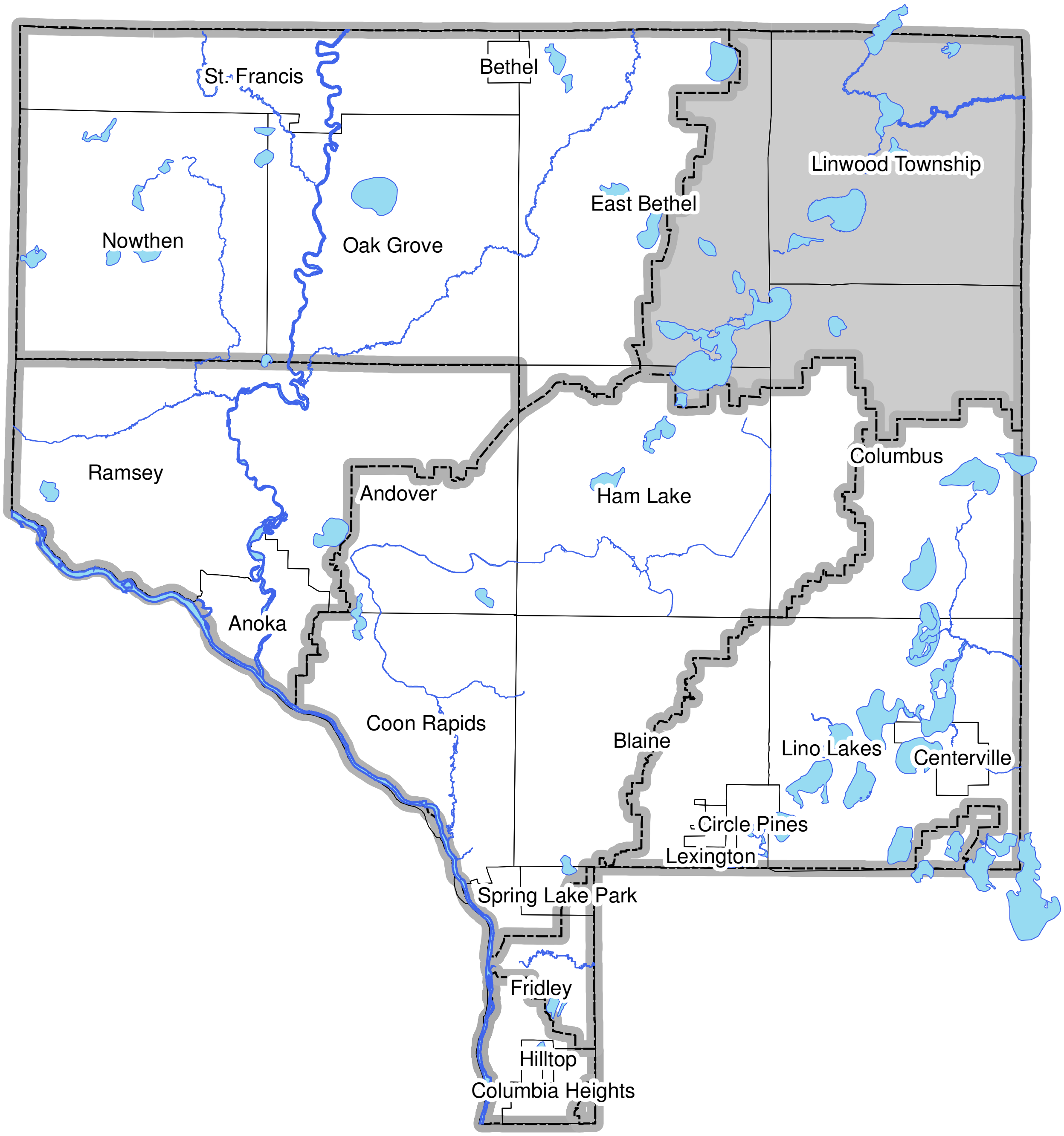
Excerpt from the 2016 Anoka Water Almanac

Chapter 2: Sunrise River Watershed



Prepared by the Anoka Conservation District

Chapter 2:
Sunrise River Watershed

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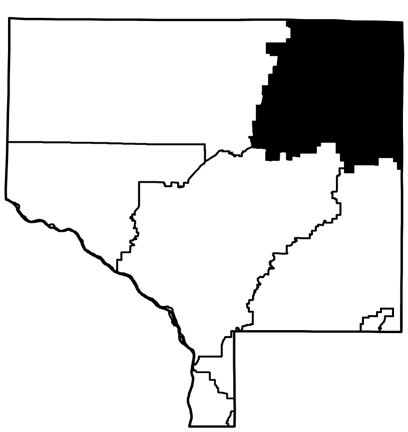
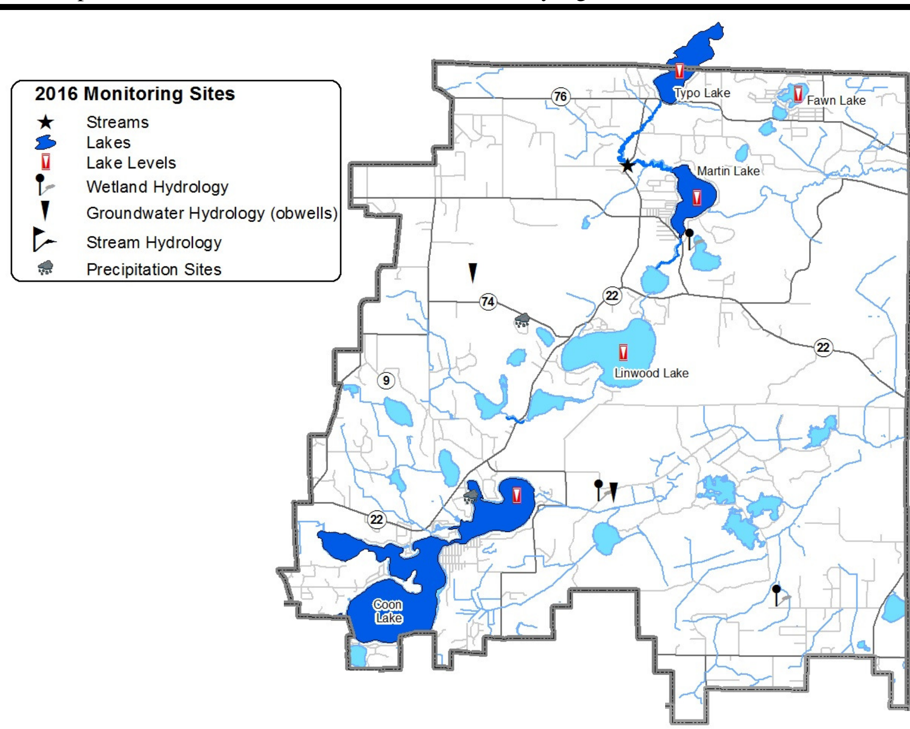
ACD = Anoka Conservation District, SRWMO = Sunrise River Watershed Management Organization, MNDNR = Minnesota Dept. of Natural Resources, ACAP = Anoka County Ag Preserves





Lake Levels

Description: Weekly water level monitoring in lakes. The past five and twenty-five years of data 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).

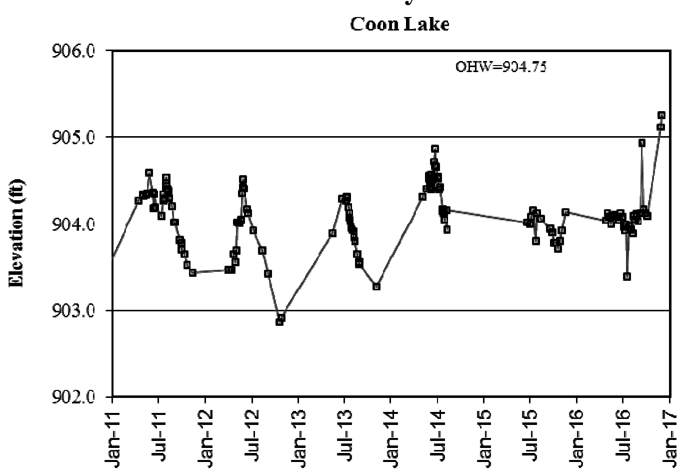
Purpose: To understand lake hydrology, including the impact of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

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

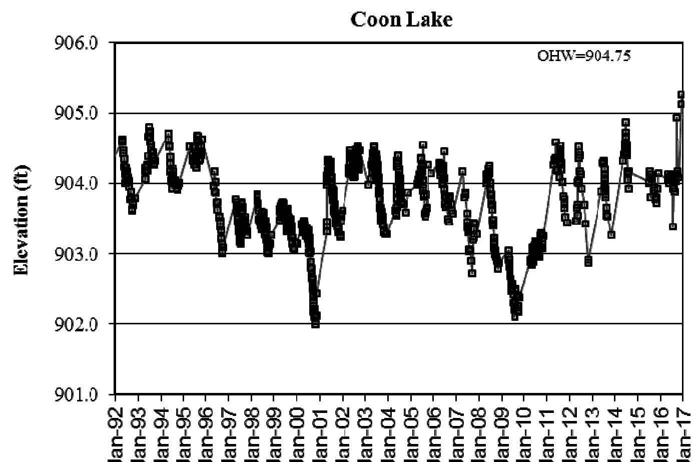
Results: Lake levels were measured by volunteers throughout the 2016 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. Lakes followed the expected pattern of increasing water levels in spring and early summer and then fell later in the summer due to less rainfall. High rainfall amounts late into fall caused a spike in lake levels at the end of the year. Coon and Fawn Lakes had their highest water levels in more than 25 years. Average lake levels were similar or slightly higher than 2015.

All lake level data can be downloaded from the MN DNR website's Lakefinder feature. 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.

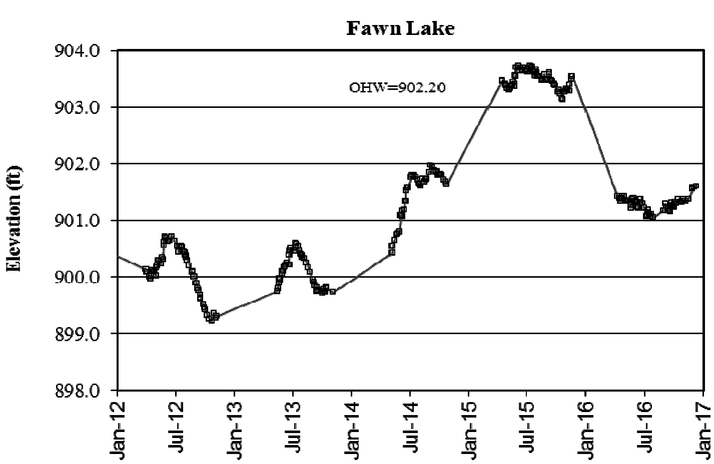
Coon Lake Levels – last 5 years



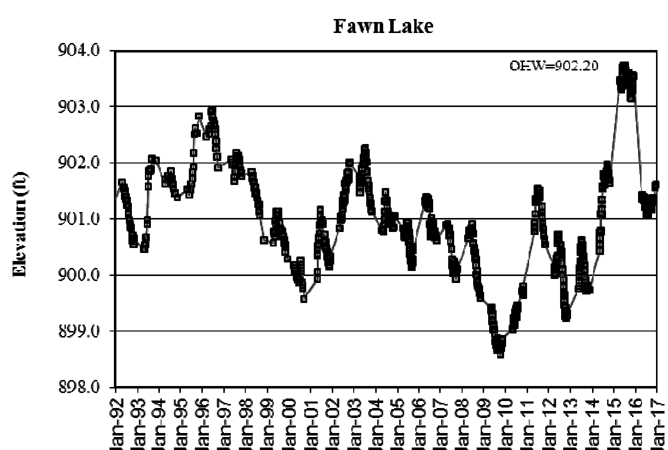
Coon Lake Levels – last 25 years



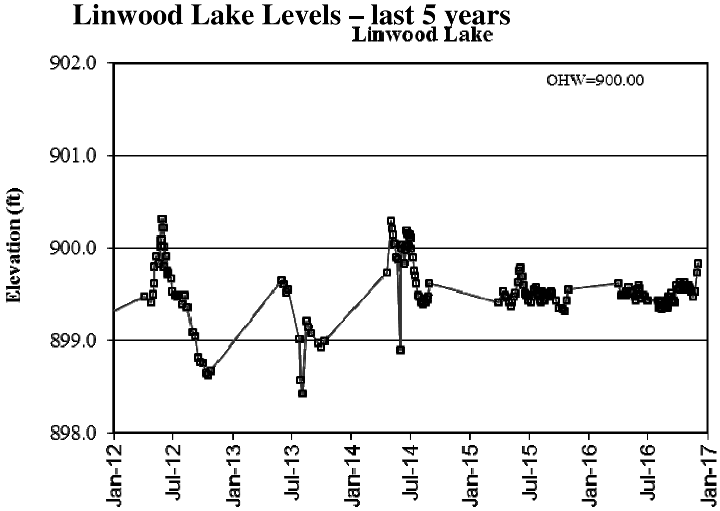
Fawn Lake Levels – last 5 years



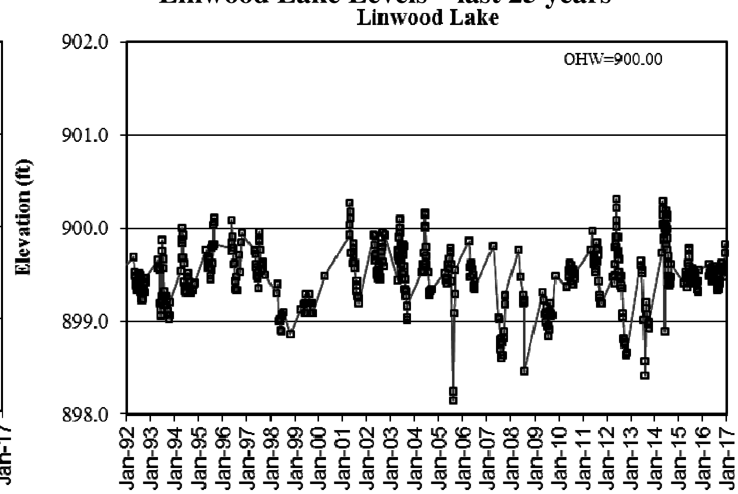
Fawn Lake Levels – last 25 years



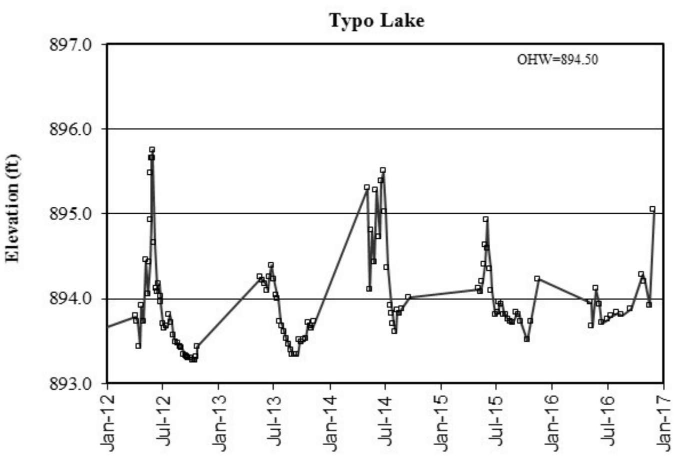
Linwood Lake Levels – last 5 years



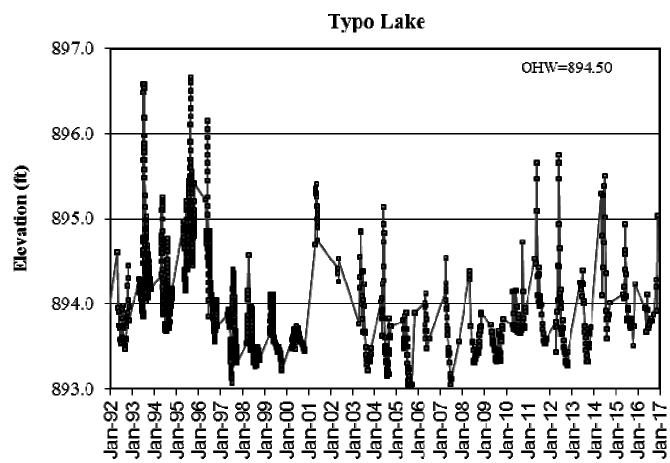
Linwood Lake Levels – last 25 years



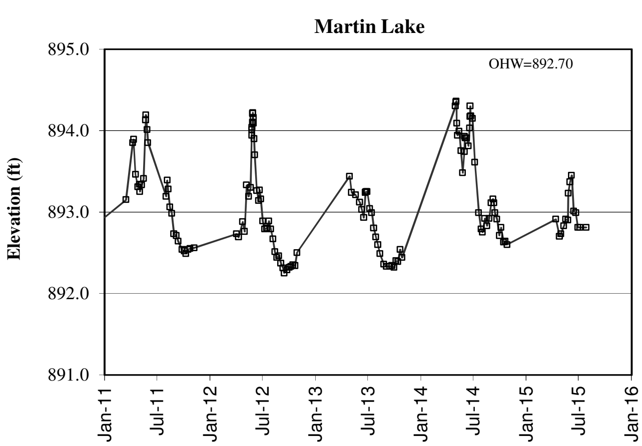
Typo Lake Levels – last 5 years



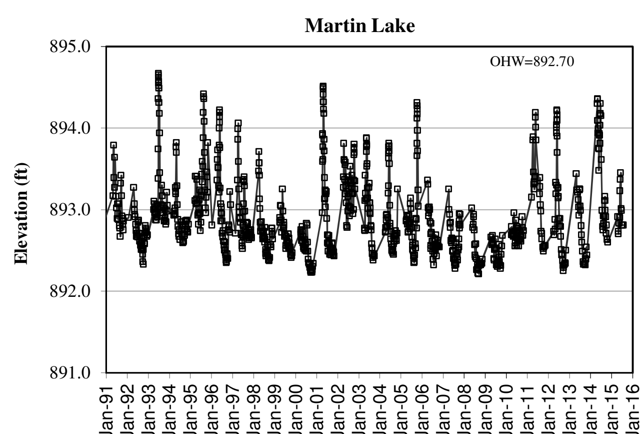
Typo Lake Levels – last 25 years



*Martin Lake Levels – last 5 years



*Martin Lake Levels – last 25 years



***No lake level data was received for Martin Lake in 2016**

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, conductivity, pH, and salinity.

