Management Plan for Lake Lansing and Its Watershed

Prepared for:

Charter Township of Meridian
Lake Lansing Special Assessment District
Ingham County Board of Commissioners

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Executive Summary

Over the past five years, there has been a cooperative effort on and around Lake Lansing to both manage current problems and study the lake and its watershed in order to identify and alleviate potential problems. This effort was spearheaded by a special Lake Lansing Advisory Committee to the Meridian Township Board. Participants in this accomplishment include residents around Lake Lansing, including both riparian homeowners and non-riparian homeowners, the Meridian Charter Township Board and staff members, the Ingham County Board of Commissioners, the Ingham County Drain Commissioner and staff, the Ingham County Parks Department, Lake Lansing Property Owner's Association, the Michigan Department of Environmental Quality, Progressive AE consultants, and other interested citizens.

Funding for this effort was provided by a special assessment district through Meridian Township Both the riparian homeowners and homeowners with direct access to Lake Lansing were taxed and contributions were made by the Ingham County Board of Commissioners, Meridian Township, and MSU Sail Club. The home owners share was approximately 80% while the governmental contributions totaled about 20%.

Management of current problems primarily consisted of chemical treatments to check the growth of both Eurasian milfoil and curlyleaf pondweed in Lake Lansing, both of which are non-indigenous, nuisance plants. The consensus is that because of active, professional management the aquatic plant problem may be coming under control, although it will require continuing vigilance and maintenance.

The goal of the study was to develop a long term watershed management plan for Lake Lansing. This four-year effort looked at many facets, including water quality monitoring, land use, zoning, ordinances, recreation usage, water runoff and drains, historical studies, and the input of the people who live around the lake. The following report is the culmination of that effort.

Phosphorus is the primary nutrient of concern since one pound of phosphorus can generate 500 pounds of aquatic plants.

The findings of the project include the following:

- Lake Lansing is a relatively shallow 453-acre lake located in Sections 2,3,10 and 11 of Meridian Township in Ingham County. As one of the few lakes in central lower Michigan, Lake Lansing is heavily used for recreational activities.
- In general Lake Lansing is in good health and the water quality is generally good.
- Historical records indicate that, for many years, the lake has been and continues to be eutrophic (i.e., nutrient-enriched and biologically productive). Phosphorus is the primary nutrient of concern since one pound of phosphorus can generate 500 pounds of aquatic plants.
- Ambient total phosphorus concentrations in the lake are high enough to stimulate excessive plant growth in the lake.
- Internal recycling of phosphorus within Lake Lansing is likely not a significant factor in determining the lake's water quality. External, or watershed sources, appear to be more important.
- The largest controllable sources of phosphorus in the watershed appears to be runoff from residential and urban areas including that which is transported to the lake via storm drains.

- During peak boating times, Lake Lansing is severely overcrowded. During periods of more typical use, the lake is at its threshold for sustaining safe boating. Any additional boating pressure, either from the county park or potentially from keyhole lots, could compromise safety on the lake.
- Lake Lansing area residents identified two major goals in their desire to manage the lake:
  1. Maintain and improve the environmental quality of Lake Lansing and its watershed.
  2. Maintain and improve recreational opportunities and public safety in Lake Lansing and its watershed.
- There are five geographic areas within the Lake Lansing Watershed that are critical for water quality improvement and protection:
  - Storm drainage systems.
  - Riparian residential lands.
  - Other residential lands within the watershed.
  - Wetlands.
  - Undeveloped lands.

The most important management efforts for Lake Lansing's future should include:

- Continue the use of special assessment district with County and Township participation to fund the continued lake maintenance and stewardship of Lake Lansing and its watershed projects.
- Continuing management of aquatic plant growth.
- Continuing lake water quality monitoring.
- Continuing education/information of riparian and watershed home owners, as well as lake users through the Ingham County Park system.
- Physical improvements to lake area storm drains.
- Installation of wetland filters to trap pollutants.
- Establishment of special, "lake area" zoning for redevelopment purposes.
- Wetland purchase and conservation easements.
- Installation of riparian vegetative buffers.
- Natural roadside planting.
- Develop alternative funding methods, possibly grants, to pay for the larger, more permanent, structural projects.
- Reduction of phosphorus and contaminant loading from the watershed area.

The cost estimate to accomplish the desired goals is approximately $60,000 annually for aquatic plant maintenance, water quality monitoring, and educational efforts. To improve the drains, install wetland filters and plant vegetative buffers along the roads and lakeshore could cost between $200,000 and $350,000.

Although Lake Lansing is generally in good health, continued effort is required and much remains to be done to maintain and improve on that quality. So as not to be burdensome in terms of both funding and volunteerism, the general idea moving forward is to continue to seek reasonable five-year special assessment districts through Meridian Township that would pay the maintenance projects, as well as begin work on the longer term issues and structural projects.

Introduction

PROJECT BACKGROUND

Lake Lansing is located in Sections 2, 3, 10 and 11 of Meridian Township in Ingham County (T4N, R1W; Figure 1). For many years, Lake Lansing residents and members of the Lake Lansing Property Owners Association (LLPOA) have taken an interest in the condition and the management of Lake Lansing. In 1998, Meridian Township established a special assessment district (SAD) under provisions of Public Act 188 of 1954 for the purposes of studying water quality, planning and implementing aquatic plant control, and developing a watershed management plan for Lake Lansing over a five-year period. In the spring of 1998, Progressive AE was retained by Meridian Township to provide lake and watershed management services. This report summarizes project activities, findings, conclusions, and provides a plan for future management of Lake Lansing and its watershed.

LAKE LANSING HISTORICAL INFORMATION

As part of the current project, historical water quality studies were compiled and reviewed in 1999. A summary of each report in chronological order is included in Appendix A. Reports and data were collected from the files of: Department of Environmental Quality; Department of Natural Resources; Michigan State University; Ingham County Health Department; Ingham County Parks Department; Ingham County Drain Commissioner; and Lake Lansing Property Owners Association. Considerable information was available on the lake dating back to the early 1900's.

Earlier issues that have been addressed by State and county agencies include: The influences of the former "dump" on the southeast shore; the levels of arsenic in lake sediments and groundwater; the use of waste oil for dust control on Mallard Street; high bacterial levels in the beach area; poor fishing quality; and abundant nuisance aquatic plants. More recently, recreational use pressure and the introduction and spread of exotic plant and animal species have been issues of concern.

The Department of Natural Resources' Fisheries Division files have some of the earliest records for Lake Lansing. The files include: Stocking records; creel census; fish mortality investigations; netting surveys; and some water quality data. Complaints of poor fishing are common in these early records particularly for panfish and black crappie. The primary fish species in the lake has consistently included: Largemouth bass, northern pike, perch, bluegill, pumpkinseed, black crappie, brown and yellow bullheads, and carp. Species' growth rates have generally been equivalent to the state averages but bluegill, pumpkinseed, and particularly black crappie have often been below these averages. In the past carp have been a nuisance sufficient to initiate fishery renovation discussions but in recent years their populations have not been a serious problem. More current data indicate the growth rates for most Lake Lansing fish species are presently at or slightly above state averages.

In addition to poor fishing, early complaints also included nuisance weed growth. A 1922 *State Journal* article headlines the effort to rid Pine Lake, the early name for Lake Lansing, of the nuisance weed crop. In 1955 a plant cutting machine was operated on the lake until controversy terminated the plant cutting effort. In 1957, the lake was treated with sodium arsenite to reduce plant densities. However, until 1941, no data existed to clearly delineate the lake's aquatic plant populations.

In 1941 Dr. Roelofs from Michigan State University did a plant survey of the lake and collected some water quality data. With a few exceptions, the present plant community in Lake Lansing is very sim-

ilar in composition, diversity, and distribution to what Dr. Roelofs found in 1941. The exceptions include the introduction of two exotic species, Eurasian milfoil and curlyleaf pondweed, and the loss of offshore and shoreline emergent plant species. Except for the southern end of the lake, most shoreline areas are now lawns and seawalls. Dr. Roelofs' limited water quality data and Secchi disk transparencies are also similar to current values.

Historical water quality and aquatic plant data suggest that Lake Lansing has been a eutrophic lake for some time. After Lake Lansing was dredged in 1978, Mikula (1985) reported some improvement in water quality conditions. Certain parameter values were characteristic of mesotrophic lakes, while others remained indicative of eutrophic waters. Citizen complaints of poor water quality, inferior fishing, and abundant aquatic plants are fairly typical in eutrophic lakes.

In addition to influencing water quality, the dredging project also probably impacted recreational use. In 1971 Szlachetka wrote a paper suggesting that the rehabilitation of Lake Lansing by dredging would increase boating pressure and suggested ways to regulate boating activity. In recent years, the County Parks Department has maintained records of boat launches and park use. In 1998 the

Figure 1. Project location map.

LLPOA conducted a preliminary riparian boat count and use survey. Urban development in the watershed has increased demand for recreational use at the lake and concern for declining water quality.

Keck's (1977) hydrologic budget for the lake suggested that surface runoff to the lake was minimal. McNabb et al. (1982) found the small streams entering the lake to be a minor component of the nutrient budget. Atmospheric loading was the most significant external source of phosphorus for the lake.

SUMMARY OF CURRENT PROJECT ACTIVITIES

The current project has consisted of water quality monitoring, aquatic plant control, and watershed management planning. In addition, the SAD conducted a series of visioning sessions throughout 2001 to seek public opinion and define long-term goals and objectives.

Water quality monitoring included baseline, storm drain, and intensive monitoring. Baseline monitoring conducted in 1999 and 2000 was used to characterize the current condition of Lake Lansing and to compare with historical data. Storm drain monitoring conducted in 1999 was used to prioritize pollutant loadings. Intensive monitoring of temperature and dissolved oxygen in 2000 was used to determine the potential for internal phosphorus loading within Lake Lansing.

Aquatic plant control in Lake Lansing has focused on the control of the nuisance exotic plants Eurasian milfoil (*Myriophyllum spicatum*) and curlyleaf pondweed (*Potamogeton crispus*). Whole-lake herbicide treatments with fluridone were conducted in 1998 and 2001. In other years, nuisance plant growth was treated with a combination of 2,4-D, contact herbicides, and algacides.

Watershed management work included watershed mapping, a storm drain and watershed survey, a boat survey conducted by the LLPOA, a nutrient budget analysis, and an imperviousness analysis.

In addition, the SAD convened a series of meetings in 2001 to acquire public input on goals and strategies for future management efforts. The culmination of this effort, along with recommendations from the consultant, is contained in this lake and watershed management plan.

LAKE AND WATERSHED CHARACTERISTICS

PHYSICAL CHARACTERISTICS

A summary of the physical characteristics of Lake Lansing is shown in Table 1. A depth contour map of the lake is shown in Figure 2. Despite dredging in 1978, Lake Lansing is shallow. The mean, or average, depth of the lake is less than 9 feet. The littoral zone, or area of the lake inhabited by plants, is generally to a depth of 10 to 15 feet. Therefore, Lake Lansing's littoral zone extends over 282 to 419 acres of the lake bottom, which represents approximately 62% to 93% of the lake's total area.

The lake shoreline is 3.8 miles long and it has a shoreline development factor of 1.3. The shoreline development factor indicates the degree of irregularity in the shape of the shoreline. That is, compared to a perfectly round lake with the same surface area (i.e., 453 acres), Lake Lansing's shoreline is 1.3 times longer because of the irregular shoreline shape.

TABLE 1
LAKE LANSING PHYSICAL CHARACTERISTICS

Lake Surface Area	453	acres
Maximum Depth	35	feet
Mean Depth	8.8	feet
Littoral zone, from shore to depth of:		
10 feet	282	acres
15 feet	419	acres
Lake Volume	3,963	acre-feet
Shoreline Length	3.8	miles
Shoreline Development Factor	1.3	
Lake Elevation		
December 1 to February 28	851.72	feet
March1 to May 31	852.29	feet
June 1 to November 30	852.08	feet
Watershed Area	2,074	acres
Ratio of Lake Area to Watershed Area	1 : 4.6	

Comparing Lakes

Clinton County:	
Lake Ovid	412 acres
Park Lake	178 acres
Rose Lake	27 acres

Comparing Watersheds

Orchard Lake, Oakland County	
Lake Area	796 acres
Watershed Area	810 acres
Lake:Watershed	1: 1
Pentwater Lake, Oceana County	
Lake Area	483 acres
Watershed Area	106,000 acres
Lake:Watershed	1: 220

Figure 2. Lake Lansing depth contour map. Depth contour map prepared by Michigan Department of Natural Resources (DNR) based on survey and soundings conducted by Engineering and Land Resource Programs Divisions of the DNR from April 24 to May 10, 1984.

Lake Lansing is one of only a few lakes in south-central Michigan (Figure 3). Lakes become more numerous approximately 30 miles to the south and east in Livingston, Oakland, and Jackson counties. Given its size, proximity to major population centers, the paucity of lakes in the region, and the presence of a public boat launch and park areas, Lake Lansing receives intense recreational use.

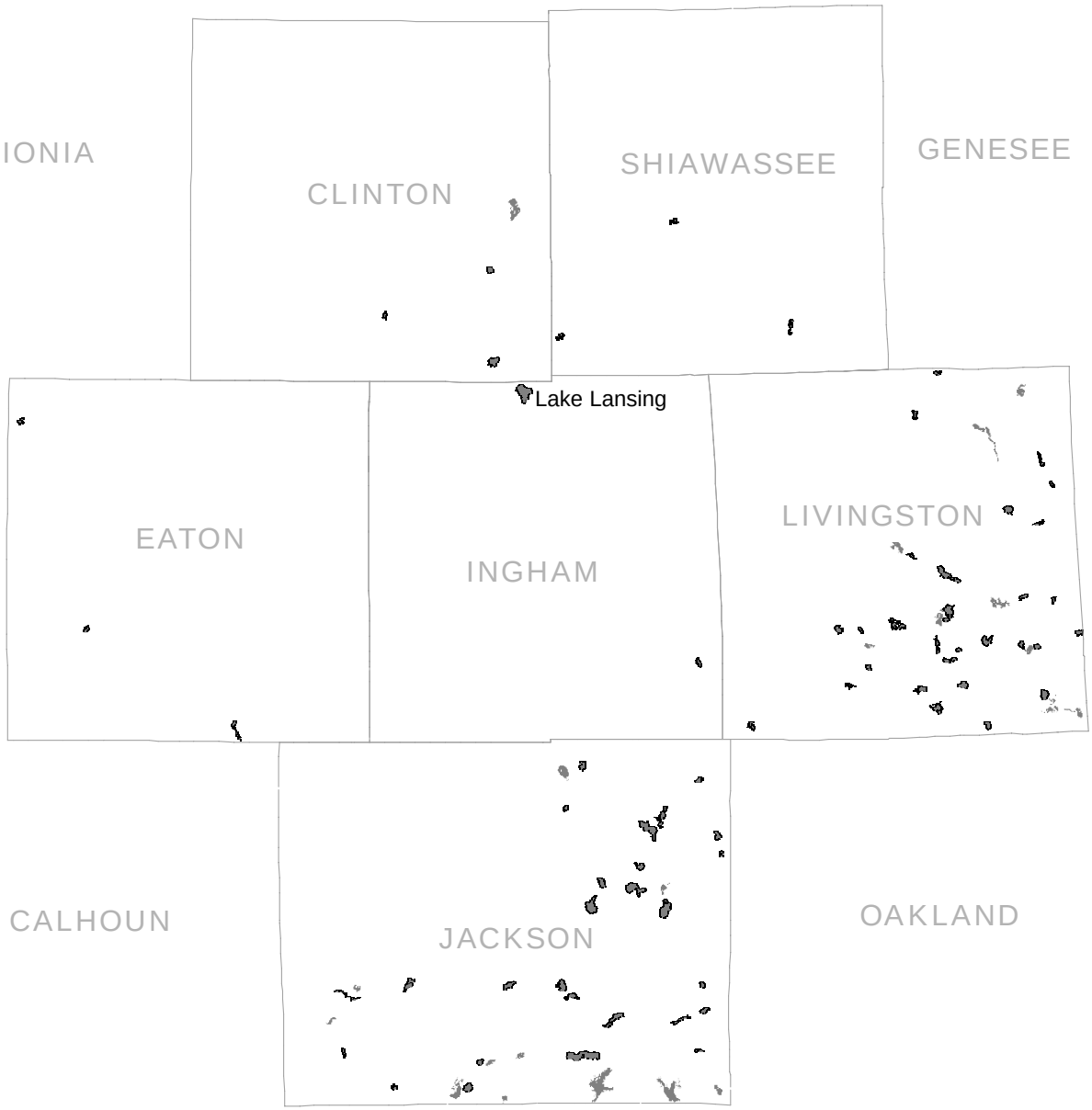

Figure 3. Location map of lakes larger than 50 acres in Lake Lansing vicinity. The population within an approximate 50-mile radius of the lake exceeds 800,000. (Source: U.S. Census.)

The land surrounding a lake that drains to the lake is called its watershed or drainage basin. Lake Lansing's 3-square-mile watershed is moderately-sized with an area just under 5 times the size of the lake itself (Figure 4). The majority of the watershed is contained within Meridian Township in Ingham County, but a portion extends into Bath Township in Clinton County.

