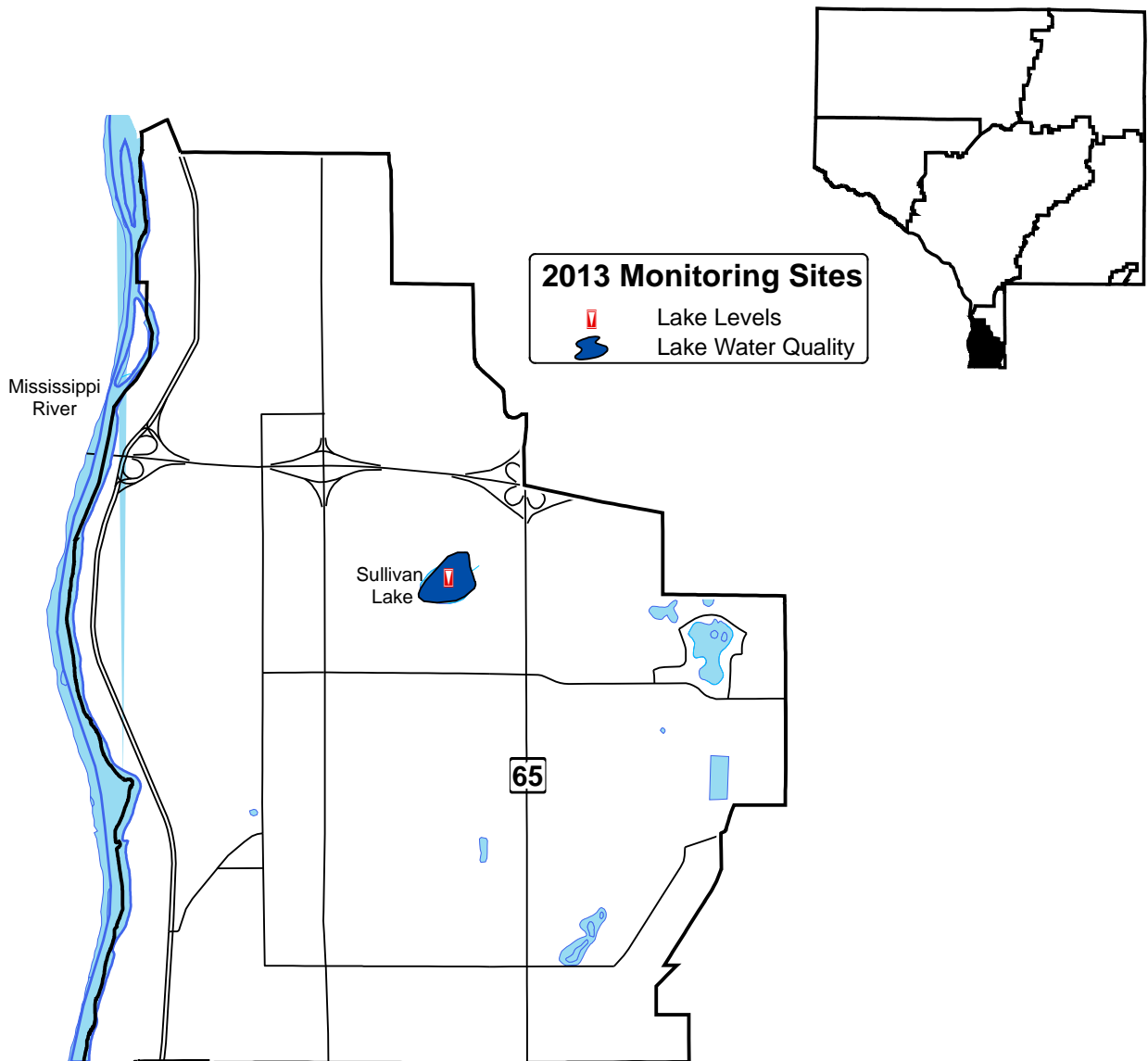




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Sullivan Lake Monitoring Report 2013



Sullivan Lake Monitoring Report 2013

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Abstract

In 2013, the Mississippi Watershed Management Organization (MWMO) contracted the Anoka Conservation District (ACD) to conduct monitoring activities on Sullivan Lake, located in Columbia Heights. Sullivan Lake, also known as Sandy Lake, had been monitored historically, but water quality had not been monitored since 2005.

