



**Lake Lansing
Special Assessment District
2010 Annual Report**

Prepared for:

Charter Township of Meridian

and

Lake Lansing Special Assessment District Advisory Committee

Prepared by:

Progressive AE

1811 4 Mile Road, NE

Grand Rapids, MI 49525-2442

616/361-2664

January 2011

Project No: 53260102

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Executive Summary

The Lake Lansing Special Assessment District (SAD) was formed in 1998 for the purposes of improving conditions in Lake Lansing. In 2007, public hearings were held to continue the project. The project includes an update of the lake and watershed management plan, water quality sampling, nuisance aquatic plant control, watershed improvements, educational programs, and grant applications. The project is overseen by the Lake Lansing SAD Advisory Committee, whose members include representatives of residents within the SAD, Meridian Township, Ingham County Parks, and the Ingham County Drain Commissioner's Office. A summary of project activities is as follows:

Water Quality Sampling: In 2010, samples were collected from Lake Lansing and from tributary streams in spring and late summer. Lake Lansing is borderline between mesotrophic (moderately productive) and eutrophic (nutrient-enriched and productive). During the 2010 sampling period, phosphorus levels were generally low with a few exceptions. Water clarity was excellent in spring and poor in late summer. Algae growth was low in spring and late summer. Tributary streams carry only a small volume of water into Lake Lansing, but nutrients in the streams likely stimulate localized aquatic plant growth.

Nuisance Aquatic Plant Control: In April and May of 2010, the herbicide fluridone was applied throughout Lake Lansing in order to control the non-native plant Eurasian milfoil. By late June, no milfoil was found and the lake remained milfoil-free for the remainder of the summer. During a late summer survey, 13 species of aquatic plants were found, including the non-native plant starry stonewort. Starry stonewort has been a severe nuisance invasive plant in several other Michigan inland lakes, therefore it will be important to monitor and control the spread of starry stonewort in the future.

Watershed Improvements: Investigation continued on the storm drain system for the Meadowbrook subdivision that drains to Lake Lansing via piping along the west side of Perry Road. Results indicate that the Meadowbrook drain carries high levels of phosphorus during storm events. The Advisory Committee will investigate improvements to the Perry Road storm sewer to reduce pollutant input to Lake Lansing.

Meetings: The Advisory Committee meets monthly to oversee activities for the Lake Lansing improvement project.

Introduction

Lake Lansing is located in Meridian Township, Ingham County, Michigan (Figure 1). 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. In March of 2002, a management plan was prepared for Lake Lansing and its watershed. Public hearings were held in the summers of 2002 and 2007 to continue the management program for Lake Lansing. Ongoing management is overseen by the Lake Lansing Special Assessment District Advisory Committee (hereinafter, the Advisory Committee) with assistance from the Advisory Committee professional consultant. The Advisory Committee includes representatives from each of the tiers in the special assessment district, Lake Lansing Property Owners Association, Meridian Township Engineering Department, Ingham County Parks Department, and Ingham County Drain Commissioner's Office. This report includes information on 2010 Lake Lansing management activities.

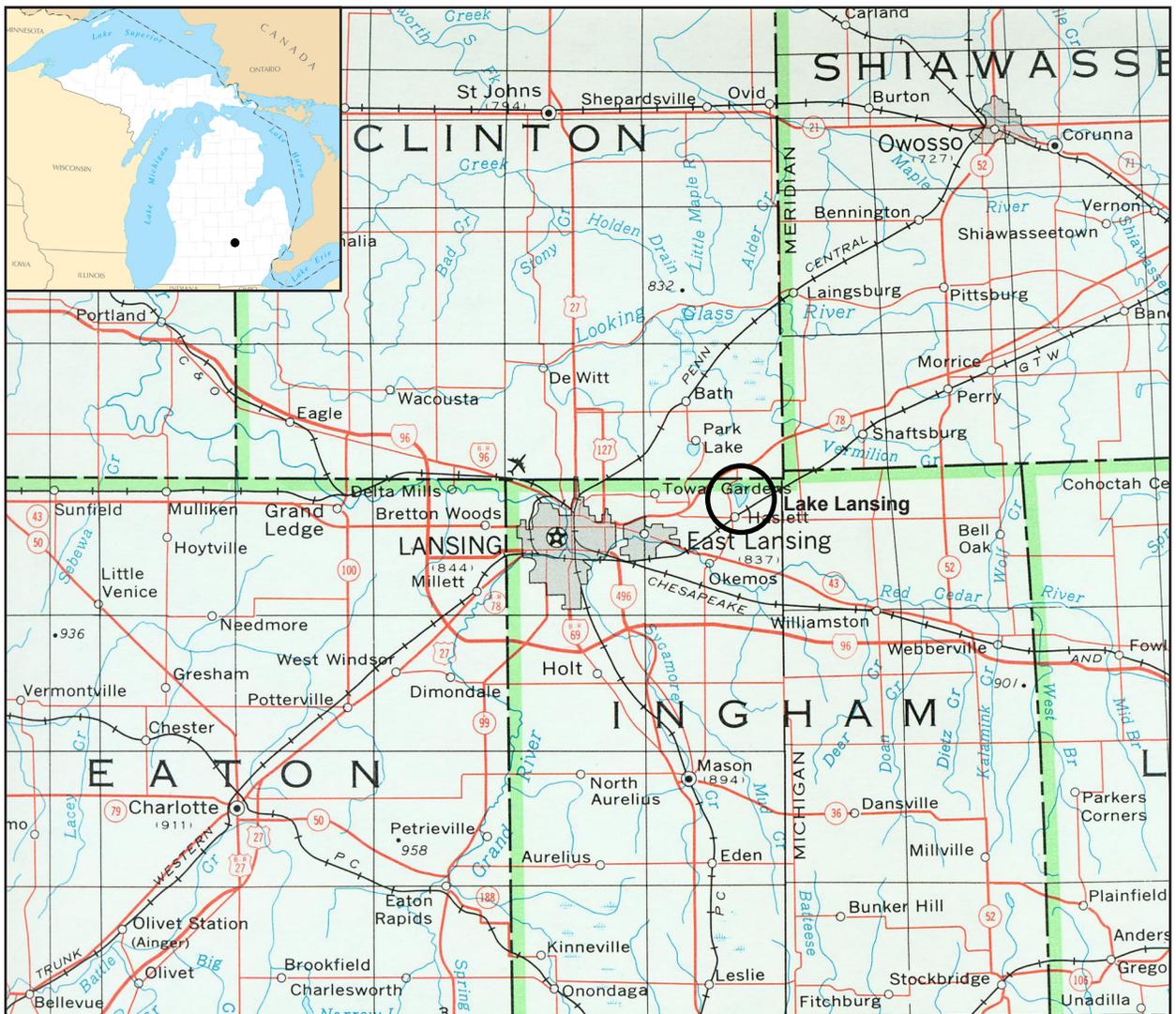


Figure 1. Lake Lansing location map. Source: United States Geological Survey.