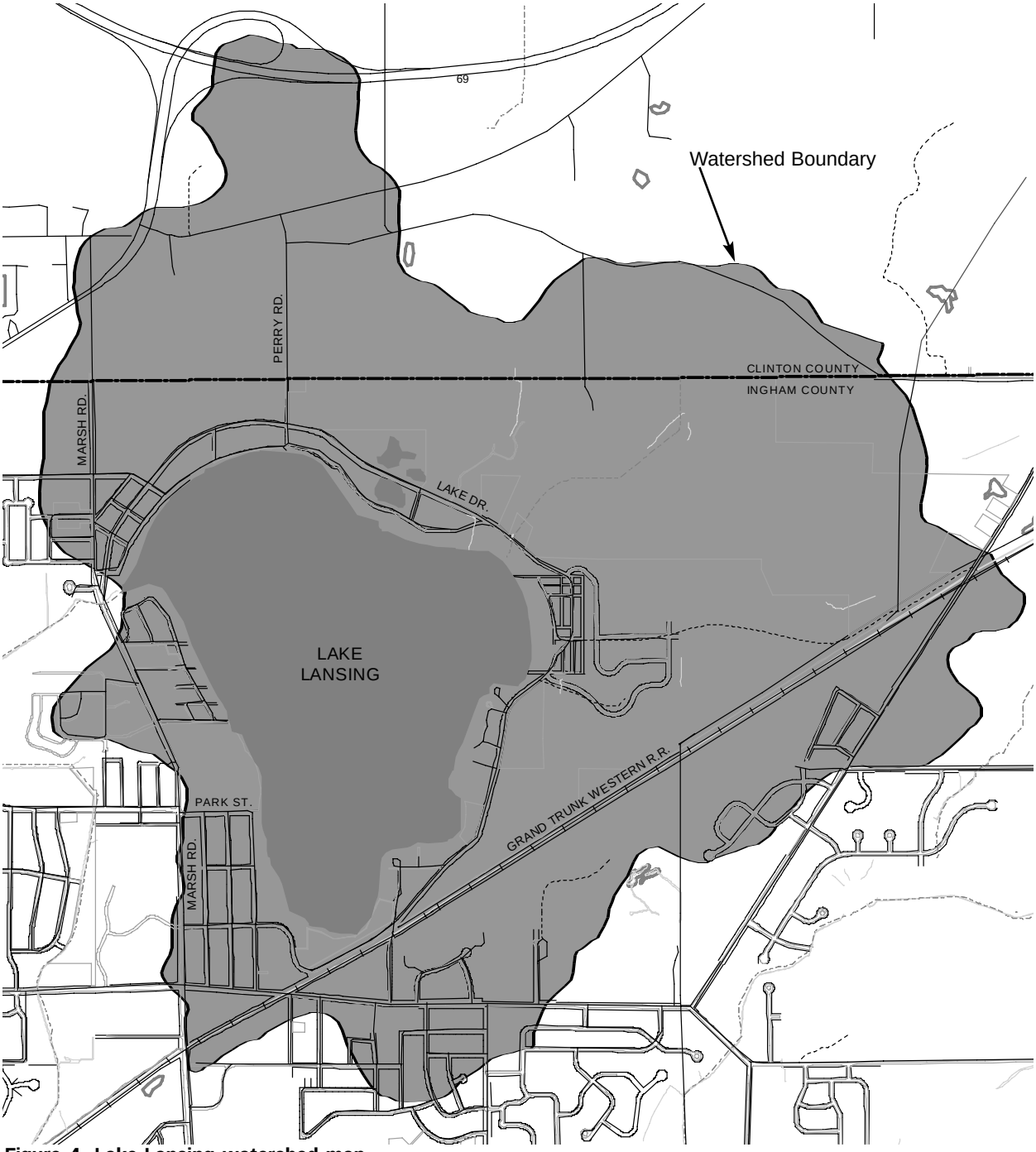

Figure 4. Lake Lansing watershed map.

TRIBUTARIES AND DRAINS

There are approximately 17 tributaries to Lake Lansing, most of which are storm drains (Figure 5) which have very low or no base flow. On March 29, 1999, members of the SAD and staff from Progressive surveyed the Lake Lansing storm drains (Appendix Table A1). At the time of the survey, water was not flowing in most of the drains, or discharge was extremely low. In April of 1999 and 2000, the SAD collected storm drain samples (Appendix Table B5). Sampling and surveys indicate storm sewers are not currently a significant source of pollutant loading to the lake when compared with other sources (primarily, atmospheric loading). However, storm sewers can have a significant local effect. That is, phosphorus may cause rooted plant growth at the point of the storm sewer outfall, but the impact on the lake as a whole is minimal. In addition, fecal coliform counts have been high at some sampling location. Given the importance of storm drains in promoting localized plant growth and as a source of bacterial contamination, storm drain improvements are discussed in the management plan section of this report.

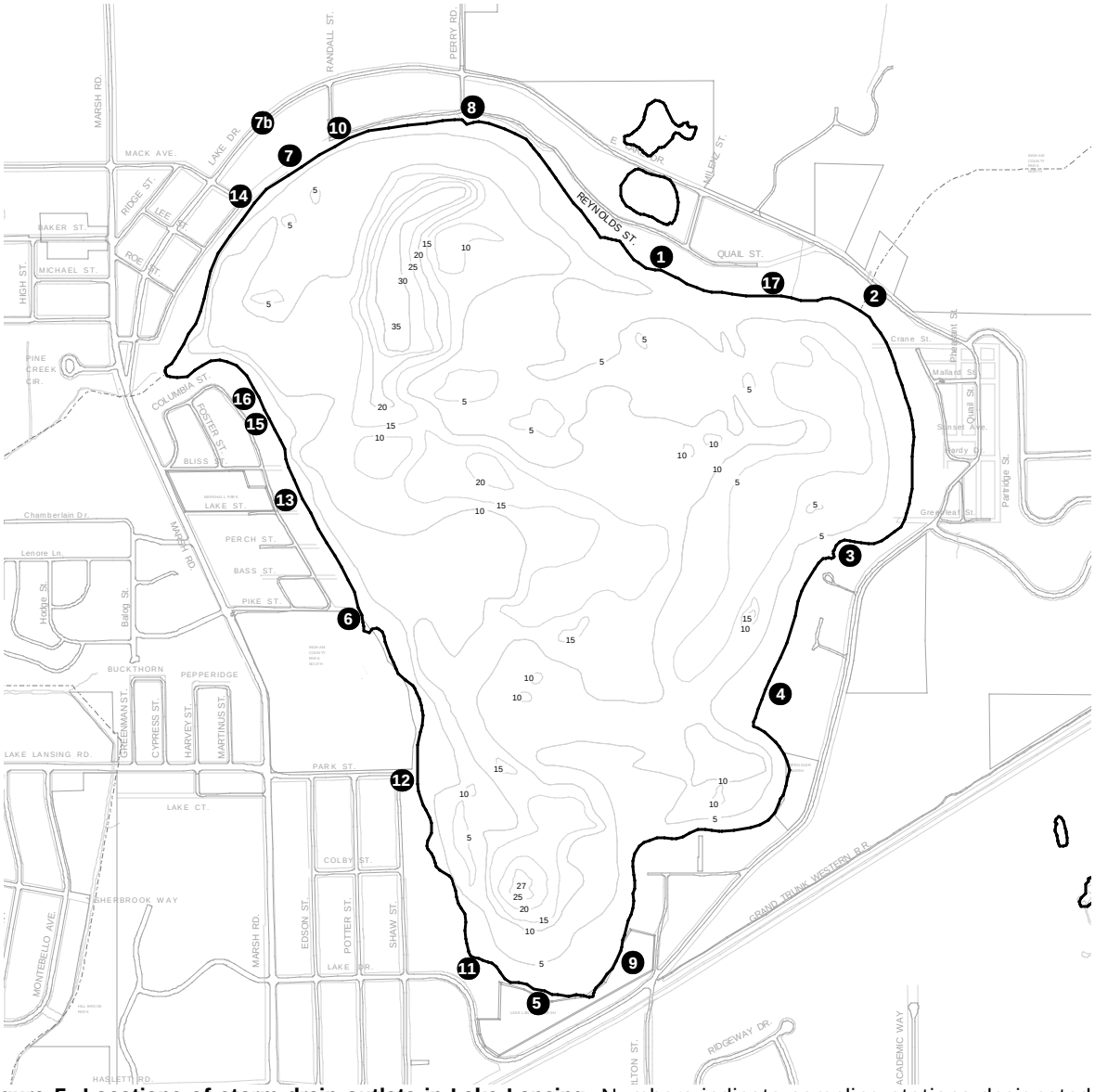

Figure 5. Locations of storm drain outlets in Lake Lansing. Numbers indicate sampling stations designated by Lake Lansing Property Owners Association.

TOPOGRAPHY

Topography in the Lake Lansing watershed is relatively flat throughout (Figure 6). The highest elevations in the watershed are approximately 30 feet above the lake. Much of the watershed contains wetlands at nearly the same elevation as the lake that drain lakeward in a slow, sheet-flow pattern.

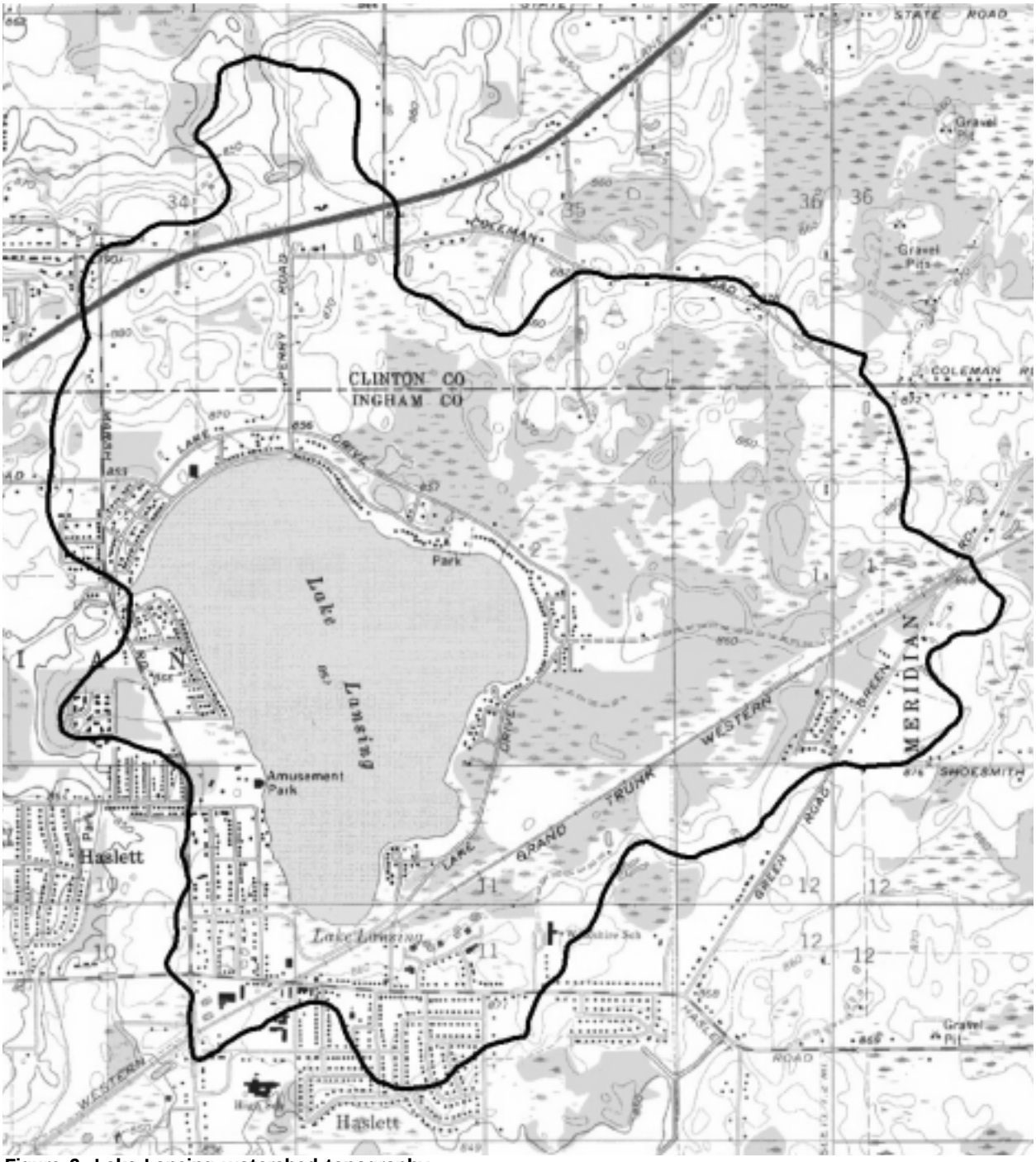

Figure 6. Lake Lansing watershed topography.

LAND USE

The predominant land uses in the watershed are residential, wetlands, and open or undeveloped land (Table 2; Figure 7). Like many lakes, much of the residential land in the watershed is concentrated around the shoreline. From a water quality perspective, the presence and extent of wetlands in the watershed is beneficial in providing filtration of nutrients, sediments, and other pollutants. Open, undeveloped lands are also beneficial in that pollutant runoff from these lands is minimal. Given the development pressures in and around the watershed, preservation of open space is important in protecting the quality of Lake Lansing.

TABLE 2
LAKE LANSING WATERSHED LAND USE

Land Uses	Acres	Percent of Total
Agriculture	111	5%
Residential	670	32%
Commercial	57	3%
Industrial	17	1%
Forested	15	1%
Open Field	576	28%
Barren	37	2%
Wetlands	591	28%
Total	2,074	100%

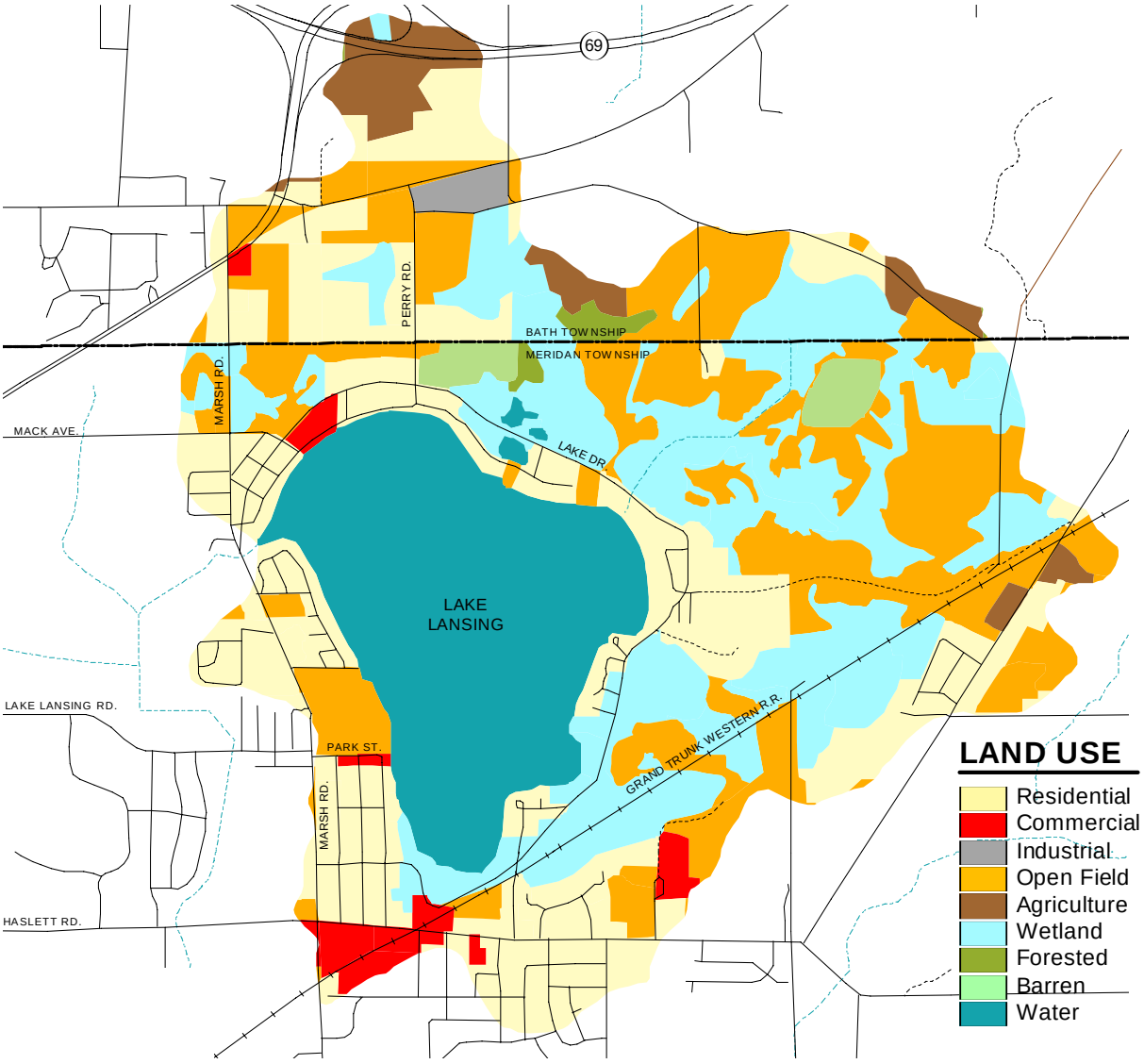

Figure 7. Lake Lansing watershed land use map.

SOIL TYPES

Soils mapping indicates most of the soils in the immediate shorelands are either muck soils (indicative of wetlands) or are fill soils (Figure 8). Thus, most of the Lake Lansing shoreland was wetland and has either remained as wetland or was filled to accommodate development. The remainder of the soils are sand and loam mixtures.