A volunteer, in coordination with ACD, conducted weekly water level monitoring in lakes during 2013 between March 2 and November 7. The average water elevation for 2013 was 880.0 feet. Sullivan Lake water elevations fluctuated frequently, routinely bouncing by 0.5 feet in response to rainfall.

ACD conducted water quality monitoring on Sullivan Lake once each month from May to September. Conductivity, pH, turbidity, salinity, dissolved oxygen (D.O.), temperature, and secchi transparency were measured in the field while samples were collected for laboratory analysis of total phosphorus, chlorophyll-a, and chloride. Water quality results indicated that during 2013 Sullivan Lake had poor water quality compared to other lakes in this region (NCHF Ecoregion), receiving an overall D grade. This was similar to the previous twelve monitored years. The lake was highly eutrophic, and phosphorus levels were two to three times the threshold for an impaired designation by the Minnesota Pollution Control Agency. ACD staff's subjective observations were that algae levels were "high" or "severe" and the lake was unsuitable for swimming during the entire period from May through September. A trend analysis for the past thirteen years of monitoring data indicated that there has been a significant decrease in Sullivan Lake's water quality.



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Table of Contents

Introduction.....	1
Sullivan Lake Monitoring.....	1
Methodology	1
Sample Collection, Handling and Preservation	1
Laboratory Analyses	2
Data analysis	2
Water Elevation Monitoring.....	3
Water Quality Monitoring Results.....	5
Results Summary.....	5
Trend Analysis.....	7
Recommendations	8

List of Tables

Table 1. Sullivan Lake water elevation statistics from 2008 through 2013.....	4
Table 2. 2013 Sullivan Lake water quality data.....	5
Table 3. Metropolitan Council’s lake quality grading system.....	6
Table 4. Sullivan Lake historic water quality conditions from 1993 through 2005 and 2013	7

List of Figures

Figure 1. Sullivan Lake water elevation during 2013.....	3
Figure 2. Sullivan Lake water elevation from April 1999 to November 2013	4
Figure 3. Sullivan Lake phosphorus (ug/L), chlorophyll-a (ug/L), and secchi depth (ft) during 2013	6
Figure 4. Sullivan Lake trophic state.....	6
Figure 5. Sullivan Lake historic summertime means of total phosphorus (ug/L), chlorophyll-a (ug/L), and secchi depth (ft).....	7

Introduction

The Mississippi Watershed Management Organization (MWMO) has monitored water quantity and water quality in the Mississippi River since 2003 and in the stormwater drainage system since 2005. In 2012, the MWMO boundaries expanded to include portions of the Cities of Fridley and Columbia Heights and the City of Hilltop. The MWMO discovered that Sullivan Lake, in Columbia Heights, had been historically monitored for water level, chlorophyll-a, and total phosphorus; however, the chemical parameters had not been monitored for several years. The MWMO contracted the Anoka Conservation District (ACD) to conduct water level and water quality monitoring during 2013, to gain an understanding of current lake conditions.

Sullivan Lake Monitoring

Sullivan Lake, also known as Sandy Lake, is located in south central Anoka County. It has a surface area of 16.8 acres and a maximum depth of 9 feet (2.7 m). A walking trail system/park circumscribes the lake. Adjacent to the trail is a mix of residential, commercial, and retail uses. The walking trail around the lake is used extensively, but the lake itself is used very little for swimming, fishing, or boating because there are few places with clear access to the water. Sullivan Lake's watershed is highly urbanized, and the lake essentially serves as a flow-through stormwater pond. It is connected directly to the stormwater drainage system. Water exiting this lake is discharged to the Mississippi River via stormwater conveyances.

