Water Quality Monitoring

Spring Lake
2022 Water Quality Monitoring Report

Prepared for:
Spring Lake - Lake Board
c/o Ottawa County Drain Commissioner's Office
12220 Fillmore, Room 141
West Olive, MI 49460

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

March 2023

Project No: 54060102

progressive|ae

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Introduction

Spring Lake is located in Ottawa and Muskegon Counties in southwest lower Michigan (T 8-9N; R 16W; Figure 1). As part of an ongoing lake improvement program being coordinated under the direction of the Spring Lake – Lake Board, sampling to evaluate baseline water quality conditions has been ongoing since 1999. In 2005, Spring Lake was treated with aluminum sulfate (alum) to reduce phosphorus release from deep water sediments and improve water quality conditions. This report contains background information on the various water quality parameters sampled, past and current water quality sampling results, and a discussion of future lake management implications for Spring Lake.

Figure 1. Spring Lake location map.

Methods

Water samples were collected from the top, middle, and bottom at multiple locations in Spring Lake (Figure 2). Temperature was measured using a YSI Model 550A probe. Samples were analyzed for dissolved oxygen 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). Total phosphorus samples were placed on ice, transported to Prein and Newhof and/or Summit Labs and analyzed using Standard Methods procedure 4500-P E. Secchi transparency was measured and a composite chlorophyll-a sample was 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 10200H.

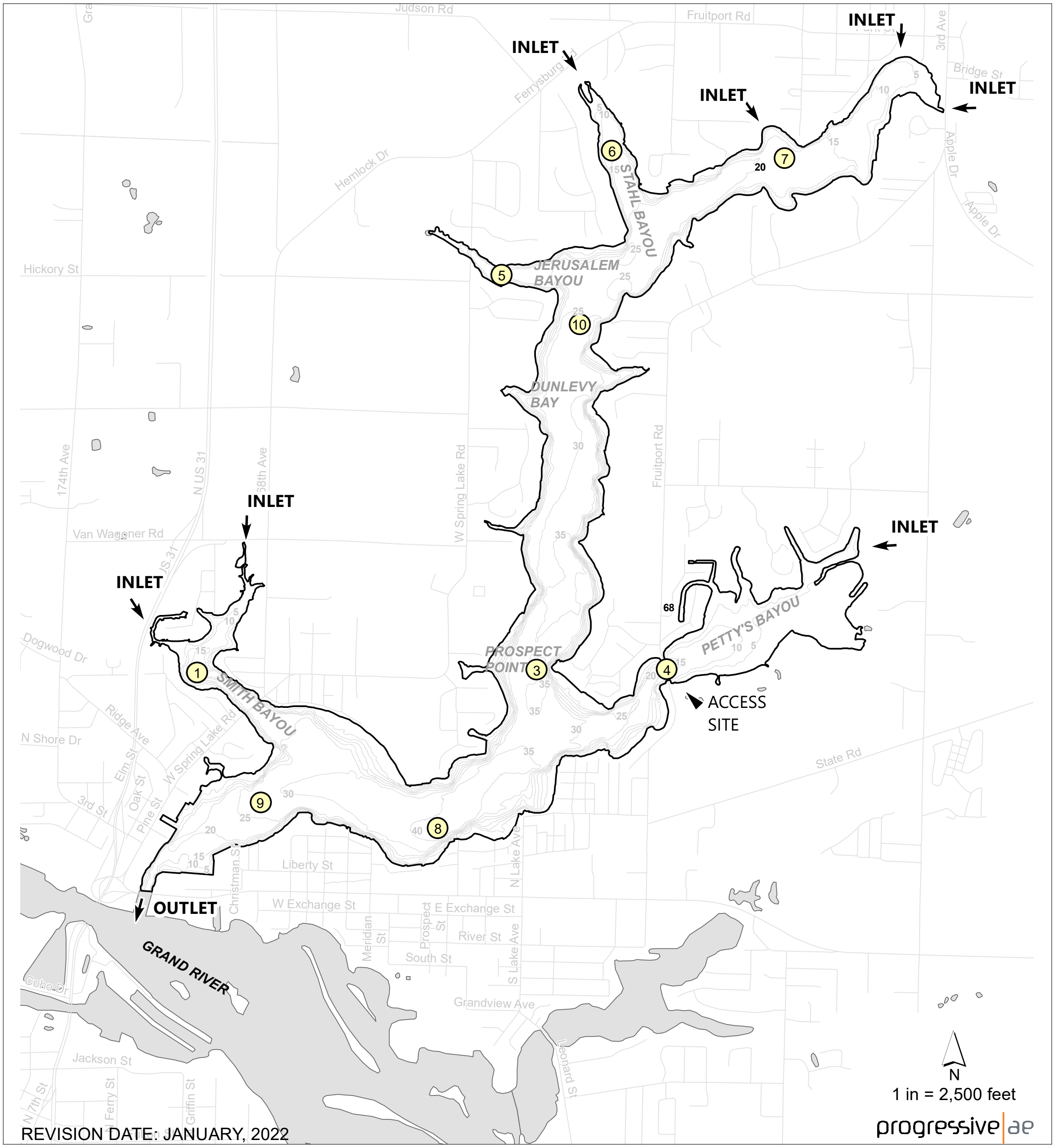

Figure 2. Spring Lake sampling location map.