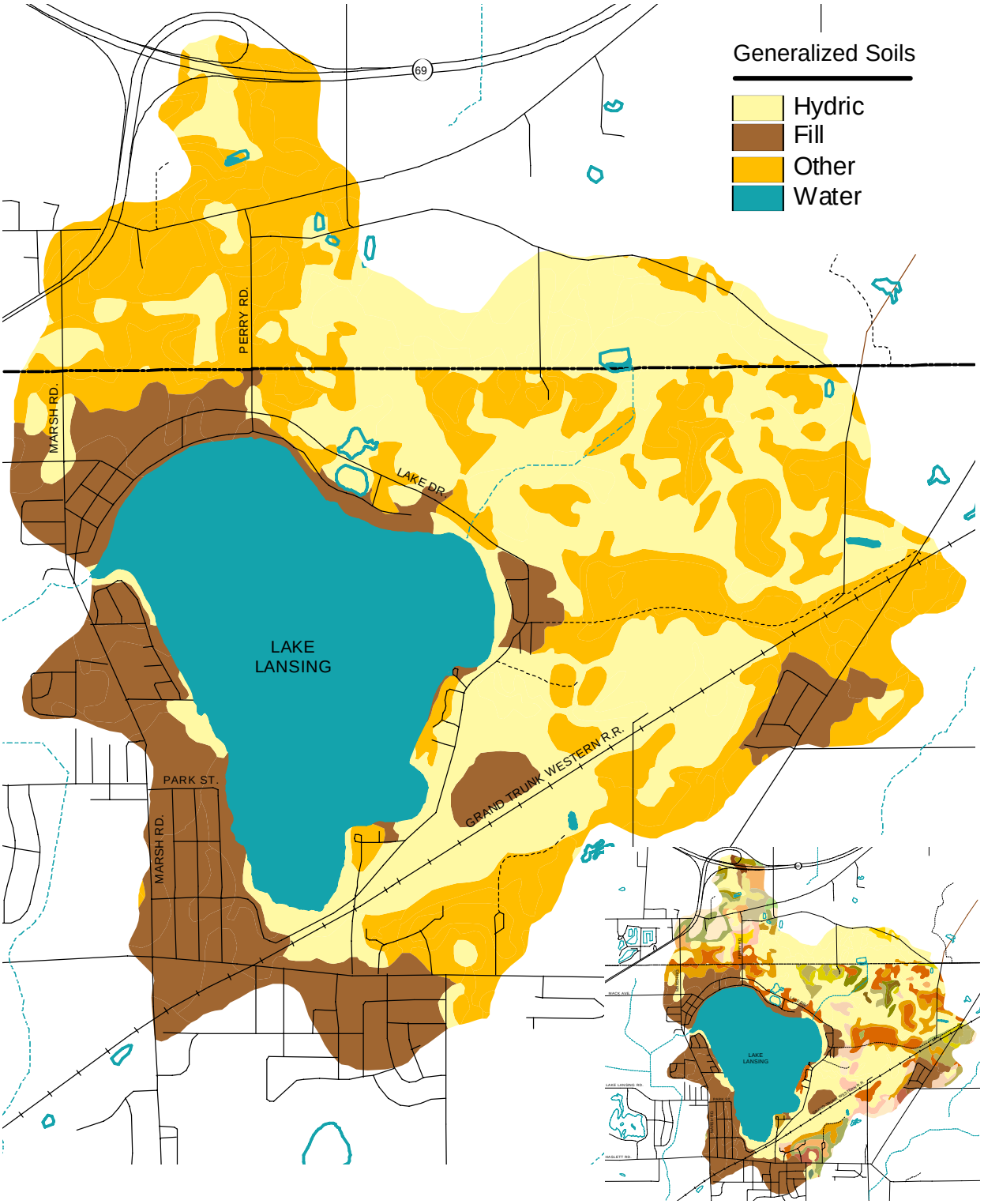

Figure 8. Lake Lansing generalized watershed soils map. Generalized map groups together all non-hydric and non-fill soils into the "other" category. Inset figure does not group other soils.

RAINFALL CHARACTERISTICS

The average total precipitation for the East Lansing area is approximately 30 inches per year and the average snowfall is approximately 40 inches per year. Precipitation varies seasonally with more than half falling in the period April through September. Figure 9 shows that the total annual precipitation (since 1980) varies considerably from year to year.

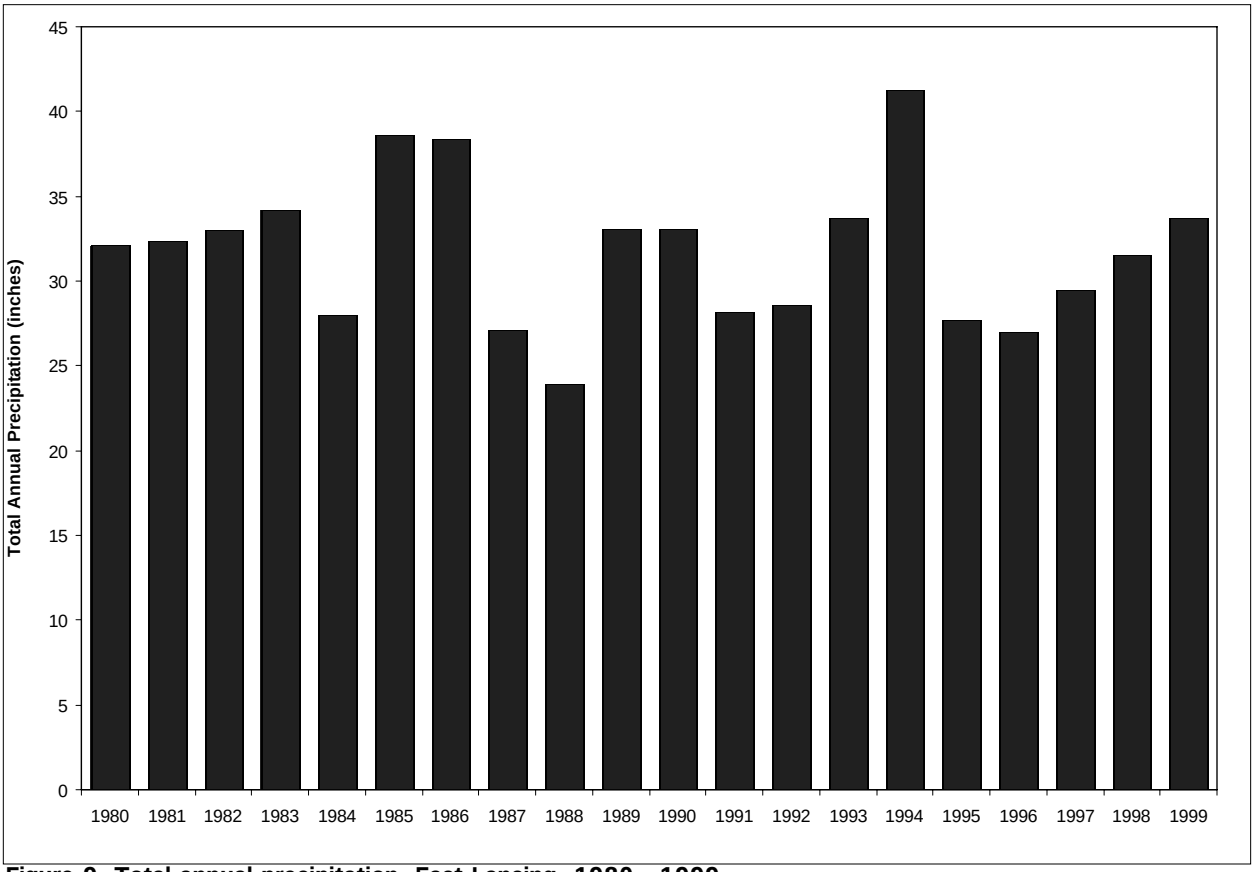

Figure 9. Total annual precipitation, East Lansing, 1980 - 1999.

WATER QUALITY

Water quality monitoring as part of the current program was started in March of 1997. Samples were collected in spring and late summer from the two deep basins in Lake Lansing along with two shoreline locations and the tributary stream on the northeast side of the lake (Figure 10 and Appendix B). In addition, volunteers from the LLPOA collected samples from some of the storm drains during storm events in 1999 and 2000. Water quality sampling results are summarized in Figures 11 through 13.

Current deep basin water quality data confirms historical reports that Lake Lansing is borderline between mesotrophic (moderately productive) and eutrophic (highly nutrient-enriched and productive). The average springtime deep basin total phosphorus concentration was 21 µg/L, or parts per billion. At levels above 20 parts per billion, lakes are highly nutrient-enriched and can support abundant plant growth. There was a slight build-up of phosphorus in the deep waters concurrent with a decrease in dissolved oxygen. Water clarity, as measured by Secchi transparency, was moderate to poor. Chlorophyll-*a* concentrations indicate algal growth was moderate to low at the time of sampling.

Figure 10. Lake Lansing water quality sampling locations, 1999 and 2000.

In 2000, Lake Lansing was monitored more extensively for temperature and dissolved oxygen in order to determine the potential for internal phosphorus loading in the lake. Measurements were made at several depths and numerous locations throughout the lake on seven dates from May 12 through September 15, 2000. Dissolved oxygen sampling indicates the lake's two deep basins became anaerobic in early June and remained so through September. During this period, the deep basins were stratified with a warmer, oxygenated layer at the top and a cooler, anaerobic layer at the bottom. The extensive shallow regions of the lake did not stratify and remained warm and well oxygenated. Thus, the potential for internal phosphorus release was restricted to the deep anaerobic zones, or a total of about 20 acres of the 453-acre lake. Based on these data and observations, it appears that internal loading is not a significant source of phosphorus to Lake Lansing.

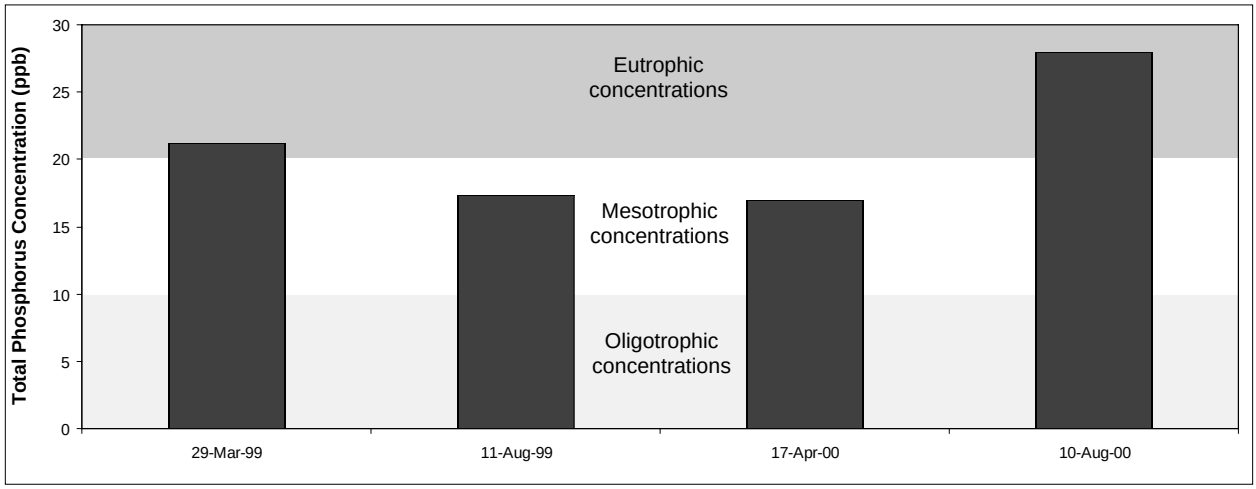

Figure 11. Volume-weighted average total phosphorus concentrations, 1999 and 2000.

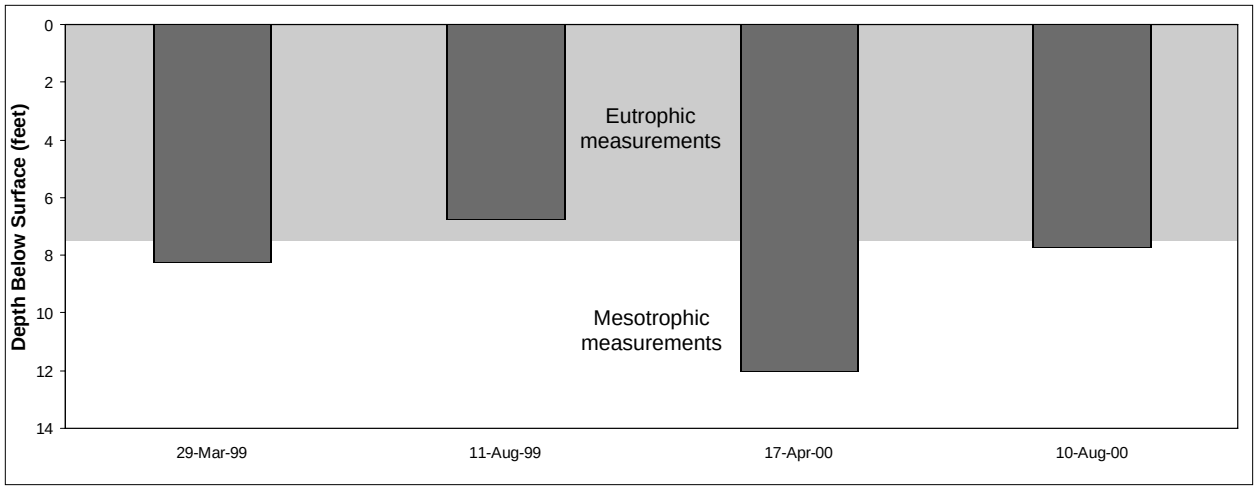

Figure 12. Average Secchi transparency measurements, 1999 and 2000.

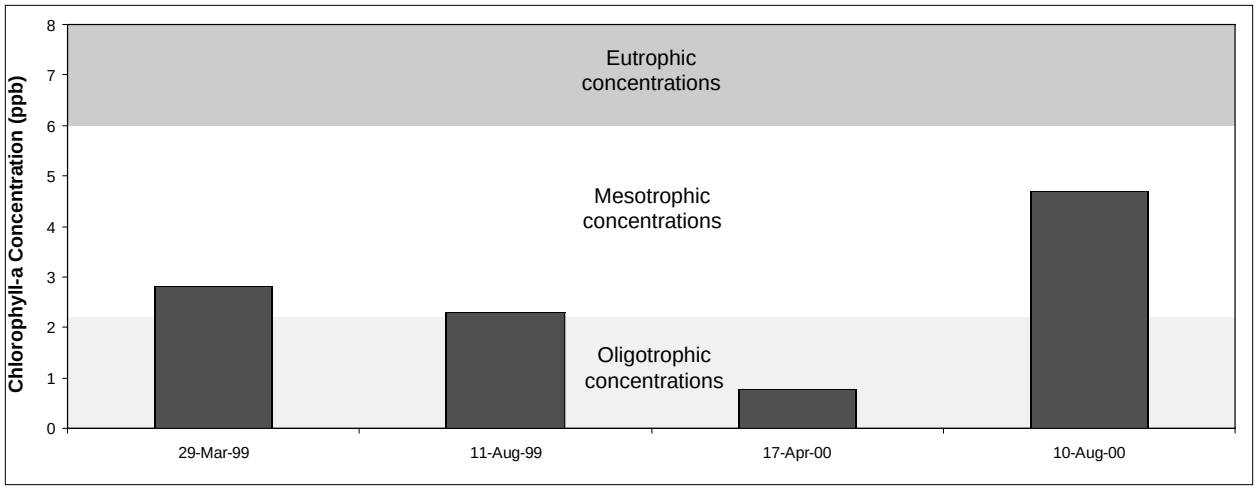

Figure 13. Average chlorophyll-*a* concentrations, 1999 and 2000.

The storm drain samples were analyzed for total phosphorus and *Escherichia coli* (*E. coli*), a bacteria commonly associated with fecal contamination. All of the phosphorus concentrations were above the 20 parts per billion eutrophic threshold. Sites 5, 8, and 14, shown in Figure 5, exceeded the current State of Michigan public health single-sampling-event standard of 300 *E. coli* per 100 milliliters of water. The fecal coliform count for site 14, Mack Street, was extremely high at 34,000. These data suggest that the concentration of pollutants that enter Lake Lansing from the watershed can be high. Although pollutant concentrations in the drains can be high, the volume of water entering the lake from the drains tends to be low, thus overall pollutant loading to the lake from the drains tends to be low. However, nutrients and sediments in stormwater promote localized plant growth in the vicinity of the drain outfalls, and therefore should be addressed as part of the overall management plan.

COMMUNITY PROFILE

Lake Lansing is located in one of the more urbanized areas of the state. The population within an approximate 50-mile radius of the lake exceeds 800,000 (Table 3). Commensurate with urbanization is an increase in hard surfaces for housing, infrastructure, and commercial and industrial developments. As such, stormwater quantity increases, quality decreases, and flooding can occur where detention or retention of stormwater is not adequate. Another symptom of urbanization, particularly for Lake Lansing, is the pressure on the lake for use and access.

TABLE 3
LAKE LANSING AREA POPULATION (BASED ON 2000 CENSUS)

Meridian Township	39,116
Bath Township	7,541
Ingham County	279,320
Clinton County	64,753
Shiawassee County	71,687
Livingston County	156,951
Jackson County	158,422
Eaton County	103,655
6-County Total	834,788

NUTRIENT BUDGET

A nutrient budget is an estimate of the amount of nutrients entering a lake from its various sources. Phosphorus (rather than nitrogen or carbon) is the nutrient that controls plant growth in Lake Lansing; additional inputs of phosphorus to the lake can theoretically generate 500 times its weight in living plants (Wetzel 1983). That is, each pound of added phosphorus could result in 500 pounds of plants.

McNabb et al. (1982) measured phosphorus inputs to Lake Lansing from June of 1978 to June of 1979 from wetland streams (77 pounds), street drains (4 pounds), and atmospheric deposition (165 pounds), as well as the quantity leaving the lake through the outlet (13 pounds). They also estimated groundwater seepage of phosphorus from the net volume of seepage and the concentrations of total dissolved phosphorus in wetland streams during the time of seepage for a total of 22 pounds. Thus, the total of 268 pounds entering the lake and 13 pounds leaving the lake results in a net input of 255 pounds of phosphorus into Lake Lansing. Atmospheric deposition accounted for the majority of inputs in the 1978-79 study. Because of the difficulty in measuring phosphorus in overland runoff that drains directly to the lake, this estimate was not included in the McNabb study.

One way the phosphorus load in overland runoff can be estimated is by constructing a theoretical nutrient budget based on land use and phosphorus runoff coefficients. That is, for various types of land uses, measurements of the amount of phosphorus that runs off over the land have been reported in the scientific literature. Using these measured rates of phosphorus runoff from other studies, a theoretical estimate can be made of the quantity entering Lake Lansing from the different land uses as well as the atmosphere. Based on this method, the estimated load of phosphorus to Lake Lansing is shown in Table 4.

TABLE 4

LAKE LANSING THEORETICAL PHOSPHORUS BUDGET CALCULATION

Source	Area (acres)	Phosphorus Loading Rates (lbs/acre/yr)	Phosphorus Load (lbs/yr)	Percent of Total Load
Agriculture	111	0.8	89	10%
Residential	599	0.7	419	48%
Lakeside Residential	71	0.3	21	2%
Commercial	57	0.9	51	6%
Industrial	17	0.9	15	2%
Forested	15	0.1	1	0%
Open Field	576	0.2	115	13%
Barren	37	0.5	19	2%
Wetland	591	0	0	0%
Atmospheric	453	0.3	140	16%
Total			871	100%

The theoretical phosphorus loading estimate is approximately 3½ times greater than McNabb's estimate, primarily due to the high residential loading rates in the theoretical budget which includes new residential subdivisions. Some of the residential runoff would have been measured by McNabb et al. in the street drains and in the groundwater seepage, which are not estimated separately in the theoretical budget. The two atmospheric estimates are nearly identical. Although the theoretical estimate of wetland runoff is zero, there are times of the year when the wetlands do release phosphorus. In theory, the annual net loading is zero because at other times of the year the wetlands may actually trap and hold phosphorus from upland areas.