Methodology

Sample Collection, Handling and Preservation

Sullivan Lake was sampled once each month from May to September. Sampling was conducted by boat at the deepest part of the lake (2.7 meters), which was located using a portable depth finder or global positioning system (GPS). Conductivity, pH, turbidity, salinity, dissolved oxygen (D.O.), and temperature were measured using a Hydrolab Quanta multi-probe at a depth of one meter below the water surface.

Water samples were collected with a Kemmerer sampler at a depth of one meter below the water surface, to be analyzed by an independent laboratory for chlorophyll-a, chloride, and total phosphorus. Sample bottles were provided by the laboratory. Total phosphorus sample bottles contained the preservative sulfuric acid (H₂SO₄), while bottles for chloride and chlorophyll-a did not require preservative. Chlorophyll-a sample bottles were wrapped in aluminum foil to exclude light. Water samples were kept on ice and delivered to the laboratory within 24 hours of collection.

Transparency was measured using a Secchi disk. The disk was lowered over the shaded side of the boat until it disappeared and then pulled up to the point where it reappeared again. The midpoint between these two depths was the Secchi disk measurement.

Laboratory Analyses

Chemical analysis was performed by Minnesota Valley Testing Laboratories (MVTTL). The following methods were used at the laboratory:

Chlorophyll –APAH 10200-H method. Reporting limit of 1 mg/m³

Total Phosphorous-EPA 365.1 method. Reporting limit of 5 ug/L

Chloride-APHA 4500-CL-(E) method. Reporting limit 3 mg/L

Data analysis

To evaluate Sullivan Lake’s current condition, sampling results were compared to historical readings and other lakes in the region. Comparisons to other lakes are based on the Metropolitan Council’s lake quality grading system and the Carlson’s Trophic State Index for the North Central Hardwood Forest ecoregion. Historical data can be obtained from the U.S. EPA’s national water quality database, EQuIS, via the Minnesota Pollution Control Agency (MPCA).

The Metropolitan Council developed the lake water quality report card in 1989. A lake receives a letter grade that is based on average summertime (May-September) chlorophyll-a, total phosphorus, and Secchi depth. In the same way that a teacher would grade students on a “curve”, the lake grading system compares each lake only to other lakes in the region. Thus, a lake that gets an “A” in the Twin Cities Metro might only get a “C” in northern Minnesota. The goal of this grading system is to provide a single, easily understandable description of lake water quality.

Carlson’s Trophic State Index is a number used to describe a lake’s stage of eutrophication (nutrient level, amount of algae). The index ranges from oligotrophic (clear, nutrient poor lakes) to hypereutrophic (green, nutrient overloaded lakes). The index values generally range between 0 and 100 with increasing values indicating more eutrophic conditions. Unlike the lake letter grading system, the Carlson’s Trophic State Index does not compare lakes only within the same ecoregion; it is a scale used worldwide. There are four trophic state index values: one each for phosphorus, chlorophyll-a, and transparency, plus an overall trophic state index value that is a composite of the others. The indices are abbreviated as follows:

TSIP-Trophic State Index for Phosphorus

TSIC-Trophic State Index for the inorganic part of algae, Chlorophyll-a

TSIS-Trophic State Index for Secchi transparency

TSI-Overall Trophic State Index

At the conclusion of each monitoring season, the summertime (May to September) average for each trophic state index is calculated.

Because of inherent natural variation, lake water quality is not the same each year. Sorting out this natural variation from true trends is best accomplished with statistical tests that analyze the data objectively. When at least 5 years of monitoring data have been collected, ACD staff test for lake trends using a Multivariate Analysis of

Variance (MANOVA). MANOVA tests the vector response of correlated response variables (Secchi depth, total phosphorus, and chlorophyll-a) while maintaining the probability of making a type I error (rejecting a true null hypothesis) at $p=0.05$. In other words, the three most important measurements of lake water quality are tested simultaneously. Testing each response variable separately would increase the chance of making a type I error.