Lake Water Quality

Lakes can be classified into three broad categories based on their productivity or ability to support plant and animal life. The three basic lake classifications are "oligotrophic," "mesotrophic," and "eutrophic" (Figure 3). 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. In a recent assessment of Michigan's lakes, the U.S. Geological Survey estimated that statewide about 25% of lakes are oligotrophic, 52% are mesotrophic and 23% are eutrophic (Fuller and Taricska 2012).

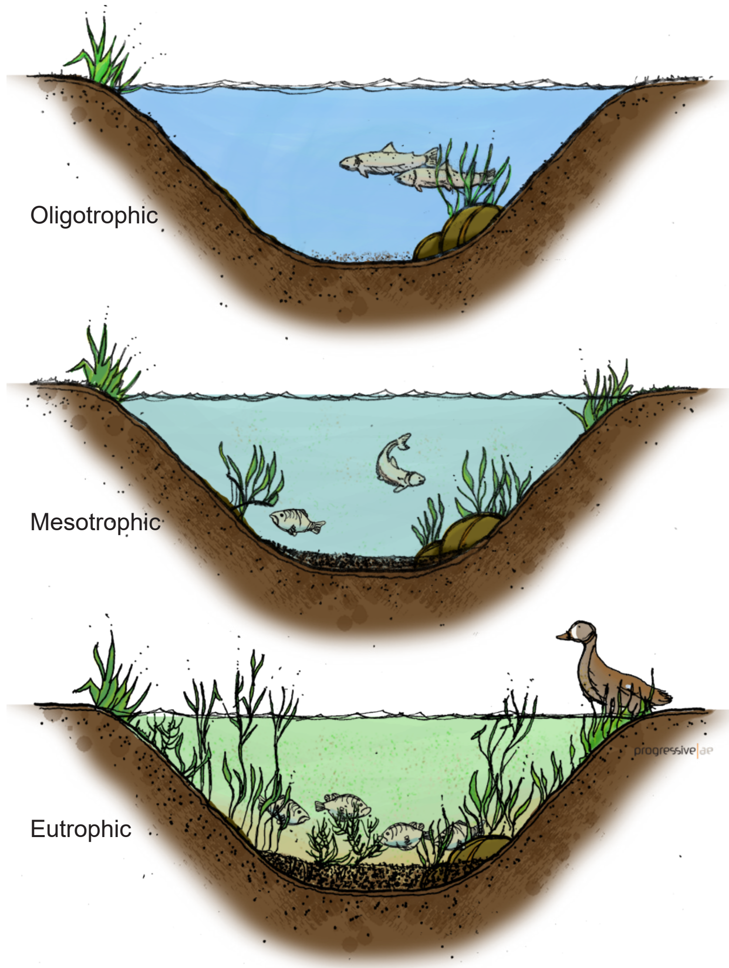

Figure 3. Lake classification.

Under natural conditions, most lakes will ultimately evolve to a eutrophic state as they gradually fill with sediment and organic matter transported to the lake from the surrounding watershed. As the lake becomes shallower, the process accelerates. When aquatic plants become abundant, the lake slowly begins to fill in as sediment and decaying plant matter accumulate on the lake bottom. Eventually, terrestrial plants become established and the lake is transformed to a marshland. The 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*.

There are many ways to measure lake water quality, but there are a few important physical, chemical, and biological parameters that indicate the overall condition of a lake. These measurements include temperature, dissolved oxygen, total phosphorus, chlorophyll-*a*, and Secchi transparency.

TEMPERATURE

Temperature is important in determining the type of organisms that may live in a lake. For example, trout prefer temperatures below 68°F. Temperature also determines how water mixes in a lake. As the ice cover breaks up on a lake in the spring, the water temperature becomes uniform from the surface to the bottom. This period is referred to as "spring turnover" because water mixes throughout the entire water column. As the surface waters warm, they are underlain by a colder, more dense strata of water. This process is called thermal stratification. Once thermal stratification occurs, there is little mixing of the warm surface waters with the cooler bottom waters. The transition layer that separates these layers is referred to as the "thermocline." The thermocline is characterized as the zone where temperature drops rapidly with depth. As fall approaches, the warm surface waters begin to cool and become more dense. Eventually, the surface temperature drops to a point that allows the lake to undergo complete mixing. This period is referred to as "fall turnover." As the season progresses and ice begins to form on the lake, the lake may stratify again. However, during winter stratification, the surface waters (at or near 32°F) are underlain by slightly warmer water (about 39°F). This is sometimes referred to as "inverse stratification" and occurs because water is most dense at a temperature of about 39°F. As the lake ice melts in the spring, these stratification cycles are repeated (Figure 4). Shallow lakes do not stratify. Lakes that are 15 to 30 feet deep may stratify and destratify with storm events several times during the year.

