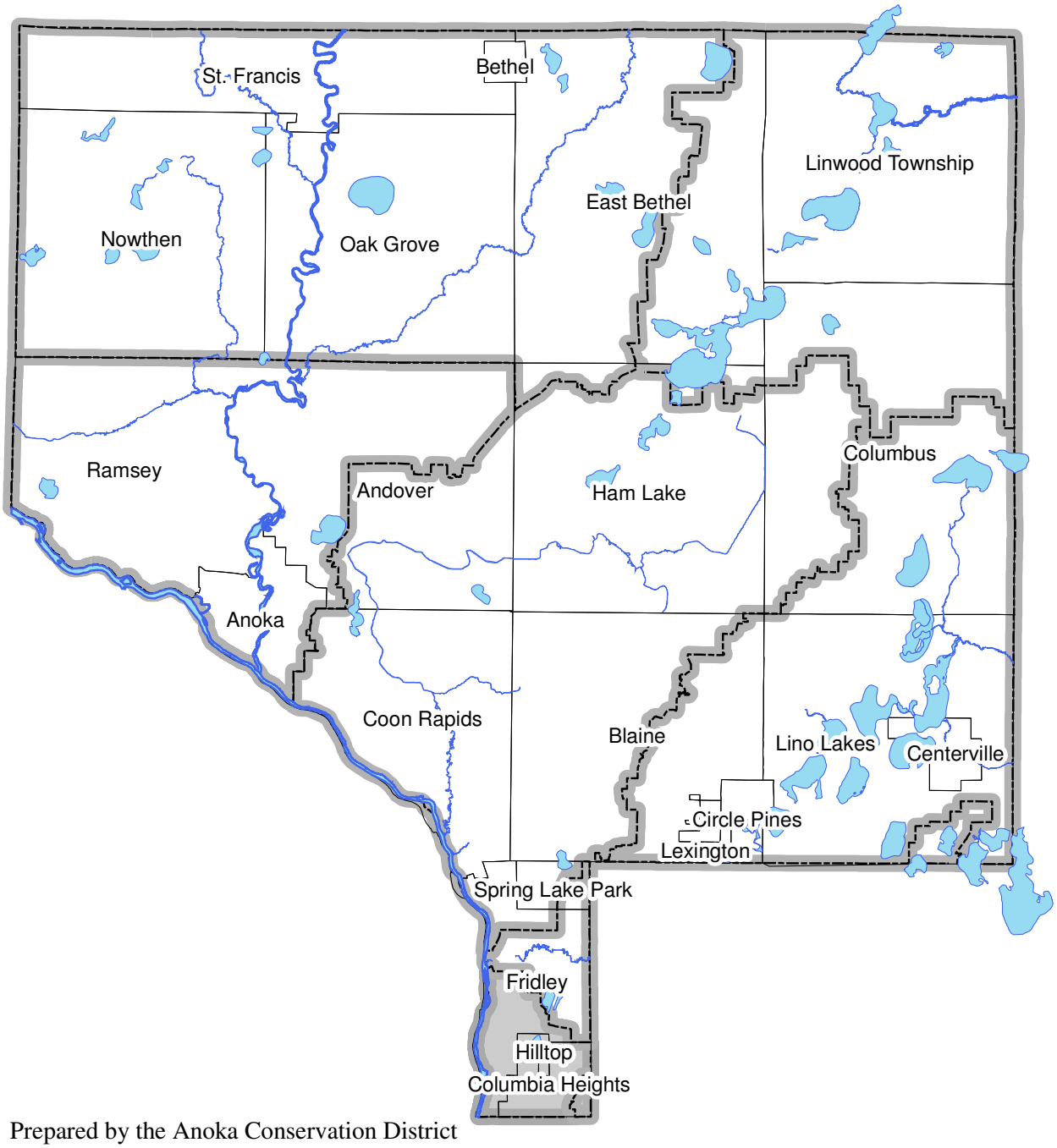
Excerpt from the
2019 Anoka Water Almanac