Water Elevation Monitoring

A volunteer, in coordination with ACD, conducted weekly water level monitoring in lakes during 2013 between March 2 and November 7. A staff gauge is located on the west side of the lake near the outflow. It is surveyed each year by ACD and the Minnesota Department of Natural Resources (DNR) using datum NGVD 29 in feet. 2013 water elevation data, as well as all additional historic data, are available on the Minnesota DNR website using the “LakeFinder” feature at www.dnr.state.mn.us/lakefind/index.html. The lake ID for Sullivan (Sandy) Lake is 02-0080.

Lake water elevation was measured 27 times during 2013. Sullivan Lake water elevations fluctuated frequently, routinely bouncing by 0.5 feet in response to rainfall. Sullivan Lake water elevations fluctuate dramatically because it receives a large amount of stormwater relative to its size and its outlet releases water in all but the lowest water conditions. Water elevation data for 2013 are shown in Figure 1. Historic water elevation data recorded since 1999 are shown in Figure 2. The Ordinary High Water Level (OHW), the elevation below which a DNR permit is needed to perform work, is 880.60 feet. Table 1 shows the average water elevation for 2008 through 2013.

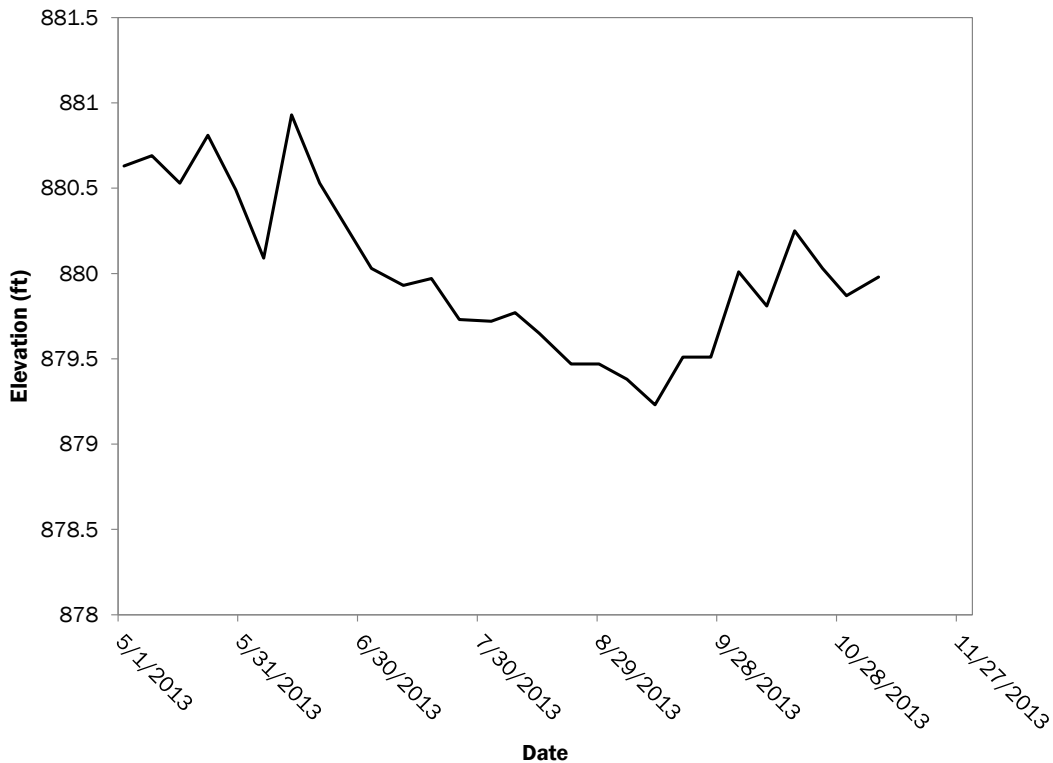


Figure 1. Sullivan Lake water elevation during 2013

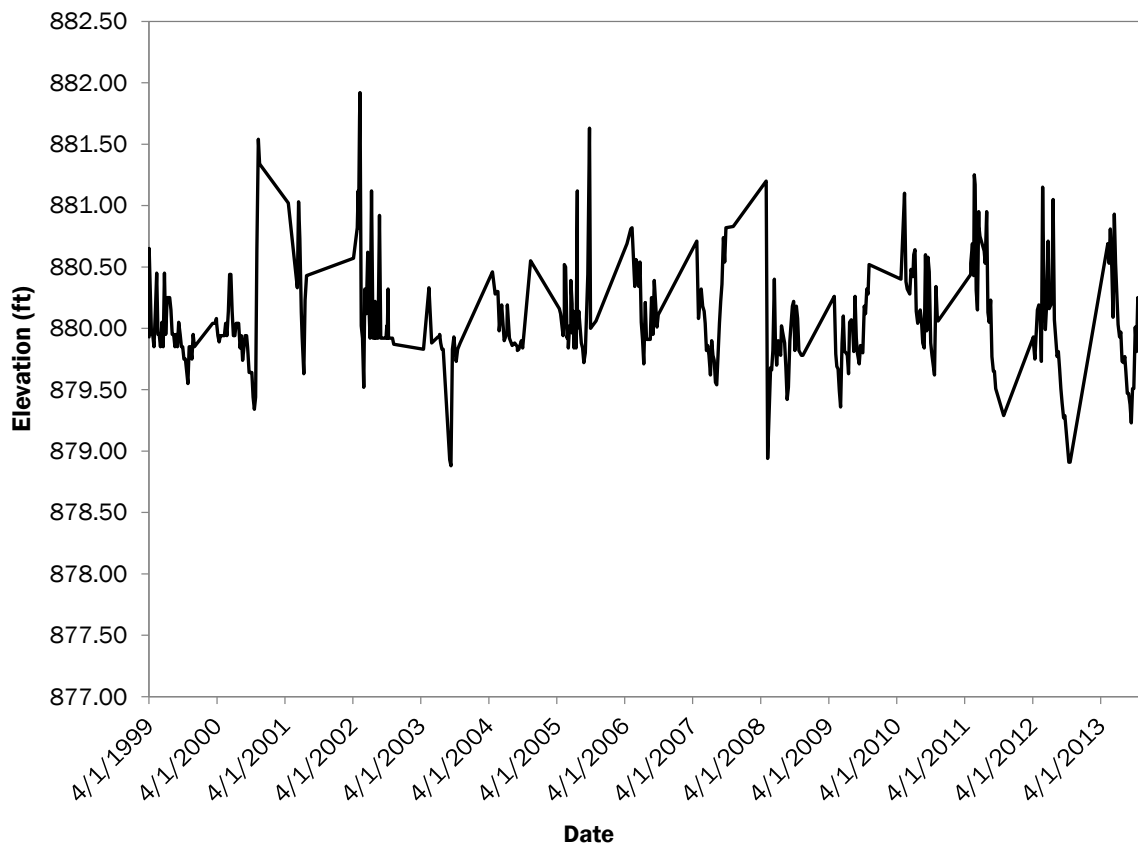


Figure 2. Sullivan Lake water elevation from April 1999 to November 2013

Table 1. Sullivan Lake water elevation statistics from 2008 through 2013

Year	Average	Minimum	Maximum
2008	880.22	879.42	881.24
2009	879.92	879.36	880.52
2010	880.23	879.62	881.10
2011	880.36	879.29	881.25
2012	879.86	878.91	881.15
2013	880.00	879.23	880.93

Water Quality Monitoring Results

Results Summary

The ACD monitored water quality in Sullivan Lake monthly from May to September 2013. ACD monitored the following parameters: total phosphorus, chlorophyll-a, chloride, secchi transparency, D.O., turbidity, temperature, conductivity, pH, and salinity. Water quality monitoring data for 2013 are shown in Table 2. Figure 3 illustrates 2013 total phosphorus, chlorophyll-a, and transparency data.