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

Locations: Coon Lake East Bay

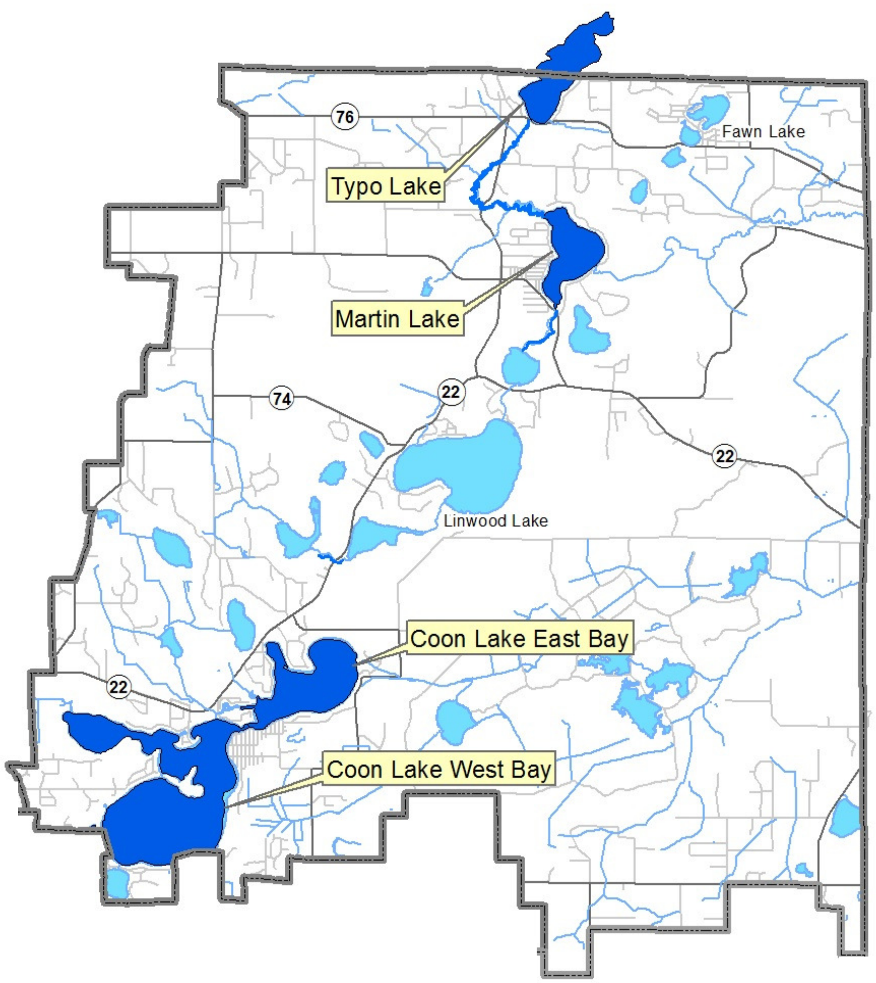
Coon Lake West Bay

Typo Lake

Martin Lake

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 ACD. Refer to Chapter 1 for additional information on lake dynamics and interpreting the data.

Sunrise Watershed Lake Water Quality Monitoring Sites



Coon Lake- East and West Bays

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

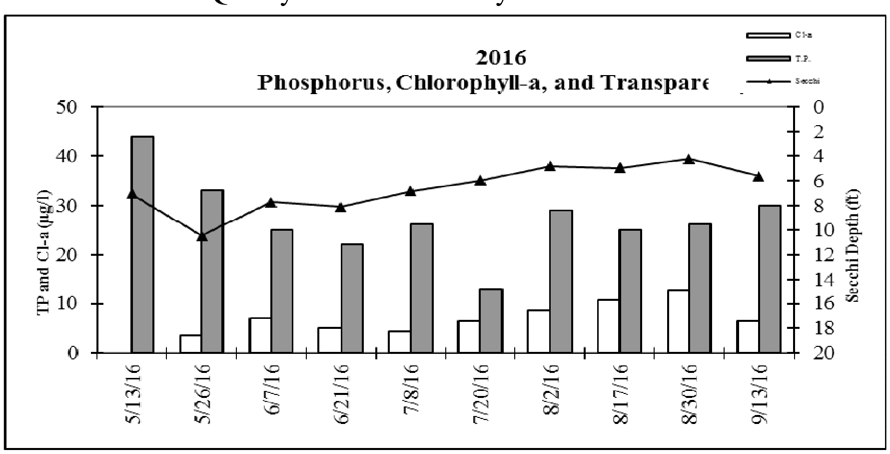
Background

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 rural residential. This report includes information for the East Bay (aka northeast or north bay) and West Bay (aka southwest or south bay) of Coon Lake in 2016. The 2010-16 data is from the Anoka Conservation District (ACD) monitoring at the MN Pollution Control Agency (MPCA) 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, please consider that both bays were monitored simultaneously only biennially from 2010 to 2016. Data from other years do not lend themselves well to direct comparisons because monitoring regimes were likely different.

2016 Results- East Bay

In 2016 the East Bay of Coon Lake was monitored every 2 weeks. Water quality was slightly better than average for this region of the state (NCHF Ecoregion), receiving a B grade, down from the A grade achieved in 2014. Average values of important water quality parameters included 27.3 µg/L for total phosphorus, 7.2 µg/L of chlorophyll-a, and an average Secchi transparency of 6.6 feet. Both chlorophyll-a and phosphorous levels were higher than levels measured in 2014, but were still much lower than levels measured before 2010. Both parameters, however, broke a trend of reduction in each of the previous 5 years sampled. Secchi transparency results were poorer than the averages of each of the previous three years sampled at 6.6 feet, but still averaged 6 inches better than historical results. The 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.

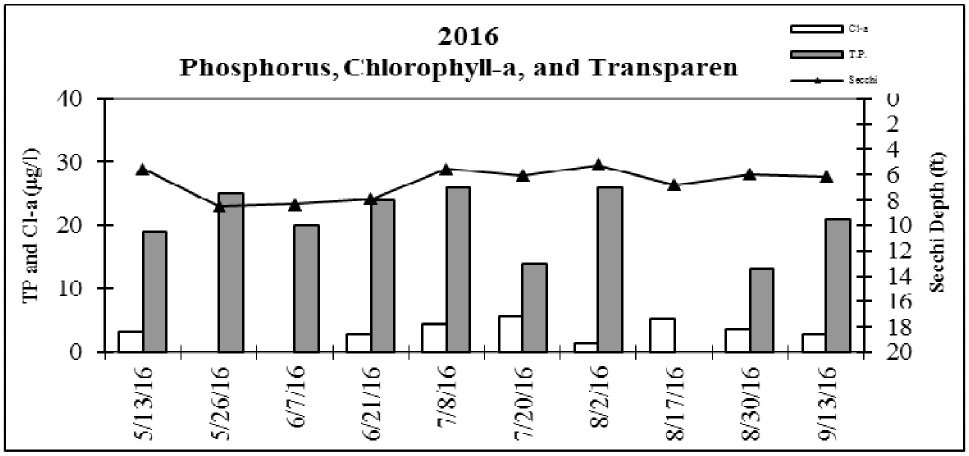
2016 Water Quality Results- East Bay



2016 Results- West Bay

In 2016 the West Bay had better than average water quality for this region of the state (NCHF Ecoregion), receiving an A- letter grade. Average values of water quality parameters included 21.0 µg/L for total phosphorus, 3.6 µg/L of chlorophyll-a, and Secchi transparency of 6.6 feet. Average total phosphorus levels were the lowest of all monitored years, and only 2014 chlorophyll-a levels were lower than those measured in 2016. Secchi transparency had its second best average of the last twelve years; only beat out by the 2014 average of 6.9 feet.

2016 Water Quality Results- West Bay



Comparison of the Bays

The East and West Bays of Coon Lake often have noticeably different water quality. In 2010, on every date sampled, 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. The West Bay had lower total phosphorus readings on each sample date but two, with an average 6.1 µg/L lower than that of the East Bay. Chlorophyll-a readings were consistently lower in the West bay after the first sample date of 5/13/2016, with levels averaging exactly half those of the East Bay. Secchi transparency was consistently deeper in the East Bay during the first half of the season, but consistently lower in the second half, with overall averages being virtually identical (6.60 feet in the East Bay and 6.62 feet in the West Bay).

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 with data. We used data only from years with data from every month from May to September, allowing for one month of missing data. Only data from May to September were used. For years 1998 and after, only data from the ACD was used for greater comparability.

East Bay Trend Analysis

In the East Bay twenty two years of water quality data have been collected since 1978. During the most recent fourteen years that were monitored (since 1996), the 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. The analysis was a repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth ($F_{2,15}$=5.43, p=0.02). 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 ($F_{1,16}$=7.84, p=0.01) , Cl-a ($F_{1,16}$=9.69, p=<0.01), and transparency ($F_{1,21}$=20.10, p=<0.001) is found. In summary, it appears that water quality improvements have been occurring. It is noteworthy that this improvement seems to have primarily occurred since 2010 (see graph below). The reason for change is unknown, but we speculate that infestation by Eurasian watermilfoil (EWM), treatment of EWM and curly leaf pondweed beginning in 2009 and constructed water quality improvement projects may be contributing.

West Bay Trend Analysis

Twelve years of data are available for the West Bay with only four of those years including phosphorus and chlorophyll-a data, so a powerful 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 exceeding the lake depth occasionally. Therefore, a statistical analysis would not be highly meaningful. Instead, we will use a non-analytical look at the data. In 2016, the average Secchi transparency was 6.62 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 (2014 and 2016), the average Secchi transparency was greater than in all but one of previous years (2002). This suggests that Secchi transparency may be mildly improving, and is at least not declining.

Discussion

While Coon Lake is not listed as "impaired" by the MN Pollution Control Agency, the East Bay has been close to, or exceeded, the state water quality standard of 40 µg/L of total phosphorus in the past. Total phosphorus averaged 42 µg/L in 2006, 37 µg/L in 2008, and 39 µg/L in 2010. However, 2011 was the beginning of a four-year consecutive decline in phosphorous levels, a trend unfortunately not continued in 2016. Phosphorous levels dropped to 27 µg/L in 2011, to 26 µg/L in 2012, to 23.2 µg/L (second lowest on record) in 2013, and in 2014 hit an all-time low of 18.8 µg/L, only to rebound to 27.3 µg/L in 2016. While this result appears to break a trend in the right direction, it is still much lower than levels measured between 2001 and 2010. One year of data cannot signify either the start or the end of such a trend.

Given the highly developed nature of the lakeshore, the practices of lakeshore homeowners are a reasonable place to begin water quality improvement efforts. Residents should increase the use of shoreline practices that improve water quality and lake health, such as native vegetation buffers and rain gardens. Clearing of native vegetation to create a "cleaner" lakefront should be avoided because this vegetation is important to lake health and water quality. Septic system maintenance and replacement where necessary, should be a priority on an individual home basis and on a community level. This might be most beneficial in the Hiawatha Beach, Interlachen, and Coon Lake Beach neighborhoods, where the greatest frequency of septic system failures is suspected.

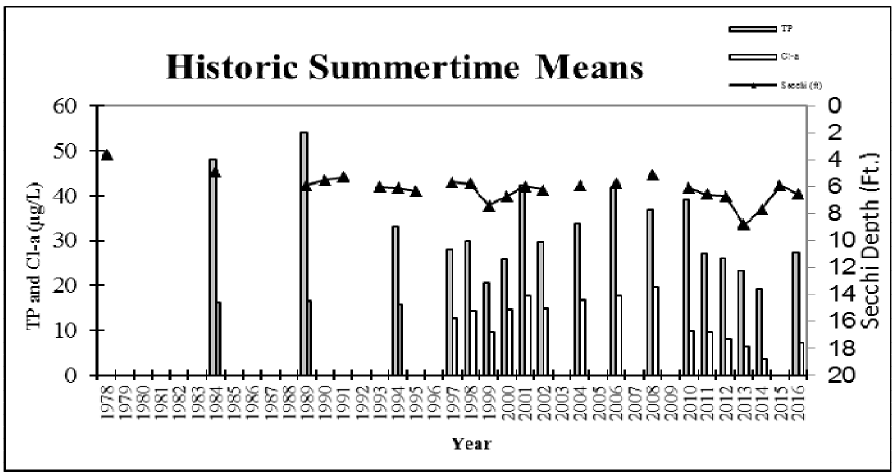
A final challenge for Coon Lake are the aquatic invasive species Eurasian water milfoil (EWM) and Curly Leaf Pondweed (CLP). EWM was discovered in the lake in 2003 and spread rapidly. In 2008 a Coon Lake Improvement District (CLID) was formed, with EWM management as a core of its function. EWM is actively monitored and treated with herbicide in accordance with DNR rules and a lake vegetation management plan. CLP has been present in Coon Lake longer than EWM and CLID began treatment of it in 2009. In 2010 the East Bay was accepted into a five-year pilot program for treatment of CLP. There is not yet enough data to say definitively, but it is possible that the early season treatment could be a contributing factor in the recent decline in phosphorous levels. CLP takes up phosphorous from the soil through its root system and dies off early summer causing a spike in phosphorous. Early treatment may be shortening the time the CLP has to uptake phosphorous from the soil as well as reducing overall regrowth due to treatments occurring prior to CLP sprouting turions (a shoot vital to reproduction).