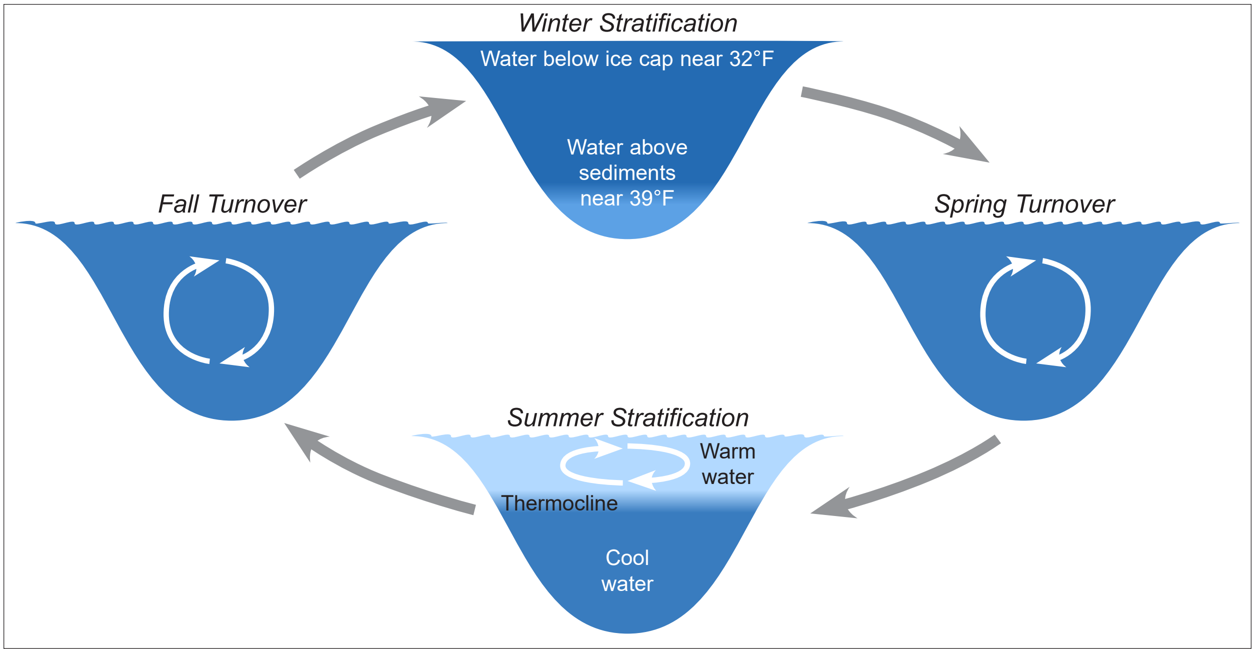

Figure 4. Seasonal thermal stratification cycles.

DISSOLVED OXYGEN

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

LAKE WATER QUALITY

PHOSPHORUS

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

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

CHLOROPHYLL-*A*

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

SECCHI TRANSPARENCY

A Secchi disk is often used to estimate water clarity. The measurement is made by fastening a round, black and white, 8-inch disk to a calibrated line (Figure 5). The disk is lowered over the deepest point of the lake until it is no longer visible, and the depth is noted. The disk is then raised until it reappears. The average between these two depths is the Secchi transparency. Generally, it has been found that aquatic plants can grow at a depth of approximately twice the Secchi transparency measurement. In eutrophic lakes, water clarity is often reduced by algae growth in the water column, and Secchi disk readings of 7.5 feet or less are common.

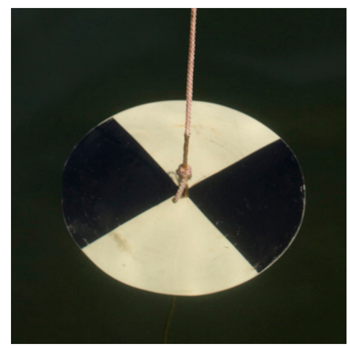

Figure 5. Secchi disk.

LAKE CLASSIFICATION CRITERIA

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

Results

Temperature, dissolved oxygen, and total phosphorus data collected from Spiring Lake in the spring and summer of 2022 are provided in Table 2, Secchi transparency and chlorophyll-a data are included in Table 3, and summary statistics comparing pre- and post-alum treatment data are provided in Table 4. Historical water quality data is summarized in Figures 6 through 8.

