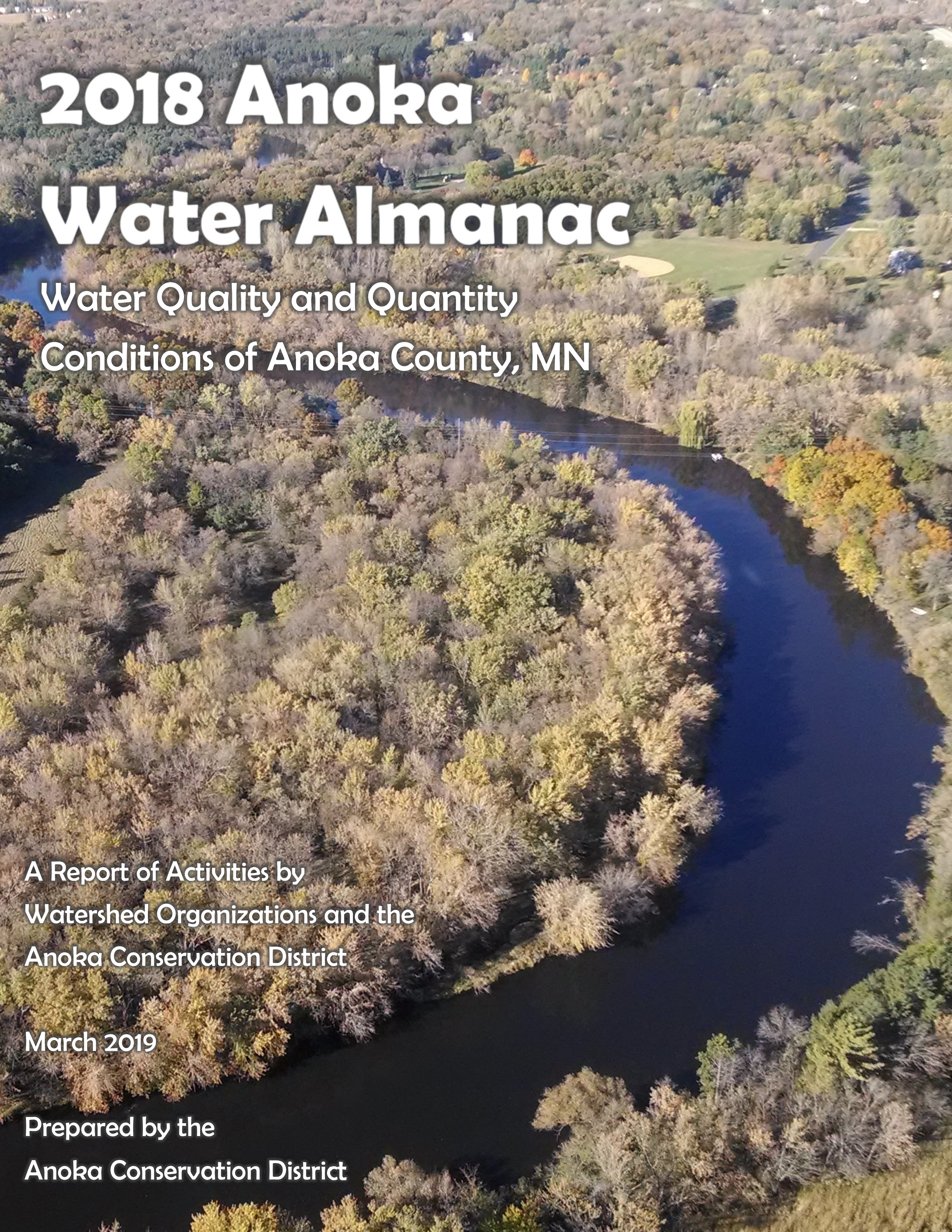
2018 Anoka Water Almanac

Water Quality and Quantity Conditions of Anoka County, MN



A Report of Activities by Watershed Organizations and the Anoka Conservation District

March 2019

Prepared by the
Anoka Conservation District

2018 ANOKA WATER ALMANAC

Water Quality & Quantity Conditions of Anoka County, Minnesota

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March 2019

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Digital copies of data in this report are available at www.AnokaSWCD.org

EXECUTIVE SUMMARY AND ORGANIZATION OF THIS REPORT

This report summarizes water resources management and monitoring work done as a cooperative effort between the Anoka Conservation District (ACD) and watershed districts or watershed management organizations. It includes information about lakes, streams, wetlands, precipitation, groundwater, and water quality improvement projects. The results of this work are presented on a watershed basis—this document serves as an annual report to each of the watershed organizations that have helped fund the work. Readers who are interested in a certain lake, stream or river should first determine which watershed it is located in, and then refer to the chapter corresponding to that watershed. The maps and county-wide summaries in Chapter 1 will help the reader determine if the information they are seeking is available and, if so, in which chapter to find it. In addition to county-wide summaries, Chapter 1 also provides methodologies used, explanations of terminology, and instruction on interpreting data.

The water resource management and monitoring work reported here include:

- Monitoring
  - precipitation,
  - lake levels,
  - lake water quality,
  - stream hydrology,
  - stream water quality,
  - stream benthic macroinvertebrates,
  - shallow groundwater levels in wetlands, and
  - groundwater levels in observation wells.
- Water quality improvement projects
  - projects designed, installed, or planned are briefly discussed in this report,
  - cost share grants for erosion correction, lakeshore restorations, and rain gardens, and
  - promotion of available grants for water quality improvement projects.
- Studies and analyses
  - stormwater retrofitting assessments,
  - upstream to downstream water quality analyses,
  - water quality trend analyses and
  - reference wetland multi-year summary analyses.
- Public education efforts
  - newsletters and mailings,
  - signage,
  - workshops,
  - web videos, and
  - websites.
- Other work done for watershed management organizations
  - reviews of local water plans,
  - grant searches and applications,
  - annual reports to the State, and
  - other administrative tasks.

While this report is perhaps the most comprehensive source of monitoring data on lakes, stream, rivers, groundwater, and wetlands in Anoka County, it is not the only source; nor is this report a summary of all work completed throughout Anoka County in 2018. Rather, it is a summary of work carried out by the Anoka Conservation District in conjunction with watershed organizations within the county. Furthermore, only work conducted during 2018 is presented in this almanac (although trend and similar analysis also include previous years' data). For results of work completed in past years, readers should refer to previous Water Almanacs. All data collected in 2018 and prior is available in digital format from the Anoka Conservation District. All applicable data is also submitted to state databases for wider availability; these include the MPCA's EQuIS water quality database, the DNR's lakefinder tool for lake levels, the DNR's Cooperative Groundwater Monitoring (CGM) tool for observation wells, and the State Climatology Office online precipitation database.

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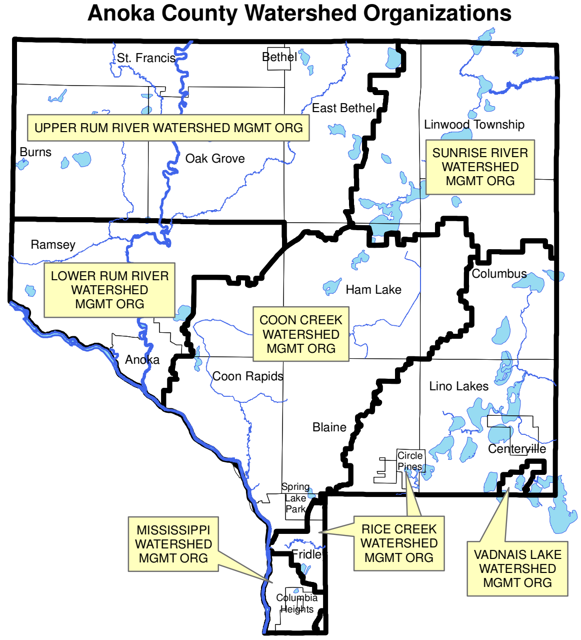
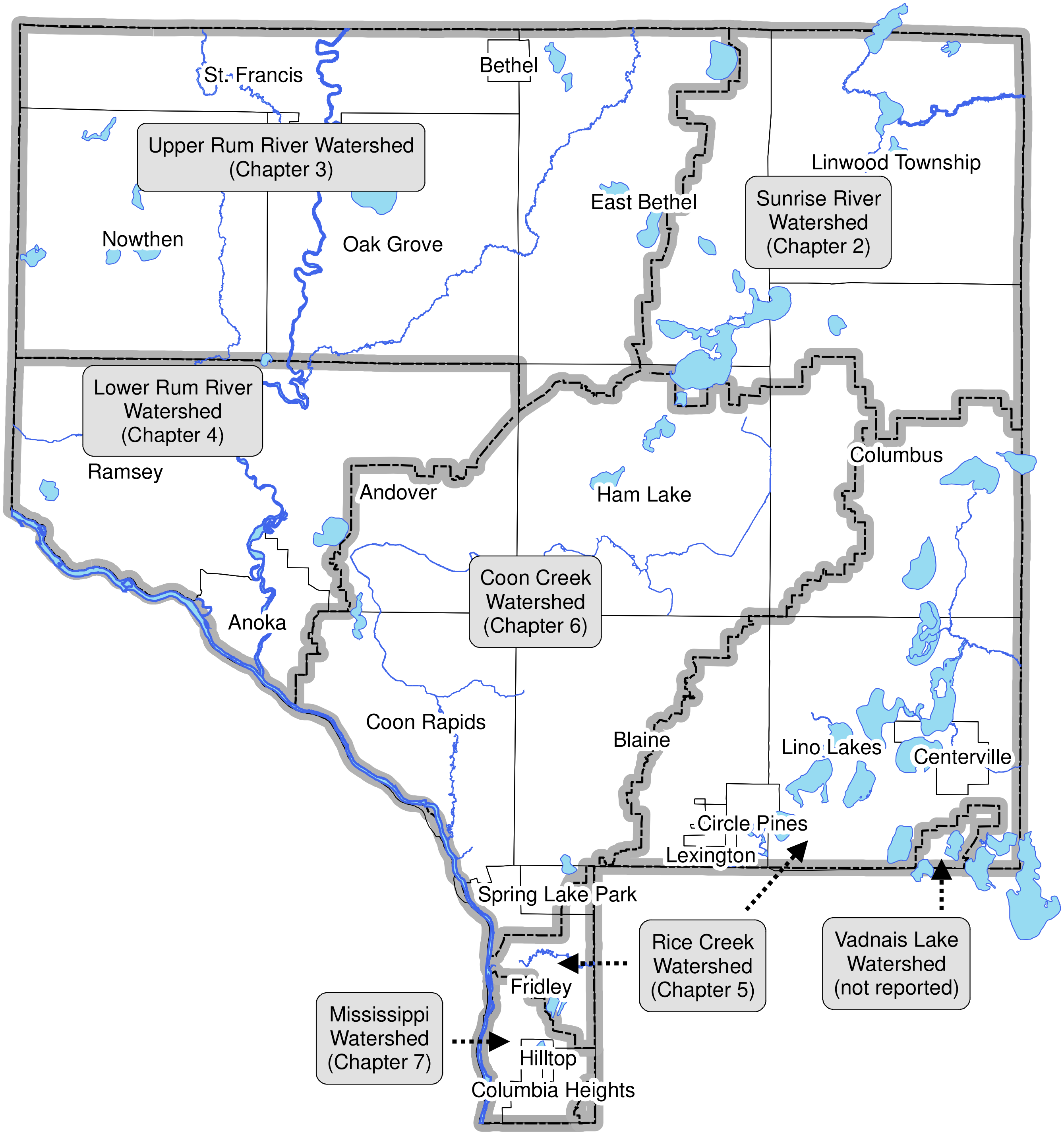
Anoka County Watershed Organizations



Chapter 1 – Primer



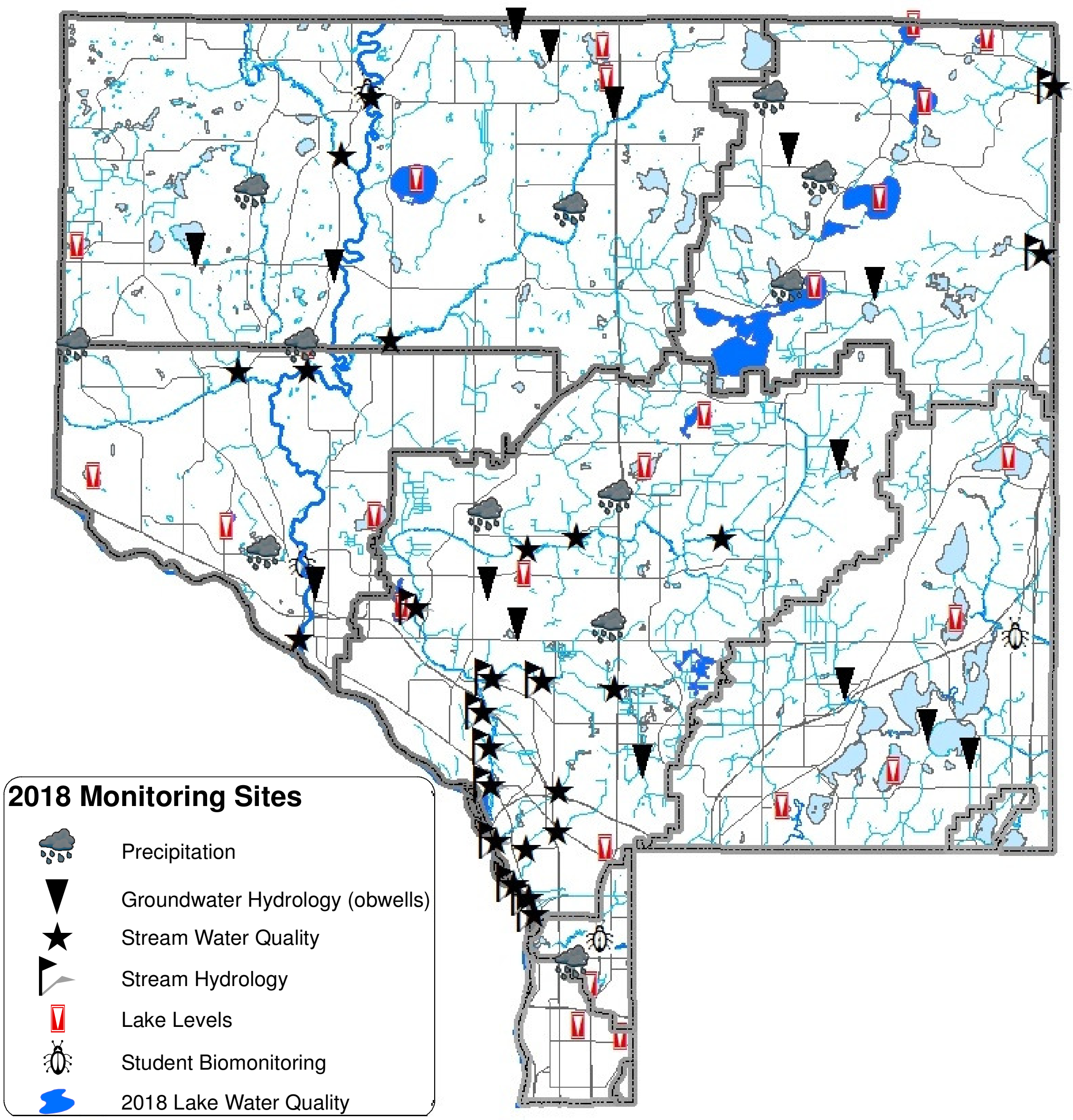
Contact Info: Anoka Conservation District
www.AnokaSWCD.org
763-434-2030

CHAPTER 1:
WATER RESOURCE MONITORING PRIMER

This report is an annual report to watershed organizations that helped fund water monitoring and management in cooperative efforts with the Anoka Conservation District. It also includes other water-related work carried out by the ACD without partners. This chapter provides an overview of the monitoring activities reported in later chapters, the methodologies used, and information that will help the reader interpret information found in later chapters. This report includes a variety of work aimed at managing water resources, including lakes, streams, rivers, wetlands, groundwater, and precipitation (see map below).

County-wide precipitation and groundwater hydrology data is presented in Chapter 1.

2018 Water Monitoring Sites



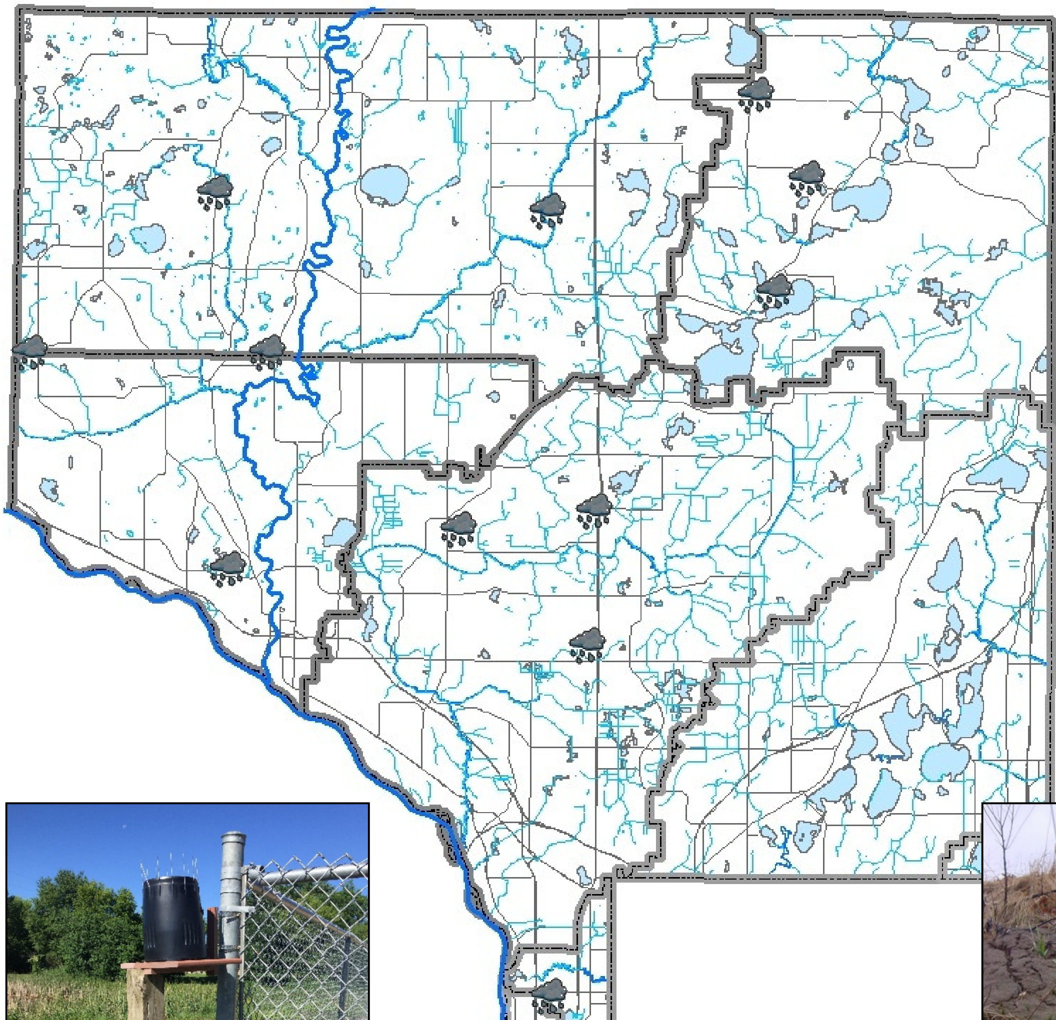
Precipitation

Precipitation data is useful for understanding the hydrology of water bodies, predicting flooding and groundwater limitations, and is needed to guide the use of special regulations that protect property and the environment in times of high or low water. Rainfall can vary substantially, even within one city.

The ACD coordinates a network of 12 rain gauges countywide, which are monitored by volunteers, including one at the ACD office. The volunteer-operated stations are cylinder-style rain gauges located at the volunteer's home. Total rainfall is read daily. All data collected by volunteers is submitted to the Minnesota State Office of Climatology where it is available to the public through http://climate.umn.edu.

A summary of county-wide data is provided on the following page.

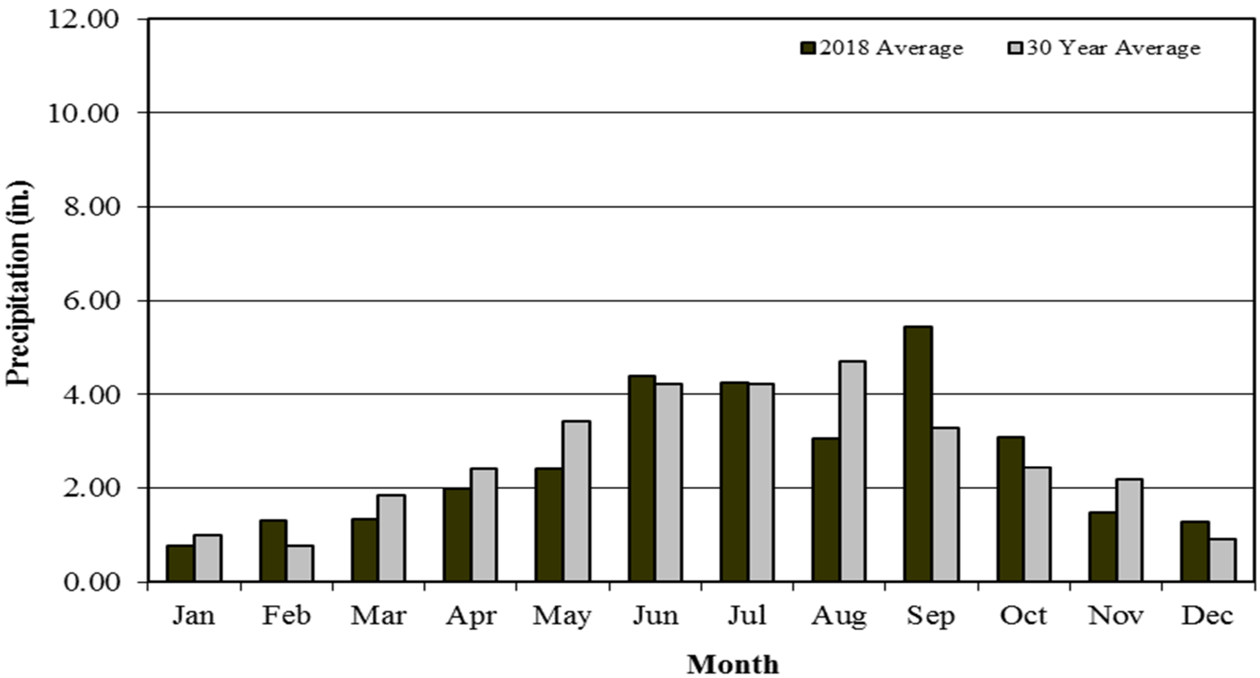
2018 Precipitation Monitoring Sites



Tipping bucket rain gauge.

Cylinder rain gauge.

2018 Anoka County Average Monthly Precipitation (average of all sites)



2018 Anoka County Monthly Precipitation at Each Monitoring Site

Location or Volunteer	City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total	Growing Season (May-Sept)
BYRG, DNR, and NWS data															
30N 24W 3 DNR	Fridley	1.29	1.53	1.66	2.77	2.44	4.23	4.35	3.9	5.58	2.96	1.53	1.72	33.96	20.50
30 24 14 BYRG	Fridley	0.82	1.27	1.19	1.84	2.68	3.54	3.44	3.53	6.87	2.92	1.44	1.32	30.86	20.06
32 22 14 BYRG	Columbus	0.99	1.32	1.02	2.02	3.18	4.37	6.42	3.25	6.67	3.07	1.31		33.62	23.89
32 24 23 NWS	Andover	0.46	1.19	2.33	2.15	1.87	5.00	4.09	2.58	5.04	2.35	1.42	*	28.48	18.58
34N 23W 36 BYRG	East Bethel	0.50	1.54	1.24	2.14	1.98		3.66	3.53	5.65	3.7	1.51		25.45	14.82
Cylinder rain gauges (read daily)															
N. Myhre	Andover	0.73	1.37	1.51	1.72	2.58	6.30	3.58	2.52	4.88	3.01	1.87	1.30	31.37	19.86
J. Rufsvold	Burns				*	1.45	4.94	3.21	2.00	4.78	2.86			19.24	16.38
J. Arzdorf	Blaine					3.07	4.14	3.96	2.82	4.78	3.36			22.13	18.77
P. Arzdorf	East Bethel					2.44	5.36	6.02	3.49	5.72	3.39			26.42	23.03
A. Mercil	East Bethel	0.37	0.68	0.65	1.59	2.87	2.74	6.26	2.57	5.29	*	1.82		24.84	19.73
K. Ackerman	Fridley	1.05	1.29	1.36	1.87	2.56	3.36	3.71	3.45	6.49	3.17	1.53		29.84	19.57
B. Myers	Linwood				1.81	2.94	3.93	3.16	3.04	5.49	2.80			23.17	18.56
B. Barkhoff	Nowthen						3.41	3.02	2.35	5.08	3.30			17.16	13.86
S. Mizell	Ramsey					2.00	4.83							6.83	6.83
ACD Office	Ham Lake			*	*	1.91	5.94	5.73	2.99	5.79	3.50	*		25.86	22.36
Y. Lyrenmann	Ramsey				*	2.04	3.73	3.99	3.61	3.50	3.04	1.16		21.07	16.87
S. LeMay	East Bethel	0.66	1.51	1.02	1.92	2.63	4.51	3.53	3.52	5.46	3.00	1.05	0.78	29.59	19.65
2018 Average	County-wide	0.76	1.30	1.33	1.98	2.42	4.40	4.26	3.07	5.44	3.10	1.46	1.28	30.80	19.58
30 Year Average	Cedar	0.99	0.76	1.84	2.40	3.43	4.22	4.21	4.70	3.29	2.44	2.18	0.90	31.36	19.85

Precipitation as snow is given in melted equivalents.

*Incomplete monthly data not included in averages

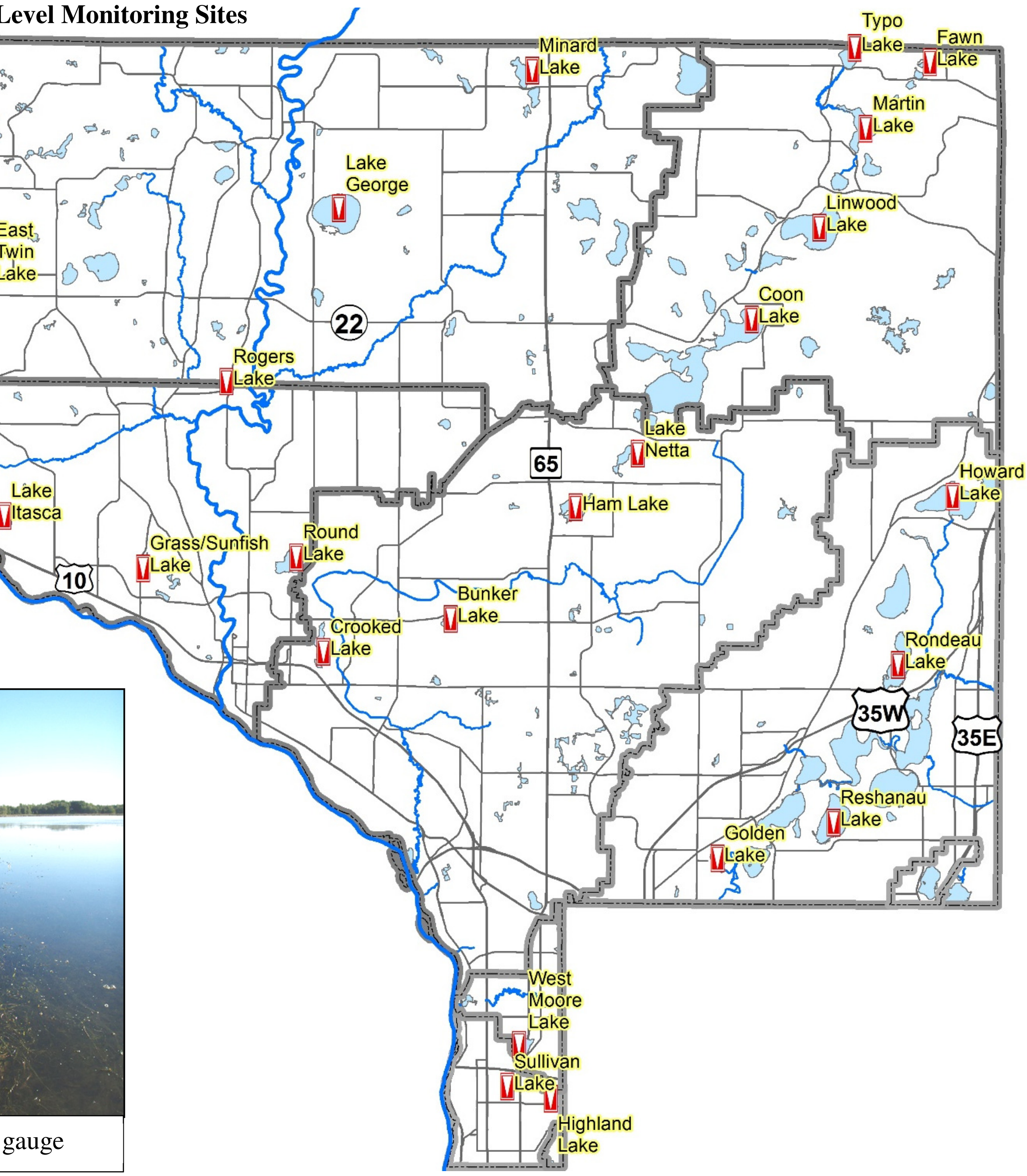
Lake Levels

Long-term lake level records are useful for regulatory decision-making, building/development decisions, lake hydrology manipulation decisions, and investigation of possible non-natural impacts on lake levels. ACD coordinates volunteers who monitor water levels on 25 lakes, with one additional lake monitored by continuous data logging equipment.

An enamel gauge is installed in each lake and surveyed so that readings coincide with sea level elevations. Each gauge is read weekly. The ACD reports all lake level data to the MN DNR, where it is posted on their website (www.dnr.mn.us.state\lakefind\index.html), along with other information about each lake.

Results of lake level monitoring are separated by watershed in the following chapters.

2018 Lake Level Monitoring Sites



Lake level gauge

Stream Hydrology

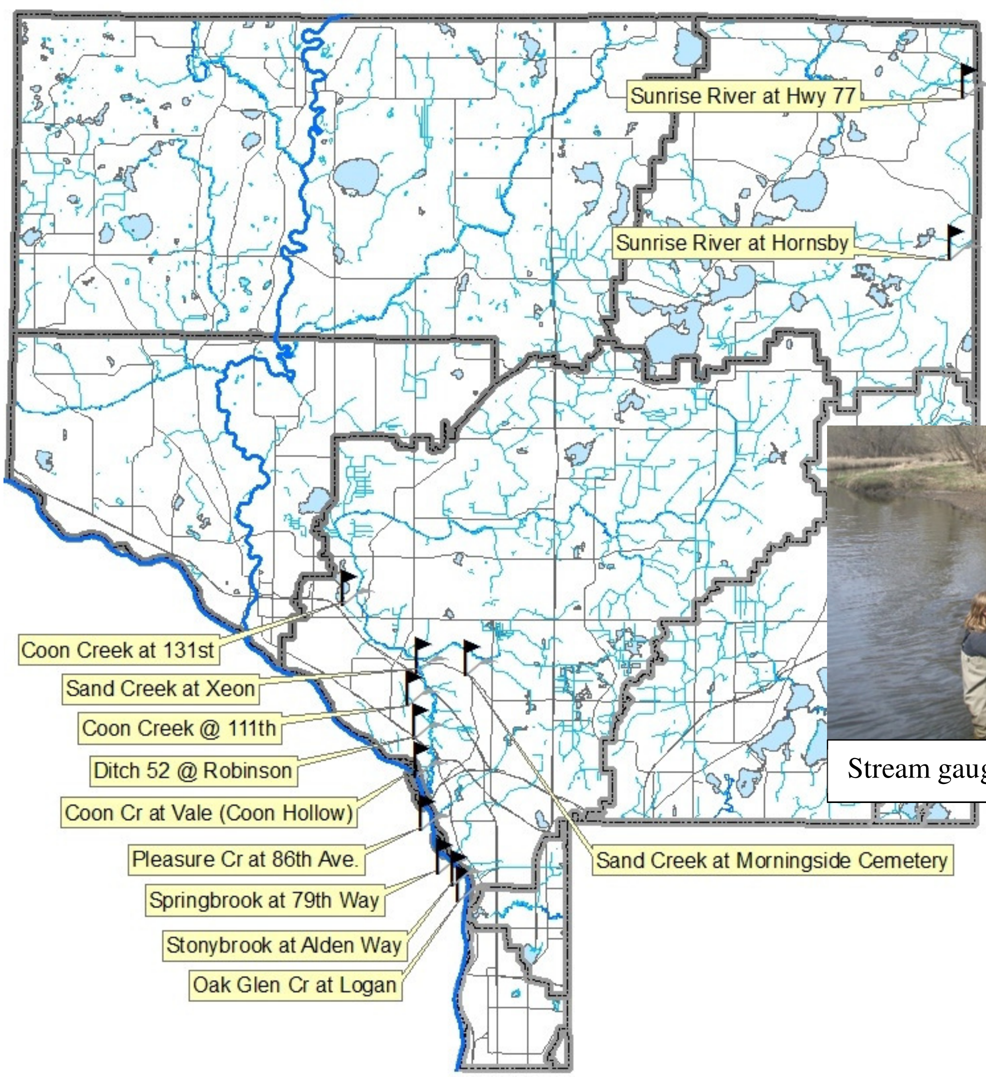
Hydrology is the study of water quantity and movement. Records of the quantity of water flowing in a stream helps engineers and natural resource managers better understand the effects of rain events, land development and storm water management. This information is also often paired with water quality monitoring and used to calculate pollutant loadings, which are used in computer models and water pollution regulatory determinations.

The ACD monitored hydrology at 12 stream sites in 2018. Each site is equipped with an electronic gauge that records water levels every hour, except for two sites where levels were recorded every 15 minutes. These gauges are surveyed and calibrated so that stream water level is measured in feet above sea level.

Rating curves—a known mathematical relationship between water level and flow such that one can be calculated from the other—have been developed for some sites, including 3 new rating curves developed this year. The information gained from the stream hydrology monitoring sites is used by the ACD, watershed management organizations, watershed districts, townships, cities, and others.

Results of stream hydrology monitoring are separated by watershed in the following chapters.

2018 Stream Hydrology Monitoring Sites



Stream gauge setup.

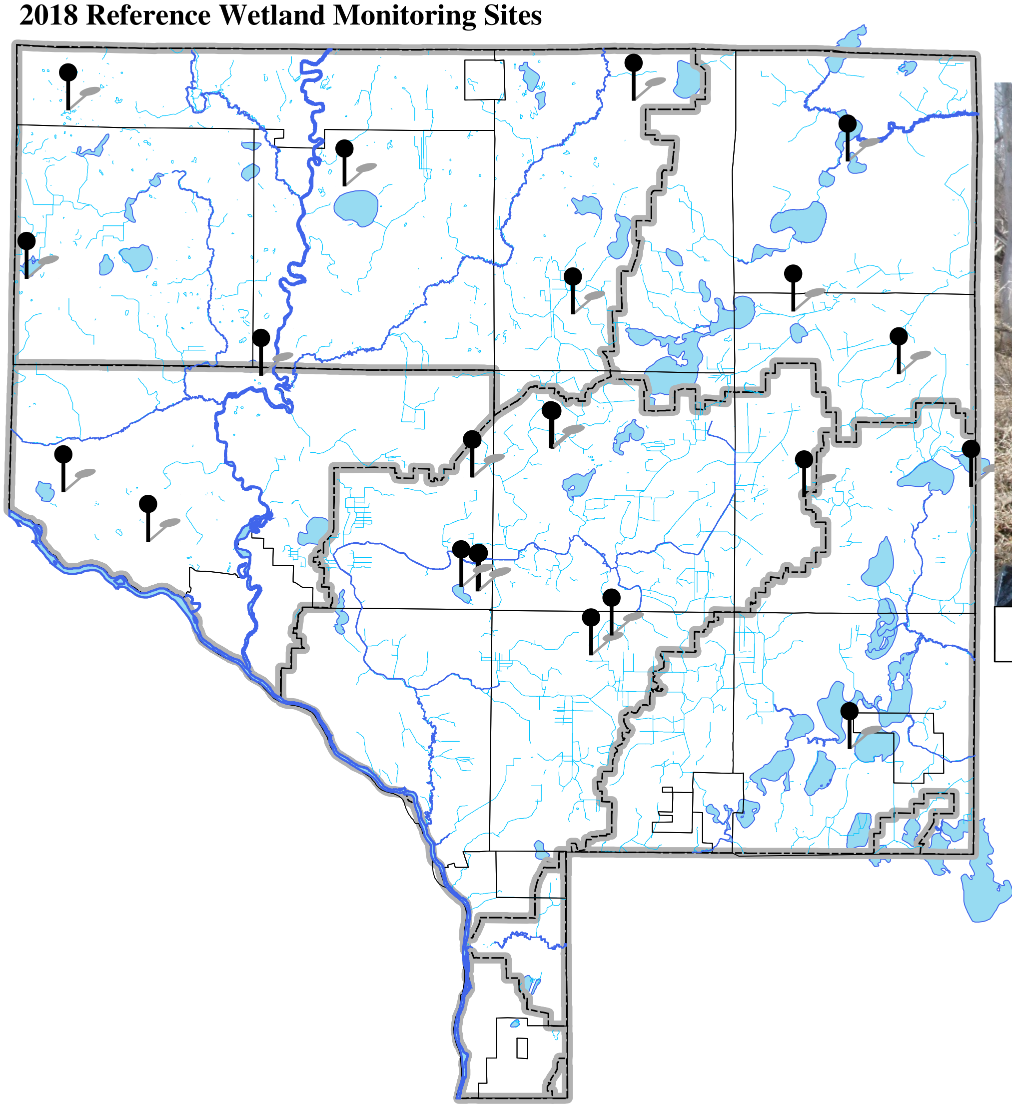
Wetland Hydrology

Wetland regulations are often focused upon determining whether an area is, or is not, a wetland. This is difficult at times because most wetlands are not continually wet, especially at the surface. In order to facilitate fair, accurate wetland determinations the ACD monitors 19 wetlands throughout the county that serve as a reference of conditions county-wide, and are thus called reference wetlands. Electronic monitoring wells are used to measure subsurface water levels at the wetland edge every four hours. This hydrologic information, along with examination of the vegetation and soils, aids in accurate wetland determinations and delineations. These reference wetlands represent several wetland types and most have been monitored for 10+ years.