2016 Coon Lake East Bay Water Quality Data

Coon Lake East Bay			5/13/2016	5/26/2016	6/7/2016	6/21/2016	7/8/2016	7/20/2016	8/2/2016	8/17/2016	8/30/2016	9/13/2016			
2016 Water Quality Data			14:45	12:45	15:30	13:40	13:10	13:15	11:00	12:45	13:10	12:30			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.23	9.15	8.61	8.42	8.17	8.73	8.60	9.09	8.46	8.11	8.56	8.11	9.15
Conductivity	mS/cm	0.01	0.242	0.260	0.267	0.235	0.246	0.253	0.238	0.250	0.234	0.220	0.245	0.220	0.267
Turbidity	NTU	1	12.60	3.50	3.40	2.60	11.90		6.10	4.60	10.20	13.20	8	3	13
D.O.	mg/L	0.01	9.53	10.64	11.47	8.87	8.51	9.61	9.45	9.56	8.69	8.30	9.46	8.30	11.47
D.O.	%	1	96%	124%	116%	109%	109%	121%	120%	123%	107%	95%	112%	95%	124%
Temp.	°C	0.1	14.5	21.4	20.6	24.5	25.3	26.9	26.6	26.5	24.4	21.7	23.2	14.5	26.9
Temp.	°F	0.1	58.1	70.5	69.1	76.0	77.6	80.4	79.8	79.7	76.0	71.1	73.8	58.1	80.4
Salinity	%	0.01	0.11	0.13	0.13	0.11	0.12	0.12	0.11	0.12	0.11	0.11	0.12	0.11	0.13
Cl-a	ug/L	0.5	<1	3.6	7.1	5.0	4.3	6.4	8.5	10.7	12.8	6.4	7.20	3.6	12.8
T.P.	mg/L	0.010	0.044	0.033	0.025	0.022	0.026	0.013	0.029	0.025	0.026	0.030	0.027	0.013	0.044
T.P.	ug/L	10	44	33	25	22	26	13	29	25	26	30	27.3	13	44
Secchi	ft	0.1	7.1	10.5	7.8	8.1	6.8	6.0	4.8	5.0	4.3	5.7	6.60	4.3	10.5
Secchi	m	0.1	2.2	3.2	2.4	2.5	2.1	1.8	1.5	1.5	1.3	1.7	2.01	1.3	3.2
Physical			2	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0	1.0	1.8	1.0	2.0
Recreational			2	2.0	2.0	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.7	1.0	2.0

*reporting limit

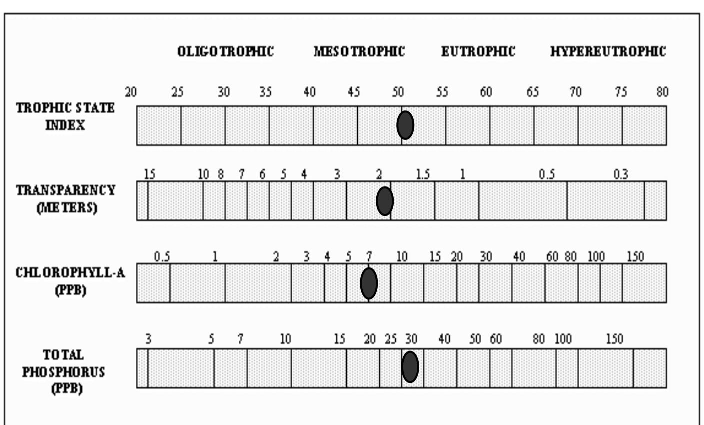
Coon Lake East Bay Water Quality Results



Coon Lake East Bay Historic Summertime Mean Values

Agency	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD
Year	1978	1984	1989	1990	1991	1993	1994	1995	1997	1998	1999	2000	2001	2002	2004	2006	2008	2010	2011	2012	2013	2014	2016
TP		48.0	54.0				33.0		28.0	29.8	20.6	25.8	42.3	29.6	33.7	41.7	36.8	39.0	27.0	26.0	23.2	19.0	27
Cl-a		16.2	16.4				15.8		12.6	14.4	9.4	14.6	17.6	14.8	16.6	17.6	19.5	9.8	9.6	8.2	6.5	3.6	7.2
Secchi (m)	1.11	1.50	1.80	1.68	1.62	1.83	1.86	1.93	1.72	1.76	2.26	2.04	1.82	1.90	1.81	1.80	1.55	1.90	2.00	2.10	2.68	2.35	2.0
Secchi (ft)	3.6	4.9	5.9	5.5	5.3	6.0	6.1	6.3	5.6	5.8	7.4	6.7	6.0	6.2	5.9	5.8	5.1	6.1	6.6	6.7	8.8	7.7	6.6
Carlsons trophic state indices																							
TSIP		60	62				55		52	53	48	51	58	53	55	58	56	57	52	51	49	47	52
TSIC		58	58				58		55	57	53	57	59	57	58	59	60	53	53	51	49	43	50
TSIS	58	54	52	53	53	51	51	51	52	52	48	50	51	51	51	52	54	51	50	49	46	48	50
TSI		57	57				54		53	54	50	53	56	54	55	56	57	54	51	51	48	46	51
Coon Lake Water Quality Report Card																							
Year	1978	1984	1989	1990	1991	1993	1994	1995	1997	1998	1999	2000	2001	2002	2004	2006	2008	2010	2011	2012	2013	2014	2016
TP		C	C				C		B	B	A	B	C	B	C	C	C	C	B	B	B+	A	B
Cl-a		B	B				B		B	B	A	B	B	B	B	B	B	A	A	A	A	A	A
Secchi	D	C	C	C	C	C	C	C	C	C	B	C	C	C	C	C	C	C	C	C+	B	B	C
Overall	**D**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**B**	**B**	**A**	**B**	**C**	**B**	**C**	**C**	**C**	**B-**	**B**	**B**	**B+**	**A**	**B**

Carlson's Trophic State Index



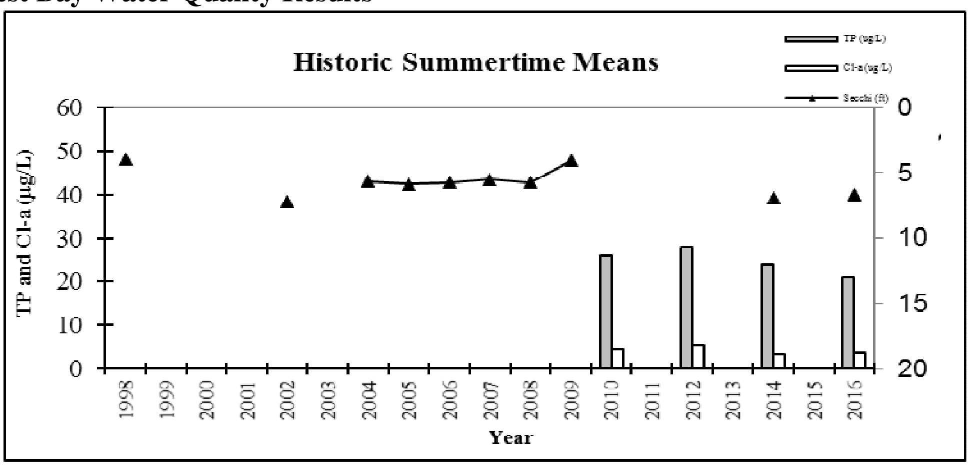
2016 Coon Lake West Bay Water Quality Data

Coon Lake West Bay
2016 Water Quality Data

		Date:	5/13/2016	5/26/2016	6/7/2016	6/21/2016	7/8/2016	7/20/2016	8/2/2016	8/17/2016	8/30/2016	9/13/2016		
		Time:	15:10	14:30	16:10	14:20	13:45	13:40	10:30	13:25	14:00	13:00		
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.42	8.91	8.61	8.06	8.65	8.81	9.08	8.95	8.61	8.28	8.64	8.06	9.08
Conductivity	mS/cm	0.01	0.217	0.227	0.225	0.200	0.180	0.206	0.166	0.190	0.175	0.166	0.195	0.166	0.227
Turbidity	FNRU	1	13.00	1.60	2.30	8.36	7.10		7.20	1.10	5.50	10.00	6	1	13
D.O.	mg/l	0.01	10.51	10.58	10.14	8.36	8.65	9.62	10.72	8.32	8.42	8.71	9.40	8.32	10.72
D.O.	%	1	102%	124%	110%	104%	113%	120%	135%	105%	103%	97%	1	1	1
Temp.	°C	0.1	13.8	21.9	20.2	25.0	24.6	27.0	26.4	25.8	24.0	20.7	22.9	13.8	27.0
Temp.	°F	0.1	56.8	71.3	68.3	77.0	76.3	80.7	79.4	78.4	75.2	69.2	73.3	56.8	80.7
Salinity	%	0.01	0.10	0.11	0.11	0.10	0.09	0.10	0.08	0.09	0.09	0.08	0.10	0.08	0.11
Cl-a	ug/L	0.5	3.2	<1	<1	2.8	4.3	5.7	1.4	5.3	3.6	2.8	3.6	1.4	5.7
T.P.	mg/l	0.010	0.019	0.025	0.020	0.024	0.026	0.014	0.026	<0.02	0.013	0.021	0.021	0.013	0.026
T.P.	ug/l	10	19	25	20	24	26	14	26	<20	13	21	20.9	13	26
Secchi	ft		5.6	8.5	8.3	7.9	5.6	6.1	5.3	6.8	6.0	6.2	6.62	5.3	8.5
Secchi	m		1.7	2.6	2.5	2.4	1.7	1.9	1.6	2.1	1.8	1.9	2.02	1.6	2.6
Field Observations															
Physical			2	2	2	2	2	2	2	2	1	1	1.8	1.0	2.0
Recreational			2	2	2	2	2	2	2	1	1	1	1.7	1.0	2.0

*reporting limit

Coon Lake West Bay Water Quality Results



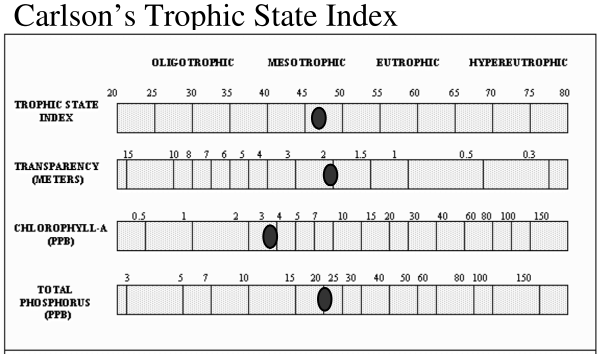
Coon Lake West Bay Historical Summertime Mean Values

Agency	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD
Year	1998	2002	2004	2005	2006	2007	2008	2009	2010	2012	2014	2016
TP									26.0	28.0	24.0	21.0
Cl-a									4.4	5.4	3.3	3.6
Secchi (m)	1.21	2.19	1.71	1.79	1.74	1.68	1.74	1.24			2.1	2.0
Secchi (ft)	3.97	7.18	5.61	5.87	5.71	5.51	5.71	4.07			6.9	6.6
Carlson's Trophic State Index												
TSIP									51	52	50	48
TSIC									45	47	42	43
TSIS	57	49	52	52	52	53	52	57			49	50
TSI									48	50	47	47

Coon Lake West Bay Water Quality Report Card

Year	1998	1999	2001	2003	2004	2006	2007	2009	2010	2012	2014	2016
TP (µg/L)									B	B	B	A
Cl-a (µg/L)									A	A	A	A
Secchi (m)	C	C	C	C	C	C	C	C			C	C
Overall									A-	A-	B	A-

Carlson's Trophic State Index



Typo Lake

Linwood Township, Lake ID # 30-0009

Background

Typo Lake is located in portions of 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 very 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, 28% wetlands, with the remainder being forested or grassland. Typo Lake is on the Minnesota Pollution Control Agency's (MPCA) list of impaired waters for excess nutrients.

2016 Results

In 2016 Typo Lake had extremely poor water quality compared to other lakes in this region (NCHF Ecoregion), receiving an overall F letter grade. This overall grade is consistent to all previous years monitored except for the D- achieved in 2014. Average total phosphorus, however, was the lowest measured in Typo Lake since 1997 at 172.0 µg/L. This is approximately half of the average total phosphorus measured in 2007 (340 µg/L) and 2009 (353 µg/L). Chlorophyll-a levels in 2016 (83.4 µg/L) rebounded from their second lowest average in 2015 (57.5 µg/L). However, this total is still well below the historical average of 111.3 µg/L. In both 2007 and 2009 a Secchi disk could be seen only 5-6 inches below the surface, on average. There was a slight improvement in 2012 to 9-10 inches and a larger improvement in 2014 to 21-22 inches. In 2016, average Secchi transparency declined back to under a foot (about 11inches) after its first consecutive years averaging over one foot in 2014 and 2015.

Trend Analysis

Sixteen years of water quality monitoring have been conducted by the Minnesota Pollution Control Agency (1993, '94, and '95) and the Anoka Conservation District (1997-2001, '03, '05, '07, '09, '12, '14, '15, '16). Water quality has significantly declined from 1993 to 2016 (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth; $F_{2,13}=4.22$, $p=0.04$). When we tested these response variables individually with one-way ANOVAs TP, Cl-a, and Secchi depth show no significant change across this time period. A superficial look at graphs of these parameters suggests that total phosphorus is generally increasing. The trend toward higher phosphorus continues even though 2016 had the lowest average in Typo since 1997. Cl-a appears to be declining and Secchi depth appears to be increasing.

Discussion

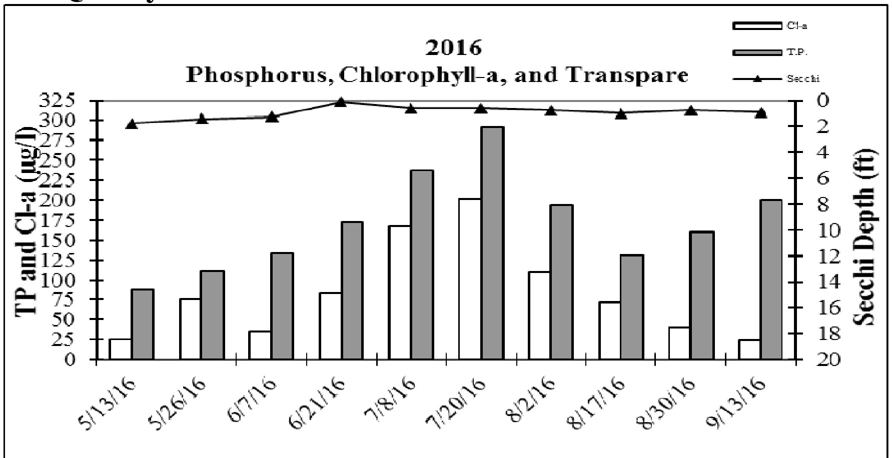
Typo Lake, along with Martin Lake downstream, were the subject of a TMDL study by the Anoka Conservation District, which was approved by the State and EPA in 2012. This study documented the source of nutrients to the lake, the degree to which each is impacting the lake, and put forward lake rehabilitation strategies. Some factors impacting water quality on Typo Lake include the presence of rough fish, high phosphorus inputs from a ditched wetland west of the lake, and lake sediments. Several rain gardens have been installed, carp barriers were completed in 2016 with carp removals planned for 2017-19 and a feasibility study of ditched wetland projects upstream of Typo Lake is underway.

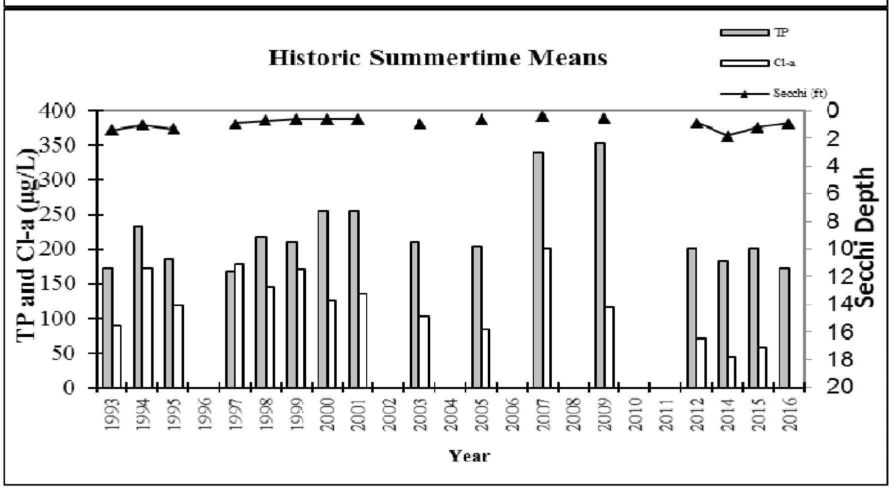
2016 Typo Lake Water Quality Data

Typo Lake		Date	5/13/2016	5/26/2016	6/7/2016	6/21/2016	7/8/2016	7/20/2016	8/2/2016	8/17/2016	8/30/2016	9/13/2016			
2016 Water Quality Data		Time	13:15	12:00	14:20	12:25	12:00	11:50	12:55	11:45	12:20	11:30			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	9.25	8.59	9.27	9.17	9.06	9.69	9.62	9.48	9.23	8.74	9.21	8.59	9.69
Conductivity	mS/cm	0.01	0.317	0.283	0.309	0.252	0.221	0.216	0.220	0.242	0.232	0.228	0.252	0.216	0.317
Turbidity	FNRU	1	42.20	60.70	71.40	87.80	218.00		120.00	105.00	104.00	106.00	102	42	218
D.O.	mg/l	0.01	12.11	8.64	12.57	11.07		10.36	13.05	7.57	10.27	9.34	10.55	7.57	13.05
D.O.	%	1	109%	100%	144%	148%	117%	140%	169%	92%	126%	102%	125%	92%	169%
Temp.	°C	0.1	13.3	21.4	21.1	24.7	24.9	27.8	27.1	23.6	24.3	19.7	22.79	13.30	27.79
Temp.	°F	0.1	55.9	70.5	70.0	76.5	76.8	82.0	80.8	74.6	75.7	67.4	73.0	55.9	82.0
Salinity	%	0.01	0.15	0.14	0.15	0.12	0.11	0.11	0.11	0.12	0.11	0.11	0.1	0.1	0.2
Cl-a	ug/l	0.5	25.6	75.8	35.6	83.3	167.0	201.0	110.0	71.2	39.9	24.2	83.4	24.2	201.0
T.P.	mg/l	0.010	0.088	0.111	0.134	0.172	0.238	0.292	0.194	0.131	0.160	0.200	0.172	0.088	0.292
T.P.	ug/l	10	88	111	134	172	238	292	194	131	160	200	172	88	292
Secchi	ft	0.1	1.8	1.4	1.3	0.1	0.6	0.6	0.8	1.0	0.8	0.9	0.9	0.1	1.8
Secchi	m	0.1	0.5	0.4	0.4	0.0	0.2	0.2	0.2	0.3	0.2	0.3	0.3	0.0	0.5
Field Observations															
Physical			3.0	5.0	4.0	5.0	5.00	5.00	5.0	4.0	3.0	3.0	4.2	3.0	5.0
Recreational			3.0	5.0	4.0	5.0	5.00	5.00	5.0	4.0	3.0	3.0	4.2	3.0	5.0