To better define overall water quality conditions in Spring Lake in 2022, additional sampling sites were added (Sites 9 & 10) and select sites were sampled monthly April through October to measure temperature, dissolved oxygen, total phosphorus, chlorophyll-a, and Secchi transparency. These data are included and discussed separately in Appendix A.

TABLE 2
SPRING LAKE 2022 DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)[1]	Total Phosphorus (μg/L)[2]
4-Apr-22	1	1	41	13.1	31
4-Apr-22	1	9	41	13.3	29
4-Apr-22	1	18	41	12.8	29
4-Apr-22	3	1	41	13.4	31
4-Apr-22	3	18	41	11.2	34
4-Apr-22	3	36	40	10.9	36
4-Apr-22	4	1	42	13.4	36
4-Apr-22	4	10	42	12.8	32
4-Apr-22	4	20	41	13.5	31
4-Apr-22	5	1	41	12.9	62
4-Apr-22	5	8	41	12.8	38
4-Apr-22	5	16	41	12.0	33
4-Apr-22	6	1	41	12.1	38
4-Apr-22	6	7	41	12.1	59
4-Apr-22	6	15	41	12.5	47
4-Apr-22	7	1	42	11.4	50
4-Apr-22	7	9	41	11.5	44
4-Apr-22	7	18	40	11.7	45
4-Apr-22	8	1	40	12.6	32
4-Apr-22	8	20	40	13.9	34
4-Apr-22	8	40	40	13.2	37

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

TABLE 2 (continued)
SPRING LAKE 2022 DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)[1]	Total Phosphorus (µg/L)[2]
29-Aug-22	1	1	78	10.1	112
29-Aug-22	1	9	76	7.1	112
29-Aug-22	1	18	75	5.4	104
29-Aug-22	3	1	76	7.0	107
29-Aug-22	3	17	76	7.0	107
29-Aug-22	3	34	66	6.1	106
29-Aug-22	4	1	77	6.8	120
29-Aug-22	4	10	77	7.1	124
29-Aug-22	4	20	76	4.8	140
29-Aug-22	5	1	77	9.4	113
29-Aug-22	5	8	77	8.2	136
29-Aug-22	5	16	76	8.1	101
29-Aug-22	6	1	77	9.0	127
29-Aug-22	6	7	77	8.4	124
29-Aug-22	6	14	76	8.1	118
29-Aug-22	7	1	77	7.0	107
29-Aug-22	7	9	77	7.0	137
29-Aug-22	7	18	76	6.7	144
29-Aug-22	8	1	76	8.1	114
29-Aug-22	8	19	76	8.1	112
29-Aug-22	8	38	62	0.0	1070

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

TABLE 3
SPRING LAKE 2022 SURFACE WATER QUALITY DATA

Date	Station	Chlorophyll-*a* (µg/L)[1]	Secchi Transparency (feet)
4-Apr-22	1	5	4.5
4-Apr-22	3	5	4.0
4-Apr-22	4	7	4.0
4-Apr-22	5	5	3.0
4-Apr-22	6	3	2.5
4-Apr-22	7	2	2.0
4-Apr-22	8	9	4.5
29-Aug-22	1	18	2.5
29-Aug-22	3	9	4.0
29-Aug-22	4	14	3.0
29-Aug-22	5	12	3.0
29-Aug-22	6	8	3.0
29-Aug-22	7	12	3.5
29-Aug-22	8	15	3.0

TABLE 4
SPRING LAKE PRE- AND POST-ALUM TREATMENT SUMMARY STATISTICS
1999-2022

	Total Phosphorus (µg/L)[2]		Chlorophyll-*a* (µg/L)[1]		Secchi Transparency (feet)	
	Pre	Post	Pre	Post	Pre	Post
Mean	101	67	10	8	3.5	3.7
Standard Deviation	101	127	13	7	1.4	1.0
Median	73	42	7	6	3.5	3.5
Minimum	6	5	0	0	1.3	2.0
Maximum	786	1610	121	44	7.0	6.0
Number of Samples	364	732	96	238	103	235

