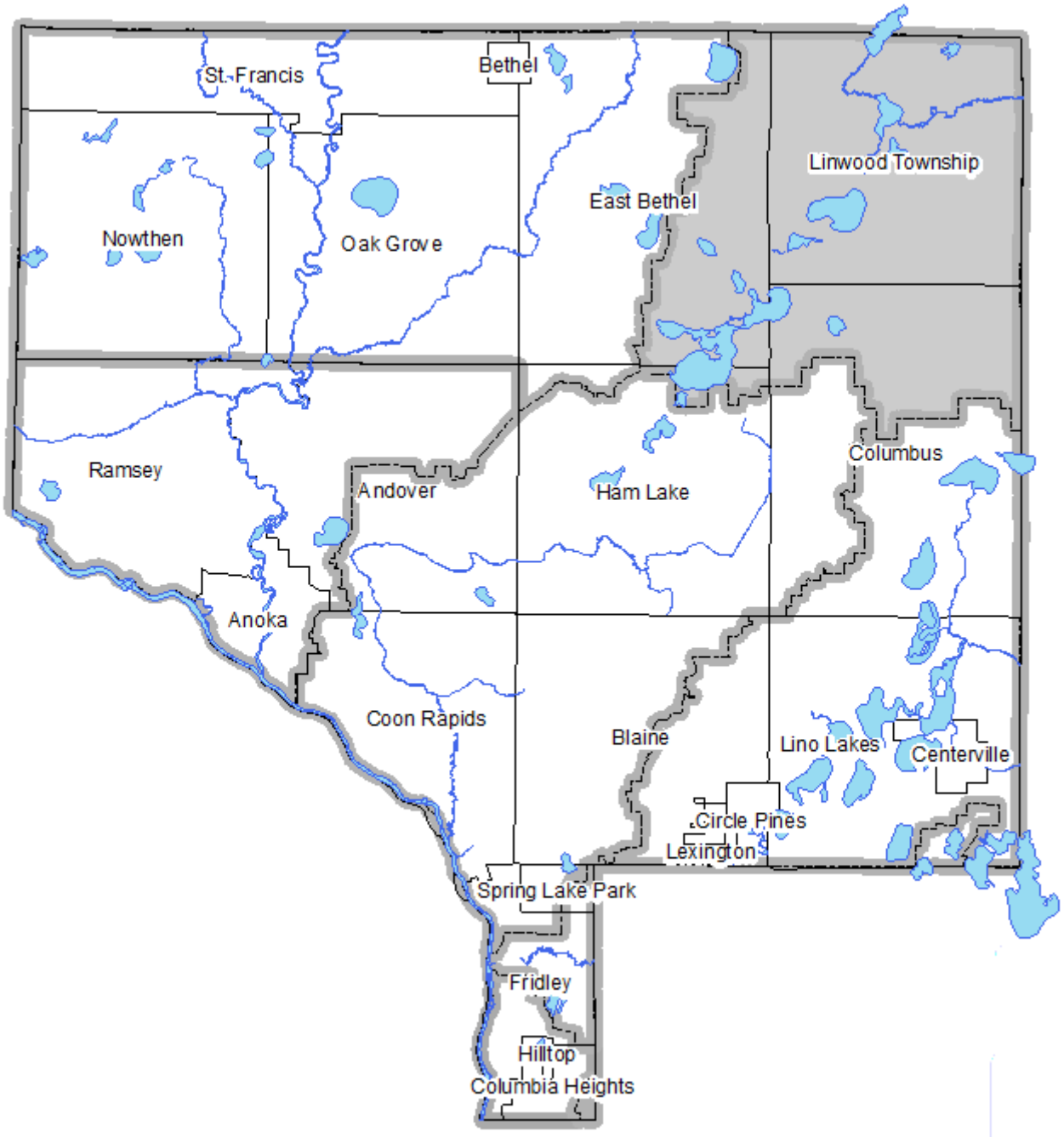
Chapter 2: Sunrise River Watershed



Prepared by the Anoka Conservation District

Sunrise River Watershed

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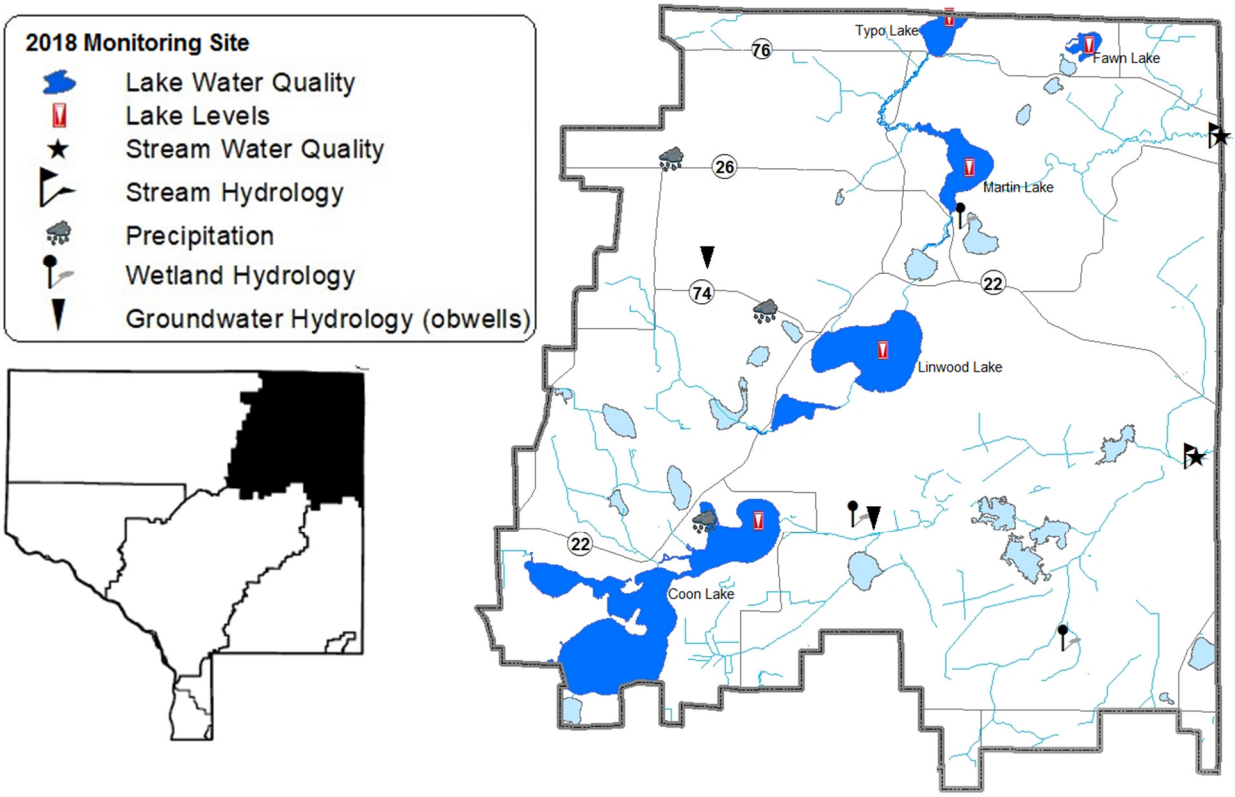


Lake Levels

Partners: SRWMO, ACD, MN DNR, volunteers

Description: Weekly water level monitoring in lakes. The past five and twenty-five years of data for each lake are illustrated below, and all historical data are available on the Minnesota DNR website using the "LakeFinder" feature (www.dnr.mn.us.state\lakefind\index.html).

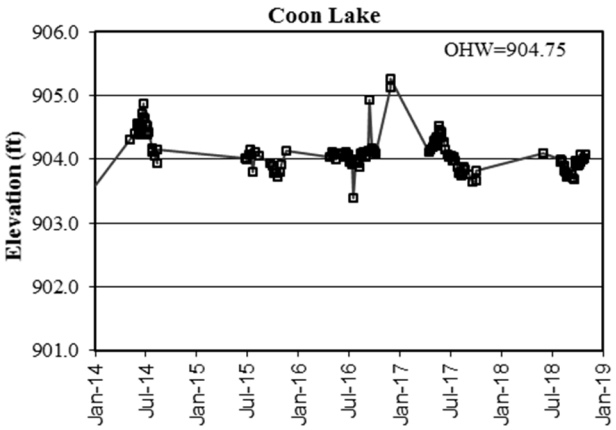
Purpose: To understand lake hydrology, including the impact of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

Locations: Coon, Fawn, Linwood, Martin, and Typo Lakes

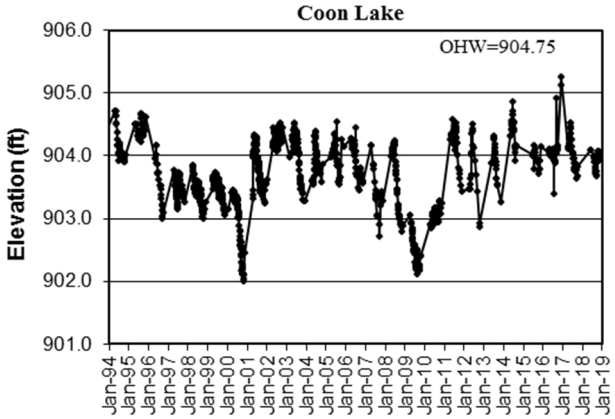
Results: Lake levels were measured by volunteers throughout the 2018 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. In 2018, there was little data prior to June 1 so the expected pattern of increasing water levels in spring was not documented. By early summer water levels were falling and continued to fall until mid-August when they began to rebound.

All lake level data can be downloaded from the MN DNR website's LakeFinder feature (https://www.dnr.state.mn.us/lakefind/index.html). Ordinary High Water Level (OHW), the elevation below which a DNR permit is needed to perform work, is listed for each lake on the corresponding graphs below.