Though the two estimates differ in magnitude, they are instructive in a few respects. First, atmospheric loading is significant, but is not a source of loading that can be managed at the local level. Second, storm sewers are not currently a significant source of loading when compared with other sources. However, storm sewers can have a significant local effect. That is, phosphorus may cause rooted plant growth at the point of the storm sewer outfall, but the impact on the lake as a whole is less significant. Third, whether net wetland runoff is zero or positive is inconsequential because the management conclusions and recommendations will still be the same: wetland runoff is natural; wetlands are beneficial to lake water quality for many reasons; wetlands should continue to be protected legally (by state law and local ordinance) and through educational efforts. Last, the largest controllable source of phosphorus to Lake Lansing is residential runoff. The greatest benefit to Lake Lansing will be derived from continued vigilance in minimizing phosphorus fertilizer use and by establishing shoreline vegetative buffers. In fact, based upon LLPOA surveys of first-tier residential property owners, it is estimated that the rate of phosphorus loading from first-tier properties is less than half of other residential land due to low rates of phosphorus fertilizer use.

Watershed Imperviousness

As land is developed for residential, commercial, and industrial uses, the ground becomes sealed with impervious surfaces like pavement and concrete in order to build roads, rooftops, sidewalks, curbs, parking lots, etc. These impervious surfaces do not allow the rainwater or snow melt to percolate into the ground. Instead, the precipitation runs off the hard surfaces, eventually flowing downstream to a body of water. Generally, these hard surfaces contain many pollutants, such as nutrients, sediments, fecal bacteria, and toxic substances such as heavy metals and pesticides. As stormwater washes over the hard surfaces, the pollutants are washed downstream to the receiving water body. If the amount of imperviousness in a watershed is low, then a water body may be protected from improper development through a variety of planning and zoning techniques.

At present, imperviousness in the Meridian Township portion of the Lake Lansing watershed is approximately 236 acres, or 15 percent, as shown in Table 5. The imperviousness analysis was restricted to the portion of the watershed within Meridian Township because digital parcel information was available for the township. Most of the developable lots are currently zoned at the lowest possible density of 40,000 square feet per lot as Rural Residential, and much of the developable land is located far from the lake with large expanses of wetland in between. Thus, it appears new development would have moderate impact on Lake Lansing's water quality.

TABLE 5

IMPERVIOUSNESS ESTIMATE FOR MERIDIAN TOWNSHIP PORTION OF LAKE LANSING WATERSHED

	Land Use (acres)	Percent Imperviousness	Total Imperviousness (acres)
Agricultural	11	10%	1
Barren	37	15%	6
Commercial	54	85%	46
Forested	4	10%	0
Open Field	449	10%	45
Residential			
0 - 0.12 acres	23	70%	15
0.13 - 0.25	123	40%	47
0.26 - 0.3	83	30%	25
0.4 - 0.5	59	30%	15
0.5 - 1.0	66	20%	13
>1	161	15%	24
Wetland	495	0	0
Total	1,553		236

Unlike new development, redevelopment of existing residential areas does have a greater potential to adversely impact Lake Lansing's water quality. That is, when property owners construct additions to an existing home or, more significantly, replace an existing cottage with a larger home, then the amount of imperviousness on a lot increases, and the stormwater has the potential to run directly into the lake. The impact of increased imperviousness is greater because of the proximity of the existing development to Lake Lansing. Thus, zoning provisions to limit imperviousness within the watershed, particularly in the residential zone immediately surrounding Lake Lansing, would be beneficial.

Microbial Pollutants

In addition to nutrients which can cause increases in plant growth, certain microorganisms can also be present in runoff. The presence of some microbes is a concern since they can cause illnesses such as diarrhea or skin rashes. There are many different types of disease-causing microbes in runoff and are derived from human sewage (i.e., illicit storm sewer connections or failing septic systems) or from non-human sources (i.e., pets, livestock, waterfowl, and wildlife). In general, contamination from human sewage tends to raise microbial concentrations to extremely high levels (in the hundreds of thousands or millions) while non-human fecal contamination is generally lower by an order of magnitude. Systematic sampling is needed to determine the type and source of microbial contamination. Sampling in Lake Lansing thus far indicates that microbial contamination does occur, but not on a consistent basis. Based on the concentrations measured, it appears that the likely sources are pet waste, waterfowl, and wildlife, rather than human waste. The problem of pet waste is best managed by educating watershed residents about the importance of pet waste clean-up and proper disposal, or regulating the activity by ordinance. There are a number of ways to address waste from waterfowl, particularly geese, but one of the more promising methods is by replacing lawn or turfgrass (the preferred goose habitat) with natural, high-growing plants which tend to repel the geese. A natural vegetative buffer will not only reduce runoff into the lake but apparently will discourage geese from frequenting lakeside properties. Other techniques include removing the geese or eggs.

RECREATIONAL CARRYING CAPACITY

Under various conditions in 1999 and 2000, the LLPOA collected information regarding the number of boats docked on shore (Figure 14) and the number of boats using the lake (Figures 15 and 16). The maximum number of boats docked on shore was 416, counted on September 3, 1999. The remainder of the carrying capacity discussion will focus on the 2000 data because of its larger data set.

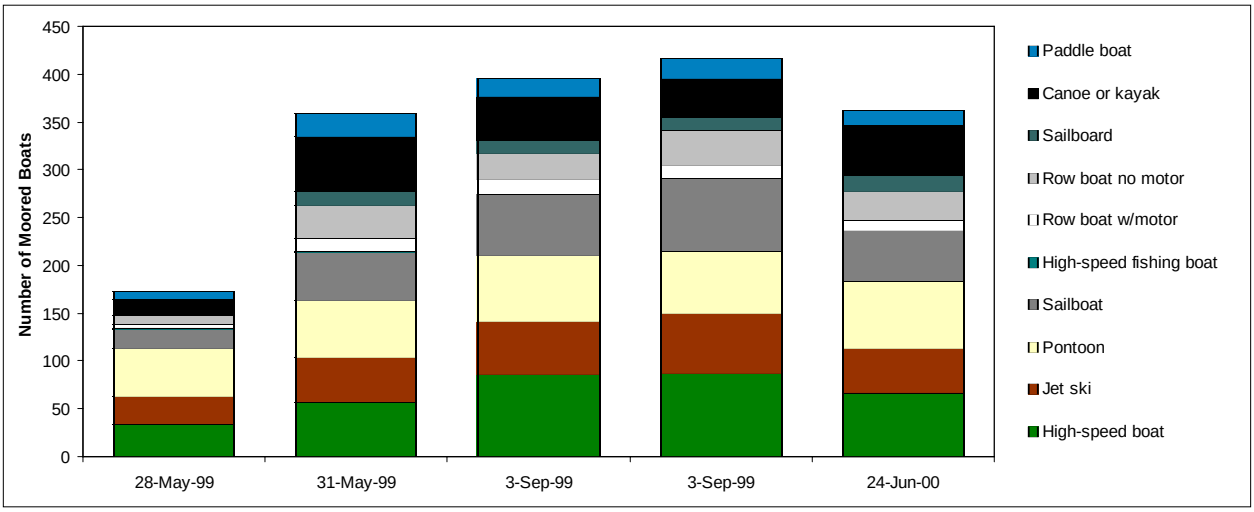

Figure 14. Lake Lansing 1999 and 2000 moored boat data. Two counts were made on September 3, 1999; one at 7:45 a.m. and another at 8:15 p.m.

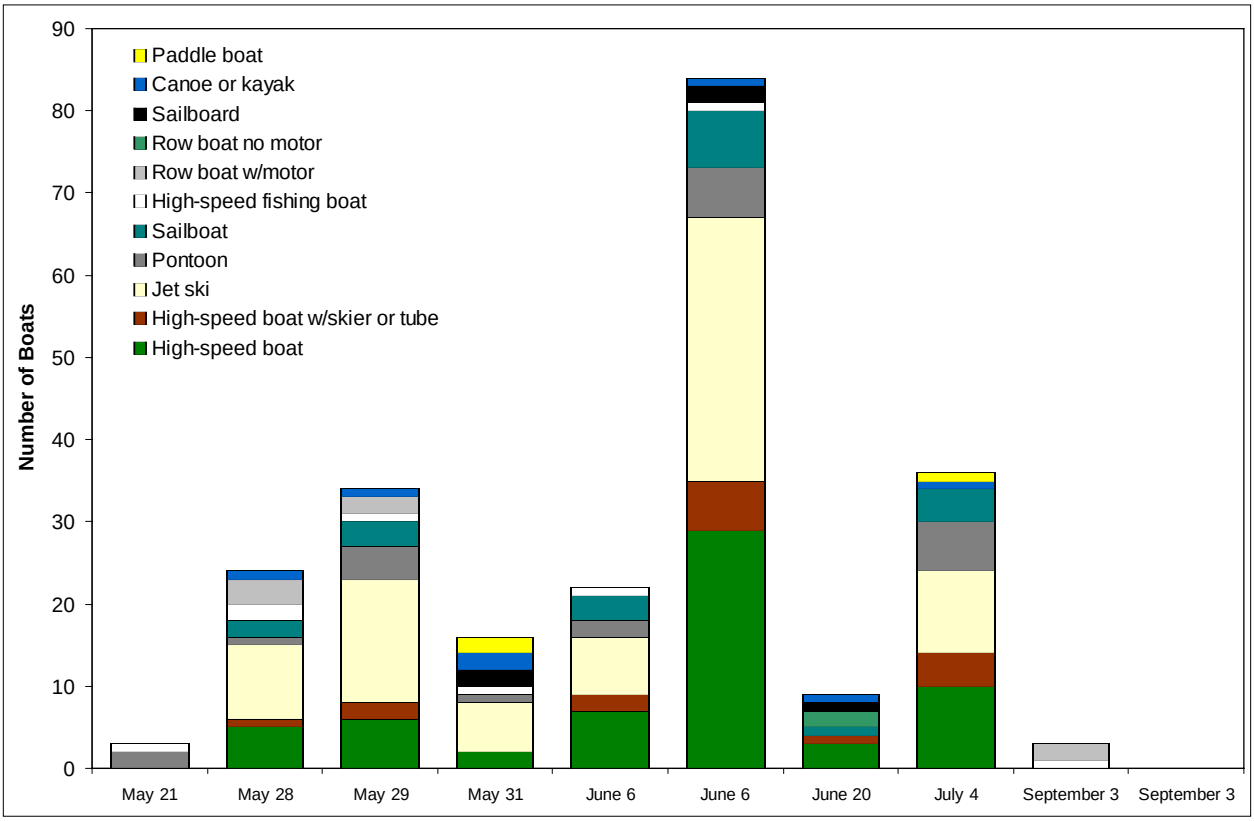

Figure 15. Lake Lansing 1999 boat use data.

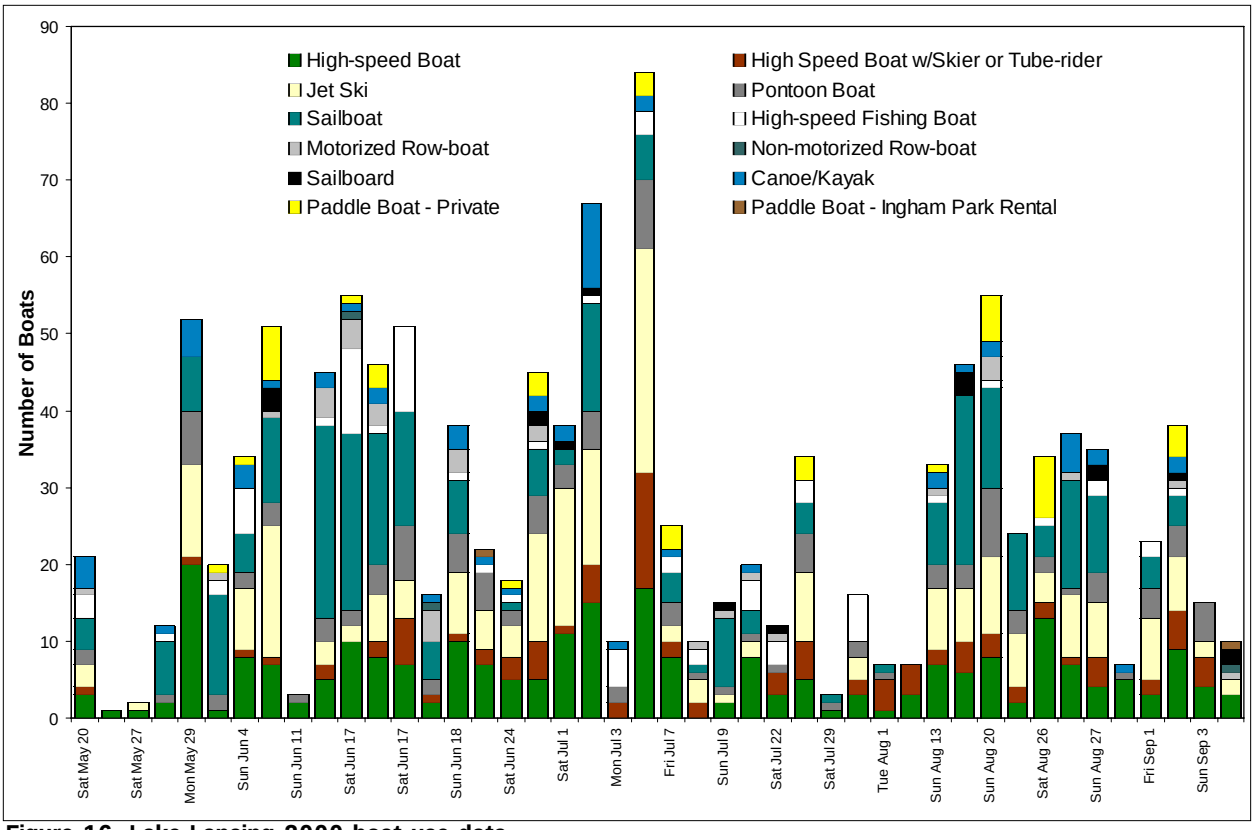

Figure 16. Lake Lansing 2000 boat use data.

A total of 44 counts were made on 36 different dates from May 20 through September 4, 2000 on the following days of the week: Sunday = 21 counts; Saturday = 18 counts; Friday = 7 counts; Monday = 4 counts; Tuesday and Wednesday = 2 counts each. Counts were made on the three summer holidays: Memorial Day, the Fourth of July, and Labor Day. Counts were made between 11:30 a.m. and 8:00 p.m. Most counts (75 percent) were made between 2:30 p.m. and 5:00 p.m. Sailboat races occurred during seven of the counts. The county sheriff marine patrol was present on the lake during six of the counts.

At any given time, most of the boats on Lake Lansing are either high-speed boats (20 percent), jet skis (i.e., personal watercraft; 17 percent), sailboats (15 percent), or pontoon boats (10 percent). On average, approximately 8 percent of the moored boats use Lake Lansing at any given time. Approximately 40 percent of all boats on the lake, including jet skis (personal watercraft), are from the public boat launch. Of the personal watercraft on the lake, 80 percent are from the public boat launch. Approximately 30 percent of the boats launched from the public access site are personal watercraft.

Table 6 provides a summary of the 2000 boat count data. The maximum number of boats counted at one time was 84 at 2:30 p.m. on July 4. The mean, or average, is 28 ± 19 boats at any given time on Lake Lansing. Overall, the distribution of the boat count data is skewed in that most (75 percent) of the totals are 40 or less (Figure 16); of the 44 boat counts made, only 11 counts exceeded a total of more than 40 boats on Lake Lansing at one time. With skewed data, it is more appropriate to examine the median counts than the numerical averages. The median value for the 2000 boat count data is 24 boats at any given time on Lake Lansing. In general, then, each boat has just under 19 acres of lake area. However, on the peak use day of July 4, the area for each boat decreased to just over 5 acres.

TABLE 6

LAKE LANSING 2000 BOAT COUNT SUMMARY STATISTICS

	Minimum	Maximum	Median	Mean	Standard Deviation
High-speed boat	1	20	5	6	4
High-speed boats with water skiers or inner tube-riders	0	15	2	3	3
Jet ski (personal watercraft)	1	29	7	7	6
Pontoon boat	1	9	3	3	2
Sailboat	1	25	7	8	7
High-speed fishing boat	1	11	2	3	3
Motorized rowboat	1	4	1	2	1
Non-motorized rowboat	1	1	1	1	0
Sailboard	1	3	2	2	1
Canoe/kayak	1	11	2	2	2
Paddleboat - private	1	8	3	3	2
Paddleboat - Ingham Park rental	1	1	1	1	0
Counting Event Totals	1	84	24	28	19

The estimate of 19 acres available per boat under average conditions does not take into account factors that reduce boating area. According to the Marine Safety Act (Part 801 of Act 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 . . ." Such a slow–no wake zone in Lake Lansing encompasses approximately 50 of the lake's 453 acres and reduces the available boating area from 19 to 17 acres per boat on an average day.

Estimates on the number of acres required for safe boating range from about 5 acres to over 30 acres per boat, generally depending upon the type of boat (Jaakson et al. 1989; Warbach et al. 1994). Using a mid-range estimate of 20 acres per boat, Lake Lansing is at its recreational carrying capacity during typical conditions.

These data suggest that during peak boating times, Lake Lansing is severely overcrowded. During periods of more typical use, the lake is at its threshold for sustaining safe boating. Any additional boating pressure, either from the county park or from keyhole lots, could compromise safe use of the lake. (A keyhole lot is a lakefront lot that provides riparian access to backlots located away from the lake's edge.)

WATER QUALITY THREATS OR IMPAIRMENTS

INVENTORY METHODS

The Lake Lansing watershed was inventoried using remote and field survey methods to determine the type and location of pollution sources. The remote survey involved review of available mapping, aerial photography, and field surveys. U.S. Geological Survey topographic maps, U.S. Department of Agriculture soils data, and Michigan Resource Inventory System (MIRIS) land cover maps were reviewed initially. Storm drain outfalls were field-inventoried on March 29, 1999 and December 6, 2001.

