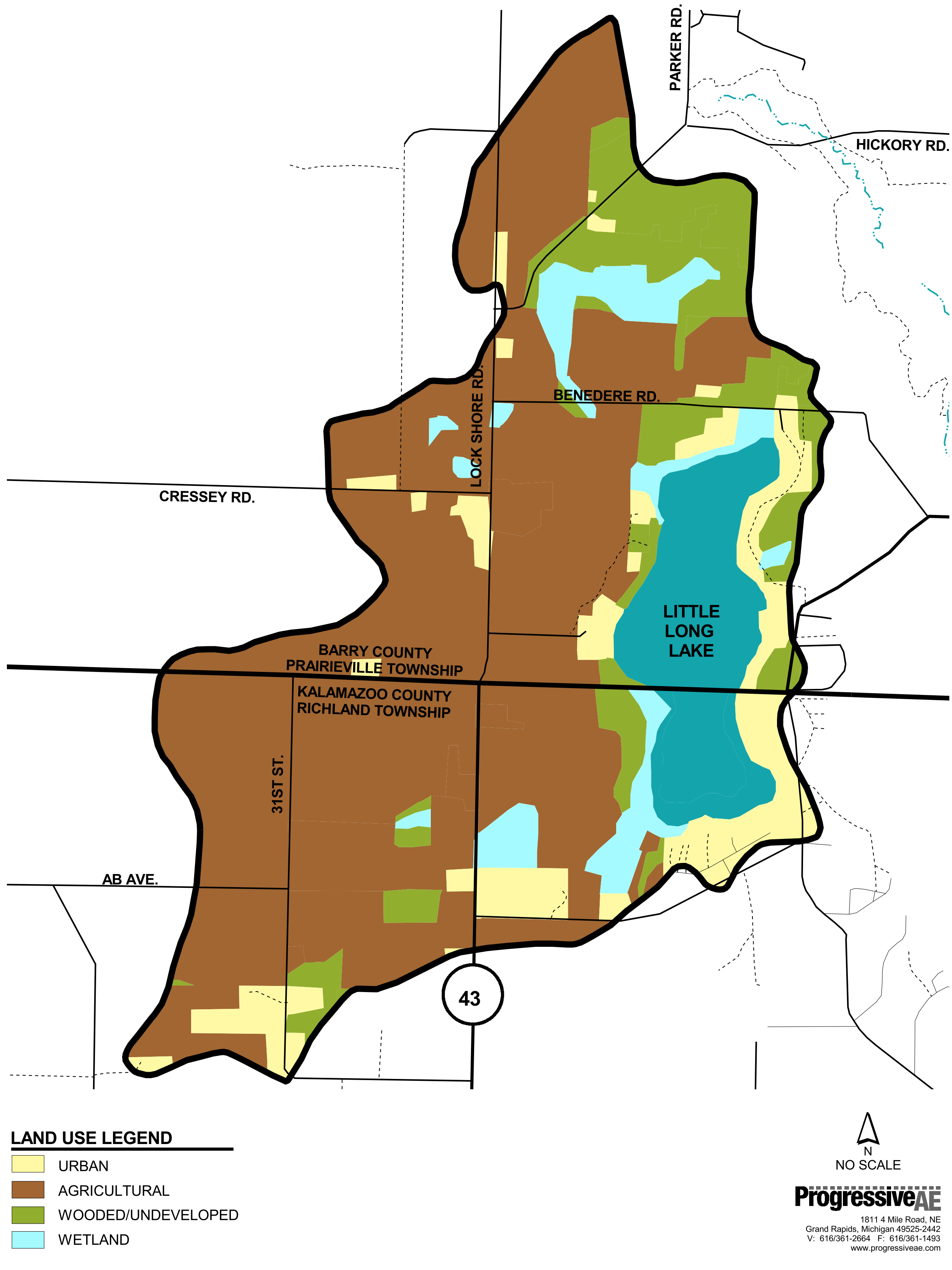


Figure 8. Little Long Lake watershed land use map.

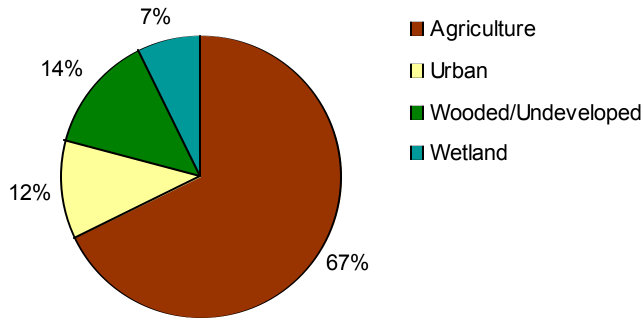


Figure 9. Little Long Lake watershed percent land use.

To facilitate identification of the generalized location of wetlands within the Little Long Lake watershed, a composite wetland map was created by combining information on hydric (i.e., muck type) soils provided by the U.S. Department of Agriculture, U.S. Fish and Wildlife Service National Wetland Inventory maps, and Michigan Resource Information System (MIRIS) land use/cover data (Figure 10 on the next page).

Another factor that influences the sensitivity of a lake to pollution loading is its water residence time (sometimes referred to as the flushing rate). Water residence time is the time it takes the volume of water in a lake to be replaced by incoming water. In general, lakes that are flushed periodically by good quality water will tend to recover more quickly from pollution inputs than lakes with long water residence times. Little Long Lake does not have a significant inflow of water. The lake is fed by surface runoff, direct precipitation on the lake surface, and groundwater springs. The estimated water residence time for Little Long Lake is 3.4 years. Thus, once a pollutant enters the lake, it may remain in the lake for several years. Wetzel (1983) noted that for lakes of average size and average water residence time, observed recovery from accelerated phosphorus loading will require 2 to 10 years.

THE IMPORTANCE OF PHOSPHORUS

Phosphorus is the nutrient that most often stimulates excessive growth of aquatic plants and algae, leading to a variety of problems collectively known as eutrophication.

Phosphorus is the nutrient that most often stimulates excessive growth of aquatic plants and algae, leading to a variety of problems collectively known as eutrophication (Figure 11). Of the major nutrient pollutants, phosphorus is most amenable to control through management practices. For these reasons, the environmental carrying capacity analysis of Little Long Lake focuses on sources of phosphorus loading to the lake.

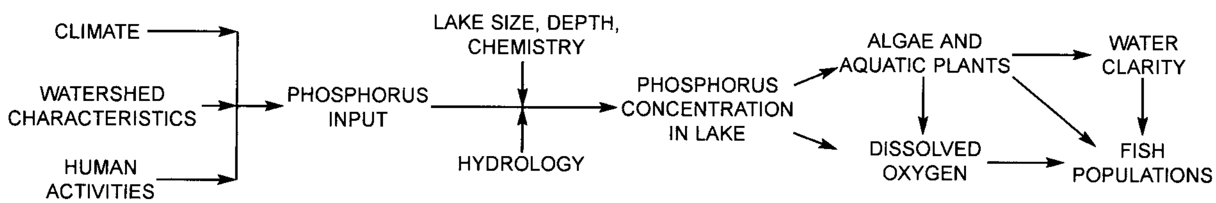


Figure 11. Phosphorus loading determinants and lake response (modified from Reckhow et al. 1980).

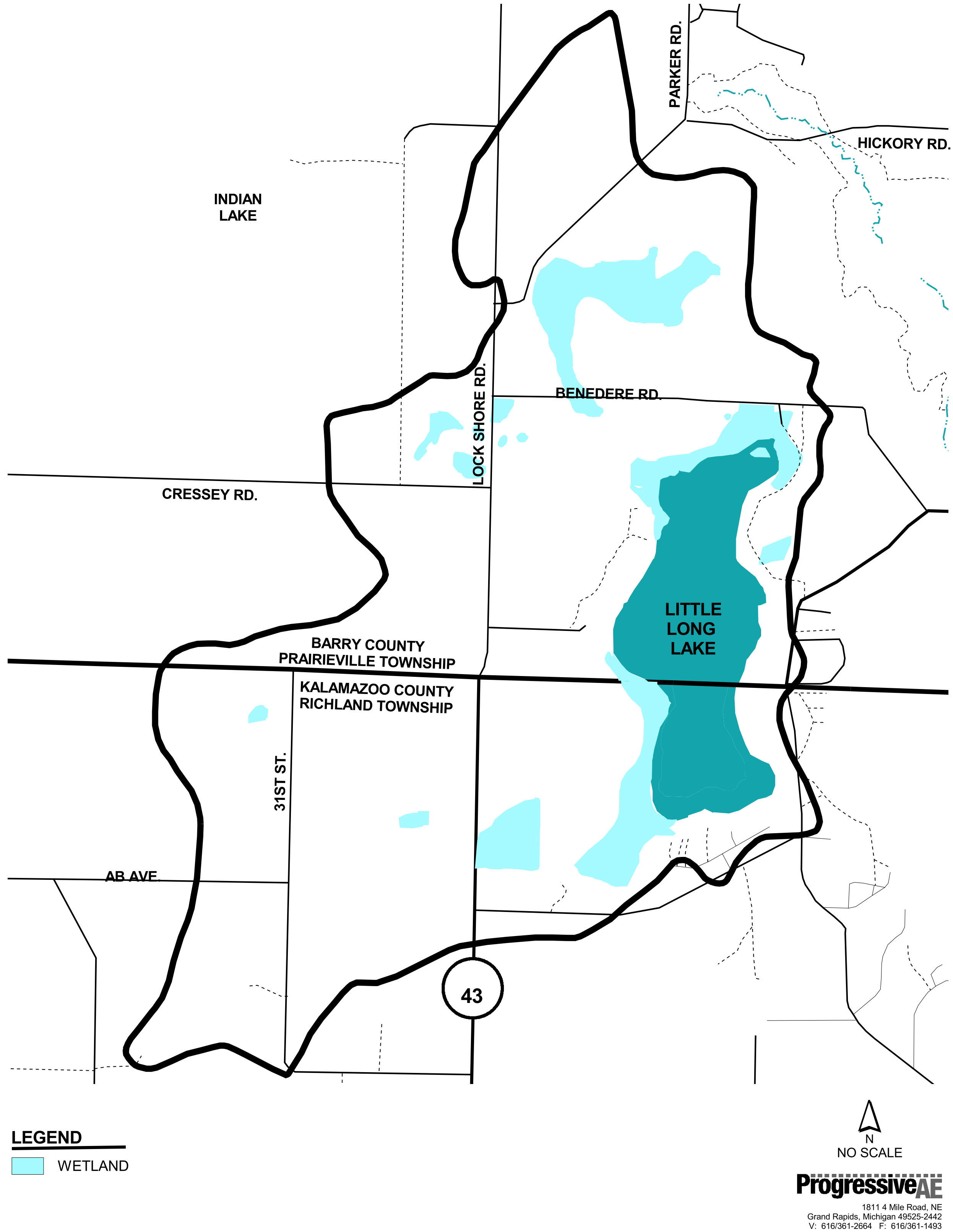


Figure 10. Little Long Lake watershed wetland map.