Water Quality Sampling

Lake Water Quality

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

Lakes are commonly classified as oligotrophic, mesotrophic, or eutrophic (Figure 2). Oligotrophic lakes are generally deep and clear with little aquatic plant growth. These lakes maintain sufficient dissolved oxygen in the cool, deep bottom waters during late summer to support cold water fish such as trout and whitefish. By contrast, eutrophic lakes are generally shallow, turbid, and support abundant aquatic plant growth. In deep eutrophic lakes, the cool bottom waters usually contain little or no dissolved oxygen. Therefore, these lakes can only support warm water fish such as bass and pike. Lakes that fall between these two extremes are called mesotrophic lakes.

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

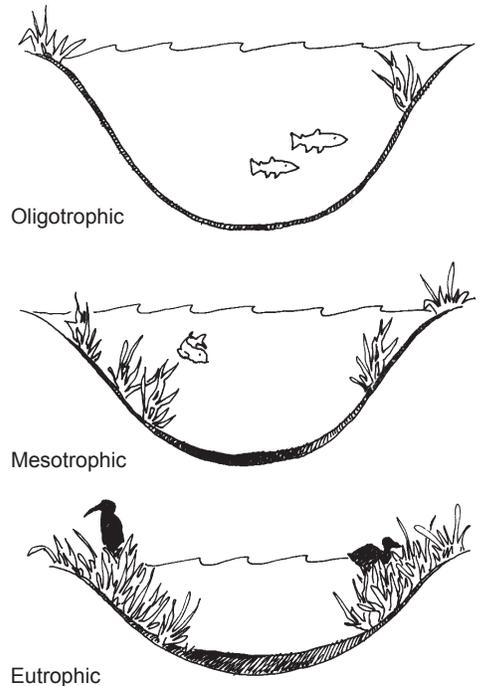


Figure 2. Lake classification.

TEMPERATURE

Temperature is important in determining the type of organisms which may live in a lake. For example, trout prefer temperatures below 68°F. Temperature also determines how water mixes in a lake. As the ice cover breaks up on a lake in the spring, the water temperature becomes uniform from the surface to the bottom. This period is referred to as "spring turnover" because water mixes throughout the entire water column. As the surface waters warm, they are underlain by a colder, more dense strata of water. This process is called thermal stratification (Figure 3). Once thermal stratification occurs, there is little mixing of the warm surface waters with the cooler bottom waters. The transition layer that separates these layers is referred to as the "thermocline." The thermocline is characterized as the zone where temperature drops rapidly with depth. As fall approaches, the warm surface waters begin to cool and become more dense. Eventually, the surface temperature drops to a point that allows the lake to undergo complete mixing. This period is referred to as "fall turnover." As the season progresses and ice begins to form on the lake, the lake may stratify again. However, during winter stratification, the surface waters (at or near 32°F) are underlain by slightly warmer water (about 39°F). This is sometimes referred to as "inverse stratification" and occurs because water is most dense at a temperature of about 39°F. As the lake ice melts in the spring, these stratification cycles are repeated.

DISSOLVED OXYGEN

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

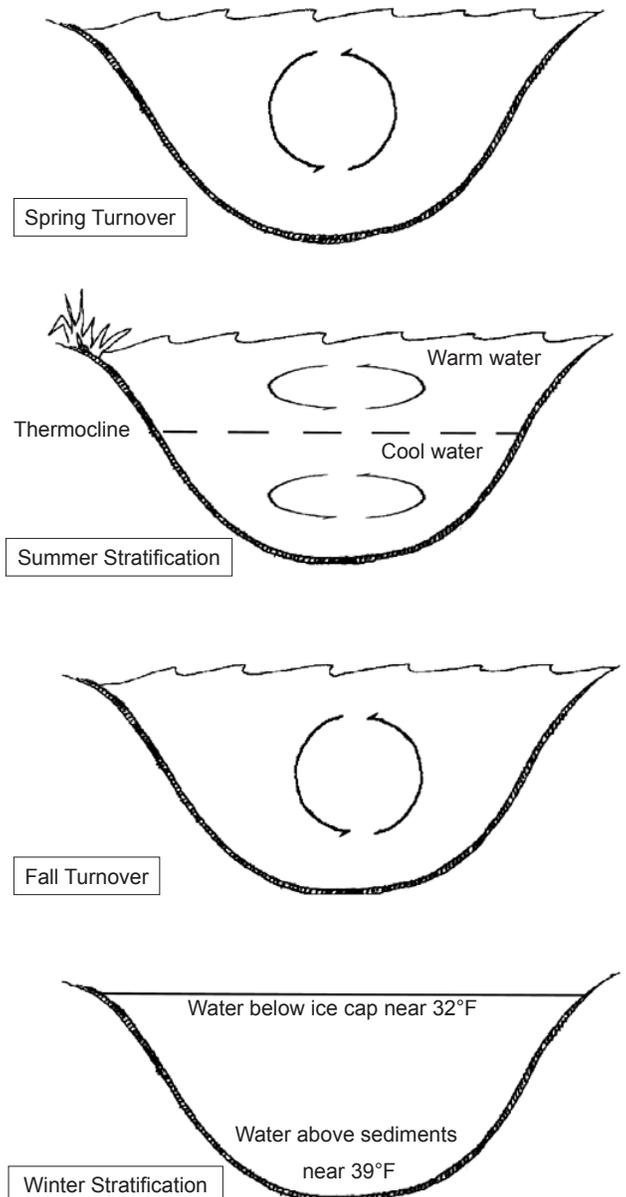


Figure 3. Seasonal thermal stratification cycles.

PHOSPHORUS

The quantity of **phosphorus** present in the water column is especially important since phosphorus is the nutrient that most often controls aquatic plant growth and the rate at which a lake ages and becomes more eutrophic. By reducing the availability of phosphorus in a lake, it is often possible to control the amount of aquatic plant growth. In general, lakes with a phosphorus concentration of 20 µg/L (micrograms per liter, or parts per billion) or greater are able to support abundant plant growth and are classified as nutrient-enriched or eutrophic.

Phosphorus enters the lake water either from the surrounding watershed, or from the sediments in the lake itself, or both. The input of phosphorus from the watershed is called "external loading," and from the sediments is called "internal loading." External loading occurs when phosphorus washes into the lake from sources such as fertilizers, septic systems, and eroding land. Internal loading occurs when bottom-water oxygen is depleted, resulting in a chemical change in the water near the sediments. The chemical change causes phosphorus to be released from the sediments into the lake where it becomes available as a nutrient for aquatic plants.

CHLOROPHYLL-a

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

SECCHI TRANSPARENCY

A **Secchi disk** is often used to estimate water clarity. The measurement is made by fastening a round, black and white, 8-inch disk to a calibrated line (Figure 4). The disk is lowered over the deepest point of the lake until it is no longer visible, and the depth is noted. The disk is then raised until it reappears. The average between these two depths is the Secchi transparency. Generally, it has been found that aquatic plants can grow at a depth of at least twice the Secchi transparency measurement. In eutrophic lakes, water clarity is often reduced by algae growth in the water column, and Secchi disk readings of 7.5 feet or less are common.