CRITICAL AREAS

There are 5 geographic areas within the Lake Lansing watershed that are critical for water quality improvement and protection: 1) Storm drainage systems; 2) riparian residential lands; 3) other residential lands within the watershed; 4) wetlands; and 5) undeveloped lands. Focusing on these critical areas is important for cost-effectiveness and manageability.

Storm Drainage Systems

Storm drainage systems include elements such as roads with drainage systems, streets, catch basins, curbs, gutters, ditches, channels, and storm drains. By design, these drainage systems convey water away from areas of pedestrian and vehicular traffic to low elevations in the system which are, generally, lakes, streams, or wetlands. To the extent that pollutants are present on the ground or carried downward in precipitation, these pollutants will be transported downgradient to the receiving water body, as is the case with Lake Lansing. Management of such drainage should involve a two-pronged approach: 1) pollution prevention to reduce pollutant concentrations within the system; and 2) remedial measures to remove pollutants that can be captured by methods such as maintenance of catch basins, installation of catch basin filters, installation of wetland filters, etc.

Figure 17. Lake Lansing storm drain outfall.

Riparian Residential Lands

Given their proximity to the lake, proper management of riparian residential lands is critical for preventing degradation of Lake Lansing. Residential lands have the potential to contribute high concentrations of pollutants in runoff, depending on the use and activities on the land, as well as the manner in which homes are built. Fertilizers, vegetative buffers, impervious surfaces (such as rooftops, driveways, walkways, etc.), pet waste, and household hazardous materials can all impact water quality. Pollution prevention is important along with remedial measures such as installation of vegetative buffers along shoreline areas.

Other Residential Lands

Although non-riparian lands do not drain directly to Lake Lansing, pollutants from these lands can be transported from storm sewers or via lateral groundwater movement. Pollution prevention is the primary means of management for non-riparian lands.

Wetlands

Wetlands perform many critical functions including filtering of pollutants, flood and storm control, and providing wildlife habitat. Soil mapping indicates much of the wetlands around Lake Lansing have been filled to accommodate housing development. As such, it is vital that the remaining wetlands be preserved. Efforts to preserve the remaining wetlands could include wetland purchase, easement acquisition, and close monitoring and review of development in and around wetlands. A more aggressive approach would involve wetland creation or reclamation.

It should be noted that wetlands can be an indirect source of nutrients and *E. coli*. That is, wetlands can be home to waterfowl that are a source of fecal contamination in the lake. Nuisance waterfowl is another pollution source that should be addressed in the management plan.

Undeveloped Lands

Undeveloped lands generally have fairly low rates of pollutant runoff but are usually not as effective as wetlands in filtering pollutants. However, once development occurs, the rate of runoff can be expected to increase and the quality to decline. Thus, preserving undeveloped land, or open space, can help to prevent water quality degradation. In addition to land purchase and easement acquisition, there are several zoning techniques that can be used to preserve open space.

LAKE AND WATERSHED ISSUES

A listing of lake and watershed issues to be addressed in the management plan is provided in Table 7.

TABLE 7

LAKE LANSING LAKE AND WATERSHED MANAGEMENT ISSUES

Issue	Causes
Nuisance aquatic plant growth	Sediment and nutrients, exotic species
Closed beaches	*E. coli*
Water quality/ Habitat health and diversity	Sediment, nutrients, low dissolved oxygen, exotic species, lack of habitat, oil and grease, heavy metals (suspected), pesticides (suspected)
Land preservation	Development pressure
Boating safety	Lake overcrowding
Navigation	Sediments, shallow water depth, nuisance plants
General recreation	Traffic speed and congestion; roadway maintenance

WATER QUALITY IMPROVEMENT AND PROTECTION GOALS

The SAD conducted a series of roundtable meetings to obtain input from lake residents and other interested citizens regarding use and management of the lake and watershed. As a result, lake and watershed goals were developed:

- Maintain and improve the environmental quality of Lake Lansing and its watershed.
- Maintain and improve recreational opportunities and public safety in Lake Lansing and its watershed.

The following objectives were developed to meet these goals:

Maintain and improve the environmental quality of Lake Lansing and its watershed.

A. Continue water quality testing to warn of any changes in water quality.

B. Prevent nutrients and pollutants from entering the lake.

C. Preserve wetlands in the Lake Lansing watershed as stormwater filters.

D. Install catch basins on the drains around the lake to trap harmful substances that may otherwise run into the lake.

E. Manage nuisance aquatic plants by methods that support all recreational activities, including boating, swimming, and fishing.

F. Manage waterfowl and wildlife fecal matter as a contributory factor in lake contamination.

G. Increase the depth of the lake.

H. Maintain the southern shoreline as a well-vegetated, viable marshland.

I. Maintain the lake shoreline for a natural appearance wherever possible.

J. Maintain views of Lake Lansing from Lake Drive and other roads surrounding the lake.

K. Maintain all buildings and grounds in the watershed in good, lake-friendly condition.

L. Maintain roads, trails, and public utilities in good, lake-friendly condition.

M. Enforce and/or develop zoning codes, i.e. footprints, permeable surface and drainage regulations.

N. Ensure the proper storage or use of dangerous materials in the Lake Lansing community. Dangerous materials include large amounts of flammable liquids, explosives, dangerous construction materials or equipment and cast-off medical equipment and appliances.

O. Prevent release of harmful wastes into the Lake Lansing community.

Maintain and improve recreational opportunities and public safety in Lake Lansing and its watershed.

A. Facilitate a variety of water activities on Lake Lansing, i.e., swimming, sailing, waterskiing, kayaking, canoeing, sailboarding, slow cruising, fishing, waterbiking (jet skis and waverunners) and other appropriate activities.

B. Boating is conducted safely on Lake Lansing.

G. Adequately enforce traffic regulations in the Lake Lansing community.

C. Trails surrounding Lake Lansing provide opportunities for enjoying the view of the water while jogging, biking, walking, in-line skating, and other non-motorized activities.

D. Lake Lansing provides a variety of winter recreation opportunities, i.e., ice fishing, walking, cross country skiing, ice boating and snowmobiling.

RECOMMENDED MANAGEMENT PLAN

MANAGEMENT ACTIVITIES

In order to accomplish the lake and watershed goals, there are many tasks that may require a number of years to complete, and will require an infusion of outside funding sources. Many of the recommendations include what are referred to as "best management practices." These include structural, vegetative, and managerial practices implemented to control nonpoint source pollution, and are further elucidated in Appendix C. The Special Assessment District (SAD) will interact and participate with a variety of people and organizations such as the LLPOA (Lake Lansing Property Owners Association), Ingham County Board of Commissioners, Meridian Township officials, the Ingham County Parks Department, the Ingham County Drain Commissioner's office as well as interested citizen groups.

Due to both budgetary and volunteer constraints, all of the goals and activities may not be able to be concluded within five years. Those with the highest priority will take precedence.

Maintain and Improve the environmental quality of Lake Lansing and its watershed

- Install wetland filters where appropriate on storm drains.
- Install catch basins for storm drains.
- Purchase wetlands in the watershed with Meridian Township Land Preservation funds.
- Enforce state and local wetlands statutes and ordinances.
- Request notification of any potential development within any wetland in the watershed.
- Adopt a viable vegetation management plan for Meridian Township property at the south end of the lake.
- Establish riparian vegetative buffers.
- Establish natural road side plantings around lake including park properties.
- Proactively maintain shoreland vegetation.
- Control and monitor Purple Loosestrife.
- Continue appropriate geese roundups.
- Investigate ways of controlling seagull population.
- Facilitate availability of phosphorus free fertilizers.
- Establish an oil recycling center in the township.
- Optimize maintenance and safety along roads surrounding Lake Lansing.
- Annual lake-wide clean-up.
- Manage the plant growth in Lake Lansing through chemical treatments so that invasive aquatic plants are kept at a minimum and native plants are allowed to flourish.
- Remove appropriate aquatic plants and reduce biomass by mechanical harvesting.
- Pursue selective, localized dredging projects.

- Increase depth of lake in summer by not lowering lake levels in June.
- Continue to conduct E.coli and bacterial monitoring of public areas.
- Continue volunteer lake monitoring for a variety of pollutants.
- Continue lake water quality, heavy metal and drain monitoring

Maintain and improve recreational opportunities and public safety in its watershed.

- Increase boating safety patrols and law enforcement.
- Apply for markers for underwater hazards for periods of low water.
- Maintain bike lanes on roads surrounding Lake Lansing.
- Enforce traffic laws, encourage and develop traffic calming devices.
- Report dangerous materials or equipment .
- Institute household hazardous waste collection.
- Make sure Meridian Township has in place a hazardous waste management plan to deal with potential hazardous waste crises.

On December 6, 2001, engineering staff from Progressive AE surveyed the storm drain outlets to determine possible improvements for reducing transport of pollutants. Engineering recommendations are listed in Table 8 according to the Association's drain numbering system (Figure 5, page 10):

TABLE 8

ENGINEERING RECOMMENDATIONS FOR LAKE LANSING STORM DRAINS

Storm Drain #	Recommendation
1	Clean out the two culvert entrances and install catch basins.
2	Ongoing maintenance needed to remove accumulated sediment.
3	A trash rack could be installed to keep leaves and branches out of lake, but maintenance would be difficult.
6	Clean out catch basin entrance.
8	Two outlets to lake. Place riprap on smaller pipe outlet to lake.
9	Clean out culvert entrances. Water is flowing through wetland before entering the lake, thus acting as natural filtration.
10	Place riprap at pipe outlet to lake.
11	Clean out culvert entrances. Culvert could be replaced. It is in poor shape.
12	Place some riprap at outlet. Clean out catch basin.
13	Clean out catch basin entrance.
14	Culvert could be replaced. Riprap should be placed at pipe outlet to lake.
15	This inlet has some potential for erosion and should be corrected. Install catch basin and storm sewer pipe down to lake or place rip rap in channel.
16	Plant vegetative cover in drainage swale.

ORDINANCES AND LAND MANAGEMENT TOOLS

Ordinances are administrative tools that can be used to establish land use policies and rules to protect water resources within municipalities. As part of plan implementation, planning and zoning work includes the following:

- Adopt a non-phosphorus fertilizer ordinance for the watershed.
- Adopt a pet waste ordinance in Meridian Township.
- Amend the Meridian Township Master Plan to include a limit on multiple boat launch sites and adopt corresponding ordinances.
- Adopt keyhole and imperviousness ordinances in Meridian Township.
- Establish lake overlay district in Meridian Township, update zoning ordinance and enforce side-yard setbacks to maintain views of the lake from between houses.
- Enforce junk and building ordinances in Meridian Township.
- Citizens report violations of building ordinances to Meridian Township.
- Citizens report violations of soil erosion and sedimentation control ordinance to Ingham County Drain Commissioner.

INFORMATIONAL AND EDUCATIONAL ACTIVITIES

Disseminating and exchanging information about Lake Lansing and its watershed to and with various target audiences is critical to both the short- and long-term success of the watershed management program. Target audiences and partners include lake residents, residents within the watershed living away from the lake, Meridian Township residents and officials, Bath Township officials, Ingham County officials, local schools, staff in the state departments of Environmental Quality and Natural Resources, and professional consultants. Not only will it be necessary to disseminate information to target audiences, but it will also be important to receive information such as feedback and technical data. The content of the messages will support the program goals and objectives, and the method of delivery will vary depending upon factors such as cost, content, and audience.

The content of educational efforts targeted to watershed residents will include:

- Pet waste containment.
- Conversion to city sewers throughout watershed.
- Provide riparians and users of boat launch pamphlets on marine safety laws and courteous and common sense boating behaviors.
- Inform watershed residents about buying lake-friendly fertilizer from Ingham County parks.
- Promote lake-friendly plantings in the riparian edge.
- Promote natural landscape plantings along the roadside of properties on both sides of Lake Drive and other near-lake roads.
- Encourage residents to either use a phosphorus-free fertilizer or no fertilizer at all on their lawns.
- Promote natural shoreline protection.
- Provides information to adjacent property owners on how to improve the quality of the easements with plantings.
- Provide in-service to citizens on how to report boating safety violators.

Educational efforts with public officials include:

- Work with Meridian Township and Department of Environmental Quality to encourage enforcement of State and local wetlands statutes and ordinances.
- Work with Meridian Township to use part of the land preservation fund to purchase wetlands within the Lake Lansing watershed.
- Encourage Meridian Township to improve Perry Road road-end with plantings.
- Encourage Ingham County Sheriff's Department to provide frequent patrols and law enforcement; and work with Meridian Township to provide lake coverage.
- Work with Meridian Township Police Department to encourage strict enforcement of existing auto speed limits around the lake.
- Encourage DNR enforcement of ice shanty identification.
- Work with Ingham County Road Commission to add the message, "Do Your Part/Keep It Clean" (possibly), to existing signs that say "Now Entering Lake Lansing Watershed."
- Work with County Road Commission or Meridian Township to erect additional friendly signs such as "Pitch In" or "Pick Up After Your Pet."
- Work with Meridian Township or County Road Commission to stencil storms drains with a reminder that the pipe drains directly into the lake.

Message delivery methods will include mailings, sign-postings, newspaper articles, public service announcements, creation of an association web site, and information added to other websites (i.e. Ingham County Parks, Meridian Township, Board of Realtors, etc.). Promotional activities will include student involvement in a water conservation program during Michigan History week, student involvement in Michigan Lakes and Streams Associations testing, involvement of Scouts in clean-up efforts, and continuation of lake-friendly yard award program.

PROJECT COSTS AND TASKS

Table 9 contains a listing of long-term project tasks and preliminary cost estimates for completing each work item, and Table 10 lists the tasks and costs for 2003 through 2007.

TABLE 9

LAKE LANSING WATERSHED MANAGEMENT PLAN LONG-TERM TASKS AND COSTS

Task	Approximate Total Cost
Drain Improvements: (Install catch basins (3), replace culverts (2), install riprap, vegetative cover	$30,000
Engineering and design	
Construction	
Install Wetland Filters	$100,000
Planning and design	
Installation	
Purchase Wetlands	$2,000,000
Planning, survey, title search, etc.	
Purchase	
Install Riparian Vegetative Buffers	$10,000
Natural Road-side Plantings	$10,000
Planning and design	
Installation	
Total	$2,150,000

TABLE 10

LAKE LANSING WATERSHED MANAGEMENT PLAN ANNUAL TASKS AND COSTS

2003 - 2007

Task	Total Annual Cost
Manage Aquatic Plant Growth	$40,000
Herbicide treatments	
Mechanical harvesting	
Volunteer Lake Monitoring	$500
Information and Education	$1,700
Engineering and Consulting	
Plant control admin. and oversight	$7,000
Lake and drain monitoring and reporting	$5,000
Engineering drain improvements	$3,000
Reporting, administration and meetings	$2,000
Township Administration	$1,400
Total	$68,600 per year

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Appendix A
Historical Data Collection Events and Studies of Lake Lansing

1891	This is the first record of Lake Lansing in the Department of Natural Resources files. The lake was recorded as Pine Lake.
1907	Mr. Ransom E. Olds was granted the full rights to "build, maintain, repair and replace a dam across the outlet of Pine Lake." The lake was raised approximately three feet.
1921 - 1990	Fish stocking records are available for many years (1921 - 28, 1930 - 42, 1945, 1970 - 1972, 1974, 1975, 1977, 1979 - 1983, 1988, and 1990). The fish stocked most frequently between the years of 1921 and 1945 were largemouth bass, perch, and bluegill. Walleye were stocked in 1921. Smallmouth bass were stocked in 1924, 1925, 1932, 1936, and 1942. Tiger muskellunge were stocked in 1970 - 72, 1974, 1975, 1977, 1979 - 83. Channel catfish were stocked in 1988 and 1990.
1922	The July 10th edition of the State Journal has an article regarding the weed problems in Pine Lake. The headline reads "Plan to Rid Pine Lake of Weed Crop - Declare Lake Will be Solid Weed Bed Unless Action is Taken This Season". The article describes how area citizens are launching a program to destroy the weeds.
1930 - 1940	Creel census. (1930, 32, 33, 36, 38, and 40). Fish most commonly caught included: largemouth bass, bluegill, pumpkinseed, black crappie, perch, northern pike, and bullheads.
1934	Mallmann, W. L. and A. Sypien of Michigan State College studied bacterial indices of natural waters as standards for pollution. Lake Lansing was their primary study site. They published their work, Pollution Indices of Natural Bathing Places, in the American Journal of Public Health. They identify the lake as having a muddy bottom.
1938	Ball, R. C. et. al., surveyed and mapped the lake, collecting fish and water chemistry data. Game fish collected included: grass pickerel, northern pike, perch, largemouth bass, warmouth bass, bluegill, pumpkinseed, black crappie, brown bullhead, and yellow bullhead. Water chemistry data suggest a productive lake. Dissolved oxygen was zero at a depth of 21 feet even though stratification was not present on August 11, 1938. Values for pH were moderately high 8.6 at the surface and 8.0 at 21 feet. The Lake was mapped by the Institute for Fisheries Research in August. In addition to the contour lines the map depicted the lake as having abundant emergent and submergent aquatic plants.
1941	Roelofs, E. W., published Report No. 689 for the Institute of Fisheries Research, titled Fisheries survey of Burke, Park and Rose Lakes in Clinton County and Lake Lansing in Ingham County. The report included fish and aquatic plant surveys and other observations. Fish species were similar to those found by Ball, R. C. et. al. Thirty-seven species of aquatic and wet land plants were identified. The more common aquatic species found included: coontail, chara sp., milfoil, naiad, white and yellow water lily, pickerel weed, largeleaf pondweed, P. angustifolius, Robbins' pondweed, flat-stemmed pondweed, and cattail. The report also observed that Lake Lansing in 1938 had 130 cottages, two resorts and four boat liveries. Considerable cottage development was occurring along the east shore at the time

of the report. The lake had only one very small intermittent inlet. The lake's water color was brown and one Secchi disk reading of six feet was recorded.

1950 Tucker, Alan published *The Relation of Phytoplankton Periodicity to the Nature of the Physico-chemical Environment with Special Reference to Phosphorus* in the American Midland Naturalist, a publication of the University of Notre Dame. Water chemistry samples were collected on Lake Lansing from August 28 to November 9, 1950. During the summer there was a decrease in temperature from top to bottom but not sufficiently great to form a thermocline by the classical definition. Even without strong stratification dissolved oxygen dropped to zero or near zero during August and September in the deepest water samples. Surface water pH values ranged from 7.4 in October to 8.4 in August. Total phosphorus values on all sampling dates and for all depths ranged from 13 to 17 micrograms per liter, except for the deepest water samples in August and September which were 33 and 57 micrograms per liter respectively.