Chapter 7: Mississippi Watershed



Prepared by the Anoka Conservation District

Mississippi Watershed Management Organization

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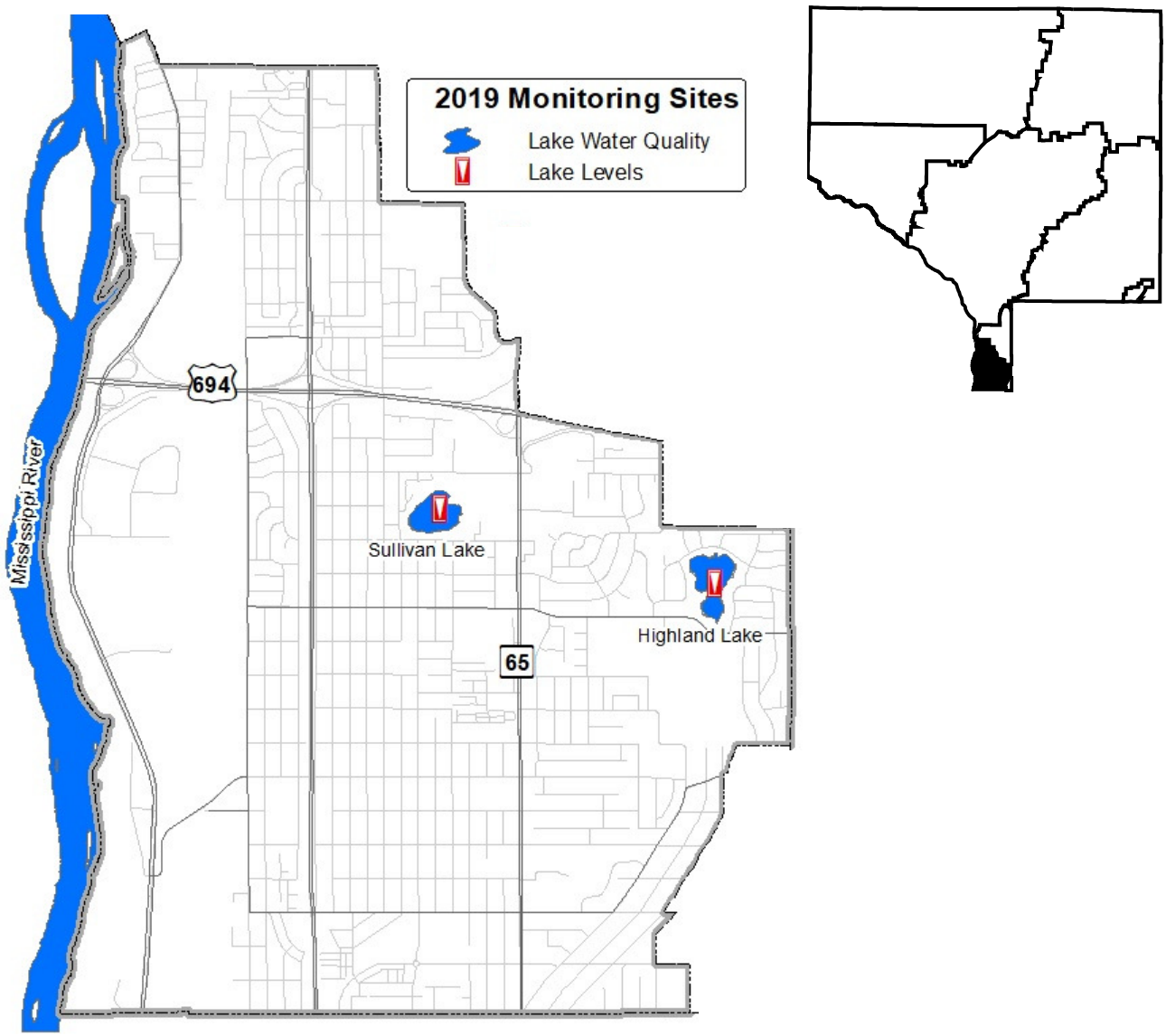


Lake Levels

Partners: MWMO, ACD, MN DNR, volunteers

Description: Weekly water level monitoring in lakes. These data, as well as all additional historical data are available on the Minnesota DNR website using the "LakeFinder" feature (www.dnr.mn.us.state\lakefind\index.html).

Purpose: To provide understanding of lake hydrology, including the impact of climate and water budget changes. These data are useful for regulatory, building/development, and lake hydrology manipulation decisions.

Locations: Sullivan/Sandy Lake

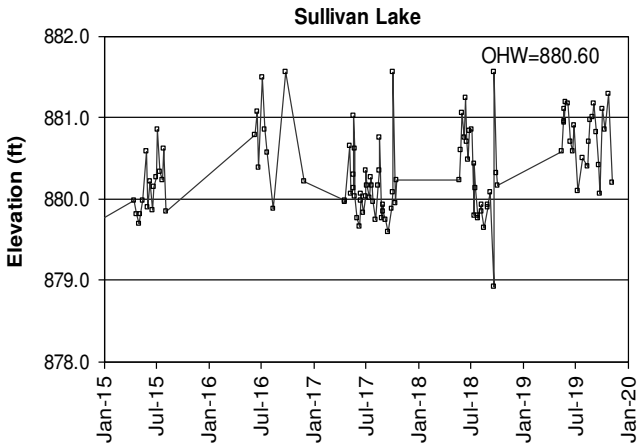
Highland Lake

Results: Lake levels were measured 23 times at each lake, May through October of 2019. Sullivan Lake water levels typically fluctuate rapidly, routinely bouncing by half a foot in response to single rainfall events due to the volume of stormwater directed to the lake compared to its small basin size. In 2019, Sullivan levels fluctuated less than the last couple of years, just 1.24 feet total, due mostly to sustained high levels throughout the year.

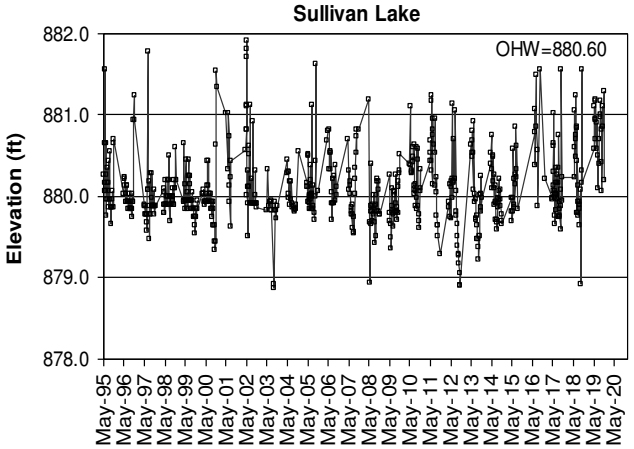
Highland Lake water levels fluctuated even less only ranging 0.32 feet throughout the season. Although 2019 was the wettest year on record Highland lake levels stayed consistent with recent averages. Both of these lakes have controlled outlet structures which help to cap the lakes' highest levels and prevent flooding.