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

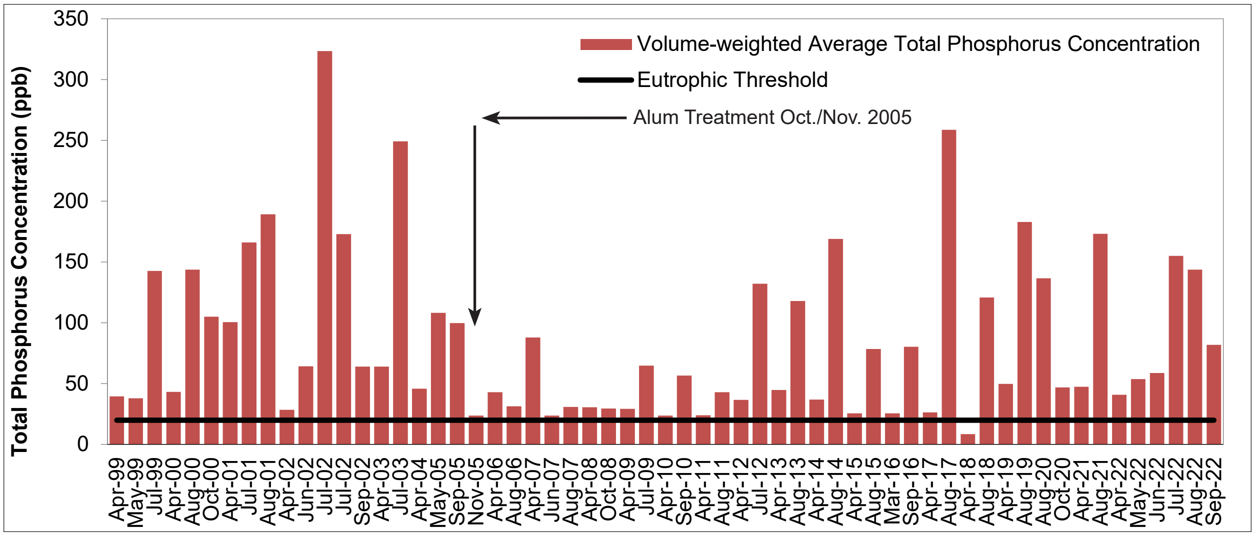

Figure 6. Volume-weighted average total phosphorus concentrations, 1999 - 2022.

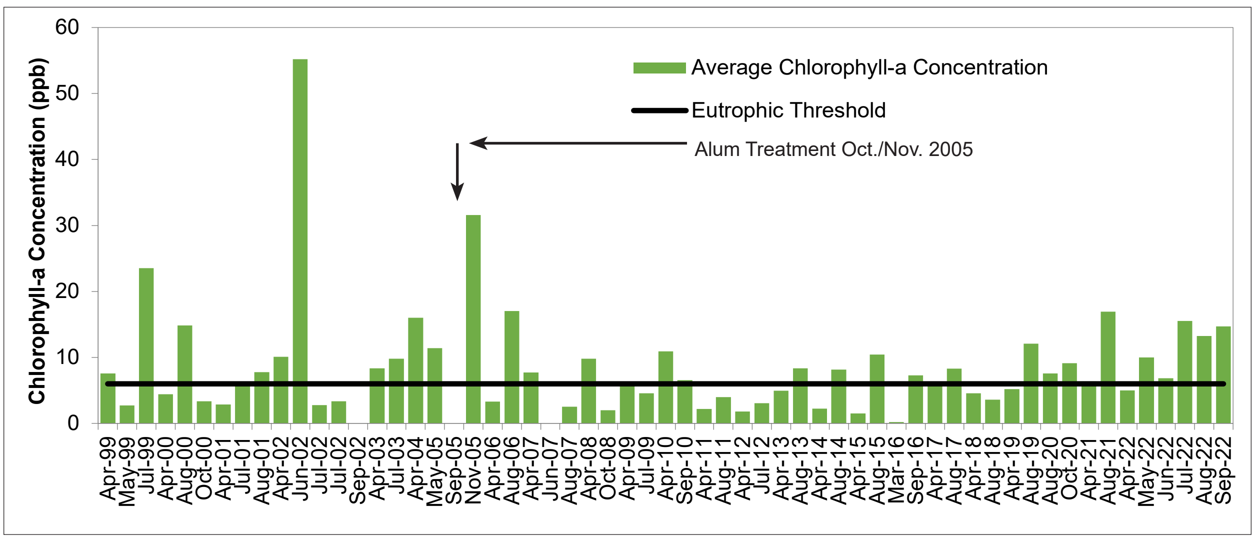

Figure 7. Average chlorophyll-*a* concentrations, 1999 - 2022.