1955 An aquatic plant cutting operation was started to remove unwanted plants from the lake. The owner of the plant cutting machine is a Mr. Paul Harper. Mr. Harper sold the machine after a controversy arose as to the effects of the operation.

1957 On June 13th the Michigan Department of Conservation began a sodium arsenite treatment to control aquatic plants in Lake Lansing. Dr. Eugene Roelofs collected vegetation and fish data during this time to evaluate the effects of the sodium arsenite treatment.

A seine survey of the fish population was done on November 1st. Populations of perch, northern pike, largemouth bass, and black crappie had high percentages of catchable fish. Bluegill and pumpkinseed populations had very low percent catchable fish.

1959 Dr. Eugene Roelofs wrote a paper for Michigan Associates Consulting Engineers of Lansing, Michigan titled Aquatic Weed Survey of Lake Lansing, Michigan. Three maps were constructed depicting Lake Lansing's vegetation on October 1959. Plants commonly found at the sampling sites included: cattail, pickerel weed, coontail, water weed, milfoil, chara sp., yellow water lily, largeleaf pondweed, Richardson's pondweed, Robbins' pondweed, sago pondweed, and flat-stemmed pondweed. Several other species were also found in lesser abundance. Three significant stands of giant bulrush were mapped, which are no longer present.

A mortality of approximately 5000 fish occurred during June. Ninety percent of the dead fish were panfish. In one report the mortality was believed to be due to reduced dissolved oxygen levels. However, in a memo by Carlos Fetterolf, Jr., an aquatic biologist from the Michigan Water Resources Commission, the cause was attributed to a spraying of DDT on uplands near the lake which took place on June 7th and 8th.

Jackson, D. C., began collecting water chemistry and algal data on Lake Lansing. His thesis for a Master of Science degree was completed in 1963 and was titled A Taxonomic and Limnological Study of the Algae in Lake Lansing.

1960 Dr. Roelofs wrote a paper titled The Effect of Weed Removal on Fish and Fishing in Lake Lansing. The date of publication of this paper is unclear. Some citations

refer to it as a 1958 publication but the paper includes data from 1959 and 1960. The study found no lasting benefits to the fish population from the one time sodium arsenite treatment. A limited creel census suggested that fish may have been easier to catch the year following treatment. Milfoil was the dominate plant returning to the treated sites.

The Michigan Department of Public Health conducted a water chemistry survey of Lake Lansing during July. Data for some parameters appear to have problems. The limits of detection for these parameters may not have been adequate.

A seine survey of the fish population was done on October 3rd and 4th. Populations of perch, northern pike, largemouth bass, and black crappie had high percentages of catchable fish. Bluegill and pumpkinseed populations had very low percent catchable fish. Perch and black crappie had growth rates above the state average. Pumpkinseeds were growing at the state average and bluegill had growth rates below the state average.

1963 A mortality of approximately 5000 fish occurred during early June. Ninety percent of the dead fish were bluegill. Perch, black crappie, and pumpkinseed were also involved; about one to two hundred of each of these species. No cause for the mortality was identified.

1964 In the early 1960's a sanitary sewer was constructed around Lake Lansing to eliminate nutrient enrichment by individual septic systems.

1966 Ennis, D. B., conducted a study of Lake Lansing sediments titled Analysis of Some Lake Lansing Bottom Sediments. Generally, he found the shallow areas of the lake to have a calcareous humus sediment type. Moving into the deeper parts of the lake the sediments progressed into a fine silt. He identified sand sediments occurring from the point on the southeast shore out toward the deep south basin.

Dr. Wade conducted a study on the possible role of water soluble vitamins as triggers of serious algae blooms in Lake Lansing.

1968 White, W. S. did a study titled, A Comparative Study of Dominant Algal Species in Burke Lake and Lake Lansing, Michigan from 28 June to 3 August 1968. The Lake Lansing algal population was dominated by species in the Cyanophyta, Chlorophyta and Chrysophyta, with the greatest number of individuals in the Cyanophyta.

1969 The Corps of Engineers did a reconnaissance report on Lake Lansing titled, Reconnaissance Report Eutrophication Problem Lake Lansing, Michigan. The report contained no new data but review existing data and the issue of dredging the lake. The report concluded that if dredging was to be done the work should be preceded and followed by appropriate data collection and monitoring.

1970 The Michigan Department of Public Health conducted a water chemistry survey of Lake Lansing during July. Some of the measured parameters appear to have problems. Limits of detection may not have been adequate for these parameters.

Snell, J. R., did a study for the Ingham County Lake Board titled, Restoration of Lake Lansing. The study focused on the feasibility of dredging Lake Lansing.

1971 The Department of Fisheries and Wildlife from Michigan State University conducted a survey of the lake in February for water chemistry and biological data. Total

phosphorus values ranged from 60 to 90 µg/l in deep water. The dissolved oxygen profile showed reduced oxygen levels, 2.6 ppm at 23 feet. Chloride ranged from 21 to 25 ppm.

Szlachetka, G. L., wrote a paper titled, Proposal for Increasing Boating Activity Through Restriction of Specific User Groups. Mr. Szlachetka postulated that the rehabilitation of Lake Lansing by dredging would substantially increase boating pressure. He explored several ways of regulating boating to maximize recreational use. He recommended restricting motor size to reduce high speed boating and create additional recreational opportunities for other user groups.

Young, T. C., R. K. Johnson and T. G. Bahr from Michigan State University begin a two year limnological study of Lake Lansing.

1972 A survey of the fish population was done on October 20 and 21 by the Department of Natural Resources. Populations of northern pike, bluegill, pumpkinseed, and largemouth bass had high percentages of catchable fish. Bluegill and black crappie were thin for their size.

1973 Spooner, C. M., from Michigan State University, Department of Geology wrote a paper titled, Major and Trace Element Loading of Central Michigan Lakes. The objective of the study was to identify chemical gradients in the unconsolidated sediment and correlate them with human activity. Sediment profiles showed increased concentrations in upper layers for sodium, potassium and manganese but not for other elements. Dr. Spooner's paper refers to an investigation by Mr. Julian Ishan, a MS candidate, studying the kinetics and absorption isotherms of mercury and copper uptake into sediments of Lake Lansing.

1974 The Inland Lakes Management Unit of the Department of Natural Resources conducted water quality sampling at the two deep basins of Lake Lansing on September 23, 1974. Approximately 22 parameters were sampled. The lake was not stratified and had dissolved oxygen over 6 ppm in deep water. pH was generally around 9.5. Secchi disk transparency was 6.5 feet in the south basin and 8 feet in the north basin. Chlorophyll-*a* was 3.4 µg/L in the south basin and 0.5 µg/L in the north basin. Total phosphorus was 20 to 30 µg/L in both basins. Aquatic plants were judged to be dense and the dominant groups were Potamogeton species, milfoil, and wild celery.

1975 Young, T. C., R. K. Johnson, and T. G. Bahr from Michigan State University published the results of their two year limnological study of Lake Lansing in Technical Report No. 43 of the Institute of Water Research. The report was titled, Limnology of Lake Lansing, Michigan. The report provides an excellent summary of available water quality and fisheries data previously collected for the lake. It describes the lake as being eutrophic with occasional blue-green algal blooms, mid-summer hypolimnetic oxygen depletion, and aquatic plant beds of sufficient expanse to hinder certain recreational activities. Secchi disk measurements ranged from approximately four to ten feet and averaged six feet during the two years of sampling. Total phosphorus values ranged from 10 to 260 µg/L. However, total phosphorus values for early in the study seem unreasonably high. Results were reported in hundredths of a ppm which was common in the early 1970's instead of thousands of

a ppm which is currently reported. Consequently, limits of detection may not have been adequate for total phosphorus and resulted in reporting higher than actual values. The study also documented that the lake can periodically destratify during the summer months after anoxic conditions have been formed.

1977 Mr. Albert Massey wrote a Department of Natural Resources, Interoffice Communication to Dr. Dennis Tierney regarding Lake Lansing sediment analysis. The analysis found all parameters monitored for to be in the classification of non-polluted sediments except for volatile solids. However, arsenic and mercury were high at some sampling locations.

Keck Consulting Services, Inc. did a water budget for the Lake Lansing dredging project. The budget did not appear to address land runoff other than to state, "Runoff from the land surrounding Lake Lansing is not taken into account in the calculations for the lake budget. The runoff potential for the wetlands is low except during the spring when the greatest amount of precipitation occurs along with snow melt. An estimate of water flowing over the new weir would be (in an average year) less than 100 acre-feet."

EcolSciences completed an environmental impact statement for the Lake Lansing dredging restoration project.

A survey of the fish population was done during May by the Department of Natural Resources. Perch, black crappie, and bullheads has small average sizes. Bluegill appeared adequate but had a rather poor condition factor.

1978 Between May 1978 and August 1983, approximately 1.6 million cubic yards of soft sediment were dredged from the lake and 220,890 cubic yards of sand were redistributed within the lake.

1979 Between 1979 and 1982 Michigan State University produced several studies regarding Lake Lansing and the dredging project.

1979 Crustacean Zooplankton of Lake Lansing, Michigan by Fatimah Md.Yusoff. The study examined the crustacean zooplankton populations of Lake Lansing before dredging. Twelve species of Cladocera and four species of Copepoda were found. The lake was dominated by three small species; *Bosmina longirostris* dominated during spring while *Ceriodaphnia lacustris* and *Chydorus sphaericus* dominated during summer.

1979 The Abundance and Distribution of Benthic Macroinvertebrates in Lake Lansing by Mehdi Siami. The study identifies the dominant types of benthic macroinvertebrates of Lake Lansing during the ice free season before the lake was dredged and estimates the relative density of individuals and biomass for the dominant types.

1980 Chlorophyll-*a* in the Plankton and Macrophytes of Two Lakes by Maureen M. Wilson. This study used chlorophyll-*a* as an indicator of standing crop for Skinner Lake in Indiana and Lake Lansing. Phytoplankton chlorophyll-*a* values for both lakes were typical of eutrophic lakes. Macrophyte chlorophyll-*a* values indicated a relative low standing crop of primary producers for Lake Lansing compared to other eutrophic conditions. The chlorophyll-*a* values were very high in the hypolimnion of Lake Lansing due to the presence of photosynthetic bacteria.

1980 Use of Three Southern Michigan Lakes by Waterbirds During Spring Migration by Douglas A. Reeves. This study looked at the distribution of waterfowl as compared to habitat variables.

1980 Arsenic in Lake Lansing, Michigan a PhD dissertation from Michigan State University, East Lansing, Michigan. 79 pp.

1981 The Vegetation and Hydrology of a Lakeside Marsh by George W. Knoecklein. The vegetation of Lake Lansing's large wetland complex was mapped. Additionally, the tendency for inundation was obtained from the 20-year average lake surface elevation. The distribution of Typha angustifolia (cattails) was unrelated to the annual water cycle. It dominated portions of the wetland where the annual rate of water renewal was highest.

1981 Arsenic Profiles in Sediments and Sedimentation Processes Along the Slope of a Lake Basin by Mehdi Siami. Lake Lansing was treated with sodium arsenite for aquatic plant control in 1957. This study used sediment cores taken on a line through the littoral zone to the deep basin to determine the rates that sediment surfaces at different depths were returning to pre-treatment levels. The magnitude of peak arsenic in the cores increased with depth of water; suggesting that arsenic precipitated to the sediments as a function of depth of overlaying water. Sediment accumulation rates were calculated and found to be low in the littoral zone and highest at 3.75 meters and decreased into deeper waters. Using a sedimentation model it was estimated that littoral sediment surface concentrations of arsenic would take over 100 years to reach background levels. The pelagial sediment surface would return to background levels in approximately 40 years. However, the estimate for the pelagial sediment surface may be low given the time line of the littoral sediment surface concentrations.

1981 A Comparison of Rain-related Phosphorus and Nitrogen Loading from Urban, Wetland and Agricultural Sources, by Glandon, R. P. et al.

1982 Pre-dredging Limnological Features of Lake Lansing, Michigan by C. D. McNabb, et. al. This report summarized the findings of the dredging pre-study. It was noted that summer stratification, particularly in spring and late summer, was typically disrupted by high winds. It was suggested that these disruptions and erosions of the theromocline and hypolimnion contributed anaerobic bacterial chlorophylls to epilimnion algal chlorophylls to produce high surface water chlorophyll-*a* values. Littoral macrophytes plus their epiphytes contained 6.1 kg chlorophyll-*a*, or 5.2 mg/m^2 of area occupied. This was a relatively low standing crop for other eutrophic lakes under study by the University. Aquatic plants common to the lake included: Chara sp., naiad, water stargrass, wild celery, native and Eurasian milfoil, and curlyleaf pondweed. A theoretical nutrient budget was calculated for the lake. The results of this assessment indicated that atmospheric loading was the principal source of nitrogen and phosphorus for the lake. Street drains contributed small percentages of annual loading; 0.4% of TN and 1.6% of TP. Wetland stream and street drain loading combined was 39% of atmospheric loading for TN and 47% for TP.

1981 A mortality of approximately two to three thousand fish occurred during late May. Ninety-five percent of the dead fish were black crappie. Because only one species was primarily affected, it was concluded that the mortality was disease related.

1983 The Inland Lakes Management Unit of the Department of Natural Resources conducted water quality sampling at the two deep basins on April 7th. Approximately 22 parameters were sampled. Secchi disk transparency was 1.0 foot in the south basin and 3.5 feet in the north basin. Total phosphorus was 42 to 86 µg/L in the south basin and 17 to 25 µg/L in the north basin. Dredging was just being completed, which may account for the poorer water quality conditions.

Batterson, T.R. and C.D. McNabb published Arsenic in Lake Lansing, Michigan in Environmental Toxicology and Chemistry. The report concludes that more than 85% of the area of surficial sediments of Lake Lansing had arsenic concentrations two to six times background and that internal loading of the water with arsenic from the sediments was occurring. The researchers hypothesized that Fe^{3+} controls arsenic concentrations over aerobic sediments and that arsenic (III) increases in anoxic water with conversion of Fe^{3+} to Fe^{2+} and As (V) to As (III) at the sediment surface. As (III) in water diminishes during prolonged anoxia by reaction with S^{2-}. As (III) and Fe^{2+} are oxidized upon aeration of anoxic water and As (V) is taken out of solution with ferric iron in a manner similar to phosphate.

1984 A survey of the fish population was done during June by the Department of Natural Resources. The survey found the composition of the fish population quite poor. All of the six species of game fish analyzed for growth rates were slow growing. Bluegill were growing ½ inches below the state average and northern pike 6 inches below the state average. Carp made up 85% (by weight) of the trap net catch and 80% of the electro-fishing sample. A whole lake fish eradication and restocking project was being considered.

A fish survey was done in October to verify the results of the spring survey. However, water temperatures were too cold for good catch results so few fish were captured. Measurements on those that were caught showed growth rates below state averages for all species.

1985 Mikula, R., working for the Inland Lakes Management Unit of the Department of Natural Resources completed the study and report titled Lake Lansing Dredging Evaluation Study 1978-1984. Overall the trophic status of Lake Lansing improved from highly eutrophic to a meso-eutrophic condition. Comparison of pre- and post-dredging data revealed an increase in transparency and reductions in in-lake phosphorus and chlorophyll-*a*. During 1983/84 Secchi disk transparency averaged six feet in the north basin and 5-1/2 feet in the south basin. The chlorophyll-*a* concentration in the littoral and upper pelagial area of Lake Lansing averaged 3.3 µg/L while total phosphorus concentration ranged from 13 to 33 µg/L with a mean of 21.4 µg/L during 1983/84. Some reduction in total Kjeldahl nitrogen occurred. Changes in nitrate + nitrite and oxygen depletion in deep water were not documented. Water quality samples in this study and in the pre-dredging study by Michigan State University were volume weighted samples. Direct comparisons between the data from these studies and the data from other studies collected for the lake are not completely valid. Heavy metals, specifically arsenic and mercury,

were not remobilized during the dredging project. Benthic macroinvertebrate communities did not change in composition, but did exhibit an increase in number of individuals after dredging. Algal communities displayed a seasonal diversity of types which varied in patterns typical of mesotrophic and/or eutrophic lakes. Aquatic plants were still abundant in Lake Lansing following the dredging. Common species in the lake during this study included: native and Eurasian milfoil, with native milfoil being much more abundant, curlyleaf pondweed abundant in early summer but dying back by early July, Potamogeton alpinus, water stargrass, naiad, Chara sp. and wild celery.

As part of the study and report by Mikula a new post-dredging hydrographic map for the lake was constructed by Engineering and Land Resource Programs Divisions of the Department of Natural Resources.

A survey of the fish population was done during June by the Department of Natural Resources. The results of the 1985 survey differed substantially from the 1984 survey. Significantly fewer carp were captured in 1985 and bluegill averaged 0.2 inches larger. Black crappie and pike populations also showed improved growth. All species were still growing below state averages but the improvements put on hold the contemplated total lake fish control project.

1986

A survey of the fish population was done during May by the Department of Natural Resources. The average size of bluegill captured was 6.4 inches. Any average of 6.0 inches or over is considered good. When compared to previous years a slight increase in average size is apparent: 1984 (5.9 in), 1985 (6.1 in). However, bluegill growth rates remain slightly below state averages. Black crappie were thin and slow growing. Pike and bass were slow growing as younger fish but growth rates picked up once the fish were large enough to take bluegill as prey. The bullhead population was very impressive. Over 485 bullheads were captured averaging 10.6 inches and over 3/4 of a pound each.

Between 1984 and 1986 the Ingham County Public Health Department sampled numerous private water supply wells for several water quality parameters. In several wells arsenic was found at levels below the established MCL (Maximum Contaminant Level), which is 0.05 ppm. From a limited data base of 29 bedrock wells throughout the county an average arsenic concentration of 0.012 ppm was found. It was the opinion of health department staff that wells with levels above 0.020 ppm may indicate a potential pollution problem. The number of wells around the lake with arsenic above 0.020 ppm was seven, with only one being a deep well. Water may leak from the lake to shallow wells, however, stiff diagrams of the study wells and lake do not support this. Water samples taken of the lake also were quite low usually being 0.003 to 0.004 ppm. If the lake was a source, then the lake sediment itself would probably be the reservoir of arsenic. Cross sections and samples of water taken from monitoring wells at spoil site 16 off Perry Road did not indicate that this site was responsible for any arsenic found in nearby private wells. Other sources of arsenic could be septic systems, pesticide use near the well and/or grout material used for well construction.