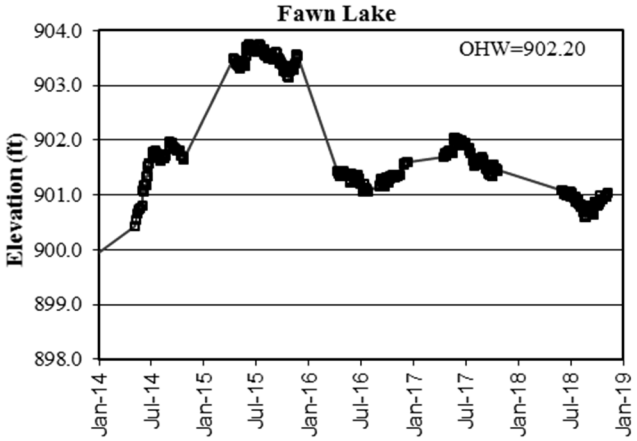
Coon Lake Levels – last 5 years



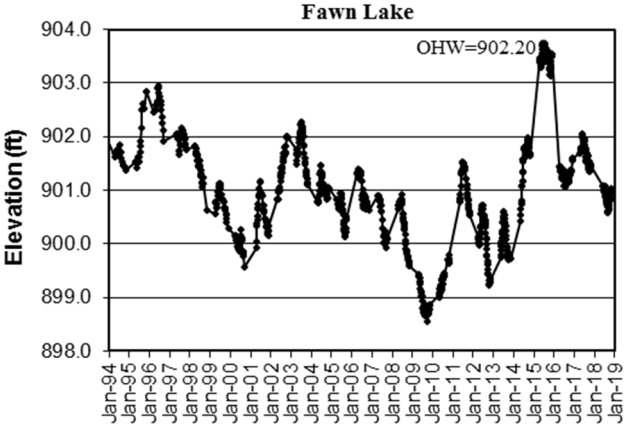
Coon Lake Levels – last 25 years



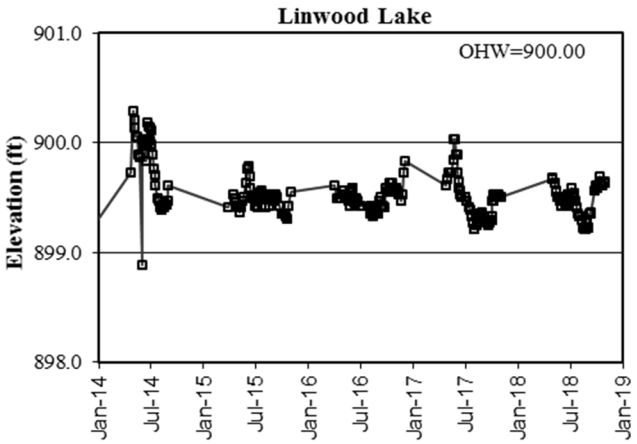
Fawn Lake Levels – last 5 years



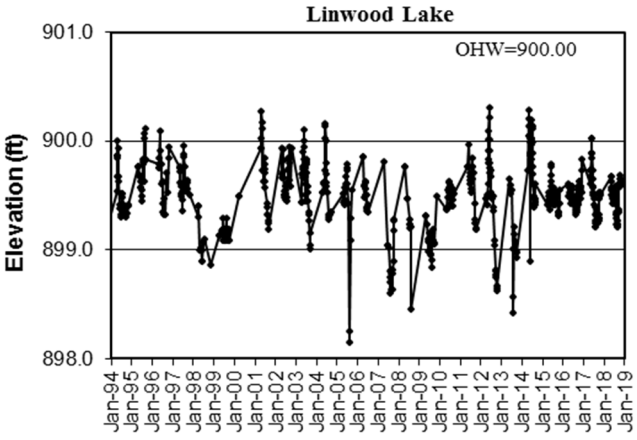
Fawn Lake Levels – last 25 years



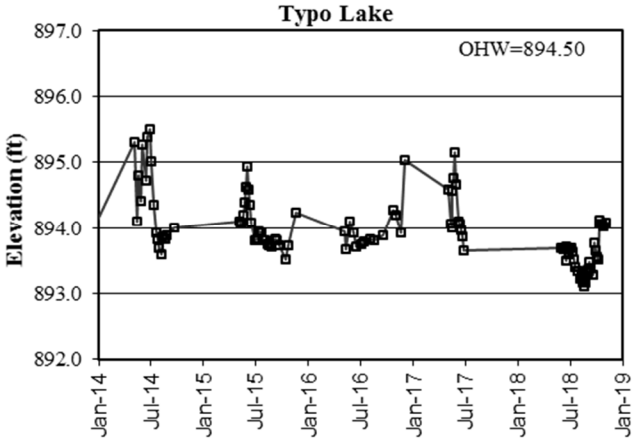
Linwood Lake Levels – last 5 years



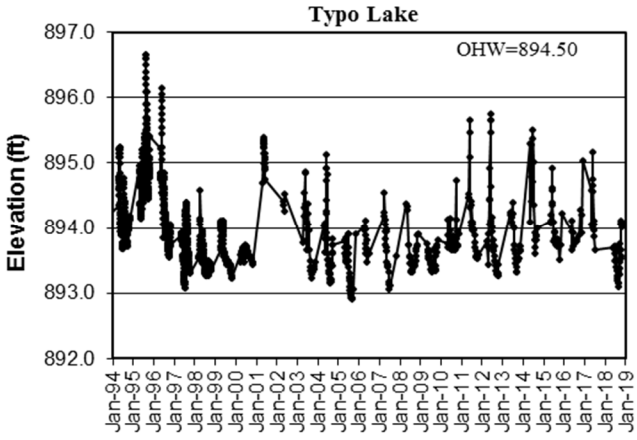
Linwood Lake Levels – last 25 years



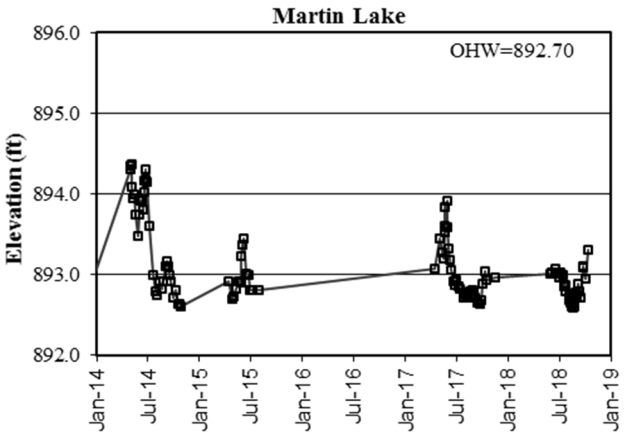
Typo Lake Levels – last 5 years



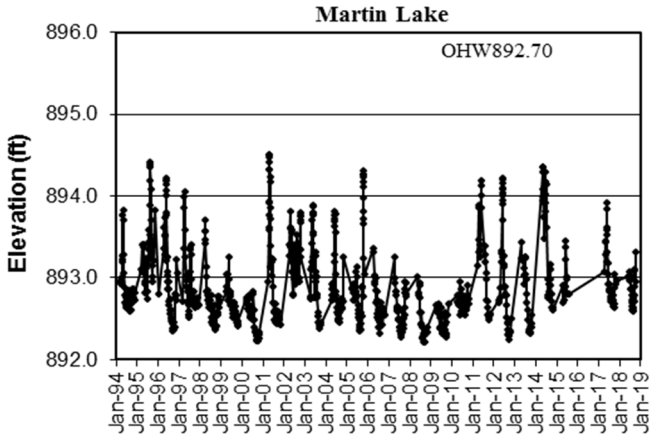
Typo Lake Levels – last 25 years



Martin Lake Levels – last 5 years



Martin Lake Levels – last 25 years



Lake Water Quality

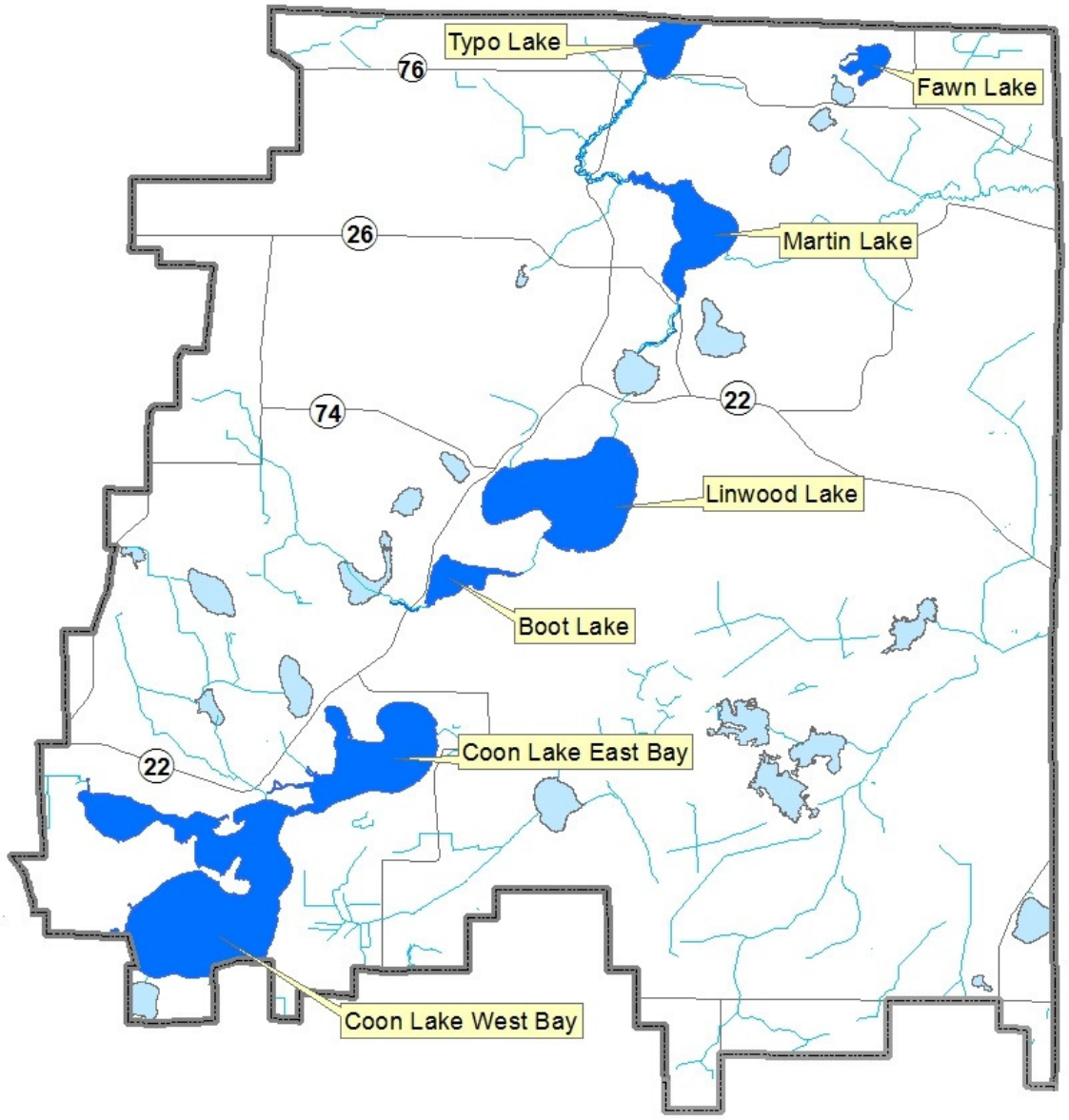
Description: May through September, every-other-week, monitoring is conducted for the following parameters: total phosphorus, chlorophyll-a, Secchi transparency, dissolved oxygen, turbidity, temperature, specific conductivity, pH, and salinity.

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

Locations: Boot, Coon East Bay & West Bay, Fawn, Linwood, Martin & Typo Lakes

Results: Detailed data for each lake are provided on the following pages, including summaries of historical conditions and trend analysis. Previous years' data are available from the Minnesota Pollution Control Agency (MPCA) (https://cf.pca.state.mn.us/water/watershedweb/wdip/search_more.cfm) or from ACD. Refer to Chapter 1 for additional information on lake dynamics and interpreting the data.

Sunrise Watershed Lake Water Quality Monitoring Sites



BOOT LAKE
LINWOOD TOWNSHIP LAKE ID # 02-0028

Background

Boot Lake is located in the northeast portion of Anoka County and has a surface area of 92 acres. While nearly all of the lake is shallow with aquatic vegetation growing to the surface, there is one area with a depth of 23 ft. (7 m) where water quality monitoring occurred.

Boot Lake is within a Scientific and Natural Area (SNA) owned and administered by the Minnesota Department of Natural Resources. The Boot Lake SNA is 660 acres and includes the entire lake as well as the undeveloped shoreline. Access, including water quality monitoring, requires a special permit.

Boot Lake has one primary stream inlet and one outlet. The inlet drains upstream lands that include undeveloped, sod fields and large-lot residential usage. The outlet stream goes to Linwood Lake.

Boot Lake was selected as a new monitoring site in 2018 for two reasons. The first is that Boot Lake is a contributing water source to Linwood Lake which is impaired for excess nutrients. Monitoring Boot Lake water quality allows us to determine whether Boot Lake is degrading Linwood Lake water quality. Secondly, Boot Lake is relatively undisturbed, and it is desirable to see what water quality is like in a rare, undeveloped lake in Anoka County.

2018 Results

Boot Lake's nutrient levels are typical of shallow lakes in the area. Average phosphorus levels in 2018 were 35 µg/L, average chlorophyll-a was 11.5 µg/L, and average Secchi transparency was 6.6 ft. (2.0 m). These are better than the State water quality standard for shallow lakes (total phosphorus <60 µg/L, chlorophyll-a <20 µg/L, Secchi transparency >1m), but only earn Boot Lake an overall C letter grade on Met Council's grading scale for metro area lakes. Boot Lake supports a rich plant community, and the lake attracts abundant waterfowl.

Trend Analysis

This is the first year of water quality monitoring for Boot Lake. Trend analysis is not yet possible.

Discussion

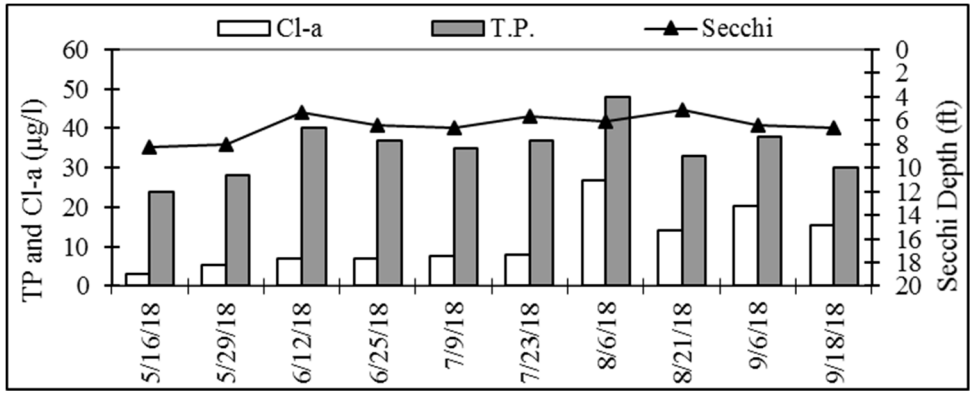
While Boot Lake is not subject to many of the potential negative impacts that occur on unprotected and/or developed lakes, its water quality is far from the pristine condition one might expect. Viking Boulevard runs near the western shore of the lake and may directly contribute pollutants. The contributing subwatershed includes some agriculture and scattered residential housing, which may affect water quality in Boot Lake. Finally, dead common carp were observed when ACD staff was monitoring water quality in Boot Lake. These factors, and likely others, appear to be degrading water quality in Boot Lake to a greater degree than may have been expected given the undisturbed condition of lands immediately surrounding the lake. In 1979 a resource inventory was completed for assessment of the site as a potential Scientific and Natural Area. The inventory did not include water quality monitoring.

Anoka Conservation District has not monitored Boot Lake previously, but in 2001 and 2003 monitored water quality in the Boot Lake inlet at Viking Boulevard. Average total phosphorus in the inlet across both years was 117 µg/L, which is typical for the area but does exceed the state water quality standard of 100 µg/L, and is likely contributing to less than stellar water quality in Boot Lake

Boot Lake's impact on Linwood Lake downstream appears neutral, as its nutrient concentrations are similar. However, efforts to improve impaired Linwood Lake should be made with Boot Lake in mind, despite its surrounding land use. It often makes sense to manage the whole watershed, and especially upstream contributing waters. A 2018-19 study is underway to examine one possible water quality linkage between the lakes – the movement and spawning of common carp.

BOOT LAKE
LINWOOD TOWNSHIP LAKE ID # 02-0028

2018 Results



2018 Median

pH		8.06
Specific Conductivity	mS/cm	0.270
Turbidity	NTU	3.25
D.O.	mg/l	8.12
D.O.	%	0.98
Temp.	°F	74.6
Salinity	%	0.1
Cl-a	µg/L	7.8
T.P.	µg/l	36.0
Secchi	ft	6.4

Historical Report Card

Year	TP	Cl-a	Secchi	**Overall**
2018	C	B	C	**C**
State Standards	60 µg/L	20 µg/L	>3.3 ft	

2018 Water Quality Data

	Units	R.L.*	Date:	5/16/2018	5/29/2018	6/12/2018	6/25/2018	7/9/2018	7/23/2018	8/6/2018	8/21/2018	9/6/2018	9/18/2018	Average	Min	Max
			Time:	13:20	9:30	10:05	9:36	10:12	9:45	9:40	9:35	9:35	9:10			
pH		0.1		8.21	8.10	8.05	8.64	8.66	8.07	7.73	7.14	7.18	7.38	7.9	7.14	8.66
Specific Conductivity	mS/cm	0.01		0.263	0.282	0.255	0.268	0.264	0.297	0.260	0.271	0.303	0.333	0.3	0.26	0.33
Turbidity	NTU	1		0.40	0.30	0.40	3.50	3.40	4.600	2.60	3.10	31.50	10.70	6.1	0.30	31.50
D.O.	mg/l	0.01		9.01	8.82	7.48	8.84	8.08	8.16	8.71	6.41	5.32	7.34	7.8	5.32	9.01
D.O.	%	100.0%		100.8%	111.2%	86.6%	104.5%	103.4%	94.9%	105.7%	76.6%	58.9%	88.0%	93.1%	58.9%	111.2%
Temp.	°C	0.1		20.77	25.41	21.35	23.78	26.29	24.37	23.50	24.09	21.66	22.35	23.4	20.77	26.29
Temp.	°F	0.1		69.4	77.7	70.4	74.8	79.3	75.9	74.3	75.4	71.0	72.2	74.0	69.39	79.32
Salinity	%	0.01		0.13	0.13	0.12	0.13	0.13	0.14	0.12	0.13	0.15	0.16	0.1	0.12	0.16
Cl-a	µg/L	1		3.12	5.34	7.12	7.1	7.7	8.0	26.7	14.2	20.2	15.4	11.5	3.12	26.70
T.P.	mg/l	0.005		0.024	0.028	0.040	0.037	0.035	0.037	0.048	0.033	0.038	0.030	0.0	0.02	0.05
T.P.	µg/l	5		24	28	40	37	35	37	48	33	38	30	35.0	24.00	48.00
Secchi	ft			8.3	8.0	5.3	6.4	6.7	5.7	6.1	5.1	6.4	6.6	6.5	5.08	8.25
Secchi	m			2.5	2.4	1.6	2.0	2.0	1.7	1.9	1.5	2.0	2.0	2.0	1.55	2.51
Physical				2	2	2	2	1	1	1	1	1	2	2	1	2
Recreational				1	2	2	2	2	2	2	2	2	2	2	1	2

*reporting limit

Coon Lake- East and West Bays

City of East Bethel, City of Ham Lake & City of Columbus, Lake ID # 02-0042

Background

Coon Lake is located in east central Anoka County and is the county's largest lake. Coon Lake has a surface area of 1,498 acres and a maximum depth of 27 feet (9 m). Public access is available at three locations with boat ramps, including one park with a swimming beach. The lake is used extensively by recreational boaters and fishers. Most of the lake is surrounded by private residences. The watershed of 6,616 acres is mostly made up of rural residential land usage. This report includes information individually reported for the East Bay (aka northeast or north bay) and West Bay (aka southwest or south bay) of Coon Lake in 2018. The 2010-18 data is from the Anoka Conservation District (ACD) monitoring at the MN Pollution Control Agency) monitoring site #203 for the East Bay and #206 for the West Bay. Over the years, other sites have been monitored and are included in this report's trend analysis when appropriate. When making comparisons between the two bays, consider that both bays were monitored simultaneously only biennially from 2010 to 2018. Data from other years do not lend themselves well to direct comparisons because monitoring regimes were likely different.

Trend Analysis

To analyze Coon Lake trends we obtained historical monitoring data from the MPCA. Over the years water quality has been monitored at 17 different sites on the lake. For the trend analysis, we pooled data from five East Bay sites (#102, 203, 208, 209, and 401) and four West Bay sites (#101, 105, 206, and 207). These sites were chosen because they were all in the bay of interest, close to each other, and distant from the shoreline. The trend analysis is based on average annual water quality data for each year data was collected. We used data only from years with data from every month May to September, allowing for up to one month of missing data. For years 1998 and after, only data collected by ACD was used for greater comparability. Results appear in each Bays sub-section below.