Reference wetland data provide insights into shallow groundwater hydrology trends. This can be useful for a variety of purposes from flood predictions to indices of drought severity. There are concerns locally that shallow aquifers are being drawn down and wetland data can help speak to this.

Results of wetland hydrology monitoring are separated by watershed in the following chapters. The Coon Creek Watershed chapter includes a multi-year and most recent year analysis of all the wetlands.

2018 Reference Wetland Monitoring Sites



Wetland gauge deploy.

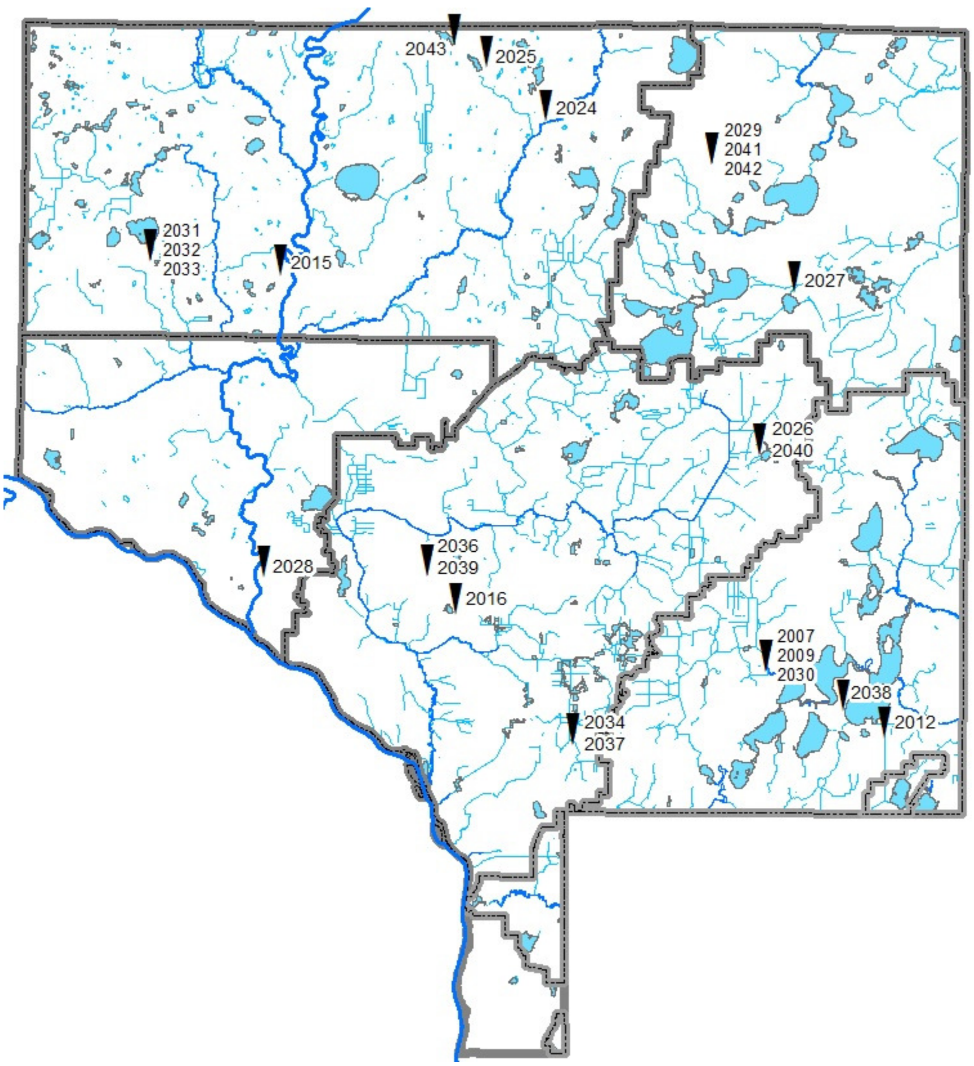
Groundwater Hydrology

The Minnesota Department of Natural Resources (MN DNR) and the ACD are interested in understanding Minnesota's groundwater quantity and flow. The MN DNR maintains a network of groundwater observation wells across the state. The ACD is contracted to take water level readings at 24 wells in Anoka County and to download continuous loggers quarterly. At most sites, the MN DNR now has automated devices taking continuous water level readings at more frequent intervals. The MN DNR incorporates these data into statewide and national databases that aid in groundwater mapping. The data are reported to the MN DNR and are available on their web site http://www.dnr.state.mn.us/waters/groundwater_section/obwell/index.html

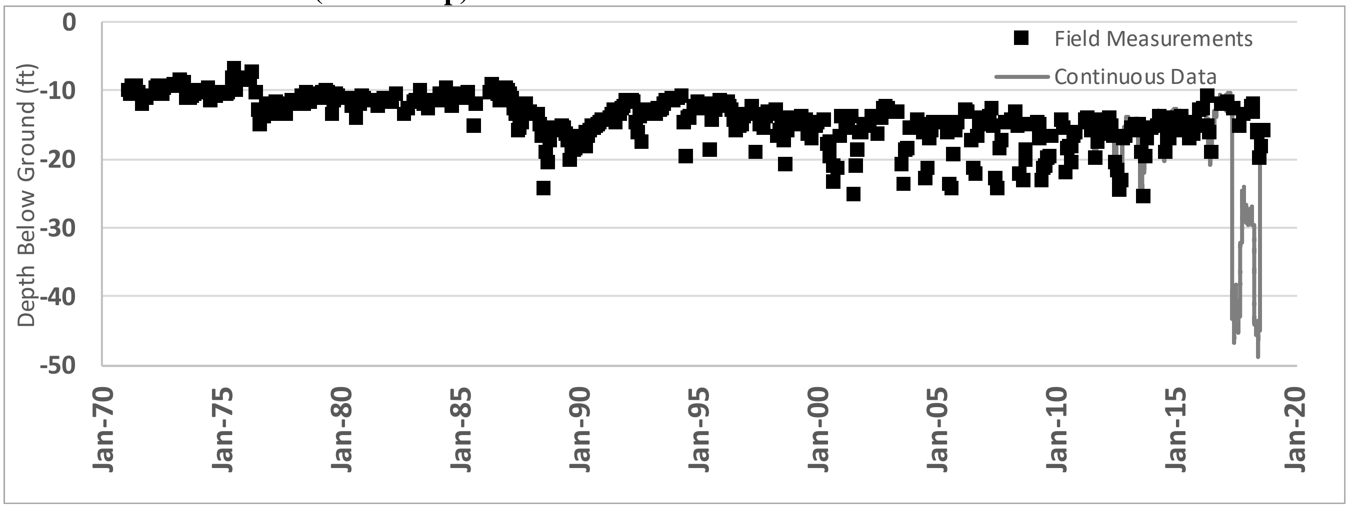
These deep groundwater wells are not as sensitive to precipitation as other hydrologic systems such as wetlands and streams, but rather respond to longer term trends.

The charts on the following pages show groundwater levels hand measured by ACD through 2018 for each well. These results are not presented elsewhere in this report. Raw data can be downloaded from the MN DNR website, as well as continuous data from wells with data loggers installed. ACD still hand measures wells with data loggers periodically to ensure accuracy.

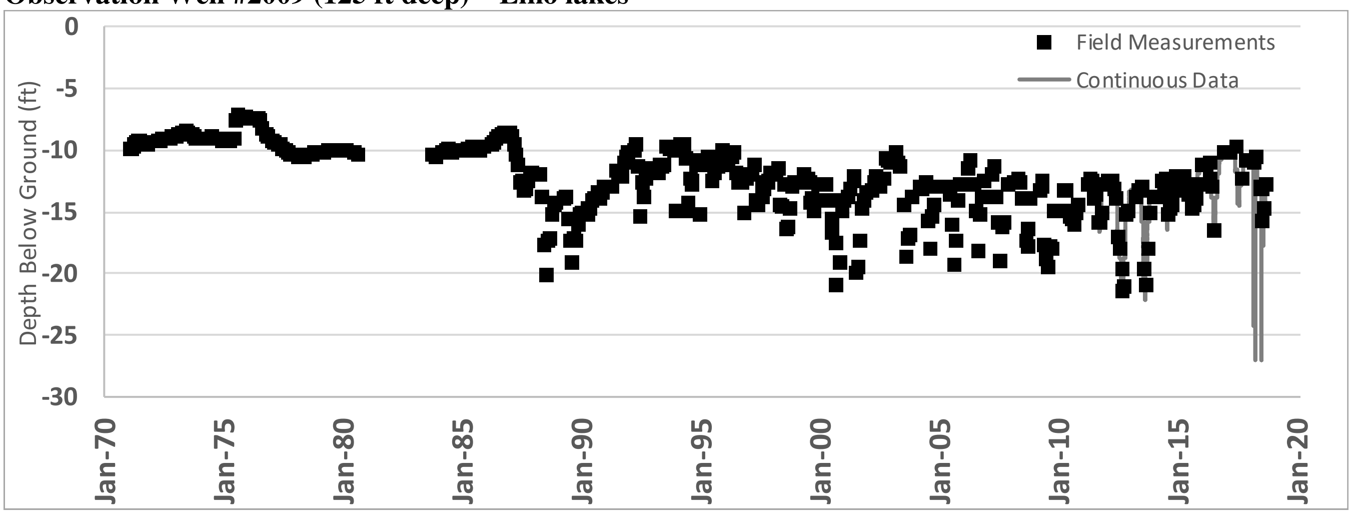
2018 Groundwater Observation Well Sites and Well ID Numbers



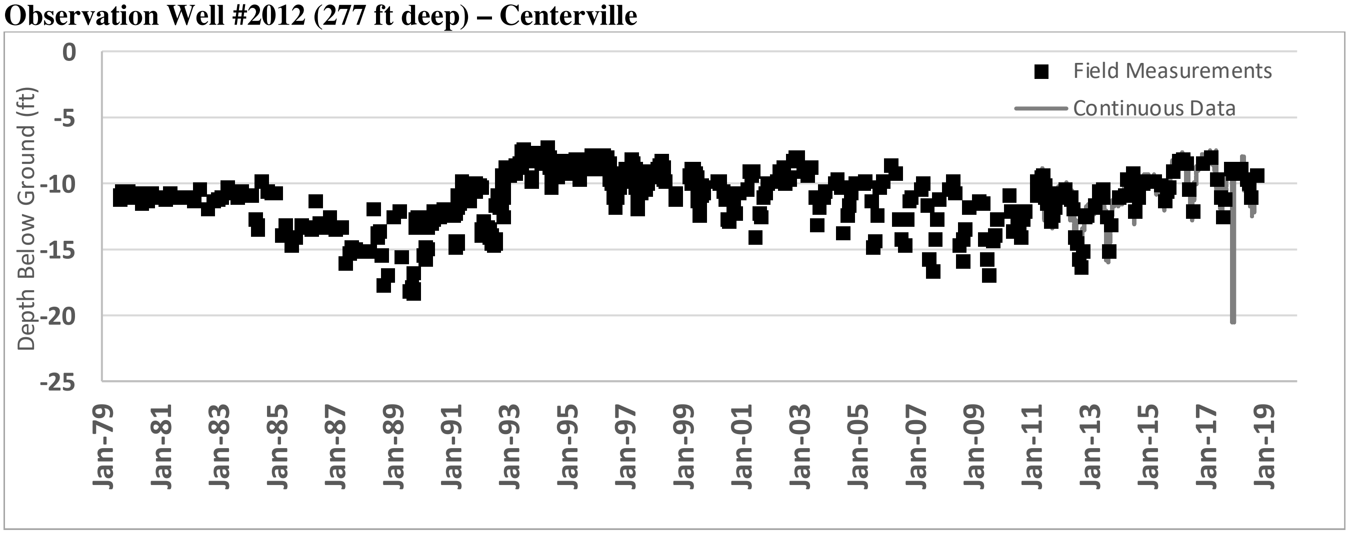
Observation Well #2007 (270 ft deep)—Lino Lakes



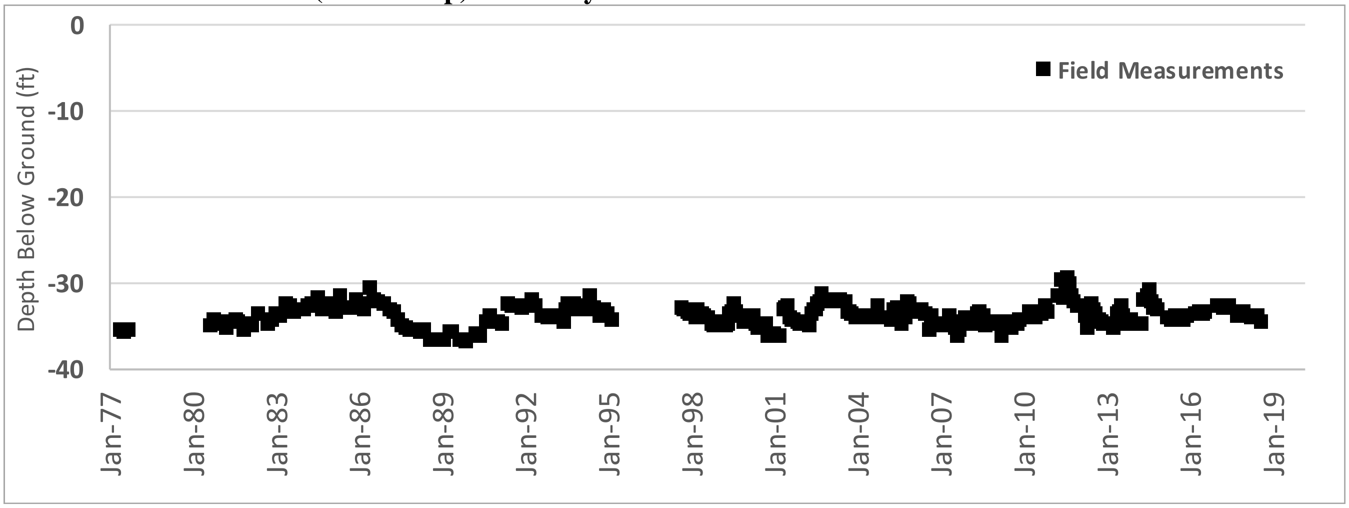
Observation Well #2009 (125 ft deep)—Lino lakes



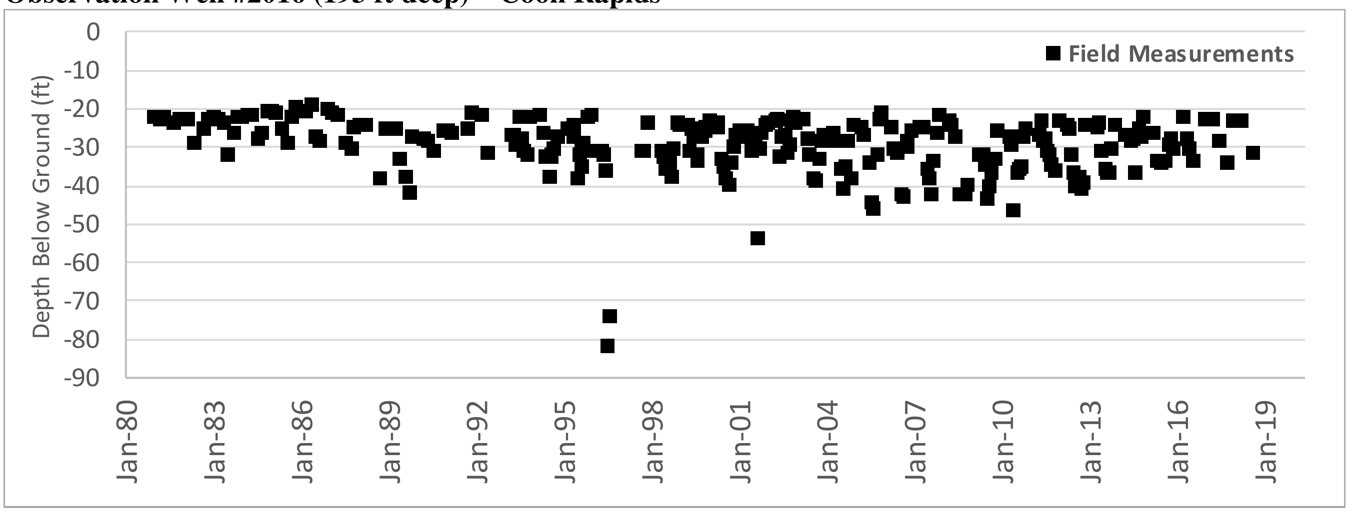
Observation Well #2012 (277 ft deep) – Centerville



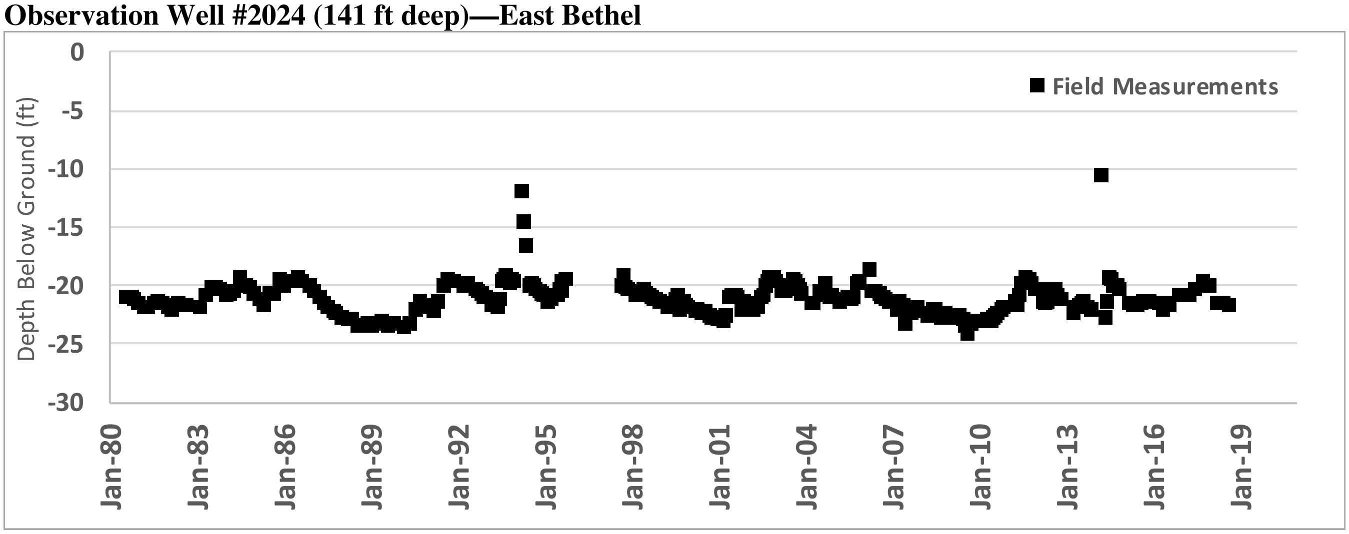
Observation Well #2015 (280 ft deep)—Ramsey



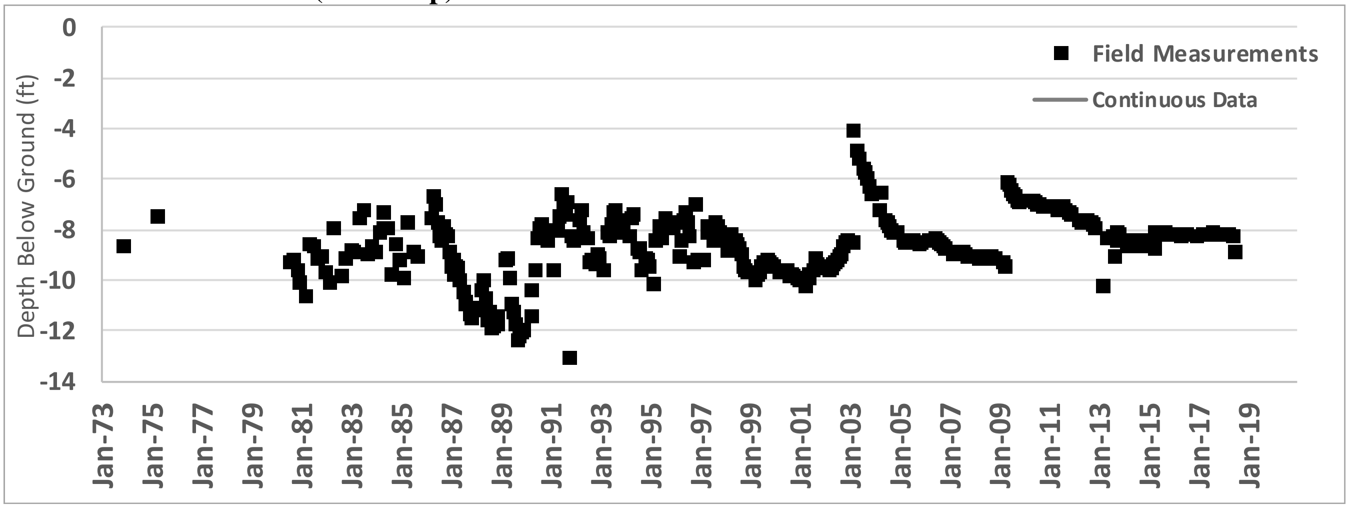
Observation Well #2016 (193 ft deep)—Coon Rapids



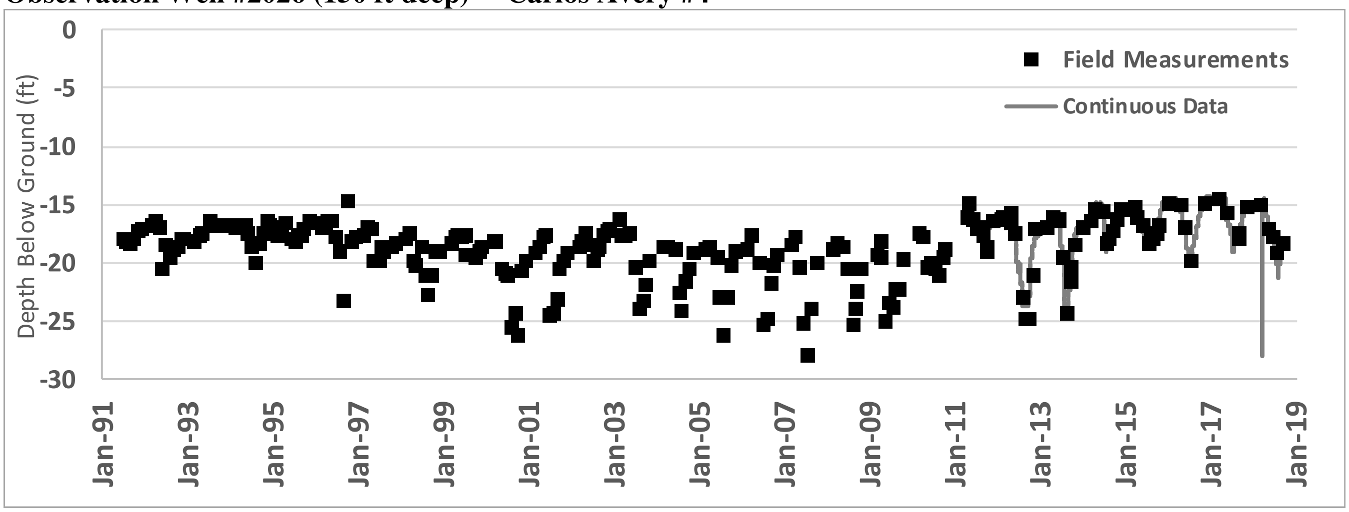
Observation Well #2024 (141 ft deep)—East Bethel



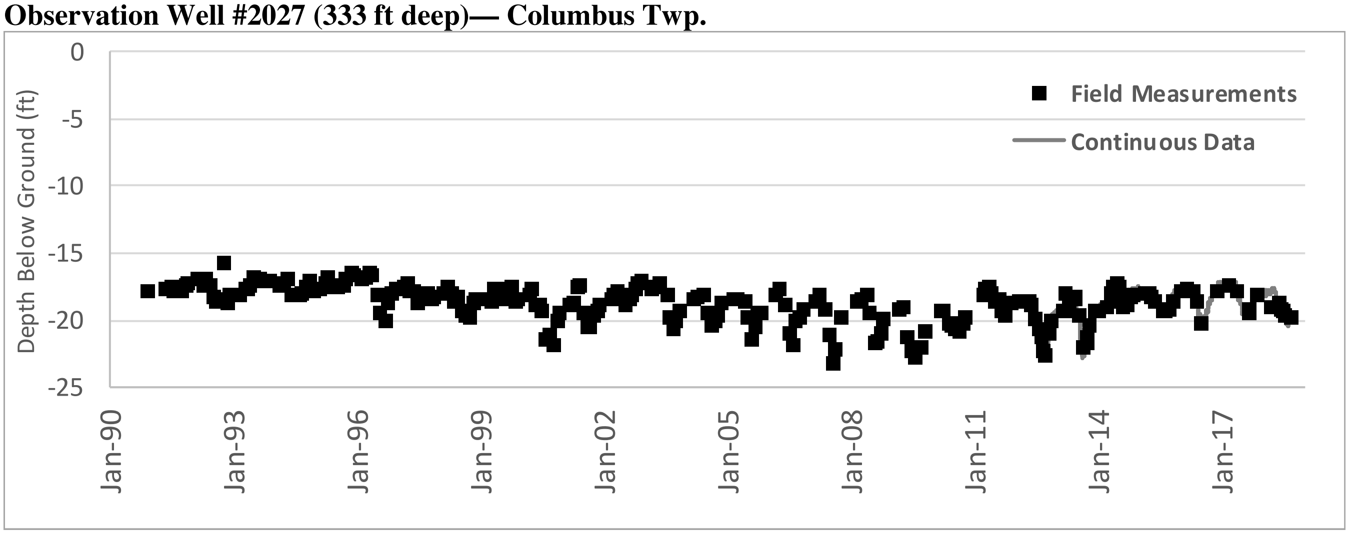
Observation Well #2025 (21 ft deep)—Bethel



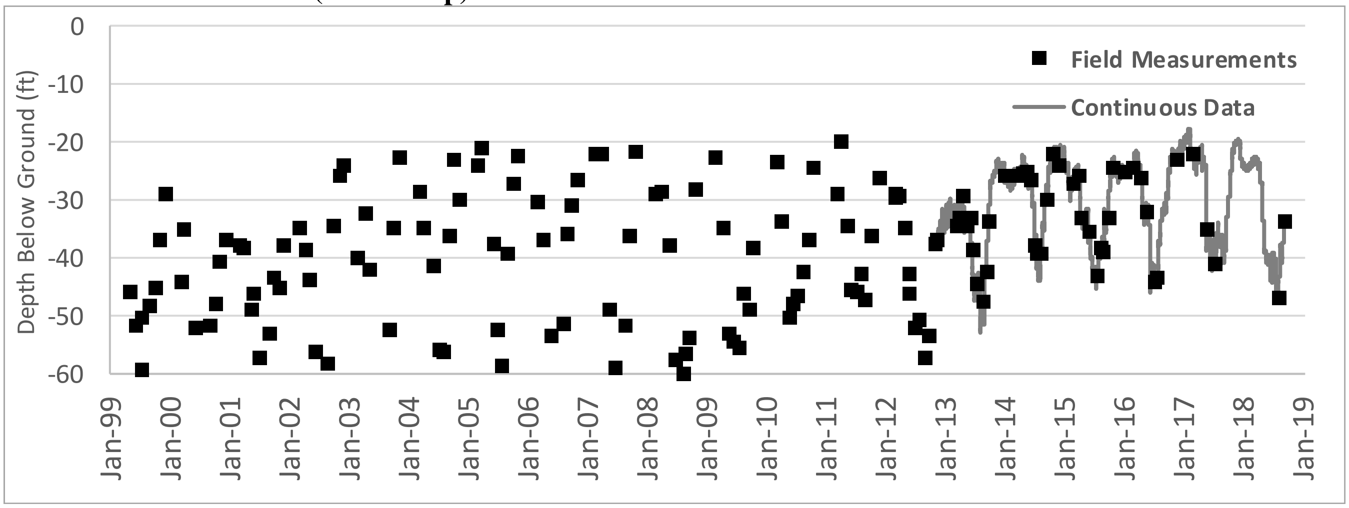
Observation Well #2026 (150 ft deep)— Carlos Avery #4



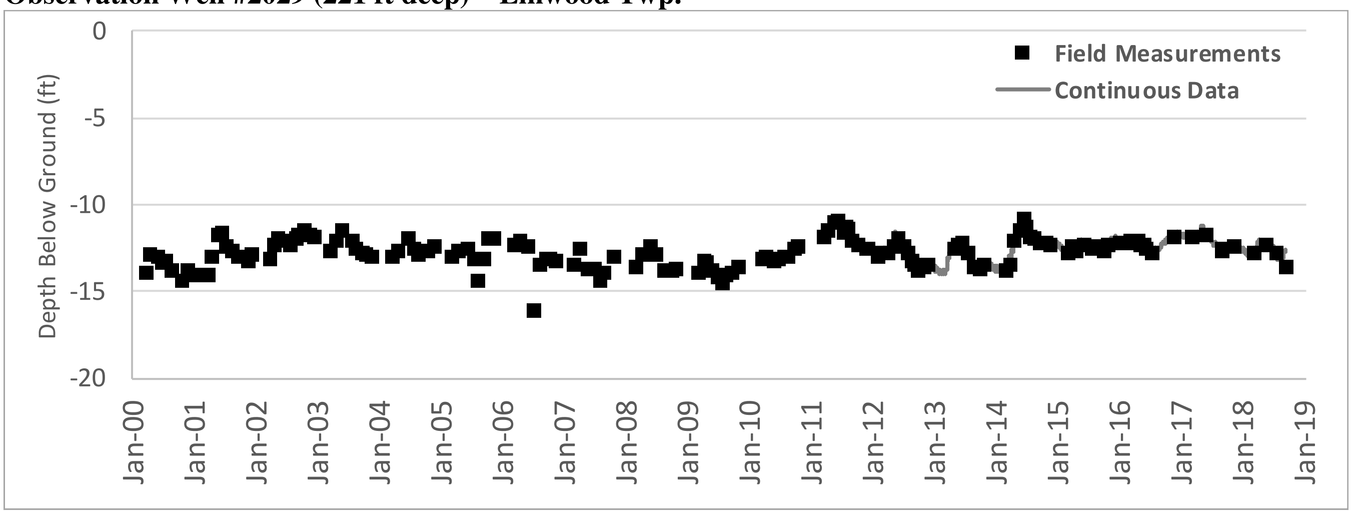
Observation Well #2027 (333 ft deep)— Columbus Twp.



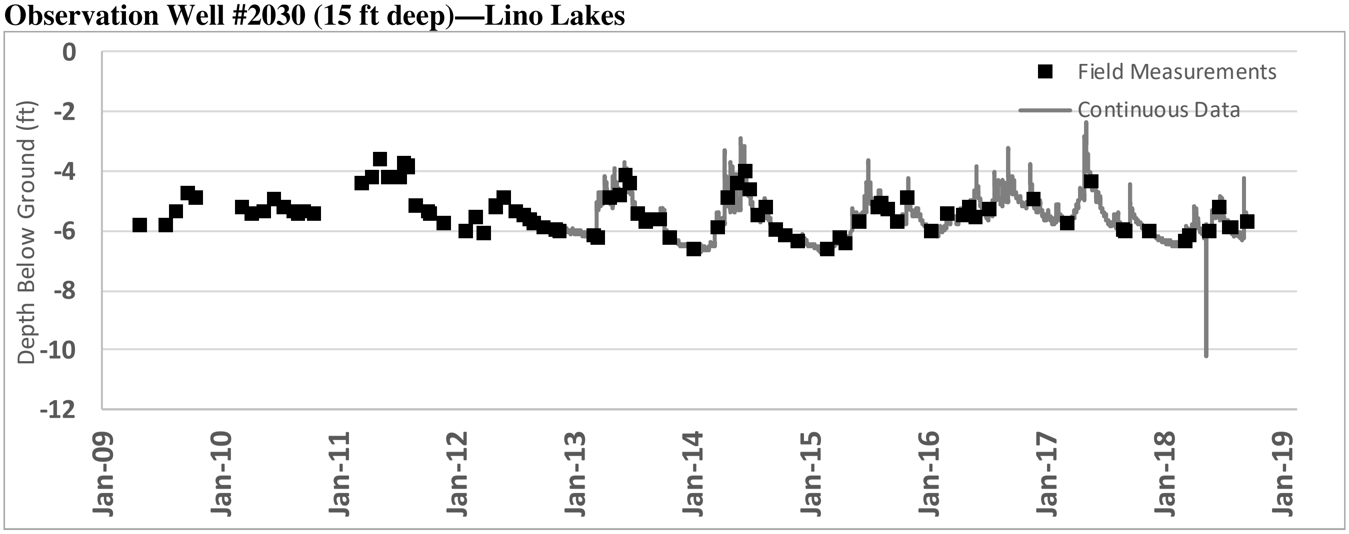
Observation Well #2028 (510 ft deep)—Anoka



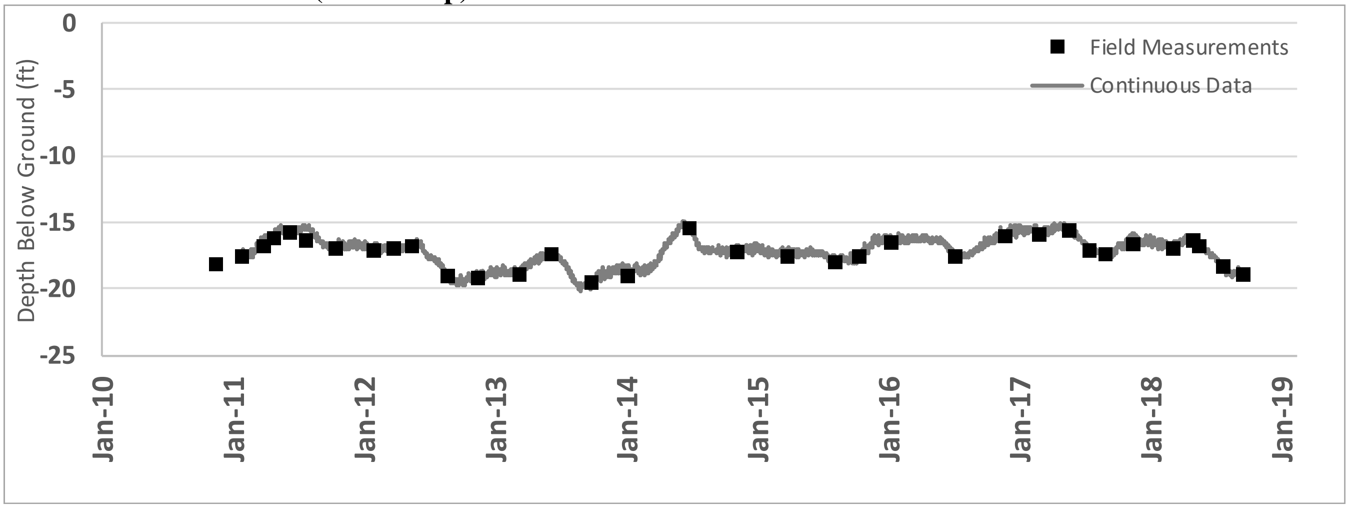
Observation Well #2029 (221 ft deep)—Linwood Twp.