Raw lake level data for all sites and all years can be downloaded from the Minnesota DNR website using the "LakeFinder" tool. Ordinary High Water Levels (OHW), the elevation below which a DNR permit is needed to perform work, are listed for each lake on the graph below.

Sullivan/Sandy Lake Levels last 5 years



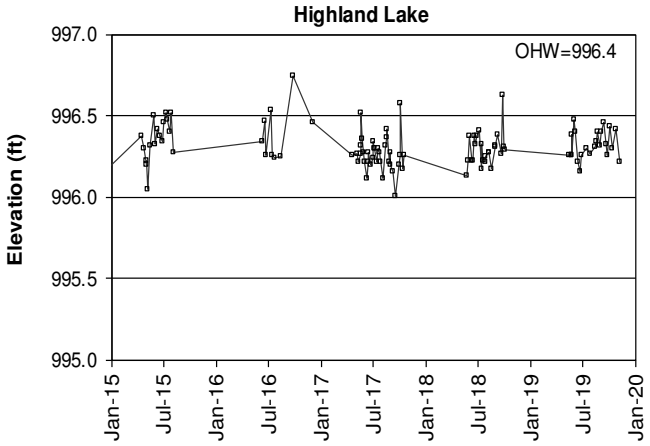
Sullivan/Sandy Lake Levels last 25 years



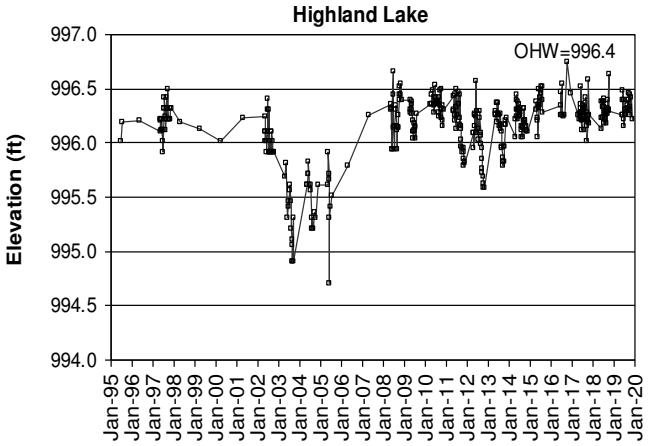
Sullivan/Sandy Lake level 5 year summary

Year	Average	Min	Max
2015	880.14	879.69	880.85
2016	880.76	879.88	881.56
2017	880.13	879.6	881.56
2018	880.29	878.93	881.57
2019	880.77	880.06	881.3
5-year	880.36	878.93	881.57

Highland Lake Levels last 5 years



Highland Lake Levels 1995-2018



Highland Lake level 5-year summary

Year	Average	Min	Max
2015	996.36	996.05	996.52
2016	996.40	996.24	996.75
2017	996.27	996.01	996.58
2018	996.30	996.13	996.63
2019	996.32	996.16	996.48
5-year	996.31	996.01	996.75

Lake Water Quality

Description: May through September monthly monitoring of the following parameters: total phosphorus, chlorophyll-a, chloride, Secchi transparency, dissolved oxygen, turbidity, temperature, conductivity, pH, and salinity.

Purpose: To detect water quality trends and diagnose the cause of changes.

Locations: Sullivan/Sandy Lake

Highland Lake

Results: Detailed data are provided on the following pages, including summaries of historical conditions and trend analysis. Previous years' data are available from the ACD. Refer to Chapter 1 for additional information on interpreting the data and on lake dynamics.

Sullivan/Sandy Lake

City of Columbia Heights, Lake ID # 02-0080

Background

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 and commercial uses. The walking trail around the lake is used extensively, but the lake itself is used very little for recreation, and there is no easy access to the water. The lake's watershed is highly urbanized, and the lake essentially serves as a flow-through stormwater pond. The stormwater conveyance system draining 433 acres of primarily residential and commercial areas of Columbia Heights and Fridley discharges directly into Sullivan Lake. The lake is listed as impaired by the MPCA for both nutrients and aquatic recreation, likely related to the volume of stormwater piped to this small lake. Water exiting this lake is discharged to the Mississippi River via additional subsurface conveyances.

Results 2019

Sullivan/Sandy Lake maintains a track record of very poor water quality. Overall water quality for all monitored years received a D letter grade or worse. The lake is highly eutrophic, and phosphorus levels are routinely two to three times the threshold for an impaired designation by the MPCA. The lake is unsuitable for swimming during the entire growing season. Both total phosphorus and chlorophyll-a levels were lower in 2019 than they were in 2016 when the lake was last sampled, but both still showed high concentrations. Total phosphorus exceeded the shallow lake water quality standard (60 µg/L) in all five sampling events in 2019. Chlorophyll-a also more than doubled the state standard (20 µg/L) in four out of five samples collected. 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.

Trend Analysis

Fifteen years of water quality data have been collected by the Metropolitan Council (1993-2003) and the Anoka Conservation District (2004, 2005, 2013, 2016, and 2019). There is no significant trend in overall water quality when accounting for phosphorus, chlorophyll-a, and Secchi transparency (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,12}$=1.92, p=0.2). We examined each of the response variables separately using a one-way ANOVA to gain insight into how individual parameters are trending over time. Total phosphorus for the total monitoring record through 2016 showed a significant increase in annual average concentrations ($F_{1,12}$=1.92, p=0.015), however the average concentration for 2019 was low enough to reduce the trend to non-significance ($F_{1,12}$=1.92, p=0.076). There is no significant trend over time for either Secchi transparency or chlorophyll-a.