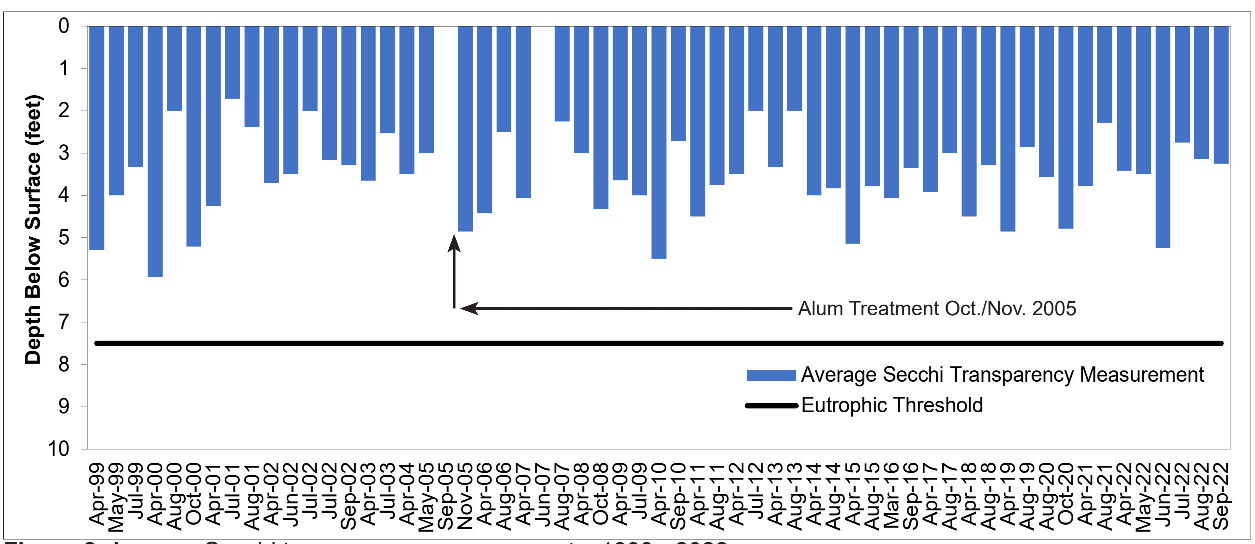

Figure 8. Average Secchi transparency measurements, 1999 - 2022.

Discussion

The April sampling was conducted during spring turnover and temperature and dissolved oxygen levels were nearly uniform throughout the water column (Table 2). Phosphorus levels at that time were above the eutrophic threshold concentration of 20 parts per billion. At several locations, chlorophyll-a exceeded the eutrophic threshold concentration of 6 parts per billion indicating abundant algae growth was occurring in portions of the lake (Table 3). During the spring sampling period, Secchi transparency was low (2 to 4.5 feet) at all sampling locations (Table 3).

The August sampling was conducted during the period of summer thermal stratification when warm surface waters were underlain by cooler bottom waters (Table 2). However, the temperature difference surface to bottom was small, suggesting that partial mixing of the water column may have occurred between the spring and summer sampling periods (see discussion in Appendix A). Dissolved oxygen levels in the deeper waters were lower than surface waters and, at the deeper sampling locations (Table 2, Sites 8 and 9), bottom waters were anoxic (i.e., oxygen-depleted). Phosphorus levels in August were well above the eutrophic threshold and, in the anoxic bottom waters, phosphorus levels were extremely elevated, indicating phosphorus release from the deep water lake sediments was occurring. Chlorophyll-a levels were high at all sampling sites, indicating abundant algae growth was occurring at the time of sampling (Table 3). Secchi transparency remained poor at all sampling locations (Table 3).

Summary statistics for data collected before and after the 2005 alum treatment of Spring Lake show that while phosphorus levels remain lower than pre-treatment levels, measurements of chlorophyll-a and Secchi transparency have returned to pre-treatment levels. A graphic depiction of the data shows a similar trend (Figures 6 through 8). These data suggest that the effectiveness of the alum treatment in preventing internal phosphorus release in Spring Lake is beginning to decline.

Water quality data collected in 2022 indicates that Spring Lake is highly eutrophic in that it has elevated phosphorus levels, persistent algae blooms, and poor transparency.

Management Implications

When the alum treatment was conducted in 2005, it was projected that the treatment would be effective for 5 to 10 years. Thus, it is not surprising that the lake is beginning to return to pre-treatment conditions a full 17 years after treatment.

A study of internal phosphorus loading in Spring Lake conducted 11 years after the alum treatment found that while internal loading rates were significantly lower than those measured before the alum treatment, elevated deep water phosphorus levels measured in the lake at that time suggested that the effectiveness of the alum treatment was beginning to wane (Steinman et al. 2018a). Possible reasons for the alum losing its effectiveness included (1) the alum floc had concentrated in the deeper portions of Spring Lake and is not covering lake sediments as it did immediately after the treatment; and (2) alum binding sites have become saturated and can no longer bind more phosphorus being made available from internal and external sources (Steinman et al. 2018a). A follow-up analysis of internal loading rates in Spring Lake conducted 17 years post-treatment found that internal loading rates have increased since the analysis conducted 11 years post-treatment, although loading rates were still less than those measured prior to the alum treatment (Holz 2022). Comparing the 2022 internal phosphorus loading estimate with a recently completed estimate of external (i.e., watershed) loadings (Steinman et al. 2018b) indicates that about half of the phosphorus in Spring Lake comes from internal loading and half from watershed sources (Holz 2022). While there are inherent uncertainties in these estimates, from a management perspective, it is imperative that both loading sources be addressed moving forward if water quality conditions in Spring Lake are going to improve in the long term.