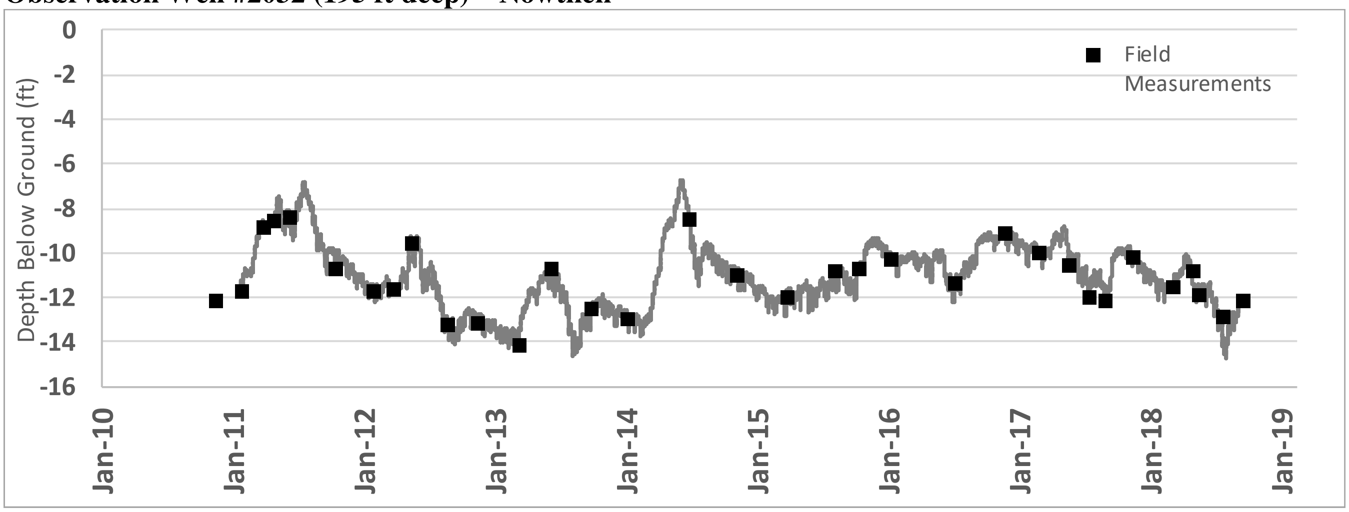
Observation Well #2030 (15 ft deep)—Lino Lakes



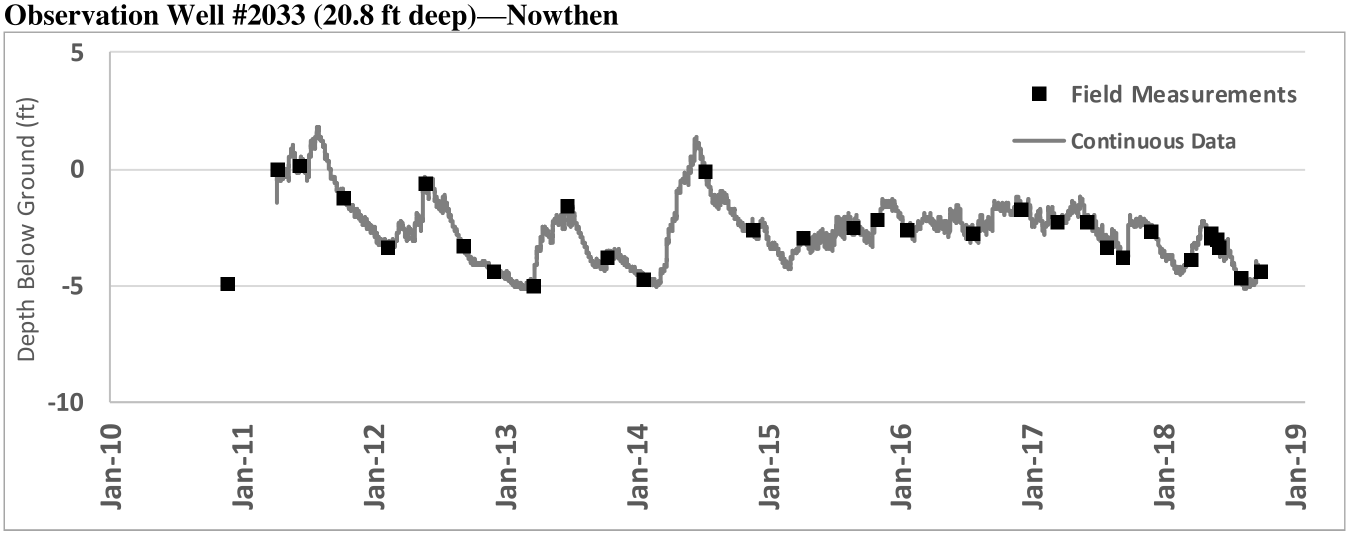
Observation Well #2031 (410 ft deep)—Nowthen



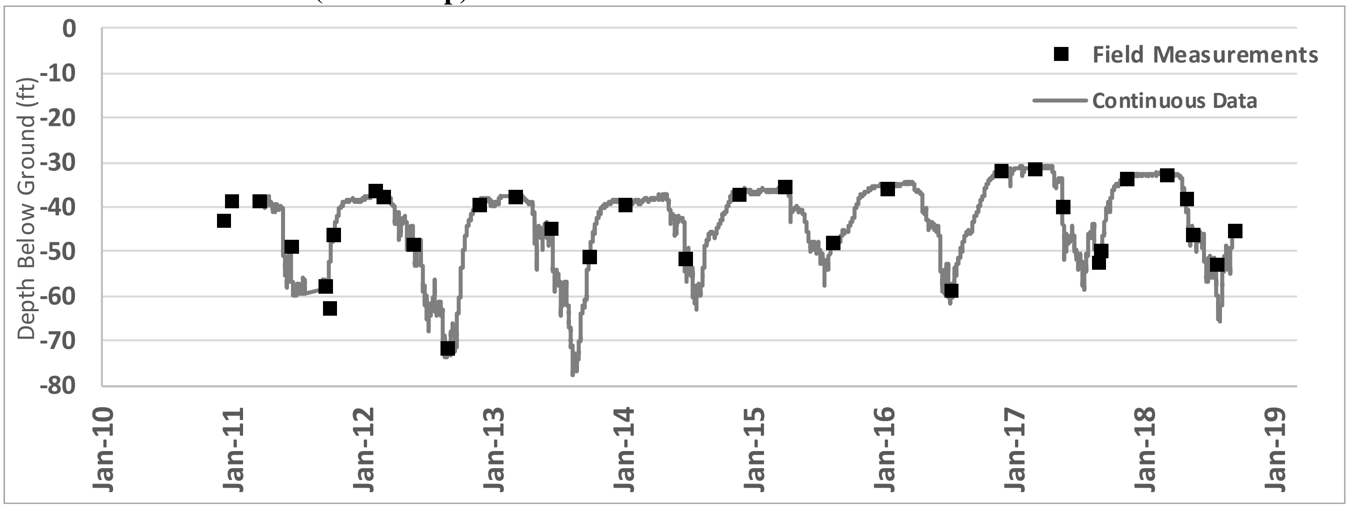
Observation Well #2032 (195 ft deep)—Nowthen



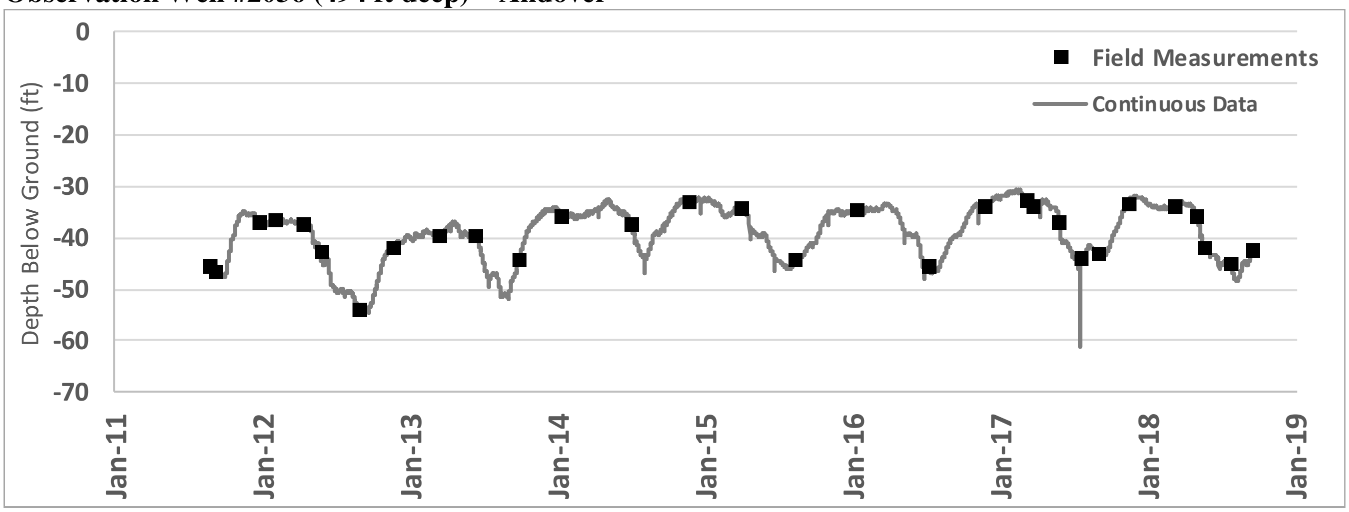
Observation Well #2033 (20.8 ft deep)—Nowthen



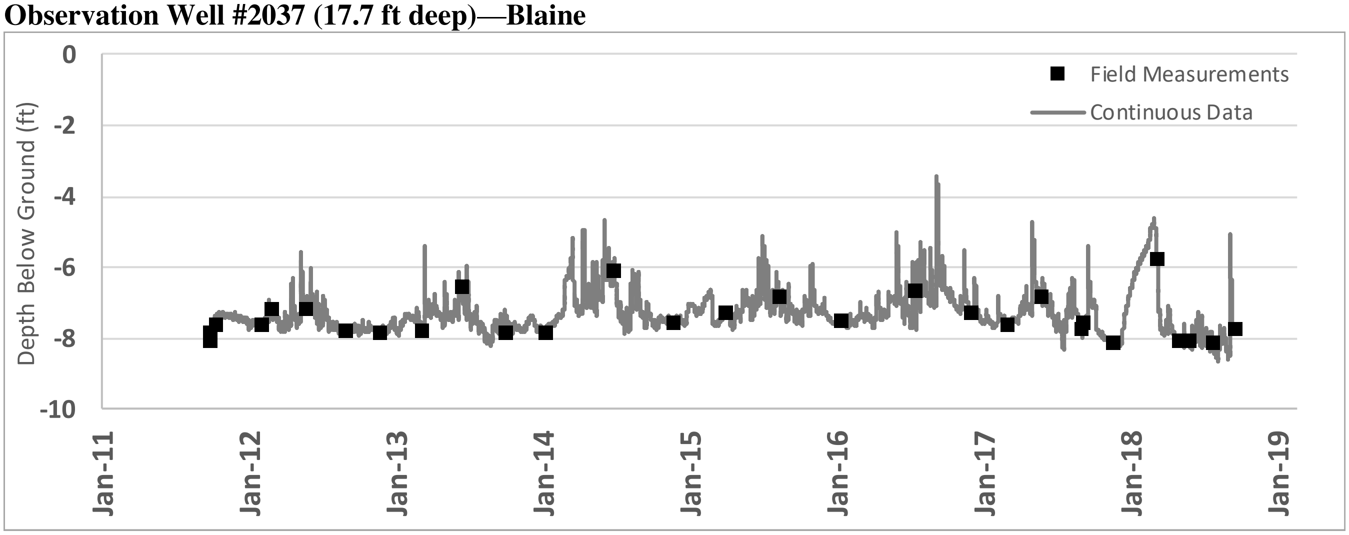
Observation Well #2034 (222 ft deep)—Blaine



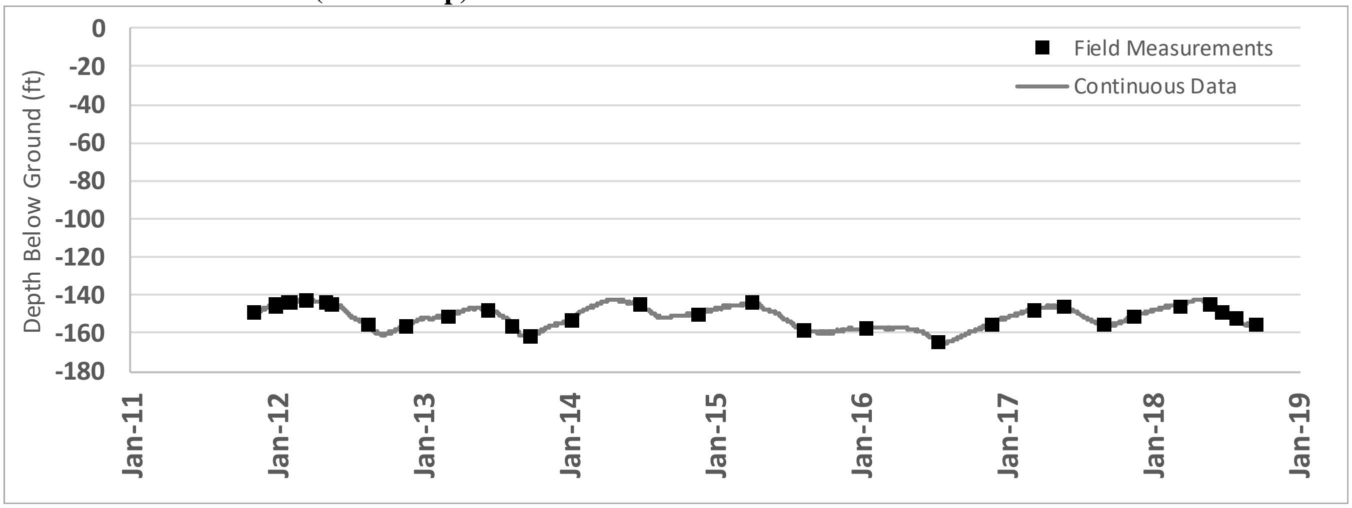
Observation Well #2036 (494 ft deep)—Andover



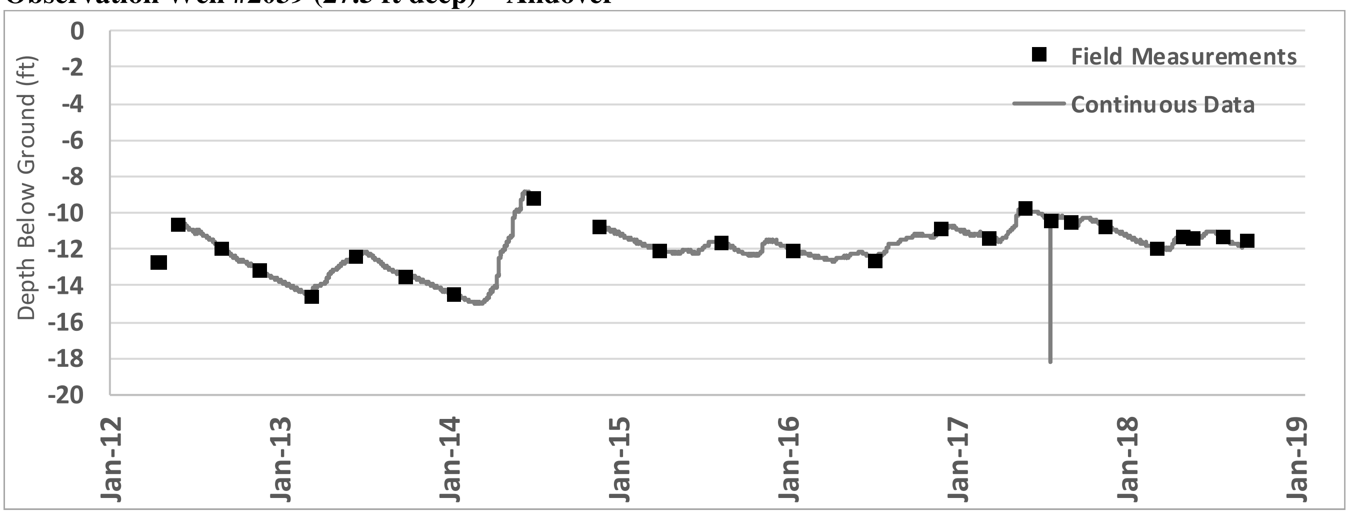
Observation Well #2037 (17.7 ft deep)—Blaine



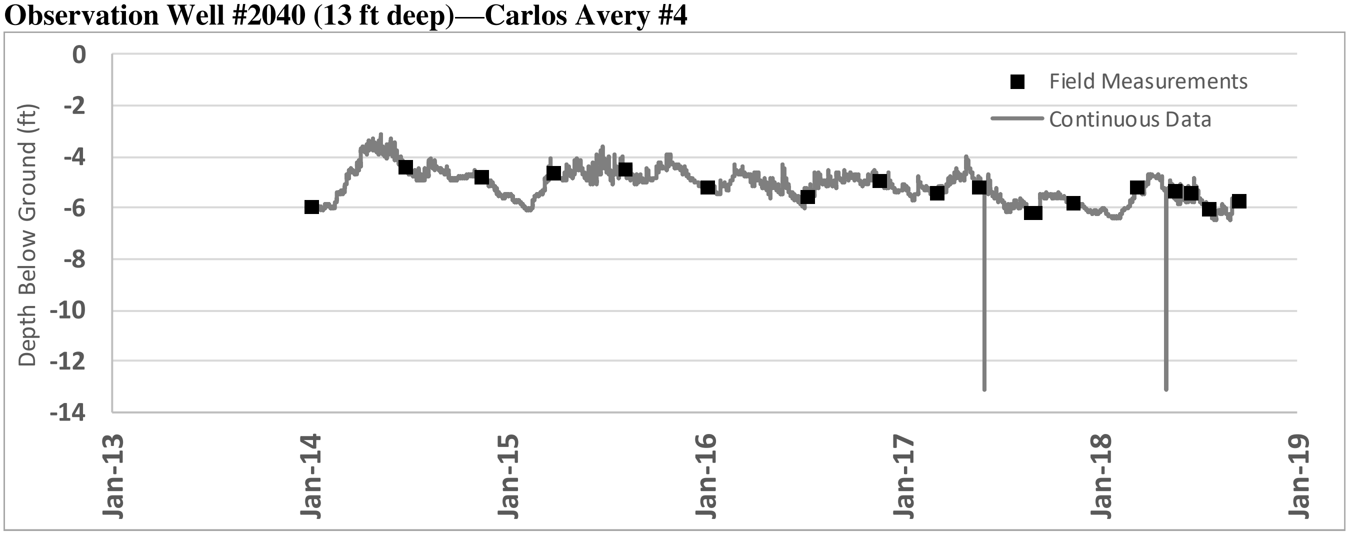
Observation Well #2038 (810 ft deep)—Lino Lakes



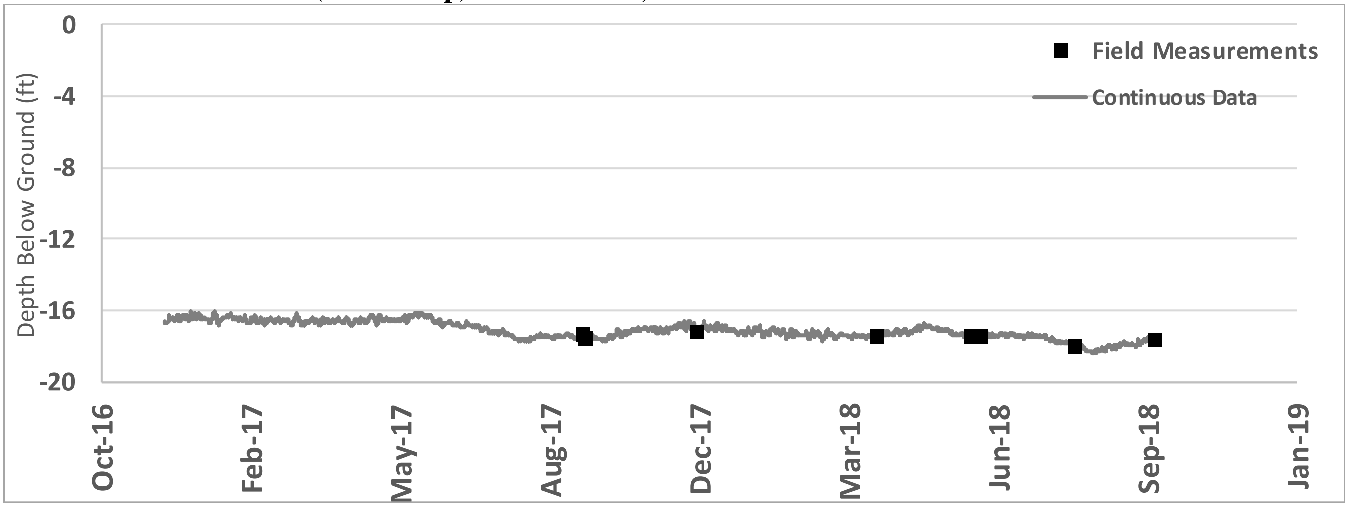
Observation Well #2039 (27.5 ft deep)—Andover



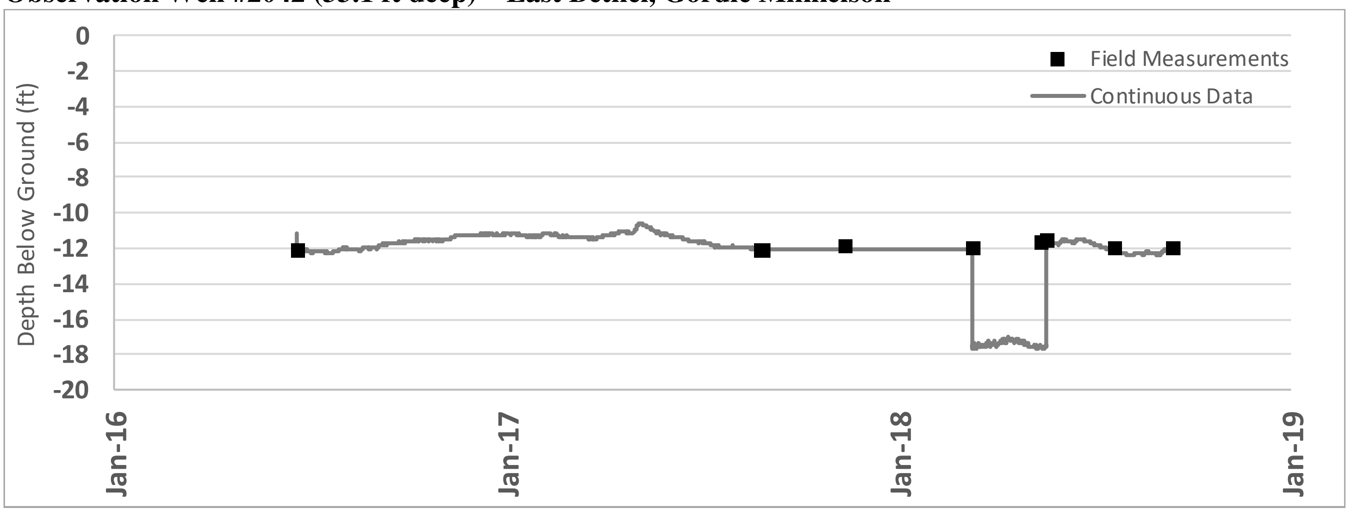
Observation Well #2040 (13 ft deep)—Carlos Avery #4



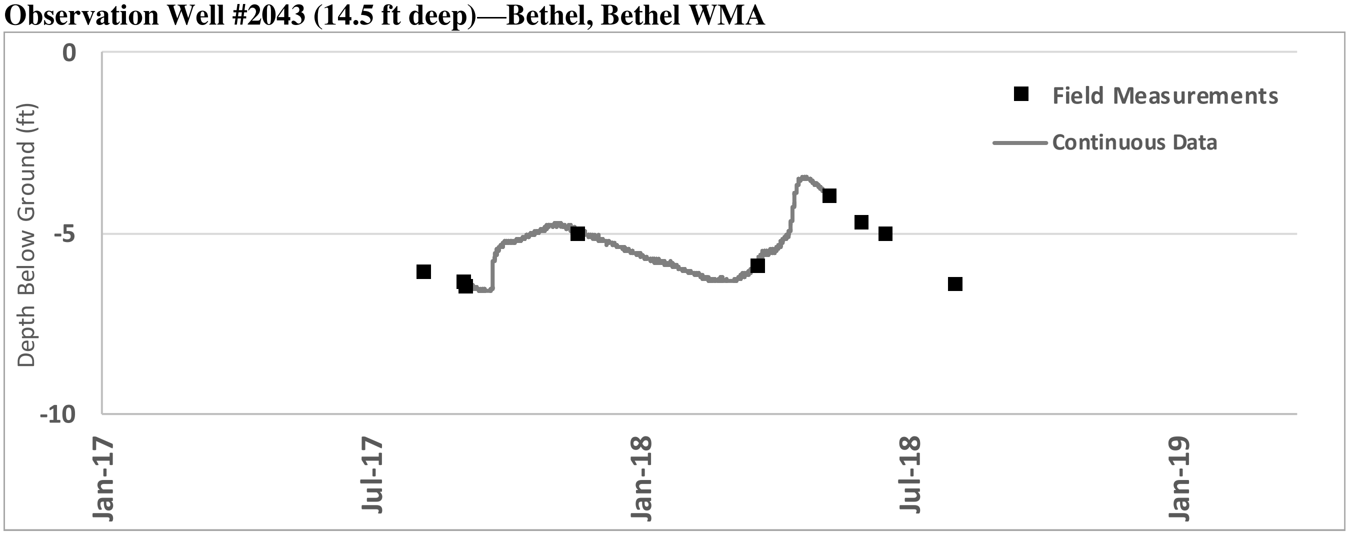
Observation Well #2041 (340 ft deep)—East Bethel, Gordie Mikkelson



Observation Well #2042 (33.1 ft deep)—East Bethel, Gordie Mikkelson



Observation Well #2043 (14.5 ft deep)—Bethel, Bethel WMA

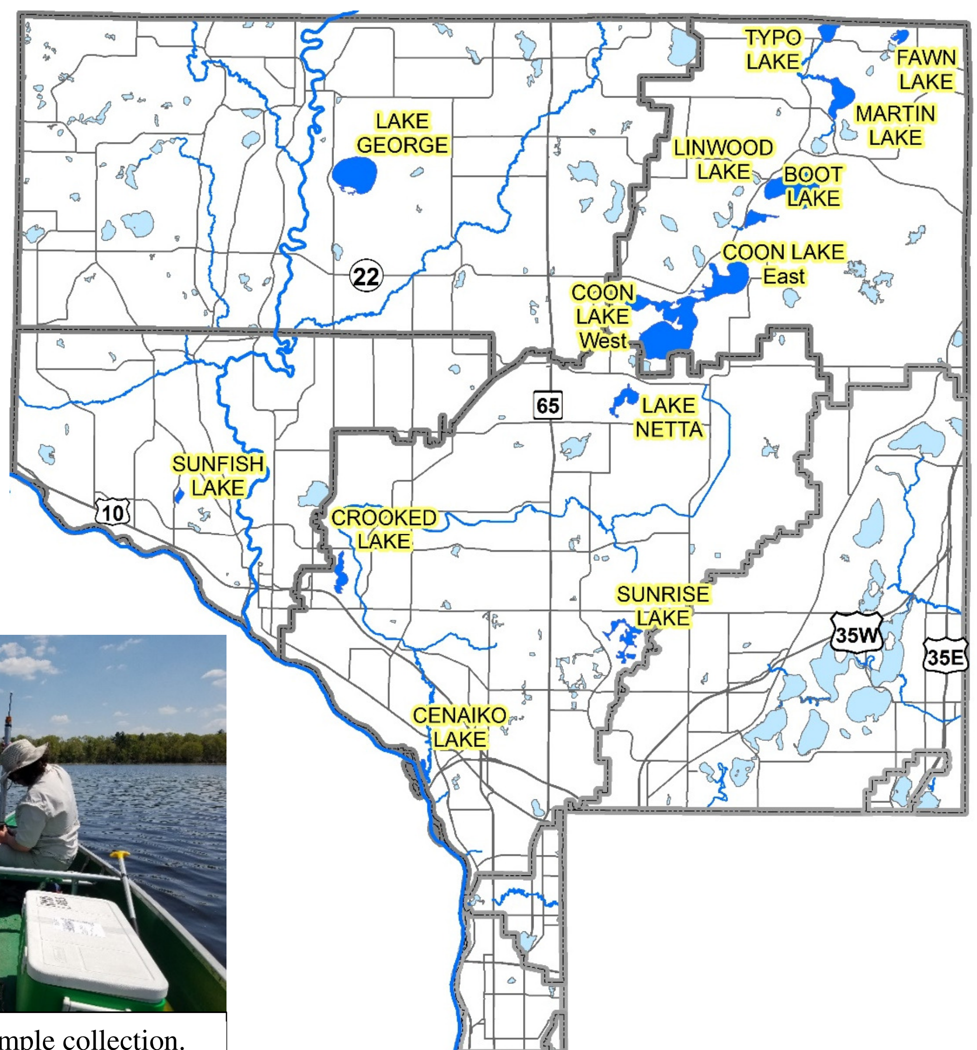


Lake Water Quality

The purpose of lake water quality monitoring is to detect and diagnose water quality problems that may affect suitability for recreation or that may adversely affect people or wildlife. The monitoring regime is designed to ensure major recreational lakes are monitored every 2-3 years. Some lakes are monitored more frequently if problems are suspected or projects are occurring that could affect lake water quality. Lakes with stable conditions, no suspected new problems, and robust datasets are monitored less often. Monitoring efforts of the Minnesota Pollution Control Agency or Metropolitan Council are not duplicated, and are not presented in this report.

In addition to this report, there are several sources of lake water quality data. For lakes monitored by the ACD, Met Council, or MPCA prior to the current year, see the letter grade table on page 23. Detailed analyses for the lakes shown in that table are in each respective year's Water Almanac Report. All data collected by the ACD and most other agencies can be retrieved through the MPCA's website Electronic Data Access tool, which draws data from their EQuIS database.

2018 Lake Water Quality Monitoring Sites



Lake water quality sample collection.

Lake Water Quality Monitoring Methods

The following parameters are tested at each lake:

- Dissolved Oxygen (DO);
- Turbidity;
- Conductivity;
- Temperature;
- Salinity;
- Total Phosphorus (TP);
- Transparency (Secchi Disk);
- Chlorophyll-a (Cl-a);
- pH.

Lakes are sampled every two weeks from May to September. Monitoring is conducted by boat at the deepest area of the lake. These sites are located using a portable depth finder or GPS. Conductivity, pH, turbidity, salinity, dissolved oxygen (DO), and temperature are measured using the Hydrolab Quanta multi-probe at a depth of one meter. Water samples are collected with a Kemmerer sampler from a depth of one meter, to be analyzed by an independent laboratory (RMB Labs) for total phosphorus and chlorophyll-a. Sample bottles are provided by the laboratory. Total phosphorus sample bottles contain the preservative sulfuric acid (H_2SO_4), while bottles for chlorophyll-a analysis do not require preservative. Brown or foil-wrapped bottles are used for chlorophyll-a to prevent light from entering the bottles. Water samples are kept on ice and delivered to the laboratory within 24 hours of collection.

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

To evaluate the lake, results are compared to other lakes in the region and past readings at the lake. Comparisons to other lakes are based on the Carlson's Trophic State Index and the Metropolitan Council's lake quality grading system for the North Central Hardwood Forest ecoregion. Historical data for each lake can be obtained from the U.S. EPA's national water quality database, EQuIS, via the Minnesota Pollution Control Agency.

Lake Water Quality Questions and Answers

This section is intended to answer basic questions about the Anoka Conservation District's methodology for monitoring lake water quality and interpreting the data.

Q- Which parameters did you test and what do they mean?

A- The table on the following page outlines technical information about the parameters measured, which include:

pH- This test measures whether the lake water is basic or acidic. A pH reading of greater than 7 signifies that the lake is basic and a reading of less than 7 means the lake is acidic. Many fish and other aquatic organisms need a pH in the range of 6.5 to 9.0 in order to remain viable. Eutrophic lakes are often basic (pH $\geq$7). The pH of a lake will fluctuate daily and seasonally due to algal photosynthesis, runoff, and other factors.

Specific Conductivity- This is a measure of the degree to which the water can conduct electricity. It is caused by dissolved minerals in the lake. Although every lake has a certain amount of dissolved matter, high conductivity readings may indicate additional inputs from sources such as storm water (i.e. road salt), agricultural runoff, or failing septic systems.

Turbidity- This is a measure of the diffraction of light from solid material suspended in the water column, due to "muddiness" or algae.

Dissolved Oxygen (DO) - Sources of dissolved oxygen include the atmosphere, aeration from stream inflow, and photosynthesis by algae and submerged plants in the lake. Dissolved oxygen is consumed by organisms in the lake and by decomposition processes.

Dissolved oxygen is essential to the metabolism of all aquatic organisms, and low dissolved oxygen is often the reason for fish kills. Extremely low DO concentrations at the lake bottom can also trigger a chemical reaction that causes phosphorus to be released from the sediment into the water column.

Salinity- This is a measurement of the quantity of salts dissolved in the water. Dissolved salts in a lake are not naturally occurring in Anoka County. High salinity measurements may be the result of inputs from other sources such as failing septic systems, spring runoff from roads, and farm field runoff.

Temperature- Fish species are sensitive to water temperature. Lake trout and salmon prefer temperatures between 46-56°F, while bass and pan fish will withstand temperatures of 76°F or greater. Temperature also affects the amount of dissolved oxygen that the water can hold in solution. At warmer temperatures, oxygen is readily released to the atmosphere and dissolved oxygen concentrations fall.

Secchi Transparency- Transparency is directly related to the amount of algae and suspended solids in the water column. A Secchi disk is a white and black disk attached to the end of a rope that is marked at 0.1-foot intervals. The disk is lowered over the shaded side of the boat until it disappears and is then pulled up to the point where it reappears again. The midpoint between these two points is the Secchi transparency. Shallow measurements indicate abundant algae and/or suspended solids.

Total Phosphorus (TP) - Phosphorus is an essential nutrient. Algal growth is commonly limited by phosphorous. High phosphorous in a lake can result in abundant algal growth. This, in turn, affects a variety of chemical and ecological factors including the lake's recreational suitability, fisheries, plants, and dissolved oxygen. A single pound of phosphorus can result in 500 pounds of algal growth. Minnesota Pollution Control Agency standards designate a lake in our ecoregion as "impaired" if average summertime phosphorus is >40 µg/L for deep lakes or >60 µg/L for shallow lakes.

Sources of phosphorus include runoff from agricultural land, runoff carrying fertilizer from lakeshore properties, failing septic systems, pet waste, and stormwater runoff. The lake itself can also be a source of phosphorus. High levels of phosphorus contained in the bottom sediments of lakes can be released when the sediment is disturbed through recreation or animal activity, or when dissolved oxygen levels are low.

Chlorophyll-a (Cl-a) - Chlorophyll-a is the inorganic portion of all green plants that absorbs the light needed for photosynthesis. Chlorophyll-a measurements are used to indicate the concentration of algae in the water column. It does not provide an indication of large plant (macrophytes) or filamentous algae abundance.

Lake water quality monitoring parameters

Parameter	Units	Reporting Limit	Accuracy	Average Summer Range for North Central Hardwood Forest
pH	pH units	0.01	± .05	8.6 - 8.8
Conductivity	**mS/cm**	0.01	± 1%	0.3 - 0.4
Turbidity	NTU	0.1	± 3%	1-2
D.O.	mg/L	0.01	± 0.1	N/A
Temperature	°C	0.1	± 0.17 °	N/A
Salinity	%	0.01	± 0.1%	N/A
T.P.	µg/L	1	NA	23 – 50
Cl-a	µg/L	1	NA	5 – 27
Secchi Depth	ft m	NA	NA	4.9 - 10.5 1.49 – 3.2

Q- Lakes are often compared to the "ecoregion." What does this mean?

A- We compare our lakes to other lakes in the same ecoregion. The U.S. Environmental Protection Agency mapped regions of the U.S based on soils, landform, potential natural vegetation, and land use. These regions are referred to as ecoregions. Minnesota has seven ecoregions. Anoka County is in the North Central Hardwood Forest ecoregion. Reference lakes, deemed to be representative and minimally impacted by man (e.g., no point source wastewater discharges, no large urban areas in the watershed, etc.), were sampled in each ecoregion to establish a standard range for water quality that should be expected in each ecoregion.
The average summer range of water quality values in the table on the previous page are the inter-quartile range (25^{th} to 75^{th} percentile) of the reference lakes for the North Central Hardwood Forest ecoregion. This provides a range of values that represent the central tendency of the reference lakes' water quality.

Q- What is the lake quality letter grading system?

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

Lake Grading System Criteria

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

Q- What do the lake physical condition and recreational suitability numbers mean?

A- The Minnesota Pollution Control Agency has established a subjective ranking system that the ACD staff use during each lake visit (see table, below). Rankings are based purely upon the observer's perceptions. These physical and recreational rankings are designed to give a narrative description of algae levels (physical condition) and recreational suitability of each lake. While the physical condition is straight-forward, the recreational suitability may be complicated by the impacts of both water quality and dense aquatic vegetation (the influence of these two factors is not separated in the ranking).

Lake Physical and Recreational Conditions Ranking System

	Rank	Interpretation
Physical Condition	1	crystal clear
	2	some algae
	3	definite algae
	4	high algae
	5	severe bloom
Recreational Suitability	1	beautiful
	2	minimal problems, excellent swimming and boating
	3	slightly swimming impaired
	4	no swimming / boating ok
	5	no swimming or boating

Q- What is Carlson's Trophic State Index?

A- Carlson's Trophic State Index (see figure below) uses a number calculated with the lakes Secchi transparency, phosphorus, and chlorophyll-a readings to describe a lake's stage of eutrophication (nutrient level, amount of algae). The index ranges from oligotrophic (clear, nutrient poor lakes) to hypereutrophic (green, nutrient overloaded lakes). The index values generally range between 0 and 100 with increasing values indicating more eutrophic conditions. Unlike the lake letter grading system, the Carlson's Trophic State Index does not compare lakes only within the same ecoregion; it is a scale used worldwide.

There are four trophic state index values: one each for phosphorus, chlorophyll-a, and transparency, plus an overall trophic state index value which is a composite of the others. The indices are abbreviated as follows:

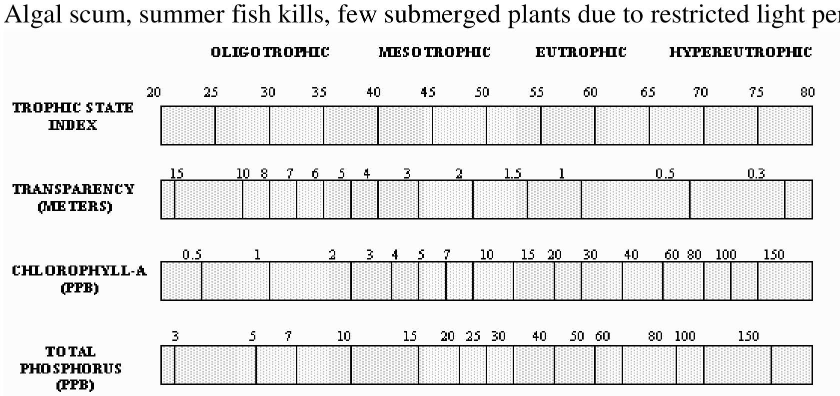
TSI- Overall Trophic State Index.
TSIP- Trophic State Index for Phosphorus.
TSIS- Trophic State Index for Secchi transparency.
TSIC- Trophic State Index for the inorganic part of algae, Chlorophyll-a.