*reporting limit

Typo Lake Water Quality Results





Typo Lake Historic Summertime Mean Values

Agency	CLMP	CLMP	MPCA	MPCA	MPCA	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD
Year	1974	1975	1993	1994	1995	1997	1998	1999	2000	2001	2003	2005	2007	2009	2012	2014	2015	2016
TP			172.0	233.0	185.6	168.0	225.7	202.1	254.9	256.0	209.8	204	340.5	353.0	201.0	182.0	201.4	172.0
Cl-a			88.1	172.8	119.6	177.8	134.7	67.5	125.3	136.0	102.5	84.7	200.9	116.2	70.7	42.8	57.5	83.4
Secchi (m)	0.23	0.27	0.43	0.29	0.38	0.27	0.21	0.25	0.18	0.19	0.3	0.2	0.1	0.1	0.2	0.6	0.4	0.3
Secchi (ft)	0.2	0.3	1.4	1.0	1.3	0.9	0.7	0.8	0.6	0.6	0.9	0.6	0.4	0.5	0.8	1.8	1.2	0.9

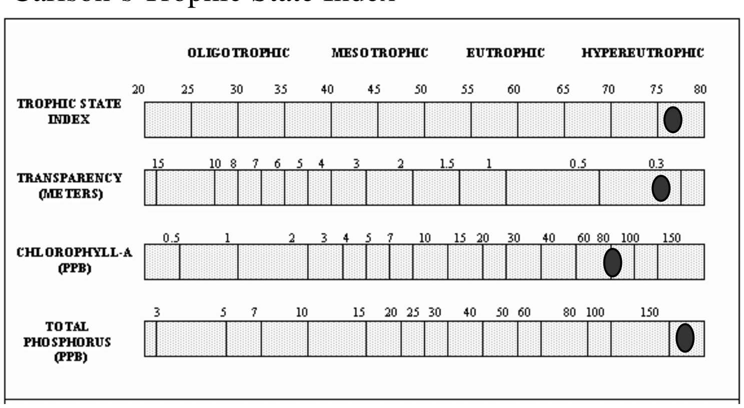
Carlson's Trophic State Indices

TSIP			78	83	79	78	82	81	83	82	81	81	88	89	81	79	81	78
TSIC			75	81	78	82	79	72	74	77	76	74	83	77	72	68	70	74
TSIS	81	79	72	78	74	79	82	80	86	85	77	83	93	93	83	67	73	77
TSI			75	81	77	79	81	78	81	81	78	79	88	86	79	71	75	77

Typo Lake Water Quality Report Card

Year	1974	1975	1993	1994	1995	1997	1998	1999	2000	2001	2003	2005	2007	2009	2012	2014	2015	2016
TP			F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Cl-a			F	F	F	F	F	D	F	F	F	F	F	F	D	C	D	F
Secchi	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Overall			**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**D-**	**F**	**F**

Carlson's Trophic State Index



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 5402 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 Minnesota Pollution Control Agency's (MPCA) list of impaired waters for excess nutrients.

2016 Results

In 2016 Martin Lake had poor water quality compared other lakes in the North Central Hardwood Forest Ecoregion (NCHF), receiving a C letter grade. This eutrophic lake has chronically high total phosphorus and chlorophyll-a. In 2016 total phosphorus averaged 69.1 µg/L, well below the lake's historical average of 92.1 µg/L and only slightly above the impairment threshold of 60 µg/L. In fact, this is the lowest average total phosphorus on record for Martin Lake, just edging out an average of 69.2 µg/L in 1999. Chlorophyll-a was higher than the previous three years, however, at 17.8 µg/L. Average Secchi transparency was only 3.1 feet in 2016, right on par with its historical average. The ACD staff's subjective perceptions of the lake were that "high" algae made the lake less than desirable for swimming from July through September.

Trend Analysis

Fifteen years of water quality data have been collected by the Minnesota Pollution Control Agency (1983), Metropolitan Council (1998, 2008), and the ACD (1997, 1999-2001, 2003, 2005, 2007, 2009, 2012-2016). 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 actually shown an improvement from 1983 to 2016 that is statistically significant (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth; $F_{2,12}$=7.06, p=<0.01). Further examination of the data (one-way ANOVAs on the individual response variables) shows that while TP and Secchi depth appear to be trending in the wrong direction, though not statistically significant, Cl-a has now shown a statistical decrease with $F_{1,13}$=7.42, p=<0.02.

Discussion

Martin Lake, along with Typo Lake upstream, were 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. Several rain gardens have been installed, carp barriers were completed in 2016 with carp removals planned for 2017-19 and a feasibility study of ditched wetland projects upstream of Typo Lake is underway. While the lowest average total phosphorus on record measured in one season does not necessarily represent a trend of improving water quality in Martin Lake, it is certainly not a bad sign. Hopefully these results can be replicated and improved on in the future.

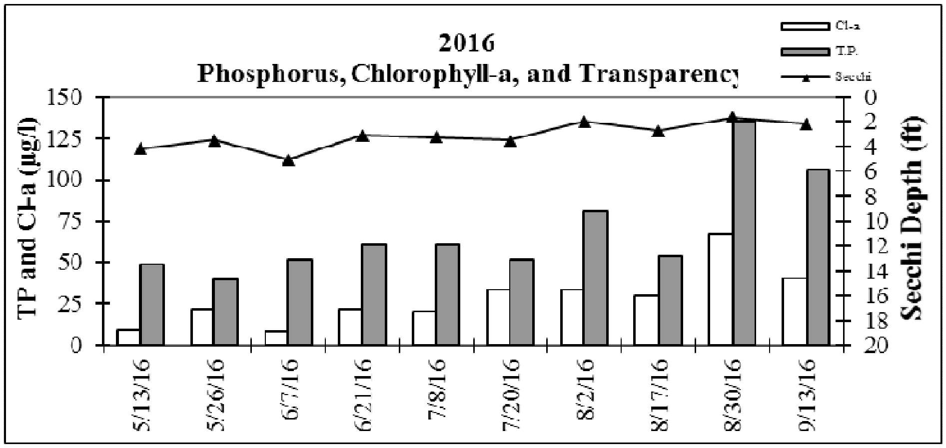
2016 Martin Lake Water Quality Data

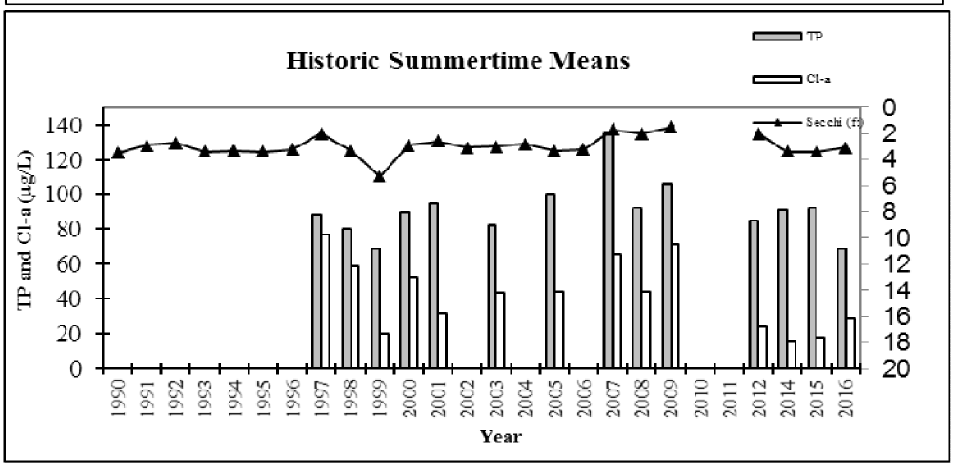
Martin Lake
2016 Water Quality Data

		Date:	5/13/2016	5/26/2016	6/7/2016	6/21/2016	7/8/2016	7/20/2016	8/2/2016	8/17/2016	8/30/2016	9/13/2016			
		Time:	13:50	12:45	14:50	13:00	12:30	12:30	12:00	12:05	12:45	12:00			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.64	9.15	7.76	8.46	8.37	9.22	8.87	9.03	8.63	8.46	8.66	7.76	9.22
Conductivity	mS/cm	0.01	0.326	0.332	0.362	0.320	0.342	0.325	0.310	0.339	0.315	0.292	0.326	0.292	0.362
Turbidity	FNRU	1	21.50	14.30	9.10	16.40	36.90		28.30	21.80	53.80	49.70	27.98	9.10	53.80
D.O.	mg/l	0.01	8.88	13.05	6.80	9.83	8.25	13.64	11.06	10.72	11.34	9.13	10.27	6.80	13.64
D.O.	%	1	90%	151%	76%	120%	105%	172%	141%	136%	139%	104%	123%	76%	172%
Temp.	°C	0.1	14.8	21.4	20.1	24.4	25.1	26.2	26.3	25.9	24.1	21.3	22.9	14.8	26.3
Temp.	°F	0.1	58.6	70.5	68.2	76.0	77.1	79.1	79.3	78.6	75.3	70.4	73.3	58.6	79.3
Salinity	%	0.01	0.15	0.16	0.18	0.15	0.16	0.16	0.15	0.16	0.15	0.14	0.16	0.14	0.18
Cl-a	ug/L	0.5	9.3	22.1	8.5	22.1	20.6	33.5	33.5	29.9	67.3	40.6	28.7	8.5	67.3
T.P.	mg/l	0.010	0.049	0.040	0.052	0.061	0.061	0.052	0.081	0.054	0.135	0.106	0.069	0.040	0.135
T.P.	ug/l	10	49	40	52	61	61	52	81	54	135	106	69.1	40	135
Secchi	ft		4.2	3.5	5.1	3.1	3.3	3.5	2.0	2.8	1.7	2.2	3.1	1.7	5.1
Secchi	m		1.3	1.1	1.5	0.9	1.0	1.1	0.6	0.8	0.5	0.7	1.0	0.5	1.5
Field Observations/Appearance															
Physical			3.0	4.0	3.0	4.0	4.0	4.0	3.0	4.0	2.0	2.0	3.3	2.0	4.0
Recreational			3.0	4.0	3.0	4.0	4.0	4.0	3.0	3.0	1.0	2.0	3.1	1.0	4.0

*reporting limit

Martin Lake Water Quality Results





Martin Lake Summertime Annual Mean

Agency	CLMP	ACD	MC	ACD	ACD	ACD	CLMP	ACD	CLMP	ACD	ACD	ACD	CAMP	CAMP	ACD	ACD	ACD	ACD
Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2012	2014	2015	2016
TP		88.0	80.0	61.7	89.4	95.4		81.9		100.0		135.0	92.0	106.0	85.0	91.0	92.6	69.1
Cl-a		77.0	58.8	18.0	52.5	31.4		43.3		44.3		65.8	44.1	71.4	24.1	15.5	17.4	28.7
Secchi (m)	1.0	0.6	1.0	1.8	0.9	0.8	0.9	0.9	0.9	1.0	1.0	0.5	0.6	0.4	0.6	1.0	1.0	1.0
Secchi (ft)	3.2	2.0	3.3	5.3	2.9	2.6	3.1	3.0	2.8	3.3	3.2	1.7	2.0	1.5	2.0	3.4	3.4	3.1

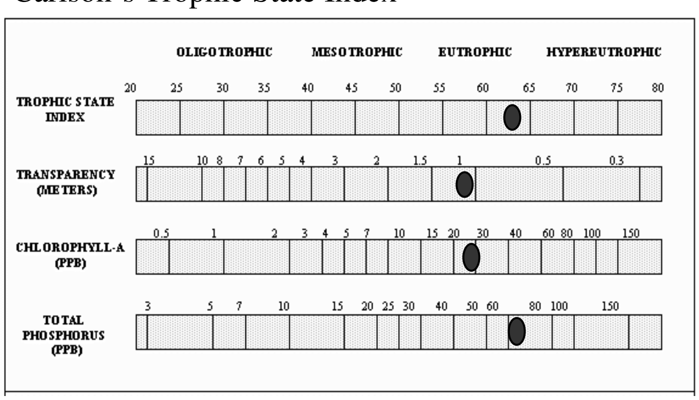
Carlson's Tropic State Indices

TSIP		69	67	64	68	69		68		71		75	69	71	68	69	69	65
TSIC		73	71	59	67	63		68		68		72	68	73	62	58	59	64
TSIS	60	67	60	52	63	65	65	62	62	60	60	70	67	73	67	60	60	60
TSI		70	66	58	66	66		66		66		72	68	72	66	62	63	63

Martin Lake Water Quality Report Card

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2012	2014	2015	2016
TP		D	D	C	D	D		D		D		D	D	D	D	D	D	C
Cl-a		D	D	B	C	C		C		C		D	C	D	C	B	B	C
Secchi	D	F	D	C	D	D	D	D	D	D	D	F	F	F	F	D	D	D
Overall		**D**	**D**	**C**	**D**	**D**		**D**		**D**		**D**	**D**	**D**	**D**	**C**	**C**	**C**

Carlson's Trophic State Index



Stream Water Quality

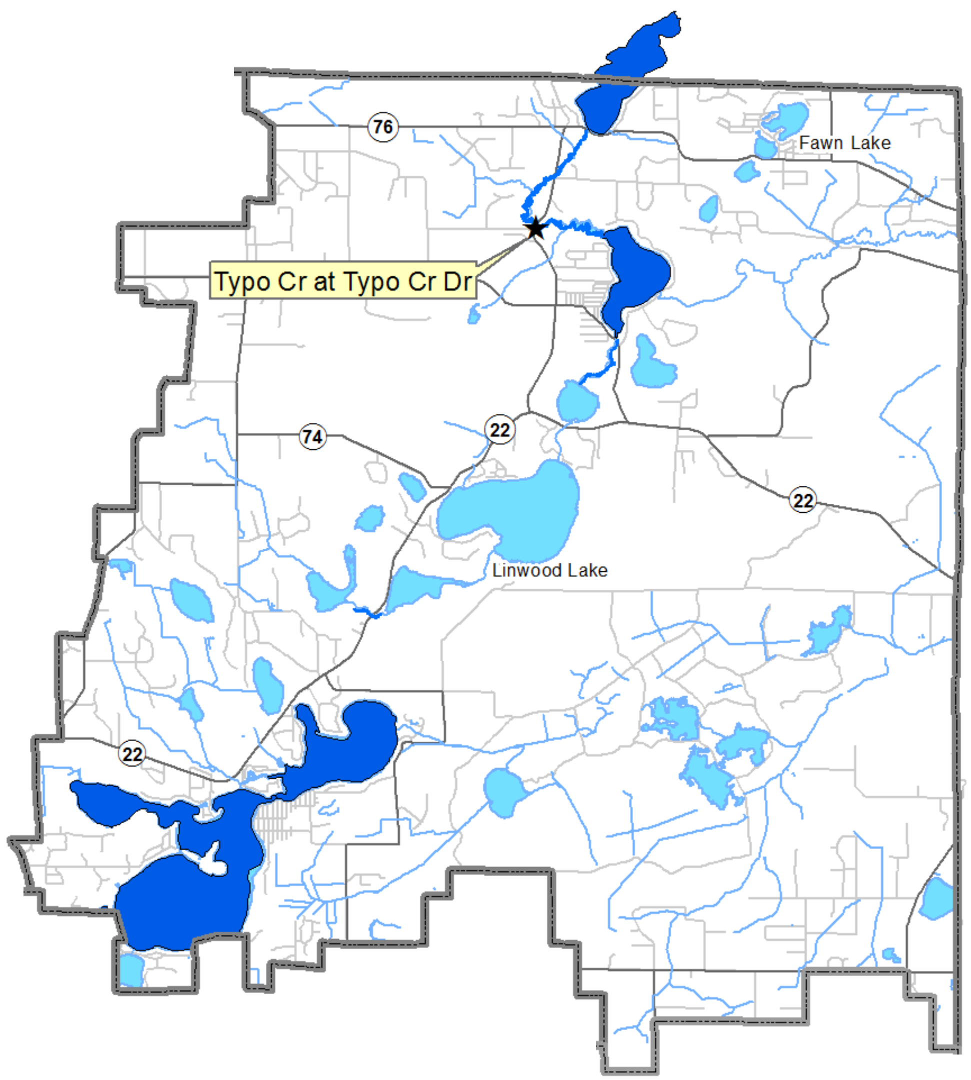
Description: Stream water quality is monitored with grab samples on eight occasions throughout the open water season, including four times immediately following a storm (1" of rain within a 24hr period) and four times during baseflow conditions. The selected site was chosen to monitor the impacts of the carp barriers installed in the watershed over time. Parameters monitored include water level, pH, 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: Typo Creek at Typo Creek Drive near 233rd Ave. NE

Results: Results are presented on the following pages.