East Bay

2018 Results

In 2018 the East Bay of Coon Lake was monitored every 2 weeks. Water quality was better than average for this region of the state (NCHF Ecoregion), receiving an A grade, up from the B grade achieved in 2016 (no monitoring occurred in 2017). 2018 results included 19.4 µg/L for total phosphorus, 6.73 µg/L chlorophyll-a, and Secchi transparency of 7.96 feet.

Phosphorus concentrations, chlorophyll-a, and Secchi transparency all improved from 2016 levels and were greatly improved over levels measured before 2010. The decline in total phosphorus that was seen from 2010 (39.0 µg/L) to 2014 (19.0 µg/L) were interrupted in 2016 but may have resumed in 2018 (19.4 µg/L). Secchi transparency in 2018 (7.96 ft.) was amongst the best that has been observed at this lake, with only the 2013 reading of 8.8 ft. exceeding it. Subjective observations of the lake's physical characteristics and recreational suitability by the ACD staff indicated that lake conditions remained excellent for swimming and boating.

Trend Analysis

In the East Bay twenty-two years of water quality data have been collected since 1978. During the most recent 14 years that were monitored (since 1996), data collected included total phosphorus, chlorophyll-a, and Secchi transparency. For most of the other eight years (pre-1997) only Secchi transparency data is available. This provides an adequate dataset for a trend analysis, however, given that most of the data is from the last couple of decades, the analysis is not strong at detecting changes that occurred prior to 1990.

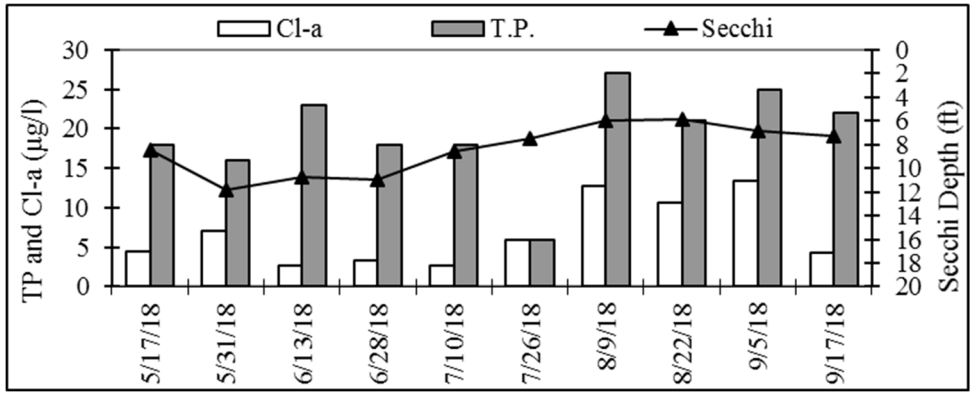
When we examined those years with total phosphorus, chlorophyll-a, and Secchi transparency, excluding the years with only Secchi transparency data, an improving water quality trend did exist. A repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth showed a statistically significant change in water quality over that time period ($F_{2, 16}$=7.27, $p < 0.01$). This is our preferred approach because it examines all three parameters simultaneously.

We also examined variables TP, Cl-a, and Secchi depth across all years of existing data using a one-way ANOVA. Including all years, a significant trend of improving TP ($F_{1, 17}$=10.64, p <0.01), Cl-a ($F_{1, 17}$=12.75, p <0.01), and Secchi transparency ($F_{1, 22}$=25.66, p<0.001) is found. In summary, all three parameters are improving. It is noteworthy that this improvement seems to have primarily occurred since 2010.

Coon Lake- East Bay

City of East Bethel, City of Ham Lake & City of Columbus, Lake ID # 02-0042

2018 Results



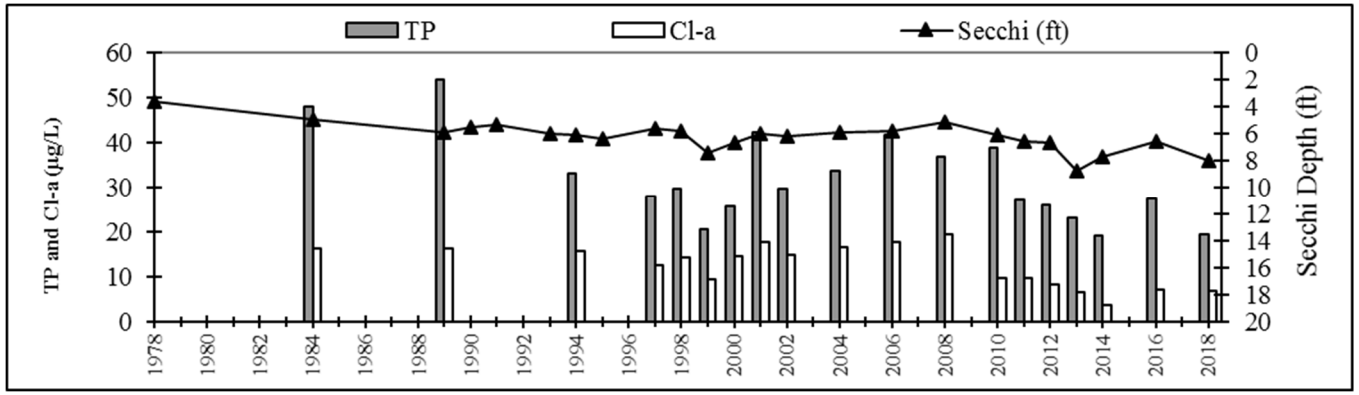
2018 Median Values

pH		8.40
Specific Conductivity	mS/cm	0.229
Turbidity	NTU	2.90
D.O.	mg/l	8.39
D.O.	%	1.05
Temp.	°F	76.3
Salinity	%	0.1
Cl-a	µg/L	5.2
T.P.	µg/l	19.5
Secchi	ft	8.0

Historical Report Card

Year	TP	Chl-A	Secchi	**Overall**
1978			D	D
1984	C	B	C	C
1989	C	B	C	C
1990			C	C
1991			C	C
1993			C	C
1994	C	B	C	**C**
1995			C	**C**
1997	B	B	C	**B**
1998	B	B	C	**B**
1999	A	A	B	**A**
2000	B	B	C	**B**
2001	C	B	C	**C**
2002	B	B	C	**B**
2004	C	B	C	**C**
2006	C	B	C	**C**
2008	C	B	C	**C**
2010	C	A	C	**B-**
2011	B	A	C	**B**
2012	B	A	C	**B**
2013	B	A	B	**B+**
2014	A	A	B	**A**
2016	B	A	C	**B**
2018	A	A	B	**A**
2018	A	A	A	**A**
State Standards	40 µg/L	14 µg/L	>4.6 ft	

Historic Annual Averages



2018 Water Quality Data

	Units	R.L.*	Date:	5/17/2018	5/31/2018	6/13/2018	6/28/2018	7/10/2018	7/26/2018	8/9/2018	8/22/2018	9/5/2018	9/17/2018	Average	Min	Max
			Time:	10:35	15:00	15:35	10:05	10:30	9:45	10:06	14:25	9:25	9:45			
pH		0.1		8.92	7.92	8.42	8.53	8.50	8.37	8.69	7.95	7.59	8.26	8.3	7.59	8.92
Specific Conductivity	mS/cm	0.01		0.247	0.257	0.233	0.219	0.249	0.246	0.217	0.217	0.210	0.225	0.2	0.21	0.26
Turbidity	NTU	1		2.30	0.30	0.0.	0.00	4.30	3.100	3.70	3.90		2.70	2.5	0.00	4.30
D.O.	mg/l	0.01		10.06	8.50	8.29	8.20	8.11	9.47	9.08	7.43	7.11	8.49	8.5	7.11	10.06
D.O.	%	100.0%		111.0%	106.9%	99.5%	98.9%	104.9%	115.4%	115.2%	84.2%	83.6%	104.3%	102.4%	83.6%	115.4%
Temp.	°C	0.1		18.84	24.99	22.97	24.55	26.57	24.65	25.38	24.84	22.71	24.11	24.0	18.84	26.57
Temp.	°F	0.1		65.9	77.0	73.3	76.2	79.8	76.4	77.7	76.7	72.9	75.4	75.1	65.91	79.83
Salinity	%	0.01		0.12	0.12	0.11	0.11	0.12	0.12	0.10	0.10	0.10	0.11	0.1	0.10	0.12
Cl-a	µg/L	1		4.45	7.12	2.67	3.3	2.7	5.9	12.8	10.7	13.4	4.3	6.7	2.67	13.40
T.P.	mg/l	0.005		0.018	0.016	0.023	0.018	0.018	0.006	0.027	0.021	0.025	0.022	0.0	0.01	0.03
T.P.	µg/l	5		18	16	23	18	18	6	27	21	25	22	19.4	6.00	27.00
Secchi	ft			8.4	11.8	10.8	11.0	8.6	7.5	5.9	5.8	6.8	7.3	8.4	5.83	11.83
Secchi	m			2.6	3.6	3.3	3.4	2.6	2.3	1.8	1.8	2.1	2.2	2.6	1.78	3.61
Physical				1	2		2	2	1	2	1	2	1	2	1	2
Recreational				1	1		1	1	1	1	1	1	1	1	1	1

*reporting limit

West Bay

2018 Results

In 2018 the West Bay had better than average water quality for this region of the state (NCHF Ecoregion), receiving an A letter grade. Total phosphorus in 2018 was the second lowest on record at 21.4 µg/L with the lowest being 2016's value of 21.0 µg/L. Phosphorus has been substantially better than state standards (40 µg/L) and low enough to earn B and then A grades since monitoring began in 2010. Chlorophyll-a, on the other hand, was at its highest level on record in 2018 at 6.9 µg/L. Despite nearly doubling since last year chlorophyll-a is still lower than state water quality standards (14 µg/L) and is low enough to earn the lake an A grade for chlorophyll-a. Secchi transparency has been monitored for longer than chlorophyll-a or phosphorus (starting in 1998). Secchi transparency has generally improved over the period of record with the lowest annual average of 3.97 ft. occurring in 1998 and the 2018 average Secchi transparency of 7.3 ft. being the highest. Until this year Secchi transparency has earned a C letter grade. This year it improved just enough to earn a B letter grade. Subjective observation of the lake's physical characteristics and recreational suitability continue to be very high indicating that the lake can be enjoyed for swimming and boating.

Trend Analysis

Thirteen years of data are available for the West Bay with only five of those years including phosphorus and chlorophyll-a data, so meaningful trend analysis is not possible. The dataset for Secchi transparency is longer, but data from 2010 and 2012 must be excluded because a full suite of Secchi measurements is not available due to clarity occasionally exceeding lake depth at the sampling point. Therefore, a statistical analysis would not be highly meaningful.

Instead, we will use a non-analytical look at the data. In 2018, the average Secchi transparency was 7.3 feet. For eight monitored years from 1998-2009, seven of those years had average Secchi transparency of <6 feet. It is notable that in the two most recent years sampled (2016 and 2018), the average Secchi transparency was the best seen since 2002. This suggests that Secchi transparency may be improving, and is at least not declining.

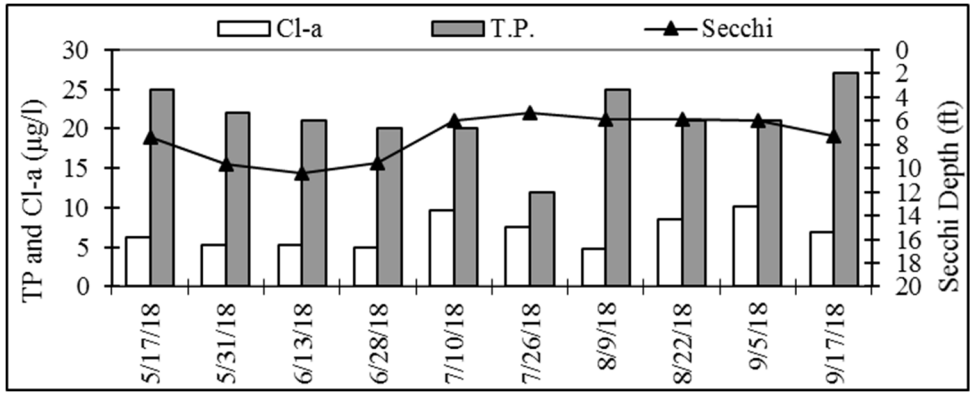
Average total phosphorus, in 2018, was 21.4 µg/L, which is the second lowest on record. Phosphorus has averaged better than 23 µg/L in 2016 and 2018. Prior to that phosphorus ranged from 24 to 28 µg/L. Similar to what is seen in Secchi transparency this may indicate that phosphorus is improving in the West Bay of Coon Lake as well.

Chlorophyll-a concentrations have varied from a low of 3.3 µg/L in 2014 to a high of 6.9 µg/L this year. Unlike phosphorus and transparency, there is no evidence of an improving trend in Chlorophyll-a. The lowest average seen in 2014 is followed by the second highest average in 2012 (5.4 µg/L), another low in 2016 (3.6 µg/L), and then a near doubling in 2018 to 6.9 µg/L. While these may seem like significant changes with average doubling over consecutive sampling years, all years of chlorophyll-a monitoring in Coon Lake have resulted in very low average concentrations when compared to other lakes and State water quality standards.