ENVIRONMENTAL CARRYING CAPACITY CALCULATIONS

Since it is extremely difficult and cost-prohibitive to directly measure nonpoint, diffuse sources of phosphorus loading such as surface runoff and atmospheric deposition, it was necessary to select phosphorus loading values from other studies in which direct measurements have been made in the field. Care was taken to apply phosphorus loading values that would be representative of the watershed conditions observed around Little Long Lake. The values selected were based largely on a comprehensive literature review of the quantity of phosphorus transported to surface water bodies from various land uses (Reckhow et al. 1980) and from previous phosphorus budget analyses of Gull Lake (Tague 1977 and Tessier 1995). Phosphorus loading values selected for Little Long Lake are summarized in Table 7. Information used to calculate the septic phosphorus contribution to Little Long Lake is contained in Appendix A. In this analysis, four land use classifications were utilized: Agricultural, urban, wooded/undeveloped, and wetland. The estimated total phosphorus load to Little Long Lake is presented in Table 7 and graphically shown in Figure 12.

TABLE 7
ESTIMATED ANNUAL PHOSPHORUS LOAD TO LITTLE LONG LAKE

Source	Area (acre)	Phosphorus Loading Values (lbs/acre/yr)	Phosphorus Load (lbs/yr)	Percent of Total Load
Agriculture	1,101	0.1	110	28%
Urban	192	0.8	154	38%
Wooded/Undeveloped	225	0.05	11	3%
Wetland	115	0	0	0%
Atmospheric	170	0.165	28	7%
Septic			97	24%
Total	1,633		400	100%

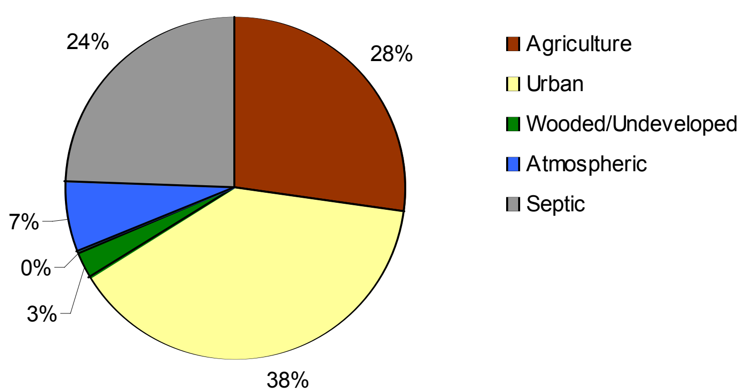


Figure 12. Estimated total phosphorus loadings to Little Long Lake.

Various researchers have studied the impact of phosphorus loading on lake water quality, and many have developed techniques for predicting lake trophic status under different phosphorus loading scenarios (Reckhow et al. 1980; Dillon and Rigler 1975; Vollenweider 1975). Reckhow et al. (1980) developed a model for northern temperate lakes (such as Little Long Lake) that can be used to predict a lake's average phosphorus concentration as a function of phosphorus loading and lake flushing rate. The model equation is:

$$P = \frac{L}{11.6 + 1.2q_s}$$

$$L = \frac{M}{A_o}$$

$$q_s = \frac{Q}{A_o}$$

$$Q = (A_d \times r) + (A_o \times Pr)$$

- P = Lake phosphorus concentration (in parts per billion)
- L = Surface area phosphorus loading (in grams per square meter-year)
- M = Total mass loading (in kilograms per year)
- A_o = Lake surface area (in square meters)
- q_s = Surface area water loading (in meters per year)
- Q = Inflow water volume to lake (in cubic meters per year)
- A_d = Watershed area, excluding the lake (in square meters)
- r = Total annual unit runoff (in meters per year)
- Pr = Mean annual net precipitation (in meters per year)

By applying this modeling methodology to Little Long Lake, it is possible to estimate the in-lake total phosphorus concentration based on current conditions. For Little Long Lake, the model predicts an in-lake phosphorus concentration of 21 parts per billion—a concentration slightly above the eutrophic threshold concentration of 20 parts per billion. The environmental carrying capacity analysis indicates that current levels of phosphorus loading are sufficient to push phosphorus concentration in Little Long Lake above the eutrophic threshold. It should be noted that the predicted total phosphorus concentration is greater than the actual phosphorus concentration measured in Little Long Lake during the course of study. However, as discussed earlier, Little Long Lake has a very high calcium carbonate content. Calcium carbonate can bind with phosphorus and remove it from the water column, making it temporarily unavailable to support plant growth. If the lake's natural ability to sustain phosphorus loadings is exceeded, plant growth in the lake would be expected to increase, water transparency and dissolved oxygen levels would decrease, and the overall quality of the lake would decline. This underscores the need to reduce phosphorus inputs into Little Long Lake to the extent practical.

The environmental carrying capacity analysis indicates that current levels of phosphorus loading are sufficient to push the phosphorus concentration in Little Long Lake above the eutrophic threshold.

The environmental carrying capacity analysis indicates that current levels of phosphorus loading are sufficient to push the phosphorus concentration in Little Long Lake above the eutrophic threshold. Environmental carrying capacity results indicate that Little Long Lake is extremely sensitive to development pressures. To preserve lake water quality, future development in the Little Long Lake watershed must be planned to minimize the potential for pollutants to be transported to the lake.

Recommendations and Conclusions

Study findings indicate that Little Long Lake currently exhibits good water quality. However, without proper planning and management, the lake's recreational and environmental carrying capacity can easily be exceeded. The following recommendations are designed to help prevent problems associated with lake overcrowding and to preserve the environmental quality of Little Long Lake over the long term.

RECREATIONAL CARRYING CAPACITY

Since it appears that the carrying capacity of Little Long Lake has the potential to be exceeded during peak-use periods, it is recommended that steps be considered to address the problem of lake congestion. Under Michigan law, there are a number of options that may be employed at the local and state level to help address lake congestion issues. Techniques that may be appropriate for Little Long Lake are discussed separately as follows.

Keyhole or Funnel Development Control Ordinances

Of primary concern on Little Long Lake is the issue of keyhole or funnel development. Funneling occurs when a waterfront lot is used to permit access to a larger development located away from the lake (Figure 13). Funneling allows a large number of individuals to gain access to the lake through a small corridor of lake property, thereby exceeding the natural limitation on access afforded by the existing shoreline. Given that the recreational carrying capacity of Little Long Lake has the potential to be exceeded under estimated current peak-use conditions, unregulated funnel development has the potential to create a number of problems including land use conflicts, unsafe and inadequate access, boating accidents, noise, lake congestion, multi-use conflicts, and decreased property values.

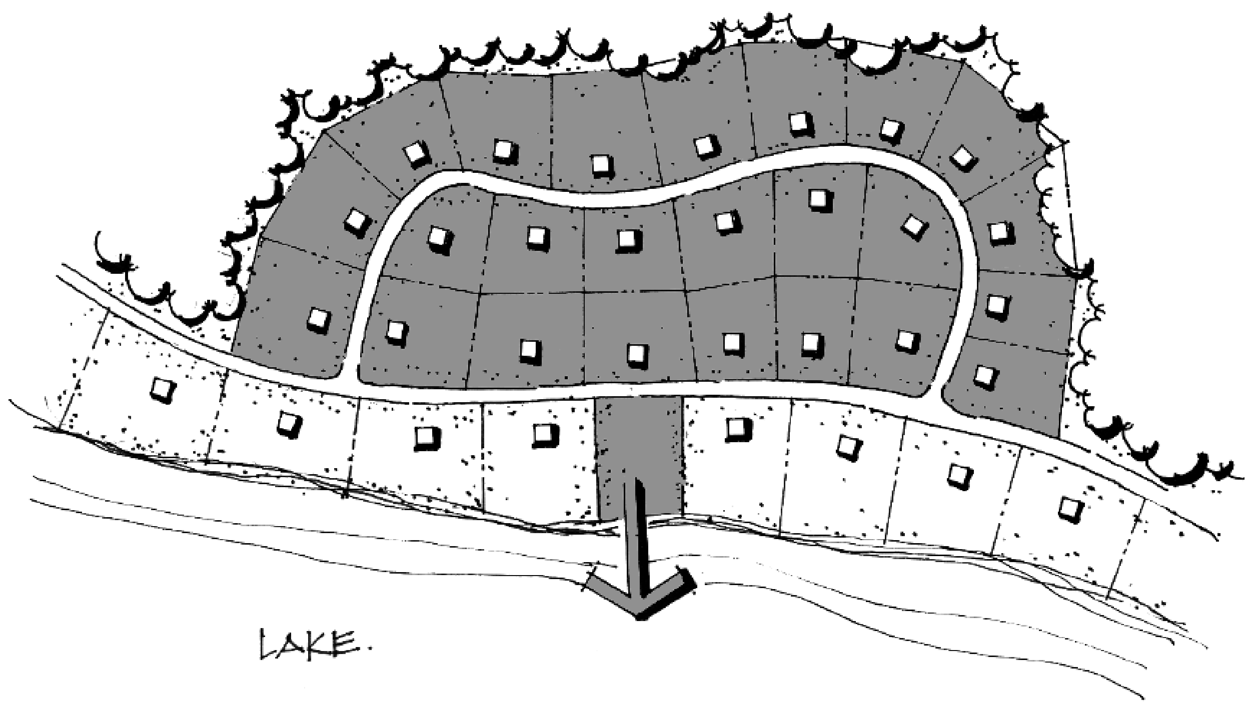


Figure 13. Lake keyhole development.

In addition, a substantial increase in boating activity on Little Long Lake could cause resuspension of bottom sediments, shoreline erosion, destruction of fishery and wildlife habitat, and diminished water quality. Without proper controls, keyhole development would also tend to concentrate development in close proximity to the lakeshore which would increase the amount of imperviousness and storm water runoff to the lake.

In the early 1990's the Michigan Supreme Court ruled that communities can provide for reasonable regulation of keyhole through zoning. Currently, the zoning ordinances for both Prairieville Township and Richland Township have keyhole regulations. With respect to the legal basis for keyholing, a recent court case of special interest is *Township of Yankee Springs v Fox*. In this case, a Court of Appeals opinion approved for publication on December 21, 2004 upheld a keyholing ordinance that had been challenged on several fronts. This case provides a precedent for future challenges to keyhole ordinances. For informational purposes, a copy of the Court of Appeals decision and the Yankee Springs Township's Riparian Lot Use Regulations are included in Appendix B.

Watercraft Control Ordinances

On lakes where there is an identified safety concern or problem associated with boating activity, watercraft control regulations can be adopted with assistance from the Michigan Department of Natural Resources in accordance with Part 801 (Marine Safety) of the Natural Resources and Environmental Protection Act. Under Part 801,

> *The department may regulate the operation of vessels, water skis, water sleds, aquaplanes, surfboards, and other similar contrivances on the waters of this state. Where special regulations are determined necessary, the department may establish vessel speed limits; prohibit the use of vessels, water skis, water sleds, aquaplanes, surfboards, and other contrivances by day and hour, establish and designate areas restricted solely for boating, skin or scuba diving, fishing, swimming or water skiing, and prescribe any other regulations relating to the use or operation of vessels, water skis, water sleds, aquaplanes, surfboards or other contrivances, which will ensure compatible use of state waters and best protect the public safety. The department shall prescribe special local regulations in such a manner as to make the regulations uniform with other special local regulations established on other waters of this state insofar as is reasonably possible.*

Often, watercraft control ordinances restrict the hours in which high-speed boating activity is allowed. For example, nearby Sherman Lake (in Ross Township) has a special watercraft control ordinance that limits hours for high speed boating activity to between 10:00 a.m. and 6:30 p.m.