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

Carlson's Trophic State Index Scale

CARLSON'S TROPHIC STATE INDEX

TSI < 30	Classic Oligotrophy: Clear water, oxygen throughout the year in the hypolimnion, salmonid fisheries in deep lakes.
TSI 30-40	Deeper lakes still exhibit classical oligotrophy, but some shallower lakes will become anoxic in the hypolimnion during the summer.
TSI 40-50	Water moderately clear, but increasing probability of anoxia in hypolimnion during the summer.
TSI 50-60	Lower boundary of classical eutrophy: Decreased transparency, anoxic hypolimnion during the summer, submerged plant growth problems evident, warm-water fisheries only.
TSI 60-70	Dominance of blue-green algae, algal scum probable, extensive submerged plant problems.
TSI 70-80	Heavy algal blooms possible throughout the summer, dense submerged plant beds, but extent limited by light penetration. Often classified as hypereutrophic.
TSI >80	Algal scum, summer fish kills, few submerged plants due to restricted light penetration.



Q- What does the "trophic state" of a lake mean?

A- Lakes fall into four categories, or trophic states, based on lake productivity and clarity.

1. Oligotrophic- In these lakes, nutrients (total phosphorus and nitrogen) are low. Oligotrophic lakes are the deepest and clearest of all lakes, but the least productive (i.e. lowest biomass of plants and fish due to lack of nutrients).

2. Mesotrophic- In these lakes, plant nutrients are available in limited quantities allowing for some, but not excessive plant growth. These lakes are still considered relatively clear. Northern Minnesota walleye and lake trout lakes are usually mesotrophic.

3. Eutrophic- In these lakes, the water is nutrient-rich. Productivity is high for both plants and fish. Abundant plant life, especially algae, results in poorer water clarity and can reduce the dissolved oxygen content when it decays. Algae blooms in the "dog days of summer" are commonplace. Bass and panfish are usually large components of the fish community, but rough fish can become problematic.

4. Hypereutrophic- In these lakes, nutrients are extremely abundant. Algae are grossly abundant, starving all other plants of light. The poor conditions often favor rough fish over game fish. These lakes have the poorest recreational potential.

Q- At what concentrations do total phosphorus and chlorophyll-a become a problem in lake water?

A- Lakes in the North Central Hardwood Forests have a certain criteria set for both total phosphorus and chlorophyll-a. For total phosphorus, the concentration for primary contact, recreation, and aesthetics is set at < 40 µg/L in deep lakes and <60 µg/L in shallow lakes. For chlorophyll-a, the average concentrations range from 5 to 22 µg/L, with maximums ranging from 7 to 37 µg/L. Once these set limits have been reached or exceeded, excessive algae growth will be observed.

Q- How do lakes change throughout the year and how does this affect water quality?

A- Water temperature is very important to the function of lakes. Lakes undergo seasonal changes that can influence water quality conditions. Because many Anoka County lakes are shallow (< 20 ft), some of the seasonal changes that are typical for deep lakes do not occur. The following discussion does not apply to these shallow lakes.

In the summer, after the lake has warmed, deep lakes typically will be divided into three layers (stratified) based on the water's temperature and density; the well-mixed upper layer (epilimnion); the middle transition layer (metalimnion); and the cool, deep bottom layer (hypolimnion). The hypolimnion is usually depleted of oxygen because of decomposition of organic matter, the lack of photosynthesis, and because there is no contact with the surface where gas exchange with air can occur. Nutrients attached to sediment or decomposing organic material also fall into the hypolimnion where they are temporarily or permanently lost from the system. This is one reason deep lakes are usually not as nutrient rich and do not experience algae problems like shallow lakes.

In the autumn, the water near the surface eventually cools to the same temperature as the water at the bottom of the lake. When the water is of uniform temperature from top to bottom, it is easily mixed by the wind. This mixes nutrients that were formerly trapped at the bottom and may cause an autumn algal bloom. If the algal bloom is too severe, it could be detrimental to the lake during the winter when it is covered with ice. These algae will decay consuming dissolved oxygen, already decreased due to ice over, which may lead to a winter fish kill. This situation is typically observed in shallow eutrophic and/or hypereutrophic lakes.

In winter an inverse thermal stratification sets up. Ice is less dense than water and therefore floats. The coldest water is nearest the surface. Water has a maximum density at 4^{o} C, and that water is found at the bottom. The reversal of the temperature layers in spring and fall is called "turning over."

In spring, the lake "turns over" with the warmer water rising to the top and the colder sinking to the bottom. When this occurs, nutrients needed for plant growth (total phosphorus and nitrogen) are distributed throughout the lake from the bottom. As solar radiation slowly warms the deeper lakes during the spring and summer, the lake starts to stratify into the three layers again, this time with the warmest water on top.

Q- How do we determine if there is a trend of improving or worsening lake water quality?

A- Because of inherent natural variation, lake water quality is not the same each year. Sorting out this natural variation from true trends is best accomplished with statistical tests that analyze the data objectively. When there is at least 5 years of monitoring data present, ACD staff test for lake trends using a Multivariate Analysis of Variance (MANOVA). MANOVA tests the vector response of correlated response variables (Secchi depth, total phosphorus, and chlorophyll-a) while maintaining the probability of making a type I error (rejecting a true null hypothesis) at $\alpha = 0.05$. In other words, we are simultaneously testing the three most important measurements of lake water quality. Testing each response variable separately would increase the chance of making a type I error.

Historical Water Quality Grades for Anoka County Lakes (includes monitoring by ACD and Met Council's CAMP program, post-1980 only.)

YEAR →	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Boot																																							C+
Cenaiko																		B	A	A	A	B	A	A	A	A	A	A	B	B	B	B	B						A-
Centerville		C		C					D												C	C		C	C	A													
Coon	C				C					C					C			C	B	A	B	C			C		C		C										
Coon (East Bay)					C					C	C	C		C	C	C		B	B	A	B	C	B		C	C	C	B	A	B	B	B	B	B+	A		B		A
Coon (West Bay)																															A		A		B		A-		A-
Crooked				C		C				C					B	C	B	B	B		B		B	B		B	B-		B	B		B	A-		A	A		B	A-
East Twin	A	B		C						B						B		A	B	A	A		A			A			A			A		A				A	
Fawn									B									A	B	A	A	A			A		A		A		A		A			A			A
Fish																																							A
George	A	A	A		A					A								A	B	A	A		A			B			B			B		B	B	A	A	B	A-
George Watch		F	D	D		D		D	D	F	D	F					F	D	F	D	D	F	D	D	F	D	F	F	D	D	D	D	F					D	
Golden						D	C	D	F	F	F	F		D			C	D	C	C	C	D	D	D	D	C	C	C	C	C	C								
Ham					C									A	B		A	A	B		C	C			B	B		B	A		B	B		A	A		B	B	
Highland																				D	D	D	F	F	F	F	F	F									F		
Howard										F	F	F							F	D	D																		
Island				C																				B	B	C	C	B	B	C	C	C	C						
Itasca																			A	B	B																		
Laddie	D													A	B	B			B	B	B	B	B	B	B	B			B			B					A	B	
Linwood	B	C		C						C					C			C	C	C	C	C		C		C		C	C	C			C			C			C
Lochness																												A	B		B	C	C					C	
Martin				D														D	D	C	D	D		D		D		D	D	D			D		C	C	C	C	C
Minard																																		A	A				
E. Moore	C	C	C	C	C	B	C	C							C				C	B	B	C	C	C		C													
W. Moore	C	C	F	C	B	C	F	C												B	B	C	C	C		C													
Mud														B						B	C																		
Netta																		B	C	A		B		A	A		B+	B+		B	A-		A-	A		A	A		A
Peltier				D										D	F	D	D	D	D	D	D	F	F	D	D	D	F	D											
Pickerel																B		A	A	B	C										A	C		B	A				
Reshanau																											D	D	D	D	D	D	D						
Rogers																			C		C			B			D		B	B									
Round																			B	A	B			A		B		C		C	C		A		A		A		
Sullivan (Sandy)														D	D	D		D	D	D	D	D	F	D	D	D								D			D		
Sunfish/Grass																																	B	B			B	A	B-
Sunrise																																							B-
Typo														F	F	F		F	F	F	F	F		F		F		F		F			F		D	F	F	F	F

Stream Water Quality – Chemical Monitoring

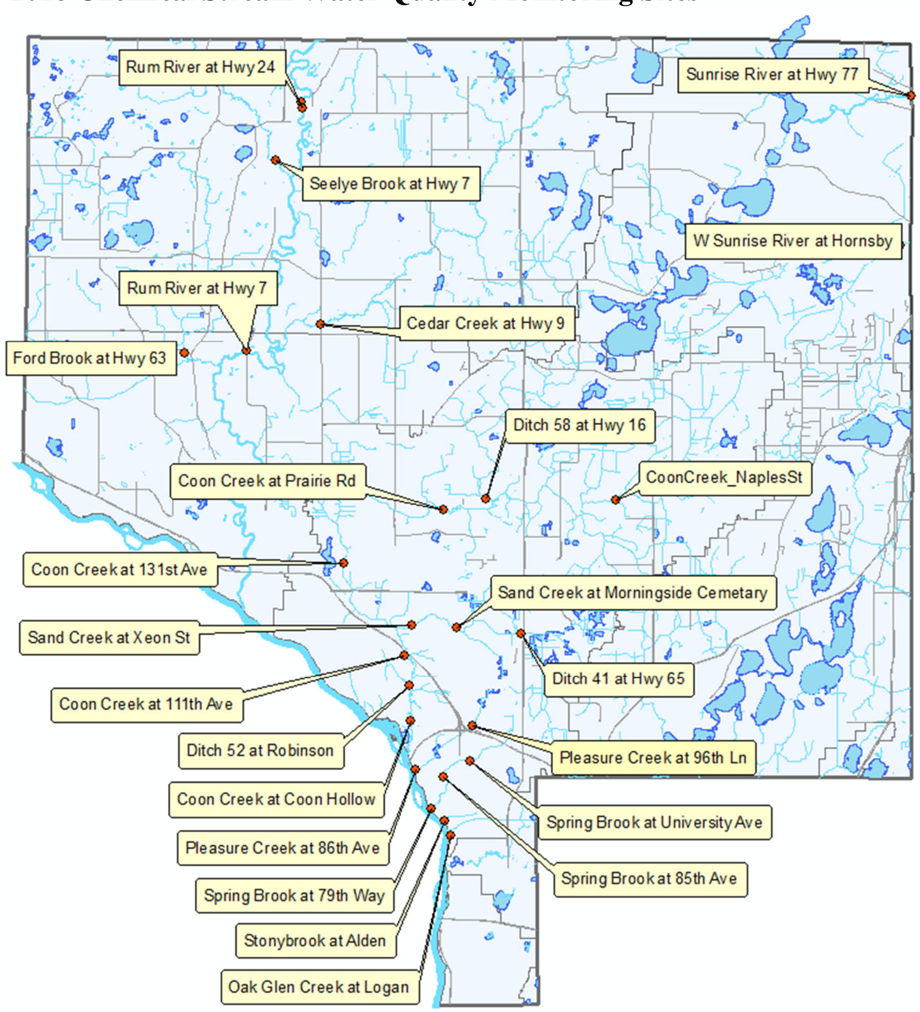
Stream water quality monitoring is conducted to detect and diagnose water quality problems impacting the ecological integrity of waterways, recreation, or human health. Because many streams flow into lakes, stream water quality is often studied as part of lake improvement studies.

Chemical stream water quality monitoring in 2018 was conducted at four Sand Creek (Ditch 41) sites, six Coon Creek sites including one tributary (Ditch 11), three Springbrook sites, three Rum River sites, and one site each in Ford Brook, Pleasure Creek, Typo Creek, Cedar Creek, Seelye Brook, Stonybrook, and Oak Glen Creek.

Additionally, the ACD continued a cooperative effort with the Metropolitan Council for monitoring of the Rum River at the Anoka Dam as part of the Metropolitan Council's Watershed Outlet Monitoring Program (WOMP). Those data are housed with the Metropolitan Council, and methodologies are available upon request from either organization.

The methodologies for chemical stream water quality monitoring and information on data interpretation can be found on the following pages. Monitoring results are presented in the following chapters.

2018 Chemical Stream Water Quality Monitoring Sites



Stream water quality sample collection.

STREAM WATER QUALITY MONITORING METHODS

Stream water is monitored four times during base flow conditions and four times immediately following storm events between the months of April and September (some special studies have different sampling regimes). Grab samples are a single sample of water collected to represent water quality for a given moment or stream condition. A composite sample, conversely, consists of collecting several small samples over a period of time and mixing them. Stream sampling is performed using a Hydrolab Quanta multi-probe in the stream and concurrently collecting grab samples for laboratory analysis.
Each stream sample was tested for the following parameters:

- pH;
- Dissolved Oxygen (DO);
- Turbidity;
- Specific Conductivity;
- Temperature;
- Salinity;
- Total Phosphorus (TP);
- Total Suspended Solids (TSS);
- Secchi Tube Transparency
- others for some special investigations.

Conductivity, pH, turbidity, salinity, dissolved oxygen (DO), and temperature are measured in the field using a Hydrolab Quanta multi-probe. E. coli samples are analyzed by the independent laboratory Instrumental Research Inc. (IRI). Total phosphorus, chlorides, total suspended solids, sulfate, hardness, and any other parameters are analyzed by the independent laboratory RMB Environmental Laboratory. Sample bottles are provided by the laboratory, along with necessary preservatives. Water samples are kept on ice and delivered to the laboratory within 24 hours of collection, with the exception of E. coli samples, which are delivered to the laboratory no later than 7 hours after being collected. Stream water level is noted when the sample is collected.

Stream Water Quality Monitoring Questions and Answers

This section is intended to answer basic questions about the Anoka Conservation District's methodology for monitoring stream water quality and interpreting the data.

Q- What do the parameters that you test mean?

A- pH- This test measures if the water is basic or acidic. A pH reading of greater than 7 signifies that the stream is basic and a reading of less than 7 means the stream is acidic. Many fish and other aquatic organisms need a pH in the range of 6.5 to 9.0.

Conductivity- This is a measure of the degree to which the water can conduct electricity. It is caused by dissolved minerals in the lake. Although every lake has a certain amount of dissolved matter, high conductivity readings may indicate additional inputs from sources such as storm water, agricultural runoff, or from failing septic systems.

Turbidity- This is a measure of the diffraction of light from solid material suspended in the water column, due to "muddiness" or algae.

Dissolved Oxygen (DO) - Sources of dissolved oxygen include the atmosphere, aeration from stream inflow, and photosynthesis by algae and submerged plants in the lake. Dissolved oxygen is consumed by organisms in the lake and by decomposition processes.

Dissolved oxygen is essential to the metabolism of all aquatic organisms, and low dissolved oxygen is often the reason for fish kills. Extremely low DO concentrations at the lake bottom can also trigger a chemical reaction that causes phosphorus to be released from the sediment into the water column.

Salinity- This parameter measures the amount of dissolved salts in the water. Dissolved salts in a lake are not naturally occurring in Anoka County. High salinity measurements may be the result of inputs from other sources such as failing septic systems, spring runoff from roads, and farm field runoff.

Temperature- Fish species are sensitive to water temperature. Lake trout and salmon prefer temperatures between 46-56°F, while bass and pan fish will withstand temperatures of 76°F or greater. Temperature also affects the amount of dissolved oxygen that the water can hold in solution. At warmer temperatures, oxygen is readily released to the atmosphere and dissolved oxygen concentrations fall.

Secchi Tube Transparency- Transparency is directly related to the amount of algae and suspended solids in the water column. A Secchi tube is a 1 m long tube marked at 1 cm intervals with a white and black disk on a string within it. The tube is filled with water and the disk is drawn upward until it is just visible than lowered until it just disappears. The midpoint between these points is the Secchi transparency

Total Phosphorus (TP) - Phosphorus is an essential nutrient. Algal growth is commonly limited by phosphorous. High phosphorous in a lake can result in abundant algal growth. This, in turn, affects a variety of chemical and ecological factors including the lake's recreational suitability, fisheries, plants, and dissolved oxygen. A single pound of phosphorus can result in 500 pounds of algal growth. Minnesota Pollution Control Agency standards designate a stream as impaired if it has >100 µg/L average summertime phosphorous.

Sources of phosphorus include runoff from agricultural land, runoff carrying fertilizer from lakeshore properties, failing septic systems, pet waste, and stormwater runoff. The lake itself can also be a source of phosphorus. High levels of phosphorus contained in the bottom sediments of lakes can be released when the sediment is disturbed through recreation or animal activity, or when dissolved oxygen levels are low.

Chlorides– This is a measure of dissolved chloride materials. The most common source is road salt (sodium chloride), but other sources include various chemical pollutants and sewage effluent.

Analytical Limits for Stream Water Quality Parameters

Parameter	Unit of Measurement	Method Detection Limit	Reporting Limit	Analysis or Instrument Used
pH	pH units	0.01	0.01	Hydrolab Quanta
Conductivity	**mS/cm**	0.001	0.001	Hydrolab Quanta
Turbidity	NTU	0.1	0.1	Hydrolab Quanta
Dissolved Oxygen	mg/L	0.01	0.01	Hydrolab Quanta
Temperature	°C	0.1	0.1	Hydrolab Quanta
Salinity	%	0.01	0.01	Hydrolab Quanta
Total Phosphorus	µg/L	0.3	1.0	EPA 365.4
Total Suspended Solids	mg/L	5.0	5.0	EPA 160.2
Chloride	mg/L	0.005	0.01	EPA 325.1
Sulfate	mg/L	1.0	4.0	ASTM D516-02
Hardness	mg/L		na	2340.B
E. *coli*	MPN/100 mL	1.0	1.0	SM9223 B-97

Q- How do you rate the quality of a stream's water?

A- We make up to three comparisons. First, with published water quality values for the ecoregion. Ecoregions are areas with similar soils, landform, potential natural vegetation, and land use. All of Anoka County is within the North Central Hardwood Forest (NCHF) Ecoregion. Mean values for our ecoregion, and for minimally impacted streams in our ecoregion, are in the table below. Secondly, we compare each stream to 48 other streams the Anoka Conservation District has monitored throughout the county. The county includes urban, suburban, and rural areas so this comparison incorporates water quality expectations in all these land uses.

Third, we compare levels of a pollutant observed to state water quality standards. These standards exist for some, but not all, pollutants.

Q- What Quality Assurance/Quality Control procedures are in place?

A- QA/QC is accomplished in the following ways:

RMB Environmental Laboratories (RMB) conducted the laboratory analysis. RMB has a comprehensive QA/QC program, which is available by contacting them directly. The ACD followed field protocols supplied by RMB including keeping samples on ice, avoiding sample contamination and delivering samples to the lab within 24 hours of sampling. Sample bottles are provided by RMB lab and include the necessary preservatives.

The hand held Hydrolab Quanta multi-probe used to conduct in-stream monitoring is calibrated at least daily.

Typical Stream Water Quality Values for the North Central Hardwood Forest (NCHF) Ecoregion and for Anoka County

Parameter	Units	NCHF Ecoregion Mean[1]	NCHF Ecoregion Minimally Impacted Stream[1]	Median of Anoka County Streams
pH	pH units		8.1	7.59
Conductivity	mS/cm	0.389	0.298	0.363
Turbidity	NTU		7.1	11.24
Dissolved Oxygen	mg/L	-	-	7.54
Temperature	°F		71.6	
Salinity	%		0	0.01
Total Phosphorus	µg/L	220	130	126
Total Suspended Solids	mg/L		13.7	13.66
Chloride	mg/L		8	13.3
Sulfate	mg/L			18.7
Hardness	mg/L CaCO3			180.5

[1]MPCA 1993 Selected Water Quality Characteristics of Minimally Impacted Streams for Minnesota's Seven Ecoregions: Addendum to Descriptive Characteristics of the Seven Ecoregions of Minnesota. McCollor & Heiskary.

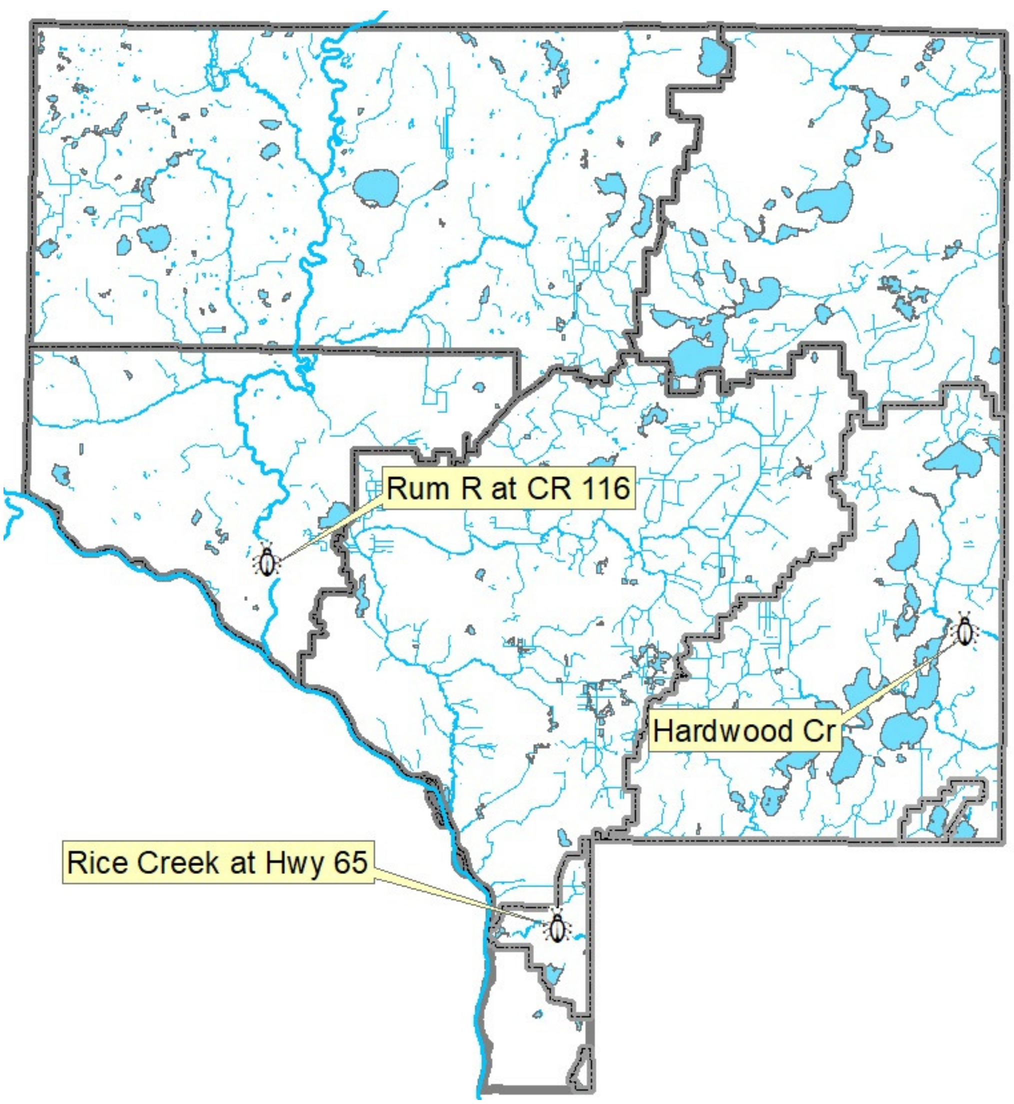
Stream Water Quality – Biological Monitoring

The stream biological monitoring program, often called biomonitoring, is both a stream health assessment and educational program. This biomonitoring program uses benthic (bottom dwelling) macroinvertebrates to determine stream health. Macroinvertebrates are animals without a backbone and large enough to see without a microscope, such as aquatic insects, snails, leeches, clams, and crayfish. Certain macroinvertebrates, such as stoneflies, require high quality streams, while others thrive in poor quality streams. Because of their extended exposure to stream conditions and sensitivity to habitat and water quality, benthic macroinvertebrates serve as good indicators of stream health.

ACD adds an educational component to the program by involving students in the biomonitoring at many of the sites. High school science classes are the primary volunteers. In 2018 there were approximately 166 students from three high schools who monitored three sites, plus a fourth high school class of 16 students in St. Francis that did a rapid assessment project in the Rum River. Since 2000, over 5,182 students have participated. The experience affords students an opportunity to learn scientific methodologies and become involved in local natural resource management.

Results of this monitoring are separated by watershed in the following chapters.

2018 Biological Stream Water Quality Monitoring Sites



Biomonitoring Methods

ACD biomonitoring is based on the US Environmental Protection Agency (EPA) multi-habitat protocol for low-gradient streams (www.epa.gov/owow/monitoring/volunteer/stream/). Using this methodology, individuals doing the sampling determine how much of the stream is occupied by four types of micro-habitat: vegetated bank margins, snags and logs, aquatic vegetation beds and decaying organic matter, and silt/sand/gravel substrate. Sampling is by "jabs" or sweeps with a D-frame net. Each habitat type is sampled in proportion to the prevalence of the habitat type. At least 20 jabs are taken. For student biomonitoring, all habitat types are sampled but not in proportion. All macroinvertebrates are preserved and returned to the lab (or classroom) for identification to the family level. The identified invertebrates are preserved in labeled vials. From the identifications, biomonitoring indices are calculated to rank stream health. Fieldwork is overseen by Anoka Conservation District (ACD) staff and student identifications are checked by ACD staff before any analysis is done.

Biomonitoring Indices

Indices are mathematical calculations that summarize tallies of identified macroinvertebrates and known values of their pollution tolerance into a single number that serves as a gauge of stream health. The indices listed below are used in the biomonitoring program, but are not the only indices available. No single index is a complete measure of stream health. Multiple indices should be considered in concert.

Taxa Richness and Composition Measures

Number of Families: This is a count of the number of taxa (families) found in the sample. A high richness or variety is good.

EPT: This is a measure of the number of families in each of three generally pollution-sensitive orders: <u>E</u>phemeroptera (mayflies), <u>P</u>lecoptera (stoneflies), and <u>T</u>richoptera (caddisflies). A high number of these families is good.

Tolerance and Intolerance Metrics

Family Biotic Index (FBI): The Family Biotic Index summarizes the various pollution tolerance values of all families in the sample. FBI ranges from 0 to 10, with LOWER values reflecting HIGHER water quality. Each macroinvertebrate family has a unique pollution tolerance value associated with it. The table below provides a guide to interpreting the FBI.

Key to interpreting the Family Biotic Index (FBI)

Family Biotic Index (FBI)	Water Quality Evaluation	Degree of Organic Pollution
0.00 - 3.75	Excellent	Organic pollution unlikely
3.76 - 4.25	Very Good	Possible slight organic pollution
4.26 - 5.00	Good	Some organic pollution probable
5.01 - 5.75	Fair	Fairly substantial pollution likely
5.76 - 6.50	Fairly Poor	Substantial pollution likely
6.51 - 7.25	Poor	Very substantial pollution likely

Population Attributes Metrics

% EPT: This measure compares the number of organisms in the EPT orders (Ephemeroptera - mayflies: Plecoptera - stoneflies: Trichoptera - caddisflies) to the total number of organisms in the sample. A high percent of EPT is good.

% Dominant Family: This measures the percentage of individuals in the sample that are in the sample's most abundant family. A high percentage is usually bad because it indicates low evenness (one or a few families dominate, and all others are rare).

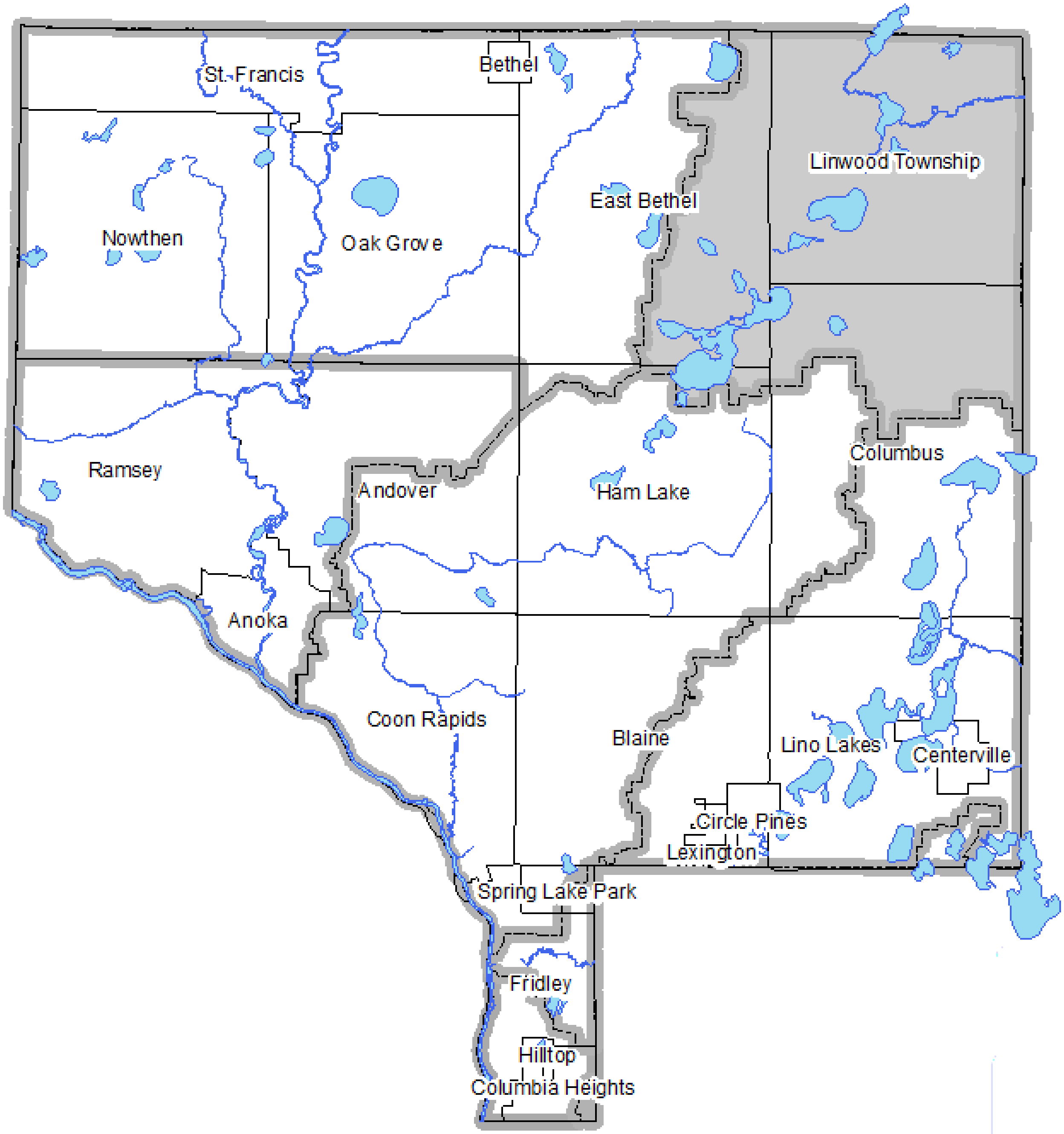
Sites

In 2018, high school classes from Anoka, Totino Grace, and Forest Lake ALC with ACD staff supervision sampled four sites for benthic macroinvertebrates and identified each organism captured to family level. Additionally, ACD staff taught a class from Saint Francis HS biomonitoring methods and groups performed a rapid assessment by counting species within each order captured. Data from the educational quick assessment are not included in this report.

2018 Biomonitoring Sites and Corresponding Monitoring Groups

Monitoring Group	Stream
Anoka High School	Rum River (South)
Forest Lake Area Learning Center	Hardwood Creek
Totino Grace High School	Rice Creek
St. Francis High School	Rum River (North)

Chapter 2: Sunrise River Watershed



Prepared by the Anoka Conservation District

Sunrise River Watershed

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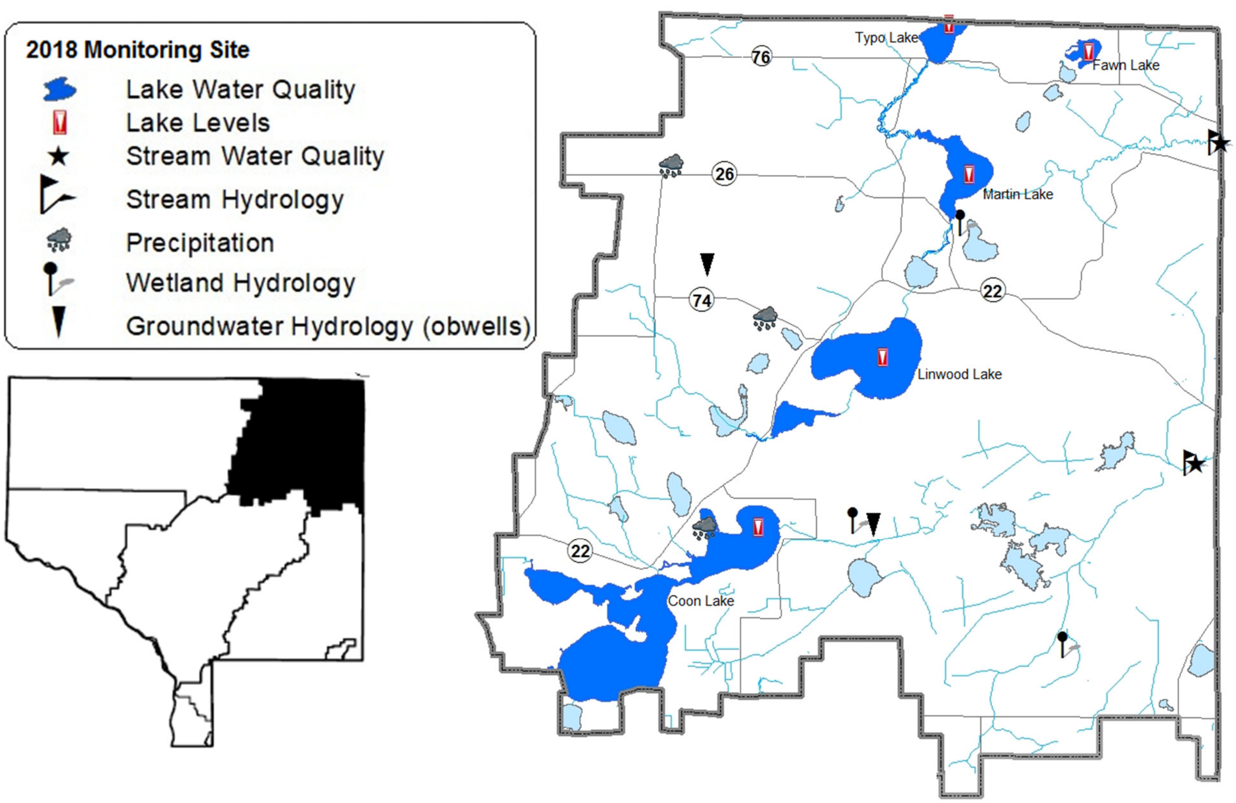


Lake Levels

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).

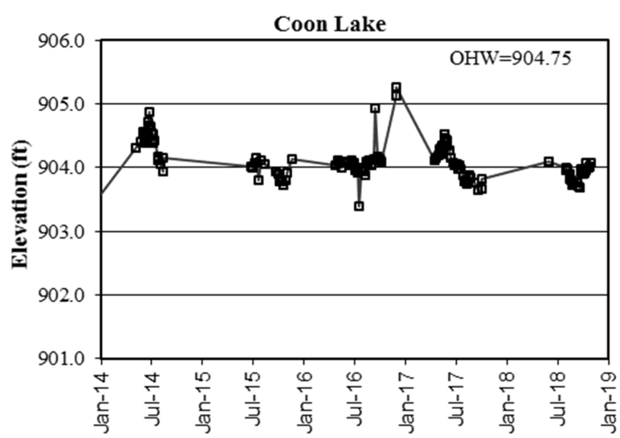
Purpose: To understand lake hydrology, including the impact of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

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

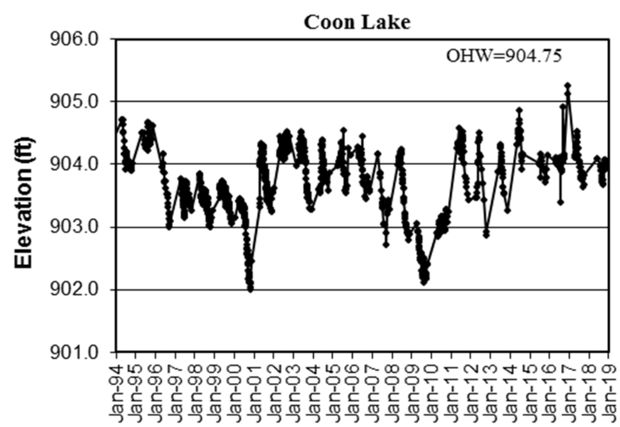
Results: Lake levels were measured by volunteers throughout the 2018 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. In 2018, there was little data prior to June 1 so the expected pattern of increasing water levels in spring was not documented. 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.