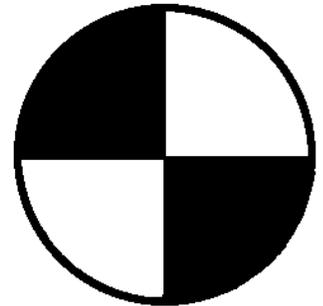


Figure 4. Secchi disk.

Ordinarily, as phosphorus inputs (both internal and external) to a lake increase, the amount of algae the lake can support will also increase. Thus, the lake will exhibit increased chlorophyll-a levels and decreased transparency. A summary of lake classification criteria developed by the Michigan Department of Environmental Quality is shown in Table 1.

TABLE 1
LAKE CLASSIFICATION CRITERIA

Lake Classification	Total Phosphorus (µg/L) ¹	Chlorophyll-a (µg/L) ¹	Secchi Transparency (feet)
Oligotrophic	Less than 10	Less than 2.2	Greater than 15.0
Mesotrophic	10 to 20	2.2 to 6.0	7.5 to 15.0
Eutrophic	Greater than 20	Greater than 6.0	Less than 7.5

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

pH and TOTAL ALKALINITY

pH is a measure of the amount of acid or base in the water. The pH scale ranges from 0 (acidic) to 14 (alkaline or basic) with neutrality at 7. The pH of most lakes generally ranges from 6 to 9 (Wetzel 1983). Alkalinity is the measure of the pH-buffering capacity of water in that it is the quantitative capacity of water to neutralize an acid.

SAMPLING METHODS

Water quality sampling was conducted in the spring and late summer of 2010 at the two deep basins within Lake Lansing (Figure 5). Temperature was measured using a YSI Model 550A probe. Samples were collected at the surface, mid-depth, and just above the lake bottom with a Kemmerer bottle to be analyzed for dissolved oxygen, pH, total alkalinity, and total phosphorus. Dissolved oxygen samples were fixed in the field and then transported to Progressive AE for analysis using the modified Winkler method (Standard Methods procedure 4500-O C). pH was measured in the field using a YSI EcoSense pH meter. Total alkalinity and total phosphorus samples were placed on ice and transported to Progressive AE and to Prein and Newhof¹, respectively, for analysis. Total alkalinity was titrated at Progressive AE using Standard Methods procedure 2320 B, and total phosphorus was analyzed at Prein and Newhof using Standard Methods procedure 4500-P E. In addition to the depth-interval samples at each deep basin, Secchi transparency was measured and composite chlorophyll-*a* samples were collected from the surface to a depth equal to twice the Secchi transparency. Chlorophyll-*a* samples were analyzed by Prein and Newhof using Standard Methods procedure 10200 H.

Tributary monitoring was conducted in spring and late summer for the most significant storm drains and inlet streams (Figure 5). Tributary stream discharge was estimated using the U.S. Geological Survey midsection method (Buchanan and Somers 1969). Stream velocity was measured with a Pygmy Gurley flow meter. Prein and Newhof analyzed samples for total phosphorus, total solids (EPA Method 160.3), and total suspended solids (Standard Methods 4500P-E).

¹ Prein and Newhof Environmental and Soils Laboratory, 3260 Evergreen, NE, Grand Rapids, MI.

WATER QUALITY SAMPLING

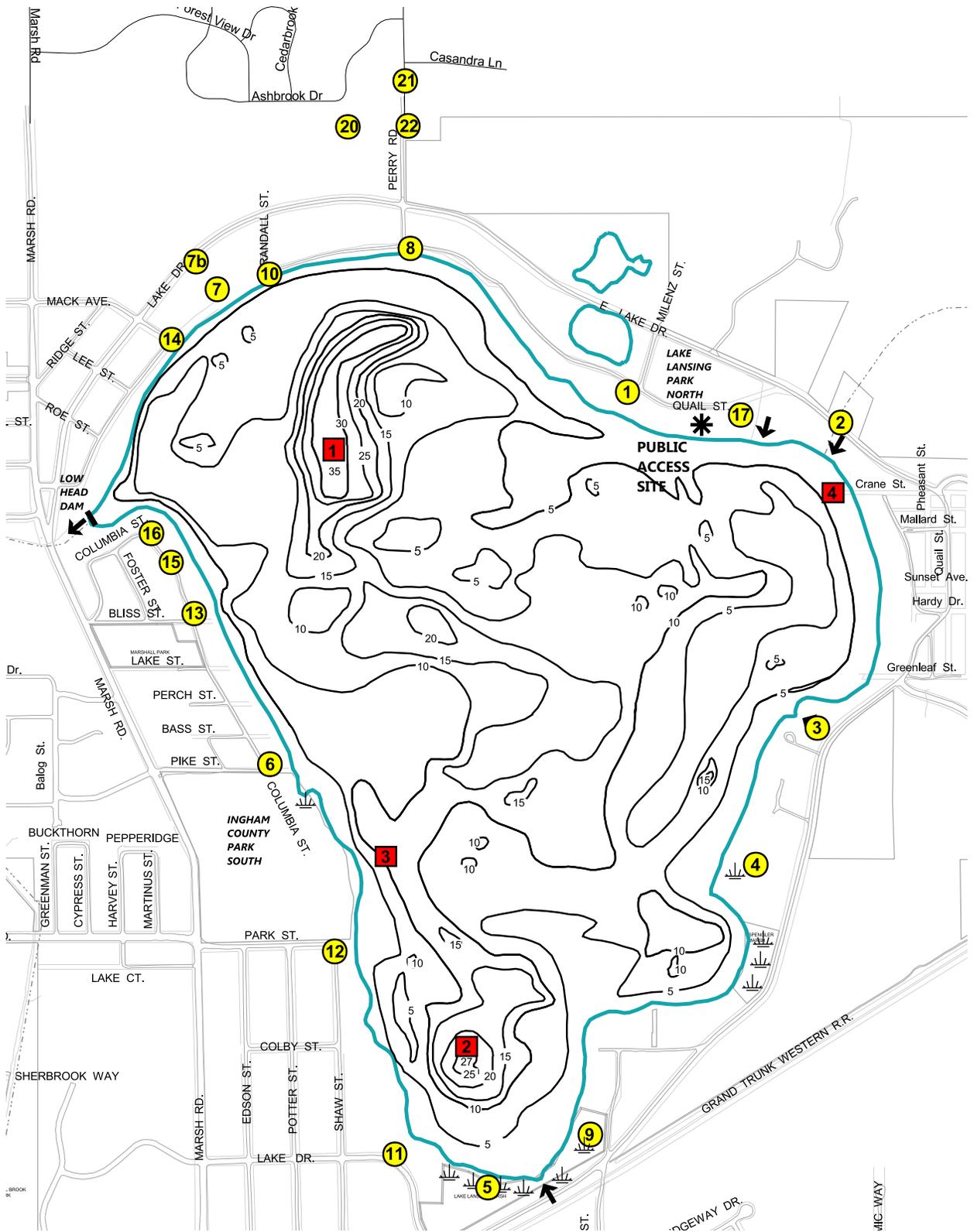


Figure 5. Lake Lansing sampling location map. Since 2003, deep basin samples were collected only from sites 1 and 2; storm drain samples were collected from sites 1, 2, 3, 5, and 8.