It should be noted that special watercraft control regulations apply to all users of a lake, both riparian (i.e., waterfront property owners) and non-riparian. In the future, if the need can be documented from a safety perspective, a special watercraft regulation that limits hours of high-speed boating activity may be appropriate as a means of alleviating overcrowding and multi-use conflicts on Little Long Lake. A regulation of this type for Little Long Lake may be most effective if only applied during periods of peak use such as summer weekends and holidays.

Information and Education

Short of additional regulatory approaches, the dissemination of information about existing navigation laws can help to alleviate many of the problems associated with lake boating activities. Examples of existing navigation laws that may prove useful include:

> *A person shall not operate a motorboat on the waters of this state at a speed greater than slow-no wake speed or the minimum speed necessary for the motorboat to maintain forward movement when within 100 feet of the shoreline where the water depth is less than 3 feet, as determined by vertical measurement, except in navigable channels not otherwise posted.*

Persons operating vessels on the waters of this state . . . shall operate the vessels in a counter-clockwise fashion to the extent that it is reasonably possible. These persons and persons being towed on water skis or on a water sled, kite, surfboard, or similar contrivance shall maintain a distance of 100 feet from any dock, raft, buoyed or occupied bathing area, or vessel moored or at anchor, except when the vessel is proceeding at a slow-no wake speed or when water skiers are being picked up or dropped off, if that operation is otherwise conducted with due regard to the safety of persons and property and in accordance with the laws of this state.

With respect to the operation of personal watercraft, state law requires:

A person shall not operate a personal watercraft on the waters of this state during the period that begins 1 hour before sunset and ends at 8 a.m.

A person operating a personal watercraft on the waters of this state shall not cross within 150 feet behind another vessel, other than a personal watercraft, unless the person is operating the personal watercraft at slow-no wake speed.

A summary of boating regulations should be provided to all residents of Little Long Lake.

ENVIRONMENTAL CARRYING CAPACITY

The environmental carrying capacity analysis indicates that Little Long Lake is extremely sensitive to increased phosphorus loading. A slight increase in phosphorus inputs could push the lake over the eutrophic threshold. If this occurred, plant and algae growth would increase and water transparency, which is currently excellent, would decline. Phosphorus inputs from both existing development around the lake and future development must be minimized to the extent practical. To this end, the following recommendations address both existing and future development around the lake.

For the most part, development in the Little Long Lake watershed is concentrated in the shorelands immediately adjacent to the lake. If not properly managed, pollutants from these shoreland areas can run directly to the lake. The primary sources of pollution from existing development are surface runoff and septic system seepage from areas not currently serviced by the community sewer system.

Phosphorus loading from these sources could be significantly reduced if lake residents establish vegetative buffer strips (i.e., a greenbelt) along the water's edge (Figure 14) and curtail the use of fertilizers containing phosphorus. Fortunately, much of the higher density development around the lake is serviced by a community sewer system. However, as the remaining septic systems bordering the lake continue to age, the finite ability of area soils to bind phosphorus will be exceeded, allowing phosphorus (and potentially other pollutants) to leach to the lake. Thus, until such time as sewer service can be made available to the entire lake, regular maintenance of area septic systems is essential to ensure optimum performance. Specific recommendations on lakeside landscaping and septic system maintenance are contained in Appendix C.

Figure 14. Lakeside vegetative buffer or greenbelt.

Given the sensitivity of Little Long Lake to increased phosphorus loadings, future development in the Little Long Lake watershed must be planned and designed to minimize water quality impacts. Of primary concern will be the protection of natural features (such as wetlands, forested lands, and natural drainage areas). The following discussion examines several development approaches that can minimize adverse impacts to land and water.

Wetland Protection

As previously noted, wetlands in the Little Long Lake watershed provide several valuable functions including pollution prevention, flood control, and groundwater recharge as well as fish and wildlife habitat. Protecting these wetlands from excessive encroachment will help to protect the quality of the lake.

According to the Fish and Wildlife Service, over half of wetlands in Michigan have been lost through piecemeal and wholesale destruction. In recognition of the huge economic losses that were resulting from the destruction of wetlands, nationwide wetland protection regulations were incorporated into the Federal Clean Water Act of 1972. In 1980, Michigan enacted its own law regulating development of wetlands consistent with federally mandated wetland protection efforts. Michigan's wetland protection regulations are contained within Part 303 (Wetlands Protection) of the Natural Resources and Environmental Protection Act. Under Part 303, wetlands are defined as follows:

> "Wetland" means land characterized by the presence of water at a frequency and duration sufficient to support and that under normal circumstances does support wetland vegetation or aquatic life and is commonly referred to as a bog, swamp, or marsh.

Wetlands which meet any of the following criteria are regulated by the Michigan Department of Environmental Quality:

- Wetlands which have direct physical contact or a permanent or intermittent surface water connection to a lake, pond, river, or stream.
- Wetlands which are located partially or entirely within 500 feet of a lake, pond, river, or stream (or within 1,000 feet of one of the Great Lakes).

In counties with population greater than 100,000 (such as Kalamazoo County), noncontiguous wetlands (i.e., wetlands not bordering or within 500 feet of a lake, pond, or stream) greater than 5 acres in size are also regulated. In counties with a population less than 100,000 (such as Barry County), noncontiguous wetlands greater than 5 acres are not regulated until the MDEQ completes a wetland inventory for that county and has notified affected landowners. Regardless of population, noncontiguous wetlands 5 acres or less in size are generally not regulated by the state. Based on these criteria, many of the wetlands in the Little Long Lake watershed are regulated by the MDEQ.

In accordance with Part 303, the following activities require a permit from the Department of Environmental Quality (MDEQ):

- Deposit or permit the placing of fill material in a wetland;
- Dredge, remove, or permit the removal of soil or minerals from a wetland;
- Construct, operate, or maintain any use or development in a wetland; and
- Drain surface water from a wetland.

Certain activities, such as fishing, trapping and hunting, grazing of animals, certain farming activities, and harvesting of lumber are exempt from permit requirements.

Part 303 requires that the Department of Environmental Quality not issue a wetland permit unless the applicant shows either of the following:

a) The proposed activity is primarily dependent on being located in a wetland.

b) A feasible and prudent alternative does not exist.

To date, an official wetland inventory for the Little Long Lake area has not been completed by the state. Until an official wetland map is available, the wetland map presented herein (Figure 10) should be used as a guide to identify the generalized location of wetlands in the watershed. This map can help property owners and developers identify wetland locations in advance of the formulation of development proposals, thereby avoiding wetland impacts and potential conflicts. Lake residents should monitor development in the watershed to ensure encroachment into area wetlands does not occur.

Shoreland Overlay District

Excessive development of environmentally sensitive lake shorelands can have direct, adverse water quality impacts including loss of fish and wildlife habitat at the water's edge, increased runoff of fertilizers and other pollutants, and erosion and sedimentation. Recognizing the need to protect shoreland areas, several states (including Maine, Minnesota, and Wisconsin) have adopted state-wide standards to minimize the impacts of shoreland development. Michigan, through the Natural Rivers Program, requires that shoreland development standards be met on several designated rivers including the Pere Marquette, Au Sable, Betsie, Huron, and Lower Kalamazoo. However, there are no state-wide shoreland development standards in Michigan for lakes. Thus, this issue of protection of lake shorelands is left largely to local units of government and waterfront property owners.

One way that shoreland protection can be accomplished at the local level is through the creation of an overlay district within a township's zoning ordinance. An overlay district is a zoning district that applies to a specific geographic area, such as a lake shoreland or a stream corridor. In an overlay district, proposed developments must meet all the conditions of the underlying district in addition to the provisions set forth in the overlay district. A shoreland overlay district could require building setbacks, shoreline vegetative buffers, limits on imperviousness, and prohibit specific uses and activities that could be detrimental to water quality, such as gas stations and confined feedlots. Overlay zoning can be used to help ensure uniform zoning regulations are in place across several zoning districts or political jurisdictions. A shoreland overlay district may be especially effective in a lake such as Little Long Lake whose shores are bordered by two townships. Sample language for a shoreland overlay district is included in Appendix D.

Open Space Development

An approach that is gaining acceptance in communities across the state is a zoning technique called "open space (cluster) development." With this approach, the base density for a zoning district does not increase (although in some cases density bonuses are given for additional preservation of open space). Open space development typically allows the same number of homes to be built, but they are clustered on a smaller portion of the development site, thus preserving more undeveloped land. With open space development, a site analysis can be required to identify natural features such as wetlands, steeply sloped lands, forested areas, stream corridors, lake shorelands, and rural views. These natural features can constitute part or all of the designated "open space" portions of the development site. Development is then clustered in appropriate locations on the site and the designated open space elements are protected in perpetuity, typically through a deed restriction or conservation easement.

Properly designed open space developments can provide the following water quality benefits:

- Clustering development can minimize impervious surfaces by shortening road lengths;
- If wetlands and forested areas are preserved as "open space elements," the natural ability of these areas to filter and trap pollutants is not lost;
- Development of erosion-prone areas (such as steeply-sloped forest lands) can be avoided;

- The land's natural ability to convey and cleanse stormwaters can be preserved; and
- The natural infiltration of stormwaters can be sustained.

In essence, a properly designed open space development can help to protect the functional integrity of the land with respect to the natural conveyance or infiltration of stormwater.

Additional benefits of open space development include:

- Permanent protection of open areas and natural features without restricting property rights;
- Rural character preservation;
- Cost savings to property owners due to less infrastructure construction and maintenance;
- Development potential of the site is not limited;
- No large public expenditures are required for land acquisition; and
- May create continuity of "greenway" open space for wildlife migration and movement.

Both Prairieville and Richland Townships have open space development provisions within their zoning ordinances. If, in the future, development is proposed within the Little Long Lake watershed, the open space alternative may help to minimize potential adverse water quality impacts.

Low Impact Development

As urbanization increases in a community, natural vegetative cover is replaced by rooftops, roadways, parking lots, and other impervious surfaces. The increase in impervious area greatly increases the rate and volume of runoff and decreases water infiltration into the ground (Figure 15). With an increase in the quantity of runoff, a concurrent increase in the quantity of pollutants transported generally occurs as well. The "first flush" of stormwater runoff often contains high concentrations of oil and grease residues, nutrients, sediment, trace metals, fecal bacteria, oxygen-consuming wastes, and a variety of other contaminants. These pollutants can cause siltation, nutrient enrichment (and accelerated eutrophication), bacterial con-tamination, and severe degradation of water resources.