Coon Lake- West Bay

City of East Bethel, City of Ham Lake & City of Columbus, Lake ID # 02-0042

2018 Results



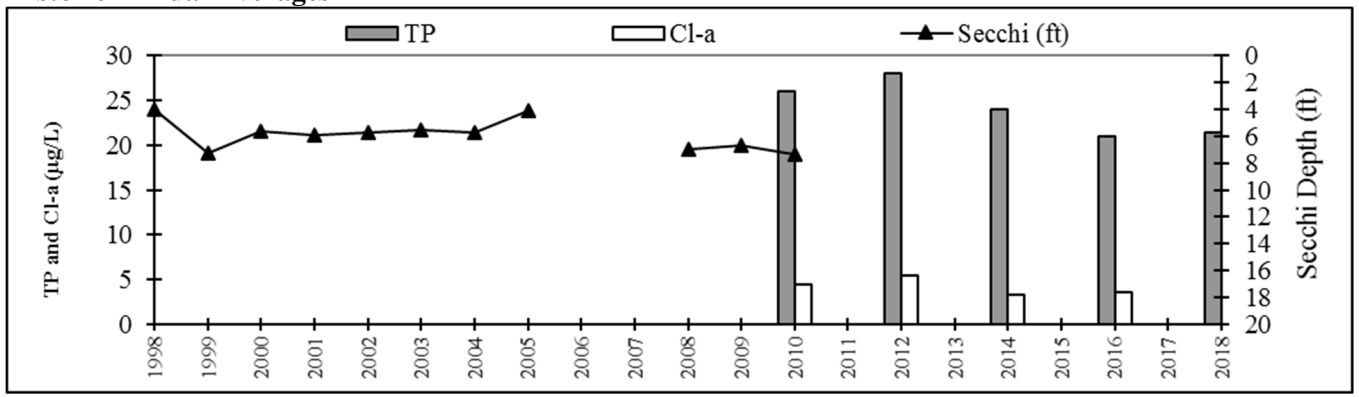
2018 Medians

pH		8.47
Specific Conductivity	mS/cm	0.191
Turbidity	NTU	2.10
D.O.	mg/l	8.04
D.O.	%	0.98
Temp.	°F	75.4
Salinity	%	0.1
Cl-a	µg/L	6.6
T.P.	µg/l	21.0
Secchi	ft	6.6

Historical Report Card

Year	TP	Cl-a	Secchi	Overall
1998			C	
1999			C	
2001			C	
2003			C	
2004			C	
2006			C	
2007			C	
2009			C	
2010	B	A		**A-**
2012	B	A		**A-**
2014	B	A	C	**B**
2016	A	A	C	**A-**
2018	A	A	B	**A**
State Standards	40 µg/L	14 µg/L	>4.6 ft	

Historic Annual Averages



2018 Water Quality Data

	Units	R.L.*	Date:	5/17/2018	5/31/2018	6/13/2018	6/28/2018	7/10/2018	7/26/2018	8/9/2018	8/22/2018	9/5/2018	9/17/2018	Average	Min	Max
			Time:	10:05	14:00	15:07	9:31	10:00	9:13	9:33	14:00	9:01	9:20			
pH		0.1		8.67	7.37	8.45	8.51	8.49	8.60	9.07	8.15	7.73	8.39	8.3	7.37	9.07
Specific Conductivity	mS/cm	0.01		0.231	0.232	0.201	0.182	0.204	0.200	0.166	0.166	0.166	0.176	0.2	0.17	0.23
Turbidity	NTU	1		2.10	0.80	0.00	0.00	8.00	0.056	2.70	3.30		3.70	2.6	0.00	8.00
D.O.	mg/l	0.01		9.82	7.60	8.08	7.82	8.40	8.96	8.81	7.19	7.20	7.99	8.2	7.19	9.82
D.O.	%	100.0%		109.5%	94.0%	97.4%	94.5%	108.0%	109.2%	112.7%	84.1%	84.8%	97.9%	99.2%	84.1%	112.7%
Temp.	°C	0.1		19.60	24.83	22.95	24.31	26.62	24.00	25.41	24.18	22.45	23.77	23.8	19.60	26.62
Temp.	°F	0.1		67.3	76.7	73.3	75.8	79.9	75.2	77.7	75.5	72.4	74.8	74.9	67.28	79.92
Salinity	%	0.01		0.11	0.11	0.10	0.09	0.10	0.10	0.08	0.08	0.08	0.09	0.1	0.08	0.11
Cl-a	µg/L	1		6.23	5.34	5.34	5.0	9.6	7.5	4.8	8.5	10.1	6.9	6.9	4.81	10.10
T.P.	mg/l	0.005		0.025	0.022	0.021	0.020	0.020	0.012	0.025	0.021	0.021	0.027	0.0	0.01	0.03
T.P.	µg/l	5		25	22	21	20	20	12	25	21	21	27	21.4	12.00	27.00
Secchi	ft			7.4	9.7	10.4	9.5	6.0	5.3	5.8	5.8	6.0	7.3	7.3	5.33	10.42
Secchi	m			2.3	3.0	3.2	2.9	1.8	1.6	1.8	1.8	1.8	2.2	2.2	1.62	3.18
Physical				1	1	2	2	2	1	2	1	2	1	2	1	2
Recreational				1	1	1	1	1	1	1	1	1	1	1	1	1

*reporting limit

Coon Lake – East and West Bay

City of East Bethel, City of Ham Lake & City of Columbus, Lake ID # 02-0042

Comparison of the Bays

The East and West Bays of Coon Lake have had noticeably different water quality in the past, but are similar in recent years, especially 2018. In 2010 on every sampling date water quality was better in the West Bay than in the East. In both 2012 and 2014, water quality in the two bays was more similar. In 2016, the West Bay regained its position of higher water quality. However, in 2018 the two bays were again similar. Average total phosphorous, Secchi depth, and chlorophyll-a were all slightly better in the East Bay. However, total phosphorous and chlorophyll-a were lower in the East Bay on only 6 out of 10 sample dates. Secchi showed the most difference between the bays in 2018, with better Secchi transparency in the East Bay on 8 out of 10 sampling dates. When averaged over the summer, Secchi transparency in both bays was very similar (7.3 ft. West Bay, 7.96 ft. East Bay). Historic report cards are shown side by side on the next page.

Discussion

Coon Lake was near State "impaired" status not long ago, but has improved substantially in the last decade. The East Bay has been close to, or exceeded, the state water quality standard of 40 µg/L of total phosphorus from 2001-2010. The West Bay has been well below the state total phosphorous standard in all years on record, except 1989. In recent years, water quality has improved, particularly in the East Bay.

2011 to present has had substantially lower phosphorus than 2001-2010 in the East Bay. Total phosphorus averaged 42 µg/L in 2006, 37 µg/L in 2008, and 39 µg/L in 2010. Phosphorous levels dropped to 27 µg/L in 2011, 26 µg/L in 2012, 23.2 µg/L in 2013, and in 2014 hit an all-time low of 18.8 µg/L. 2016 saw a rebound to 27.3 µg/L, but 2018 saw it drop back down to 19.4 µg/L (second lowest on record). By comparison, the West Bay's highest phosphorus annual average has been 26.0 µg/L in 2010.

The reason for water quality improvement is unknown, but we can speculate on a few contributing factors. The first factor is aquatic invasive species and their treatment, which has been documented to affect water quality in varying ways in other lakes. Best documented and consistently affecting other lakes is curly-leaf pondweed. This species takes up phosphorous from the soil through its root system and dies off in early summer sometimes causing a spike in water-borne phosphorous. Coon Lake has a Eurasian watermilfoil (EWM) and curly-leaf pondweed (CLP) infestation. Treatment of EWM and curly leaf pondweed began in 2009.

Looking back at pre-2010 data we do see a common mid-summer spike in phosphorus that might be at least partially due to CLP. In post-2010 years a mid-summer phosphorus increase is less conspicuous or absent. Herbicide treatment of CLP that is intended to kill the plant when it is small may also result in less phosphorus release compared to decomposition of large plants dying off naturally in mid-summer.

The impact of treating EWM is less clear. This species does not die off in mid-summer, so mass decomposition is not known as an important phosphorus source. Still, it is speculated to have varying effects on lake water quality. It may do so through abundant growth that protects bottom sediments from wind and boat disturbance, nutrient uptake, or even effects on the fishery. Whether this is happening in Coon Lake is unclear.

Water quality improvement projects are likely also part of the water quality improvement story at Coon Lake. Projects have been constructed, mostly in 2015 with a State Clean Water Fund grant, including two rain gardens, one filtration basin and three lakeshore restorations. Based on pollutant reduction estimates for these projects they are responsible for only some small portion of the improvement in lake conditions.

Future management should focus on the ecological health of the lake, as well as protecting water quality. Removal of native shoreline and aquatic vegetation by homeowners is a specific concern. This vegetation is important habitat for fish and other shoreline wildlife, and helps filter runoff to the lake. Septic system maintenance and replacement is also an area of concern, both from a public health and lake water quality point of view. Finally, additional stormwater treatment projects around the lake have been identified by a 2014 study by the Anoka Conservation District. These projects, including many lakeshore restorations, are prioritized by cost effectiveness.

Coon Lake – East and West Bay

City of East Bethel, City of Ham Lake & City of Columbus, Lake ID # 02-0042

Historical Report Card for Both Bays of Coon Lake

Year	TP	Chl-A	Secchi	**Overall**	Year	TP	Chl-A	Secchi	**Overall**
1978			D	D					
/\/\/\/\/\	/\/\/\/	/\/\/\/	/\/\/\/	/\/\/\/\/	/\/\/\/	/\/\/\/	/\/\/\/	/\/\/\/	/\/\/\/\/
1984	C	B	C	C					
/\/\/\/\/\	/\/\/\/	/\/\/\/	/\/\/\/	/\/\/\/\/	/\/\/\/	/\/\/\/	/\/\/\/	/\/\/\/	/\/\/\/\/
1989	C	B	C	C					
1990			C	C					
1991			C	C					
1992									
1993			C	C					
1994	C	B	C	**C**					
1995			C	**C**					
1996									
1997	B	B	C	**B**					
1998	B	B	C	**B**	1998			C	
1999	A	A	B	**A**	1999			C	
2000	B	B	C	**B**					
2001	C	B	C	**C**	2001			C	
2002	B	B	C	**B**					
2003					2003			C	
2004	C	B	C	**C**	2004			C	
2005									
2006	C	B	C	**C**	2006			C	
2007					2007			C	
2008	C	B	C	**C**					
2009					2009			C	
2010	C	A	C	**B-**	2010	B	A		**A-**
2011	B	A	C	**B**					
2012	B	A	C	**B**	2012	B	A		**A-**
2013	B	A	B	**B+**					
2014	A	A	B	**A**	2014	B	A	C	**B**
2015									
2016	B	A	C	**B**	2016	A	A	C	**A-**
2017									
2018	A	A	B	**A**	2018	A	A	B	**A**
State Standards	40 µg/L	14 µg/L	>4.6 ft						

LINWOOD LAKE

LINWOOD TOWNSHIP, LAKE ID # 02-0026

Background

Linwood Lake is located in the northeast portion of Anoka County. It has a surface area of 559 acres and maximum depth of 42 feet (12.8 m). Public access is available on the north side of the lake at Martin-Island-Linwood Regional Park, and includes a boat landing and fishing areas. The lake's shoreline is about 1/3 developed and 2/3 undeveloped. Most of the undeveloped shoreline is on the eastern shore and is part of a regional park. The lake's watershed is primarily undeveloped with scattered residential plots.

Linwood Lake is on the MPCA's 303(d) list of impaired waters for excess nutrients and this year was added for mercury in fish tissue.

2018 Results

In 2018 Linwood Lake has shown a slight improvement in average total phosphorus and Secchi clarity for three straight monitored years (2012, 2015, 2018). Total phosphorous in 2018 averaged 34.4 µg/L, the first time it has averaged under the state standard of 40 µg/L since the year 2000. Secchi clarity averaged 4.2 ft. in 2018, the best on record since 2005, but still below the state standard for clarity. Chlorophyll-a averaged 20.2 µg/L in 2018, typical for this lake, but exceeding the state standard of 14 µg/L.

Trend Analysis

Eighteen years of water quality data have been collected by the Metropolitan Council (1980, '81, '83, '89, '94, '97, and 2008) and the ACD (1998-2001, 2003, '05, '07, '09, '12, '15, and '18). Water quality has not significantly changed from 1980 to 2018 (repeated measures MANOVA with response variables TP, Cl-a, and Secchi transparency; $F_{2, 15}$=2.74, p=0.10). However, graphing each of these response variables over time shows that total phosphorus, chlorophyll-a and Secchi transparency appear to be better in recent years than each was a decade ago, even if not statistically significant.

Discussion

Linwood Lake is on the MPCA's list of impaired waters for excess nutrients, but it is a borderline case. Linwood Lake was placed on the state impaired waters list because summertime average total phosphorus is routinely over the water quality standard of 40 µg/L for deep lakes. The state has since added separate standards for shallow lakes. Linwood does not technically meet the definition of a shallow lake (maximum depth of <15 ft. or >80% of the lake shallow enough to support aquatic plants) due to a large deep hole in the lake's basin. However, it is very similar to other shallow lake systems and expectations for water quality should perhaps be more in line with shallow lake standards (total phosphorus <60 µg/L, chlorophyll-a <20 µg/L, and Secchi transparency >1m).

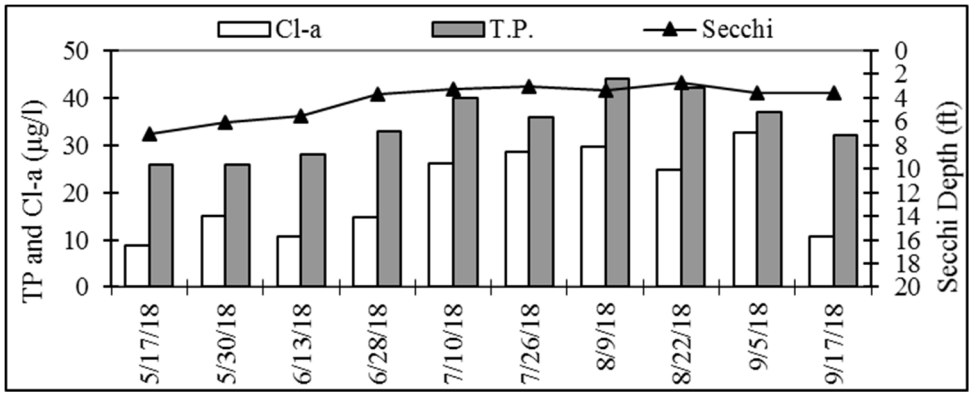
Regardless, water quality improvement is needed. A TMDL impaired waters study has identified the following factors as management targets at Linwood Lake: internal sediments, shoreline management, shoreline septic systems, watershed runoff, agricultural practices, curly-leaf pondweed, and common carp. High powered boats may be impacting water quality by disturbing sediments because the lake is large enough for these boats to get up to full speed, but is mostly shallow. Multi-faceted management is likely needed.

The primary inlet to Linwood Lake comes from Boot Lake. In 2018 Boot Lake was monitored for the first time. It has phosphorus concentrations that are similar to Linwood Lake, and chlorophyll-a concentrations that are lower than Linwood Lake. It appears that while both lakes have similar nutrient levels, those nutrients generate proportionately more algae in Linwood Lake and macrophytes in Boot Lake. In summary, it appears that Boot Lake is neutral in its water quality impact on Linwood Lake, but improvements in or upstream of Boot Lake may be needed to achieve goals at Linwood Lake.