Sunrise Watershed Stream Water Quality Monitoring Sites



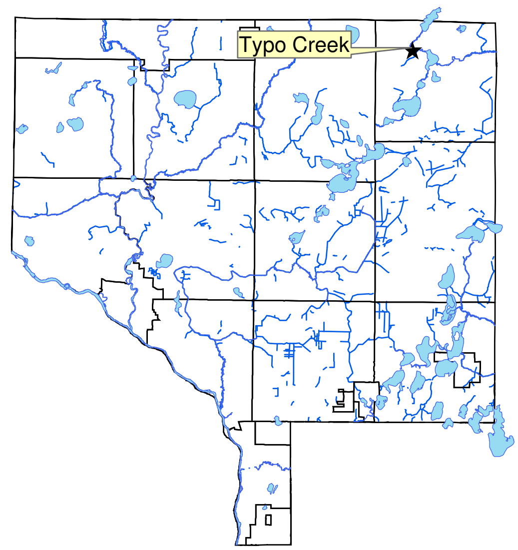
TYPO CREEK AT TYPO CREEK DR.

Near Typo Creek Dr. and 233rd Ave. NE, Linwood Township

STORET SiteID = S003-188

Years Monitored

1998, 2000, 2001, 2003, 2016



Background

The northern inlet to Martin Lake, also called Typo Creek, flows from the outlet of Typo Lake about 1.9 miles south to Martin Lake. It is the primary inlet to Martin Lake. This stream was monitored in 2001 and 2003 as part of a TMDL impaired waters study for the two lakes it links. The watershed is primarily undeveloped. This stream carries a relatively large volume of water, with flows ranging from 4-6 cfs during baseflow and 10-17 cfs during stormflow.

Methods

The creek was monitored by grab samples. Eight water quality sampling events were conducted in 2016; four during baseflow and four 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, conductivity, turbidity, temperature, dissolved oxygen, and salinity. Parameters tested by water samples sent to a state-certified lab included total phosphorus, and total suspended solids.

Summary

Summarized water quality monitoring findings and management implications include:

- Dissolved pollutants, as measured by conductivity and chlorides, are at low and healthy levels.

  Management discussion: Road deicing salts are a concern region-wide. They are measurable in area streams year-round, including Typo Creek. While they may be acceptably low here currently, excessive use should be avoided.

- Phosphorus loading and eutrophication remains the biggest concern for Typo Creek.

  Management discussion: Management in response to the TMDL report, including projects like the installation of carp barriers, will reduce phosphorus levels in the creek as well as the upstream and downstream lakes, but additional work and time may be needed to reach goals.

- Suspended solids and turbidity remain a large problem in Typo Creek. This problem is directly related to the issues causing excessive nutrient loading.

  Management discussion: Efforts involved with the reduction of nutrient loading and management of carp populations will have a direct effect on the suspended solids and turbidity issues in Typo Creek.

- pH was within the range considered normal and healthy for streams in this area during 2016, but this has not been the case in most years and the creek is listed by the State as impaired for high pH. High algal production in Typo Lake upstream causes the high pH. Management to address eutrophication will address the pH problem.

- Dissolved oxygen (DO) was quite low in 2016 compared to the years this site was monitored shortly after the turn of the millennium. This issue is likely also tied to the nutrient loading of this system.

  Management discussion: Low dissolved oxygen is likely having a profound impact on aquatic life. This issue is primarily driven by the nutrient loading at the root of this system's problems and will likely see improvements which coincide with the nutrient reduction strategies identified and underway.

Results and Discussion

Nutrient loading is the root cause of intense eutrophication and turbidity in Typo Creek. This, along with populations of invasive carp species, is having a profound negative impact on the flora and fauna of this system. A TMDL study has been completed for this stream, and corrective projects are being implemented. It is likely that the severity of the issues facing this creek, and the rest of its watershed, will require a large amount of time, involvement and project development to reach goals.

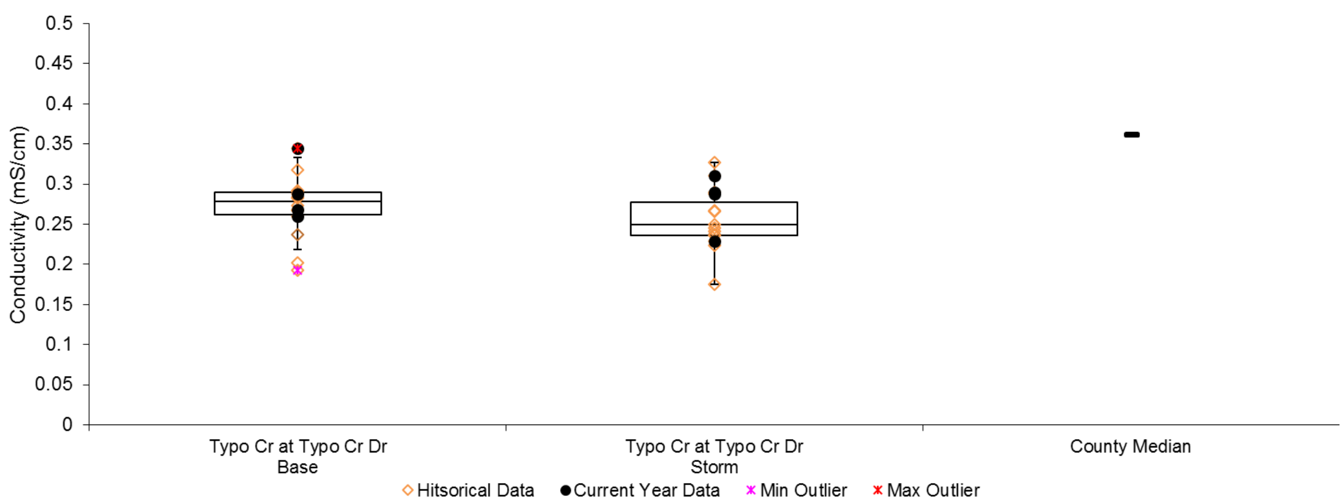
Conductivity and chlorides

Conductivity and chlorides are measures of dissolved pollutants. Dissolved pollutant sources include urban road runoff, industrial chemicals, among many others. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Conductivity is the broadest measure of dissolved pollutants we used. It measures electrical conductivity of the water; pure water with no dissolved constituents has zero conductivity. Chlorides are the measure of chloride salts, the most common of which are road de-icing chemicals. Chlorides can also be present in other pollutant types, such as wastewater. These pollutants are of greatest concern because of the effect they can have on the stream's biological community.

Conductivity was acceptably low in Typo Creek, averaging 0.285 mS/com over the sampling season. This is notably lower than the median for 34 Anoka County streams of 0.362 mS/cm. Conductivity was slightly lower during storms, suggesting that stormwater runoff contains fewer dissolved pollutants than the surficial water table that feeds the river during baseflow. High baseflow conductivity has been observed in many other area streams with the largest cause believed to be road salts that have infiltrated into the shallow aquifer.

Chlorides were not tested in 2016, and were last sampled at this site in 2003. Chloride results in 2003 ranged between 8 mg/L and 12 mg/L, far below the Minnesota Pollution Control Agency's (MPCA) chronic standard for aquatic life of 230 mg/L. The primary reason for low chloride levels in this river is low road densities in the watershed, and therefore less use of road deicing salts.

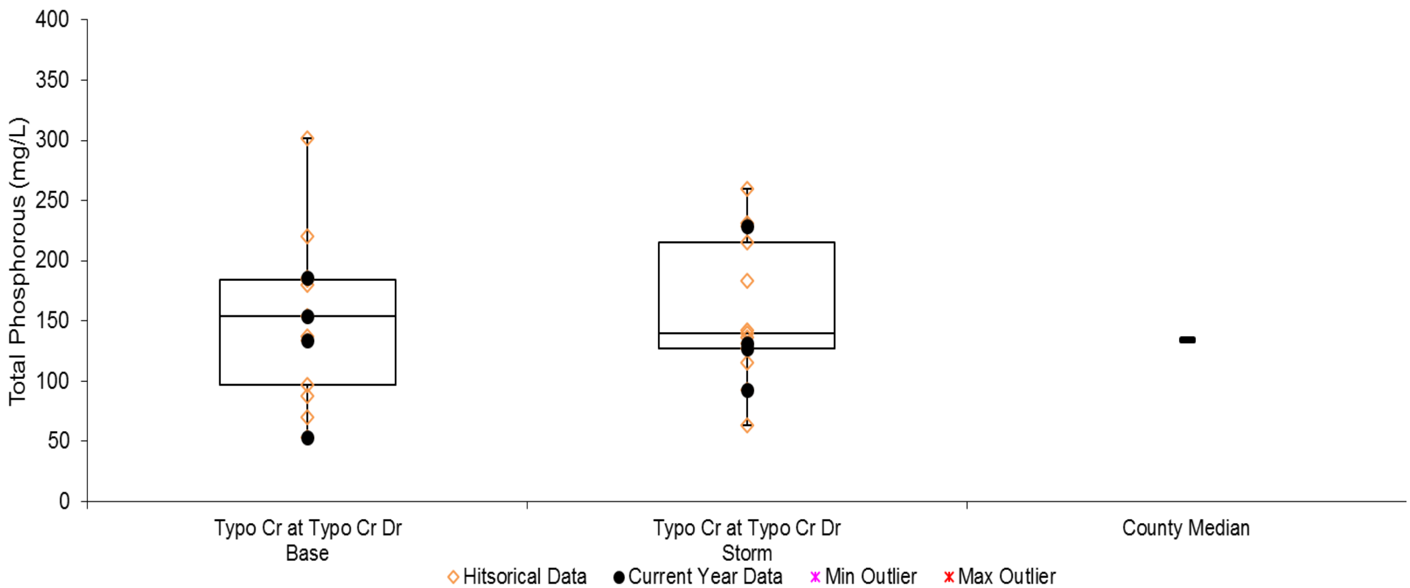
Conductivity during baseflow and storm conditions. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Total Phosphorus

Total phosphorus (TP), a nutrient, is one of the most common pollutants in our region, and can be associated with urban runoff, agricultural runoff, wastewater, and many other sources. The average total phosphorus concentration of Typo Creek in 2016 was 138 ug/L, well in exceedance of the state standard (100 ug/L). These high phosphorus levels are common for the area. In the case of Typo Creek, phosphorus levels are also reflective of conditions of Typo Lake upstream. A TMDL was approved for Typo Creek in 2012 for pH and turbidity before the current stream eutrophication standards applied. Nutrients are the primary cause of high turbidity and pH. Nutrient reduction projects are ongoing.

Total phosphorus during baseflow and storm conditions. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Turbidity and Total Suspended Solids (TSS)

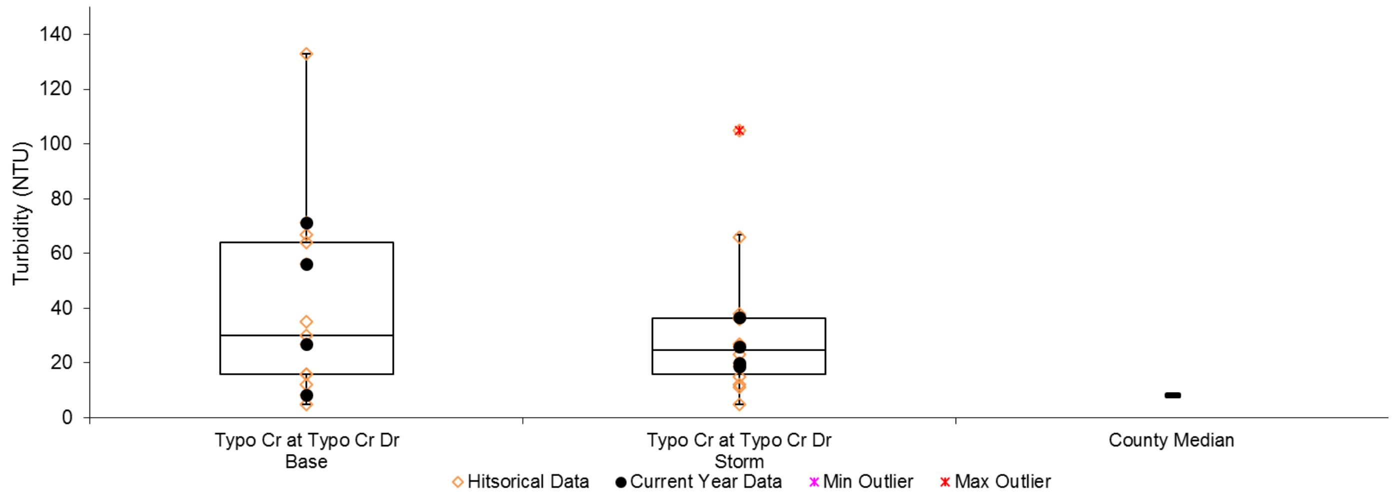
Turbidity and total suspended solids (TSS) are two different measurements of solid material suspended in the water. Turbidity is measured by refraction of a light beam passed through a water sample. It is most sensitive to large particles. Total suspended solids is measured by filtering solids from a water sample and weighing the filtered material. The amount of suspended material is important because it affects transparency and aquatic life, and because many other pollutants are attached to particles. Many stormwater treatment practices such as street sweeping, sumps, and stormwater settling ponds target sediment and attached pollutants.

It is important to note the suspended solids can come from sources both internal and external of the river. Sources on land include soil erosion, road sanding, and many others. Internally, riverbank erosion and movement of the river bottom also contributes to suspended solids. Algal production and sediment disturbance I upstream lakes also contribut.

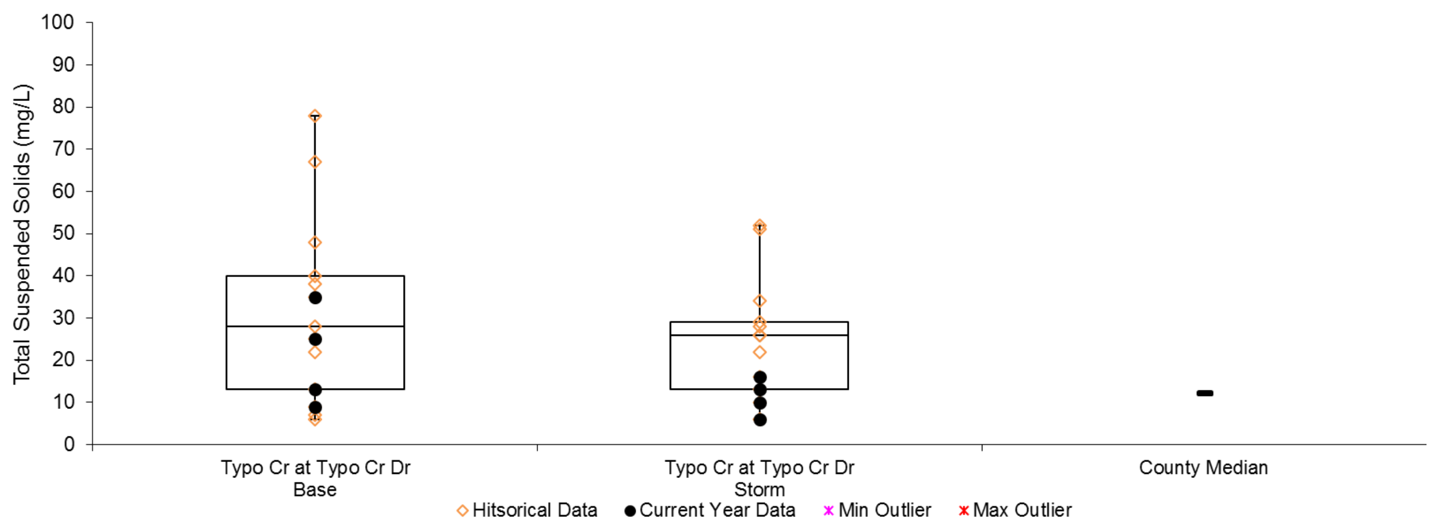
Typo Creek has been on the MPCA Impaired Waters List for turbidity since 2006. The threshold is 25 NTU turbidity. If a river exceeds this value on three occasions and at least 10% of all sampling events it is declared impaired for turbidity. Based on all years of ACD sampling, Typo Creek has exceeded 25 NTU turbidity on 15 of 27 sampling occasions, or 56% of the time. In 2016 five of eight samples had turbidity in excess of 25 NTU, with 71.2 NTU being the highest level recorded for the year.