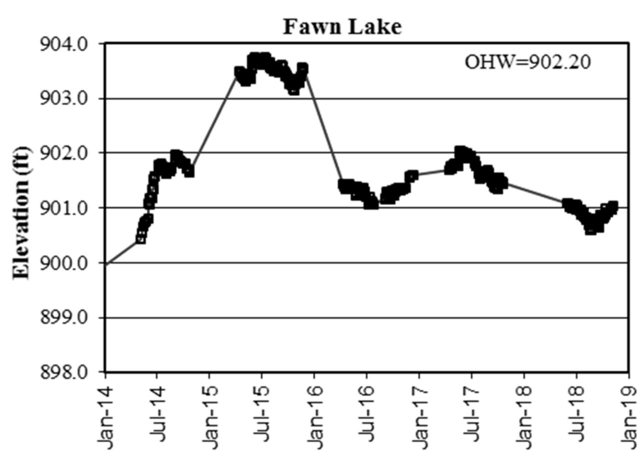
Coon Lake Levels – last 5 years



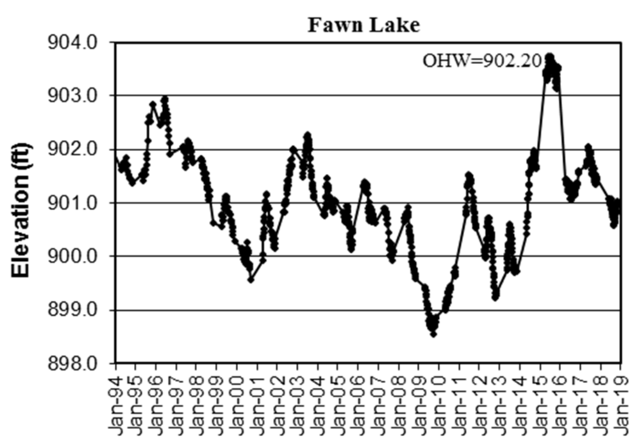
Coon Lake Levels – last 25 years



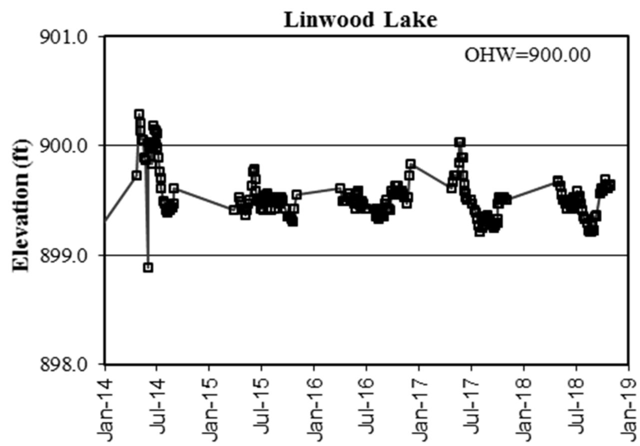
Fawn Lake Levels – last 5 years



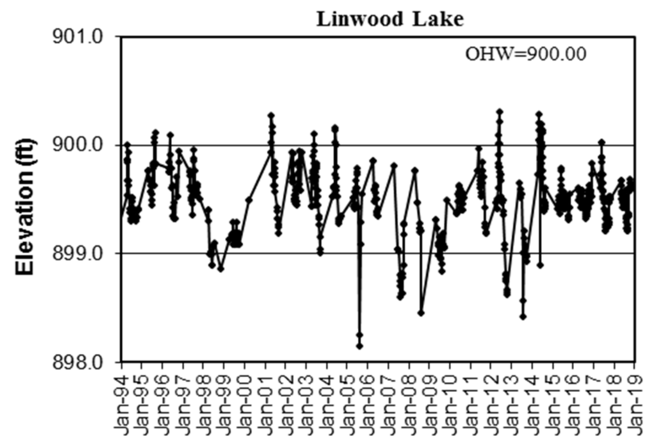
Fawn Lake Levels – last 25 years



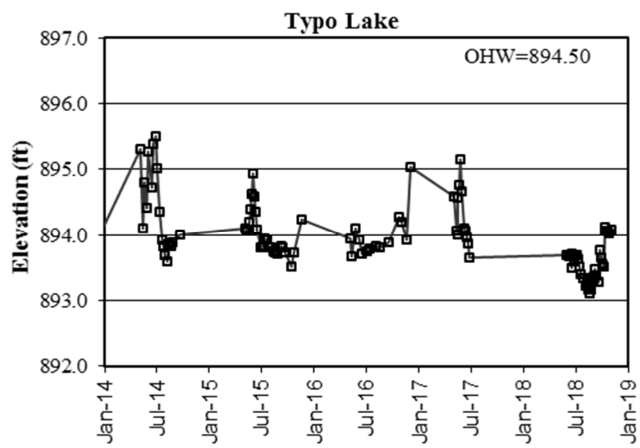
Linwood Lake Levels – last 5 years



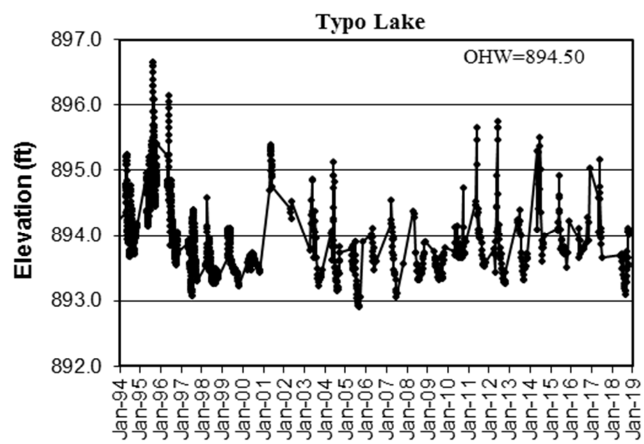
Linwood Lake Levels – last 25 years



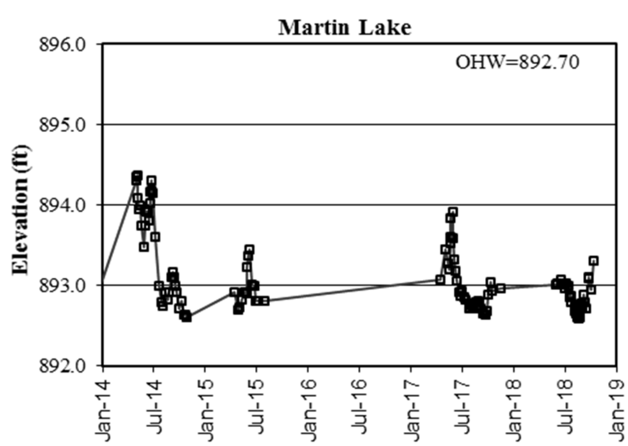
Typo Lake Levels – last 5 years



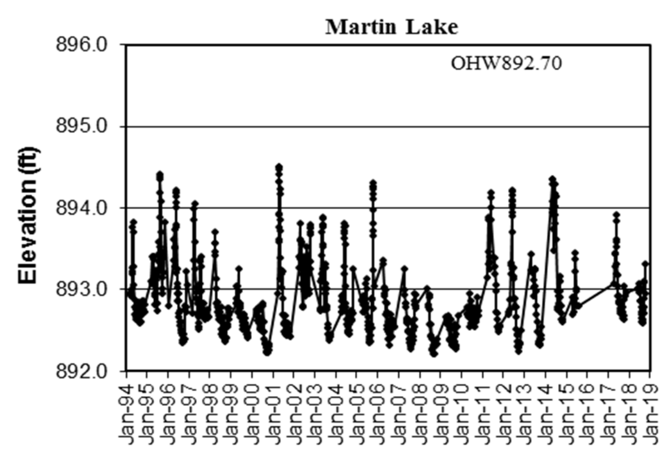
Typo Lake Levels – last 25 years



Martin Lake Levels – last 5 years



Martin Lake Levels – last 25 years



Lake Water Quality

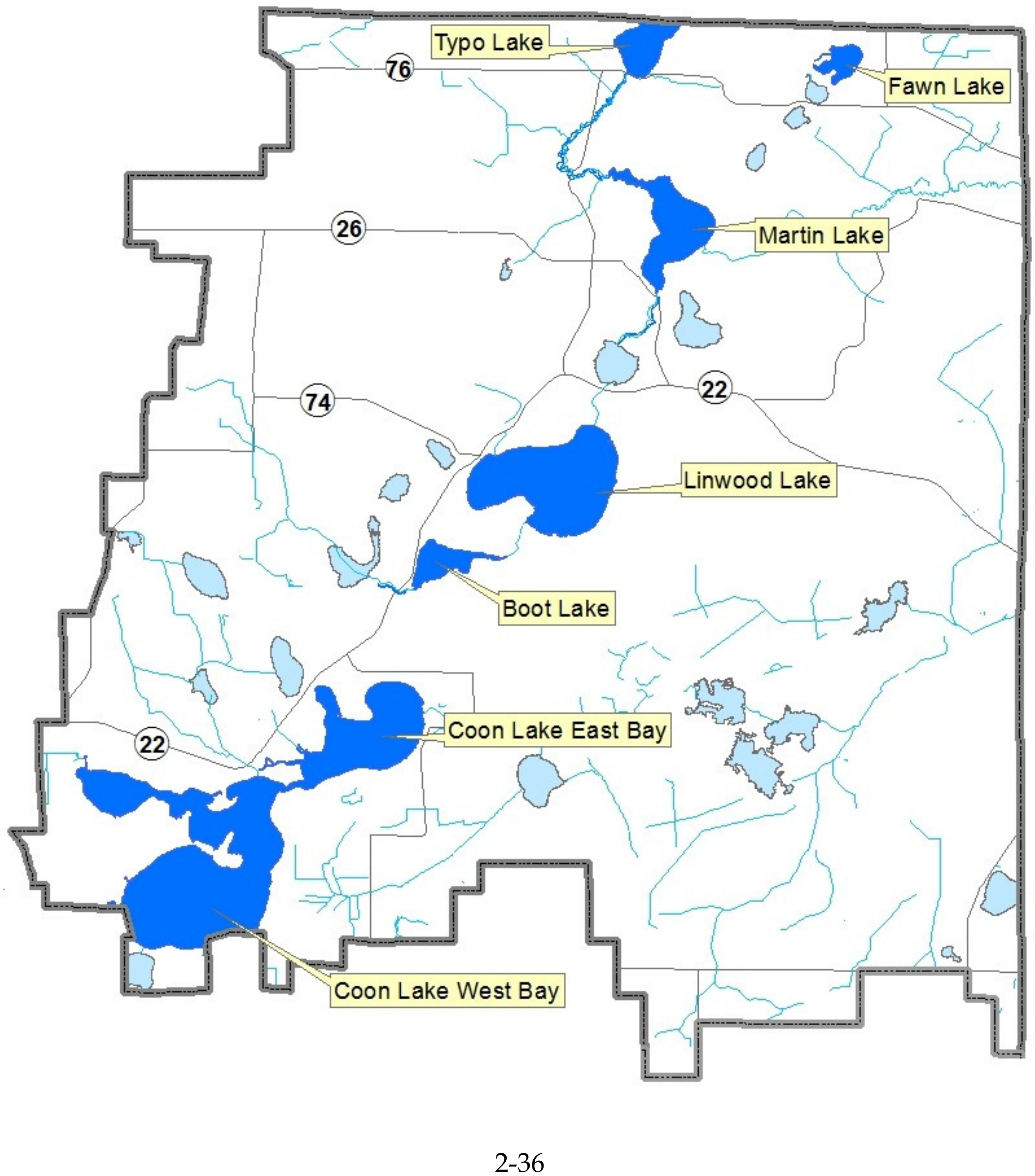
Description: May through September, every-other-week, monitoring is conducted for the following parameters: total phosphorus, chlorophyll-a, Secchi transparency, dissolved oxygen, turbidity, temperature, specific conductivity, pH, and salinity.

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.

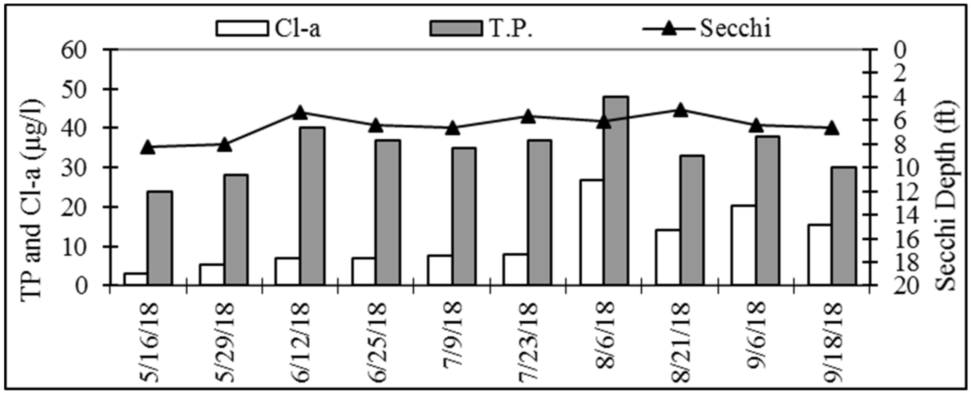
Anoka Conservation District has not monitored Boot Lake previously, but in 2001 and 2003 monitored water quality in the Boot Lake inlet at Viking Boulevard. Average total phosphorus in the inlet across both years was 117 µg/L, which is typical for the area but does exceed the state water quality standard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

		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			
		Time:	13:20	9:30	10:05	9:36	10:12	9:45	9:40	9:35	9:35	9:10			
	Units	R.L.*											Average	Min	Max
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.

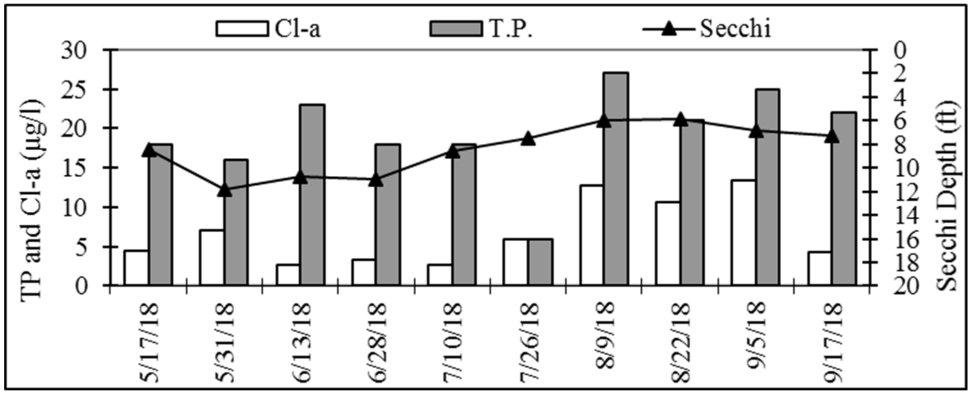
When we examined those years with total phosphorus, chlorophyll-a, and Secchi transparency, excluding the years with only Secchi transparency data, an improving water quality trend did exist. A repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth showed a statistically significant 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



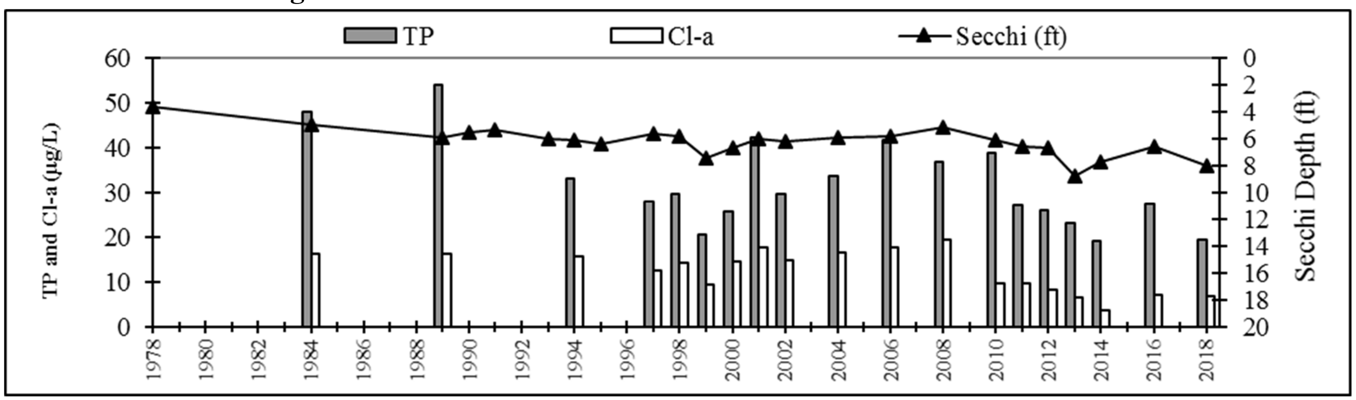
2018 Median Values

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.*	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.

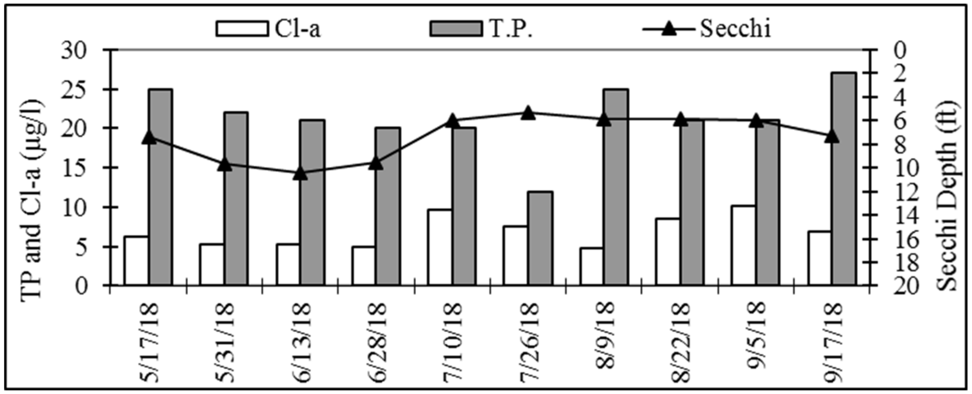
Average total phosphorus, in 2018, was 21.4 µg/L, which is the second lowest on record. Phosphorus has averaged better than 23 µg/L in 2016 and 2018. Prior to that phosphorus ranged from 24 to 28 µg/L. Similar to what is seen in Secchi transparency this may indicate that phosphorus is improving in the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



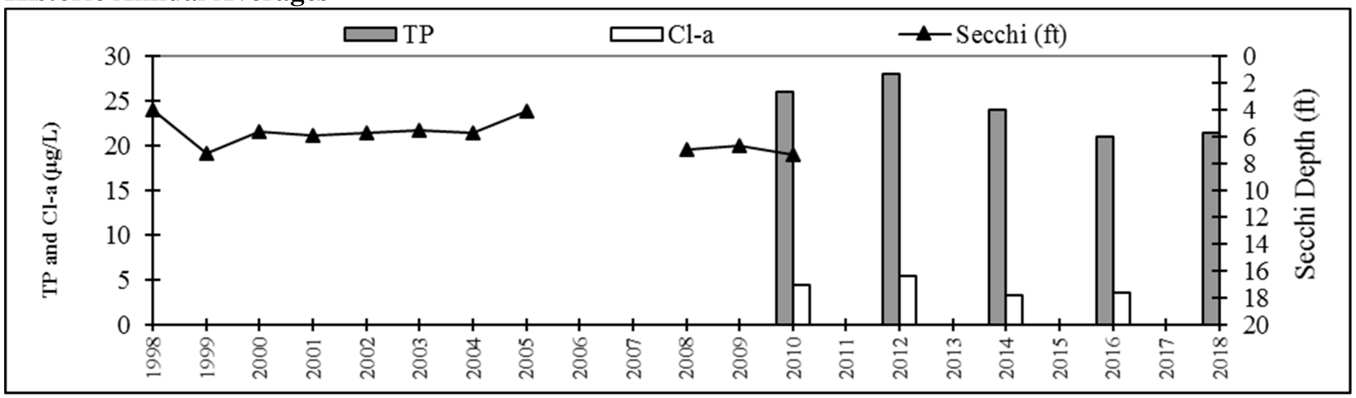
2018 Medians

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.*	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).

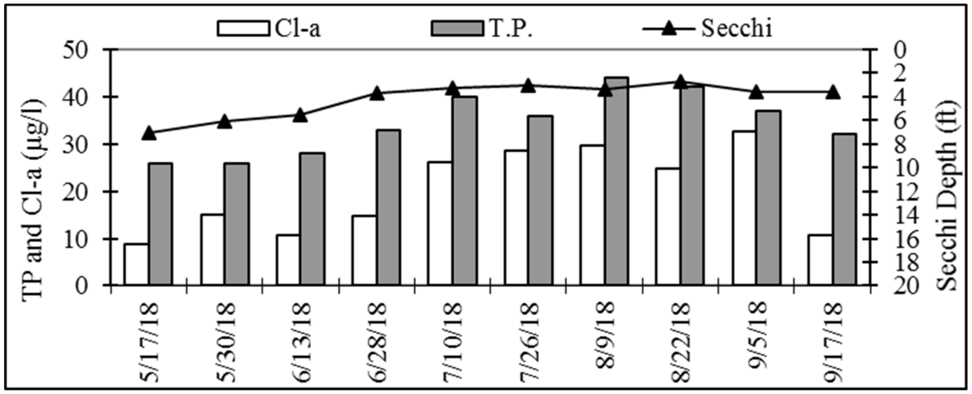
Regardless, water quality improvement is needed. A TMDL impaired waters study has identified the following factors as management targets at Linwood Lake: internal sediments, shoreline management, shoreline septic systems, watershed runoff, agricultural practices, curly-leaf pondweed, and common carp. 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



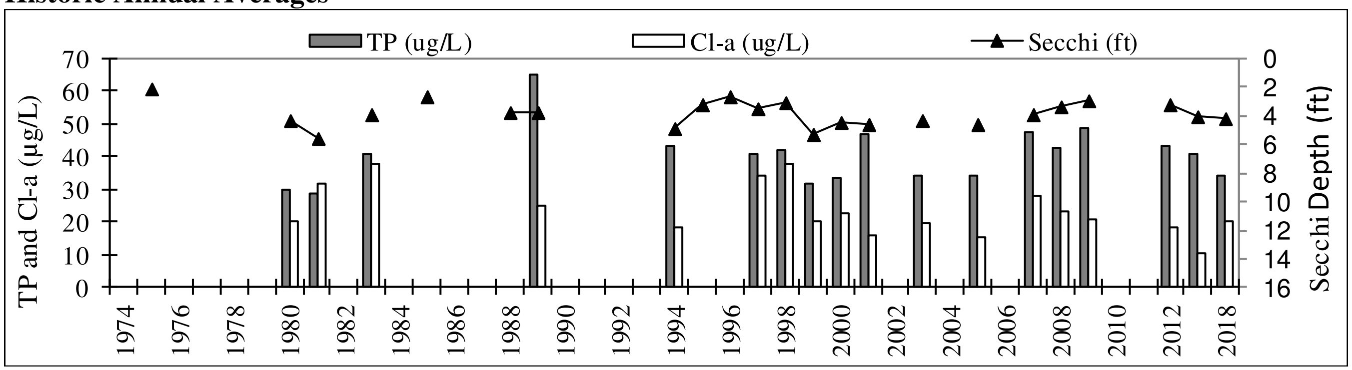
2018 Median Values

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.*	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
		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			
		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

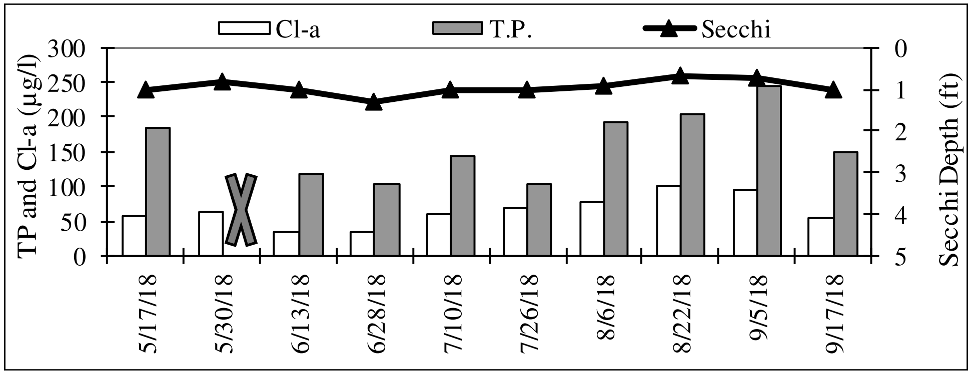
Eighteen years of water quality monitoring have been conducted by the MPCA (1993, '94, and '95) and the Anoka Conservation District (1997-2001, '03, '05, '07, '09, '12, 2014-2018). Overall, water quality has improved from 1993 to 2018 in a statistically significant way (repeated measures MANOVA with 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



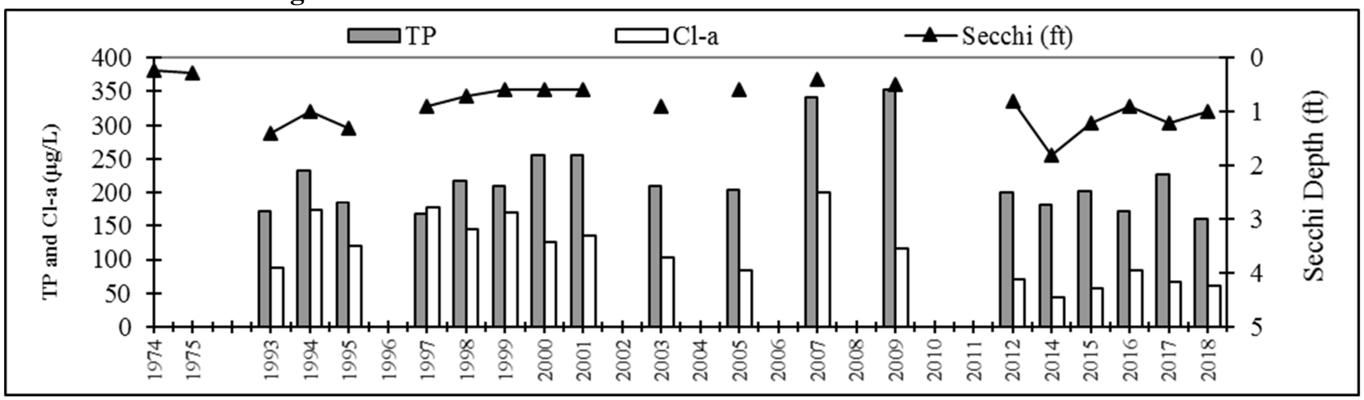
2018 Median Values

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	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			
		Time:	13:20	13:30	12:00	12:22	12:55	12:15	11:08	11:30	11:25	11:55			
		R.L.*											Average	Min	Max
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.

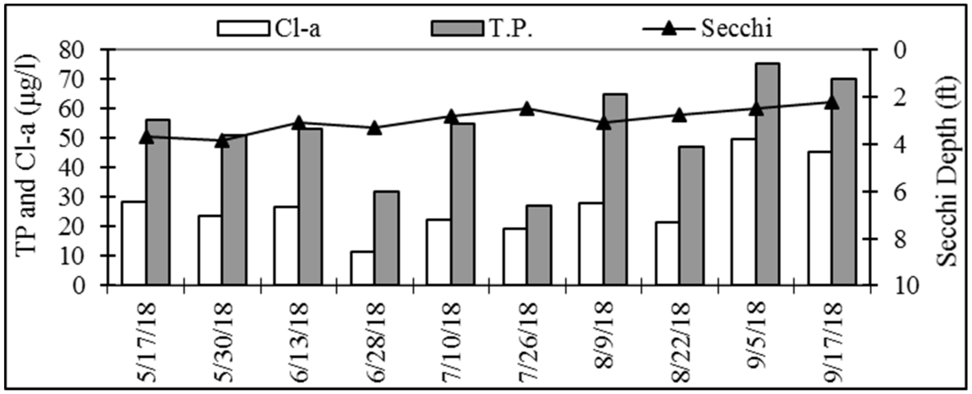
Installation of carp barriers was completed in 2016. Carp removals and other management efforts are taking place in 2017-19. Upstream of Typo Lake, a feasibility study was completed in early 2018 regarding restoration of ditched wetlands (Ditch 20). This study identified 4 potential projects and also 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



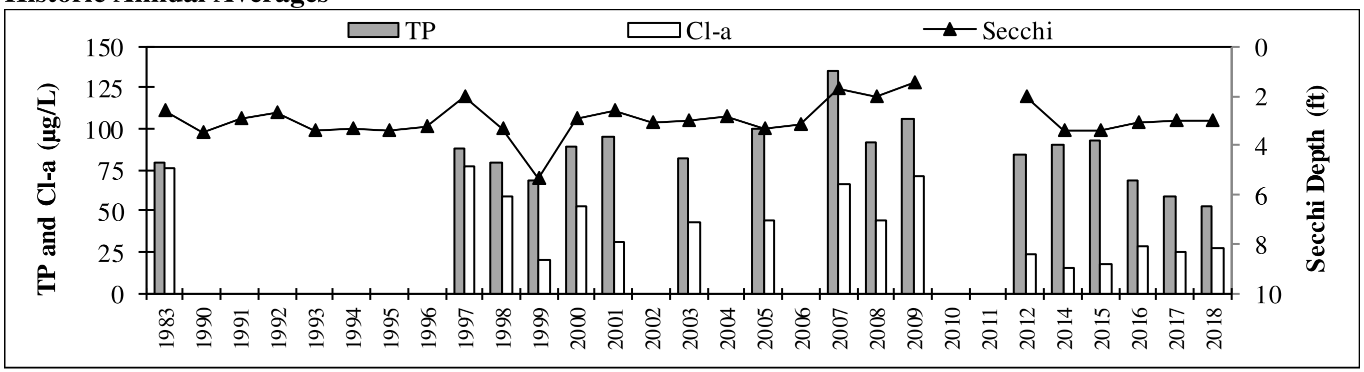
2018 Median Values

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.*	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:			14:00	14:20	13:14	11:03	12:22	11:30	11:41	12:10	10:55	11:25			
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).

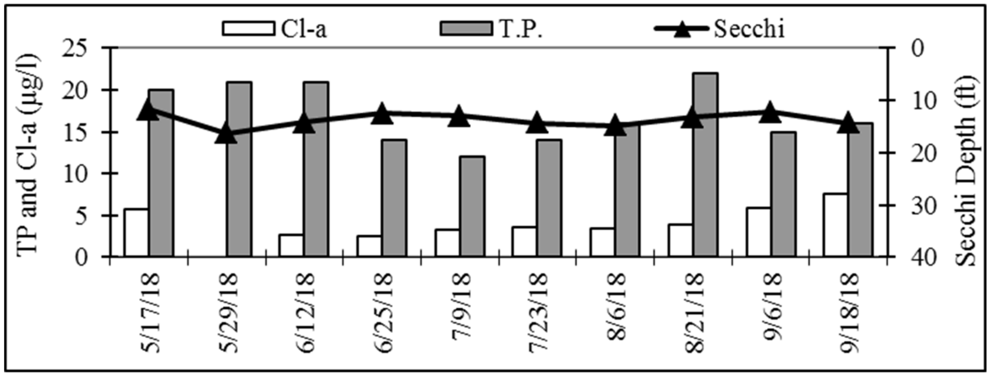
Discussion

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



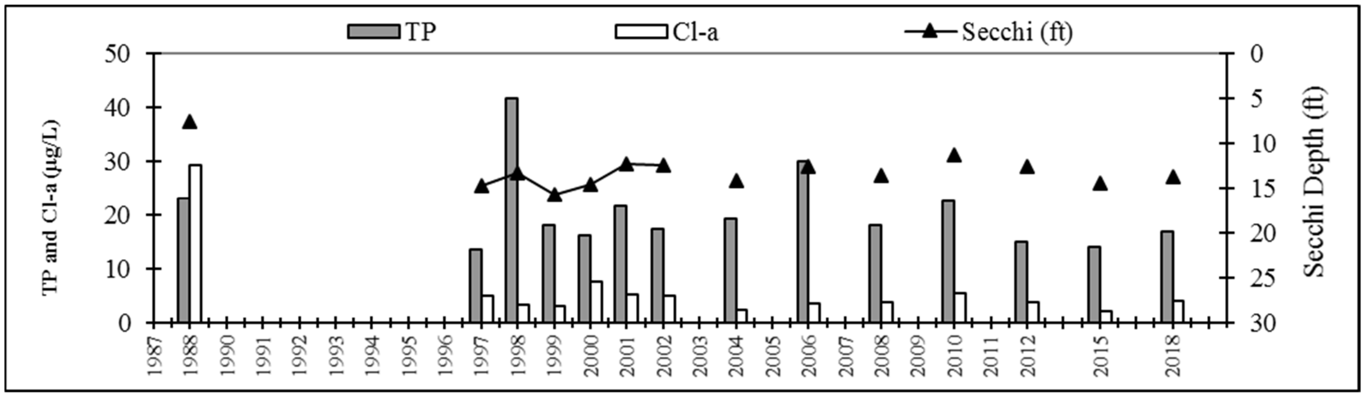
2018 Median Values

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.*	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

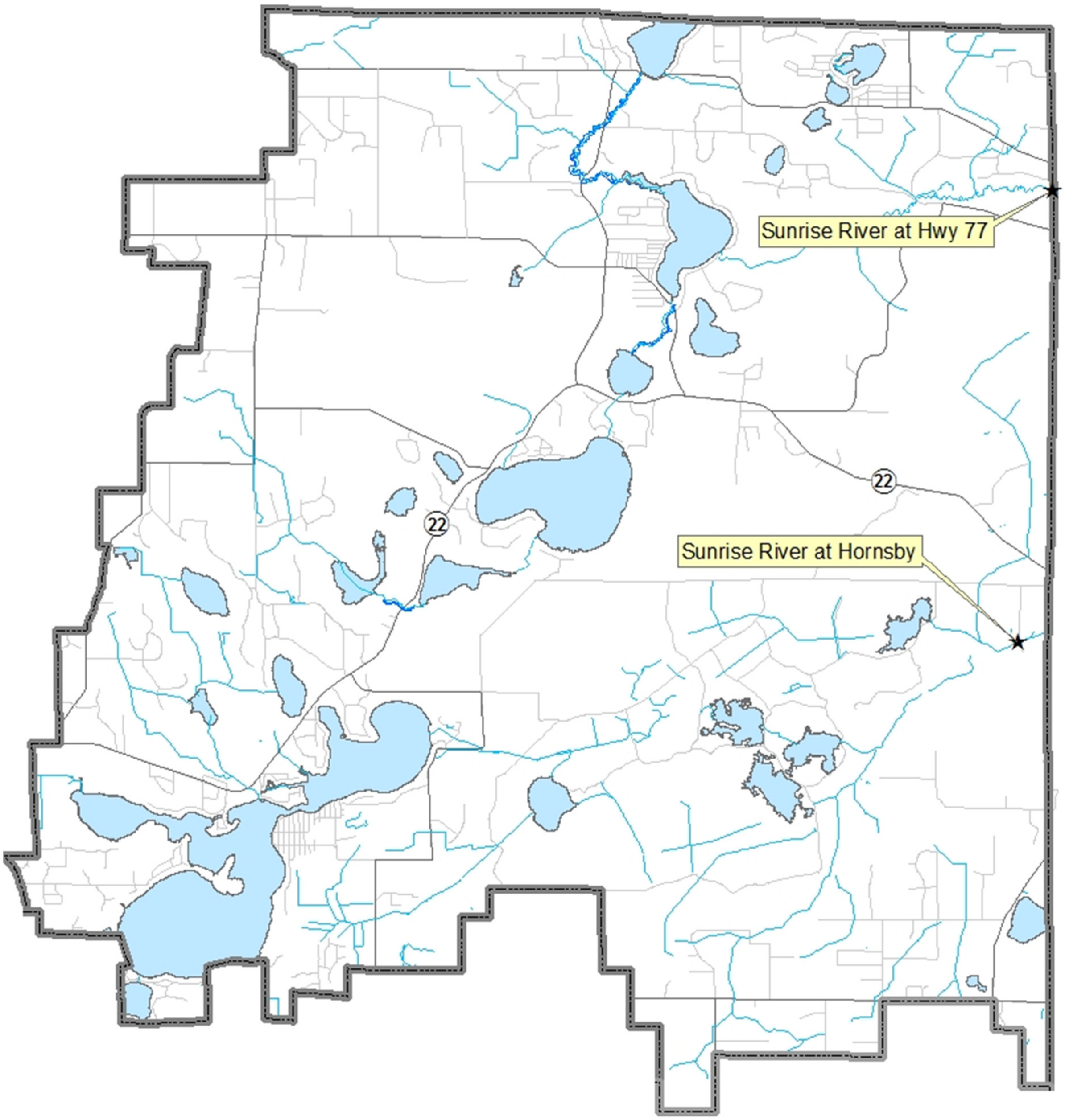
Description: Continuous water level monitoring in streams.