LINWOOD LAKE

LINWOOD TOWNSHIP, LAKE ID # 02-0026

2018 Results



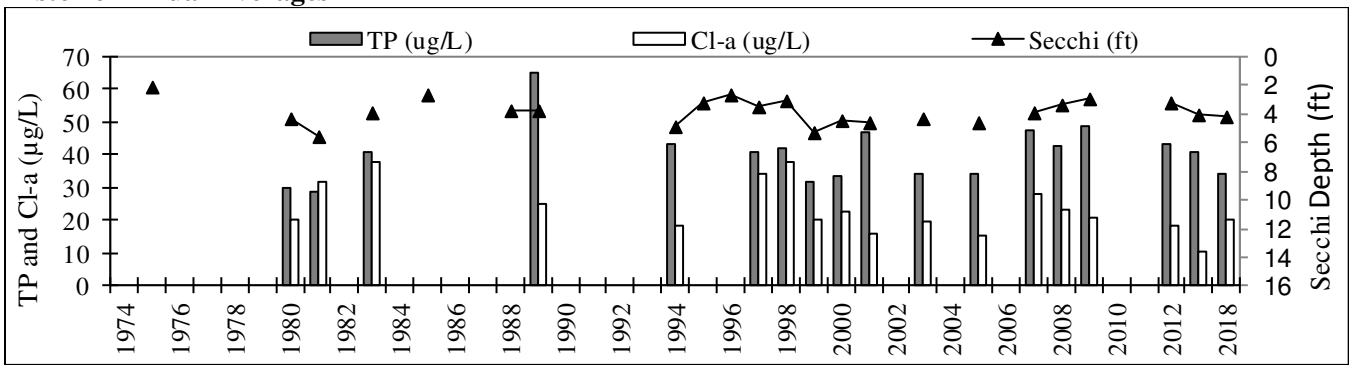
2018 Median Values

pH		8.65
Specific Conductivity	mS/cm	0.314
Turbidity	NTU	11.20
D.O.	mg/l	8.50
D.O.	%	1.07
Temp.	°F	75.3
Salinity	%	0.2
Cl-a	µg/L	20.0
T.P.	µg/l	34.5
Secchi	ft	3.6

Historical Report Card

Year	TP	Cl-a	Secchi	Overall
1975			F	
1980	B	B	C	**B**
1981	B	B	C	**B**
1983	C	C	C	**C**
1985			D	
1988			D	
1989	C	C	D	**C**
1994	C	B	C	**C**
1995			D	
1996			D	
1997	C	C	D	**C**
1998	C	C	D	**C**
1999	C	C	D	**C**
2000	C	C	C	**C**
2001	C	B	C	**C**
2003	C	B	C	**C**
2005	C	B	C	**C**
2007	C	C	D	**C**
2008	C	C	D	**C**
2009	C	C+	D	**C**
2012	C	B	D	**C**
2015	C	B	C	**C**
2018	C	C+	C	**C**
State Standards	40 µg/L	14 µg/L	>4.6 ft	

Historic Annual Averages



2018 Water Quality Data

	Units	R.L.*	Date: 5/17/2018	5/30/2018	6/13/2018	6/28/2018	7/10/2018	7/26/2018	8/9/2018	8/22/2018	9/5/2018	9/17/2018	Average	Min	Max
			Time: 11:45	15:30	14:10	11:03	11:30	10:47	11:00	13:00	10:21	10:45			
pH		0.1	8.80	8.79	8.53	8.85	8.61	8.35	9.10	8.18	8.08	8.68	8.6	8.08	9.10
Specific Conductivity	mS/cm	0.01	0.337	0.346	0.323	0.304	0.345	0.352	0.282	0.271	0.268	0.286	0.3	0.27	0.35
Turbidity	NTU	1	2.90	5.50	3.40	4.30	14.50	16.900	16.40	14.20		11.20	9.9	2.90	16.90
D.O.	mg/l	0.01	10.05	8.02	8.46	8.52	8.47	8.61	10.57	6.56	7.54	9.20	8.6	6.56	10.57
D.O.	%	100.0%	111.9%	103.2%	100.7%	112.2%	109.5%	104.4%	135.0%	78.9%	88.1%	113.6%	105.8%	78.9%	135.0%
Temp.	°C	0.1	19.15	24.43	22.31	23.95	26.65	23.95	25.25	24.53	22.52	24.16	23.7	19.15	26.65
Temp.	°F	0.1	66.5	76.0	72.2	75.1	80.0	75.1	77.5	76.2	72.5	75.5	74.6	66.47	79.97
Salinity	%	0.01	0.16	0.17	0.15	0.15	0.17	0.17	0.14	0.13	0.13	0.14	0.2	0.13	0.17
Cl-a	µg/L	1	8.90	15.10	10.70	14.7	26.2	28.7	29.8	24.9	32.6	10.7	20.2	8.90	32.60
T.P.	mg/l	0.005	0.026	0.026	0.028	0.033	0.040	0.036	0.044	0.042	0.037	0.032	0.0	0.03	0.04
T.P.	µg/l	5	26	26	28	33	40	36	44	42	37	32	34.4	26.00	44.00
Secchi	ft		7.1	6.1	5.5	3.7	3.3	3.1	3.4	2.7	3.6	3.6	4.2	2.67	7.08
Secchi	m		2.2	1.9	1.7	1.1	1.0	0.9	1.0	0.8	1.1	1.1	1.3	0.81	2.16
Physical			2	2	2	2	2	1	2	2	2	3	2	1	3
Recreational			1	1	2	1	1	1	1	1	1	2	1	1	2

*reporting limit

TYPO LAKE

LINWOOD TOWNSHIP, LAKE ID # 30-0009

Background

Typo Lake is located in northeast Anoka County and southeast Isanti County. It has a surface area of 290 acres and maximum depth of 6 feet (1.82 m), though most of the lake is about 3 feet deep. The lake has a mucky, loose, and unconsolidated bottom in some areas, while other areas have a sandy bottom. The public access is located at the south end of the lake along Fawn Lake Drive. The lake is used little for fishing or recreational boating because of the shallow depth and extremely poor water quality. The lake's shoreline is mostly undeveloped, with only 21 homes within 300 feet of the lakeshore. The lake's watershed of 11,520 acres is 3% residential, 33% agricultural, and 28% wetlands, with the remainder being forested or grassland. Typo Lake is on the MPCA's list of impaired waters for excess nutrients.

2018 Results

In 2018 Typo Lake had poor water quality compared to other lakes in this region (NCHF Ecoregion), receiving an overall F letter grade. This overall grade is consistent with previous years monitored except for the D achieved in 2014. Average total phosphorus (TP) was lower than the previous five years monitored at 160.3 µg/L. In fact, 2018 levels are the lowest on record. While total phosphorus levels continue to far exceed the 60 µg/L state standard, average concentrations appear to be staying well below averages from a decade ago.

Chlorophyll-a (Cl-a) levels in 2018 averaged 61.5 µg/L. This is well below the historical average of 115.3 µg/L and lower than the 2017 average of 66.7 µg/L, but still many times higher than the State shallow lakes standard concentration of 20 µg/L.

Average Secchi transparency in 2018 was 1.0 feet. A decade ago transparency was poorer. In 2007 and 2009 a Secchi disk could be seen only 5-6 inches below the surface, on average. In recent years transparency has been better, including 9.6 inches in 2012, 21-22 inches in 2014, and 14 inches in 2017. The State standard for transparency is 3 feet for a shallow lake to not be considered 'impaired.'

Trend Analysis

Eighteen years of water quality monitoring have been conducted by the MPCA (1993, '94, and '95) and the Anoka Conservation District (1997-2001, '03, '05, '07, '09, '12, 2014-2018). Overall, water quality has improved from 1993 to 2018 in a statistically significant way (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth; $F_{2, 15}$=5.6, p=0.02). When we tested these response variables individually with one-way ANOVAs, TP and Secchi depth still show no significant change across this time period. Cl-a, however, is showing a statistically significant decline (p=0.001). A superficial look at graphs of these parameters suggests that total phosphorus is generally stable between 150 µg/L and 250 µg/L (excluding high outlier years 2007 and 2009) without any sort of long-term trend. Secchi transparency in recent years is similar to averages from the early 1990s, an improvement from the late 1990s-2010. The major driver of improved water quality is decreasing Cl-a concentrations.

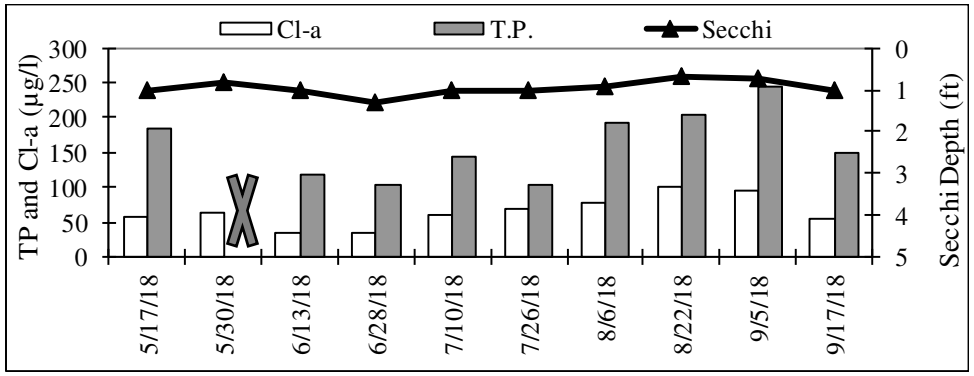
Discussion

Typo Lake, along with Martin Lake downstream, was the subject of a Total Maximum Daily Load (TMDL) study by the Anoka Conservation District, which was approved by the State and EPA in 2012. This study documented the sources of nutrients to the lake, the degree to which each is impacting the lake, and put forth lake rehabilitation strategies. Some factors impacting water quality in Typo Lake include rough fish, high phosphorus inputs from a ditched wetland west of the lake, and lake sediments. Recent work has included installation of carp barriers (completed in 2016), carp removals (2017-18, to be continued in 2019), and a feasibility study of ditched wetland restorations upstream of Typo Lake (2018). The feasibility study was completed in early 2018 and identified 4 potential projects along Ditch 20 upstream of Type Lake. It also recommends that dredging of Ditch 20 not occur. For more information on these projects contact the Anoka Conservation District.

TYPO LAKE

LINWOOD TOWNSHIP, LAKE ID # 30-0009

2018 Results



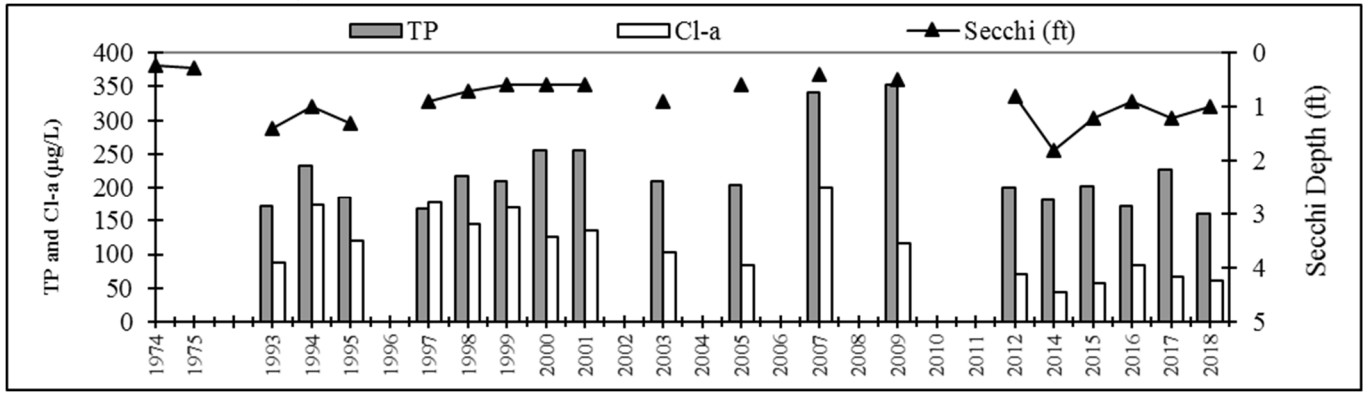
2018 Median Values

pH		8.99
Specific Conductivity	mS/cm	0.275
Turbidity	NTU	82.50
D.O.	mg/l	9.73
D.O.	%	1.15
Temp.	°F	73.3
Salinity	%	0.1
Cl-a	µg/L	61.9
T.P.	µg/l	149.0
Secchi	ft	1.0

Historical Report Card

Year	TP	Cl-a	Secchi	**Overall**
1974			F	
1975			F	
^^^^^	^^^^^	^^^^^	^^^^^	^^^^^
1993	F	F	F	F
1994	F	F	F	F
1995	F	F	F	F
1996				
1997	F	F	F	F
1998	F	F	F	F
1999	F	D	F	F
2000	F	F	F	F
2001	F	F	F	**F**
2002				
2003	F	F	F	**F**
2004				
2005	F	F	F	F
2006				
2007	F	F	F	**F**
2008				
2009	F	F	F	**F**
^^^^^	^^^^^	^^^^^	^^^^^	^^^^^
2012	F	D	F	**F**
2013				
2014	F	C	F	**D-**
2015	F	D	F	**F**
2016	F	F	F	**F**
2017	F	D	F	**F**
2018	C	B	C	**C**
State Standards	60 µg/L	20 µg/L	>3.3 ft	

Historic Annual Averages



2018 Water Quality Data

	Units	R.L.*	Date: 5/17/2018	5/30/2018	6/13/2018	6/28/2018	7/10/2018	7/26/2018	8/6/2018	8/22/2018	9/5/2018	9/17/2018	Average	Min	Max
			Time: 13:20	13:30	12:00	12:22	12:55	12:15	11:08	11:30	11:25	11:55			
pH		0.1	9.23	8.13	8.92	9.01	9.20	9.29	9.10	8.96	8.73	8.69	8.93	8.13	9.29
Specific Conductivity	mS/cm	0.01	0.249	0.320	0.300	0.269	0.309	0.280	0.247	0.233	0.228	0.281	0.272	0.228	0.320
Turbidity	NTU	1	74.50	110.00	50.70	40.00	59.30	99.10	92.40	90.50	140.00	65.30	80	40	140
D.O.	mg/l	0.01	10.19	6.21	9.43	10.64	10.02	10.73	8.92	10.40	7.22	8.57	9.23	6.21	10.73
D.O.	%	100.0%	118%	60%	114%	138%	128%	127%	107%	116%	84%	106%	110%	60%	138%
Temp.	°C	0.1	20.7	24.0	22.2	24.8	27.1	22.5	23.5	21.9	21.9	24.8	23.34	20.71	27.12
Temp.	°F	0.1	69.3	75.3	72.0	76.7	80.8	72.5	74.2	71.3	71.4	76.7	74.0	69.3	80.8
Salinity	%	0.01	0.12	0.15	0.14	0.13	0.15	0.13	0.12	0.11	0.11	0.14	0.1	0.1	0.2
Cl-a	µg/L	1	58.7	64.1	33.4	34.4	59.6	69.4	77.4	101.0	96.1	53.4	61.5	33.4	101.0
T.P.	mg/l	0.005	0.185		0.118	0.103	0.144	0.104	0.192	0.204	0.244	0.149	0.160	0.103	0.244
T.P.	µg/l	5	185		118	103	144	104	192	204	244	149	160	103	244
Secchi	ft		1.0	0.8	1.0	1.3	1.0	1.0	0.9	0.7	0.8	1.0	1.0	0.7	1.3
Secchi	m		0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.2	0.4
Physical			3	4	3	3	3	2	3	3	3	4	3.1	2.0	4.0
Recreational			4	3	3	3	3	2	2	2	2	4	2.8	2	4

*reporting limit

Martin Lake

Linwood Township, Lake ID # 02-0034

Background

Martin Lake is located in northeast Anoka County. It has a surface area of 223 acres and maximum depth of 20 ft. The public access is located on the southern end of the lake. The lake is used moderately by recreational boaters and fishers, and would likely be used more if water quality improved. Martin Lake is almost entirely surrounded by private residences. The 5,402-acre watershed is 18% developed; the remainder is vacant, agricultural, or wetlands. The non-native, invasive plant curly-leaf pondweed occurs in Martin Lake but not at nuisance levels. Martin is on the MPCA's list of impaired waters for excess nutrients.

2018 Results

In 2018 Martin Lake had typical water quality compared to other recent years, receiving a C letter grade. This compares poorly to other lakes in the North Central Hardwood Forest Ecoregion (NCHF). Martin Lake is quite eutrophic for a lake of its size and depth due to chronically high total phosphorus (TP) and chlorophyll-a (Cl-a). In 2018 total phosphorus levels, however, continued a four-year improvement averaging 53.1 µg/L. This is the lowest average on record, though it remains above the impairment threshold of 40 µg/L. This now marks three consecutive monitoring years with lowest average total phosphorus on record for Martin Lake following the previous record low average of 59.3 µg/L in 2017. These averages are half, or less than half, of averages from a decade ago (135.0 µg/L in 2007).

Chlorophyll-a rose slightly from the previous year to 27.6 µg/L in 2018. While the 5-year average since 2014 (22.8 µg/L) has been much lower than the 2005-2009 average (108.3 µg/L), this average still remains above the impairment standard of 14 µg/L. Average Secchi transparency was 3.0 feet in 2018, exactly matching its historical average. This average remains about 30% below the State impairment threshold of 4.6 feet. The ACD staff continues to note green water during late summer months.