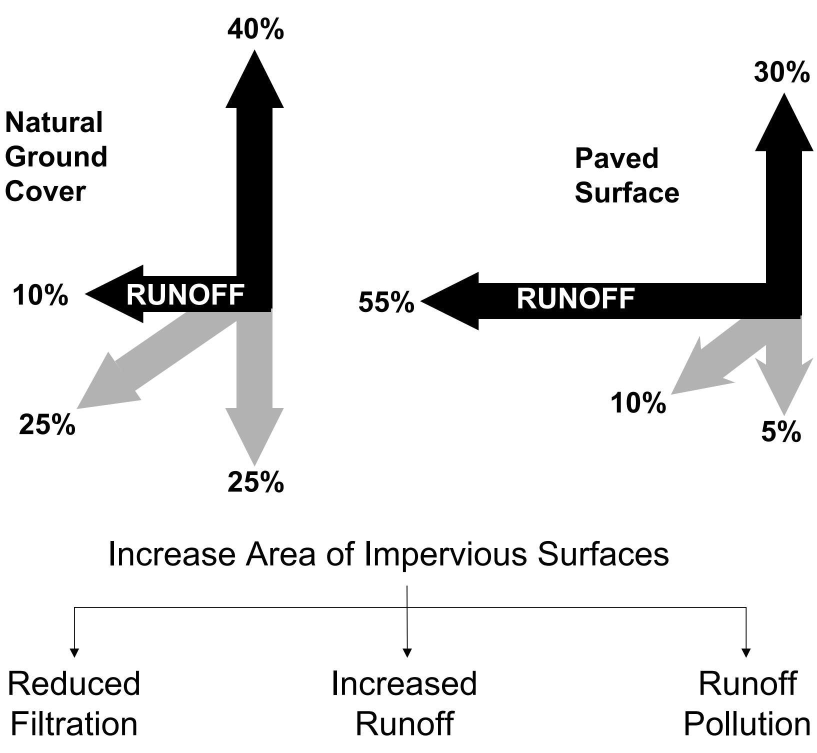


Figure 15. Increased imperviousness and runoff.

A method of managing stormwater that is gaining prominence and acceptance is a concept called Low Impact Development or LID. In *The Practice of Low Impact Development* (NAHB Research Center, Inc. 2003), LID is defined as an approach to land development that uses various land planning and design practices and technologies to simultaneously conserve and protect natural resource systems and reduce infrastructure costs. LID still allows land to be developed, but in a cost-effective manner that helps mitigate potential environmental impacts. Essentially, LID's are designed to maintain the natural hydrological cycle by:

- Preserving open space and minimizing land disturbances;
- Protecting natural features and natural processes;
- Reexamining the use and sizing of traditional infrastructure (lots, streets, curbs, gutters, sidewalks) and customizing site design;
- Integrating natural site elements (wetlands, stream corridors, mature forests) into site designs; and
- Decentralizing and managing stormwater at its source.

With an LID, the development process includes a detailed site analysis that identifies natural drainage patterns and key natural features such as forested areas, wetlands, stream corridors, steeply sloped areas, and soil types. This information is then used to help define development opportunities and constraints and areas requiring protection. The site analysis is followed by an evaluation of alternatives to minimize development impacts. Alternatives to accomplish these objectives could include minimizing clearing and grading, reducing impervious surfaces, clustering development, limiting lot disturbance, and preserving permeable soil types. An attempt is then made to slow the conveyance of stormwater from the site by dispersing (rather than concentrating) drainage, maintaining natural flow paths, and by using vegetated swales to convey water (as opposed to pipes). A key element of an LID is to treat stormwater at its source, rather than conveying water to a centralized stormwater basin (Figure 16). The overall goal of stormwater management in an LID is to mimic pre-development hydrologic conditions.

The overall goal of stormwater management in an LID is to mimic pre-development hydrologic conditions.

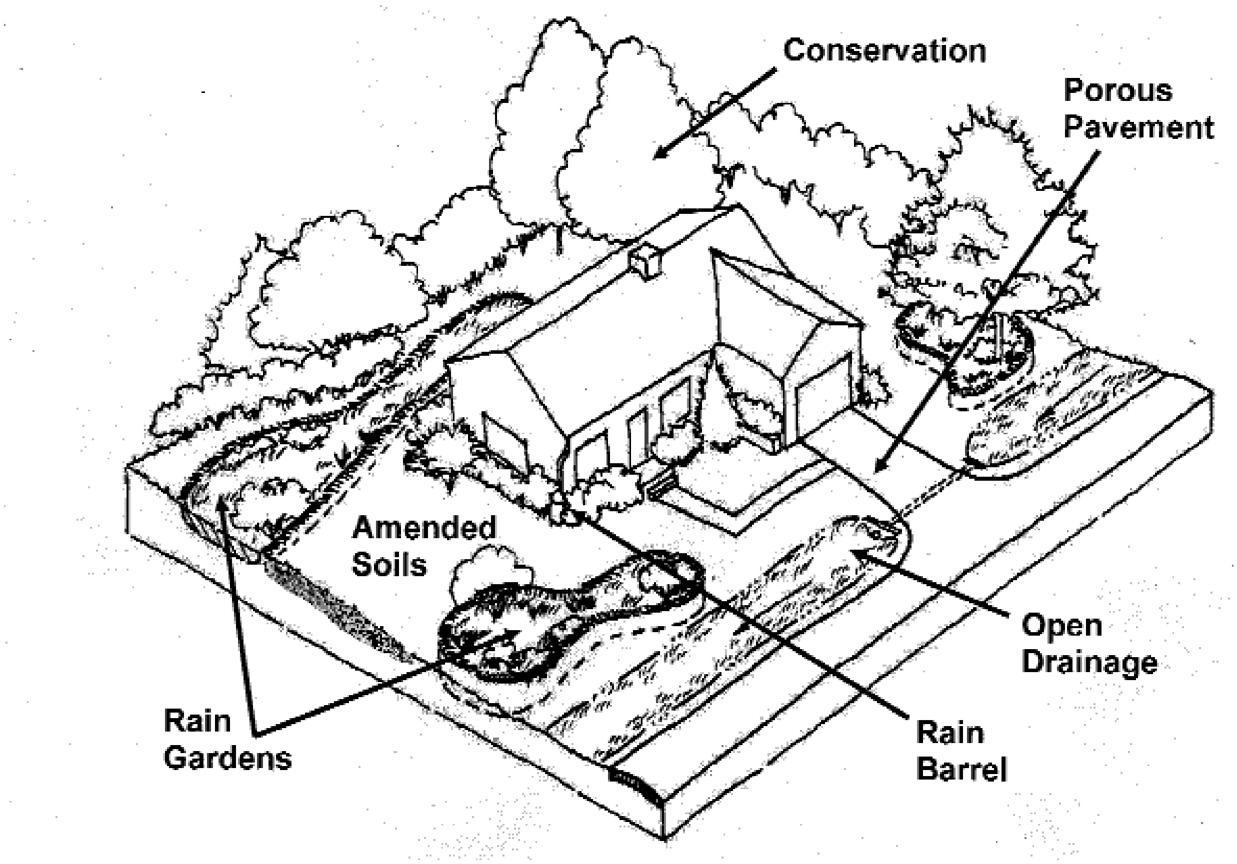


Figure 16. Low impact development lot level source controls.

In *The Practice of Low Impact Development* (NAHB Research Center, Inc. 2003), it is noted that developers who have used LID practices and technologies have indicated that one of the keys to a successful project is to invest additional time and money in the initial planning stages of development. While this idea may be unpopular because of increased up-front costs, the expenditures are often recouped in the form of rapid home sales, enhanced community marketability, and higher lot yields. The LID approach is being embraced by several federal agencies, including the Environmental Protection Agency and U.S. Department of Housing and Urban Development, and state and local governments, as an effective way to minimize stormwater impacts.

The management recommendations presented herein are designed to provide a basis and framework for decision making. Ultimately, the protection of Little Long Lake over the long term will require that lake residents and local governmental units collaborate to ensure future development within the Little Long Lake watershed does not adversely impact the lake.

Appendix A

Little Long Lake Septic Phosphorus Loading Calculations

The rationale used for estimating the septic contribution to the nutrient budget is as follows:

1. Estimate the average phosphorus load from household wastewater discharged to septic systems:

   3.26 lbs/capita/year (Table A1).

   Reduce the estimate by 50 percent to account for the Michigan ban on phosphorus detergents (Sawyer 1962; Rodiek 1979):

   0.50 x 3.26 = 1.6 lbs/capita/year.

2. Multiply the estimate in Item No. 1 by the average capita per residence and the average occupancy rate in the local municipality:

   1.6 lbs/capita/year x 2.7 capita/residence[1] x 75% occupancy[1] = 3.2 lbs/residence/year.

3. Estimate the quantity of phosphorus from septic system effluent that is retained by the soil (Table A2) for each household adjacent to the lake (Table A3). Estimate the quantity of phosphorus that is not retained by the soil and leaches to the lake (Table A4).

TABLE 1
PHOSPHORUS LOADS FOR HOUSEHOLD WASTEWATER DISCHARGED TO SEPTIC SYSTEMS
(lbs/capita/year)

Total Phosphorus	Reference
3.29	Ligman et al. 1974
3.15	Laak 1975
1.63	Chan 1978
3.51	Ellis and Childs 1973
3.29	Siegrist et al. 1976
6.62	Bernhard 1975
1.76	Otis et al. 1975
2.82	U.S. EPA 1974
Mean = 3.26	
Standard Deviation = ±1.53	

[1] Source: U.S. Census Data 2000.

TABLE A2
SOIL EFFICIENCY RATING FOR IMMOBILIZING PHOSPHORUS FROM SEPTIC SYSTEMS[1]

Drainage	Phosphorus Adsorption Capacity (lbs/acre-ft)	Retention Coefficient (R.C.)	Fraction Of Phosphorus Not Retained By Drainfield Soil (1 - R.C.)
	High - Very High		
Good	480 - 650	0.75	0.25
	Medium		
Good	380 - 480	0.55	0.45
	Low - Very Low		
Good	325 - 380	0.35	0.65
	High - Very High		
Poor	480 - 650	0.65	0.35
	Medium		
Poor	380 - 480	0.45	0.55
	Low - Very Low		
Poor	325 - 380	0.25	0.75

TABLE A3
NUMBER OF RESIDENCES PER SOIL TYPE ADJACENT TO LITTLE LONG LAKE[2]

Soil Type	Number of Residences Per Soil Type[3]
Oshtemo sandy loam	34
Histosols and aquents	7
Kalamazoo loam	4
Granby sand	3
Houghton muck	1
Total	49

[1] Schneider and Erickson 1972; Ellis and Childs 1973.
[2] Source: Soil Survey of Kalamazoo and Barry Counties (USDA-SCS).
[3] Only residences abutting the lake were counted in this analysis.

TABLE A4
ESTIMATE OF ANNUAL SEPTIC CONTRIBUTION TO LITTLE LONG LAKE

Soil Type[1]	Drainage[2]	Phosphorus Adsorption[2]	(1 - R.C.)[3]	Number Of Residence Per Soil Type[1]	Load To Septic Systems (lbs/res/yr)	Phosphorus Loading Per Soil Type (lbs/yr)
Oshtemo sandy loam	Good	Low	0.65	34	3.2	70.3
Histosols and aquents			0.5	7	3.2	11.1
Kalamazoo loam	Good	Medium to Low	0.5	4	3.2	6.4
Granby sand	Poor	Very low	0.75	3	3.2	7.2
Houghton muck	Very poor	Very low	0.75	1	3.2	2.4
Total				49		97.3

[1] Table A3.
[2] Schneider and Erickson 1972.
[3] Table A2.