Sampling Results and Discussion

Sampling results are provided in Tables 2 through 4. A graphic summary of water quality data compiled to date is shown in Figures 6 through 8 and summary statistics are included in Table 5. Historical data for Lake Lansing is contained in Appendix A.

**TABLE 2
LAKE LANSING
2010 DEEP BASIN WATER QUALITY DATA**

Date	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L) ¹	pH (S.U.) ²	Total Alkalinity (mg/L CaCO ₃) ³	Total Phosphorus (µg/L) ⁴
30-Mar-10	1	1	46	10.6	8.1	127	6
30-Mar-10	1	15	44	11.0	7.8	129	14
30-Mar-10	1	30	44	10.8	7.5	128	6
30-Mar-10	2	1	45	11.2	7.9	128	12
30-Mar-10	2	12	44	10.3	7.9	130	11
30-Mar-10	2	24	43	10.7	7.9	129	6
31-Aug-10	1	1	78	8.6	8.2	125	<5
31-Aug-10	1	15	75	7.3	8.3	125	<5
31-Aug-10	1	30	58	1.1	7.3	160	327
31-Aug-10	2	1	77	9.4	8.2	120	<5
31-Aug-10	2	12	74	8.4	8.3	124	<5
31-Aug-10	2	24	59	0.5	6.9	176	26

**TABLE 3
LAKE LANSING
2010 SURFACE WATER QUALITY DATA**

Date	Station	Secchi Transparency (feet)	Chlorophyll-a (µg/L) ⁴
30-Mar-10	1	19.5	1
30-Mar-10	2	19.0	0
31-Aug-10	1	7.0	2
31-Aug-10	2	7.0	1

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

² S.U. = standard units.

³ mg/L CaCO₃ = milligrams per liter as calcium carbonate.

⁴ µg/L = micrograms per liter = parts per billion.

**TABLE 4
LAKE LANSING
2010 STORM DRAIN MONITORING DATA**

Date	Site	Name	Discharge (cfs)¹	Total Phos. (µg/L)²	Total Solids (mg/L)³	Total Susp. Solids (mg/L)
30-Mar-10	1	Barnhart		27	392	<4
30-Mar-10	2	Milliman	0.5	21	336	<4
30-Mar-10	3	Wallace	0.6	9	316	<4
30-Mar-10	5	South End	0	32	360	<4
30-Mar-10	8	Perry Road	0	33	452	14
6-Apr-10	20	Meadowbrook Subdivision		98		
7-Apr-10	20	Meadowbrook Subdivision		37	228	7.27
7-Apr-10	21	Perry Road between county line and Ashbrook		54		
16-Sep-10	20	Meadowbrook Subdivision		583		24
22-Sep-10	20	Meadowbrook Subdivision		162		10
22-Sep-10	22	Perry Road Buried Manhole #107		218		20

1 cfs = cubic feet per second.

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

3 mg/L = milligrams per liter.

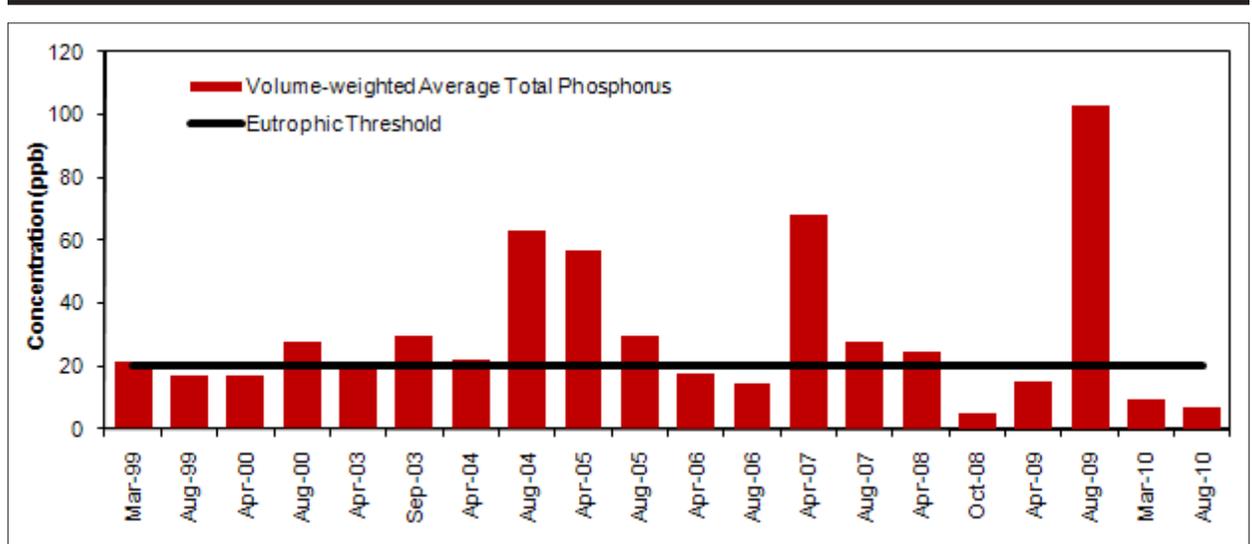


Figure 6. Volume-weighted average total phosphorus concentrations, 1999-2010.

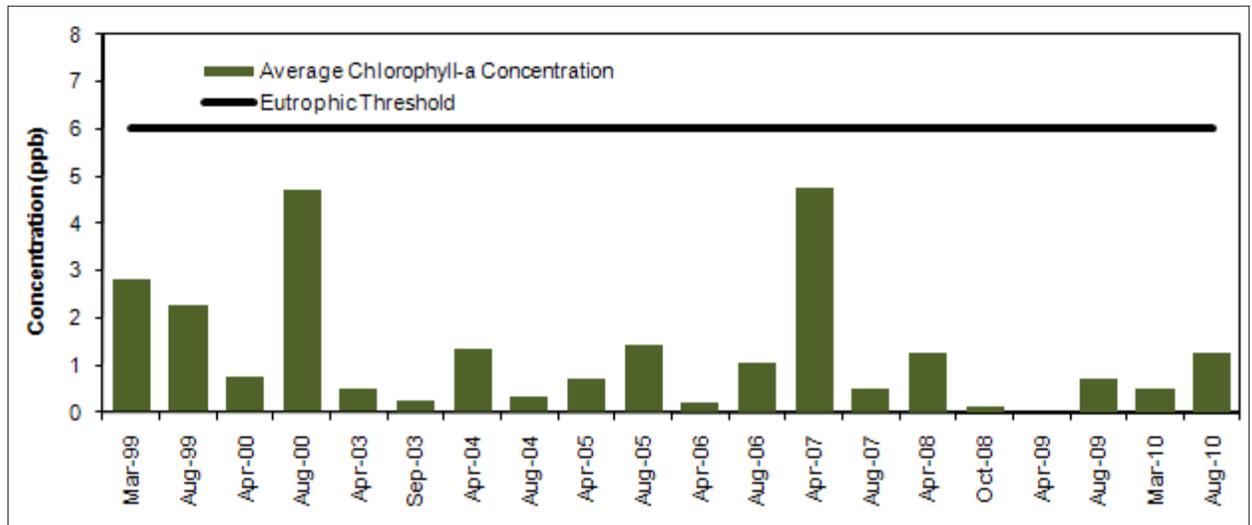


Figure 7. Chlorophyll-a concentrations, 1999-2010.