Trend Analysis

Eighteen years of water quality data have been collected by the MPCA (1983), Metropolitan Council (1998, 2008), and the ACD (1997, 1999-2001, 2003, 2005, 2007, 2009, 2012-2018). Citizens monitored Secchi transparency 17 other years. Anecdotal notes from DNR fisheries data indicate poor water quality dating back to at least 1954. Although still pretty poor, water quality in Martin Lake has shown an improvement from 1983 to 2018 that is statistically significant (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth; $F_{2, 14}=5.33$, $p < 0.05$). This is especially true for the last decade. Further examination of the data shows that while TP and Secchi transparency have not changed in the long-term since 1983, chlorophyll-a has shown a statistical decrease ($p < 0.01$) over this time. Water quality in Martin Lake declined through the late 1990's and reached its worst in 2007. In nine years sampled since 2007, all three parameters have improved on a statistically significant basis (TP $p < 0.01$, Cl-a $p < 0.05$, Secchi $p < 0.01$).

Discussion

Martin Lake, along with Typo Lake upstream, was the subject of a TMDL study by the Anoka Conservation District that was approved by the State and EPA in 2012. This study documented the source of nutrients to the lake, the degree to which each is impacting the lake, and put forward lake rehabilitation strategies. Water from Typo Lake and internal loading (carp, septic systems, sediments, etc.) are two of the largest negative impacts on Martin Lake water quality.

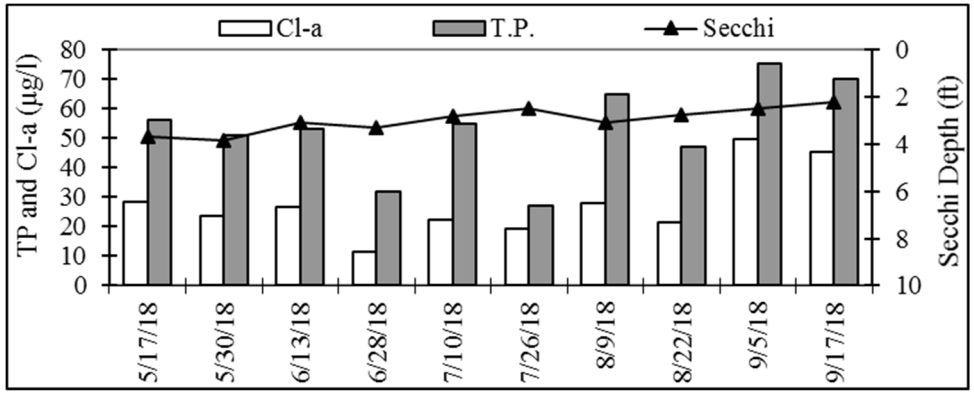
Installation of carp barriers was completed in 2016. Carp removals and other management efforts are taking place in 2017-19. Upstream of Typo Lake, a feasibility study was completed in early 2018 regarding restoration of ditched wetlands (Ditch 20). This study identified 4 potential projects and also recommends that dredging of Ditch 20 not occur. For more information on these projects contact the Anoka Conservation District.

In the neighborhoods adjacent to Martin Lake three rain gardens were installed in 2011and more stormwater retrofits are anticipated in 2020-2021. Recent water quality monitoring results suggest these management approaches are improving conditions in these lakes, but reaching goals will require additional efforts and time.

Martin Lake

Linwood Township, Lake ID # 02-0034

2018 Results



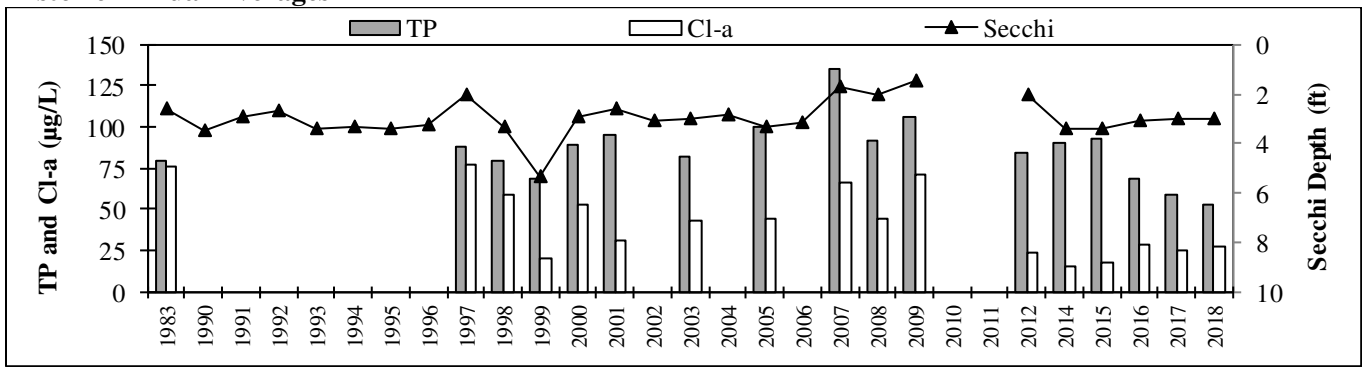
2018 Median Values

pH		8.80
Specific Conductivity	mS/cm	0.309
Turbidity	NTU	15.80
D.O.	mg/l	9.53
D.O.	%	1.19
Temp.	°F	75.4
Salinity	%	0.2
Cl-a	µg/L	25.1
T.P.	µg/l	54.0
Secchi	ft	3.0

Historical Report Card

Year	TP	Cl-a	Secchi	Overall
1996			D	
1997	D	D	F	**D**
1998	D	D	D	D
1999	C	B	C	**C**
2000	D	C	D	**D**
2001	D	C	D	**D**
2002			D	
2003	D	C	D	**D**
2004			D	
2005	D	C	D	**D**
2006			D	
2007	D	D	F	**D**
2008	D	C	F	**D**
2009	D	D	F	**D**
2012	D	C	F	**D**
2014	D	B	D	**C**
2015	D	B	D	**C**
2016	C	C	D	**C**
2017	C	C	D	**C**
2018	C	C	D	**C**
State Standards	40 µg/L	14 µg/L	>4.6 ft	

Historic Annual Averages



2018 Water Quality Data

	Units	R.L.*	Date: 5/17/2018 Time: 14:00	5/30/2018 14:20	6/13/2018 13:14	6/28/2018 11:03	7/10/2018 12:22	7/26/2018 11:30	8/9/2018 11:41	8/22/2018 12:10	9/5/2018 10:55	9/17/2018 11:25	Average	Min	Max
pH		0.1	9.59	8.69	8.95	9.04	8.44	8.36	9.12	8.04	7.94	8.90	8.7	7.94	9.59
Specific Conductivity	mS/cm	0.01	0.322	0.336	0.307	0.299	0.350	0.369	0.310	0.302	0.301	0.307	0.3	0.30	0.37
Turbidity	NTU	1	15.80	14.30	12.50	4.60	17.90	23.100	20.50	12.40		22.40	15.9	4.60	75.20
D.O.	mg/l	0.01	12.02	9.29	10.02	9.59	9.22	9.46	12.45	6.67	7.34	11.30	9.7	6.67	12.45
D.O.	%	100.0%	131.9%	N/A	119.1%	118.8%	114.0%	116.5%	157.0%	80.1%	86.9%	138.4%	118.1%	80.1%	157.0%
Temp.	°C	0.1	18.56	24.50	22.62	24.82	26.78	24.04	25.60	24.19	22.47	24.03	23.8	18.56	26.78
Temp.	°F	0.1	65.4	76.1	72.7	76.7	80.2	75.3	78.1	75.5	72.4	75.3	74.8	65.41	80.20
Salinity	%	0.01	0.15	0.16	0.15	0.15	0.17	0.18	0.15	0.15	0.14	0.15	0.2	0.14	0.18
Cl-a	µg/L	1	28.30	23.50	26.70	11.3	22.4	19.4	27.8	21.4	49.6	45.4	27.6	11.30	49.60
T.P.	mg/l	0.005	0.056	0.051	0.053	0.032	0.055	0.027	0.065	0.047	0.075	0.070	0.1	0.03	0.08
T.P.	µg/l	5	56	51	53	32	55	27	65	47	75	70	53.1	27.00	75.00
Secchi	ft		3.7	3.8	3.1	3.3	2.8	2.5	3.1	2.8	2.5	2.3	3.0	2.25	3.83
Secchi	m		1.1	1.2	0.9	1.0	0.9	0.8	0.9	0.8	0.8	0.7	0.9	0.69	1.17
Physical			3	3	3	3	2	2	3	3	3	4	3	2	4
Recreational			1	2	2	1	1	1	1	1	1	2	1	1	2

*reporting limit

Fawn Lake

Linwood Township Lake ID # 02-0035

Background

Fawn Lake is located in the northeast corner of Anoka County. It has a surface area of 57 acres and a maximum depth of 30 feet (9.1 m). There is no public access to this lake and no boat landing. A neighborhood association has established a small park and swimming beach for the homeowners. Most of the lake is surrounded by private residences, with the densest housing on the southern and western shores. The watershed for this lake is quite small, consisting mostly of the area within ¼ mile of the basin.

Fawn is one of the clearest lakes in the county. Groundwater likely feeds this lake to a large extent. Vegetation in the lake is healthy, but not so prolific as to be a nuisance, and contributes to high water quality. In 2008 and 2010 an invasive plant species, curly-leaf pondweed, was noticed in a few locations, although it may have been present for some time. It does not appear to occur in high densities. Another aquatic invasive species survey was conducted in 2015 by the Anoka Conservation District. Curly-leaf pondweed was still not a nuisance and no new species were identified. Once again a great variety of healthy-native vegetation was identified.

2018 Results

Fawn Lake is classified as mesotrophic and has some of the clearest water in Anoka County. In 2018, Fawn Lake continued its trend of excellent water quality for this region of the state (NCHF Ecoregion) receiving an overall A grade. Water clarity was high while total phosphorus and chlorophyll-a were low throughout the 2018 sampling season. Water clarity averaged 13.7 ft. from May through September. Chlorophyll-a and phosphorus averaged 4.0 µg/L and 17.0 µg/l, respectively. The subjective observations of the lake's physical characteristics and recreational suitability by the ACD staff indicated that lake conditions were excellent for swimming and boating throughout the summer, although an occasional and slight greenish tint to the water was noted.

Trend Analysis

Fourteen years of water quality data have been collected by the MPCA (1988) and the Anoka Conservation District (between 1997 and 2018). If we examine all years, there is not a statistically significant trend of improving or declining water quality. The first year of monitoring (1988) has notably worse water quality than all years since. Excluding 1988, the trophic state index (TSI) score for Fawn Lake has only varied from 40-47 with the controlling variable appearing to be changes in phosphorus (low of 13.6 µg/L, high of 41.6 µg/L).

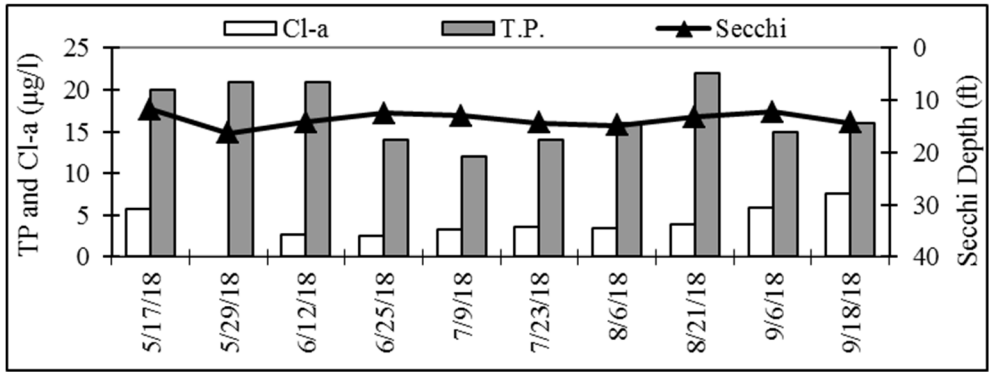
Discussion

This lake's water quality future lies with the actions of the lakeshore homeowners. Because the lake has such a small watershed each lakeshore lot comprises a significant portion of the watershed. Poor practices on a few lots could result in noticeable changes to the lake. Some ways to protect the lake include lakeshore buffers of native vegetation, keeping yard waste out of the lake, and eliminating or minimizing the use of fertilizer. Soil testing on nearby lakes and throughout the metro has found that soil phosphorus fertility is high, and lawns do not benefit from additional phosphorus. Additionally, lakeshore homeowners should refrain from disturbing or removing lake vegetation. This lake's exceptionally high water quality is likely in part due to its healthy plant community. Moreover, curly-leaf pondweed, an invasive species only recently noticed in the lake, readily colonizes disturbed areas and can affect both water quality and recreation.

Fawn Lake

Linwood Township Lake ID # 02-0035

2018 Results



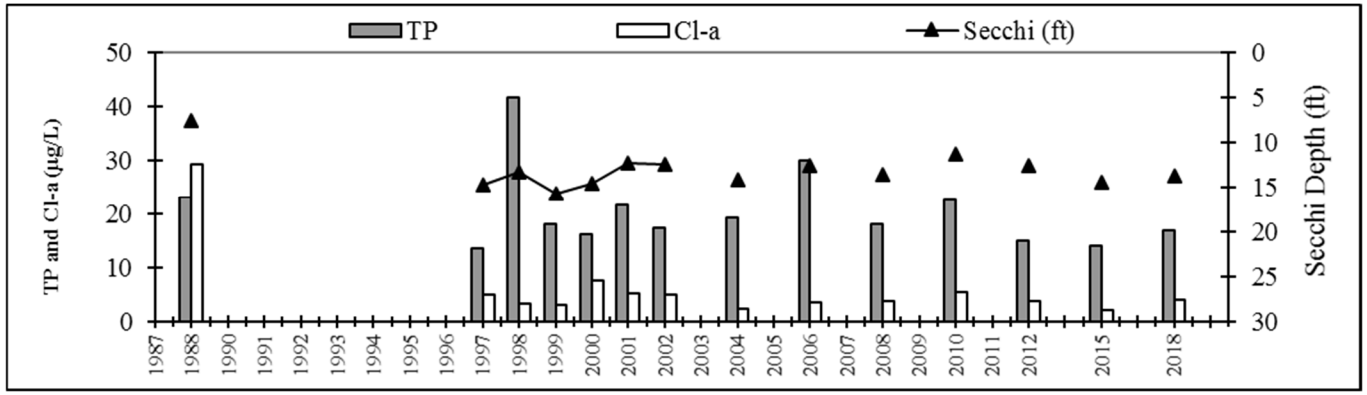
2018 Median Values

pH		8.37
Specific Conductivity	mS/cm	0.234
Turbidity	NTU	0.30
D.O.	mg/l	8.69
D.O.	%	1.08
Temp.	°F	75.9
Salinity	%	0.1
Cl-a	µg/L	3.7
T.P.	µg/l	16.0
Secchi	ft	13.7

Historical Report Card

Year	TP	Chl-A	Secchi	Overall
1988	B	C	A	**B**
1997	A	A	A	**A**
1998	C	A	A	B
1999	A	A	A	**A**
2000	A	A	A	**A**
2001	A	A	A	**A**
2002	A	A	A	**A**
2004	A	A	A	**A**
2006	B	A	A	**A**
2008	A	A	A	**A**
2010	A	A	A	**A**
2012	A	A	A	**A**
2015	A	A	A	**A**
2018	A	A	A	**A**
State Standards	40 µg/L	14 µg/L	>4.6 ft	