Appendix B

Michigan Court of Appeals Decision and Riparian Lot Use Regulations

S T A T E O F M I C H I G A N

C O U R T O F A P P E A L S

TOWNSHIP OF YANKEE SPRINGS,

Plaintiff-Appellee,

UNPUBLISHED
October 12, 2004
APPROVED FOR
PUBLICATION
December 21, 2004
9:00 a.m.

v

No. 249045
Barry Circuit Court
LC No. 02-000142-CZ

RICHARD FOX,

Defendant-Appellant,

and

ANTONIO VELOSO, NINA VELOSO, EDWIN HARTMAN, MRS. EDWIN HARTMAN, TODD GREENMAN, RACHEL GREENMAN, ROGER G. TRUCKENMILLER, TRISHA J. TRUCKENMILLER, JAMES S. SWANSON, LINDA J. SWANSON, MIKE BEDFORD, RON HEETHUIS, JOHN ROUGH and LINDA ROUGH,

Official Reported Version

Defendants.

Before: Fort Hood, P.J., and Donofrio and Borrello, JJ.

PER CURIAM.

Defendant Richard Fox, as an owner of an undivided one-eighth interest in 2620 First Street (the First Street lot), a riparian lot on Gun Lake previously owned by defendants John and Linda Rough, appeals as of right from the trial court order permanently enjoining defendant and several other First Street lot owners from using the First Street lot to access Gun Lake in violation of the plaintiff Yankee Springs Township's antifunneling ordinance found within its riparian-lot-use regulations. We affirm.

Defendant first argues that the plaintiff's riparian ordinance does not apply to Gun Lake because the lake is not wholly located within the plaintiff's borders. We disagree. We review the trial court's interpretation of the township zoning ordinance de novo. *Brandon Charter Twp v Tippett*, 241 Mich App 417, 421; 616 NW2d 243 (2000).

In *Hess v West Bloomfield Twp*, 439 Mich 550, 562; 486 NW2d 628 (1992), our Supreme Court held that riparian rights are derived from land. Thus, it is the location of the riparian land, and not the location of the lake that abuts the land, that determines the plaintiff's authority and jurisdiction in this case. Further, the Township Zoning Act, MCL 125.271 *et seq*., "permits townships to regulate riparian rights, such as dockage of boats, as part of their zoning power." *Hess*, *supra* at 565-566. Therefore, because the riparian lot at issue is located within plaintiff's boundaries and because plaintiff is authorized by statute to regulate riparian rights, plaintiff has the authority to regulate defendant's riparian rights in this case.

Defendant next contends that the riparian-lot-use regulations are void for vagueness because the regulations do not provide fair notice of the conduct proscribed. We review the constitutionality of this ordinance de novo. *Jott, Inc v Clinton Charter Twp*, 224 Mich App 513, 525; 569 NW2d 841 (1997).

A statute or ordinance may be void for vagueness if (1) it is overbroad and impinges on First Amendment freedoms, (2) it does not provide fair notice of the conduct it regulates, or (3) it gives the trier of fact unstructured and unlimited discretion in determining whether the statute has been violated. *Dep't of State v Michigan Ed Ass'n-NEA*, 251 Mich App 110, 116; 650 NW2d 120 (2002). Because defendant's void-for-vagueness challenge is limited to the argument that the ordinance does not provide fair notice of the conduct proscribed, we must examine the constitutionality of the ordinance "'without concern for the hypothetical rights of others.'" *People v Knapp*, 244 Mich App 361, 374 n 4; 624 NW2d 227 (2001), quoting *People v Vronko*, 228 Mich App 649, 652; 579 NW2d 138 (1998). Thus, "'[t]he proper inquiry is not whether the [ordinance] may be susceptible to impermissible interpretations, but whether the [ordinance] is vague as applied to the conduct allegedly proscribed in this case.'" *Knapp, supra* at 374 n 4, quoting *Vronko, supra* at 652.

The relevant section of the plaintiff's zoning ordinance concerning riparian-lot-use regulations provides as follows:

> In any zoning district where a parcel of land is contiguous to a lake or pond, either natural or man-made, such parcel of land may be used as access property or as common open space held in common by a subdivision, association or any similar agency; or held in common by virtue of the terms of a plat of record; or provided for common use under deed restrictions of record; or owned by two or more dwelling units located away from the waterfront only if the following conditions are met:
>
> 1. That said parcel of land shall contain at least 70 lineal feet of water frontage and a lot depth of at least 100 feet for each dwelling unit or each single-family unit to which such privileges are extended or dedicated. . . . [Section 15.14.2.]

Defendant argues that, under one permissible interpretation, the various types of ownership listed in the introductory paragraph of this section can be interpreted as modifying both "access property" and "common open space." According to defendant, if such an interpretation is adopted, the lot owners are not in violation of the ordinance because the First Street lot does not constitute access property "owned by two or more dwelling units located away from the waterfront." Defendant further contends that one can also interpret the types of ownership listed in the introductory paragraph as modifying only "common open space." Under the second interpretation, defendant would be in violation of the ordinance because the First Street lot qualifies as access property.

Under the rules of grammar and statutory construction, which apply to ordinances, *Gora v City of Ferndale*, 456 Mich 704, 711; 576 NW2d 141 (1998), if reasonable minds can differ with respect to the meaning of a statute, judicial construction is appropriate. *Adrian School Dist v Michigan Pub School Employees' Retirement Sys*, 458 Mich 326, 332; 582 NW2d 767 (1998). However, we believe that reasonable minds could not disagree regarding the meaning of the ordinance.

The disjunctive term "or" refers to a choice or alternative between two or more things. *Root v Ins Co of North America*, 214 Mich App 106, 109; 542 NW2d 318 (1995). Accordingly, applying basic grammar rules and rules of statutory construction, the introductory paragraph set forth in § 15.14.2 of the zoning ordinance can only correctly be interpreted in one way. Consequently, there can be no question that for a parcel of land to be used as access property, it must comply with the conditions listed in § 15.14.2, including:

> 1. That said parcel of land shall contain at least 70 lineal feet of water frontage and a lot depth of at least 100 feet for each dwelling unit or each single-family unit to which such privileges are extended or dedicated. Frontage shall be measured by a straight line which intersects each side lot line at the water's edge.

At least eight families with nonwaterfront dwellings own one-eighth interests in the First Street lot. Because the lot has only 103 feet of water frontage, the riparian-lot-use regulations prohibit the use of the lot as access property. Thus, we find that the ordinance was not void for vagueness.

Defendant next argues that the ordinance is unconstitutional because it denies him substantive due process. We disagree.

As stated previously, we review the trial court's ruling on a constitutional challenge to a zoning ordinance de novo. *Jott, supra* at 525. Judicial review of a challenge to an ordinance on substantive due process grounds requires application of three rules:

> (1) the ordinance is presumed valid; (2) the challenger has the burden of proving that the ordinance is an arbitrary and unreasonable restriction upon the owner's use of the property; that the provision in question is an arbitrary fiat, a whimsical ipse dixit; and that there is not room for a legitimate difference of opinion concerning its reasonableness; and (3) the reviewing court gives considerable weight to the findings of the trial judge. [*A & B Enterprises v Madison Twp*, 197 Mich App 160, 162; 494 NW2d 761 (1992).]

To establish that a zoning ordinance violates substantive due process protections, a party must show (1) that there is no reasonable governmental interest advanced by the zoning classification or (2) that the ordinance is unreasonable because it contains arbitrary, capricious and unfounded exclusions of legitimate land use. *Frericks v Highland Twp*, 228 Mich App 575, 594; 579 NW2d 441 (1998).

The 1987 antifunneling ordinance in question explains the problems that led to its adoption, including overcrowding and pollution of lakes and other waterways, as well as the dangers to life and property posed by an increased risk of boating accidents. Likewise, the expressed intent of the riparian-lot-use regulations is that the regulations are designed to prevent funnel development and to protect and preserve lakes.

The protection of natural resources such as lakes is a reasonable governmental interest. In *Hess*, our Supreme Court stated that the Legislature, in granting townships the authority to promote public health, safety, and general welfare by enacting zoning ordinances, was complying with its "constitutional mandate to protect the environment, including bodies of water, from impairment or destruction." *Hess*, *supra* at 565. Protecting Gun Lake from congestion and pollution and protecting the public from the risk of increased boating accidents promotes public health, safety, and welfare. The goals of the ordinance are reasonable governmental interests that state law expressly permits townships to regulate. Further, limiting the number of dwelling units given access to riparian lots will curtail funneling, or lake access by nonriparian lot owners. Thus, the ordinance is rationally related to its stated purpose.

Furthermore, the ordinance is not unreasonable as an arbitrary and capricious exclusion of legitimate uses of land. We find a rational relationship between the ordinance and its objective. Limiting the number of dwelling units with lake access to one for every seventy feet of lakefront property would curtail lake congestion, pollution, and the risk of boating accidents by cutting down on overuse. The fact that the ordinance does not seek to regulate public lake access does not make it arbitrary or capricious. Likewise, the fact that the ordinance does not regulate all types of access does not mean it is not rationally related to its goals of reducing lake congestion, lowering the risk of accidents on the lake, and preserving the lake. On the contrary, the riparian regulations at issue limit overuse by cutting down on the private use of the lakefront by owners of nonwaterfront property. Thus, the regulations are neither arbitrary nor capricious.

Plaintiff's failure to similarly regulate the use of state-licensed marinas or planned unit developments or to coordinate its riparian ordinance with ordinances of other townships surrounding the lake does not render the ordinance arbitrary and capricious. As our Supreme Court has cautioned:

> [I]t is the burden of the party attacking to prove affirmatively that the ordinance is an arbitrary and unreasonable restriction upon the owner's use of his property. . . . It must appear that the clause attacked is an arbitrary fiat, a whimsical *ipse dixit*, and that there is no room for a legitimate difference of opinion concerning its reasonableness. [*Brae Burn, Inc v Bloomfield Hills*, 350 Mich 425, 432; 86 NW2d 166 (1957).]

Here defendant has not shown that there is no room for a difference of opinion on the reasonableness of the ordinance. Again, the mere fact that the ordinance does not regulate all types of lakefront access, but only regulates lakefront access of residential riparian lots, does not lead to the conclusion that the ordinance is an arbitrary one. The ordinance's riparian-lot-use regulations apply uniformly to all residential riparian lots, and not just to defendant's lot. We therefore conclude that the ordinance is not an arbitrary restriction on defendant's use of his property.