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

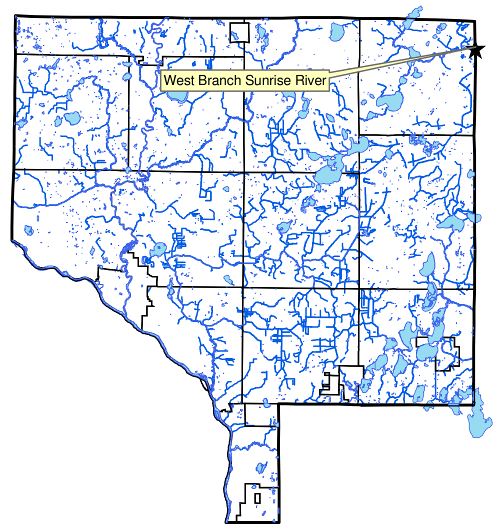


WEST BRANCH OF SUNRISE RIVER

At Co Rd 77, Linwood Township

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

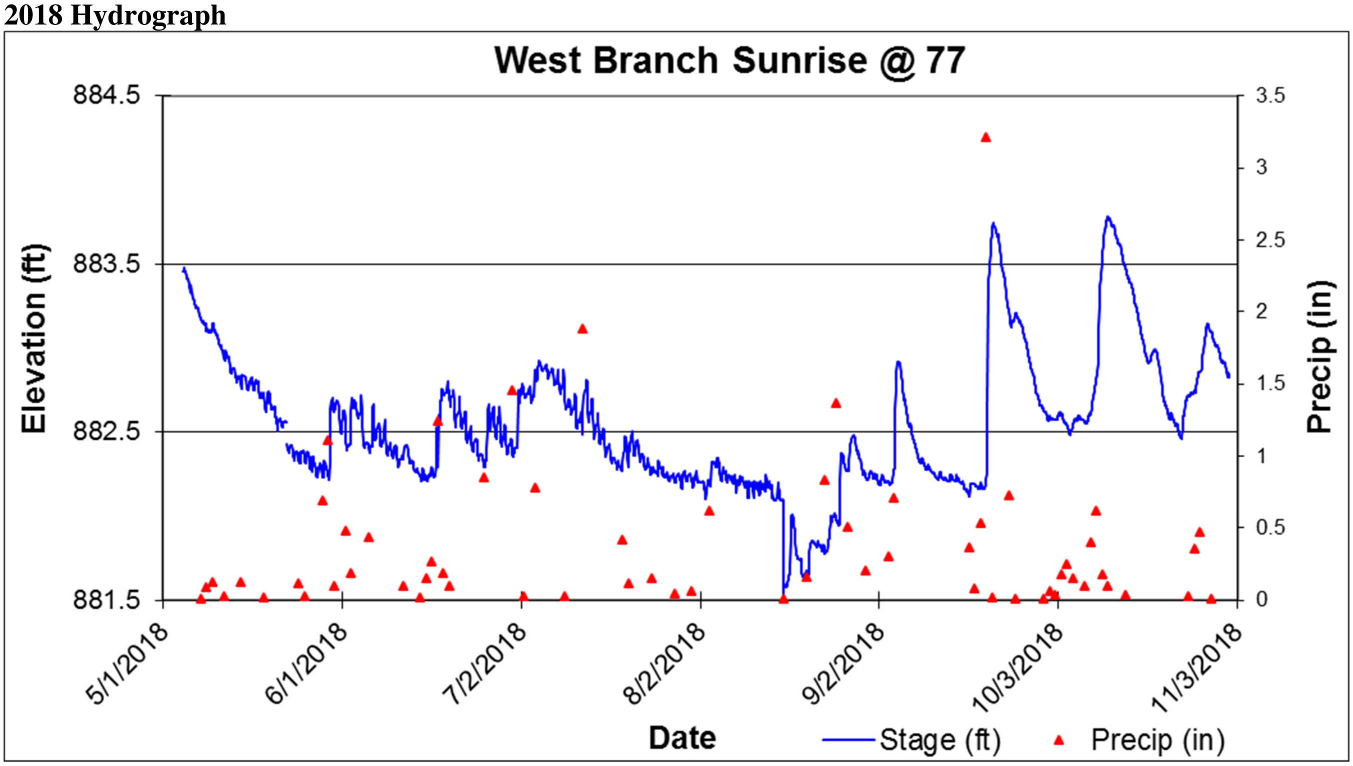
Background: This site is at the bottom of the Sunrise River watershed in Anoka County, at the Chisago County border. This site is monitored to develop an understadning of water quality and quantity in this stream when it leaves Anoka County. Upstream, this river drains through Linwood, Island, Martin, 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

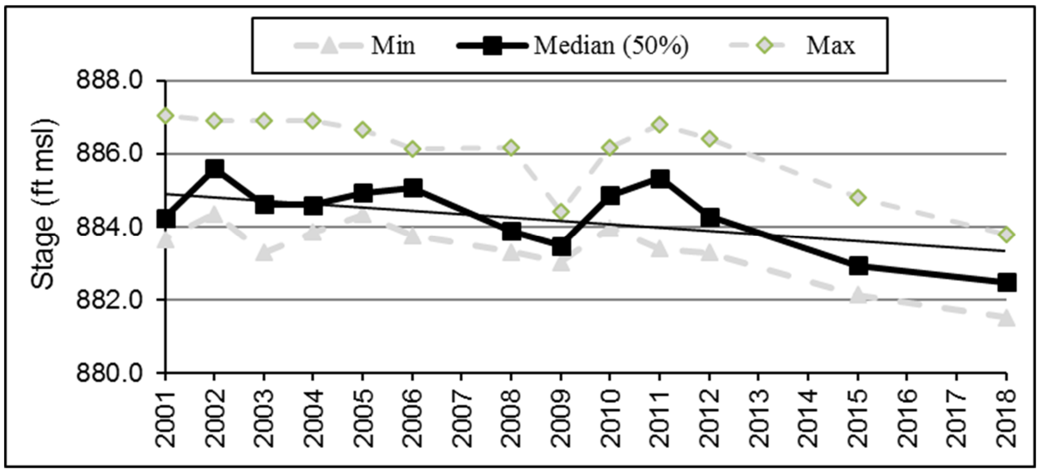


WEST BRANCH OF SUNRISE RIVER

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

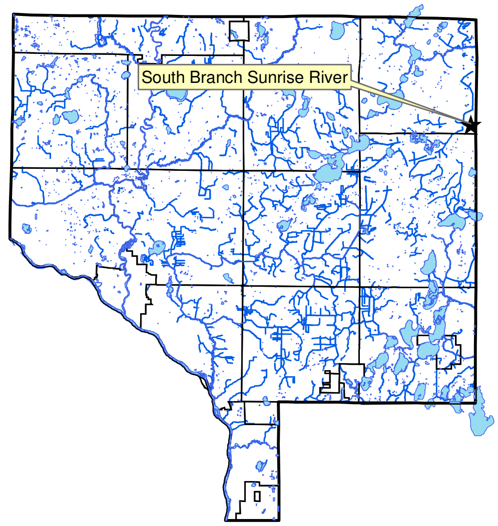


South Branch of Sunrise River at Hornsby

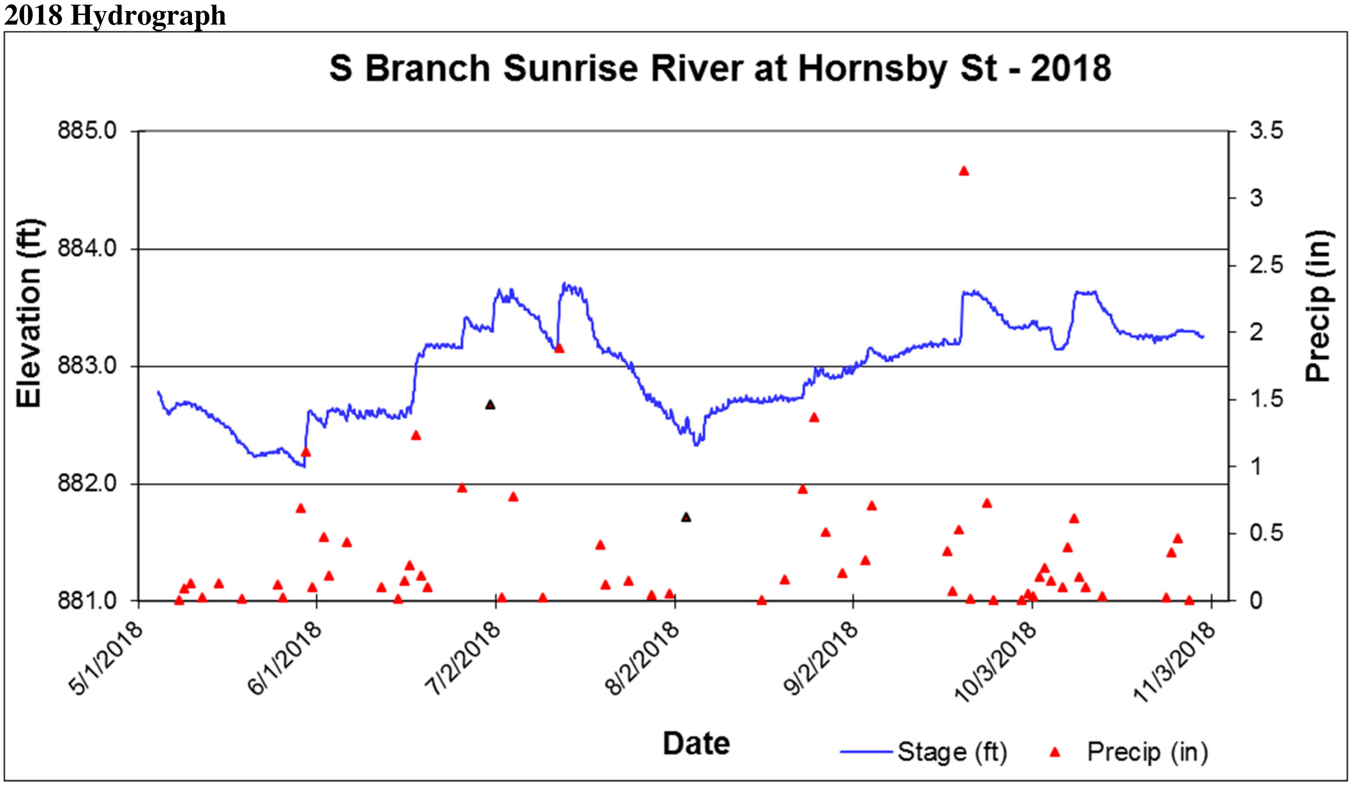
At Hornsby St, Linwood Township

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.



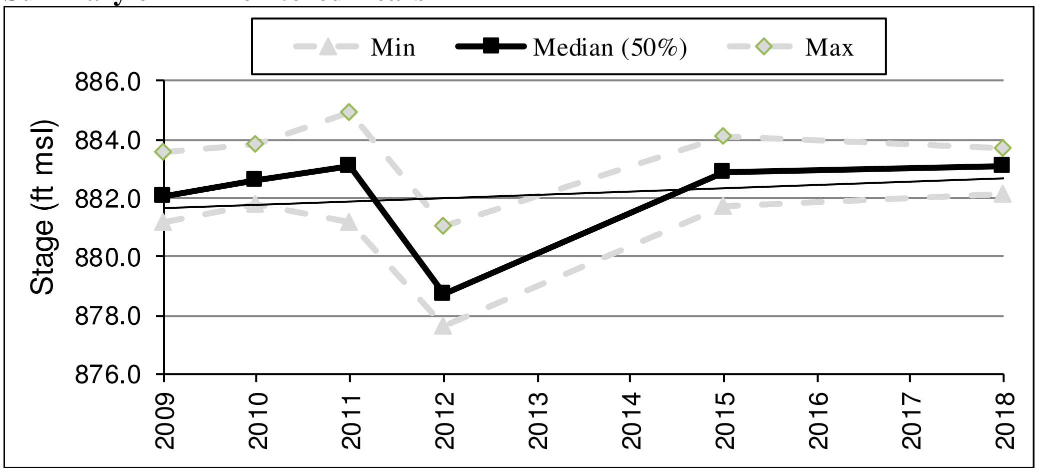
2018 Hydrograph



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

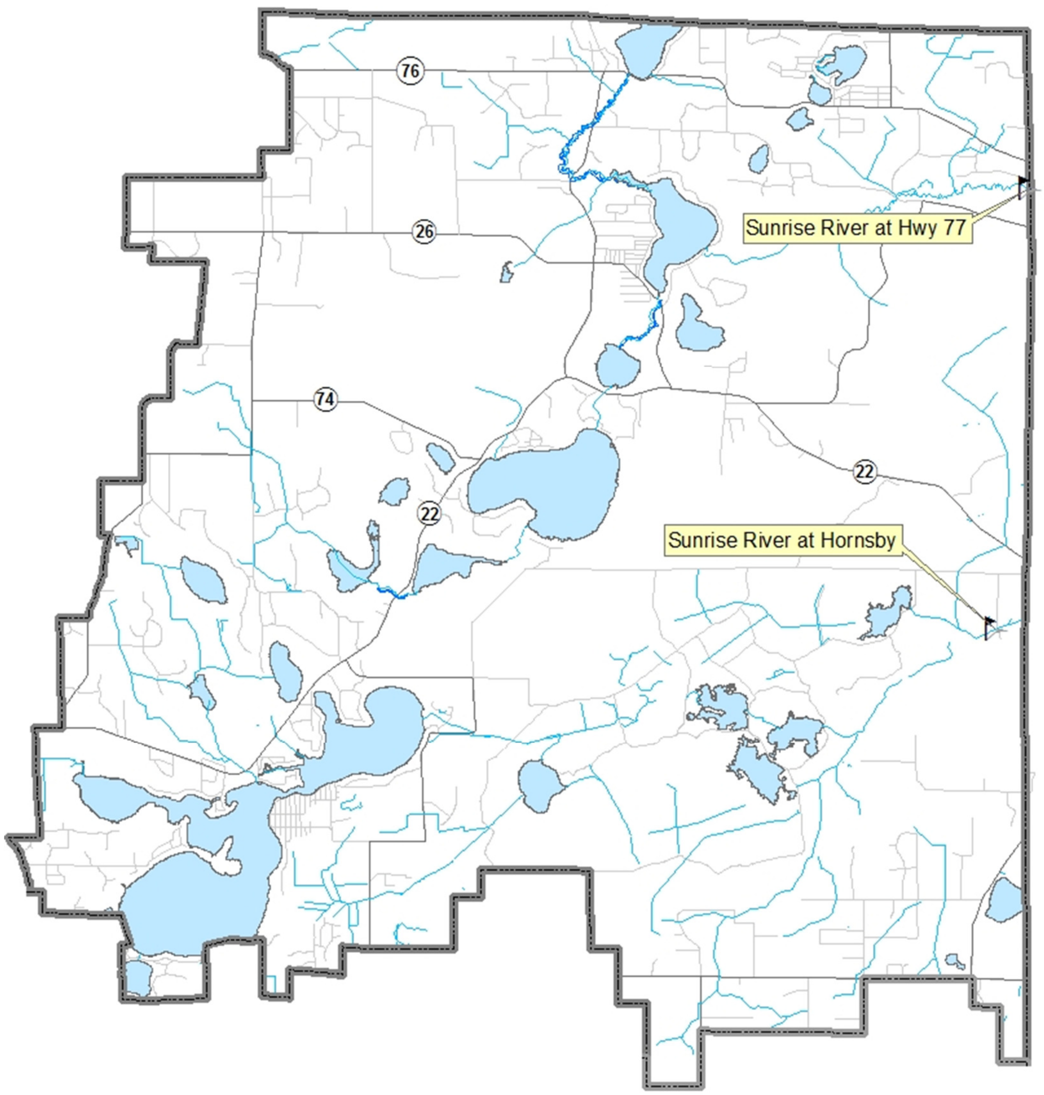
Description: Stream water quality is monitored with grab samples on eight occasions throughout the open water season, including four times immediately following a storm (1” of rain within a 24 hr. period) and four times during baseflow conditions. The selected sites are the farthest downstream limits 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.

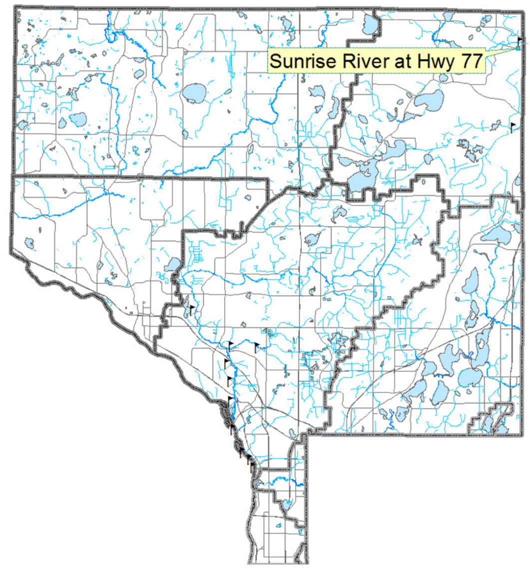
2018 Sunrise River Watershed Stream Water Quality Monitoring Sites



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.

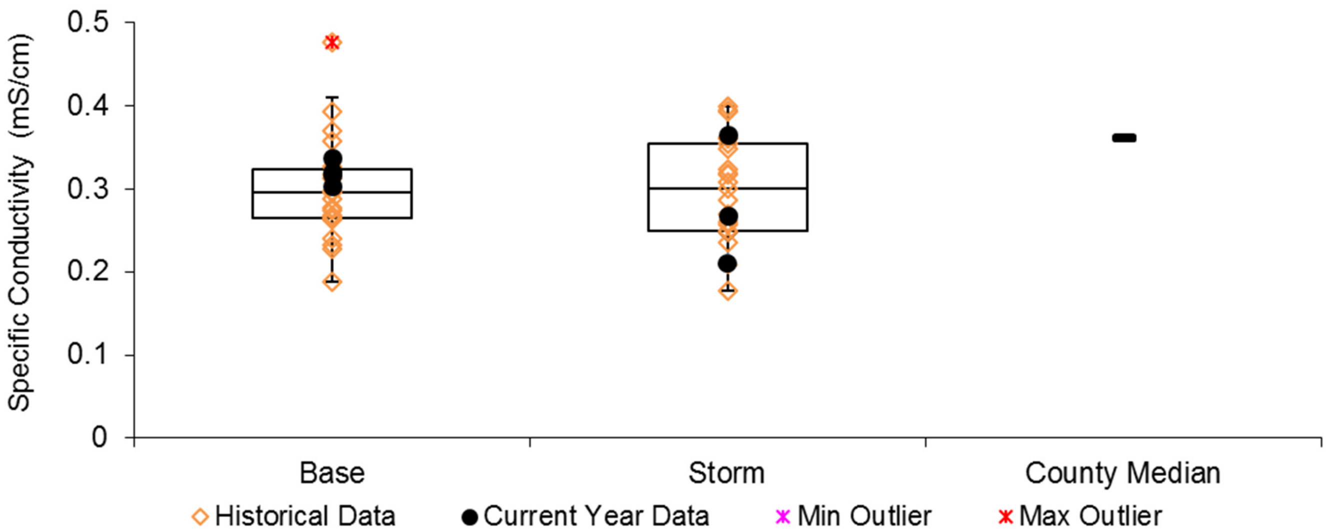
Below the data are presented and discussed for each parameter in greater detail. Management recommendations will be included at the conclusion of this report.

Specific conductivity

Specific conductivity and chlorides are measures of dissolved pollutants. Dissolved pollutant sources include urban road runoff, industrial chemicals, and others. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Specific conductivity is the broadest measure of dissolved pollutants we use. It measures electrical conductivity of water standardized for temperature; pure water with no dissolved constituents has zero specific conductivity.

Specific conductivity was acceptably low in the West Branch of the Sunrise River. Median specific conductivity this year was 0.311 mS/cm. This is notably lower than the median for 49 Anoka County streams of 0.420 mS/cm. Specific conductivity was lower during storms (baseflow median 0.319 mS/cm, stormflow median 0.240 mS/cm), suggesting that stormwater runoff contains fewer dissolved pollutants than the surficial water table that feeds the river during baseflow. High baseflow specific conductivity has been observed in many other area streams too. This has been studied extensively leading to the determination that the largest cause is road salts that have infiltrated into the shallow aquifer.

Specific conductivity during baseflow and storm conditions. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

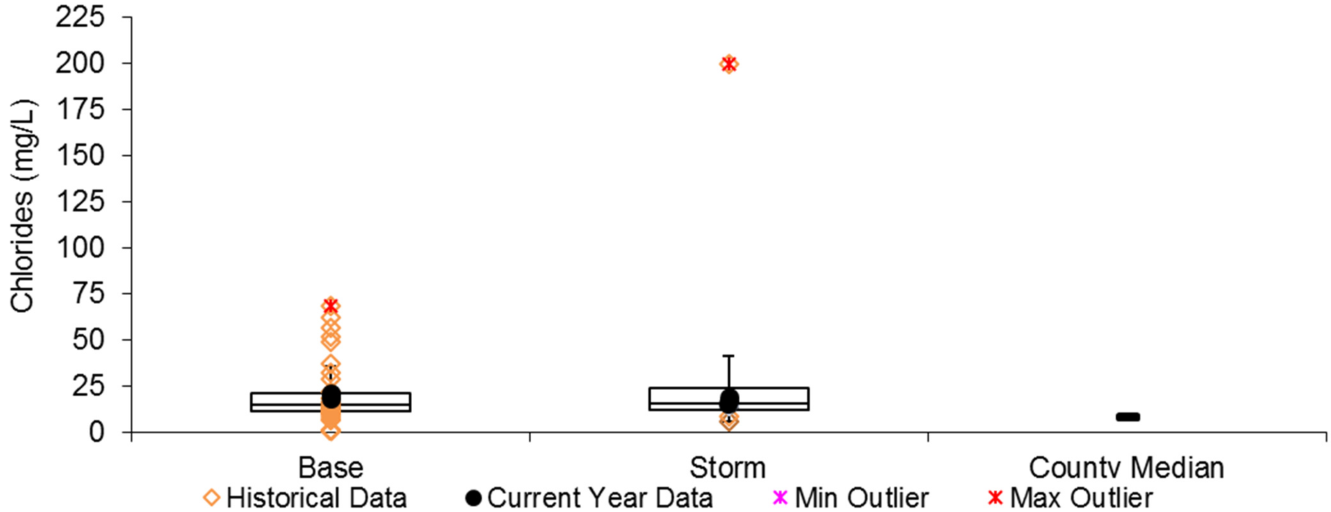


Chlorides

Chlorides are the measure of chloride salts, the most common of which are road de-icing chemicals and those used in water softening. 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. Specific Conductivity data, reported above, is partially a reflection of chlorides with higher specific conductivity corresponding to higher chlorides, generally.

Chlorides in the West Branch of the Sunrise River are higher than the median for Anoka county. This year median chlorides were 21.0 and 15.9 mg/L during base and stormflows, respectively, well below the state standard of 230 mg/L. This mirrors the pattern seen in specific conductivity of higher readings during baseflow and further supports the finding that road salts seeping into the shallow aquifer is a primary cause of higher baseflow chloride and high specific conductivity readings.

Chlorides during baseflow and storm conditions. Orange diamonds are historical data from previous years and black circles are 2018 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 are measured by filtering solids from a water sample and weighing the filtered material. The amount of suspended material is important because it effects 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.

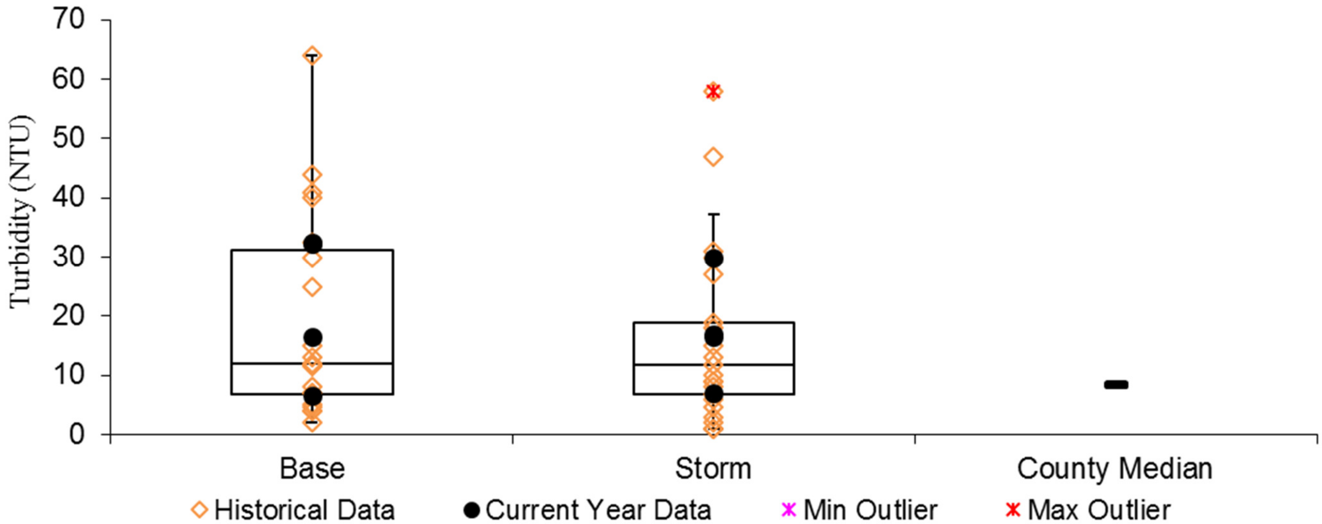
It is important to note that suspended solids can come from sources within the river itself or outside of the river from the contributing watershed. Sources from the watershed include soil erosion, road sanding, and others. In-stream sources of TSS include riverbank erosion and movement of the river bottom. Finally, algae from the river and upstream lakes contribute to suspended solids.

In the past the West Branch of the Sunrise River has been listed as "impaired" for excess turbidity by the MPCA. Their threshold is 25 NTU. If a river exceeds this value on three occasions and at least 10% of all sampling events, it is impaired for turbidity. Based on all years of data, the West Branch of the Sunrise River has exceeded 25 NTU on 13 of 48 sampling occasions (27%). Turbidity decreased markedly in the last year sampled (2015), with the highest turbidity sample being less than half the standard (11.7 NTU). In 2018 turbidity once again often surpassed the standard with 3 of 8 samples (37.5%) above 25 NTU.

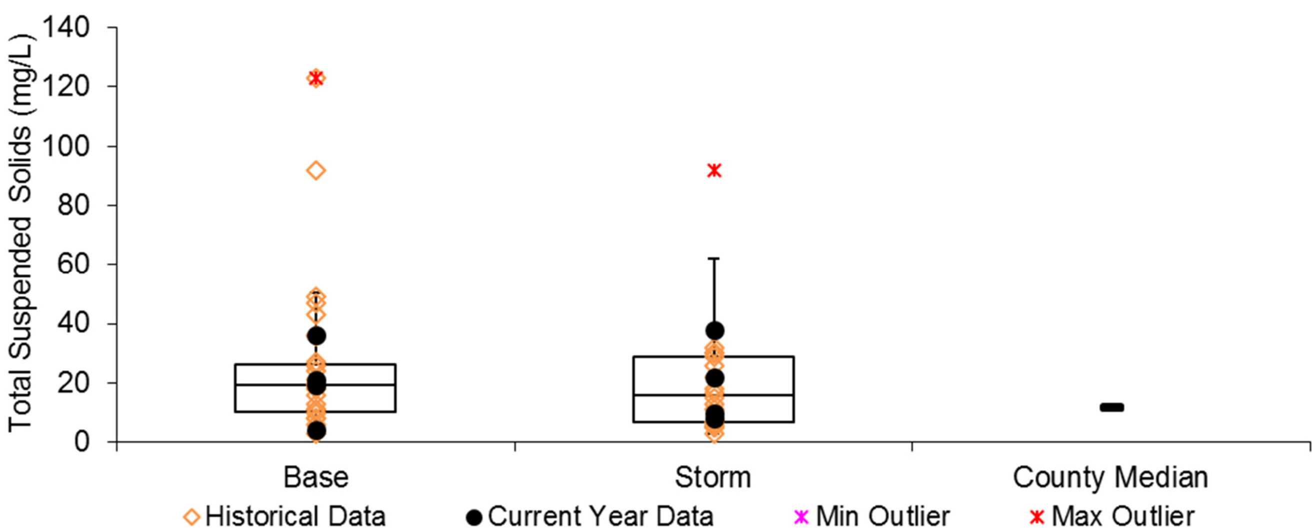
The most obvious source of turbidity is algae from upstream lakes. Three of the four immediately upstream lakes are impaired for excess nutrients and high algae. They include Linwood, Martin, and Typo Lakes. The river sampling site is 3 miles downstream from Martin Lake. The area between the lake and sampling site is wide floodplain fringe and forests with little human impact that wouldn't be expected to add much sediment to the river. Therefore, efforts to reduce suspended material in the river should focus on the upstream lakes. It is also worth noting that this section of the river has unconsolidated bottom material which can re-suspend and contribute to turbidity.

Total suspended solids in the West Branch of the Sunrise River frequently exceed the regional standard. The standard is no more than 10% of samples exceeding 30 mg/L during April 1-September 30. In 2018 the standard was exceeded on 2 of 6 sampling occasions during that period (33%), and over all years monitored the West Branch exceeded the standard on 18% of sampling occasions (7 of 39). The exceedance of the TSS standard suggests that it may be more than algae driving high turbidity and TSS readings as TSS does not reflect algae presence as much as turbidity does. However, it is still likely that the upstream impaired lakes are a leading cause of high TSS in the river due to both algae and abundant common carp disturbing the lake bottom sediments. Additionally, the unconsolidated river bottom likely contributes to high TSS, especially during times of higher flow.

Turbidity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2018 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 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

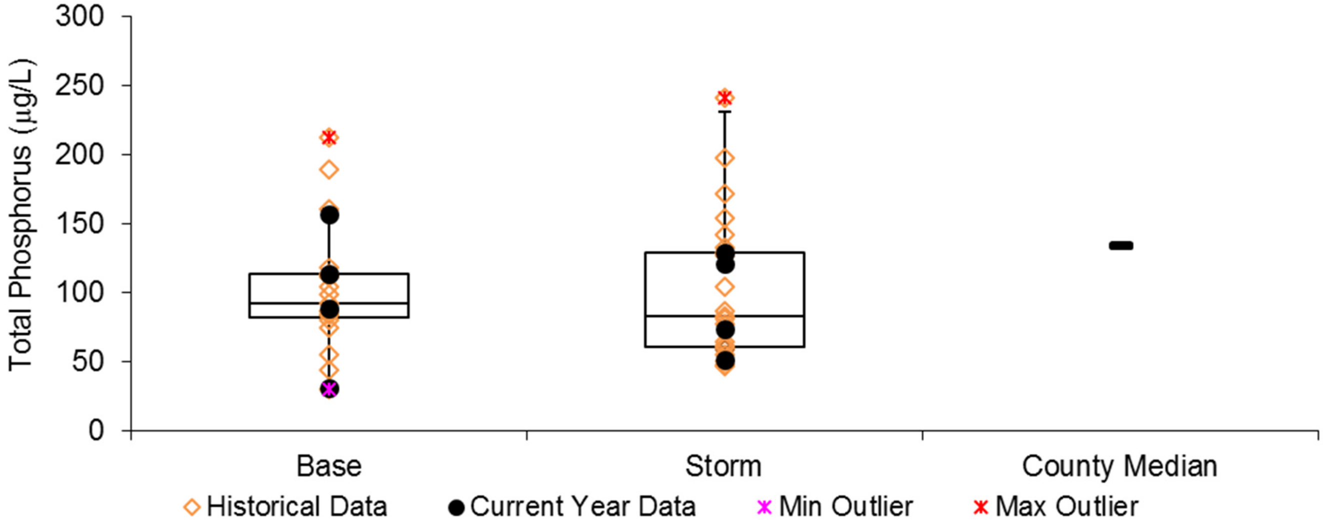


Total Phosphorus

The nutrient phosphorus is one of the most common pollutants in our region, and can be associated with urban runoff, agricultural runoff, wastewater, and many other sources. Total phosphorus (TP) in the West Branch of the Sunrise River often exceeds the state standard of 100 µg/L. In 2018 this level was exceeded on 4 of 8 sampling occasions representing both storm and baseflow conditions. The median phosphorus concentration in the West Branch of the Sunrise River across all years monitored is 88.0 µg/L, and in 2018 was 101.5 µg/L. Over all years sampled 21 of 48 samples have exceeded the standard. There is not a large difference between storm and base flow median or average total phosphorus at this site (medians 94 µg/L and 97.8 µg/L, average 97.5 µg/L and 101.5 µg/L, respectively).

These phosphorus levels are common for the area. In the case of the West Branch of the Sunrise River phosphorus levels are, at least in part, reflective of conditions of Martin Lake about 3 miles upstream from the sampling site. Martin Lake is impaired for excess phosphorus, with a summertime average of 93.4 µg/L during the last 10 years. Water quality improvements to Martin Lake will benefit the river downstream. Recent upstream projects including carp barriers, carp harvests, and stormwater retrofits coincide with improved conditions in upstream lakes, but those benefits are not yet apparent in the West Branch of the Sunrise River.

Total phosphorus during baseflow and storm conditions. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

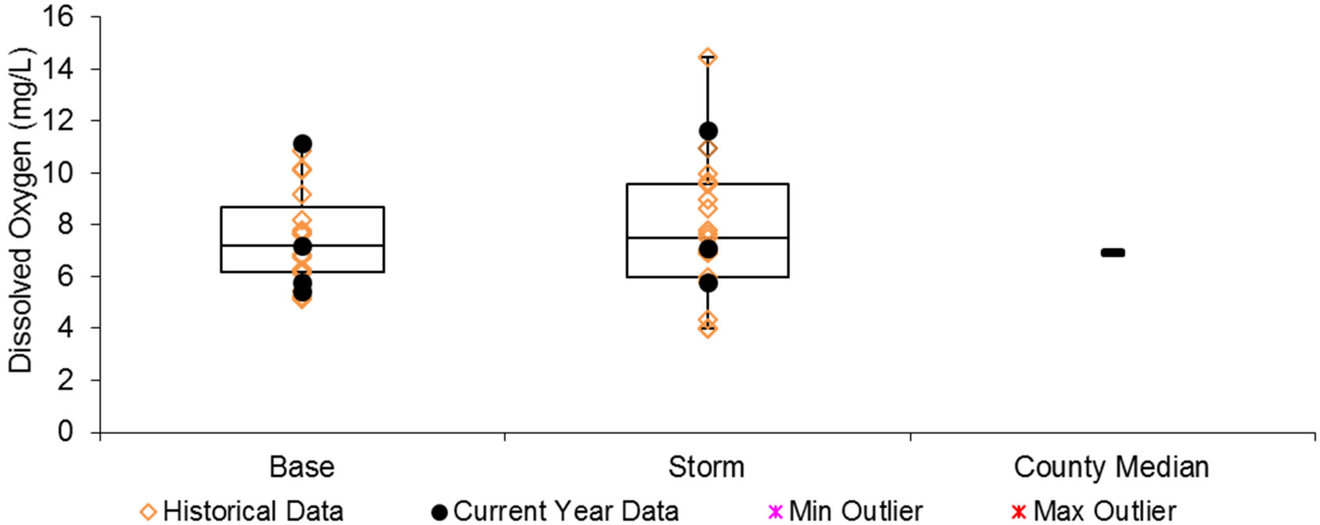


Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution causes oxygen consumption 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. The stream is 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.

For the West Branch of the Sunrise River there are two datasets to consider. First, spot measurements were taken with the other water quality monitoring described in this report. Dissolved oxygen has been found at less than 5 mg/L on three different occasions. All were during storm events, occurring in 2003, 2012 and 2015. In 2018 there were no instances of DO dipping below 5 mg/L but sampling did not occur in early morning. Secondly, MPCA took around-the-clock DO measurements for eight days in 2012. They found DO dipped below 5 mg/L every morning. The river has been designated as impaired for poor fish and invertebrate communities although it is not listed as impaired for DO.

Dissolved oxygen results during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

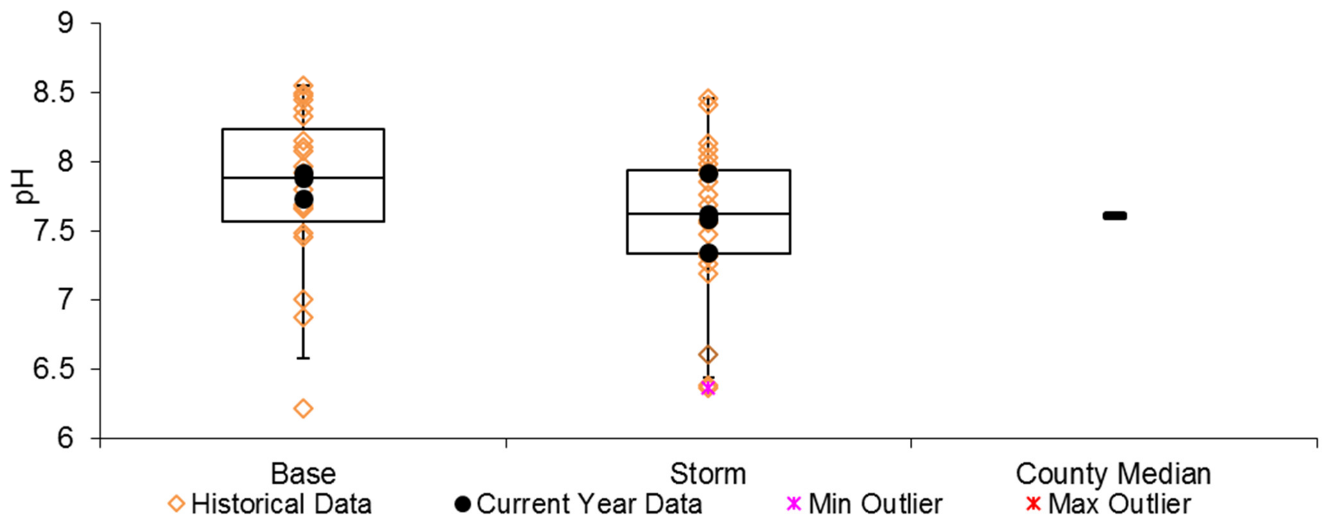


pH

pH refers to the acidity of the water. The MPCA's water quality standard is for pH to be between 6.5 and 8.5. The West Branch of the Sunrise River is regularly within this range (see figure below). It often has slightly higher pH than other streams because of the impact of algal production in upstream lakes.