Historic Annual Averages



2018 Water Quality Data

	Units	R.L.*	Date: 5/17/2018	5/29/2018	6/12/2018	6/25/2018	7/9/2018	7/23/2018	8/6/2018	8/21/2018	9/6/2018	9/18/2018	Average	Min	Max
			Time: 14:00	10:30	11:00	10:41	12:45	10:40	10:30	10:25	10:35	10:00			
pH		0.1	9.09	8.37	8.37	8.55	8.41	8.24	8.46	7.88	7.68	7.72	8.3	7.68	9.09
Specific Conductivity	mS/cm	0.01	0.267	0.270	0.232	0.240	0.236	0.238	0.200	0.198	0.214	0.222	0.2	0.20	0.27
Turbidity	NTU	1	2.10	0.00	0.00	1.00	0.00	0.600	0.00	0.30		10.70	1.6	0.00	29.70
D.O.	mg/l	0.01	9.60	8.58	8.75	9.00	8.40	8.70	8.96	8.68	7.03	8.10	8.6	7.03	9.60
D.O.	%	100.0%	109.6%	111.7%	104.0%	109.1%	107.8%	108.9%	107.0%	109.2%	81.7%	93.7%	104.3%	81.7%	111.7%
Temp.	°C	0.1	20.37	25.36	22.22	24.57	27.04	25.51	24.25	25.44	22.41	22.85	24.0	20.37	27.04
Temp.	°F	0.1	68.7	77.6	72.0	76.2	80.7	77.9	75.7	77.8	72.3	73.1	75.2	68.67	80.67
Salinity	%	0.01	0.13	0.13	0.11	0.12	0.11	0.12	0.10	0.10	0.10	0.11	0.1	0.10	0.13
Cl-a	µg/L	1	5.78	<1	2.67	2.5	3.3	3.7	3.4	3.9	5.9	7.6	4.0	<1	7.59
T.P.	mg/l	0.005	0.020	0.021	0.021	0.014	0.012	0.014	0.016	0.022	0.015	0.016	0.0	0.01	0.02
T.P.	µg/l	5	20	21	21	14	12	14	16	22	15	16	17.1	12.00	22.00
Secchi	ft		11.8	16.3	14.2	12.5	13.0	14.3	14.8	13.3	12.3	14.3	13.7	11.75	16.25
Secchi	m		3.6	5.0	4.3	3.8	4.0	4.4	4.5	4.0	3.7	4.4	4.2	3.58	4.95
Physical			1	1	2	1	2	2	1	1	1	1	1	1	2
Recreational			1	1	1	1	1	1	1	1	1	1	1	1	1

*reporting limit

Stream Hydrology Monitoring

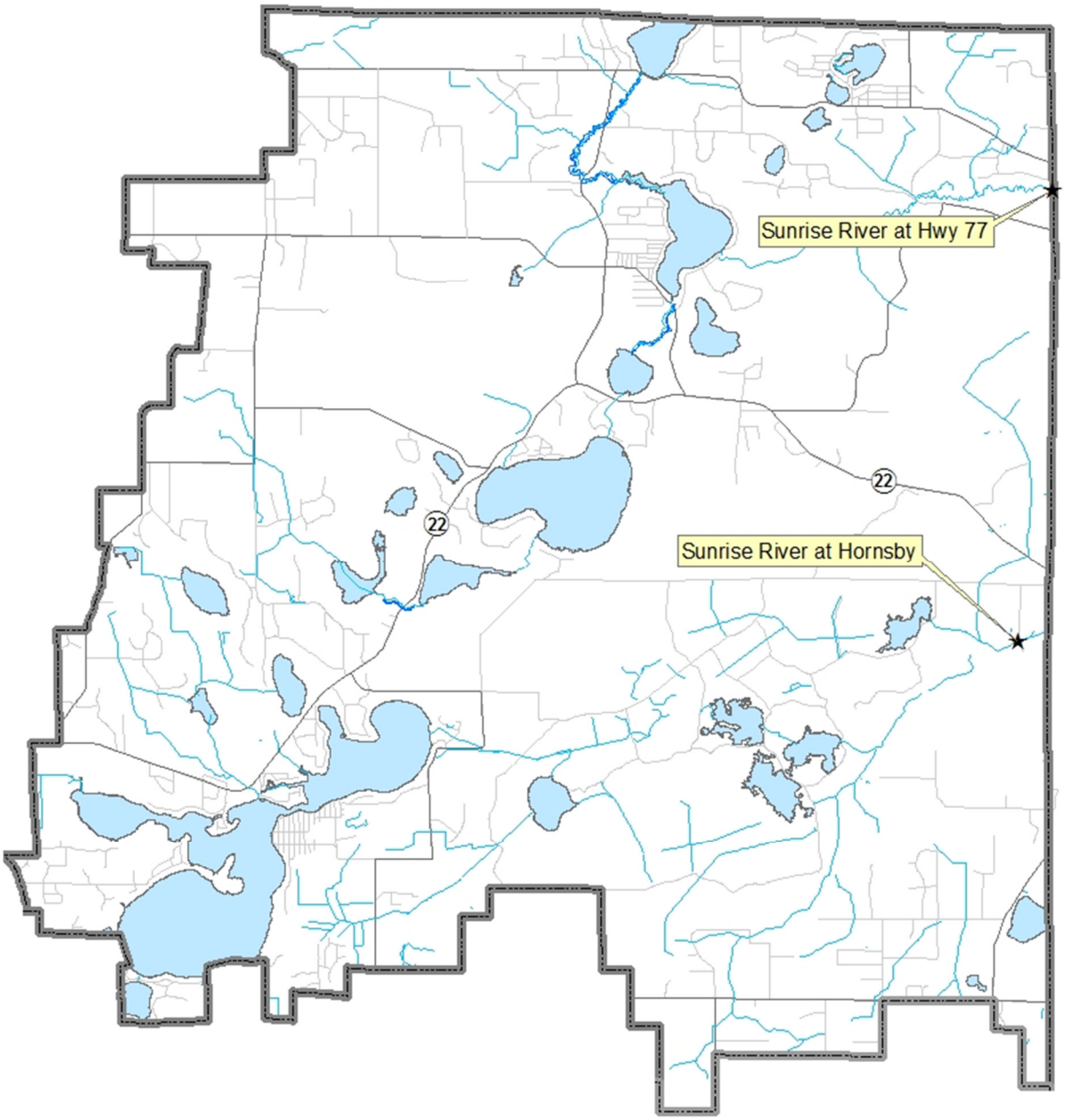
Description: Continuous water level monitoring in streams.

Purpose: To provide understanding of stream hydrology, including the impact of climate, land use, or discharge changes. These data also facilitate calculation of pollutant loads, use of computer models for developing management strategies, and water appropriations permit decisions.

Locations: Sunrise River at Co Rd 77
Sunrise River at Hornsby Rd.

Results: Results are presented on the following pages

2018 Sunrise River Watershed Stream Hydrology Monitoring Sites



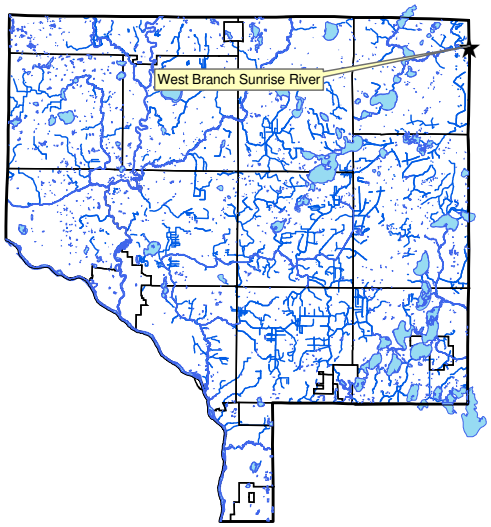
Stream Hydrology Monitoring

WEST BRANCH OF SUNRISE RIVER

At Co Rd 77, Linwood Township

Years Monitored: 2002-2006, 2008, 2010-2012, 2015, 2018

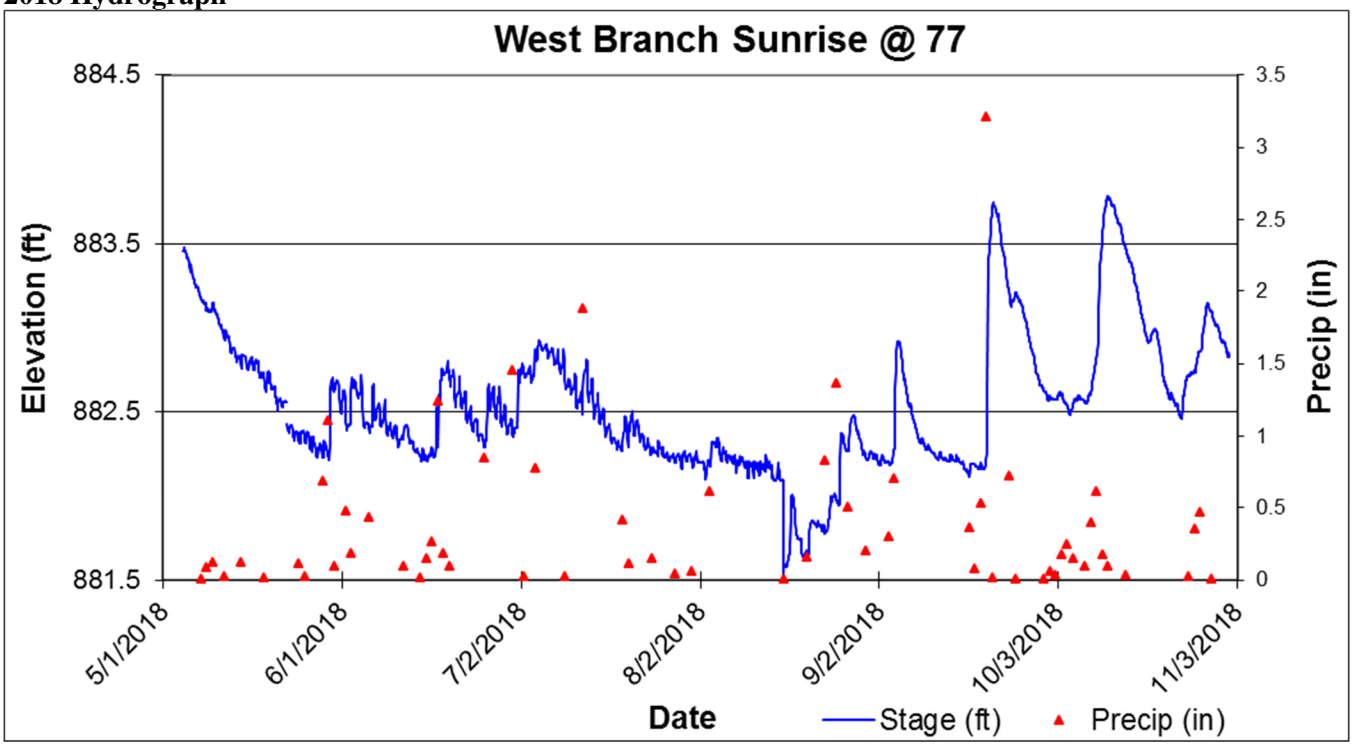
Background: This site is at the bottom of the Sunrise River watershed in Anoka County, at the Chisago County border. This site is monitored to develop an understadning of water quality and quantity in this stream when it leaves Anoka County. Upstream, this river drains through Linwood, Island, Martin, and Typo Lakes. The SRWMO has done water quality monitoring at this site and created a rating curve to estimate flow volumes from continuous water level measurements. In 2008 and 2009 this site was also monitored to collect data for a computer model of the entire Sunrise River watershed being done by the US Army Corps of Engineers, Chisago County, and other partners. A rating curve was developed in 2002 and updated in 2008-2009, however, it does not cover the full range of stages measured in 2018.



Summary of All Monitored Years

In the last 2 years when data was collected stream levels were substantially lower. The cause of this change is unclear, although there are a number of potential causes.

2018 Hydrograph

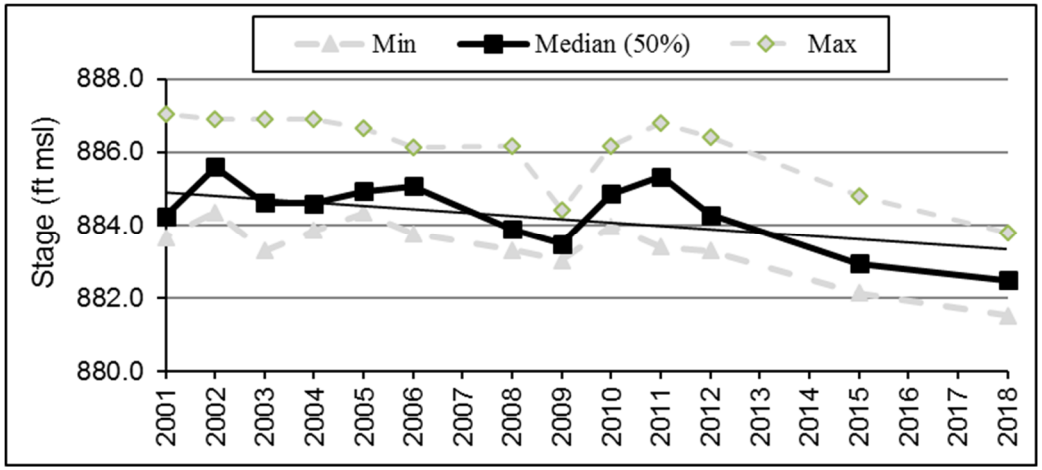


WEST BRANCH OF SUNRISE RIVER

At Co Rd 77, Linwood Township

Summary of All Monitored Years

Percentiles	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2008	2009	2010	2011	2012	2015	2018
Min	883.78	884.25	885.25	884.06	883.41	883.65	884.36	883.28	883.84	884.33	883.76	883.31	883.02	883.96	883.39	883.28	882.13	881.52
2.5%	884.00	884.31	885.35	884.12	883.50	883.76	884.50	883.64	883.93	884.44	883.87	883.40	883.17	884.03	883.45	883.31	882.27	881.81
10.0%	884.14	884.48	885.42	884.22	883.52	883.81	884.63	883.73	884.02	884.58	884.04	883.51	883.21	884.21	883.69	883.35	882.41	882.19
25.0%	884.48	884.79	885.71	884.58	883.55	883.91	885.13	883.83	884.31	884.69	884.50	883.64	883.30	884.48	884.62	883.50	882.60	882.25
Median (50%)	884.77	885.51	886.06	884.80	883.68	884.25	885.59	884.62	884.59	884.93	885.06	883.89	883.48	884.86	885.33	884.28	882.93	882.49
75.0%	885.39	886.03	886.46	884.99	884.21	885.60	886.18	885.66	885.10	885.29	885.27	884.99	883.83	885.14	885.78	884.92	883.33	882.75
90.0%	885.88	886.58	887.10	885.21	884.42	886.69	886.48	886.12	886.03	885.61	885.59	885.74	884.12	885.37	886.42	885.80	883.59	883.12
97.5%	886.90	886.82	887.61	885.65	885.75	887.05	886.84	886.74	886.82	885.92	886.06	886.04	884.31	885.94	886.76	886.36	884.15	883.61
Max	887.13	887.14	887.81	885.77	886.02	887.05	886.89	886.91	886.89	886.67	886.14	886.17	884.42	886.18	886.79	886.41	884.80	883.79