As part of the Ingham County Public Health Department well sampling program several wells were identified as having high levels of iron bacteria which could cause odor and staining problems.

From 1974 to 1984 a resident on Mallard Street used waste oil as a dust suppressant on the road until complaints by neighbors brought this activity to the attention of the county health department. The activity was stopped and sediment samples were taken next to the street. Analysis of these samples indicated the presence of PCB's (380 μg/kg) and lead (320 μg/kg) as well as some other heavy metals. No information concerning waste quantity was available.

Housing construction on the corner of Hickory Street and Lake Drive raised the question of ground water quality at the site of the old "landfill". The Ingham County Public Health Department sampled these wells for potential problems.

1987 The Inland Lakes Management Unit of the Department of Natural Resources conducted water quality sampling at the two deep basins on April 29th. Secchi disk transparency was 8 feet in the south basin and 9 feet in the north basin. Chlorophyll-*a* was 0.8 μg/L in the south basin and 0.8 μg/L in the north basin. Total phosphorus was 11 to 21 μg/L in the south basin and 7 to 13 μg/L in the north basin.

The Inland Lakes Management Unit of the Department of Natural Resources conducted water quality sampling at the two deep basins on September 17th. The lake had a 5.5 degree centigrade temperature gradient from top to bottom but was not strongly stratified. In the north basin dissolved oxygen was 1.4 ppm at 25 feet and 0.2 at 28 feet. pH was generally around 8.5. Secchi disk transparency was 8 feet in both basins. Chlorophyll-*a* was 9.0 μg/L in the south basin and 7.0 μg/L in the north basin. Total phosphorus was 11 to 21 μg/L in the south basin and 7 to 13 μg/L in the north basin. Total phosphorus was 9 to 26 μg/L in the south basin and 9 to 43 μg/L in the north basin. Aquatic plants were judged to be moderate to dense and the dominant groups were native and Eurasian milfoil, water weed, naiad, and wild celery.

During the week of June 14 - 20 an experimental manual carp removal project was attempted by the Department of Natural Resources. Gill nets, trap nets, fyke nets, and Morton traps were used to capture as many carp as possible. The experiment did not produce a reliable method for carp capture. Only 137 carp were harvested with 55 net nights.

A survey of the fish population was done during June by the Department of Natural Resources as part of the carp removal project. Results showed an increase in bluegill growth and average length, which has steadily increased since 1984. All age classes of bluegill exhibited good growth and averaged from 0.5 to 1.0 inches above state averages. Pumpkinseeds were also growing at a rate 0.5 inches above the state average and 40% of those netted were catchable size (larger than six inches). Crappie showed increase in average length but continued to have a poor condition factor. Largemouth bass were growing a nearly the state average. Bullheads were again abundant and averaged nearly 10 inches and 3/4 pounds. Over 97% of the bullheads were catchable (larger than seven inches).

The Department of Natural Resources also conducted a creel census survey in 1987. Largemouth bass were the most sought after species in Lake Lansing and 70% of the ninety anglers surveyed keep all of their legal fish. The anglers were asked to rate the lake's fishing, 50% rated fishing as good, 38% said fishing was fair, and 6% felt fishing was poor. The most common complaint with regard to fishing on Lake Lansing was the inconsiderate use of the lake by other boaters.

1990 Ingham County Park Department statistics for the Lake Lansing Park has 3,913 boat launches.

1991 During 1991/92 the Inland Lakes Management Unit of the Department of Natural Resources conducted water quality sampling and aquatic plant surveys of Lake Lansing. During these years the dominate aquatic plant in the lake was Eurasian milfoil. Other plants with fair populations were Chara sp., wild celery, naiad, coontail, flatstem pondweed, thin-leaf pondweed, Illinois pondweed, and Richardson's pondweed.

A survey of the fish population was done during May by the Department of Natural Resources. The average size of bluegill captured was over six inches. Their growth rate was 0.9 inches above the state average. For the first time in recent surveys black crappie were growing above (0.4 inches) the state average. Bass were growing only slightly below the state average. The bullhead population was very good.

Ingham County Park Department statistics for the Lake Lansing Park has 4,365 boat launches. Visitation figures showed 118,122, 149,926, and 268,195 individuals using Lake Lansing Park North, Lake Lansing Boat Site and Lake Lansing Park South respectively.

A mortality of approximately five hundred fish occurred during late May. The mortality involved primarily bluegills with a few other species. The mortality appeared to be the result of spawning fish stress, unusually early warm weather and low predawn dissolved oxygen levels.

1993 Ingham County Park Department statistics for the Lake Lansing Park has 3,262 boat launches. Visitation figures showed 160,527, 134,122, and 244,497 individuals using Lake Lansing Park North, Lake Lansing Boat Site, and Lake Lansing Park South respectively.

1994 Mr. Patrick Lindemann, Ingham County Drain Commissioner and Mr. Bob Godbold, Ingham County Environmental Health Director had prepared a report on Lake Lansing titled, Lake Lansing and Its Watershed. Bacteria and water quality samples were collected for the report. Nineteen inlets to Lake Lansing were found. On August 3, 1994, bacterial samples were collected at six of these inlets. On October 21, 1994, after heavy precipitation samples were collected on an additional four inlets which were then flowing. Based on the results of the inlet sampling, it was concluded that the inlets were not a source for the lake's high bacterial condition. Geese and seagulls appear to be the major reason for the high bacterial conditions.

Ingham County Park Department statistics for the Lake Lansing Park has 2,719 boat launches.

1995 Lake Lansing was treated with the herbicide Sonar at 8 ppb. Rooted aquatic plants were greatly reduced by the treatment during the year. Only Chara sp. and flatstem pondweed had fair populations all other species could be found only in extremely minor amounts. It was a general consensus of the resource managers that the treatment had removed too much of the aquatic plant vegetation for a eutrophic lake like Lake Lansing.

A survey of the fish population was done during May by the Department of Natural Resources. The average size of bluegill and pumpkinseed captured was six inches. However, bluegill and pumpkinseed growth rates were slightly below state averages. Pike and bass also had good average size but with grow rates slightly below state averages. The black crappie population was thin and slow growing. The bullhead population was excellent.

Ingham County Park Department statistics for the Lake Lansing Park has 3,607 boat launches. Visitation figures showed 117,690, 106,932, and 239,181 individuals using Lake Lansing Park North, Lake Lansing Boat Site and Lake Lansing Park South respectively.

Zebra mussels were detected in Lake Lansing.

1996 As a follow-up to the 1995 Sonar treatment the Inland Lakes Management Unit of the Department of Natural Resources conducted a late summer aquatic plant survey of the lake. Very little Eurasian milfoil was found in Lake Lansing the year following the Sonar treatment. Aquatic plants with fair populations were Chara sp., water stargrass, large leaf pondweed, flatstem pondweed, thin-leaf pondweed, curly leaf pondweed, and Richardson's pondweed. Other plants were found in very minor amounts.

The Lake Lansing Property Owners Association conducted a comprehensive survey of riparian property owners. A total of 205 survey forms were mailed out and 105 were returned. Topics covered in the survey included: activities, safety, water quality, aquatic plants, watershed management, lake and watershed development and zoning, funding, the role of the association, and general information.

The Lake Lansing Property Owners Association participated in the Department of Environmental Quality's, Cooperative Lake Management Program. Summer Secchi disk transparency values ranged from 4.7 to 12.25 feet and averaged 7.5 feet.

Ingham County Park Department statistics for the Lake Lansing Park has 3,440 boat launches.

1997 The Special Assessment District (SAD) contracted for a aquatic plant chemical treatment of the lake using contact herbicides.

Progressive AE out of Grand Rapids conducted an aquatic plant survey for the SAD and wrote a report titled, Lake Lansing Aquatic Plant Survey Report - September 1997. The survey found that Eurasian milfoil had made a major recovery in the lake and was again the dominate plant besides Chara sp. Other plants with major populations included naiad, water stargrass, flatstem pondweed, large leaf pondweed, Richardson's pondweed, and curly leaf pondweed. Other plants were present in minor amounts.

The Lake Lansing Property Owners Association participated in the Department of Environmental Quality's, Cooperative Lake Management Program. Summer Secchi disk transparency values ranged from 5.1 to 7.5 feet and averaged 6.7 feet.

Ingham County Park Department statistics for the Lake Lansing Park has 2,846 boat launches. Visitation figures showed 97,912, 71,872, and 248,317 individuals using Lake Lansing Park North, Lake Lansing Boat Site and Lake Lansing Park South respectively.

1998

The Special Assessment District created by Meridian Township in cooperation with the county initiate a five-year comprehensive study of Lake Lansing and its watershed. Progressive AE was hired to implement the study and write the report.

Lake Lansing was treated with the herbicide Sonar at 5 ppb. Progressive AE conducted four plant surveys for the treatment (April 28th, May 8th, June 30th and September 3rd). The treatment completely controlled curly leaf pondweed. Eurasian milfoil was basically eliminated except for a few green plants, however it did take almost two months to drop out of the water column. Native plants were not as seriously damaged as in the 1995 Sonar treatment. Dominate species remaining after the treatment were Chara sp., wild celery, thinleaf pondweed, and flatstem pondweed. Large leaf pondweed, whitestem pondweed, naiad, and water stargrass were present in lesser amounts.

The Lake Lansing Property Owners Association and SAD conducted a riparian boat count. A total of 416 boats were counted. The major boat types present on the lake were speed boat, sail boat, pontoon, jet ski, and canoe. On June 27th, 50 to 55 boats were on the water using the lake. Additional counts of both riparian and non-riparian boats were done over a two-year time frame.

A survey of the fish population was done during May by the Department of Natural Resources to evaluate fish populations following use of the herbicide Sonar in the lake. The average size of bluegill and pumpkinseeds captured was nearly 7.0 inches and growth rates were slightly above state averages. Bass also had good average size and grow rates. The bullhead population was excellent. Carp continued to have a presence but not at nuisance levels.

In a letter to Mr. Tom Page, Lake Lansing Property Owners Association president, Dr. Lois Wolfson summarized the results of sampling done on the lake during 1998 by the Michigan State University limnology class. Aquatic plants found included: Chara sp., naiad, flatstem pondweed, sago pondweed, a broad leaf pondweed, and wild celery. Electrofishing produced many bluegill, pumpkinseed, and minnow species as well as a few pike and bass. One total phosphorus measurement during fall turnover found 27.8 µg/L. The Secchi disk transparency was 4.5 feet on September 22nd. Dissolved oxygen dropped of dramatically below 17 feet to zero at the bottom.

The Lake Lansing Property Owners Association participated in the Department of Environmental Quality's, Cooperative Lake Management Program.

Note:

In approximately 1972 an unknown author put together a chronology of studies and management programs undertaken at Lake Lansing. This person's work was extremely helpful in the development of this chronology.

TABLE A1
LAKE LANSING WATERSHED STORM DRAIN SURVEY
MARCH 29, 1999

No.[1]	Name	Culvert size (inches)	Estimated Discharge (cfs)	Notes
1	Barnhart	2 1/2-inch	0.25	This inlet drains a wetland between East Reynolds and Lake Drive. The two culverts discharge to the lake at a sea wall.
2	Milliman	Undetermined	1.25	This inlet is usually the largest entering the lake and has some flow most summers. Culvert buried, surface of water about 54 inches wide in culvert.
3	Wallace	24	0.75	This inlet drains to the wetland adjacent to the transfer station. Pike have been known to move up the inlet and into the wetland for spawning.
4	Defoe	No culvert		This inlet drains a small wetland on the lake side of Lake Drive. At the shore line it enters Lake Lansing as a small channel about 20 feet wide, one to two feet deep and about 200 feet long. On March 29th wind was driving water from the lake into the channel. During the summer, the inlet often is disconnected from the lake and the channel becomes a stagnant pool.
5	South End	21	0.25	This inlet drains a small area south of the railroad tracks and flows into the wetland on the lake's south shore. At the inlet there appears to be a small channel through the emergent vegetation to deeper water. A 20-inch pike was found dead along the inlet bank south of the railroad tracks.
6	Pike Street	18	0	This inlet is a street drain and only flows during rain events. It drains a small area west to Lake Drive. North of Pike Street is a residential area; south of the street is the county park. The drain used to flow directly into the lake. A few years ago it was diverted into the county park. It now flows overland in an undefined channel through a shrub wetland to the lake.
7	Condos	15	0	This inlet drains the condos and a small wetland north of the road. The drain's outlet to the lake is armored with rocks. This inlet appears to be primarily a storm drain but may carry some base flow in wet springs.

[1] Storm drain locations are shown in Figure 5 in the report.

TABLE A1 (CONTINUED)
LAKE LANSING WATERSHED STORM DRAIN SURVEY
MARCH 29, 1999

No.	Name	Culvert size (inches)	Estimated Discharge (cfs)	Notes
7	Condos	15	0	This inlet drains the condos and a small wetland north of the road. The drain's outlet to the lake is armored with rocks. This inlet appears to be primarily a storm drain but may carry some base flow in wet springs.
7b	Condos Upstream	12	0	The inlet flows from the wetland north of the road into a rock lined waterway on the condos property. On the condos lawn there is a small catch basin, which on the day of sampling had some water in it. Although there was no flow on the day observed this drain may carry some base flow in wet springs.
8	Perry Road	24	0	This inlet drains a fairly large area from Clinton County. There is a subdivision in Clinton County but it has a detention basin and little water is ever seen leaving the basin.
9	Carlton	12	0.25	This inlet drains wetlands near the railroad tracks on both sides of Lake Drive. It flows into the large wetland on the south end of the lake. There is no defined channel through the emergent vegetation to deeper water.
10	Reynolds	8	0	This inlet appears to be a storm drain for a small residential area.
11	New Condos	12	0	This inlet drains a small wetland and residential development south of Lake Drive. It appears to be primarily a storm drain with little or no base flow. North of the road the inlet flows through a wooded wetland to the lake. There is no defined channel in the wetland for the drain.
12	Lake Lansing Road	15	0	This inlet is a storm drain. North of the street is the county park. South of the street is a small commercial and residential area. Because it discharges near the county park beach, this inlet is sometimes sampled for bacteria by the park's staff.

TABLE A1 (CONTINUED)

LAKE LANSING WATERSHED STORM DRAIN SURVEY
MARCH 29, 1999

No.	Name	Culvert size (inches)	Estimated Discharge (cfs)	Notes
13	Lake Street & Columbia	24	0	This inlet is a storm drain. It drains a residen tial area and Marshall Park. There is little elevation through Marshall Park, consequently, storm water drains slowly off of this area, often accumulating in depressions.
14	Mack Avenue	12	0	This is a storm drain. It drains a residential area of about five plus acres.
15	Columbia St. South	No culvert	0	This inlet is primarily sheet runoff from a high density residential area of about two acres. It has no channel and flows over a grassy area between two houses to the lake.
16	Columbia St. North	No culvert	0	This inlet is primarily sheet runoff from a high density residential area of about three acres. It has no channel except where it flows to the lake between two houses. This channel is a cut about one foot wide and six inches deep.
17	Boat Launch	No culvert	0	This inlet is primarily sheet runoff from a residential area and the boat launch area. It may drain one or two acres. It is a grassy swale and flows along the east boundary of the boat launch area.

Other Notes: The Trails of Lake Lansing subdivision appears to have no direct drainage to Lake Lansing. The area soils appear to be well drained and may produce little runoff. Runoff from impervious areas flows to wetlands on both sides of the subdivision. The wetland to the south of the subdivision may drain to the Wallace (Number 3) inlet. There are plans to expand this subdivision to the east, away from the lake.