The high turbidity levels in Typo Creek are likely due to many factors within the watershed. Rough fish are present in the creek, as well as each of the lakes it connects. Typo Lake upstream is hypertrophic, and MN DNR fisheries anecdotal notes suggest large algae blooms dating back to the 1960s. Additionally, Typo Creek and Typo Lake each have a very loose, unconsolidated, silty bottom that easily mixes with the water column and readily remains suspended.

Turbidity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Total suspended solids during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

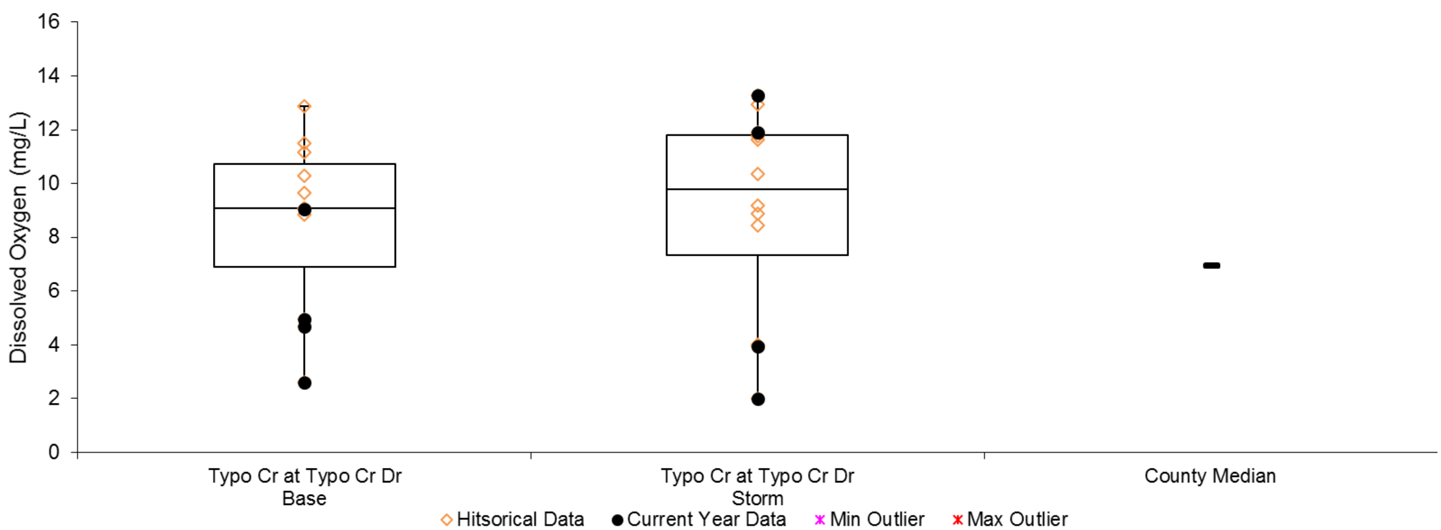


Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution cases oxygen to be consumed when it decomposes. If oxygen levels fall below 5 mg/L aquatic life begins to suffer, therefore, the state water quality standard is a daily minimum of 5 mg/L. A stream is considered impaired if 10% of observations are below this level in the last 10 years. Dissolved oxygen levels are typically lowest in the early morning because of decomposition consuming oxygen at night without offsetting oxygen production by photosynthesis.

In three past years of sampling, Typo Creek only had a DO level below 5 mg/L on one occasion. In 2016, five of eight samples yielded sub-5 mg/L results. These results are especially disconcerting considering low DO was measured during both storm and baseflow conditions during a year that was generally wet but without flooding. These low DO concentrations are likely directly attributable to decomposition, eutrophication and lack of clarity within the stream. These conditions cause high levels of oxygen consumption without allowing sunlight to penetrate the water column and trigger photosynthesis.

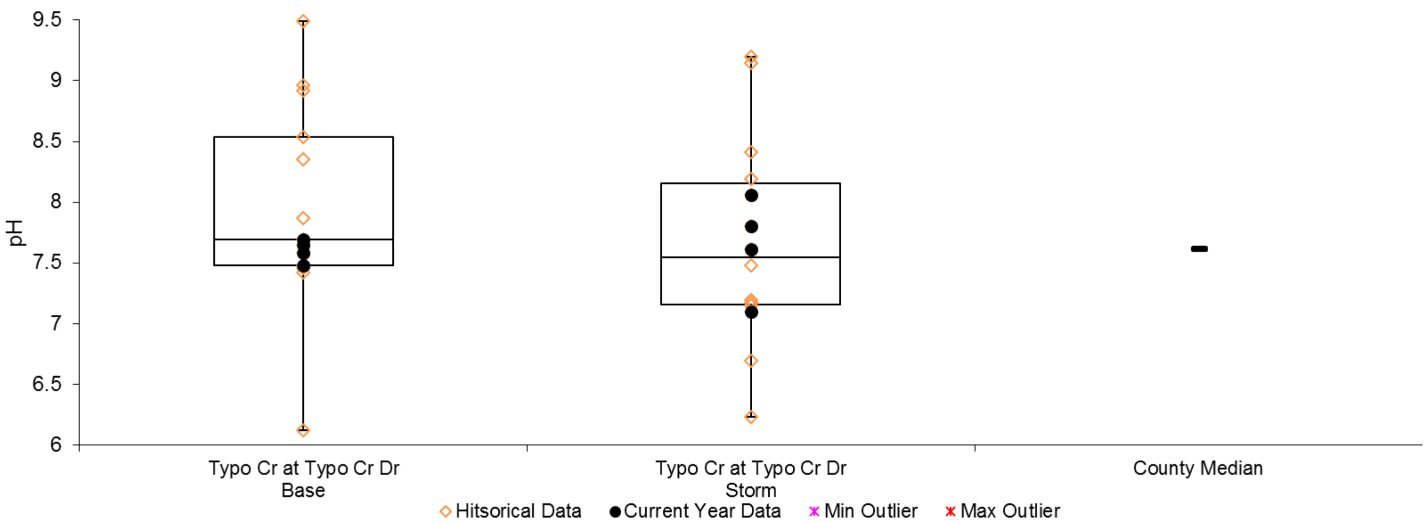
Dissolved oxygen results during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



pH

pH refers to the acidity of the water, and has a large effect on a stream's ability to support aquatic life. The Minnesota Pollution Control Agency's water quality standard is for pH to be between 6.5 and 8.5. Typo Creek has been listed as impaired for pH since 2006 due to great swings both above and below the state standard range in past sampling years. In 2016, however, pH was much more stable, ranging from 7.10 to 8.06.

pH results during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Recommendations

A Total Maximum Daily Load (TMDL) plan was approved in 2012 for Typo Creek for pH and turbidity. By far the biggest issue with Typo Creek is the nutrient loading and eutrophication of the watershed. Projects including the Martin and Typo Lake carp barriers and carp removal (barriers in 2016, removals in 2017-19), projects in ditched wetalnds upstream of Typo Lake (feasibility study underway) and stormwater retrofits (rain gardens installed) aim to address these issues. Conditions in Typo Creek are not likely to improve until the water quality of Typo Lake upstream improves.

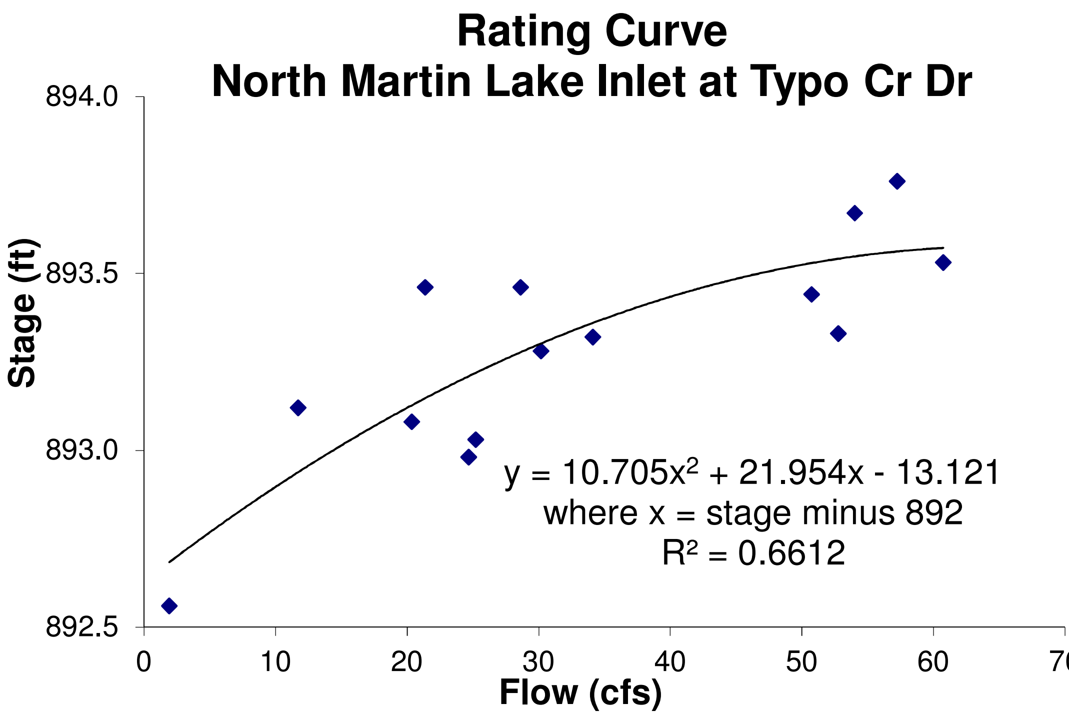
Stream Rating Curves

Description: Rating curves are the mathematical relationship between water level and flow volume. They are developed by manually measuring flow at a variety of water levels. These water level and flow measurements are plotted against each other and the equation of the line best fitting these points is calculated. That equation allows flow to be calculated from continuous water level monitoring in streams.

Purpose: To allow flow to be calculated from water level, which is much easier to monitor.

Locations: North Inlet of Martin Lake (Typo Cr) at Typo Creek Drive

Results: Rating curves were developed for the site listed above in previous years. In 2012 ACD staff discovered an error in the equations and corrected them. They also corrected all past hydrology records that used the equations. Below are the corrected rating curves.



Wetland Hydrology

Description: Continuous groundwater level monitoring at a wetland boundary. Countywide, the ACD maintains a network of 23 wetland hydrology monitoring stations.

Purpose: To provide understanding of wetland hydrology, including the impacts of climate and land use. These data aid in delineation of nearby wetlands by documenting hydrologic trends including the timing, frequency, and duration of saturation.

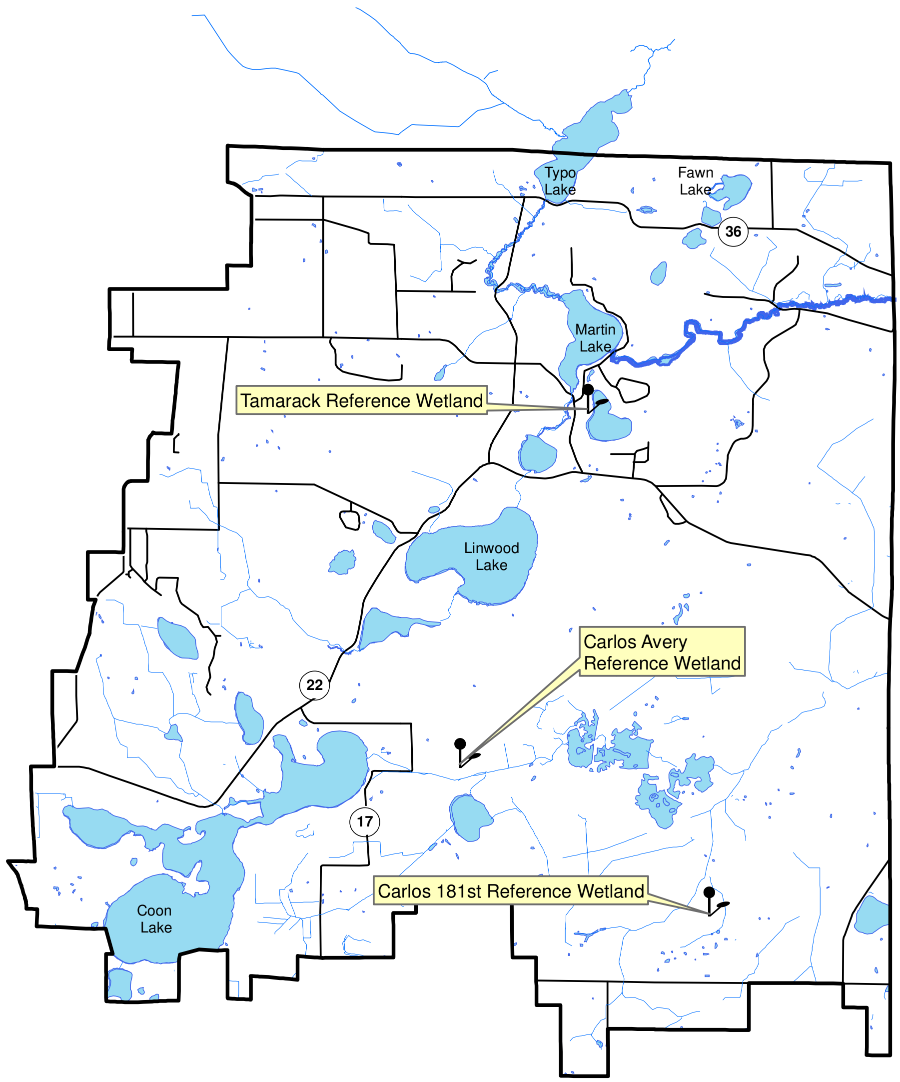
Locations: Carlos Avery Reference Wetland, Carlos Avery Wildlife Management Area, City of Columbus

Carlos 181[st] Reference Wetland, Carlos Avery Wildlife Management Area, City of Columbus

Tamarack Reference Wetland, Linwood Township

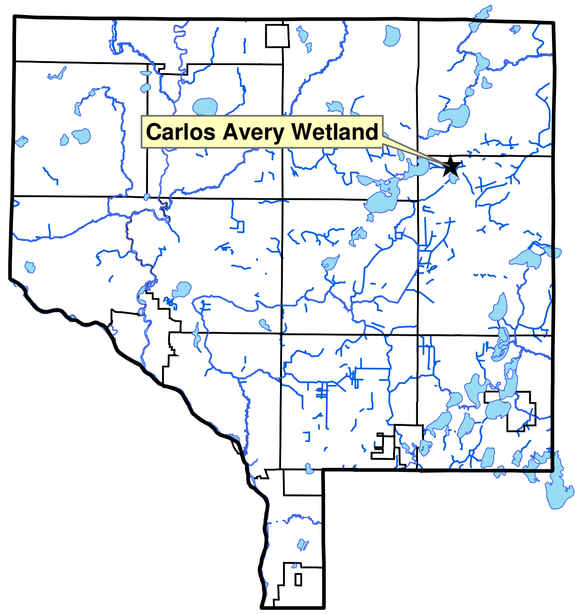
Results: See the following pages.