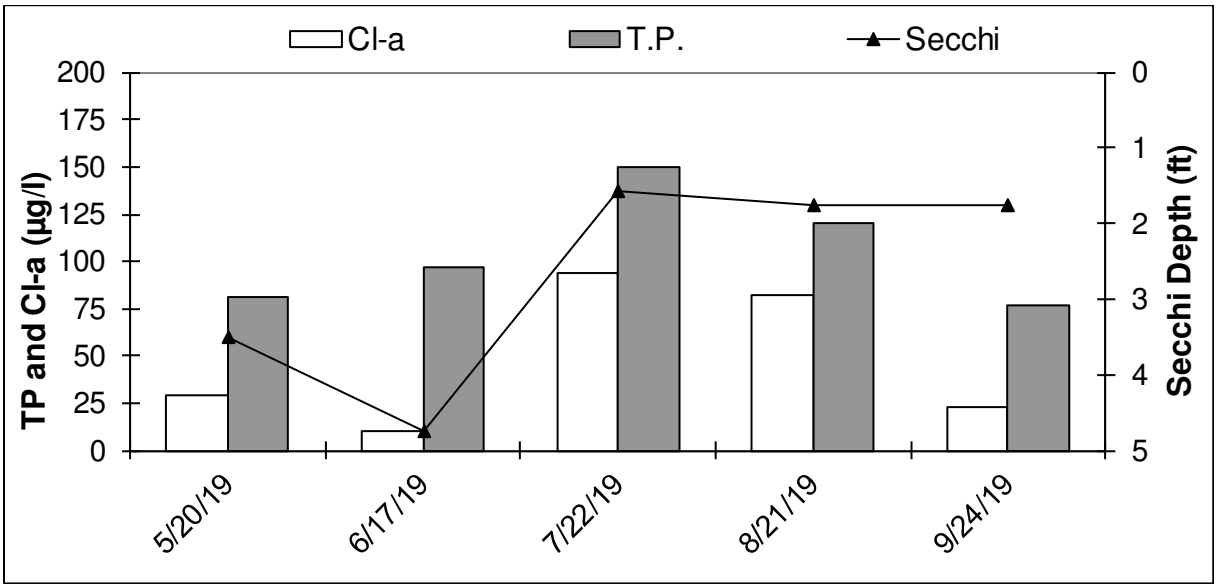
Discussion

Sullivan Lake likely has poor water quality because of both the quality and quantity of stormwater that it receives. Stormwater from urbanized areas commonly has high concentrations of sediment, nutrients and other pollutants. When a small lake receives the majority of its water volume from highly polluted stormwater sources, it can't offer the dilution factor that most lakes can. Improvements to the stormwater system that could benefit Sullivan Lake, especially projects ranked high in the 2019 Subwatershed Assessment Analysis, should be explored.

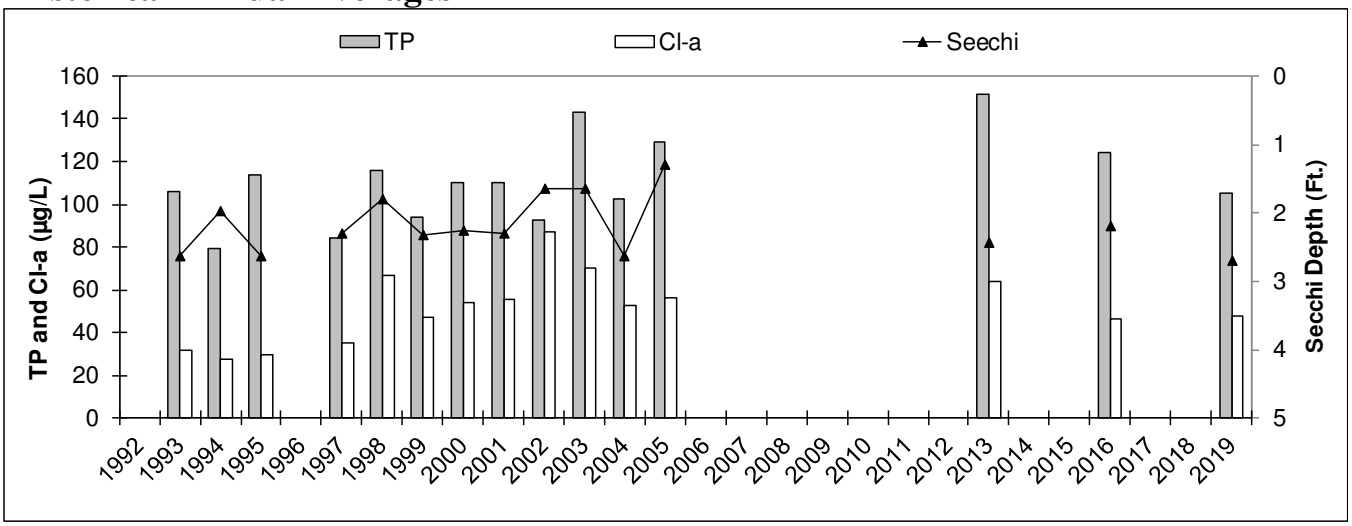
Sullivan Lake			Date	5/20/2019	6/17/2019	7/22/2019	8/21/2019	9/24/2019			
2019 Water Quality Data			Time	14:30	13:20	13:00	12:40	13:15			
	Units	R.L.*		Results	Results	Results	Results	Results	Average	Min	Max
pH				8.18	7.75	8.48	7.81	8.64	8.17	7.75	8.64
Specific Conductivity	mS/cm			0.826	0.483	0.326	0.199	0.150	0.397	0.150	0.826
Turbidity	FNRU			6.5	6.6	30.2	30.3	30.2	21	7	30
D.O.	mg/l			10.18	7.88	15.17	10.26	11.97	11.09	7.88	15.17
D.O.	%			98.8	90.1	188.7	115.7	132.9	125.2	90.1	188.7
Temp.	°C			12.84	22.37	24.32	22.75	20.50	20.56	12.84	24.32
Temp.	°F	0.1		55.1	72.3	75.8	73.0	68.9	69.0	55.1	75.8
Salinity	%	0.01		0.39	0.24	0.16	0.09	0.07	0.2	0.1	0.4
Chloride	mg/l	0.1		196.0	101.0	54.5	34.3	24.0	82.0	24.0	196.0
Cl-a	ug/l	0.5		29.6	10.7	93.4	81.7	23.5	47.8	10.7	93.4
T.P.	mg/l	0.010		0.081	0.097	0.150	0.120	0.077	0.105	0.077	0.150
T.P.	ug/l	10		81	97	150	120	77	105	77	150
Secchi	ft	0.1		3.5	4.8	1.58	1.8	1.8	2.7	1.6	4.8
Secchi	m	0.1		1.1	1.4	0.5	0.5	0.5	0.8	0.5	1.4
Physical				3.0	3.0	3.0	3.0	3.00	3.0	3.0	3.0
Recreational				4.0	4.0	4.0	3.0	3.00	3.6	3.0	4.0