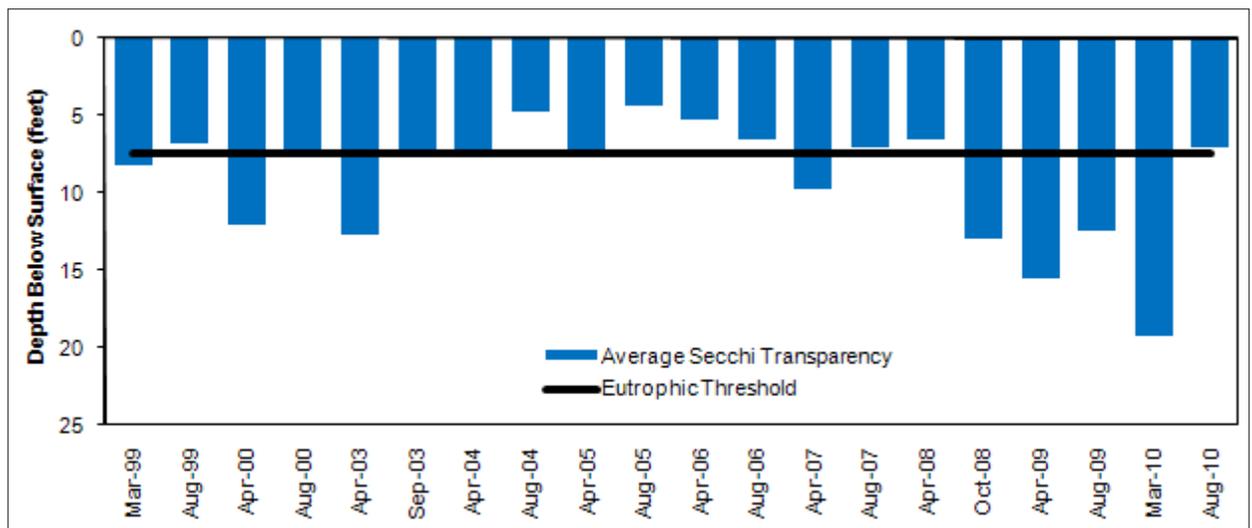


Figure 8. Secchi transparency measurements, 1999-2010.

TABLE 5
LAKE LANSING
SUMMARY STATISTICS (1999-2010)¹

	Total Phosphorus (µg/L)²	Chlorophyll-a (µg/L)²	Secchi Transparency (feet)
Mean	37	1	9.1
Standard deviation	51	2	3.9
Median	23	1	7.5
Minimum	5	0	4.3
Maximum	327	9	19.5
Number of samples	131	40	40

In March of 2010, sampling was conducted during spring turnover when water temperatures were cool, dissolved oxygen was high, and both were nearly uniform from the surface to bottom. During the August sampling period, Lake Lansing was stratified with the warm surface waters underlain by cool oxygen-depleted water in the deepest portions of the lake. The elevated phosphorus level measured at the bottom of Site 1 indicated that internal release of phosphorus from the anaerobic bottom sediments was occurring at this location. With the exception of the deep basins in the lake, dissolved oxygen levels throughout the water column of Lake Lansing appear sufficient to sustain warm water fish during ice-free periods.

Chlorophyll-a levels indicate algae growth was low during both sampling periods in 2010, which has generally been the case since sampling began in 1999. Water clarity was excellent in spring and poor in late summer. The spring Secchi transparency was the highest measurement since the program began in 1999. Improved clarity in recent years is likely related to the presence of zebra mussels which filter lake water and consume algae, and, in doing so, increase water clarity. The reduced late summer transparency may be related to boating activity which stirs the water and reduces clarity. In general, plants can grow to a depth of about twice the Secchi transparency reading. With a median Secchi transparency of 7.5 feet, the clarity of Lake Lansing is sufficient to allow sunlight to penetrate to about 15 feet of depth, which is over 90 percent of the lake bottom, making nearly all of the lake habitable for plant growth.

Tributary sampling in 2010 showed only a small volume of water drains to Lake Lansing from the tributary streams and drains. Thus, the overall load of pollutants into Lake Lansing from the inlets may be low, but nutrients carried to the lake likely stimulate localized aquatic plant growth. Samples were also collected in the Meadowbrook subdivision downstream of the wetland detention areas (site #20), from two catch basins along Perry Road (sites #21 and #22). Storm sewers from sites #20 and #21 both drain into Site #22. Phosphorus levels from the subdivision and Perry Road were high or very high. During storm events, high levels of phosphorus wash into Lake Lansing from the storm sewer that runs along Perry Road. The Lake Lansing Advisory Committee will investigate improvements to the Perry Road storm sewer to reduce pollutant input to Lake Lansing.

Summary statistics indicate Lake Lansing is borderline between mesotrophic (moderately productive) and eutrophic (nutrient-enriched and productive). Phosphorus levels range from moderate to high, bottom-water oxygen is reduced, and water clarity is moderate. Rooted plant growth in Lake Lansing is locally dense and algae growth is generally moderate or low, thus it would appear that phosphorus is more readily used by rooted plants in the lake rather than algae.

¹ Summary statistics include data from sampling stations 1 and 2 only. Historically, samples were also collected from two additional stations near the shoreline, but only deep basin data is included in this analysis.

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

Nuisance Aquatic Plant Control

The focus of the plant control program in Lake Lansing is control of exotic (i.e., non-native) plants such as Eurasian milfoil and curly-leaf pondweed, and control of native plants that reach nuisance densities (Figure 9). On April 16, 2010, the herbicide fluridone was applied throughout Lake Lansing at 6 parts per billion in order to control Eurasian milfoil. On May 4, the lake was re-treated for the final time to bring the concentration of fluridone in the lake back up to 6 parts per billion. On June 1, milfoil plants appeared impacted, but were still upright in the water column. By June 24, no milfoil was found. Lake Lansing was surveyed four times in July and August and remained milfoil-free for the remainder of the summer. On August 23, the lake was surveyed using the Department of Natural Resources and Environment's *Procedures for Aquatic Vegetation Surveys*. Lake Lansing was segmented into a 68 survey sites and the type and density of plants at each sites was recorded (Table 6).