Defendant finally argues that the trial court erred in finding that plaintiff's claim was not barred by the equitable affirmative defense of laches. We disagree. We review a trial court's equitable decisions de novo. *Webb v Smith (After Second Remand)*, 224 Mich App 203, 210; 568 NW2d 378 (1997). We review for clear error the findings of fact supporting the trial court's equitable decision. *Id.*

The doctrine of laches is concerned with unreasonable delay that results in "circumstances that would render inequitable any grant of relief to the dilatory plaintiff." *In re Contempt of United Stationers Supply Co*, 239 Mich App 496, 503-504; 608 NW2d 105 (2000). The application of the doctrine of laches requires the passage of time combined with a change in condition that would make it inequitable to enforce the claim against the defendant. *Gallagher v Keefe*, 232 Mich App 363, 369; 591 NW2d 297 (1998). Laches does not apply unless the delay of one party has resulted in prejudice to the other party. *City of Troy v Papadelis (On Remand)*, 226 Mich App 90, 97; 572 NW2d 246 (1997). "'It is the effect, rather than the fact, of the passage of time that may trigger the defense of laches.'" *Id.*, quoting *Great Lakes Gas Transmission Co v MacDonald*, 193 Mich App 571, 578; 485 NW2d 129 (1992). The defendant has the burden of proving that the plaintiff's lack of due diligence resulted in some prejudice to the defendant. *Gallagher*, *supra* at 369-370. Laches can be applied to bar an attempt to abate a zoning ordinance violation. *Independence Twp v Skibowski*, 136 Mich App 178, 185; 355 NW2d 903 (1984).

Defendant presented testimony that plaintiff knew of John Rough's plan to sell undivided one-eighth interests in his riparian lot to provide nonriparian lot owners with private lakefront access as early as 1994, as evidenced by the fact that the plaintiff's assessor and supervisor warned Rough at that time that his actions violated the plaintiff's antifunneling ordinance. According to defendant, plaintiff, despite knowing of Rough's plan in 1994, failed to initiate its action to enforce the antifunneling ordinance until March 2002 and, therefore, failed to exercise due diligence in bringing its action against defendant.

On June 4, 1997, Rough filed an affidavit with the Barry County Register of Deeds acknowledging that he was aware of the existence of an antifunneling ordinance before he pursued his plan to convey undivided interests in the First Street lot for lakefront access. The trial court, relying on the fact that Rough's affidavit was recorded in 1997, concluded that defendant and the other First Street lot owners had constructive notice that plaintiff had an antifunneling ordinance before they purchased their interests in the First Street lot. Therefore, according to the trial court, defendant was not prejudiced by plaintiff's delay in initiating its action.

Defendant contends that constructive notice was insufficient to permit the conclusion that defendant was not prejudiced by plaintiff's dilatory tactics. In *Larzelere v Starkweather*, 38 Mich 96, 107 (1878), our Supreme Court stated:

> There are cases which go very far in extending the doctrine of laches in applying the rule of constructive notice. We think, however, the better and certainly the safer rule to be that a mere want of caution is not sufficient,—not

> that [a party] had incautiously neglected to make inquiries, but that he had designedly abstained from making inquiry for the very purpose of avoiding knowledge. In other words, that he acted in bad faith.

To the extent that this language can be interpreted as suggesting that constructive notice is insufficient when applying the doctrine of laches, we conclude that it is inapplicable because it speaks to a set of facts not present in this case.[1] When Rough first informed plaintiff of his plan to subdivide the First Street lot to provide lakefront access, plaintiff told him that such actions were in violation of the plaintiff's antifunneling ordinance. Thereafter, plaintiff sent Rough a letter specifically informing him that his conveyances of one-eighth interests in the First Street lot were not in compliance with the riparian-lot-use regulations of the plaintiff's zoning ordinance. The trial court correctly held that, following Rough's recording of the affidavit with the register of deeds, plaintiff had every reason to believe that any potential buyers of a one-eighth interest in the First Street lot had, at the very least, constructive notice of the plaintiff's position regarding enforcement of its antifunneling ordinance relative to the First Street lot. At a minimum, on the basis of the filing of the affidavit, defendant had constructive notice of the existence of plaintiff's antifunneling ordinance in 1997, before he purchased a one-eighth interest in the First Street lot. Therefore, he was not prejudiced by plaintiff's failure to initiate this action until 2002. We hold that the trial court did not err in concluding that plaintiff's claims were not barred by laches.

Affirmed.

/s/ Karen M. Fort Hood
/s/ Pat M. Donofrio
/s/ Stephen L. Borrello

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[1] Moreover, we observe that in *Larzelere,* our Supreme Court recognized that, notwithstanding the doctrine of *stare decisis*, a rule of law from a case that is factually distinguishable may not be binding on a different set of facts:

> In the preparation of an opinion, the facts of the case are in mind. It is prepared with reference to such facts, and when considered in connection therewith, will generally be found satisfactory. When, however, an attempt is made to pick out particular parts or sentences, and apply them indiscriminately in other cases, nothing but confusion and disaster will be likely to follow. In other words, the opinion and decision of a court must be read and examined as a whole in the light of the facts upon which it was based. [*Larzelere*, *supra* at 101.]

ARTICLE XVIII
RIPARIAN LOT USE REGULATIONS

15.18.

15.18.1. PURPOSE:

IT IS THE PURPOSE OF THIS ARTICLE TO PROMOTE THE INTEGRITY OF THE LAKES WITHIN YANKEE SPRINGS TOWNSHIP WHILE PRESERVING THE QUALITY OF RECREATIONAL USE OF THE INLAND WATER; TO PROTECT THE QUALITY OF THE LAKES BY DISCOURAGING EXCESSIVE USE; TO PROMOTE THE ECOLOGICAL BALANCE OF THE WATERS BY LIMITING INCOMPATIBLE LAND USE OF THE WETLANDS ASSOCIATED WITH THE LAKES; AND TO MAINTAIN THE NATURAL BEAUTY OF THE LAKES BY MINIMIZING MAN-MADE ADJUSTMENTS TO THE ESTABLISHED SHORELINES.

NOTING WITHIN THIS ORDINANCE SHALL BE CONSTRUED TO LIMIT ACCESS TO THE LAKES OR WATERWAYS BY THE GENERAL PUBLIC BY WAY OF A PUBLIC PARK, OR PUBLIC ACCESS SITE PROVIDED OR MAINTAINED BY ANY UNIT OF STATE, COUNTY OR LOCAL GOVERNMENT.

15.18.2. DEFINITIONS:

"ACCESS PROPERTY"

SHALL MEAN A PROPERTY, PARCEL, OR LOT ABUTTING A LAKE OR POND, EITHER NATURAL OR MAN-MADE, AND USED OR INTENDED TO BE USED, FOR THE PURPOSE OF PROVIDING ACCESS TO A LAKE OR POND BY PEDESTRIAN OR VEHICULAR TRAFFIC TO AND FROM OFFSHORE LAND REGARDLESS OF WHETHER SAID ACCESS TO THE WATER IS GAINED BY EASEMENT, COMMON FEE OWNERSHIP, SINGLE FEE OWNERSHIP, LEASE, LICENSE, GIFT, BUSINESS INVITATION OR ANY OTHER FORM OR DEDICATION OR CONVEYANCE.

"PUBLIC EASEMENT OR ACCESS"

PUBLIC EASEMENT OR ACCESS SHALL MEAN ANY RIGHT OF WAY OR ACCESS ACROSS ANY PARCEL OF LAND FROM A PUBLIC OR PRIVATE ROAD, TO ANY LAKE WITHIN YANKEE SPRINGS TOWNSHIP, DEDICATED BY A DEVELOPER. ALL EASEMENTS CREATED AFTER JULY 14, 1994 SHALL MEET THE REQUIREMENTS OF SECTIONS 15.14.1 THROUGH 15.14.3.

15.18.3. REGULATIONS:

IN ANY ZONING DISTRICT WHERE A PARCEL OF LAND IS CONTIGUOUS TO A LAKE OR OTHER WATERWAY, EITHER NATURAL OR MAN-MADE, SUCH PARCEL OF LAND MAY BE USED AS ACCESS PROPERTY OR AS COMMON OPEN SPACE HELD IN COMMON BY A SUBDIVISION, ASSOCIATION OR SIMILAR AGENCY; OR HELD IN COMMON BY VIRTUE OF THE TERMS OF A PLAT OF RECORD; OR PROVIDED FOR COMMON USE UNDER DEED RESTRICTIONS OF RECORD; OR OWNED BY TWO (2) OR MORE DWELLING UNITS LOCATED AWAY FROM THE WATER FRONT ONLY IF THE FOLLOWING CONDITIONS ARE MET:

A. THAT SAID PARCEL OF LAND SHALL CONTAIN AT LEAST SEVENTY (70) FEET OF WATER FRONTAGE AND A LOT DEPTH OF AT LEAST ONE-HUNDRED (100) FEET FOR EACH DWELLING UNIT OR EACH SINGLE FAMILY UNIT TO WHICH SUCH PRIVILEGES ARE EXTENDED OR DEDICATED. FRONTAGE SHALL BE MEASURED BY A STRAIGHT LINE WHICH INTERSECTS EACH SIDE LOT LINE AT THE WATER'S EDGE.

B. THAT IN NO EVENT SHALL WATER FRONTAGE OF SUCH PARCEL OF LAND CONSIST OF SWAMP, MARSH, OR BOG AS SHOWN ON THE MOST RECENT U.S. GEOLOGICAL SURVEY

MAPS, OR THE MICHIGAN DEPARTMENT OF NATURAL RESOURCES MIRIS MAP, OR HAVE OTHERWISE BEEN DETERMINED TO BE WETLAND BY THE MICHIGAN DNR; AND THAT IN NO EVENT SHALL A SWAMP, MARSH, OR BOG BE ALTERED BY THE ADDITION OF EARTH OR FILL MATERIAL OR BY DRAINAGE OF WATER FOR THE PURPOSE OF INCREASING THE WATER FRONTAGE REQUIRED BY THIS ARTICLE.

C. THAT IN NO EVENT SHALL SUCH PARCEL OF LAND ABUT A MAN-MADE CANAL OR CHANNEL, AND NO CANAL OR CHANNEL SHALL BE EXCAVATED FOR THE PURPOSE OF INCREASING THE WATER FRONTAGE REQUIRED BY THIS ARTICLE.

D. THAT ACCESS PROPERTY, AS PROVIDED FOR IN AND MEETING THE CONDITIONS OF THIS ORDINANCE, REGARDLESS OF TOTAL AREA, SHALL NOT BE USED AS A RESIDENTIAL LOT FOR THE PURPOSE OF CONSTRUCTING A DWELLING AND/OR ACCESSORY STRUCTURE(S), OR FOR ANY COMMERCIAL OR BUSINESS USE. SUCH PARCEL OF LAND

15.18.4. USE OF PUBLIC EASEMENTS:

USE OF PUBLIC EASEMENTS BETWEEN PUBLIC OR PRIVATE ROADS AND ANY LAKE IN YANKEE SPRINGS TOWNSHIP. THESE RULES SHALL NOT APPLY TO ANY EASEMENT WITHIN YANKEE SPRINGS TOWNSHIP WHERE A COURT OF LAW AS PREVIOUSLY SET UP OPERATING REGULATIONS.

A. THE USE OF ANY EASEMENT DEDICATED TO THE PUBLIC SHALL NOT BE LIMITED TO ANY GROUP OF RESIDENTS OF THE STATE, COUNTY OR TOWNSHIP EXCEPT AS FOLLOWS:

1. USE SHALL BE BY PEDESTRIAN TRAFFIC ONLY:

(A). NO PERSON SHALL PLACE ANYTHING ON ANY EASEMENT THAT WOULD PREVENT ANOTHER PERSON FROM USING ANY PART OF THE EASEMENT.