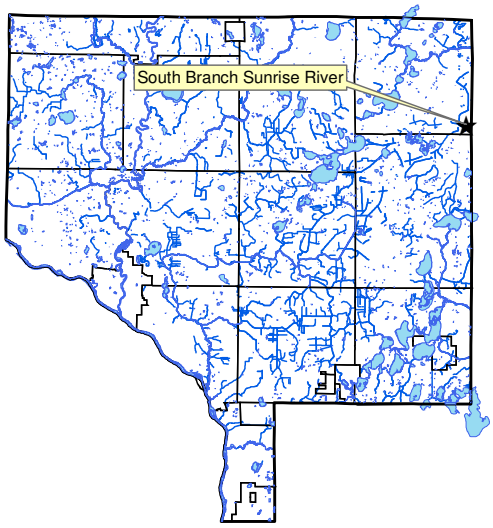


SOUTH BRANCH OF SUNRISE RIVER AT HORNSBY

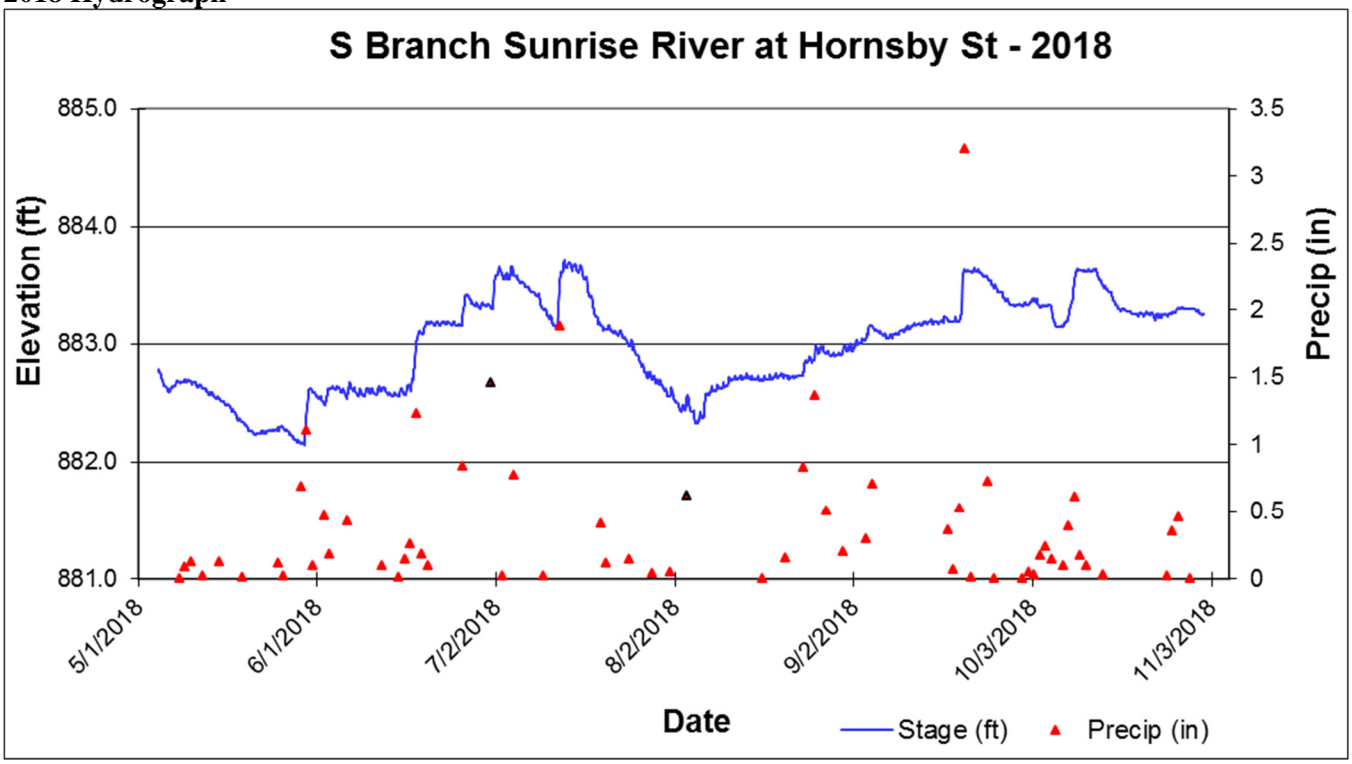
At Hornsby St, Linwood Township

Years Monitored: 2009-2012, 2015, 2018

Background: This monitoring site is the also at the bottom of this watershed in Anoka County, at the closest accessible point to the Anoka-Chisago County boundary. Upstream, this river drains from Coon Lake and through the Carlos Avery Wildlife Management Area. The Sunrise River Watershed Management Organization monitors this site because it is at the bottom of their jurisdictional area. This site was first monitored in 2009 to collect data for a computer model of the entire Sunrise River watershed being done by the US Army Corps of Engineers, Chisago County, and other partners. Water quality monitoring has occurred in some years at this site. A rating curve has not been developed to estimate flow volumes from the water level measurements.



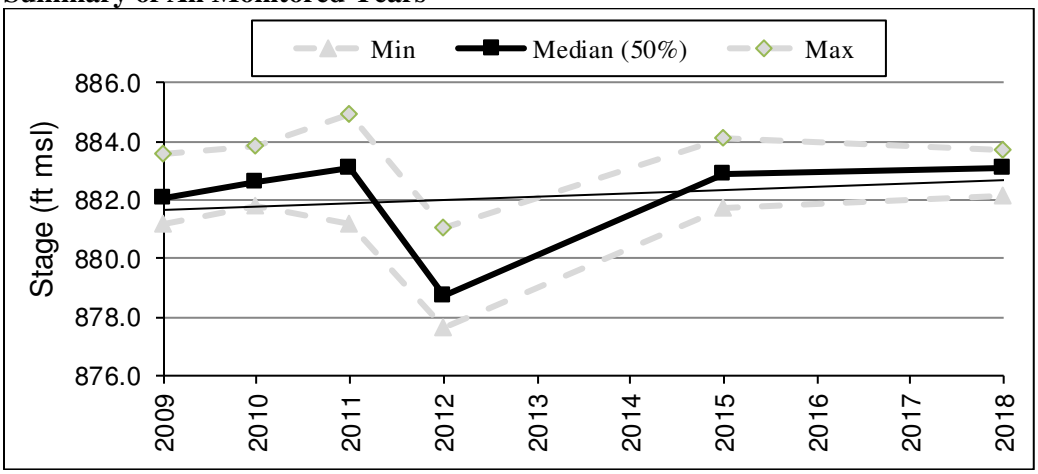
2018 Hydrograph



SOUTH BRANCH OF SUNRISE RIVER AT HORNSBY

At Hornsby St, Linwood Township

Summary of All Monitored Years



Percentiles	2009	2010	2011	2012	2015	2018
Min	881.20	881.77	881.16	877.64	881.75	882.14
2.5%	881.34	881.91	881.28	877.90	882.01	882.24
10.0%	881.57	882.02	881.57	878.10	882.25	882.49
25.0%	881.74	882.17	882.46	878.43	882.62	882.63
Median (50%)	882.09	882.59	883.12	878.70	882.92	883.08
75.0%	883.01	883.02	883.59	879.31	883.22	883.30
90.0%	883.34	883.58	884.04	880.14	883.61	883.54
97.5%	883.52	883.79	884.47	880.64	884.01	883.63
Max	883.56	883.85	884.94	881.05	884.12	883.71

Stream Water Quality

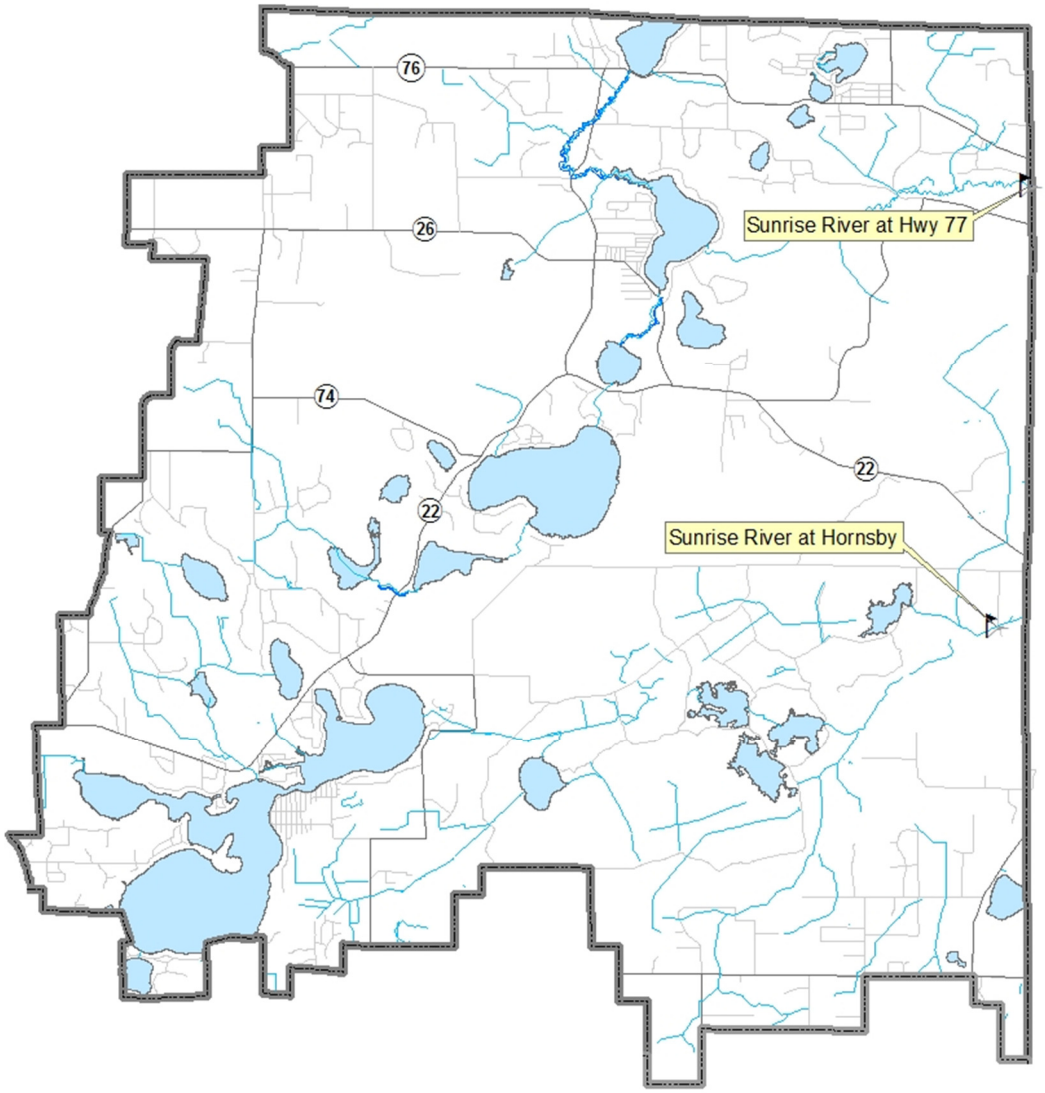
Description: Stream water quality is monitored with grab samples on eight occasions throughout the open water season, including four times immediately following a storm (1" of rain within a 24 hr. period) and four times during baseflow conditions. The selected sites are the farthest downstream limits of the Sunrise River Watershed Management Organization's jurisdictional area. Parameters monitored include water level, pH, specific conductivity, turbidity, transparency, dissolved oxygen, total phosphorus, and total suspended solids. This data can be paired with stream hydrology monitoring to do pollutant-loading calculations.

Purpose: To detect water quality trends and problems, and diagnose the source of problems.

Location: Sunrise River at Co Rd 77
Sunrise River at Hornsby Rd.

Results: Results are presented on the following pages.

2018 Sunrise River Watershed Stream Water Quality Monitoring Sites



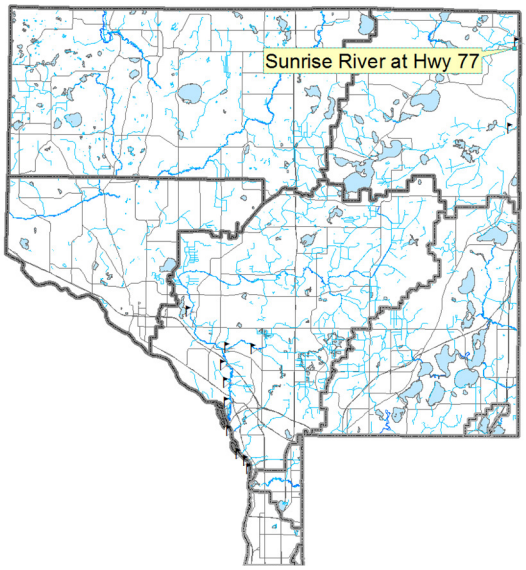
SUNRISE RIVER AT HWY 77

Near Fawn Lake Dr. NE, Linwood Township

STORET SiteID = S001-424

Years Monitored

2001, 2003, 2006, 2012, 2015, 2018



Background

This monitoring site is the bottom of this watershed in Anoka County, at the Chisago County border. Upstream, this river drains through Boot, Linwood, Island, Martin, and Typo Lakes. The Sunrise River Watershed Management Organization monitors this site because it is where the river leaves their jurisdiction. Additionally, monitoring is considered important because this portion of the river is impaired for aquatic life with turbidity identified as a stressor. A TMDL study was completed in 2013.

Methods

The river was monitored by grab samples. Eight water quality samples were taken each year; half during baseflow and half following storms. Storms were generally defined as one-inch or more of rainfall in 24 hours or a significant snowmelt event combined with rainfall. Parameters tested with portable meters included pH, specific conductivity, turbidity, temperature, dissolved oxygen, and salinity. Parameters tested by water samples sent to a state-certified lab included total phosphorus, chlorides, and total suspended solids. Continuous water level monitoring occurred in the open water season.

Summarized Results

Summarized water quality monitoring findings and management implications include:

- Specific conductivity was below the county median of 0.420 mS/cm. The median specific conductivity was 0.311 mS/cm. The median specific conductivity for all years at this site is 0.297 mS/cm. For management considerations see chlorides.
- Chlorides were measured at this site in all years, except 2015. In 2018 the median chloride concentration was 17.95 mg/L. The median for all years at this site is 15.2 mg/L and the countywide median is 13.29 mg/L.
  Management discussion: Road deicing salts are a concern region-wide. They are measurable in area streams year-round, including in the Sunrise River. While they may be low now, excessive use should be avoided.
- Suspended solids and turbidity levels were similar in 2018 to other years monitored, excluding 2015. The 2018 median TSS concentration was 20.1 mg/L, up from 5.5 mg/L in 2015. The median for all years at this site is 18 mg/L. These levels are higher than most other Anoka County streams, but still below the state standard of 30 mg/L TSS.
  Management discussion: Efforts to reduce suspended material in upstream lakes will help decrease turbidity and suspended solids throughout the Sunrise River.
- Phosphorus has fluctuated above and below the water quality standard for the Central River Nutrient Region of ≤100 µg/L. In 2015, the last year monitored, Average phosphorus concentrations were 63.5 µg/L, much lower than other years tested. This year the median phosphorus was up to 101.5 µg/L. The median TP for all years at this site is 88 µg/L.
  Management discussion: Management in upstream lakes will help reduce phosphorus in the river.
- pH was within the range considered normal and healthy for streams in this area. The median pH was 7.69.
- Dissolved oxygen (DO) was typically within the range considered normal and healthy.