*reporting limit

2019 Results



Historical Annual Averages



2019 Medians

pH		8.18
Specific Conductivity	mS/cm	0.326
Turbidity	NTU	30.2
D.O.	mg/l	10.26
D.O.	%	115.7
Temp.	℉	77.26
Salinity	%	0.16
Chlorides	mg/L	54.5
Cl-a	µg/L	29.6
T.P.	µg/l	97
Secchi	ft	1.75

Historical Report Card

Year	TP	Cl-a	Secchi	Overall
1993	D		D	**D**
1994	D	C	F	**D**
1995	D	C	D	**D**
1997	D	C	D	**D**
1998	D	D	F	**D**
1999	D	C	D	**D**
2000	D	D	D	**D**
2001	D	D	D	**D**
2002	D	F	F	**F**
2003	D	D	F	**D**
2004	D	D	D	**D**
2005	D	D	F	**D**
2013	D	D	D	**D**
2016	D	C	D	**D**
2019	D	C	C	D
State Standards	60 ug/L	20 ug/L	>3.3 ft	

Highland Lake

City of Columbia Heights, Lake ID # 02-0079

Background

Highland Lake is a shallow lake with approximately 14 acres of surface area in south central Anoka County. It is surrounded by the mostly wooded Kordiak park, which features a popular paved trail that circumnavigates Highland Lake The contributing watershed to Highland lake is 140 acres of primarily residential land cover that drains to Highland Lake via direct storm sewer discharge. Like Sullivan Lake, Highland Lake is listed as impaired by the MPCA for both nutrients and aquatic recreation, likely related to the volume of stormwater piped to this small lake.

Results 2019

The Anoka Conservation District (ACD) monitored Highland Lake for the first time in 2016. Prior to 2016, the lake had been monitored through the MPCA citizen volunteer program annually from years 2000-2007. Throughout its recorded history, Highland Lake has had extremely high levels of nutrients and chlorophyll-a, which are likely contributing to poor water clarity.. In 2019, Highland Lake had poor water quality compared to other lakes in the region (NCHF Ecoregion), receiving an overall F grade. Highland Lake has consistently scored an F letter grade since 2002. Total phosphorus levels in the lake were two to four times the state standard (60 µg/L) for shallow lakes in the NCHF Ecoregion on every sampling event and the seasonal average more than tripled the state standard (190.2 µg/L). In 2019, Chlorophyll-a exceeded the state standard (20 µg/L) on all five sampling events with a maximum concentration of 308.0 µg/L and a seasonal average of 139.8 µg/L. This was a large increase from the 2018 Cl-a average of 49.6 µg/L.

Trend Analysis

Ten years of water quality data have been collected by the MPCA (2000-2007) and the Anoka Conservation District (2016 and 2019). While this is a pretty small dataset to perform any meaningful statistical analysis on, we did perform a repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, ($F_{2,6}$=0.48,p=0.67) and each of the response variables separately, using a one-way ANOVA. None of these analyses produced a trend of statistical significance. A surficial look at the data graphed (below) appears to show that water quality steadily deteriorated through the early 2000s, with almost year on year increases in average phosphorus, and decreases in Secchi transparency from 2000-2007. Recent results from 2016 and 2019 appear to have broken that trend. While we don't have a long enough monitoring record to show any statistical trends in water quality for Highland Lake, its water quality remains very poor and should be a high priority for manangment efforts. Improvements to the stormwater system that could benefit Highland Lake, especially projects ranked high in the 2019 Subwatershed Assessment Analysis, should be explored.