In 2013 Sullivan Lake had poor water quality compared to other lakes in this region (NCHF Ecoregion), receiving an overall D grade (Table 3). This was similar to the previous twelve monitored years. The lake was highly eutrophic (Figure 4), and phosphorus levels were two to three times the threshold for an impaired designation by the Minnesota Pollution Control Agency. ACD staff's subjective observations were that algae levels were "high" or "severe" and the lake was unsuitable for swimming during the entire period from May through September. Past depth profiles indicate that dissolved oxygen is too low for most fish (<4 mg/L) below four feet, and is too low for most aquatic life (<1 mg/L) near the bottom. This is likely due to oxygen consumption by decomposition of expired algae.

Table 2. 2013 Sullivan Lake water quality data

Parameter	Units	Recording Limit	5/15/13	6/12/13	7/10/13	8/7/13	9/5/13	Average	Min	Max
pH		0.1	8.31	7.33	8.66	9.30	9.15	8.55	7.33	9.30
Conductivity	mS/cm	0.01	0.886	0.604	0.356	0.331	0.385	0.512	0.331	0.886
Turbidity	NTU	1	10	10	13	44.7	74.90	30	10	75
D.O.	mg/L	0.01	12.9	5.06	10.72	12.56	12.95	10.83	5.06	12.95
D.O.	%	1	130	53	143	138	155	124	53	155
Temperature	C	0.1	16.6	18.2	28.4	22.7	24.0	21.98	16.60	28.41
Temperature	F	0.1	61.9	64.7	83.1	72.8	75.2	71.6	32.0	83.1
Salinity	%	0.01	0.0	0.3	0.2	0.2	0.2	0.2	0.0	0.3
Chloride	mg/L	0.1	372.0	197.0	94.5	89.4	103.0	171.2	89.4	372.0
Chlorophyll-a	ug/L	0.5	16	17	27	136	125	64.0	15.5	136.0
Total P	mg/L	0.010	0.066	0.136	0.130	0.194	0.232	0.152	0.066	0.232
Total P	ug/L	10	66	136	130	194	232	152	0	232
Secchi	ft	0.1	3.7	3.6	2.3	1.6	1.0	2.4	1.0	3.7
Secchi	m	0.1	1.1	1.1	0.7	0.5	0.3	0.7	0.0	1.1
Physical			3.0	3.0	2.0	4.0	4.00	3.2	2.0	4.0
Recreational			3.0	3.0	4.0	4.0	2.00	3.2	2.0	4.0