Appendix B
Lake Lansing 1999 and 2000 Water Quality Data

TABLE B1
LAKE LANSING 1999 and 2000 DEEP BASIN WATER QUALITY DATA
SAMPLING SITE 1

Date	Depth	Temperature (°F)	Dissolved Oxygen (mg/L)	pH (S.U.)	Total Alkalinity (mg/L)	Total Phosphorus (µg/L)
29-Mar-99	1	44.0	12.9	8.4	124	20
29-Mar-99	5	44.0	11.9			
29-Mar-99	10	44.0	11.6			
29-Mar-99	15	44.5	12.9	8.3	122	20
29-Mar-99	20	44.5	13.4			
29-Mar-99	25	44.5	12.5			
29-Mar-99	30	44.5	13.8	8.3	127	22
11-Aug-99	1	73.1	8.0	8.3	114	14
11-Aug-99	5	72.8	8.0			
11-Aug-99	10	72.5	7.3			
11-Aug-99	15	72.0	7.4	8.4	116	20
11-Aug-99	20	71.0	6.6			
11-Aug-99	25	60.0	1.3			
11-Aug-99	30	58.0	0.8	7.2	172	56
17-Apr-00	1	50.0	10.9	8.7	132	14
17-Apr-00	5	50.0	10.8			24
17-Apr-00	10	50.0	10.9			28
17-Apr-00	15	50.0	10.8	8.4	133	27
17-Apr-00	20	50.0	10.8			19
17-Apr-00	25	50.0	10.7			19
17-Apr-00	30	50.0	10.8	8.4	130	13
10-Aug-00	1	75.9	7.9	8.8	132	25
10-Aug-00	5	75.9	7.7			27
10-Aug-00	10	75.7	7.9			20
10-Aug-00	15	75.2	7.5	7.9	110	20
10-Aug-00	20	71.8	3.5			35
10-Aug-00	25	61.9	0.4			184
10-Aug-00	30	58.3	0.5	7.6	160	71

TABLE B2
LAKE LANSING 1999 and 2000 DEEP BASIN WATER QUALITY DATA
SAMPLING SITE 2

Date	Depth	Temperature (°F)	Dissolved Oxygen (mg/L)	pH (S.U.)	Total Alkalinity (mg/L)	Total Phosphorus (µg/L)
29-Mar-99	1	44.5	12.2	8.2	127	22
29-Mar-99	6	44.5	13.4			
29-Mar-99	12	44.5	12.6	8.4	128	23
29-Mar-99	18	44.5	12.6			
29-Mar-99	23	44.5	12.3	8.2	126	23
11-Aug-99	1	73.2	8.2	8.4	104	17
11-Aug-99	6	72.5	8.4			
11-Aug-99	12	72.0	7.0	8.3	115	20
11-Aug-99	18	69.0	2.4			
11-Aug-99	23	56.5	1.1	7.5	130	40
17-Apr-00	1	50.7	10.7	8.4	119	11
17-Apr-00	6	50.9	10.6			15
17-Apr-00	12	50.7	10.4	8.4	131	29
17-Apr-00	18	50.7	10.3			13
17-Apr-00	23	50.5	10.6	8.5	127	11
10-Aug-00	1	76.1	8.4	8.8	143	20
10-Aug-00	6	75.9	8.3			20
10-Aug-00	12	74.1	6.2	8.6	128	27
10-Aug-00	18	67.1	0.9			232
10-Aug-00	24	57.2	1.2	7.6	169	93

TABLE B3
LAKE LANSING 1999 and 2000 SURFACE WATER QUALITY DATA
SAMPLING SITE 1

Date	Secchi Transparency (feet)	Chlorophyll-*a* (µg/L)
29-Mar-99	9.0	4
11-Aug-99	7.0	4
17-Apr-00	13.5	1
10-Aug-00	8.5	3

TABLE B4
LAKE LANSING 1999 and 2000 SURFACE WATER QUALITY DATA
SAMPLING SITE 2

Date	Secchi Transparency (feet)	Chlorophyll-*a* (µg/L)
29-Mar-99	7.5	2
11-Aug-99	6.5	1
17-Apr-00	10.5	0
10-Aug-00	7.0	6

TABLE B5
LAKE LANSING STORM DRAIN MONITORING DATA

Date	Drain Number	Name	Total Phosphorus (µg/L)	*E. coli* (Count per 100 mL)
22-Apr-99	1	Barnhart	51	120
22-Apr-99	2	Milliman		40
22-Apr-99	3	Wallace	71	280
22-Apr-99	5	South End		460
22-Apr-99	7	Condos	100	60
22-Apr-99	7b	Condos Upstream		10
22-Apr-99	8	Perry Road		320
22-Apr-99	9	Carlton	43	80
22-Apr-99	14	Mack Street	190	34,000
23-Apr-00	1	Barnhart	65	
23-Apr-00	2	Milliman	41	60
23-Apr-00	3	Wallace	23	40
23-Apr-00	5	South End	53	50
23-Apr-00	7b	Condos Upstream	44	110
23-Apr-00	8	Perry Road	16	60
23-Apr-00	10	Reynolds		10

Appendix C
Goals, Objectives, and Strategies

LAKE LANSING WATERSHED MANAGEMENT PLANNING PROJECT

GOALS, OBJECTIVES AND STRATEGIES

February 17, 2002

The Lake Lansing Management Planning Assessment District held a series of public meetings in 2000 and 2001 to gain public input into how to manage Lake Lansing and its watershed in the future. The meetings were advertised through mailings, posters and notice on the Meridian Township cable television channel.

Participants were guided through a series of exercises to help develop goals and objectives. Subsequent public meetings were used to verify goals and objectives and to develop strategies.

The topic range was not constrained during the public meetings. As a result, a public wish list developed that centered on lake management but also dealt with quality of life issues of a more general nature. The Assessment District Board reviewed the goals, objectives and strategies and refined them to focus on lake and watershed management issues. Other public forums remain for interested citizens to pursue ancillary issues.

The goals, objectives and strategies developed based on public input and analysis by the Assessment District Board of the water quality data and land use maps are listed below. Where possible, an entity was identified to implement the strategy and a time frame suggested for beginning the effort.

Purpose:

To continue to maintain and improve the recreational and aesthetic enjoyment of the lake, the quality of the water, and the quality of life in and around Lake Lansing.

Specific Goal # 1: The Quality of Lake Lansing is maintained or improved from current year standards.

Objective: Water quality testing is on going to warn of any changes in water quality

· Strategy: Ingham County Parks Department continues bacterial testing of public beach and boat launch area of Lake Lansing.

· Strategy: LLPOA continues MLSA volunteer tests.

· Strategy: Special Assessment District continues to hire professional water quality testing.

· Strategy: Haslett Public Schools participate in water quality testing.

· Strategy: MSU limnology and other natural science programs continue.

· Strategy: Ingham County Health Department serves in an active advisory and resource capacity for water quality issues regarding Lake Lansing.

· Strategy: Begin continuous drain monitoring and include heavy metals in the tests.

Objective: Nutrients and other pollutants are prevented from entering the lake. Nutrients are primarily phosphorus and nitrogen. Other pollutants include sediment, bacteria, water of increased temperature, oils, pesticides, heavy metals and other harmful substances.

· Strategy: Advisory Committee initiates establishment through the Ingham and Clinton County Drain Commissioners of drainage districts for all drains within the watershed not already established. Begin process in first year and continue as funds available. Intent is to spread cost of drain district establishment and improvements so they are not burdensome on individuals.

- Strategy: Drain Commission/Township Public Works installs improved catch basins and/or drain filters for all storm drains through either drain districts, special assessment district funds, or grants. Begin process in first year. Implementation may take 5-10 years.
- Strategy: Assessment District, LLPOA, Meridian Township and Drain Commission install new wetland filters where appropriate on storm drains into Lake Lansing. Begin planning in first year in conjunction with storm drain catch basin improvements. Implementation may take 5-10 years.
- Strategy: LLPOA continues educational efforts regarding vegetation buffers and lake friendly lawn care. On-going implementation
- Strategy: LLPOA continues lake friendly yard award program. On-going implementation
- Strategy: Assessment District develops and circulates educational materials that address pet waste containment. Distribute by year two.
- Strategy: Meridian Township adopts a pet waste ordinance. Year two.
- Strategy: Ingham County Parks Department and local hardware and garden suppliers make phosphorus-free lawn fertilizer available to residents in the watershed. On-going.
- Strategy: Meridian Township and Bath Township (or Clinton County) Public Works Departments insure adequate treatment of sewage from all residences and businesses within the watershed.
- Strategy: Establish an oil recycling center in the Township. Meridian Township Public Works Department and others as appropriate. By year two.

Objective: Preserve Wetlands in the Lake Lansing Watershed as storm water filters.

- Strategy: Advisory Committee to encourage Meridian Township to use part of the Land preservation fund to purchase wetlands within the Lake Lansing watershed. On-going implementation.
- Strategy: Assessment District and LLPOA interacts with Meridian Township and Department of Environmental Quality to encourage enforcement of State and local wetlands statutes and ordinances. On-going implementation
- Strategy: Advisory Committee requests notification of any potential development within any wetland in the watershed in order to review and comment on lake impact of the plans. On-going implementation
- Strategy: Advisory Committee to review management plans for wetland or wetland development rights purchases within the Lake Lansing watershed. On-going implementation.

Objective: Aquatic plants managed by methods that support all recreational activities, including boating, swimming, and fishing. Nuisance and non-native invasive plant species will be kept to a minimum and native plants allowed to flourish to help provide fish habitat.

- Strategy: Advisory Committee continues to manage the plant growth in Lake Lansing through chemical treatments so that invasive aquatic plants are kept at a minimum and native plants are allowed to flourish. On-going implementation
- Strategy: Assessment District continues to work with professional lake management and treatment firms to gain input on management objectives. On-going implementation
- Strategy: Assessment District employs harvesting to remove appropriate aquatic plants and reduce biomass. Target every other year as funds are available and as lake management professionals advise.

Objective: Management of waterfowl and wild animal excrement as a contributory factor in lake contamination.

- Strategy: LLPOA continues appropriate geese round-ups. On-going implementation
- Strategy: Begin educational efforts regarding proper pet waste disposal. Include mailings to residents and sign postings for non - residents. Begin by year two
- Strategy: Assessment District Board will investigate impact of gull roosting on water quality and seek methods to reduce roosting gull population if determined to be a problem for the lake.

Objective: Zoning codes, i.e. foot prints, permeable surface and drainage regulations are enforced.

- Strategy: Meridian Township works with the Assessment District Board and LLPOA to update zoning requirements for the watershed. New regulations would promote consistency in zoning codes that allow nice homes to be built on reasonable footprints and that encourage greater permeable surfaces. Lake area residents begin background work in conjunction with Planning Department staff in order to make recommendations to Planning Commission by year two.
- Sub-Strategy: Encourage the idea of trade-off or mitigation, i.e. a larger footprint may be acceptable as long as the driveway is gravel or some other permeable surface. Another example would be to continue strict footprint enforcement in return for an easing of the Township's height restriction.
- Strategy: Meridian Township strictly enforces updated zoning requirements. On-going implementation

Objective: Dangerous materials are not improperly stored or used in the Lake Lansing community. Dangerous materials include large amounts of flammable liquids, explosives, dangerous construction materials or equipment and cast-off medical equipment and appliances.

- Strategy: Meridian Township Public Safety Department, Assessment District and Ingham County Health Department distribute educational materials on laws regarding dangerous materials. On-going implementation
- Strategy: Citizens within the watershed report dangerous materials or equipment to the Meridian Township Department of Public Safety, Ingham County Health Department or other appropriate agency. On-going implementation
- Strategy: Meridian Township Environmental Commission investigates status of hazardous materials plans for the township in regard to lands within the watershed.

Objective: Harmful wastes are not released in the Lake Lansing community.

- Strategy: LLPOA organizes household hazardous waste collections in cooperation with Ingham County Health Department. This may require use of Assessment District funds. On-going implementation
- Strategy: Ingham County Health Department distributes educational materials to inform residents as to what constitutes hazardous materials and how to dispose of them, i.e. how to dispose of left over paint or old batteries on proper handling, storage and disposal of hazardous materials. On-going implementation
- Strategy: Citizens within the watershed report hazardous waste discharges to the Ingham County Health Department or other appropriate agency. On-going implementation

Objective: Increase the depth of the lake.

· Strategy: Assessment District Board and LLPOA through Drain Commissioner, seeks to maintain legal lake level as high as practical.

· Strategy: Assessment District Board will investigate potential for selective dredging of hazardous areas as time and funds are available.

Specific Goal #2: Lake Lansing and its watershed provide a variety of safe recreational opportunities.

Objective: A variety of water activities are facilitated on Lake Lansing i.e. swimming, sailing, waterskiing, kayaking, canoeing, sailboarding, slow cruising, fishing, waterbiking (jet skis and waverunners) and other appropriate activities.

· Strategy: LLPOA, Ingham County Parks Department and Assessment District continue to encourage a variety of lake stakeholders to use and help manage Lake Lansing. On-going implementation

· Strategy: Assessment District, LLPOA and Ingham County Parks Department seek input on lake recreation and management from a variety of lake stakeholders. On-going implementation

· Strategy: Assessment District continues to monitor numbers and types of boats used on the lake and kept at riparian properties. If excessive boat use becomes a problem, LLPOA and Ingham County Parks Department will seek limitation on time, speed, type of use or numbers launched through Department of Natural Resources or other appropriate agencies. On-going implementation

Objective: Boating is conducted safely on Lake Lansing. People feel safe while boating on Lake Lansing and not at risk from other boaters.

· Strategy: LLPOA maintains close relations with Ingham County Sheriff's office and Meridian Township Police. On-going implementation

· Strategy: LLPOA encourages County and Township to provide frequent patrols and law enforcement. On-going implementation

· Strategy: LLPOA continues to provide riparians and users of boat launch pamphlets on marine safety laws and courteous and common sense boating behaviors. On-going implementation

· Strategy: LLPOA and law enforcement agencies provide in-service to citizens on how to report violators to the appropriate law enforcement office. LLPOA coordinates beginning in year one

· Sub-Strategy: LLPOA Safety Committee develops methods of enforcing the rules when the Sheriff is not on the lake.

· Sub-Strategy: Promulgate additional safety rules concerning waterskiing in one direction, speed limits, etc and propose to DNR for additional safety regulations. Begin as soon as boating levels become excessive or carrying capacity study establishes similar finding.

· Strategy: LLPOA continues to apply for markers for underwater hazards for periods of low water.

· Strategy: Assessment District will work with Meridian Township, stakeholders and Ingham County Parks Department to establish a carrying capacity for Lake Lansing and to set an agreed-upon limit for the number of multiple boat launch sites, including keyhole properties. Begin in year one

· Sub-Strategy: Meridian Township will amend the Master Plan to include the limit of multiple boat launch sites and adopt ordinances as necessary. Lake area residents begin background work in conjunction with Planning Department staff in order to make recommendations to Planning Commission by year two.

· Sub-Strategy: Township adopts anti-keyhole ordinance (s). Target year two

· Sub-Strategy: Include jet ski's, sailboats, etc when developing carrying capacity.

Objective: Lake Lansing provides a variety of winter recreation opportunities, i.e. ice fishing, walking, cross country skiing, ice boating and snowmobiling.

· Strategy: Ingham County Parks Department continues to provide winter access to Lake Lansing. On-going implementation

Specific Goal # 3: The Community at large takes responsibility for the care of Lake Lansing.

Objective: All those who benefit from and enjoy Lake Lansing help fund the management of the lake and its watershed.

· Strategy: Recommend renewal of Assessment District for an additional five years with funding from two or three tier special assessment district with Ingham County and Meridian Township participation. Current activity at end of first Assessment District period.

· Strategy: LLPOA will seek larger input of Countywide funding for lake management. Current activity at end of first Assessment District period

· Sub-strategy: Encourage Ingham County to institute a charge for cars at the South park with the proceeds going towards lake maintenance.

· Sub-strategy: Encourage greater financial participation from Ingham County by increased public awareness.

· Sub-strategy: Encourage Meridian Township to solicit Ingham County to contribute more because this is the only lake in the county.

· Strategy: Ingham County and Meridian Township apply for grants to assists with funding of lake maintenance. On-going implementation

· Strategy: Seek prticipation, including financial support from Clinton County (Bath Township)

· Strategy: Start a "Friends of Lake Lansing" non profit organization in order to raise funds for lake maintenance projects. LLPOA activity beginning year one.

Objective: There is widespread sharing of responsibility for the care of Lake Lansing and its watershed.

· Strategy: Continue Assessment District "Advisory Committee" type decision making structure with participation from riparian owners, tier two owners (and any others included in the Assessment District) Ingham County and Meridian Township. On-going implementation

· Strategy: Continue cooperative water quality testing efforts with some components completed by volunteers, some by professionals, and some components completed by the Ingham County Health Department. On-going implementation

Objective: The entire population of the Lake Lansing watershed is aware of the watershed management principles and understands why they are important and how to implement them.

· Strategy: Assessment District will expand educational efforts watershed wide, including information at the library, schools, Meridian Township's Home TV, newspapers, newsletters and other approaches as needed. On-going implementation

· Strategy: LLPOA will keep students involved in lake activities, i.e. include water conservation with history during Michigan History week or MLSA testing. On-going implementation

· Strategy: LLPOA will invite Scouts to be involved in clean up efforts. On-going implementation

· Strategy: LLPOA will inform John Schneider or other columnists at local newspapers about clean up efforts and try to get stories in the area newspapers. On-going implementation

· Strategy: LLPOA will inform all homes within the watershed about buying lake friendly fertilizer from Ingham County parks and other local suppliers. On-going implementation

· Strategy: Meridian Township will create public service spots regarding pet waste and appropriate fertilizer use. On-going implementation.

· Strategy: LLPOA will create a Lake Lansing web site to inform people of issues affecting the lake. Target implementation by year two.

· Strategy: LLPOA will add Lake Lansing information to other websites, i.e. Ingham County Parks, Meridian Township, Board of Realtors. On-going implementation

· Strategy: Ingham County Road Commission will add to "Now entering Lake Lansing watershed" signs. Possibly "Do your part/keep it clean", "For the Sake of the Lake"/Please don't Litter. Target implementation by year two.

· Strategy: County Road Commission and or Meridian Township will put up additional friendly signs such as "Pitch In" or "Pick Up after Your pet". Target implementation by year two

· Strategy: Meridian Township and or County Road Commission will put up signs by storms drains reminding people that they run directly into the lake and affect the fish. Target implementation by year two

Specific Goal #4: The Lake Lansing area retains its natural beauty and is a healthy, safe place to live or spend time.

Objective: The southern shoreline remains a well-vegetated, viable marshland.

· Strategy: Meridian Township adopts a viable vegetation management plan for its property at the south end of the lake. Target completion by year two, Meridian Township Environmental Affairs Commission and or Land Preservation Commission to implement.

· Strategy: Assessment District and LLPOA elicit support of resource professionals to investigate proactive methods of maintaining existing natural vegetation and to plant additional natural vegetation. Target recommendations by year two.

· Strategy: Assessment District and LLPOA elicits support of resource professionals to investigate methods to control and monitor purple loosestrife. On-going implementation

· Strategy: Citizens erect birdhouses to attract kingfishers and/or purple martins to this area. (LLPOA provides information) On-going implementation

· Strategy: Citizens erect bat houses in this area. (LLPOA provides information) On-going implementation

Objective: The lake shoreline has a natural appearance wherever possible.

· Strategy: LLPOA promotes lake-friendly plantings in the riparian edge. On-going implementation

· Strategy: LLPOA promotes natural landscape plantings along the roadside of properties on both sides of Lake Drive and other near-lake roads. On-going implementation

· Strategy: Ingham County Parks Department maintains natural plantings along road edges of park properties along the lake. On-going implementation with initial plantings as soon as funding available.

- Strategy: Ingham County Road Commission practices a minimum maintenance program along roads near Lake Lansing (within safety guidelines). On-going implementation
- Strategy: LLPOA encourages residents to either use a phosphorus free fertilizer or no fertilizer at all on their lawns. On-going implementation
- Strategy: LLPOA promotes natural seawalls. On-going implementation
- Strategy: LLPOA encourages and provides information to adjacent property owners on how to improve the quality of the easements with plantings. On-going implementation
- Strategy: Assessment District and LLPOA encourages Meridian Township to improve Perry Road road-end with plantings. Target implementation by year two.

Objective: Views of the Lake Lansing are maintained from Lake Drive and other roads surrounding the lake.

- Strategy: Meridian Township adopts an overlay district and updated zoning ordinance for the lake and strictly enforces side-yard setbacks on new construction. Lake area residents begin background work in conjunction with Planning Department staff in order to make recommendations to Planning Commission by year two.