Discussion

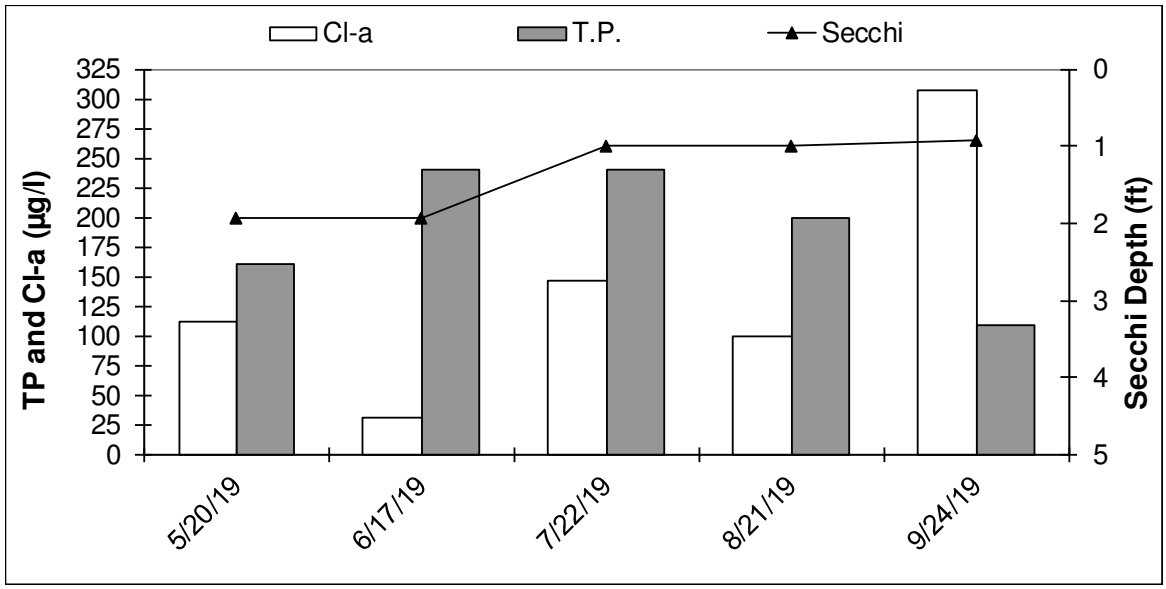
Highland Lake, similar to Sullivan Lake, likely has poor water quality because of both the quality and quantity of stormwater that it receives. Stormwater from urbanized areas can be high in sediment, nutrients and other pollutants. Improvements to the storm water system that could benefit Highland Lake should be explored.

Highland Lake
2019 Water Quality Data

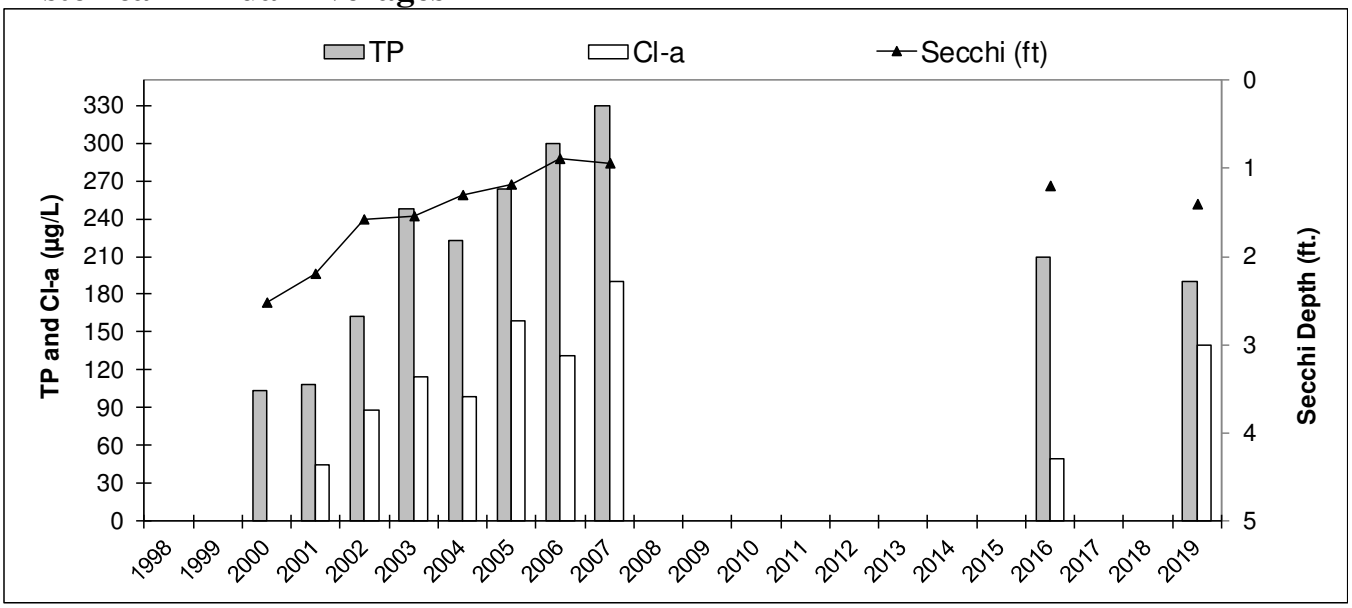
			Date:	5/20/2019	6/17/2019	7/22/2019	8/21/2019	9/24/2019			
			Time:	14:30	13:45	13:20	13:10	13:40			
	Units	R.L.*		Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1		8.60	7.90	7.79	7.64	8.08	8.00	7.64	8.60
Specific Conductivity	mS/cm	0.01		0.281	0.258	0.233	0.174	0.148	0.219	0.148	0.281
Turbidity	FNRU	1		55.00	58.90	49.40	49.90	60.20	55	49	60
D.O.	mg/l	0.01		14.38	12.45	11.49	15.55	13.08	13.39	11.49	15.55
D.O.	%	1		138.0	147.6	129.9	157.8	142.8	143.2	129.9	157.8
Temp.	°C	0.1		12.95	21.64	23.06	22.70	19.60	20.0	13.0	23.1
Temp.	°F	0.1		55.3	71.0	73.5	72.9	67.3	68.0	55.3	73.5
Salinity	%	0.01		0.13	0.12	0.11	0.08	0.07	0.10	0.07	0.13
Cl-a	ug/L	0.5		113.0	32.0	146.0	100.0	308.0	139.8	32.0	308.0
T.P.	mg/l	0.010		0.160	0.241	0.240	0.200	0.110	0.190	0.110	0.241
T.P.	ug/l	10		160	241	240	200	110	190.200	110	241
Chloride	mg/L			40.8	35.3	26.5	21.7	16.6	28.2	17	41
Secchi	ft	0.1		1.9	1.9	1.0	1.0	0.9	1.4	0.9	1.9
Secchi	m	0.1		0.6	0.6	0.3	0.3	0.3	0.4	0.3	0.6
Physical				4	3.0	3.0	3.0	3.0	3.2	3.0	4.0
Recreational				4	4.0	3.0	3.0	3.0	3.4	3.0	4.0