TABLE 6
LAKE LANSING AQUATIC PLANT FREQUENCY AND DENSITY
AUGUST 23, 2010

Common Name	Scientific Name	Number of Survey Sites Where Plant Was Found		
		Rare	Sparse	Common Dense
Wild celery	<i>Vallisneria americana</i>		35	22
Chara	<i>Chara</i> sp.	1	23	10
Flat-stem pondweed	<i>Potamogeton zosteriformis</i>		11	11
Cattail	<i>Typha</i> sp.		2	1 10
Yellow waterlily	<i>Nuphar</i> sp.		3	3
Thin-leaf pondweed	<i>Potamogeton</i> sp.		2	2
White waterlily	<i>Nymphaea odorata</i>		1	3
Elodea	<i>Elodea canadensis</i>		3	
Starry stonewort	<i>Nitellopsis obtusa</i>		1	2
Arrow arum	<i>Peltandra virginica</i>		2	1
Large-leaf pondweed	<i>Potamogeton amplifolius</i>		2	
Needle spikerush	<i>Eleocharis acicularis</i>		1	1
Bulrush	<i>Scirpus</i> sp.		2	

NUISANCE AQUATIC PLANT CONTROL

A total of 13 species was found. Wild celery and Chara were the most common plants. Of concern was the occurrence of non-native plant starry stonewort which has become a severe nuisance plant in several Michigan lakes. Starry stonewort looks like a rooted plant but is actually an algae, similar in appearance to the native plant Chara (Figure 9). However, unlike Chara, starry stonewort can grow in mats several feet thick which can interfere with navigation, recreational use, and may interfere with fish spawning habitat. It will be important to monitor and control the spread of starry stonewort in the future.



Figure 9. Chara (left) and starry stonewort (right).

Appendix A
Lake Lansing
Historical Water Quality Data

**TABLE A1
LAKE LANSING
1999-2009 DEEP BASIN WATER QUALITY DATA**

Date	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L) ¹	pH (S.U.) ²	Total Alkalinity (mg/L CaCO ₃) ³	Total Phosphorus (µg/L) ⁴
29-Mar-99	1	1	44.0	12.9	8.4	124	20
29-Mar-99	1	5	44.0	11.9			
29-Mar-99	1	10	44.0	11.6			
29-Mar-99	1	15	44.5	12.9	8.3	122	20
29-Mar-99	1	20	44.5	13.4			
29-Mar-99	1	25	44.5	12.5			
29-Mar-99	1	30	44.5	13.8	8.3	127	22
29-Mar-99	2	1	44.5	12.2	8.2	127	22
29-Mar-99	2	6	44.5	13.4			
29-Mar-99	2	12	44.5	12.6	8.4	128	23
29-Mar-99	2	18	44.5	12.6			
29-Mar-99	2	23	44.5	12.3	8.2	126	23
29-Mar-99	3	1	44.0	12.6	7.9	130	25
29-Mar-99	4	1	44.5	12.7	8.4	126	27
11-Aug-99	1	1	73.1	8.0	8.3	114	14
11-Aug-99	1	5	72.8	8.0			
11-Aug-99	1	10	72.5	7.3			
11-Aug-99	1	15	72.0	7.4	8.4	116	20
11-Aug-99	1	20	71.0	6.6			
11-Aug-99	1	25	60.0	1.3			
11-Aug-99	1	30	58.0	0.8	7.2	172	56
11-Aug-99	2	1	73.2	8.2	8.4	104	17
11-Aug-99	2	6	72.5	8.4			
11-Aug-99	2	12	72.0	7.0	8.3	115	20
11-Aug-99	2	18	69.0	2.4			
11-Aug-99	2	23	56.5	1.1	7.5	130	40
11-Aug-99	3	1	72.5	8.0	8.5	115	22
11-Aug-99	4	1	74.0	8.1	8.4	118	18

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

2 S.U. = standard units.

3 mg/L CaCO₃ = milligrams per liter as calcium carbonate.

4 µg/L = micrograms per liter = parts per billion.

TABLE A1 (continued)
LAKE LANSING
1999-2009 DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L) ¹	pH (S.U.) ²	Total Alkalinity (mg/L CaCO ₃) ³	Total Phosphorus (µg/L) ⁴
17-Apr-00	1	1	50.0	10.9	8.7	132	14
17-Apr-00	1	5	50.0	10.8			24
17-Apr-00	1	10	50.0	10.9			28
17-Apr-00	1	15	50.0	10.8	8.4	133	27
17-Apr-00	1	20	50.0	10.8			19
17-Apr-00	1	25	50.0	10.7			19
17-Apr-00	1	30	50.0	10.8	8.4	130	13
17-Apr-00	2	1	50.7	10.7	8.4	119	11
17-Apr-00	2	6	50.9	10.6			15
17-Apr-00	2	12	50.7	10.4	8.4	131	29
17-Apr-00	2	18	50.7	10.3			13
17-Apr-00	2	23	50.5	10.6	8.5	127	11
10-Aug-00	1	1	75.9	7.9	8.8	132	25
10-Aug-00	1	5	75.9	7.7			27
10-Aug-00	1	10	75.7	7.9			20
10-Aug-00	1	15	75.2	7.5	7.9	110	20
10-Aug-00	1	20	71.8	3.5			35
10-Aug-00	1	25	61.9	0.4			184
10-Aug-00	1	30	58.3	0.5	7.6	160	71
10-Aug-00	2	1	76.1	8.4	8.8	143	20
10-Aug-00	2	6	75.9	8.3			20
10-Aug-00	2	12	74.1	6.2	8.6	128	27
10-Aug-00	2	18	67.1	0.9			232
10-Aug-00	2	24	57.2	1.2	7.6	169	93
7-Apr-03	1	1	40.5	12.2			16
7-Apr-03	1	14	40.3	12.4			
7-Apr-03	1	28	40.6	11.8			23
7-Apr-03	2	1	39.7	11.8			23
7-Apr-03	2	9	39.7	11.7			28
7-Apr-03	2	18	39.6	11.7			34

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

2 S.U. = standard units.

3 mg/L CaCO₃ = milligrams per liter as calcium carbonate.

4 µg/L = micrograms per liter = parts per billion.