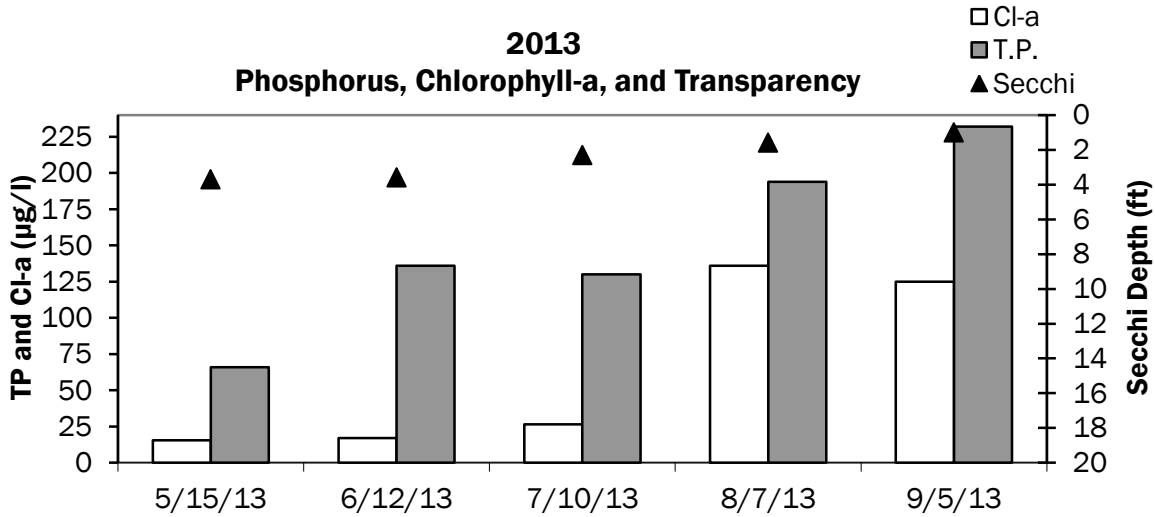


Figure 3. Sullivan Lake total phosphorus (µg/L), chlorophyll-a (µg/L), and secchi depth (ft) during 2013

Table 3. Metropolitan Council's lake quality grading system

Grade	Percentile	TP (µg/L)	Chlorophyll-a (µg/L)	Secchi Depth (m)
A	<10	<23	<10	>3.0
B	10 - 30	23 - 32	10 - 20	2.2 - 3.0
C	30 - 70	32 - 68	20 - 48	1.2 - 2.2
D	70 - 90	68 - 152	48 - 77	0.7 - 1.2
F	>90	>152	>77	<0.7

Carlson's Trophic State Index

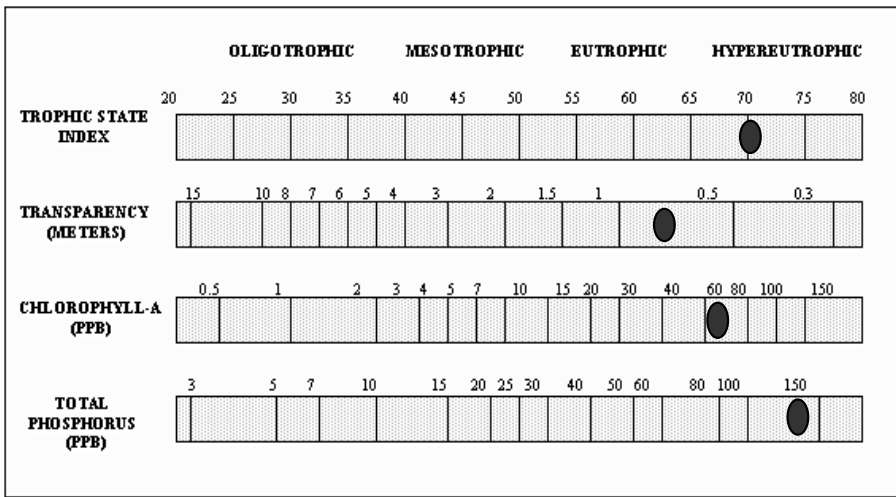


Figure 4. Sullivan Lake trophic state

Trend Analysis

Thirteen years of water quality data in total have been collected by the Metropolitan Council (1993-2003) and Anoka Conservation District (2004, 2005, & 2013). Historical summertime means of total phosphorous, chlorophyll-a, and transparency from 1993 to 2013 are shown in Figure 5. Historical summertime means and lake grade data are shown in Table 4. Water quality is showing a significant, downward trend (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth ($F_{2,10}=8.21$, $p=0.0078$). We examined each of the response variables separately to gain insight into which might be responsible for the trend. Both phosphorus and chlorophyll-a have been increasing over time.