Sunrise Watershed Wetland Hydrology Monitoring Sites



CARLOS AVERY REFERENCE WETLAND

Carlos Avery Wildlife Management Area, City of Columbus



Site Information

Monitored Since: 1997

Wetland Type: 3

Wetland Size: >300 acres

Isolated Basin? No

Connected to a Ditch? Yes

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
Oa	0-4	N2/0	Organic	-
Bg	4-25	10yr 5/2	Sandy Loam	25% 10yr 5/6 with organic streaking

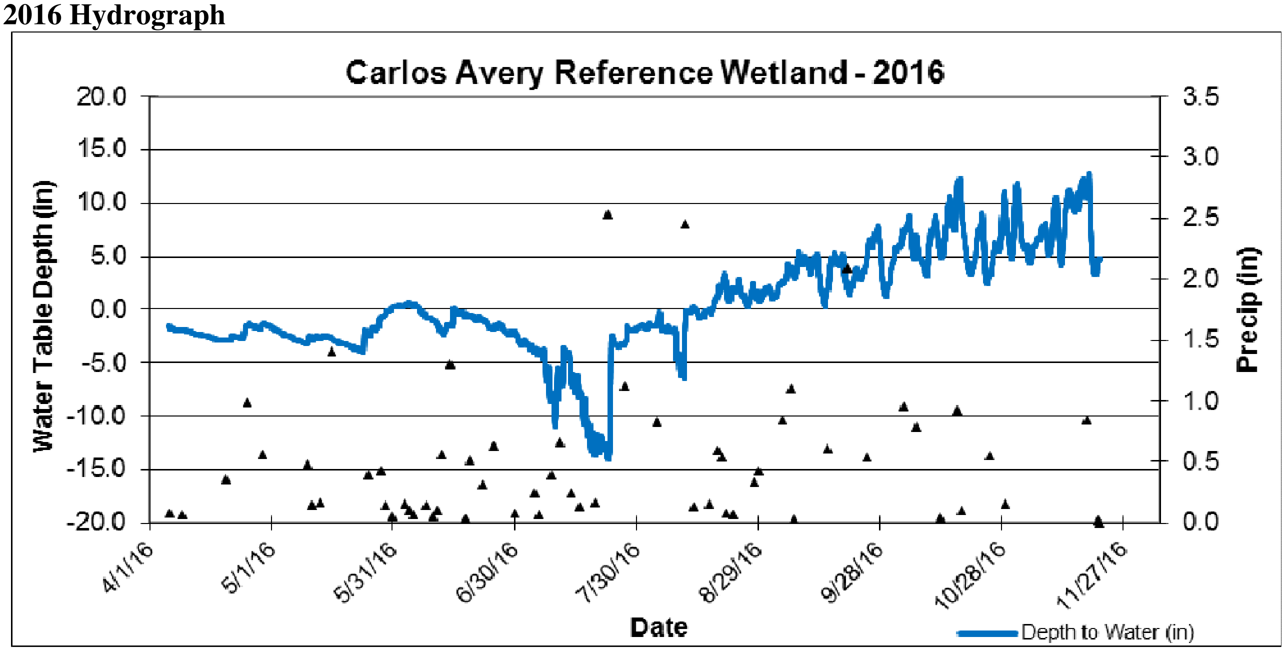
Surrounding Soils: Lino loamy fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	80
Carex Spp	Sedge undiff.	40
Quercus macrocarpa	Bur Oak	40
Sagitaria latifolia	Broad-leaf Arrowhead	20
Cornus stolonifera	Red-osier Dogwood	20

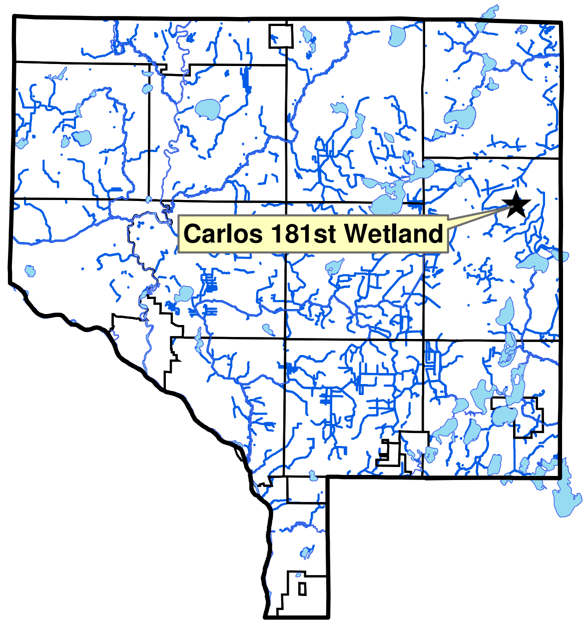
Other Notes: This is a broad, expansive wetland within a state-owned wildlife management area. Cattails dominate within the wetland.

2016 Hydrograph



CARLOS 181ST REFERENCE WETLAND

Carlos Avery Wildlife Management Area, City of Columbus



Site Information

Monitored Since: 2006

Wetland Type: 2-3

Wetland Size: 3.9 acres (approx)

Isolated Basin? Yes

Connected to a Ditch? Roadside swale only

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
Oa	0-3	N2/0	Sapric	-
A	3-10	N2/0	Mucky Fine Sandy Loam	-
Bg1	10-14	10yr 3/1	Fine Sandy Loam	-
Bg2	14-27	5Y 4/3	Fine Sandy Loam	-
Bg3	27-40	5y 4/2	Fine Sandy Loam	-

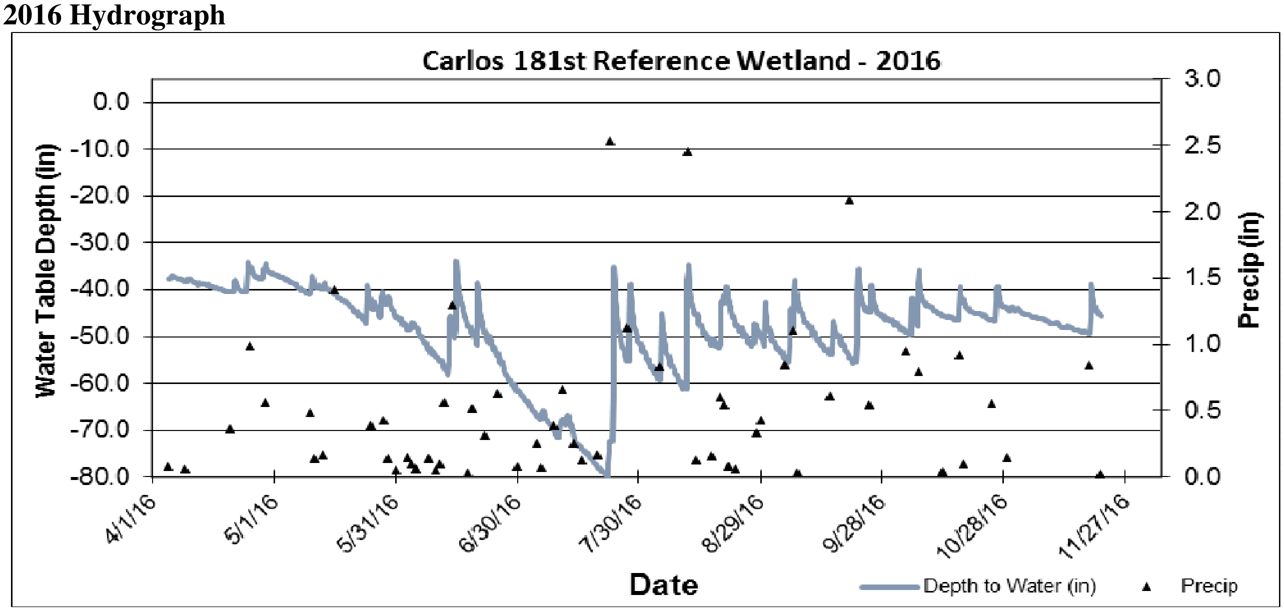
Surrounding Soils: Soderville fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	100
Rhamnus frangula (S)	Glossy Buckthorn	40
Ulmus american (S)	American Elm	15
Populus tremulodies (T)	Quaking Aspen	10
Acer saccharum (T)	Silver Maple	10

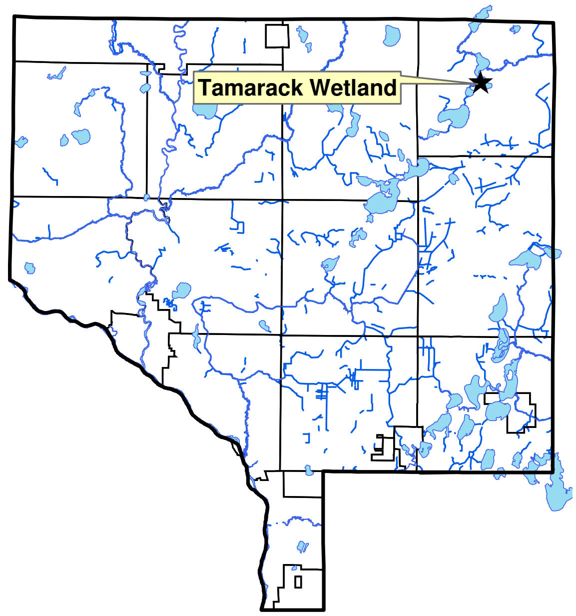
Other Notes: The site is owned and managed by MN DNR. Access is from 181st Avenue.

2016 Hydrograph



TAMARACK REFERENCE WETLAND

Martin-Island-Linwood Regional Park, Linwood Township



Site Information

Monitored Since: 1999

Wetland Type: 6

Wetland Size: 1.9 acres (approx)

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A	0-6	N2/0	Mucky Sandy Loam	-
A2	6-21	10yr 2/1	Sandy Loam	-
AB	21-29	10yr3/2	Sandy Loam	-
Bg	29-40	2.5y5/3	Medium Sand	-

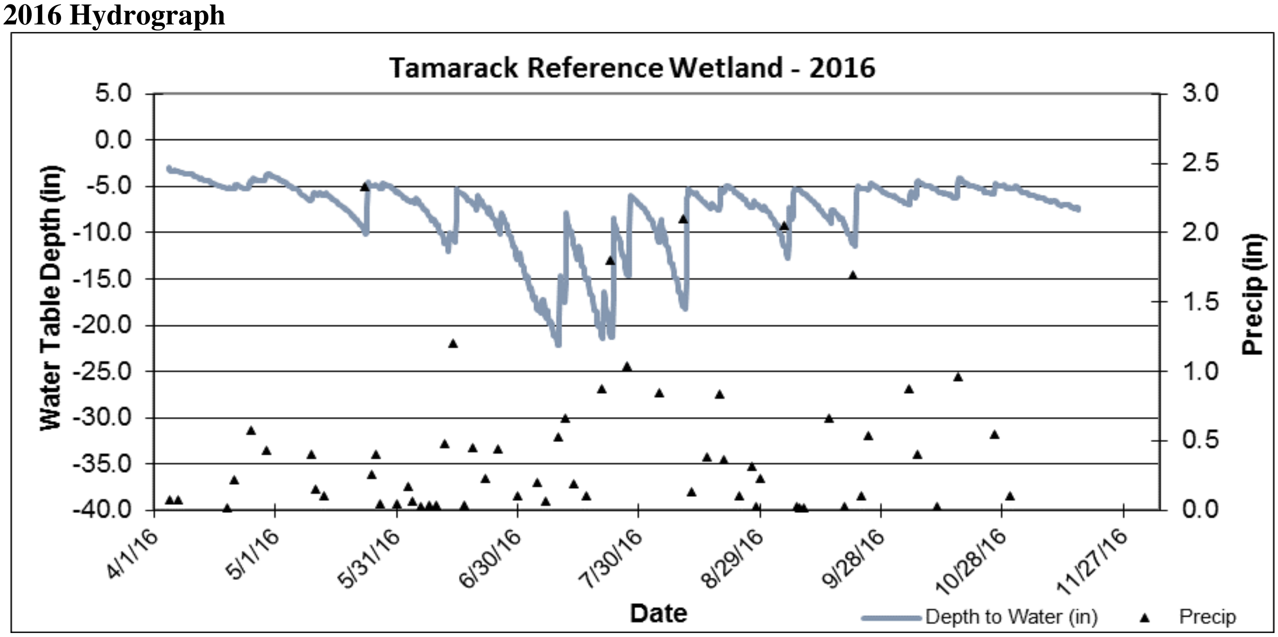
Surrounding Soils: Sartell fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Rhamnus frangula	Common Buckthorn	70
Betula alleghaniensis	Yellow Birch	40
Impatiens capensis	Jewelweed	40
Phalaris arundinacea	Reed Canary Grass	40

Other Notes: The site is owned and managed by Anoka County Parks.

2016 Hydrograph



Water Quality Grant Fund

Description: The Sunrise River Watershed Management Organization (SRWMO) offers cost share grants to encourage projects that will benefit lake and stream water quality. These projects include lakeshore restorations, rain gardens, erosion correction, and others. These grants, administered by the ACD, offer 50-70% cost sharing of the materials needed for a project. The landowner is responsible for the remaining materials expenses, all labor, and any aesthetic components of the project. The ACD assists interested landowners with design, materials acquisition, installation, and maintenance.

Purpose: To improve water quality in area lakes, streams, and rivers.

Locations: Throughout the watershed.

Results: Projects reported in the year they are installed. Installation for one rain garden began in 2016.

SRWMO Cost Share Fund Summary

2005 SRWMO Contribution	+	$1,000.00
2006 SRWMO Contribution	+	$1,000.00
2006 Expense - Coon Lake, Rogers Property Project	-	$ 570.57
2007 – no expenses or contributions		$ 0.00
2008 SRWMO Contribution	+	$2,000.00
2008 Expense - Martin Lake, Moos Property Project	-	$1,091.26
2009 SRWMO Contribution	+	$2,000.00
2010 SRWMO Contribution	+	$1,840.00
2011 SRWMO Contribution	+	$2,000.00
2012 SRWMO Contribution	+	$2,000.00
2012 Expense – Linwood Lake, Gustafson Property Project	-	$ 29.43
2012 Expense – Transfer to Martin-Typo Lakes Carp Barriers	-	$4,300.00
2013 – no expenses or contributions		$ 0.00
2014 SRWMO Contribution	+	$2,000.00
2015 SRWMO Contribution		$ 0.00
2016 SRWMO Contribution		$ 0.00
2016 Expense – Voss Rain Garden	-	$1,229.31
2017 Expense – Anticipated Voss Finish Up	-	$2,658.69*
Fund Balance		**$3,960.74**

*Actual amount anticipated amount to be spent = $451.00

Coon Lake Area Stormwater Retrofits

Description: Two more water quality improvement projects were completed in 2016, both lakeshore restorations**.** These projects, along with the four projects completed in 2015, were identified in a 2014 stormwater retrofit analysis study. The projects were funded by a State Clean Water Legacy Grant and local partners. An additional rain garden project was started in 2016 and is to be finished in early 2017.

Purpose: To improve Coon Lake water quality.

Results: Installed two lakeshore restorations and started work on installing a rain garden.

Four water quality improvement projects were installed in 2015 including two rain gardens, a new stabilized conveyance of stormwater flowing down Lincoln Drive and a lakeshore restoration.

Coon Lake Beach Community Center rain garden

19511 East Tri Oak Circle NE lakeshore restoration

19303 East Front Blvd rain garden

Lincoln Avenue stormwater stabilization.

Two water quality improvement projects were completed in 2016, both lakeshore restorations, with a third project, a rain garden, planned to be finished in early 2017.

3340 183rd Ave. NE lakeshore restoration

18453 Lakeview Pt. Drive Lakeshore Restoration

19303 E Front Blvd. NE rain garden to be finished in 2017

Carp Barriers Installation

Description: This project aims to improve water quality in Martin and Typo Lakes by controlling carp with strategically placed barriers and increased commercial harvests. Both lakes fail to meet state water quality standards due to excessive phosphorus, which fuels algae blooms. As a result, the lakes are often strongly green or brown and the game fishery is depressed. Carp are a major cause of poor water quality in these lakes, diminishing their value for swimming, boating, and fishing.

Barriers are an effective strategy for carp control because Typo and Martin Lake each provide something important for carp, and moving between the lakes is important to their success. Martin Lake is deeper, and good for overwintering. Typo Lake and Typo Creek are shallow and good for spawning. Stopping migrations between the lakes with barriers will reduce overwintering survival and spawning success. Additionally, barriers will allow successful commercial carp harvests.

Purpose: To improve water quality.

Results: In 2014, the SRWMO installed one carp barrier at the south inlet of Martin Lake. In the early spring of 2016, the installation of three additional barriers was completed at the following locations: Typo Lake outlet, Martin Lake north inlet, and Martin Lake outlet.

Martin Lake south inlet (completed 2014)

Typo Lake outlet (completed early 2016)

Martin Lake outlet (completed early 2016)

Martin Lake north inlet (completed early 2016)

Annual Education Publication

Description: An annual newsletter article about the SRWMO is required by MN Rules 8410.010 subpart 4, and planned in the SRWMO Watershed Management Plan.

Purpose: To improve citizen awareness of the SRWMO, its programs, and accomplishments.