TABLE A1 (continued)
LAKE LANSING
1999-2009 DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)¹	pH (S.U.)²	Total Alkalinity (mg/L CaCO₃)³	Total Phosphorus (µg/L)⁴
11-Sept-03	1	1	74.8	8.1			28
11-Sept-03	1	13	70.7	6.7			36
11-Sept-03	1	25	63.5	0.0			198
11-Sept-03	2	1	74.3	8.5			18
11-Sept-03	2	11	70.5	8.1			41
11-Sept-03	2	21	65.3	0.0			79
12-Apr-04	1	1	47	11.9	8.6	123	26
12-Apr-04	1	15	47	11.8	8.6	121	32
12-Apr-04	1	30	47	11.6	8.7	122	31
12-Apr-04	2	1	47	12.1	8.7	125	17
12-Apr-04	2	11	47	12.1	8.7	120	17
12-Apr-04	2	22	46	11.5	8.6	125	27
30-Aug-04	1	1	73	7.3			11
30-Aug-04	1	15	73	7.1			12
30-Aug-04	1	30	59	1.2			39
30-Aug-04	2	1	72	7.3			116
30-Aug-04	2	10	72	7.3			127
30-Aug-04	2	21	62	0.5			9
5-Apr-05	1	1	47	10.8		149	71
5-Apr-05	1	14	46	10.4		149	44
5-Apr-05	1	28	44	10.8		151	37
5-Apr-05	2	1	47	11.0		137	44
5-Apr-05	2	11	47	10.6		151	44
5-Apr-05	2	22	44	10.6		154	123

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

2 S.U. = standard units.

3 mg/L CaCO₃ = milligrams per liter as calcium carbonate.

4 µg/L = micrograms per liter = parts per billion.

TABLE A1 (continued)
LAKE LANSING
1999-2009 DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)¹	pH (S.U.)²	Total Alkalinity (mg/L CaCO₃)³	Total Phosphorus (µg/L)⁴
26-Aug-05	1	1	75	8.5	9.3	106	30
26-Aug-05	1	14	72	7.0	8.8	118	30
26-Aug-05	1	28	57	2.3	8.1	169	53
26-Aug-05	2	1	75	9.6	9.4	105	30
26-Aug-05	2	12	72	7.1	9.3	126	29
26-Aug-05	2	23	61	0.3	8.9	134	29
3-Apr-06	1	1	46	11.4	8.1	125	15
3-Apr-06	1	15	46	8.6	8.2	121	12
3-Apr-06	1	29	45	9.3	8.1	125	38
3-Apr-06	2	1	47	9.9	8.2	123	22
3-Apr-06	2	11	46	9.8	8.1	125	19
3-Apr-06	2	22	46	10.6	8.4	123	22
11-Aug-06	1	1	75	7.0	8.8	108	12
11-Aug-06	1	15	74	5.6	8.6	113	23
11-Aug-06	1	30	64	1.7	7.9	130	17
11-Aug-06	2	1	75	7.5	8.8	106	11
11-Aug-06	2	12	72	6.8	8.7	104	21
11-Aug-06	2	24	65	1.1	7.8	130	47

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

2 S.U. = standard units.

3 mg/L CaCO₃ = milligrams per liter as calcium carbonate.

4 µg/L = micrograms per liter = parts per billion.

TABLE A1 (continued)
LAKE LANSING
1999-2009 DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)¹	pH (S.U.)²	Total Alkalinity (mg/L CaCO₃)³	Total Phosphorus (µg/L)⁴
16-Apr-07	1	1	42	12.9	8.1	128	73
16-Apr-07	1	15	43	12.6	7.9	128	60
16-Apr-07	1	30	42	10.5	8.0	125	67
16-Apr-07	2	1	43	10.9	8.0	128	63
16-Apr-07	2	11	43	11.1	7.9	130	73
16-Apr-07	2	22	43	12.0	7.9	127	64
30-Aug-07	1	1	77	8.8	9.1	127	19
30-Aug-07	1	14	74	6.7	8.7	128	23
30-Aug-07	1	28	58	0.5	8.1	148	35
30-Aug-07	2	1	77	8.4	9.0	124	37
30-Aug-07	2	12	76	8.2	8.9	121	31
30-Aug-07	2	23	60	0.2	7.9	142	39
7-Apr-08	1	1	50	11.0	8.4	139	28
7-Apr-08	1	15	49	11.2	8.3	135	30
7-Apr-08	1	30	48	11.5	8.3	137	19
7-Apr-08	2	1	48	11.4	8.3	135	20
7-Apr-08	2	12	48	11.3	8.3	138	23
7-Apr-08	2	24	46	11.5	8.2	135	23
14-Oct-08	1	1	63	9.4	9.2	112	<5
14-Oct-08	1	15	60	9.3	9.2	113	<5
14-Oct-08	1	30	58	7.0	8.8	116	<5
14-Oct-08	2	1	62	9.3	9.2	111	<5
14-Oct-08	2	12	61	9.6	9.2	109	<5
14-Oct-08	2	24	59	8.5	9.0	108	<5

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

2 S.U. = standard units.

3 mg/L CaCO₃ = milligrams per liter as calcium carbonate.

4 µg/L = micrograms per liter = parts per billion.

TABLE A2
LAKE LANSING
1999-2009 SURFACE WATER QUALITY DATA

Date	Station	Secchi Transparency (feet)	Chlorophyll- <i>a</i> (µg/L) ¹
29-Mar-99	1	9.0	3.8
29-Mar-99	2	7.5	1.8
29-Mar-99	3	5.0	2.8
29-Mar-99	4	5.0	
11-Aug-99	1	7.0	3.8
11-Aug-99	2	6.5	0.8
11-Aug-99	3	7.0	1.1
11-Aug-99	4	6.0	1.3
17-Apr-00	1	13.5	1.1
17-Apr-00	2	10.5	0.5
10-Aug-00	1	8.5	2.9
10-Aug-00	2	7.0	6.5
07-Apr-03	1	13.5	1.1
07-Apr-03	2	12.0	0
11-Sept-03	1	7.0	0.5
11-Sept-03	2	7.5	0
12-Apr-04	1	8.0	1
12-Apr-04	2	7.5	2
30-Aug-04	1	4.5	1
30-Aug-04	2	5.0	0
5-Apr-05	1	8.0	1
5-Apr-05	2	7.0	0
26-Aug-05	1	4.3	2
26-Aug-05	2	4.5	1

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

TABLE A2 (continued)
LAKE LANSING
1999-2009 SURFACE WATER QUALITY DATA

Date	Station	Secchi Transparency (feet)	Chlorophyll-a ($\mu\text{g/L}$) ¹
3-Apr-06	1	5.5	0
3-Apr-06	2	5.0	0
11-Aug-06	1	6.0	1
11-Aug-06	2	7.0	1
10-Apr-07	1	10.0	0
10-Apr-07	2	9.5	9
30-Aug-07	1	6.5	1
30-Aug-07	2	7.5	0
7-Apr-08	1	6.0	1
7-Apr-08	2	7.0	2
14-Oct-08	1	12.5	0
14-Oct-08	2	13.5	0

¹ $\mu\text{g/L}$ = micrograms per liter = parts per billion.