It is interesting to note that pH is generally lower during storms than during baseflow. This is because the pH of rain is typically lower (more acidic). While acid rain is a longstanding problem, its effect on this aquatic system is small. In 2018 there was one occurrence of sub-standard pH in October when pH was 5.66. This is not concerning. At all other times pH was at the high end of the normal range (7.35 to 7.92).

pH results during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Recommendations

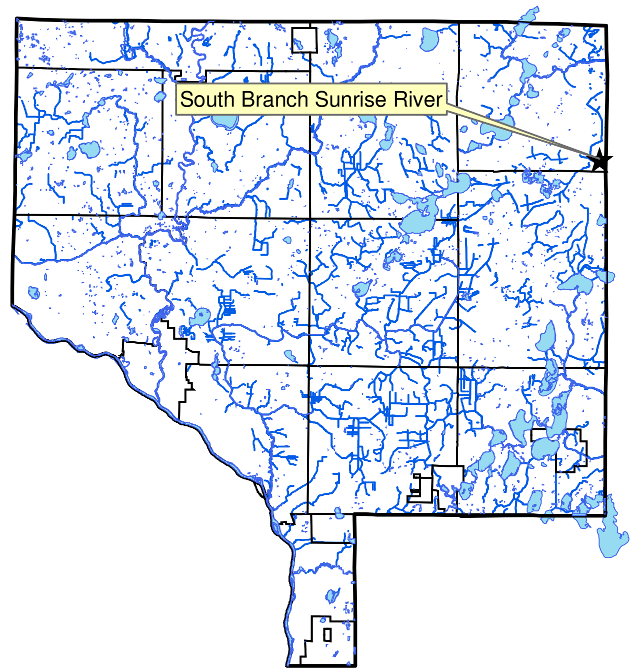
Water quality in the West Branch of the Sunrise River is lower than ideal. A Total Maximum Daily Load (TMDL) study was completed in 2013 to determine impairments of this river. The study found that aquatic life in this river was struggling with turbidity identified as the main stressor. Low dissolved oxygen may also be a stressor contributing to aquatic life impairment. At this time, it appears that many of the issues in the river would be best addressed with water quality improvement projects targeted at upstream lakes. These lakes are likely the main sources of nutrients and suspended solids in this river.

Dissolved oxygen is not low in the lakes however, and low nighttime levels in the river may be related to decomposition occurring in the large wetland floodplain. With regards to water quality improvements in the lakes there are a number of ongoing projects including carp removals in Typo and Linwood lakes. For more information, see the Martin and Typo Lake Carp Removal section.

SOUTH BRANCH SUNRISE RIVER

at Hornsby Street, Linwood Township

STORET SiteID = S005-640



Years Monitored
2012, 2015, 2018

Background

This monitoring site is 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.

The MPCA has designated this site as "impaired" due to low dissolved oxygen. A TMDL study was completed in 2013. Since that time MPCA has determined that this stream's low oxygen is primarily from decomposition in the vast upstream Carlos Avery Wildlife Management Area wetlands. Because of this, it is not a high priority for corrective action or future monitoring.

Methods

Water quality was monitored by grab samples and a portable meter. 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, salinity, and dissolved oxygen. Parameters tested by water samples sent to a state-certified lab included total phosphorus, chlorides, and total suspended solids. Water level was monitored continuously in the open water season. A rating curve has not been developed at this site so flows and thus loading cannot be calculated.

Summarized Results

Water quality in the South Branch of the Sunrise River has several problems which appear linked. The river has already been designated as impaired by the MN Pollution Control Agency for low dissolved oxygen. Our monitoring also found high turbidity and phosphorus during periods with low oxygen.

High turbidity and phosphorus coincide with low oxygen at baseflow. At times the water also has a reddish color, consistent with iron reduction during low oxygen conditions. Iron reduction is not harmful, but simply serves as a visible indicator of low oxygen conditions when phosphorus might also be released from soils through chemical processes.

Low oxygen is likely due to decomposition in upstream wetlands, which might be described as "natural." Understanding this, corrective action is a low priority. The MN Pollution Control Agency has elected not to monitor the stream in 2019-2020 for this reason. Other entities may similarly reduce activity.

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 in 2018 was 0.284 mS/cm. The median specific conductivity for all years at this site is 0.277 mS/cm.
- Chloride was measured at this site in 2012 and 2018. In 2018 the median chloride concentration was 12.8 mg/L. The median for all years at this site is 10.1 mg/L and the countywide median is 13.29 mg/L.

- Phosphorus was high and comparable to 2012 values after being relatively low in 2015. Average phosphorus this year was 131.1 µg/L after dipping to 90 µg/L in 2015. Phosphorus exceeded the state standard of ≤100 µg/L on half of all sampling occasions, with a maximum of 277 µg/L occurring on July 12th during baseflow conditions.
- Suspended solids and turbidity averaged 11.6 mg/L and 18.3 NTU, respectively in 2018. Turbidity was high during midsummer and low during spring and fall, regardless of storm or baseflow conditions. Suspended solids (TSS) also peaked in summer (20.5 mg/L on July 12) but was not as consistently high as turbidity during midsummer. Twenty measurements are required to determine if a stream fails to meet state water quality standards. This year we reached 23 measurements and at this time the stream was above the turbidity standard (25 NTU) on 13 of 23 occasions. The stream has not, on the other hand, exceeded the TSS standard (30 mg/L) at any time.
- pH was within the range considered normal and healthy for streams in this area. pH was similar during both storm and base flows though the highest pH, 8.21, occurred during baseflow conditions.
- Dissolved oxygen was low, as expected. Six out of eight reading recorded DO levels below the state standard of 5 mg/L. This river reach is already listed by the State as "impaired" for low dissolved oxygen. Interestingly, the samples taken in October had much higher DO levels (8.29 and 9.25 mg/L). These are the highest DO measurements on record. As colder water can hold more oxygen, temperature may be most responsible for this positive result.

Management Summary:

Water quality in the South Branch of the Sunrise River has several problems which appear linked. The river has already been designated as "impaired" by the MN Pollution Control Agency for low dissolved oxygen. Our monitoring also found high turbidity and phosphorus during periods with low oxygen.

The issues of low oxygen, turbidity, and phosphorus appear to be related. High turbidity and phosphorus coincide with low oxygen at baseflow. At times the water also has a reddish color, consistent with iron reduction during low oxygen. Iron reduction is not harmful, but simply serves as a visible indicator of low oxygen conditions when phosphorus might also be released form soils through chemical processes.

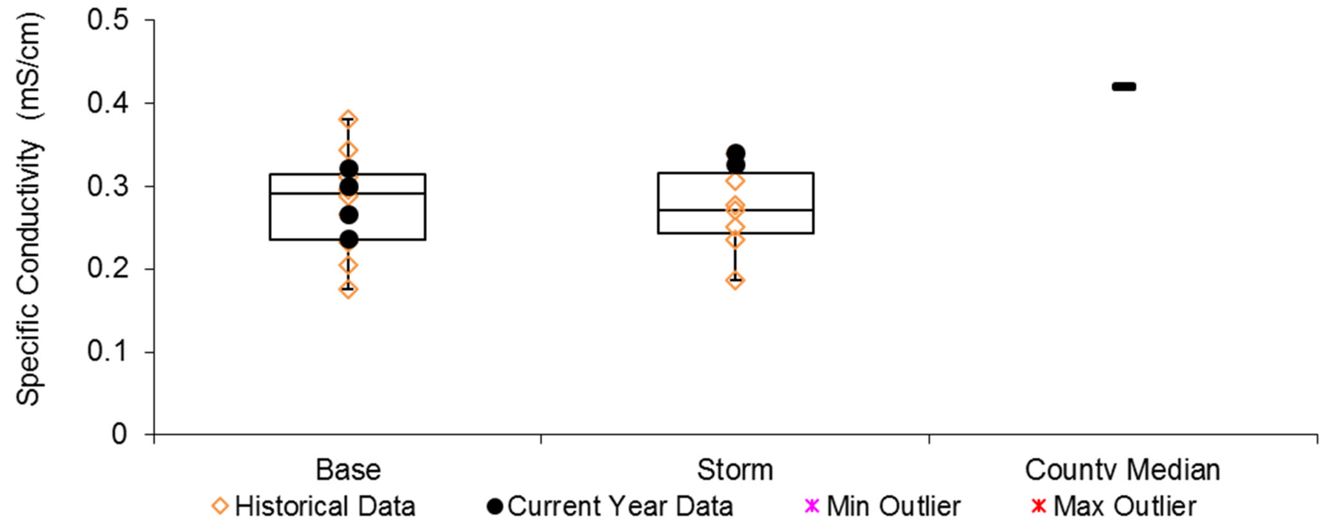
Results and Discussion

Specific Conductivity

Specific conductivity measures dissolved pollutants. Dissolved pollutant sources include urban road runoff, industrial chemicals, and others. Specific conductivity is the broadest measure of dissolved pollutants we use. It measures electrical conductivity of water standardized for temperature; pure water with no dissolved constituents has zero specific conductivity.

Specific conductivity is low in the South branch of the Sunrise River (2018 median 0.284 mS/cm). Specific conductivity was generally lower during storms, suggesting that stormwater runoff contains fewer dissolved pollutants than the surficial water table that feeds the river during baseflow. Higher specific conductivity during baseflow suggests that road deicing salts have infiltrated to the shallow groundwater that feeds the stream during baseflow (see graph on next page).

Specific conductivity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

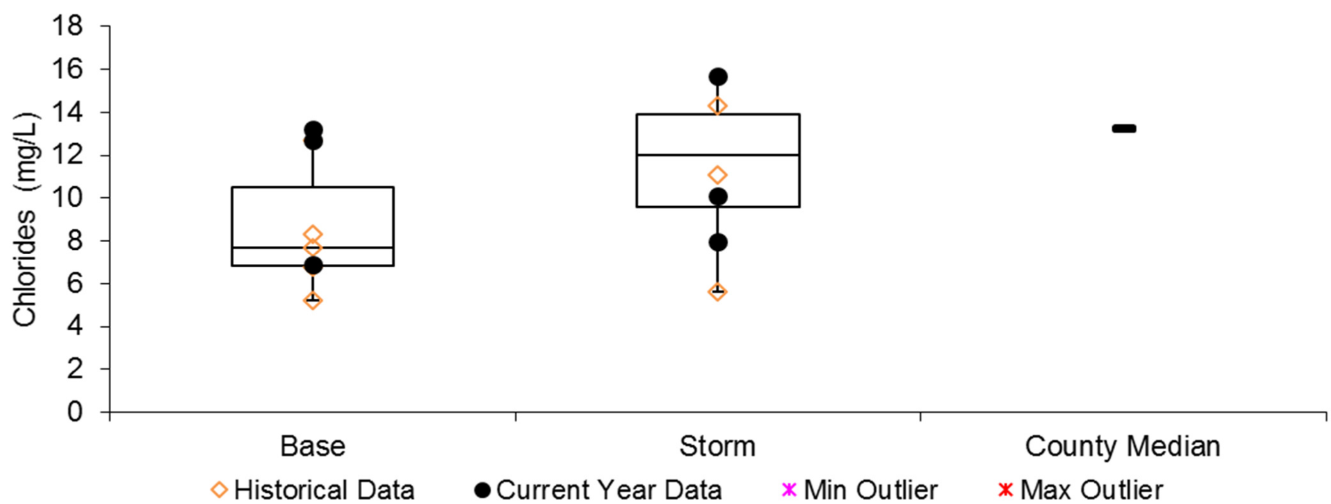


Chlorides

Chlorides tests for 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.

Chlorides have been monitored at this site in 2012 and again this year. The levels observed are much lower than the MPCA's chronic standard for aquatic life of 230 mg/L. Chlorides ranged from 6.9 to 15.7 mg/L this year and were highest in the spring and during storms. The relatively low chlorides are likely because of low road densities (and therefore deicing salt use) in the watershed. However, the higher levels in the spring may relate to winter salt use. Because of large expanses of public natural areas in the watershed, future increases in chlorides should be minimal.

Chlorides during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

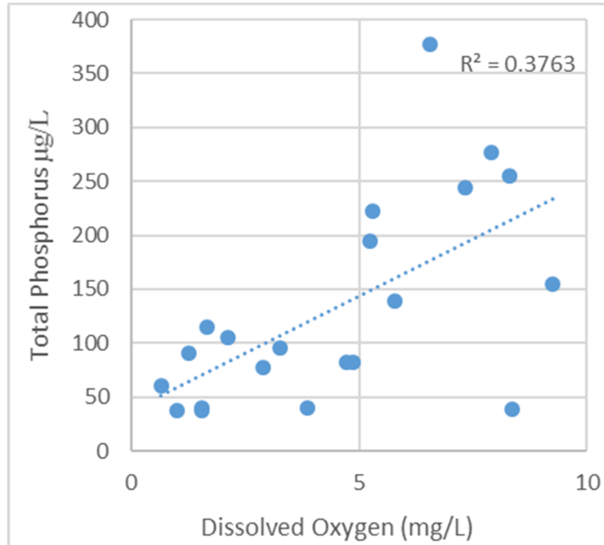


Total Phosphorus

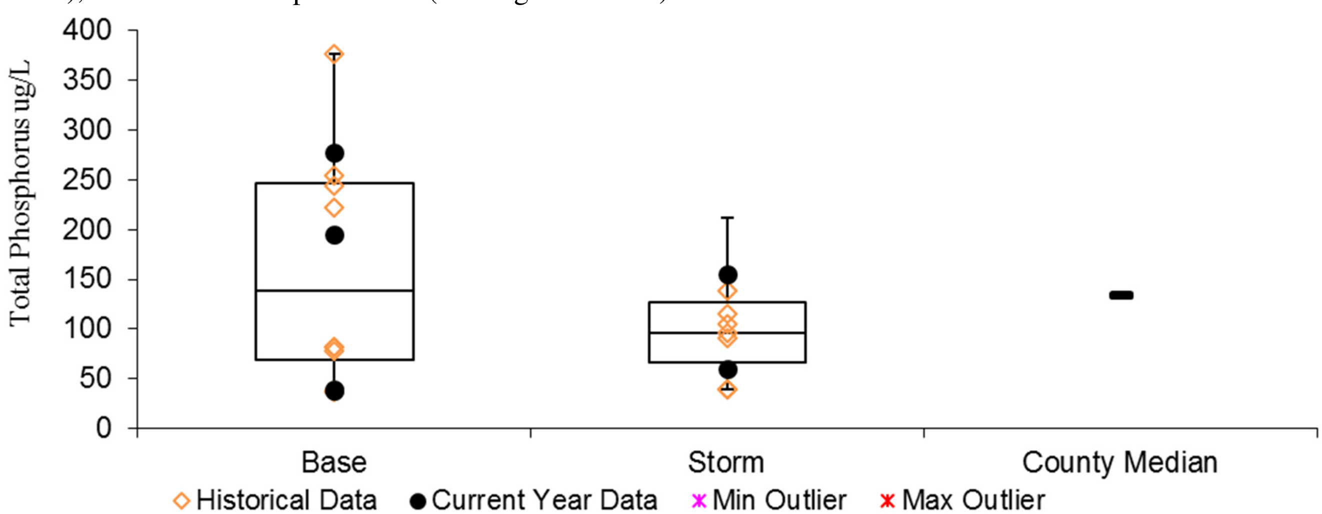
Total phosphorus (TP) in 2018 was higher during baseflow (average 137.5 µg/L) and lower during storms (average 124.8 µg/L). This is unusual as most streams experience high phosphorus as a result of storm runoff. As described earlier, we have hypothesized that an important source of phosphorus and turbidity in this river is native soils and low oxygen. During baseflow conditions the water is occasionally red tinted, dissolved oxygen is low, and phosphorus is high. When oxygen is low, the iron in soils becomes reduced. Reduced iron is less able to bind phosphorus. Dissolved oxygen and total phosphorus in the stream are loosely correlated (R^2=0.38) (see graph to right).

A management implication of these findings is that if dissolved oxygen is kept higher, then turbidity and phosphorus should fall as well. However, there will likely be challenges to achieving higher oxygen. Decomposition within the vast wetlands and pools of the Carlos Avery Wildlife Management Area upstream is likely the cause of low oxygen and it is not desirable to change the natural processes in these wetlands.

Total phosphorus as a function of dissolved oxygen showing that higher phosphorus occurs with lower dissolved oxygen.



Total phosphorus during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2018 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)

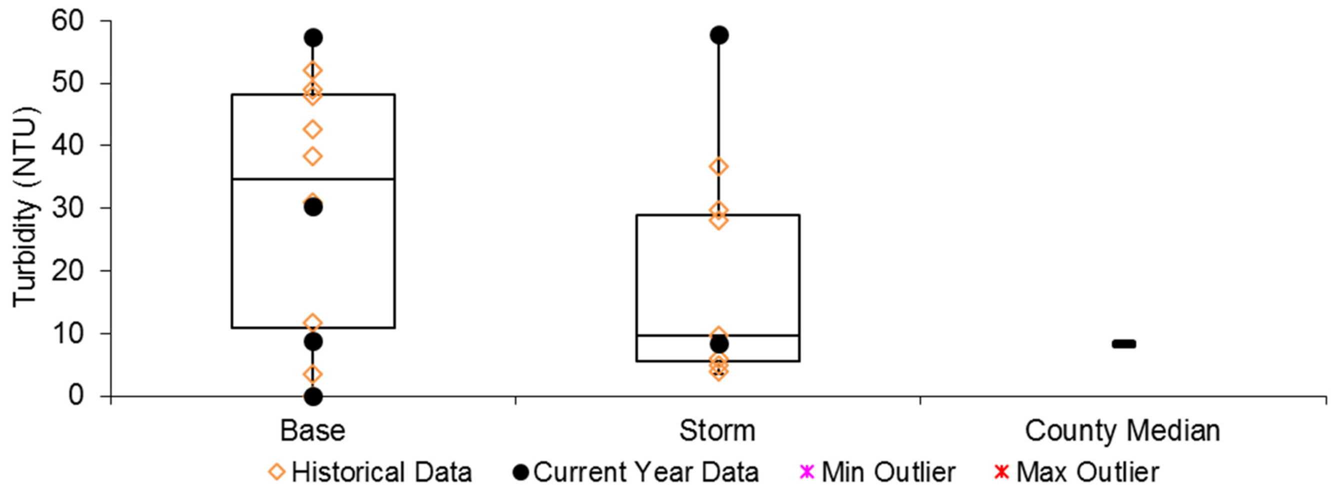
Turbidity and total suspended solids (TSS) are two different measurements of solid material suspended in the water. Turbidity is measured by refraction of a light beam passed through a water sample. It is most sensitive to large particles. Total suspended solids is measured by filtering solids from a 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.

Turbidity was similar during baseflow and stormflow samples, averaging 24.13 NTU and 24.43 NTU respectively. The state turbidity standard is no more than 10% of samples exceeding 25 NTU from April 1-September 30. In order to establish a standard impairment there needs to be at least 20 readings taken. So far, 19 readings have been taken during the required period and, of those, 11 exceeded the standard. As a result the South Branch of the Sunrise River could be designated as "impaired" for turbidity when more data exists.

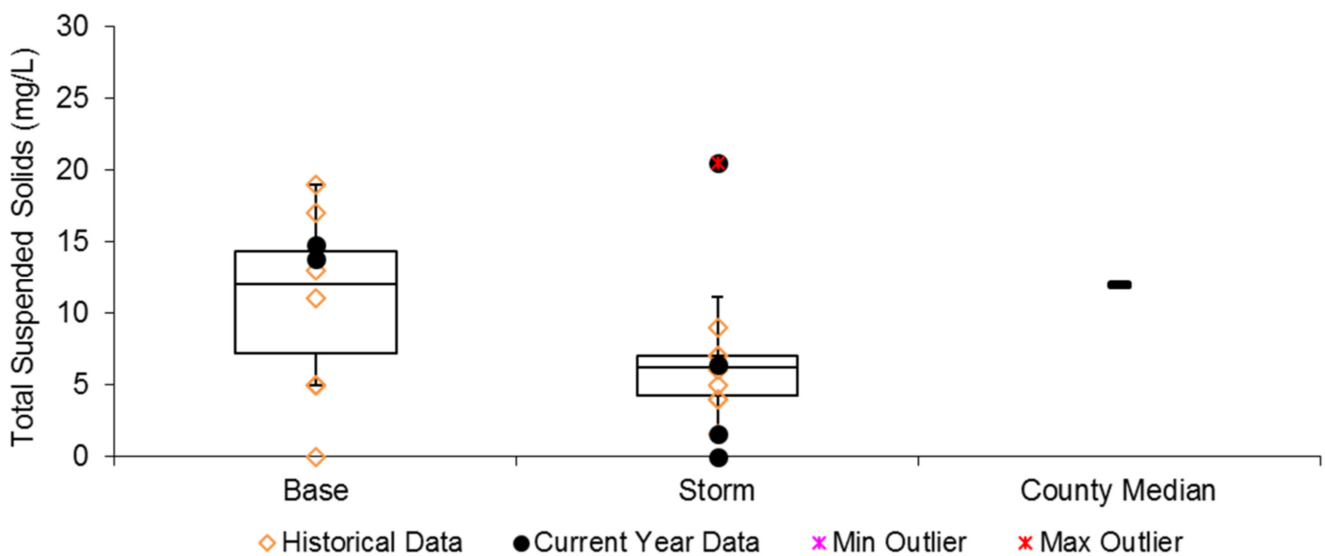
TSS concentrations were higher during baseflow than stormflow samples, averaging 13.1 mg/L and 10.2 mg/L, respectively. These concentrations remain below the state standard of 30 mg/L.

The cause of high turbidity, like high phosphorus, is likely iron-rich native soils in low oxygen conditions. Reduced iron is mobile. Another cause of turbidity may be the nature of the peat soils through which the river flows. Peat-soils when dried can be susceptible to crumbling easily. These snowflake-like particles stay suspended in the water column.

Turbidity during baseflow and storm conditions. Orange diamonds are historical data from previous years and black circles are 2018 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 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

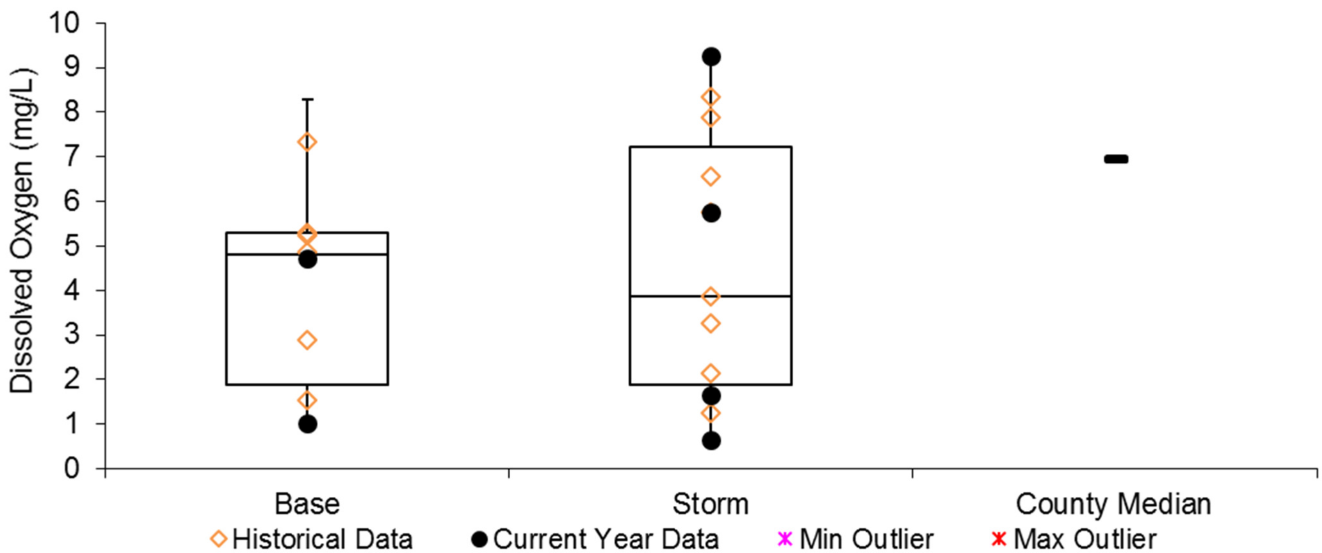


Dissolved Oxygen (DO)

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution consumes oxygen 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. The stream is 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 productions by photosynthesis.

The South Branch of the Sunrise River is already designated as “impaired” for low dissolved oxygen. In 2018, 5 out of 8 readings were below the state standard. The lowest measurement was 0.65 mg/L during a storm sample while the lowest baseflow reading was 1.01 mg/L. All readings from July through September were below 2.0 mg/L. Decomposition in the vast wetlands and pools of the Carlos Avery Wildlife Management Area upstream are the likely cause of low oxygen. While these very low levels of dissolved oxygen are not conducive to supporting aquatic life in the stream, they are attributed to natural processes.

Dissolved oxygen results during baseflow and storm conditions. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

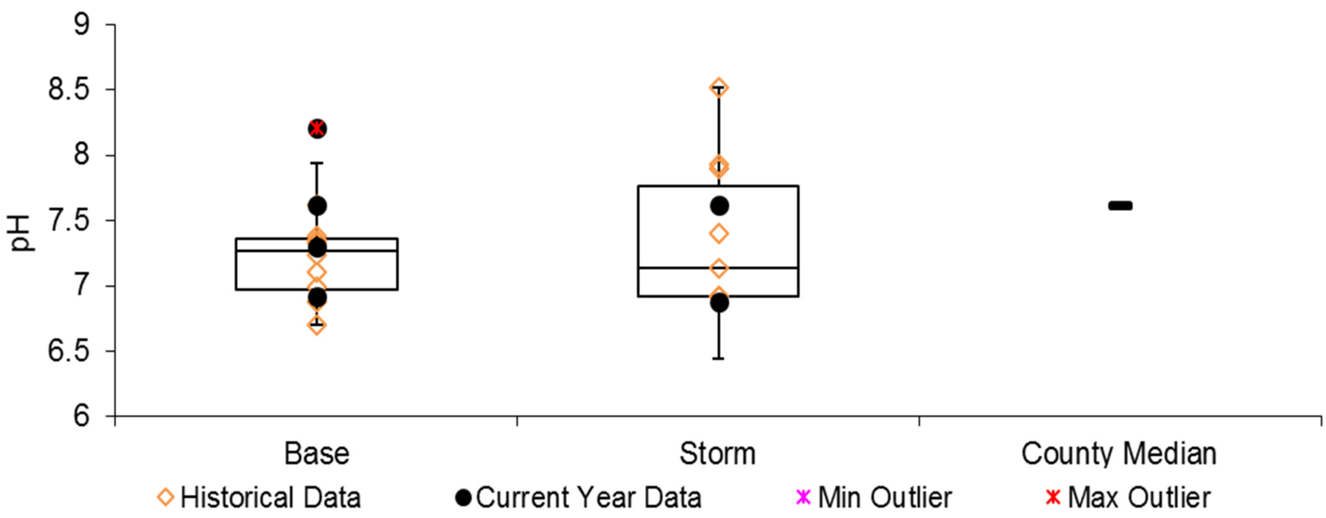


pH

pH refers to the acidity of the water. The MPCA’s water quality standard is for pH to be between 6.5 and 8.5.

pH in the South Branch of the Sunrise River is within the acceptable range, however the results between storm and baseflow are the opposite of most streams. In most streams, pH lowers during storms due to the acidity of rainfall. At this river pH was higher during storms, although the variation was not large. During baseflow pH ranged from 6.92-8.21, during storms pH ranged from 6.44-7.62. The reason for this may simply be the small number of samples collected during each condition. A graph of all years of pH data is presented on the next page.

pH results during baseflow and storm conditions. Orange diamonds are historical data from previous years and black circles are 2018 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) study was completed in 2013 to determine the causes of impairments of this river. While presently this river's only impairment is dissolved oxygen, we suggest that a focus should also be improving turbidity and total phosphorus. These improvements should be low priorities for managers as the cause is natural decomposition in large upstream wetlands.

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.

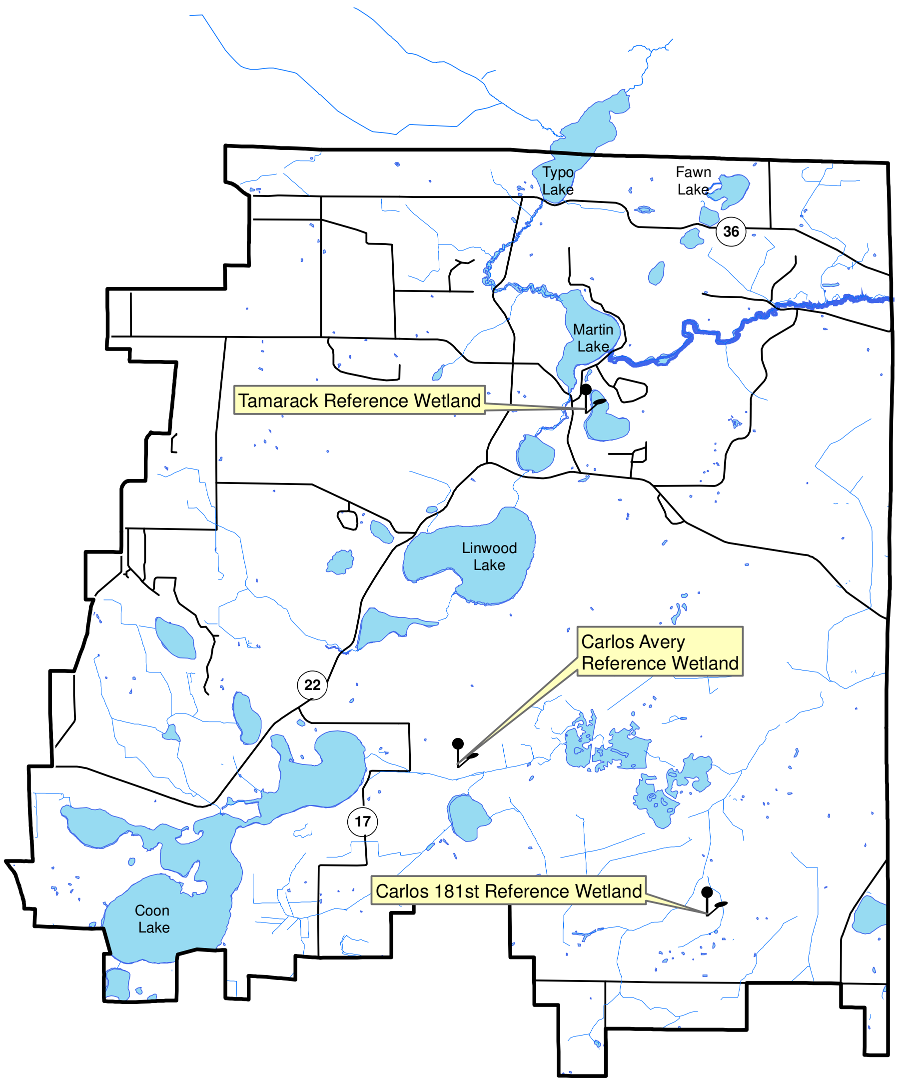
Locations: Carlos Avery Reference Wetland, Carlos Avery Wildlife Management Area, City of Columbus

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

Tamarack Reference Wetland, Linwood Township

Results: See the following pages.

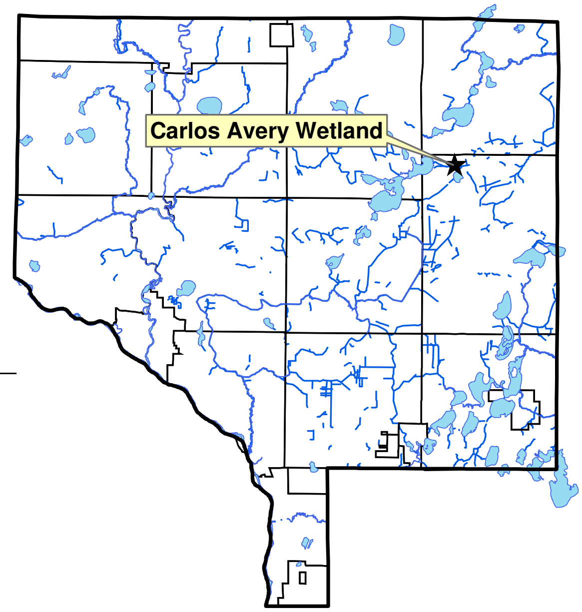
Sunrise Watershed Wetland Hydrology Monitoring Sites



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

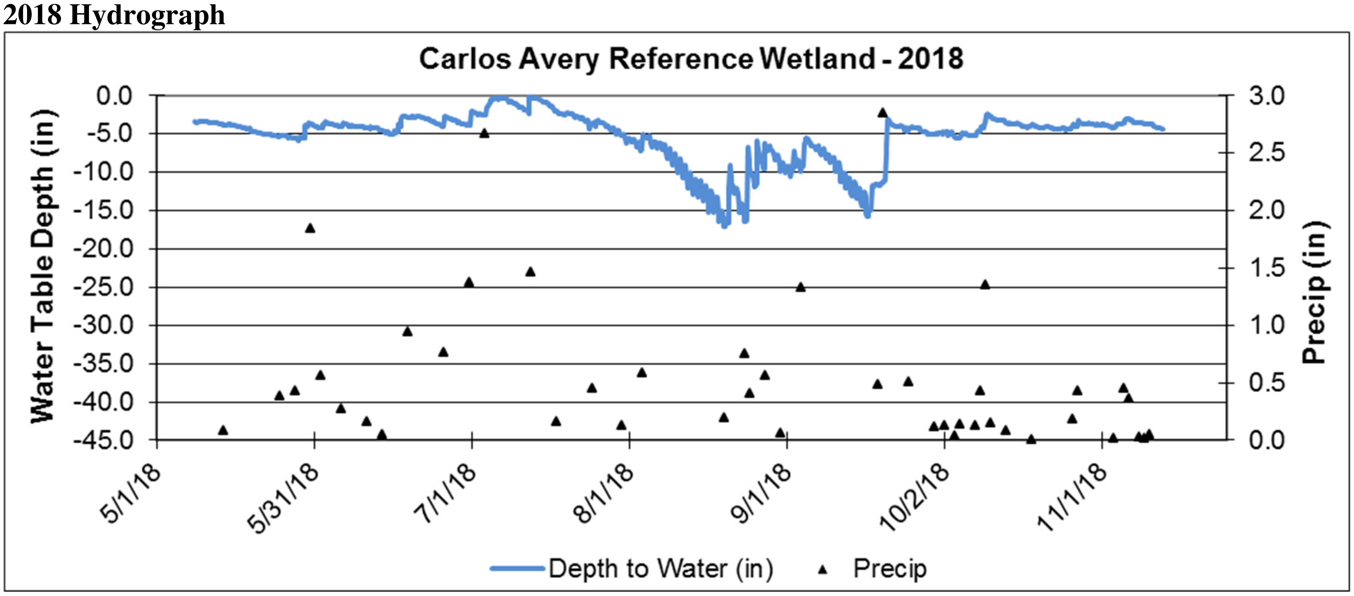
Surrounding Soils: Lino loamy fine sand

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

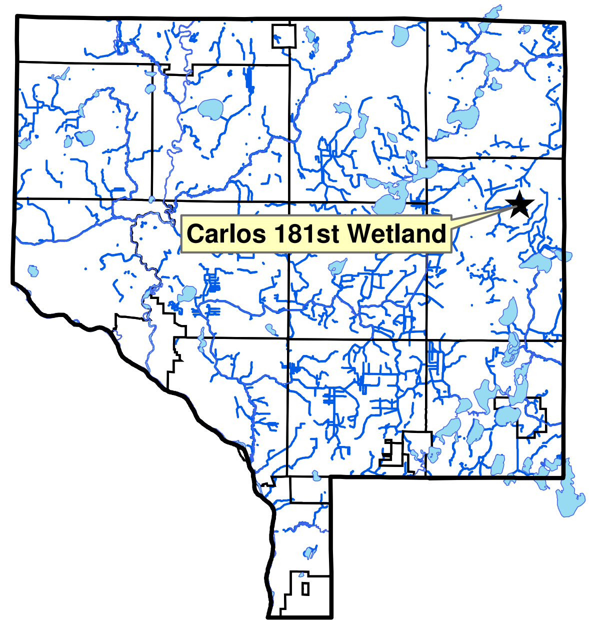
Other Notes: This is a broad, expansive wetland within a state-owned wildlife management area. Cattails dominate within the wetland.

2018 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	-

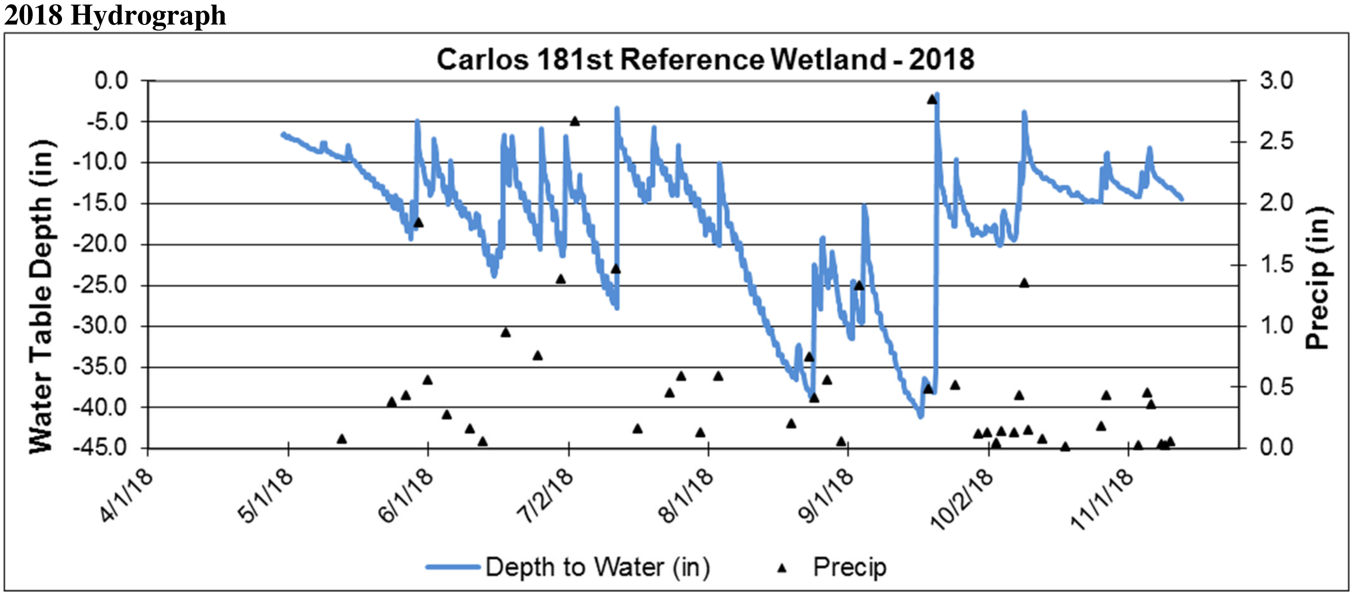
Surrounding Soils: Soderville fine sand

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 the MN DNR. Access is from 181st Avenue.