To address internal phosphorus loading, it is recommended that a second alum treatment of Spring Lake be considered. Since the original alum treatment in 2005, advances have been made in alum dosing and application methods (Wagner 2017). Based on the recent sediment study to determine the amount of potentially mobile (i.e., available) phosphorus in Spring Lake sediments, a dose rate was determined to effectively inactivate mobile phosphorus and reduce internal phosphorus loading in Spring Lake. This dose rate is about 20% greater than the alum dose applied to Spring Lake in 2005. An increased alum dose rate, coupled with today's improved application technology and the fact that current internal phosphorus loading rates in Spring Lake are less than before the first alum treatment, may help to enhance the efficacy of a second alum treatment. Given that the initial alum treatment provided over 10 years of improved water quality conditions in Spring Lake, it is anticipated that a second alum treatment would provide similar if not better results assuming watershed pollution inputs do not increase. It appears that cyanobacteria (blue-green algae) levels have been increasing in Spring Lake in recent years although levels are still well below health guidelines for recreational use (Steinman et al. 2018b). An additional benefit of a second alum treatment would be to reduce the potential for toxic cyanobacteria blooms in Spring Lake.

To address watershed loadings, a multi-faceted watershed management approach would be required to reduce loadings from the developed shorelands around the lake and from agricultural lands in the upper watershed (Steinman et al. 2018b, Steinman et al. 2015). The urbanized shoreland areas near the lake are especially important in that urbanization around Spring Lake has increased dramatically in recent years (Steinman et al. 2015). With this increase in urbanization, the amount of imperviousness (i.e., hard surfaces) has increased as well. As a result, there is a greater potential for surface runoff to the lake (Steinman et al. 2015). A general framework for best management practices in the Spring Lake watershed is presented in Steinman et al. 2015.

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Appendix A

To better define overall water quality conditions in 2022 and the influence of internal phosphorus loading in Spring Lake, additional sites were sampled (Sites 9 & 10) and select sites over the deeper portions of the lake were sampled monthly April through October to measure temperature, dissolved oxygen, total phosphorus, chlorophyll-a, and Secchi transparency. Monthly temperature, dissolved oxygen, and total phosphorus data are presented in Table A-1 and monthly chlorophyll-a and Secchi transparency data are presented in Table A-2.

The monthly temperature and dissolved oxygen data indicate thermal stratification occurred at all the deep water sampling sites in Spring Lake and, by mid-summer, deep water oxygen levels were depressed and phosphorus levels were elevated (Table A-1). This is especially evident at Site 8 where the deep water phosphorus level exceeded 1,000 parts per billion, a concentration 50 times the eutrophic threshold concentration. These data strongly suggest that the alum treatment is beginning to lose its effectiveness and that internal phosphorus loading is occurring in Spring Lake. Given that Spring Lake is only weakly stratified, it is possible that in some years partial mixing of the lake occurs and/or the lake destratifies and mixes early in the summer season, making deep water phosphorus available to stimulate algae growth during the active growing season. This potential is exacerbated by strong prevailing winds from Lake Michigan. This possibility further underscores the importance of internal loading in Spring Lake. Internal phosphorus loading may well be the primary driver of algae blooms during the peak summer recreational period in Spring Lake.

Abundant algae growth in Spring Lake occurred throughout the April to October sampling period, especially from July to October when chlorophyll-a levels were often greater than twice the eutrophic threshold value of 6 parts per billion (Table A-2). Secchi transparency was poor throughout the period of sampling.

TABLE A-1
SPRING LAKE 2022 MONTHLY DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)[1]	Total Phosphorus (µg/L)[2]
4/4/2022	3	1	41	13.4	31
4/4/2022	3	18	41	11.2	34
4/4/2022	3	36	40	10.9	36
5/11/2022	3	1	65	12.7	24
5/11/2022	3	18	54	10.4	49
5/11/2022	3	36	52	7.2	56
6/6/2022	3	1	69	8.2	39
6/6/2022	3	18	68	8.3	26
6/6/2022	3	36	54	1.3	41
7/21/2022	3	1	79	10.3	142
7/21/2022	3	17	73	7.9	73
7/21/2022	3	34	57	1.0	286
8/29/2022	3	1	76	7.0	107
8/29/2022	3	17	76	7.0	107
8/29/2022	3	34	66	6.1	106
9/28/2022	3	1	66	5.4	115
9/28/2022	3	17	66	5.5	113
9/28/2022	3	34	64	6.4	75
10/20/2022	3	1	53	9.1	49
10/20/2022	3	18	53	9.2	51
10/20/2022	3	36	51	9.8	51