TABLE A3
LAKE LANSING
1999-2009 STORM DRAIN MONITORING DATA

Date	Number	Name	Discharge (cfs)¹	Total Phosphorus (µg/L)²	<i>E. coli</i> per 100 mL³
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
12-Apr-00	1	Barnhart	0.1		4
12-Apr-00	2	Milliman	1.1		12
12-Apr-00	3	Wallace	0.03		4
12-Apr-00	8	Perry Road	0		3
12-Apr-00	9	Carlton	0		2
12-Apr-00	11	New Condos	0		19
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	8	Perry Road		44	110
23-Apr-00	9	Carlton		16	60
23-Apr-00	11	New Condos			10
10-Apr-03	1	Barnhart	0	249	25
10-Apr-03	2	Milliman	1.2	92	20
10-Apr-03	3	Wallace	2.2	50	21
10-Apr-03	5	South End	0	77	9
10-Apr-03	8	Perry Road	0.04	71	91

1 cfs = cubic feet per second.

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

3 mL = milliliters.

TABLE A3 (continued)
LAKE LANSING
1999-2009 STORM DRAIN MONITORING DATA

Date	Number	Name	Discharge (cfs)¹	Total Phosphorus (µg/L)²	<i>E. coli</i> per 100 mL³
12-Apr-04	1	Barnhart	0.2	36	14
12-Apr-04	2	Milliman	0.4	34	23
12-Apr-04	3	Wallace	0.2	53	<1
12-Apr-04	5	South End	0	44	<1
12-Apr-04	8	Perry Road	0	165	<1
11-May-04	1	Barnhart	4.8	131	249
11-May-04	2	Milliman	1.3	109	157
11-May-04	3	Wallace	0.8	203	816
11-May-04	5	South End	0.7	161	99
11-May-04	8	Perry Road	0.4	195	2,420
29-Jun-04	1	Barnhart	0.9	164	15
29-Jun-04	2	Milliman	0		
29-Jun-04	3	Wallace	0.1	29	62
29-Jun-04	5	South End	0		
29-Jun-04	8	Perry Road	0		
5-Apr-05	1	Barnhart	1.4	141	<1
5-Apr-05	2	Milliman	1.2	62	27
5-Apr-05	3	Wallace	1.2	55	16
5-Apr-05	5	South End	0.5	214	14
5-Apr-05	7	Condos	0		
5-Apr-05	8	Perry Road	0		
5-Apr-05	14	Mack Avenue	0		

1 cfs = cubic feet per second.

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

3 mL = milliliters.

TABLE A3 (continued)
LAKE LANSING
1999-2009 STORM DRAIN MONITORING DATA

Date	Number	Name	Discharge (cfs)¹	Total Phosphorus (µg/L)²	<i>E. coli</i> per 100 mL³
27-Apr-05	1	Barnhart	0.5	58	17
27-Apr-05	2	Milliman	2.3	39	98
27-Apr-05	3	Wallace	0.7	45	29
27-Apr-05	5	South End	0	45	91
27-Apr-05	7	Condos	0		
27-Apr-05	8	Perry Road	0	78	17
28-Mar-06	1	Barnhart	1.8	24	40
28-Mar-06	2	Milliman	0.9	19	11
28-Mar-06	3	Wallace	0.2	19	4
28-Mar-06	5	South End	0	35	1
28-Mar-06	8	Perry Road	0	48	99
3-Apr-06	1	Barnhart	0.5	33	54
3-Apr-06	2	Milliman	1.0	31	3
3-Apr-06	3	Wallace	0.2	21	41
3-Apr-06	5	South End	0	48	
3-Apr-06	8	Perry Road	0	79	
27-Apr-06	1	Barnhart	0.1	51	82
27-Apr-06	2	Milliman	0.1	63	24
27-Apr-06	3	Wallace	0.1	13	199
27-Apr-06	5	South End	0	86	1
27-Apr-06	8	Perry Road	0	27	26
12-Sep-06	1	Barnhart	0		
12-Sep-06	2	Milliman	0		
12-Sep-06	3	Wallace	0		
12-Sep-06	5	South End	0	21	34
12-Sep-06	8	Perry Road	0	336	525

1 cfs = cubic feet per second.

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

3 mL = milliliters.

TABLE A3 (continued)
LAKE LANSING
1999-2009 STORM DRAIN MONITORING DATA

Date	Number	Name	Discharge (cfs)¹	Total Phosphorus (µg/L)²	<i>E. coli</i> per 100 mL³
26-Mar-07	1	Barnhart	1.4	61	7
26-Mar-07	2	Milliman	2.6	80	12
26-Mar-07	3	Wallace	1.6	56	10
26-Mar-07	5	South End	0.9	77	21
26-Mar-07	8	Perry Road	0	99	866
10-Apr-07	1	Barnhart	1.2	62	1
10-Apr-07	2	Milliman	0.7	75	4
10-Apr-07	3	Wallace	0.4	61	8
10-Apr-07	5	South End	0	115	11
10-Apr-07	8	Perry Road	0	80	16
16-Apr-07	1	Barnhart		85	
16-Apr-07	2	Milliman		63	
16-Apr-07	3	Wallace		62	
16-Apr-07	5	South End	0	87	
16-Apr-07	8	Perry Road	0	87	
30-Aug-07	1	Barnhart	0		
30-Aug-07	2	Milliman	0		
30-Aug-07	3	Wallace	0		
30-Aug-07	5	South End	0	281	42
30-Aug-07	8	Perry Road	0	178	249

1 cfs = cubic feet per second.

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

3 mL = milliliters.

TABLE A3 (continued)
LAKE LANSING
1999-2009 STORM DRAIN MONITORING DATA

Date	Number	Name	Discharge (cfs)¹	Total Phosphorus (µg/L)²	<i>E. coli</i> per 100 mL³
7-Apr-08	1	Barnhart	0.6	62	6
7-Apr-08	2	Milliman	0.8	37	11
7-Apr-08	3	Wallace	1.4	23	26
7-Apr-08	5	South End	0	37	11
7-Apr-08	8	Perry Road	0	59	33
14-Apr-08	1	Barnhart		14	22
14-Apr-08	2	Milliman	1.4	16	15
14-Apr-08	3	Wallace	2.4	5	23
14-Apr-08	5	South End		16	6
14-Apr-08	8	Perry Road	0	23	16
12-May-08	1	Barnhart	0.7	61	26
12-May-08	2	Milliman	0.8	46	326
12-May-08	3	Wallace	0.3	6	205
12-May-08	5	South End	0	110	53
12-May-08	8	Perry Road	0	69	147
12-May-08	18	Marshall Upstream	0	67	461
12-May-08	19	Marshall Downstream	0		
14-Oct-08	1	Barnhart	0.1	123	33
14-Oct-08	2	Milliman	0	276	108
14-Oct-08	3	Wallace	0	83	12
14-Oct-08	5	South End	0	526	91
14-Oct-08	8	Perry Road	0	134	194
14-Oct-08	18	Marshall Upstream	0	276	206
14-Oct-08	19	Marshall Downstream	0	5	37

1 cfs = cubic feet per second.

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

3 mL = milliliters.

References

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