*reporting limit

2019 Results



Historical Annual Averages

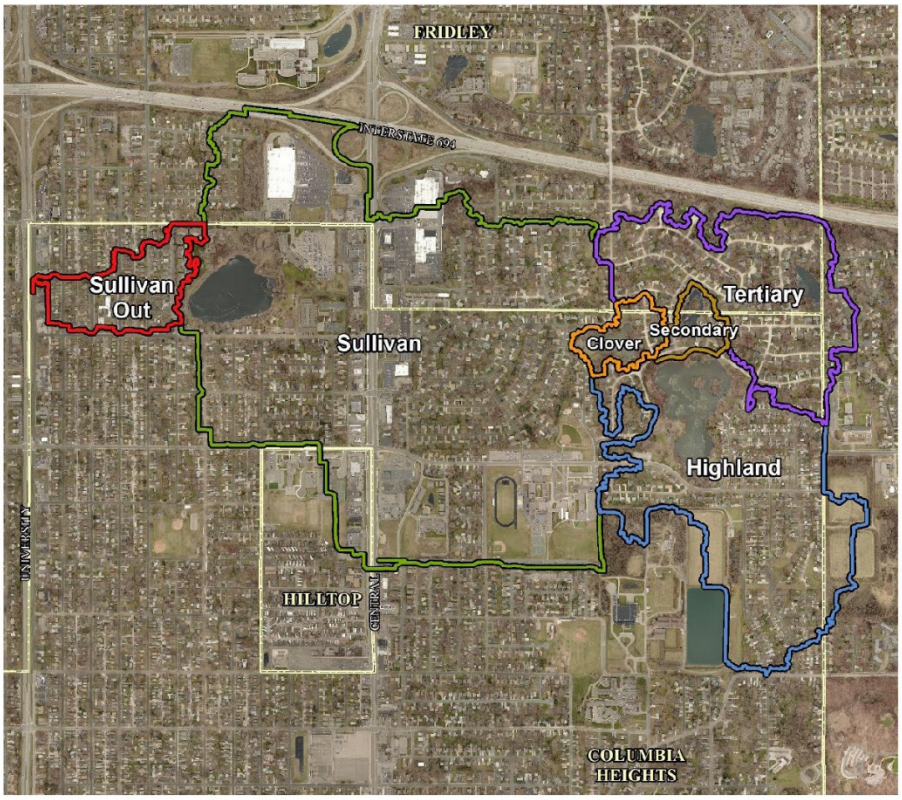


2019 Medians

pH		7.9
Specific Conductivity	mS/cm	0.233
Turbidity	NTU	55
D.O.	mg/l	13.08
D.O.	%	142.8
Temp.	℉	70.952
Salinity	%	0.11
Chlorides	mg/L	113
Cl-a	µg/L	26.5
T.P.	µg/l	200
Secchi	ft	1

Historical Report Card

Year	TP	Cl-a	Secchi	Overall
2000	D		D	**D**
2001	D	C	F	**D**
2002	F	F	F	**F**
2003	F	F	F	**F**
2004	F	F	F	**F**
2005	F	F	F	**F**
2006	F	F	F	**F**
2007	F	F	F	**F**
2016	F	D	F	**F**
2019	F	F	F	**F**
State Standards	60 ug/L	20 ug/L	>3.3 ft	



Highland and Sullivan Lakes Stormwater Retrofit Analysis

Prepared by:

ANOKA CONSERVATION DISTRICT

for the

MISSISSIPPI WATERSHED MANAGEMENT ORGANIZATION

Description: The Mississippi WMO contracted the Anoka Conservation District to perform a Stormwater Retrofit Analysis (SRA) for the subwatershed areas draining to Highland and Sullivan Lakes, as well as three nearby stormwater ponds, Clover, Secondary, and Tertiary Ponds. This process was aimed at identifying and prioritizing potential best management practices for stormwater treatment that could be retrofit into the already developed landscape to benefit the lakes and ponds.