(B). NO PERSON SHALL BE PREVENTED FROM CROSSING ANY EASEMENT TO GAIN ACCESS TO ANY LAKE WITHIN THE TOWNSHIP.

(C). INGRESS AND EGRESS SHALL NOT BE DENIED TO ANY PRIVATELY OWNED PROPERTY.

2. USE OF DOCKS, BOATS, PONTOONS, JET SKIS AND ALL OTHER WATERCRAFT:

(A). NO DOCK, RAFT OR SIMILAR EQUIPMENT SHALL BE PLACED IN ANY LAKE WITHIN THE BOUNDARIES OF ANY EASEMENT. THIS SECTION SHALL APPLY TO THOSE LIVING ADJACENT TO AN EASEMENT AS WELL AS TO THOSE USING THE EASEMENT.

(B). NO WATERCRAFT SHALL BE MOORED AT THE END OF ANY EASEMENT. THIS SECTION SHALL APPLY TO THOSE LIVING ADJACENT TO AN EASEMENT AS WELL AS TO THOSE USING THE EASEMENT.

Appendix C

Lakeside Landscaping and Septic System Maintenance Guidelines

Lakeside Lawn Care

In General . . .

- 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.
- Avoid using herbicides near the lake, many are toxic to aquatic life.

Fertilizing the Lawn

- If you don't use fertilizer, don't start now. If you do...
- Most lakeside lawns don't need phosphorus. Don't use fertilizer that contains phosphorus unless a soil test shows a need for it. Once in the lake, 1 pound of phosphorus can generate several hundred pounds of aquatic plants.
- Fertilizers are labeled with a 3-number system that indicates the percentage of the bag that contains nitrogen (first number), phosphorus (second number) and potassium (third number). Example: a 50-pound bag of 20-0-10 fertilizer contains 20% nitrogen (or 10 pounds), 0% phosphorus, and 10% potassium (5 pounds).
- Make sure the nitrogen is a slow-release type, such as sulfur-coated urea or IBDU.
- Use no more than 8 pounds of nitrogen per ¼-acre of lawn (¼-acre is about 100 by 100 feet).
- Don't fertilize the lawn until 3 weeks after the lawn begins to turn green in spring. If needed, the lawn may be lightly fertilized again in fall (late September through November) to promote root growth.
- When spreading fertilizer, don't allow fertilizer to land directly in the water.

Irrigation

- Lightly water after fertilizer is applied. Too much water will cause the fertilizer to leach right past the lawn and into the lake; the turf roots will never get a chance to use it.
- Irrigation during the hot, dry period of late summer can prevent the grass from turning brown. At that time, it's better to water for short periods (10 to 15 minutes) daily, rather than heavy watering once per week.
- The best time to water is early afternoon, just prior to the hottest part of the day.

Mowing

- Don't cut the grass too short! Near lakes, a mowing height of 3 to 3½ inches or higher is recommended.
- A general recommendation for mowing frequency is twice per week in spring, every two weeks in summer, and once per week in the fall.
- Return grass clippings back to the lawn. You can reduce the nitrogen needs of your lawn significantly by doing so. If possible, use a mulching lawn mower to aid in this process.

Greenbelt

- A greenbelt is a strip of land along the lakeshore that contains plants to trap pollutants that would otherwise wash into the lake.
- A greenbelt should be at least 10 feet wide, but more than 30 feet wide is best.
- Don't fertilize the greenbelt.
- For a natural look, don't mow the greenbelt. Allow natural grasses and wildflowers to grow.
- For a landscaped look, plant groundcovers, ferns, perennials, and shrubs.

Guidelines are based on Michigan State University research

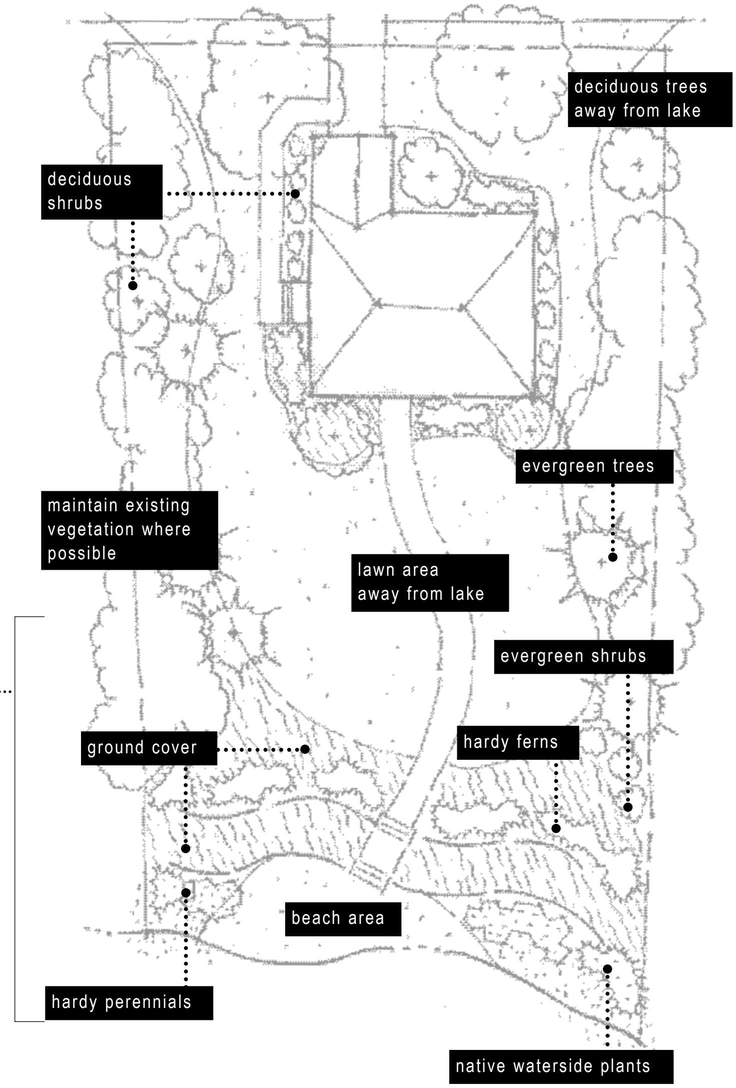
If you use a professional lawn care service, be sure to request a fertilizer that does not contain phosphorus.

Hardy Perennials	
Sweet Flag	*Acorus calamus*
Astilbe	*Astilbe spp.*
Bergenia	*Bergenia cordifolia*
Marsh Marigold	*Caltha palustris*
Swamp Rose Mallow	*Hibiscus moscheutos*
Daylily	*Hemerocallis spp.*
Plantain Lily	*Hosta spp.*
Japanese Iris	*Iris kaempferi*
Red Iris	*Iris fulva*
Siberian Iris	*Iris sibirica*
Blue Flag	*Iris versicolor*
Cardinal Flower	*Lobelia cardinalis*
Snake Weed	*Polygonum bisorta 'Superflame'*
Pickerel Weed	*Pontederia cordata*
Primrose	*Primula spp.*
Arrowhead	*Sagittaria sagittifolia 'Flore Pleno'*
Lizard's Tail	*Saururus cernus*
Arum Lily	*Zantedeschia aethiopica*
Hardy Ferns	
Maidenhair Fern	*Adiantum pedatum*
Cinnamon Fern	*Osmunda cinnamomea*
Royal Fern	*Osmunda regalis*
Ostrich Fern	*Matteucia struthiopteris*
Ground Covers	
Ajuga or Bugleweed	*Ajuga reptans*
Crown Vetch	*Coronilla varia*
Pachysandra	*Pachysandra terminalis*
Periwinkle	*Vinca minor*
Deciduous Shrubs	
Autumn-Olive	*Elaeagnus umbellata*
Cotoneaster	*Cotoneaster spp.*
Dogwood, shrub form	*Cornus spp.*
Forsythia	*Forsythia spp.*
Honeysuckle	*Lonicera spp.*
Lilac, shrub form	*Syringa spp.*
Mockorange	*Philadelphus coronarius*
Ninebark	*Physocarpus opulifolius*
Privet	*Ligustrum spp.*
Rose-of-Sharon	*Hibiscus syriacus*
Viburnum	*Viburnum spp.*
Evergreen Shrubs	
Juniper	*Juniperus spp.*
Sheep Laurel	*Kalmia angustifolia*
Deciduous Trees	
Ash	*Fraxinus spp.*
Balsam Poplar	*Populus balsamifera*
Basswood	*Tilia americana*
Beech	*Fagus spp.*
Birch	*Betula spp.*
Black Locust	*Robinia pseudoacacia*
Crabapple	*Malus spp.*
Quaking Aspen	*Populus tremuloides*
Red Maple	*Acer rubrum*
Red Oak	*Quercus rubra*
Redbud	*Cercis canadensis*
Serviceberry	*Amelanchier spp.*
Silver MapleSugar	*Acer saccharinum*
Maple	*Acer saccharum*
White Oak	*Quercus alba*
Evergreen Trees	
Baldcypress	*Taxodium spp.*
Canadian Hemlock	*Tsuga canadensis*
Cedar	*Cedrus spp.*
Eastern Red Cedar	*Juniperus virginiana*
Red Pine	*Pinus resinosa*
Tamarix	*Tamarix spp.*
White Pine	*Pinus strobus*

Lakeside landscaping involves planting or preserving a zone of natural vegetation, a greenbelt, around the lake's edge. This vegetation acts as a buffer, trapping runoff and absorbing nutrients 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. See list at left for some native greenbelt varieties.



Septic System Maintenance Guidelines

If a septic system is not properly designed and maintained, bacteria and nutrients (such as nitrogen and phosphorus) can readily pass through the soil to the water table and ultimately to the lake or a nearby well. In some instances, septic contaminants can move several hundred feet. Therefore, proper maintenance of lakeside septic systems is critical to water quality protection. This section describes how septic systems function and may be properly maintained.

Most septic systems fail due to improper maintenance.

Parts of a Septic System

A septic system consists of two components: a septic tank and a drainfield. Wastewater flows from the house to the septic tank. In the septic tank, most of the solids settle to the bottom and form a sludge layer that is partially decomposed by bacteria. Floating solids form a scum layer on the water surface. Baffles may be positioned in the septic tank to help prevent solids from flowing into and clogging the drainfield. Liquids from the septic tank flow into the drainfield where the wastewater is treated by filtration and microorganisms in the soil. Most commonly, the drainfield consists of a series of perforated pipes that allow water from the septic tank to slowly drain to the surrounding soils.

The following practices will help to reduce septic contamination problems and will prolong the life and efficiency of your septic system.

Septic System Maintenance Practices

Maintaining the Septic Tank

- Inspect the septic tank scum and sludge depth once a year. If the scum depth is within 1 inch of the outlet baffle, the tank requires cleaning. If the sludge depth is within 12 inches of the outlet baffle or within 18 inches of the outlet fitting, the tank requires cleaning.
- Pump the tank at regular intervals (usually every 2 to 3 years).
- To avoid overburdening your septic system with solids, do not use a kitchen garbage disposal unit.
- Do not use chemical agents to clean your system except on the advice of the county health department.
- Do not put harmful materials, such as fats, solvents, oils, paints, coffee grounds, paper towels, disposable diapers, cigarettes, sanitary napkins, or tampons, into your system.
- If your system is equipped with a distribution box between the septic tank and the drainfield, at 1-year intervals, allow one side of your system to “rest.”
- If your system is equipped with a dosing chamber, be sure the submersible pump is operating and properly maintained for uniform discharge of effluent into the drainfield, followed by drainage between doses.