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

TABLE A-1 (CONTINUED)
SPRING LAKE 2022 MONTHLY DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)[1]	Total Phosphorus (µg/L)[2]
4/4/2022	8	1	40	12.6	32
4/4/2022	8	20	40	13.9	34
4/4/2022	8	40	40	13.2	37
5/11/2022	8	1	65	13.1	59
5/11/2022	8	21	54	10.3	23
5/11/2022	8	42	51	7.6	29
6/6/2022	8	1	69	8.8	26
6/6/2022	8	20	68	8.5	36
6/6/2022	8	40	53	0.4	178
7/21/2022	8	1	79	10.8	81
7/21/2022	8	20	75	5.9	122
7/21/2022	8	40	56	0.0	1040
8/29/2022	8	1	76	8.1	114
8/29/2022	8	19	76	8.1	112
8/29/2022	8	38	62	0.0	1070
9/28/2022	8	1	65	6.9	103
9/28/2022	8	20	65	6.9	95
9/28/2022	8	40	62	8.3	66
10/20/2022	8	1	53	9.1	54
10/20/2022	8	19	53	9.1	54
10/20/2022	8	38	51	8.9	46

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

TABLE A-1 (CONTINUED)
SPRING LAKE 2022 MONTHLY DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)[1]	Total Phosphorus (µg/L)[2]
4/4/2022	9	1	40	13.8	34
4/4/2022	9	15	40	13.5	49
4/4/2022	9	30	40	12.8	53
5/11/2022	9	1	62	10.6	36
5/11/2022	9	14	54	10.1	23
5/11/2022	9	28	53	9.2	26
6/6/2022	9	1	69	10.0	93
6/6/2022	9	14	69	9.1	58
6/6/2022	9	28	57	2.0	35
7/21/2022	9	1	79	10.3	112
7/21/2022	9	13	77	7.4	95
7/21/2022	9	26	74	1.7	192
8/29/2022	9	1	76	8.6	129
8/29/2022	9	13	75	8.3	121
8/29/2022	9	26	70	0.4	262
9/28/2022	9	1	65	7.7	82
9/28/2022	9	13	65	7.5	87
9/28/2022	9	26	62	8	73
10/20/2022	9	1	52	9.1	49
10/20/2022	9	14	52	9.4	51
10/20/2022	9	28	52	9.1	51

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

TABLE A-1 (CONTINUED)
SPRING LAKE 2022 MONTHLY DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)[1]	Total Phosphorus (µg/L)[2]
4/4/2022	10	1	41	N/A	30
4/4/2022	10	13	41	10.7	32
4/4/2022	10	26	40	11.9	82
5/11/2022	10	1	65	13.1	32
5/11/2022	10	13	55	10.9	31
5/11/2022	10	26	52	8.7	20
6/6/2022	10	1	69	8.2	26
6/6/2022	10	13	69	7.9	55
6/6/2022	10	26	62	3.9	30
7/21/2022	10	1	81	9.9	115
7/21/2022	10	13	79	7.5	296
7/21/2022	10	26	70	0.9	323
8/29/2022	10	1	77	7.8	164
8/29/2022	10	13	76	7.8	138
8/29/2022	10	26	76	7.5	111
9/28/2022	10	1	65	5	127
9/28/2022	10	13	66	4.4	131
9/28/2022	10	26	66	4.3	126
10/20/2022	10	1	53	8.5	55
10/20/2022	10	13	53	8.7	56
10/20/2022	10	26	53	8.7	53

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

TABLE A-2
SPRING LAKE 2022 MONTHLY SURFACE WATER QUALITY DATA

Date	Station	Chlorophyll-*a* (µg/L)[1]	Secchi Transparency (feet)
4/4/2022	3	5	4.0
4/4/2022	8	9	4.5
4/4/2022	9	8	4.0
4/4/2022	10	5	3.0
5/11/2022	3	11	3.5
5/11/2022	8	10	3.5
5/11/2022	9	12	*
5/11/2022	10	9	3.0
6/6/2022	3	3	5.5
6/6/2022	8	7	5.0
6/6/2022	9	15	4.0
6/6/2022	10	3	5.5
7/21/2022	3	15	2.5
7/21/2022	8	11	3.0
7/21/2022	9	21	3.0
7/21/2022	10	16	3.0
8/29/2022	3	9	4.0
8/29/2022	8	15	3.0
8/29/2022	9	22	3.5
8/29/2022	10	9	3.5
9/28/2022	3	15	3.5
9/28/2022	8	14	3.0
9/28/2022	9	18	3.5
9/28/2022	10	12	2.5
10/20/2022	3	16	2.5
10/20/2022	8	16	3.0
10/20/2022	9	12	3.0
10/20/2022	10	9	2.5

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