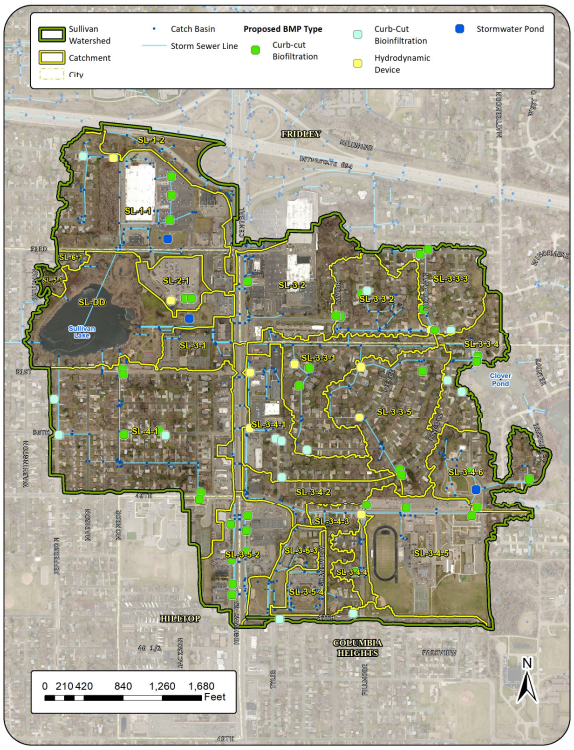
Purpose: Generate a list of potential stormwater retrofit projects in a priority drainage area ranked by cost effectiveness for pollutant removal.

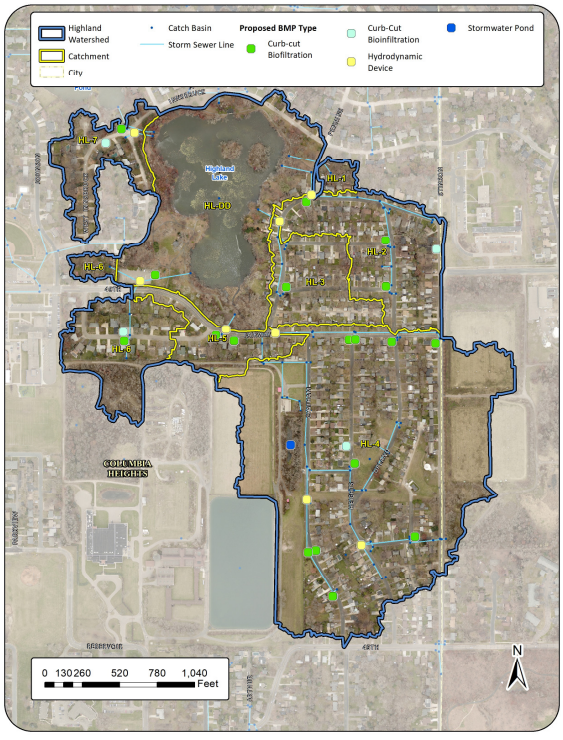
Location: Contributing drainage areas to Highland and Sullivan Lakes, as well as Clover, Secondary, and Tertiary Ponds.

Results: ACD developed models of the drainage areas down to the scale of individual micro catchments draining to each stormwater catch basin using the Source Loading and Management Model for Windows (WinSLAMM). Using these models, we assessed the base conditions of the subcatchments draining to each water resource, as well as the existing conditions factoring in all existing stormwater treatment. This process gave us a relative estimates of pollutant delivery from the subcatchments to the lakes and ponds.

The next step in the analysis involved ACD siting individual stormwater practices that could be retrofit into the existing landscape. To do this, we paired an intensive GIS analysis of the individual catchments, and drove or walked each catchment to the extent practicable. We then modeled each identified potential project and assessed the relative pollutant removal to the receiving water bodies, as well as provided a cost estimate for the installation of each project. Using the modeled pollutant treatment potential, and expected cost of installation for each potential project, we ranked all 123 potential retrofit projects for cost effectiveness of pollutant removal.

The full report, including the ranked project list, is available from the Anoka Conservation District or the Mississippi WMO. It can be found on the ACD website at: https://www.anokaswcd.org/images/AnokaSWCD/Reports/Highland_and_Sullivan_Lakes_SRA.pdf





Financial Summary

ACD accounting is organized by program and not by customer. This allows us to track all of the labor, materials and overhead expenses for a program, such as our lake water quality monitoring program. We do not, however, know specifically which expenses are attributed to monitoring which lakes. To enable reporting of expenses for monitoring conducted in a specific watershed, we divide the total program cost by the number of sites monitored to determine an annual cost per site. We then multiply the cost per site by the number of sites monitored for a customer. The process also takes into account equipment that is purchased for monitoring in a specific area.

MWMO Financial Summary to be included here in final 2019 Anoka Water Almanac:

Recommendations

- Continue to monitor water quality and water levels on Highland and Sullivan Lakes.
- Implement practices identified in the Highland and Sullivan SRA report to benefit the water quality of these two lakes. Both lakes have very poor water quality, are impaired for nutrients and recreation, and both have popular parks adjacent to them that many visitors and occupants of the area frequent. Many people would enjoy and appreciate improved water quality in these lakes.