Maintaining the Drainfield

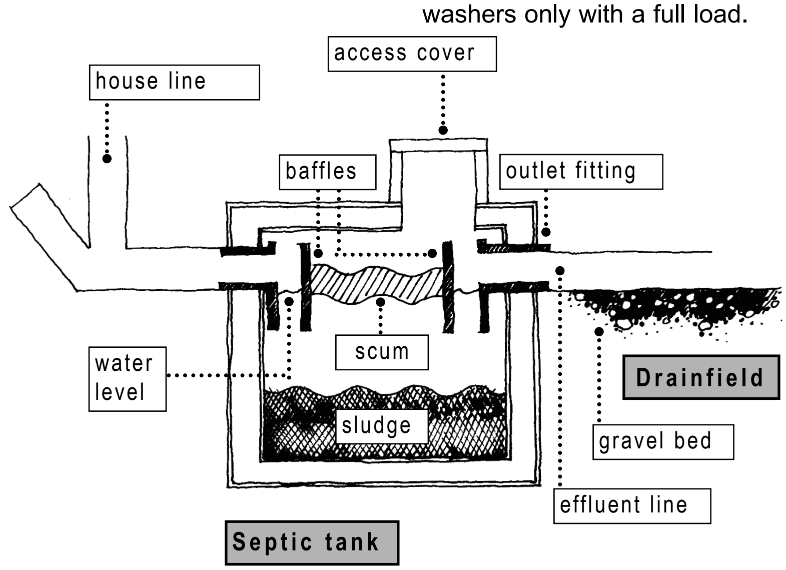
- Know the location of your drainfield.
- Keep automobiles and all heavy vehicles off the drainfield.
- Do not allow puddles of storm-water to form over the drainfield.
- Do not fertilize the soil above the drainfield.
- Do not stockpile snow or soil on the drainfield.
- Do not allow downspouts to drain onto or into your drainfield.
- Dense grass cover and other shallow-rooted plants are beneficial over a drainfield.
- Avoid planting deep-rooted trees and shrubs over the drainfield. Although they promote moisture removal from the drainfield, their roots may clog the drain tiles.

Water Conservation Measures

The less water you use, the better your septic system will function.

- Toilets are among the most water-consumptive appliances in a house. By installing a low-flush toilet, with a 1 gallon-per-flush capacity, instead of the 3.5 to 5-gallon toilets, you may reduce toilet water use by as much as 30 percent.
- Use low-flow, water-saving shower heads. This plumbing fixture can reduce shower water use by up to 50 percent but increases water velocity so the shower feels the same.
- Faucet aerators can decrease faucet water use by as much as 50 percent.
- Other simple things that can be done in the home include repairing leaky faucets and toilets; and using dish and clothes washers only with a full load.

Note: Much of the information in this section was derived from the Michigan State University Cooperative Extension Service Publications "How to Conserve Water in Your Home and Yard" (Bulletin WQ16) and "Maintaining Your Septic System" (Bulletin WQ39).



Appendix D
Sample Shoreland Overlay District

ROSS TOWNSHIP
PROPOSED ZONING ORDINANCE AMENDMENT
SHORELAND OVERLAY DISTRICT

Amend Section 4, Definitions, with the following new definitions:

Lot Coverage: The part or percent of a lot occupied by impervious surfaces, including, but not limited to, buildings or structures, paving, drives, patios, and decks.

Natural Vegetative Cover: Natural vegetation, including bushes, shrubs, groundcover, and trees, on a lot. Lawn shall not qualify as natural vegetative cover.

Replace the current Section 9.7, with a new Section 9.7, Water Quality Overlay District to read in full as follows:

9.7 Shoreland Overlay District

A. Purpose and Application

1. The purpose of this District is to recognize the unique physical, environmental, economic, and social attributes of water bodies, watercourses, and shoreland properties in RossTownship, to ensure that the structures and uses in this District are compatible with and protect these unique attributes. Other specific purposes include the prevention of water pollution, preservation of wildlife habitat, protection from the negative effects of erosion and storm water runoff, conservation of natural beauty and open space, and management of development in sensitive shoreland areas.

2. The Shoreland Overlay District is a supplemental District which applies to certain designated lands, as described in this Section, simultaneously with any of the other Zoning Districts established in this Ordinance, hereinafter referred to as the "underlying" Zoning District. Lands included in the Shoreland Overlay District are:

a. Watercourses - All lands located within five hundred (500) feet of the shoreline of the watercourses in the township including: Augusta Creek and its tributaries, Kalamazoo River and its tributaries; and;

b. Water Bodies - All lands located within five hundred (500) feet of the shoreline of the following water bodies in the township: Duck, Gull, Hamilton, Sherman, and Stony Lakes.

3. In cases where a parcel is partially inside and partially outside of the Shoreland Overlay District, only those portions located within the Overlay District are required to comply with the requirements of this District.

B. Development Requirements

1. Permitted Uses: With the exception of uses and activities prohibited herein, the following uses of land and structures shall be permitted in the Shoreland Overlay District: Permitted Uses and Special Exception Uses permitted in the underlying District, provided that Special Exception Uses meet the requirements of Section 9.8.

2. Prohibited Uses: The following uses and activities shall be specifically prohibited in the Shoreland Overlay District:

a. Concentrated Animal Feeding Operation
b. Slaughterhouses
c. Gasoline Service Stations
d. Automobile Repair Garage, Auto Body and Auto Paint Shops.
e. Auto Washes, either self service or automatic
f. Hazardous Waste Storage Facilities
g. Petroleum Storage Facilities
h. Landfills, Salvage or Junkyards

i. The construction of a canal, channel, or any artificial waterway
j. Any other use not specifically permitted in the underlying Districts.

C. Lot Area, Width, Yard, Building Area, Height, and Setback Requirements

1. Except as noted below, minimum requirements for lot area, lot width, yards, building area and building height shall conform to those required by the underlying District.

2. The following additional requirements shall apply for structures within the Shoreland Overlay District. Unless otherwise noted, all requirements apply to both watercourses and water bodies.

3. As of the effective date of this Ordinance, no dwelling or other main building, accessory building shall be constructed, erected, installed, or enlarged unless in compliance with the following setback requirements:

a. Watercourses - The structures noted shall be set back a minimum of one hundred (100) feet, as measured from the shoreline, except that for each one (1) foot of elevation above a minimum of seven (7) feet above the shoreline, new structures may be placed five (5) feet closer to the shoreline of the watercourse, provided that no structure shall be located closer than seventy-five (75) feet from the watercourse.

b. Water Bodies - The structures noted shall be set back a minimum of twenty-five (25) feet, as measured from the shoreline.

4. Average setbacks

   a. Where the watercourse and water body setbacks for existing main buildings entirely or partially within two hundred (200) feet of the side lot lines, on the same side of the street and in the same zoning district of the subject lot are less than the setbacks required by C, 2, above, the required setback for the subject lot shall be the average of the setbacks of existing main buildings within the two hundred (200) foot distance.

   b. The setback reduction shall only be permitted if there are two (2) or more lots occupied by main buildings within the two hundred (200) foot distance.

5. No dwelling shall be constructed or placed on lands which are subject to flooding.

D. Shoreline Vegetative Buffer

1. A buffer bordering any watercourse or water body, shall be maintained in its natural vegetative state. Lawn shall not qualify as natural vegetative buffer under this section. The minimum width of the buffer, as measured from the shoreline, shall be:

   a. Watercourses - one hundred (100) feet
   b. Water Bodies - twenty five (25) feet

2. Within the shoreline vegetative buffer, no more than an aggregate of twenty (20) feet for each one hundred (100) feet of shoreline may be cleared to afford water body or watercourse access, provided that the clearing does not cause erosion or sedimentation. Since the intent of the vegetative buffer is water quality protection, the lake access area must be covered in grass or other vegetative groundcover. Impervious materials such as asphalt or concrete shall not be used within the shoreline buffer area.

3. The Zoning Administrator may allow limited clearing of the vegetative buffer when required for construction of a permitted building or structure outside the vegetative buffer, provided that the land cleared is returned to a vegetative state of approximately the same quality as

that which existed prior to clearing and is equally effective in retarding runoff, preventing erosion, and preserving natural beauty.

4. These provisions shall not apply to the removal of noxious, dead, diseased, or dying vegetation or trees that are in danger of falling, causing damage to dwellings or other structures, or causing blockage of the watercourse or water body.

5. The shoreline vegetative buffer shall not be used for any motorized vehicular traffic, parking, or for storage of any kind, including junk, waste, or garbage, or for any other use not otherwise authorized by this Ordinance.

E. Lot Coverage and Natural Vegetative Cover

1. Not withstanding the requirements of the underlying zoning district, lot coverage shall not exceed forty percent (40%).

2. At a minimum, lots shall maintain a minimum of thirty percent (30%) of the entire lot area in natural vegetative cover. To the extent practicable, natural vegetative areas shall be maintained along lot lines, water bodies and watercourses, natural drainage courses, wetlands, and steep slopes. On lots bordering water bodies and watercourses, the Shoreline Vegetative Buffer required by this provision may be included as part of the natural vegetative cover required by this subparagraph.

3. In the case of planned unit developments, site condominiums, and open space developments, each individual lot need not meet the requirements of this Section, provided that the total project or an individual phase of a project meets the requirements of this Section.

F. General Design and Development Standards: For all development in the Shoreland Overlay District, the following design and construction standards shall be followed:

1. Natural vegetation shall be maintained wherever possible.

2. Existing mature trees shall be maintained on site where feasible.

3. To the extent feasible, natural drainage areas should be protected from grading activity.

4. Buildings and structures shall be clustered as much as possible to retain open space and surrounding tree cover and to minimize changes in topography.

5. The smallest practical area may be exposed at any one time during construction.

6. When land is exposed during development, the exposure shall be kept to the shortest practical period of time.

7. Appropriate measures shall be taken to ensure stormwater drainage will not adversely affect neighboring properties or the quality of area water resources. Where feasible, steps should be taken to retain and infiltrate uncontaminated stormwater (such as roof top drainage) on site.

G. Approvals

1. Site plan approval, in accordance with the requirements of Section 9.9 shall be obtained for the following uses or buildings (including additions or extensions to these uses or buildings) that are located wholly or partially within the Shoreland Overlay District.

a. Any Commercial establishment
b. Any Industrial establishment
c. Multiple Family Residential Dwellings

2. Development within the Shoreland Overlay District must conform with all applicable County, State, and Federal, and Township statutes and ordinances including, but not limited to, Part 91, Soil Erosion and Sedimentation Control, of Michigan Act 451 of 1994. A building permit shall not be issued in the Shoreland Overlay District unless a copy of the soil erosion control permit required pursuant to Part 91 has been submitted to the Zoning Administrator.

3. All other requirements, including parking, signs, and other similar provisions shall be as required by the underlying zone district, except that where specific requirements of the Shoreland Overlay District vary or conflict with the regulations contained in the underlying zoning district, the stricter shall govern.

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