Results: In 2016 the SRWMO contracted with the ACD to write the annual newsletter and provide it to member communities for distribution in their newsletters. Topics for the annual newsletter were discussed by the SRWMO Board. Shoreline restoration grant opportunities was the chosen topic.

SRWMO 2016 Newsletter Article:

Grants Available to Homeowners for Shoreline Restoration

Grants and technical help are being offered by the Sunrise River Watershed Management Organization (SRWMO) to homeowners for projects that benefit water quality. Grants are targeted toward stabilizing eroding shorelines and filtering runoff before it reaches the lake. Other projects that benefit water quality are also considered. The eligible area includes Coon, Linwood, Martin and Typo Lakes, as well as smaller waterbodies in the vicinity.

Most projects include “soft engineering” to stabilize erosive losses and planting of native grasses and wildflowers that filter runoff and provide habitat. Portions of the shoreline are typically left unplanted for a dock, beach and other water access. Each design is unique but all projects provide beauty and a lasting benefit to the lake’s water quality and fish.

No-cost consultations are offered, as well as assistance with a design and cost estimate. The grants pay 50-70% of materials costs. Homeowners are responsible for labor costs.

Interested landowners should contact Jamie Schurbon at the Anoka Conservation District at 763-434-2030 ext. 12 or jamie.schurbon@anokaswcd.org.

Additional information about lakeshore landscaping, including hints for do-it-yourselfers and recommended plant lists, is at www.SRWMO.org.

The SRWMO is a collaboration of Linwood Township and the Cities of East Bethel, Ham Lake and Columbus to manage water resources. It covers all of Linwood and portions of each city in the Sunrise River watershed.

Photo: Restored shoreline at Coon Lake.

SRWMO Website

Description: The Sunrise River Watershed Management Organization (SRWMO) contracts the Anoka Conservation District (ACD) to maintain a website about the SRWMO and the Sunrise River watershed.

Purpose: To increase awareness of the SRWMO and its programs. The website also provides tools and information that helps users better understand water resources issues in the area. The website serves as the SRWMO's alternative to a state-mandated newsletter.

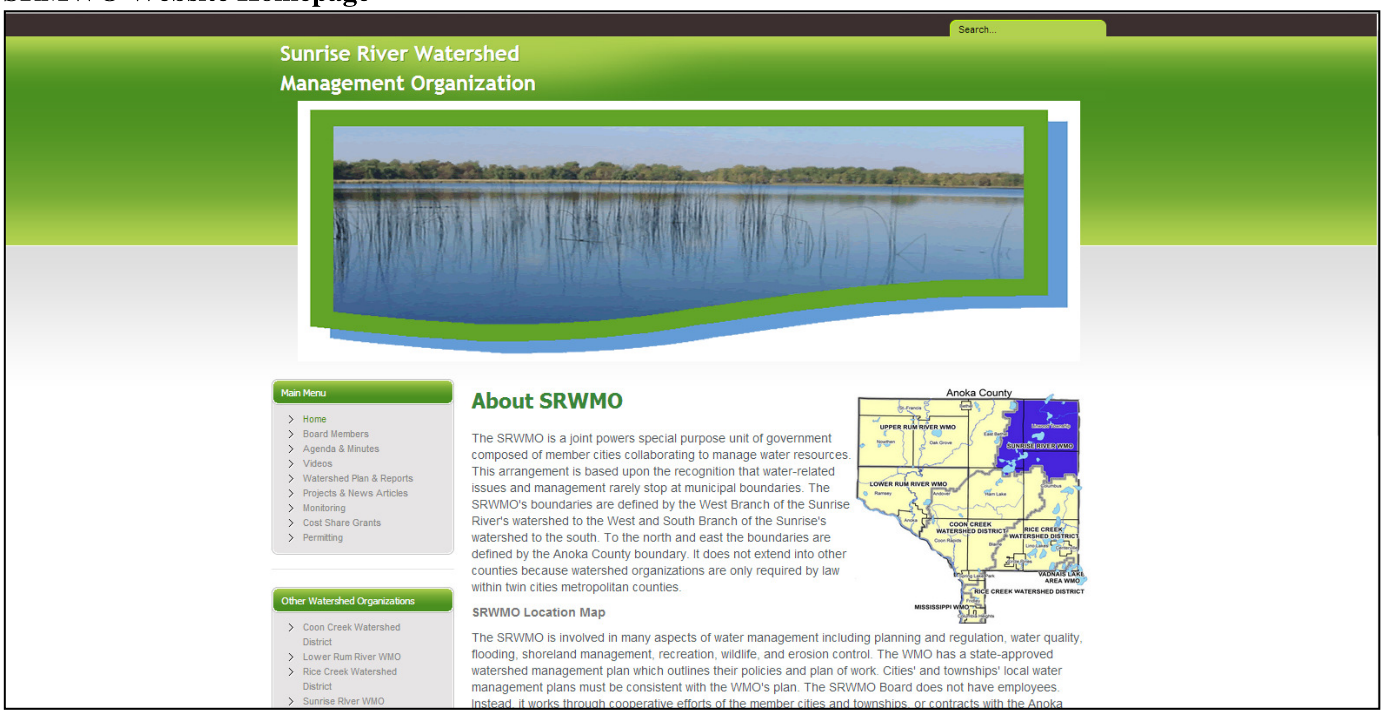
Location: www.SRWMO.org

Results: In 2013, the ACD re-launched the SRWMO website.

Regular website updates occurred throughout 2016. The SRWMO website contains information about both the SRWMO and about natural resources in the area.
Information about the SRWMO includes:

- a directory of board members,
- meeting minutes and agendas,
- the watershed management plan and information about plan updates,
- descriptions of work that the organization is directing,
- highlighted projects.

SRMWO Website Homepage



Grant Searches and Applications

Description: The Anoka Conservation District (ACD) partners with the SRWMO with the preparation of grant applications. Several projects in the SRWMO Watershed Management Plan need outside funding in order to be accomplished.

Purpose: To provide funding for high priority local projects that benefit water resources.

Results: Several grant opportunities were explored in 2016, however no grant applications were prepared. Recent successful grant applications have included the Ditch 20 Feasibility Study ($72,402) and Martin and Typo Lake Carp Barriers ($435,754).

Installation of the Martin and Typo Lake Carp Barriers was completed in 2016, and the grant is in the final stages of being wrapped up.

SRWMO Annual Report to BWSR and State Auditor

Description: The Sunrise River Watershed Management Organization (SRWMO) is required by law to submit an annual report to the Minnesota Board of Water and Soil Resources (BWSR), the state agency with oversight authorities. This report consists of an up-to-date listing of SRWMO Board members, activities related to implementing the SRWMO Watershed Management Plan, the status of municipal water plans, financial summaries, and other work results. The SRWMO bolsters the content of this report beyond the statutory requirements so that it also serves as a comprehensive annual report to SRWMO member communities. The report is due annually 120 days after the end of the SRWMO's fiscal year (April 30th).

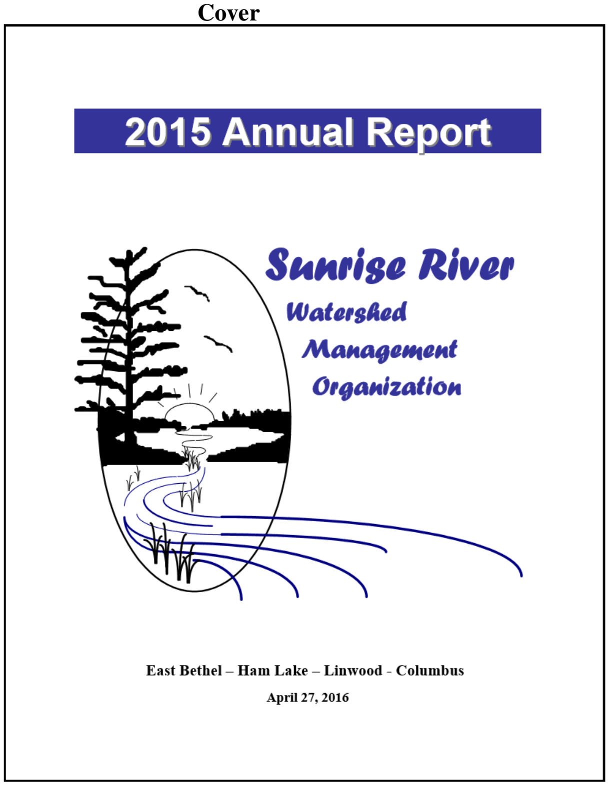
The SRWMO must also submit an annual financial report to the State Auditor. They accept unaudited financial reports for financial districts with annual revenues less than $185,000.

Purpose: To document progress toward implementing the SRWMO Watershed Management Plan and to provide transparency of government operations.

Locations: Watershed-wide

Results: Anoka Conservation District (ACD) assisted the SRWMO with preparation of an annual Sunrise River WMO Annual Report. The ACD drafted the report and a cover letter. After SRWMO Board review the final draft was forwarded to BWSR. A sufficient number of copies of the report were sent to each member community to ensure that each city council person and town board member would receive a copy. The report is available to the public on the SRWMO website.

Cover


2015 Annual Report

Sunrise River Watershed Management Organization

East Bethel – Ham Lake – Linwood - Columbus

April 27, 2016

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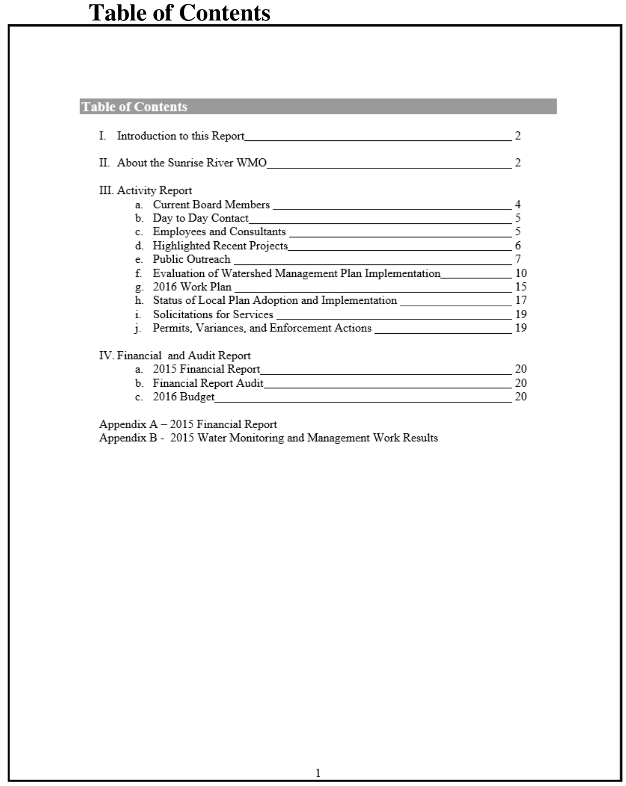
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On-call Administrative Services

Description: The Anoka Conservation District Water Resource Specialist provides limited, on-call administrative assistance to the SRWMO. Tasks are limited to those defined in a contractual agreement.

Purpose: To ensure day-to-day operations of the SRWMO are attended to between regular meetings.

Results: In 2016 a total of 39.5 hours of administrative assistance occurred as of December 31.

The following tasks were accomplished:

- Provided BWSR with information needed for the PRAP performance assessment of the WMO. Met with BWSR and the SRWMO to discuss draft findings. Prepared a letter to BWSR outlining corrections needed to the draft report.
- Responded to inquires from the Linwood Lake Association regarding the SRWMO, budgeting, and meetings.
- Fielded questions from the Wolens family about whether they are in the SRWMO or CCWD. Ultimately, the discussion is leading to a boundary amendment, as their property is currently in the wrong watershed organization.
- Prepared a resolution supporting a WMO boundary change. Discussed this item with Mike Bury of the lake association for feedback.
- Prepared a SRWMO display for Linwood Family Fun Day.
- Prepared 2017 budget, met with the SRWMO to edit, and forwarded the budget to the cities for ratification.
- Began preparation of the 2018 budget.
- Prepared a resolution regarding One Watershed One Plan and presented the concept to the SRWMO board.
- Completed a lobbying expenses report required by the State.
- Contacted all the member cities about whether to pursue changes to the joint powers agreement proposed by Ham Lake, received their feedback and reported to the SRWMO Board.
- Filled a City of East Bethel request for a map of the WMO.
- Delivered annual reports to the member cities.
- Forwarded an offer from FEMA and DNR for floodplain mapping services to member cities.
- Occasional inquiries from contractors and developers about any SRWMO permitting requirements.
- Answered Board member questions outside of meetings.
- Assist with meeting packet preparation.

Financial Summary

The 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. We do not, however, know specifically which expenses are attributed to monitoring which sites. 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.

Sunrise River Watershed Financial Summary

Sunrise River Watershed	WMO Asst (no charge)	Volunteer Precip	Reference Wetlands	Ob Well	Lake Level	Lake WQ	Stream Level	Stream WQ	SRWMO Admin/Grant Search	WMO Annual Rpts to State	SRWMO Outreach/Promo	WMO Website Maint	Martin/Typo Carp Barriers	Buckthorn Clean Sweep	Coon Lake Retrofits	Boot Lake Buckthorn	Ditch 20 Feasibilty	Total
Revenues																		
SRWMO	0	0	1725	0	1250	6600	1250	1400	2875	1100	500	505	8000	0	19675	0	2500	47379
State	0	0	0	240	0	0	0	0	0	0	0	0	50607	3847	7093	8669	9034	79490
Anoka Co. General Services	390	0	32	235	751	242	12	0	510	0	0	50	185	6057	1389	8789	110	18751
Anoka Conservation District	0	0	69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	69
County Ag Preserves/Projects	0	0	0	0	0	0	0	0	0	0	0	0	0	0	743	0	0	743
Service Fees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2500	2500
Regional/Local	0	0	48	0	0	557	0	0	0	0	0	0	0	0	2000	0	(0)	2605
BWSR Cons Delivery	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BWSR Capacity Funds	0	0	1834	0	0	0	0	0	0	0	0	0	12704	0	6211	0	0	20749
BWSR Cost Share TA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Metro ETA & AWQCP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6977	0	0	6977
Local Water Planning	0	367	911	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1278
TOTAL	390	367	4619	475	2001	7399	1262	1400	3385	1100	500	555	71496	9904	44088	17458	14144	180542
Expenses-																		
Capital Outlay/Equip	5	5	24	6	23	59	11	7	39	6	5	5	230	113	111	170	165	984
Personnel Salaries/Benefits	339	356	1771	413	1741	4370	810	501	2945	474	409	352	17186	8449	8254	12694	12288	73351
Overhead	25	26	130	30	128	321	60	37	217	35	30	26	1264	621	607	934	904	5395
Employee Training	2	2	10	2	10	25	5	3	17	3	2	2	97	48	46	71	69	413
Vehicle/Mileage	7	8	37	9	37	92	17	11	62	10	9	7	363	179	174	268	260	1551
Rent	12	13	63	15	62	156	29	18	105	17	15	13	614	302	295	454	439	2621
Program Participants	0	0	0	0	0	0	0	0	0	0	0	0	51430	0	31366	0	0	82795
Program Supplies	0	-42	2411	0	0	1777	2	265	0	0	0	191	311	192	3235	2866	20	11229
TOTAL	390	367	4447	475	2001	6801	933	840	3385	545	470	596	71496	9904	44088	17458	14144	178338

Recommendations

- **Pursue carp harvests now that Martin and Typo Lakes carp barriers are complete**. The SRWMO, ACD and Martin Lakers applied for a carp removal grant in January 2017.
- **Collaborate with the Linwood Lake Association.** The association has recently become more active, and has requested partnerships to manage aquatic invasive species and improve water quality.
- **Support the Ditch 20 (Data Creek) water quality improvement projects feasibility study.** The grant-funded project is led by the Anoka Conservation District. The study will be completed by 2018. Thereafter, construction of favored projects is anticipated.
- **Continue installation of stormwater retrofits around Coon and Martin Lakes** where completed studies have identified and ranked projects.
- **Continue efforts to secure grants.** A number of water quality improvement projects are being identified with more to come in 2017. Outside funding will be necessary for installation of most of these. These projects should be highly competitive for those grants.
- **Bolster lakeshore landscaping education efforts.** The SRWMO Watershed Management Plan sets a goal of three lakeshore restorations per year. Few are occurring. Fresh approaches should be welcomed.
- **Increase the use of web videos as an effective education and reporting tool.**
- **Continue the SRWMO cost share grant program** to encourage water quality projects. Consider refining the program to increase participation.
- **Encourage communities to report water quality projects to the SRWMO.** An overarching goal in the SRWMO Plan is to reduce phosphorus by 20% (986 lbs). State oversight agencies will evaluate efforts toward this goal. Both WMO and municipal project benefits should be counted.