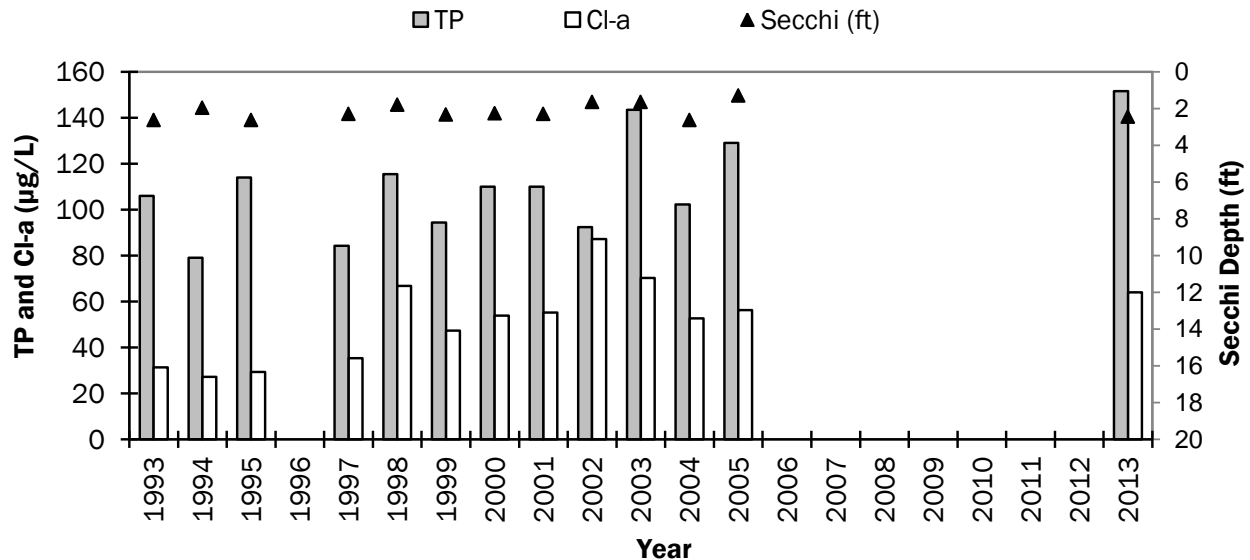


Figure 5. Sullivan Lake historic summertime means of total phosphorus (ug/L), chlorophyll-a (ug/L), and secchi depth (ft)

Table 4. Sullivan Lake historic water quality conditions from 1993 through 2005 and 2013

Agency	MC	MC	MC	MC	MC	MC	MC	MC	MC	MC	ACD	ACD	ACD
Year	93	94	95	97	98	99	2000	2001	2002	2003	2004	2005	2013
Sullivan Lake Historic Summertime Mean Values													
TP	106.0	79.1	114.0	84.2	115.5	94.4	110.0	110.0	92.4	143.4	102.3	129	151.6
Cl-a	31.4	27.2	29.4	35.3	66.8	47.3	53.8	55.2	87.2	70.3	52.6	56.3	64.0
Secchi (m)	0.80	0.60	0.80	0.70	0.55	0.71	0.69	0.70	0.50	0.50	0.80	0.40	0.7
Secchi (ft)	2.6	2.0	2.6	2.3	1.8	2.3	2.3	2.3	1.6	1.6	2.6	1.3	2.4
Carlson's Tropic State Indices													
TSIP	71	67	72	68	73	70	72	72	69	76	71	74	77
TSIC	65	63	64	66	72	69	70	70	75	72	70	70	72
TSIS	63	67	63	65	69	65	65	65	70	70	63	73	64
TSI	66	66	67	66	71	68	69	69	71	73	68	73	71
Sullivan Lake Water Quality Report Card													
TP	D	D	D	D	D	D	D	D	D	D	D	D	D
Cl-a	C	C	C	C	D	C	D	D	F	D	D	D	D
Secchi	D	F	D	D	F	D	D	D	F	F	D	F	D
Overall	D	D	D	D	D	D	D	D	F	D	D	D	D

Recommendations

Sullivan Lake may have poor water quality because of the composition of the stormwater that it receives. ACD recommends investigating the stormwater quality draining to Sullivan Lake. Stormwater from urbanized areas may be high in sediment, nutrients, and other pollutants. Improvements to the stormwater drainage system that could benefit Sullivan Lake should be explored.