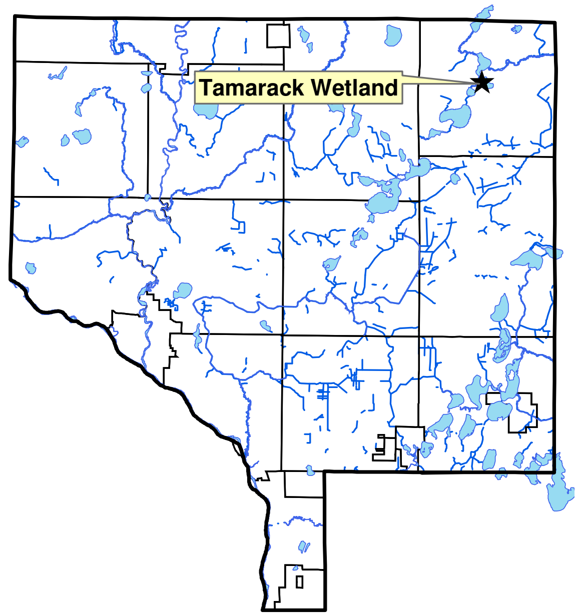
2018 Hydrograph



Wetland Hydrology Monitoring

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	-

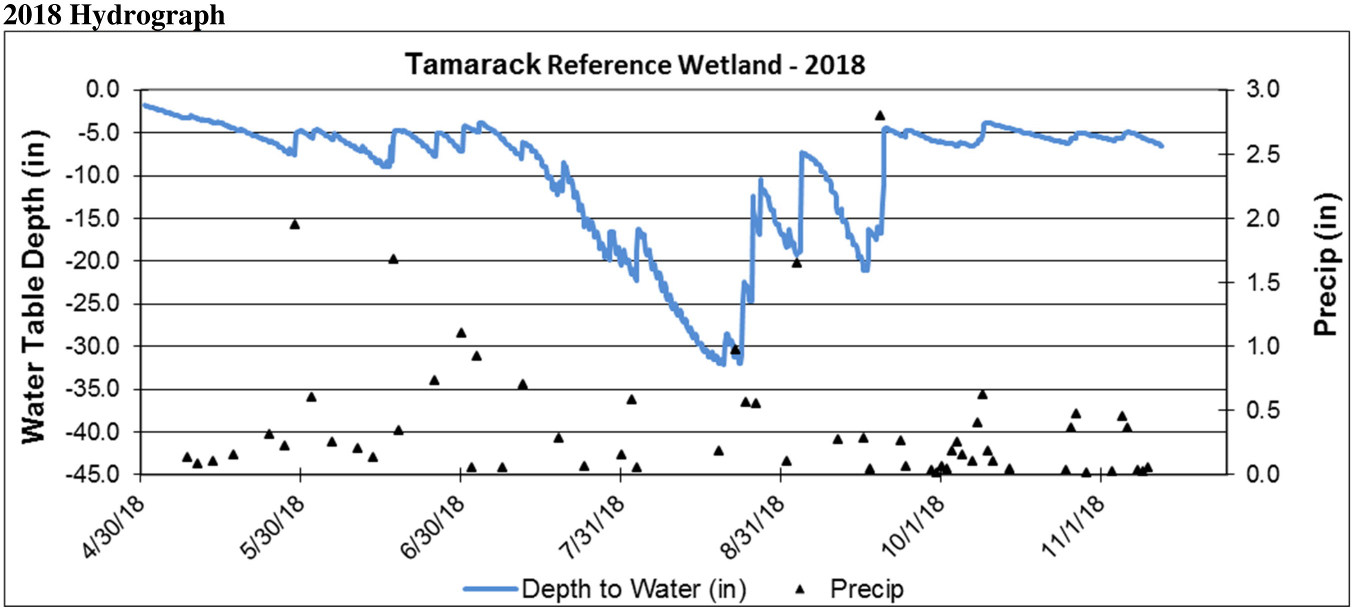
Surrounding Soils: Sartell fine sand

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.

2018 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 cost sharing of the materials needed for a project. The landowner is responsible for some expenses. 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.

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 – Voss Rain Garden Plants	-	$ 654.50
2017 SRWMO Contribution	+	$1,000.00
2018 Surplus Funds Returned from ACD to SRWMO Gen Fund	-	$2,000.00
2018 Expense – Gunnink Coon Lakeshore	-	$1,148.40
Fund Balance		**$3,816.53**

Gunnink Lakeshore Restoration

Description: A Coon Lake lakeshore restoration was completed on private property using SRWMO water quality cost share funds in 2018.

Purpose: To stabilize minor shoreline erosion, filter runoff to the lake and provide shoreline habitat.

Location: Coon Lake, 3573 Interlachen Drive NE

Results: 102 linear feet of native plant shoreline buffer totaling 1,276 square feet was installed. This included 60-feet of biology at the water's edge to stop minor existing shoreline erosion. The Anoka Conservation District provided the design, permitting assistance and construction oversight. Construction was done by Shoreline Landscaping Inc.

Finances: Expenses

$730.00	Design, permitting and planning assistance
$8,009.30	Installation by contractor
$8,739.30	TOTAL

Funding

$1,148.00	Cost share grant through ACD using SRWMO funds
$7,591.50	Landowner
$8,739.30	TOTAL

Pre-project photo

Post-installation photo

Martin and Typo Lake Carp Removal Project

Description: Martin and Typo 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. Efforts to manage and reduce carp are being undertaken to improve both water quality and the fishery.

In 2015-2016 carp barriers were installed at four strategic locations near the inlets and outlets of both lakes to prevent carp migration, overwintering, and spawning. In 2017-2019 carp are being removed. Additionally, a detailed assessment of the carp population, age structure, and spawning history is being completed. A long-term management plan for carp will be prepared in 2019.

Purpose: To improve water quality in Typo and Martin Lakes, as well as downstream waterways.

Location: Typo and Martin Lakes

Results: In 2018 the following work was completed:

- Radio telemetry monitoring of carp in Typo and Martin Lakes.
- 209 carp heads were preserved for aging during winter 2017-18. Fish age is determined by internal balance organs called otoliths. The population age structure reveals the spawning history.
- 3,366 carp were removed from Martin Lake and 3,552 carp were removed from Typo Lake

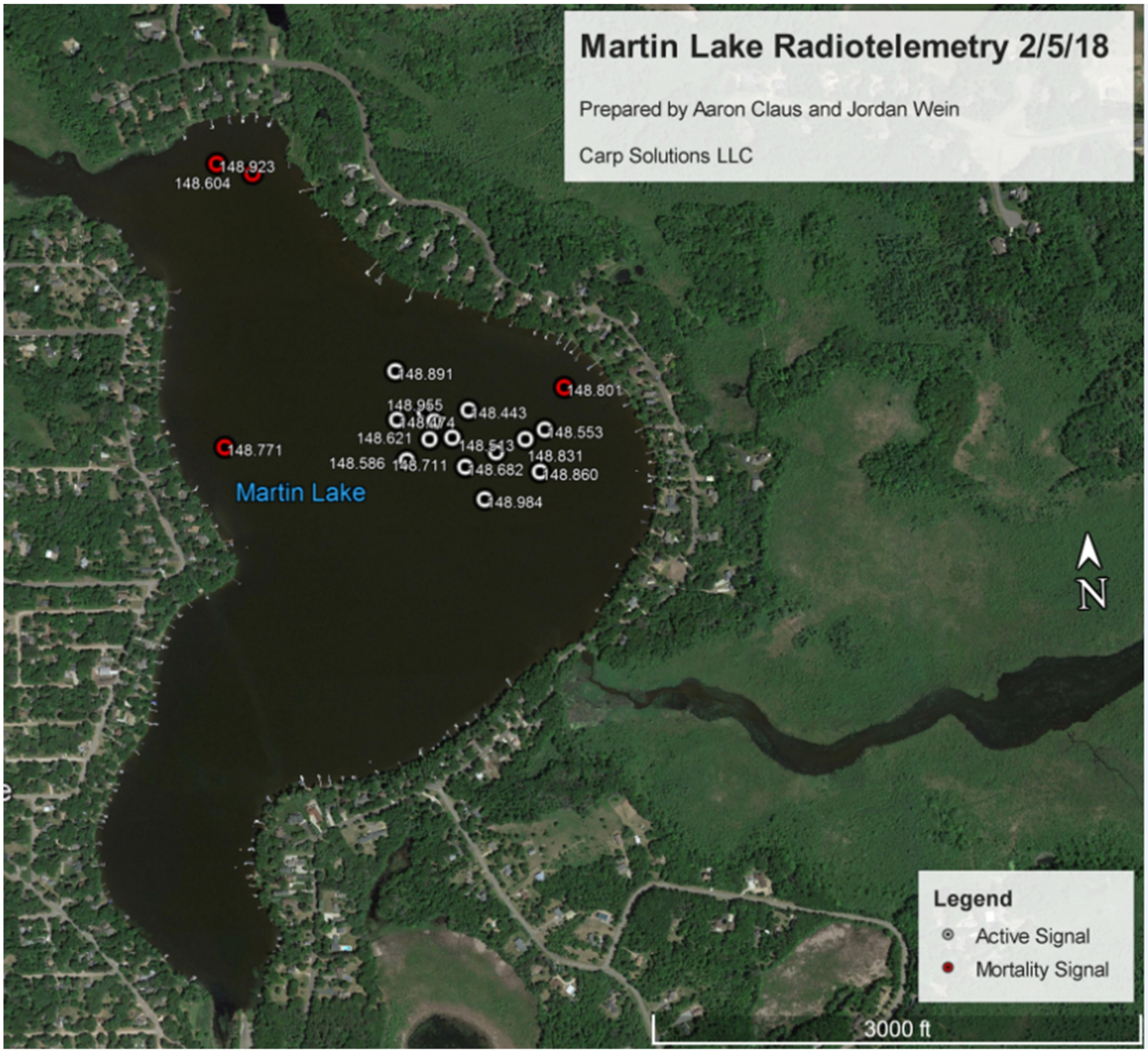
Radio transmitter being surgically implanted in a carp. 40 carp were implanted with radio loggers, 20 each from Typo and Martin Lakes. Radio loggers will help track the schooling, feeding, and movement patterns of the carp to aide in future harvesting efforts.

A sprung box net in Typo Lake. Nets were set, baited, and sprung at four sites each in Typo and Martin Lake for a total of 30 nettings on 8 different days from June through September, 2018.

A boat full of harvested carp. A total of 3,552 carp were removed from Typo Lake during the summer of 2018. 3,366 carp were removed from Martin Lake during August through September 2018. Harvest efforts in both lakes will continue through 2019.

Martin and Typo Lake Carp Removal Project

Telemetry Map from February 5, 2018



Linwood Lake Carp Population Study

Description: Linwood Lake has relatively poor water quality, though not quite as bad as Martin and Typo Lakes. It is close to exceeding the standard for phosphorus, and this year exceeded the standard for chlorophyll-a. As a result, the lake often has a green or brown tinge to it. Carp are a major cause of poor water quality in Typo and Martin Lake, and the goal of this study is to determine how much of a role carp play in causing poor water quality in Linwood Lake.

Purpose: Estimate carp abundance and population age structure; identify likely carp nursery sites; map carp movement using radio telemetry

Location: Linwood Lake

Results: Carp Solutions LLC has completed electrofishing surveys for carp at Linwood Lake, box netting surveys for young carp in Linwood and Boot Lakes, collected otolith samples for determining the carp population's age structure, and implanted radio transmitters in 20 carp.
Initial findings:

- Average sized carp: 7 pounds (3.2 kg). 24.5 inches (627 mm)
- Population estimate: 9,851 individuals
- Biomass estimate: **136 kg/ha**.

The ecological goal of this project is to have a carp population under **100 kg/ha**, so preliminarily Linwood Lake may be marginally over that goal. By comparison, the estimates for Typo Lake were 18,808 carp and 384 kg/ha and for Martin Lake was 13,409 carp and 408 kg/ha.

The next steps for this project include:

- Getting results on the age structure of the carp population. Such as how often do they successfully reproduce? How old are the carp?
- Radio telemetry surveys to find out where carp go during spawning and overwintering. Do any go to Boot Lake?
- Report and management recommendations

Carp Otoliths

Implanting a radio tag

Tour of Water Quality Projects

Description: A tour was given to local officials to highlight recent water quality improvement projects.

Purpose: The purpose of this event was to connect local elected officials, local and state staff, and the SRWMO board with the people, projects, and priorities of the SRWMO. The tour included visits to three large lakes where lake association members provided a brief presentation and recent water quality projects were seen and discussed. This tour was conducted immediately before the SRWMO Watershed Planning Kickoff and Public Input meeting. Nearly all tour attendees stayed for that meeting and provided valuable input on future SRWMO directions.

Location: Voss Residence, Linwood Lake access, Martin Lake access

Results: Sixteen officials representing 11 state and local organizations attended a tour which included rain gardens, water sampling demonstrations, and a carp barrier, amongst others.

Summary of Tour Itinerary

Tour stops included:

1. **Voss residence, Coon Lake**
At this location we were hosted by Steve and Lisa Voss who have installed three rain gardens treating a 4 acre drainage area of the neighborhood and are considering lakeshore landscaping with native plants. Steve is the Mayor of East Bethel and added insights into collaboration, incentive programs and the importance of Coon Lake. During this tour stop Al Beck of the Coon Lake Improvement District and Bruce McEachran of the Coon Lake Improvement Association spoke about the roles of their groups in managing invasive species and improving the lake.

2. **Linwood Lake Public Access**
At this tour stop we were hosted by a group of Linwood Lake Association members. Lake association fundraising leader Elizabeth Kiserow spoke about their recent fundraising successes, collaboration with the SRWMO and ACD on an upcoming carp feasibility study, water monitoring and a vision for improving water quality. Anoka Conservation District staff Jared Wagner provided a dockside demonstration of lake water quality monitoring techniques.

3. **Martin Lake Public Access**
The Martin Lake Association hosted this tour stop. We viewed a carp barrier and discussed water quality improvement efforts including stormwater treatment, carp management and lakeshore restorations. John Matilla and Mike Smith from the lake association discussed their fundraising efforts and their collaboration on these projects.

Annual Education Publication

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

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

Location: Watershed-wide

Results: In 2018 the SRWMO contracted with the ACD to prepare its annual education publication. This year's newsletter was used to announce the SRWMO Watershed Management Plan update process.

Education Material Produced for 2018

Public Invited to Sunrise River Watershed Planning Meeting

The Sunrise River Watershed Management Organization (SRWMO) is beginning a once-every-10-years update of its Watershed Management Plan. To kick off this effort, it is hosting a facilitated meeting to get input from elected officials, lake groups, and the general public on Thursday, May 24 at the Coon Lake Beach Community Center.

The SRWMO is jointly formed by Linwood Township and the Cities of Columbus, Ham Lake and East Bethel. The organization is responsible for water management including lakes and streams, including issues that require management across municipal boundaries. The organization is governed by a board of two appointees from each community.

Recent SRWMO work has focused on improving water quality. Several area lakes do not meet State water quality standards due to excessive nutrients and algae, including Typo, Martin and Linwood Lakes. Coon Lake, the largest recreational lake in Anoka County, is also a high priority. Recent projects have included carp barriers and carp removal, rain gardens, public outreach and water monitoring.

The public meeting will include a brief presentation and facilitated discussion. The presentation will outline SRWMO duties, managed natural resources and recent work. The facilitated discussion will give the public an opportunity to help identify priorities, concerns and SRWMO work in next 10 yrs.

The meeting is Thursday, May 24 from 6:30 to 8:00pm at the Coon Lake Beach Community Center (182 Forest Road Wyoming, MN). More information is available from Jamie Schurbon at 763-434-2030 ext. 12 or at www.SRWMO.org.

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.

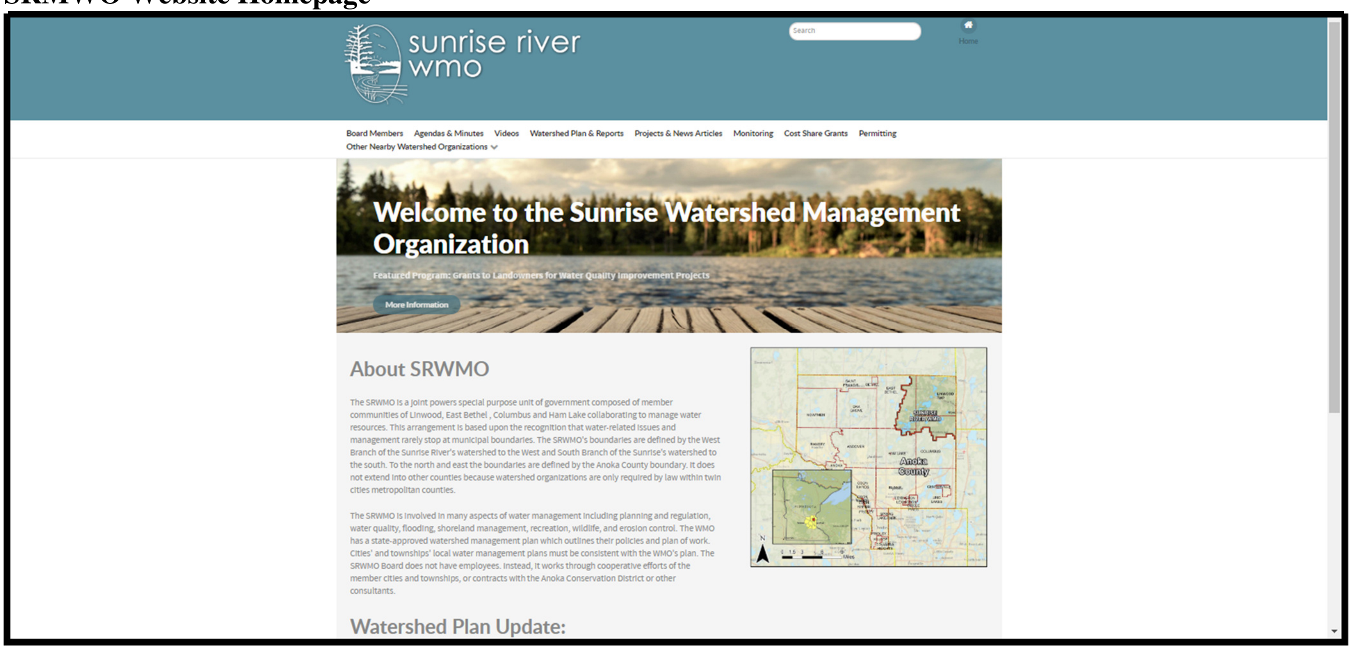
Location: www.SRWMO.org

Results: In 2018 a new SRWMO website was developed. The previous website was outdated and there were security concerns. The Anoka Conservation District developed a template website and finalized it with URRWMO Board input. The new website includes:

- Directory of board members,
- Meeting minutes and agendas,
- Watershed management plan and annual reports,
- Descriptions of work that the organization is directing,
- Highlighted projects,
- Informational videos,
- Maps of the URRWMO.

The website is regularly updated throughout the year.

SRMWO Website Homepage



Grant Searches and Applications

Description: The Anoka Conservation District (ACD) partners with the SRWMO for 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: In 2018 the SRWMO pursued a new pot of State Clean Water Funds called Watershed Based Funding. Through a collaborative process with other county-wide agencies, funding allocations were determined, with the SRWMO receiving $156,750. The Anoka Conservation District guided the SRWMO through the process in which SRWMO board members were active participants. After funding allocations were decided, ACD facilitated a process with the SRWMO and its member cities to select projects to fund. Project ideas were generated through a meeting with member communities' staff, SRWMO board discussions, review of completed studies, and review of the SRWMO Watershed Management Plan. The selected projects were:

- Stormwater retrofits around Martin and Coon Lakes, as identified in a previous study.
- Linwood Lake Carp Management Feasibility Study.
- Lakeshore stewardship outreach.

ACD completed BWSR Elink work plans for the SRWMO. Funds were distributed in fall 2018.

Since 2014 the following grants have been secured for SRWMO projects though the assistance of the Anoka Conservation District:

2014 Martin and Typo Lake Carp Barriers, site 2	MN DNR CLP	$ 35,770
2014 Martin and Typo Lake Carp Barriers, sites 1,3,4	MN DNR CLP	$399,983
2014 Coon Lake Area Stormwater Retrofits	BWSR CWF	$ 42,987
2015 Ditch 20 Wetland Restoration Feasibility Study	BWSR CWF	$ 72,400
2017 Martin and Typo Lake Carp Harvests	MN DNR CLP	$ 99,000
2017 Septic System Fix Up Fund*	MPCA	$ 25,931
2018 Watershed Based Funding	BWSR WBF	$156,750
	TOTAL	$832,821

*Septic system fix up funds are available county-wide but the grant application was prompted by septic system inventory work by Linwood Township and the SRMWO.

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).

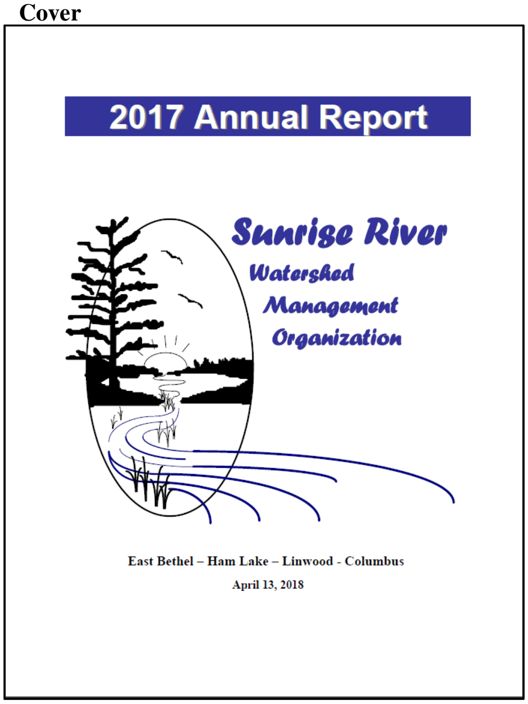
The SRWMO must also submit an annual financial report to the State Auditor. They accept unaudited financial reports for financial districts with annual revenues less than $185,000.

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 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



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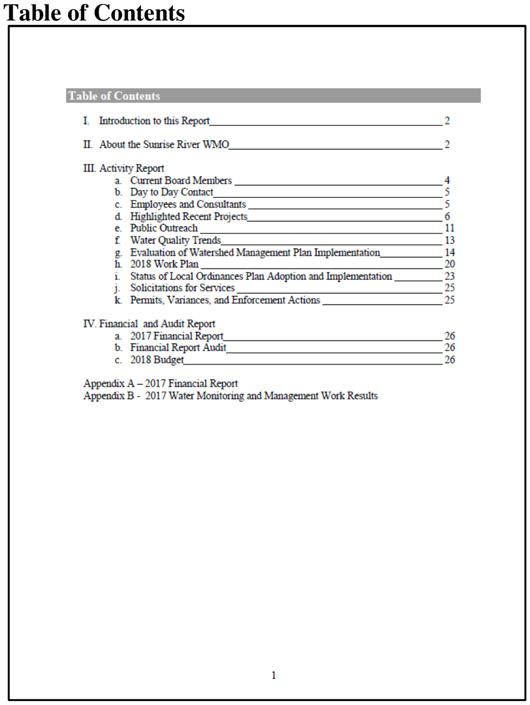
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On-call Administrative Services

Description: The Anoka Conservation District Watershed Projects Manager 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 2018 a total of 65+ hours of administrative assistance were provided to the SRWMO by the Anoka Conservation District. The following tasks were accomplished:

- Helped the SRWMO come up with priority suggestions for the new county-wide outreach program.
- Coordinated a Linwood Lake Carp Management Feasibility Study with the Linwood Lake Association.
- Prepared a draft 2019 budget for the SRWMO and subsequent revisions.
- Responded to an MPCA request for water monitoring requests. MPCA is planning a once-every-10-years monitoring blitz in the area, and I communicated that the SRWMO would like its watershed outlets to be monitored. This will likely result in a $2,850 savings to the SRWMO, which would have otherwise paid for the monitoring.
- Dealt with a data mining company that submitted a public information request for all of the SRWMO's financial records for the last 5 years. The company uses the information to determine government purchasing trends, which it sells to interested businesses. It required 8 emails to resolve.
- Reviewed the Columbus Local Water Plan and presented findings.
- Prepared requests for proposals for 2018 water monitoring and watershed plan update.
- Fielded permitting questions from the county highway department and builders.
- Determined a planned meeting would not have a quorum, then sent cancellation and rescheduling notices.
- Distributed contact information for two new board members to the rest of the board, and sent welcome emails.
- Presented the county weed management program to the SRWMO Board, which decided to participate.
- Prepared a display for a Linwood Family Fun booth staffed by the SRWMO board.
- Prepared seven meeting agendas and packets of information (some of which was related to projects and paid by other funds).
- Attended seven SRWMO meetings, portions of which were not related to projects paid by other funds.
- Reviewed and edited meeting minutes three times.
- Wrote meeting minutes twice in the absence of the recording secretary.

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 2018 Financial Summary

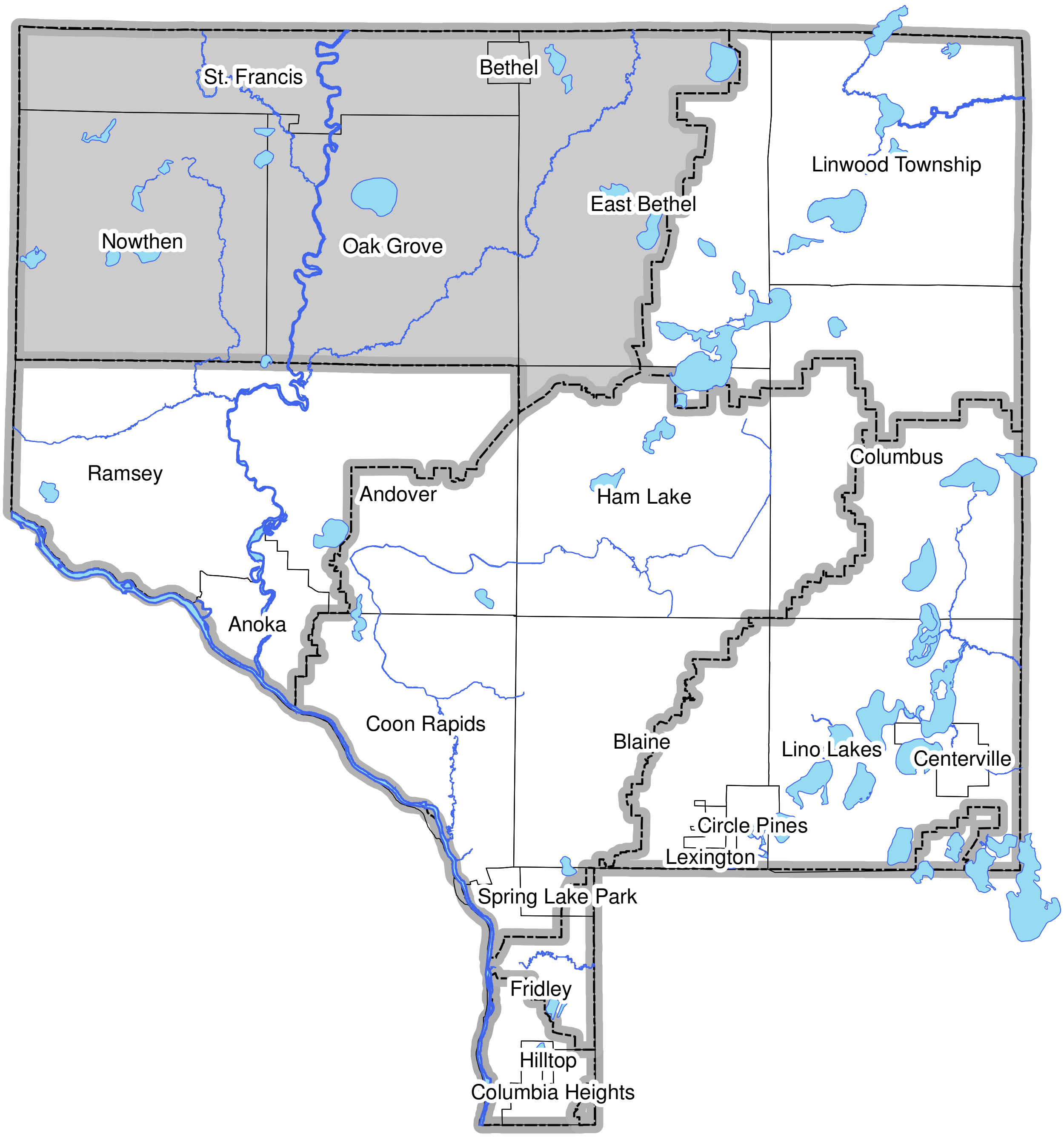
		Monitoring							Inventory		Analysis			Planning & Land Protection						Technical Assistance							Resource Improvement Projects						Administrative Assistance			Outreach					
Sunrise River Watershed	Total	Volunteer Precip	DNR Groundwater Wells	Wetland Levels	Lake Levels	Stream Levels	Lake Water Quality	Stream Water Quality	Inventory - Linwood Lake SSTS	Inventory - Lakeshore Photos	Water Resources Almanac	Ditch 20 Analysis	Linwood Lake Carp Mgmt Feasbility Study	Anoka Sandplain Partnership	Sunrise WMO Planning	1W1P St. Croix	Wetland Resto Opportunities	Land Prot/Resto Strategies	Land Protection Outreach	SRWMO Grant Search	Landowner Tech. Asst.	Project Profiles	BMP Maintenance & Inspection	WCA Enforcement	Wetland Consultation	Wetland Restoration and Banking	Buckthorn Boot Lake	Buckthorn Mikkelson	Carp Management	Cooperative Weed Management	BMP Installation	SSTS - Fix-Up	SRWMO Admin/Reporting/Website	WCA Implementation	Watershed Based Funding Coordination	Video Development	Brochures & Displays	Web Blog	Web Story Map	SRWMO Educ/Newsletter	Anoka County Outreach Program
Revenues																																									
SRWMO	62897			1950	1500	1400	13050	2800				3059	409		25920					1000											1148		####							2000	
State - Other	8311		350																											1336				6626							
MPCA	10354																															10354									
DNR OHF	24000																										3410	20590													
DNR CPL	48581																												48581												
BWSR - Service Grant	7998									520				760			770	272			692	217	472						2014						1586	225	428	42			
BWSR - Project Grant	16858											549	14674																												1635
Metro ETA & NPEAP	61																				61																				
Regional/Local	4764						646									4117																									
Anoka Conservationi District	23164									5	3283			110		6051		19	80		711		36	244	2119	181	214	1858	4614	7	916	23		2439	4		43	10	132		63
County Ag Preserves/Projects	16512						1885		3627			1520																			9480										
Service Fees	2567																		262										2000	159	130			16							
TOTAL	226064		350	1950	1500	1400	15581	2800	3627	526	3283	5128	15083	870	25920	10168	770	291	343	1000	1464	217	508	244	2119	181	3624	22448	57209	1501	11675	10377	8660	9080	1590	225	471	53	132	2000	1697
Expenses-																																									
Personnel Salaries/Benefits	######	367	759	1155	974	2178	11622	1401	1627	498	4515	4334	385	730	23175	9118	651	251	290	329	1278	195	407	216	1768	158	3042	16125	7111	1111	9436	1083	5809	5972	1346	53	367	40	121	452	1181
Overhead	14946	47	98	133	111	252	1396	165	218	46	603	666	36	102	2553	1086	98	30	43	46	151	26	50	28	245	22	471	2206	881	124	1025	117	762	667	200	8	53	4	14	58	104
Vehicle/Mileage	2249	7	12	29	24	51	274	28	34	9	35	16	7	6	603	194	4	3	2	7	27	2	8	4	24	1	19	183	155	24	163	24	99	117	16	0	5	1	2	11	21
Project Direct - Supplies	52768	4		20	3	33	2635	730	60	5			3700		419				6				36		36			2942	36965	253	1208		1000	2453	4	163	43	8			42
Project Direct - Capital	636						545	91																																	
Project Direct - Installation	33182												10974															1158	11850			9200									
TOTAL	225410	425	869	1338	1112	2513	16472	2415	1939	558	5153	5016	15103	839	26749	10398	752	284	341	382	1456	222	502	248	2073	181	3532	22614	56962	1512	11831	10424	7670	9209	1566	224	469	53	136	521	1349

Recommendations

- **Continue update of the SRWMO Watershed Management Plan.** The current plan expires December 2019.
- **Continue engaging in the Lower St. Croix One Watershed, One Plan process** to ensure SRMWO priorities are reflected. This is necessary to ensure access to future Watershed Based Funding grants.
- **Continue carp removals at Martin and Typo Lakes.** Attaining goals is feasible.
- **Collaborate with the Anoka County Outreach Coordinator.** This new position in 2018 seeks efficiency and consistent messaging across many cities and natural resources agencies.
- **Conduct Boot Lake water quality monitoring two more years.** 2018 results have been instructive for Linwood Lake management. Three years of data should be sufficient to understand basic year-to-year variability.
- **Support the Linwood Lake Association.** The association has recently become more active and has requested partnerships to manage aquatic invasive species and improve water quality. The SRWMO may be able to help with identifying and promoting projects, or assist with fundraising.
- **Create a new SRWMO display for use at community events.**
- **Continue installation of stormwater retrofits around Coon and Martin Lakes** where completed studies have identified and ranked projects.
- **Promote newly available Septic System Fix Up Grants to landowners,** particularly in shoreland areas.
- **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.

2018 Anoka Water Almanac

Chapter 3: Upper Rum River Watershed



Prepared by the Anoka Conservation District

Upper Rum River Watershed

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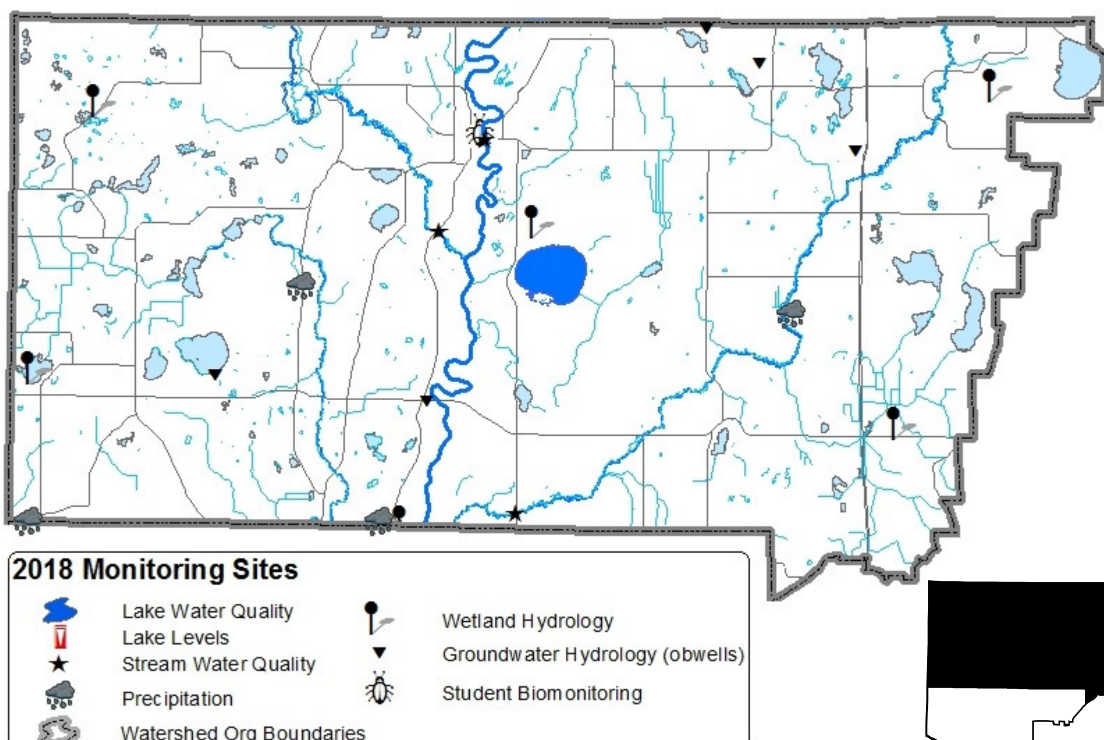
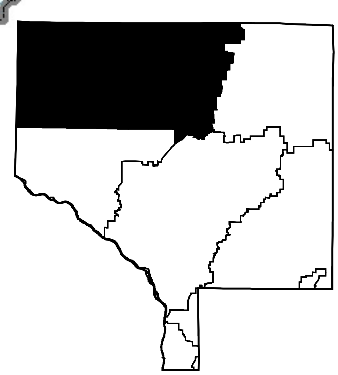




Lake Levels

Partners: URRWMO, ACD, MN DNR, volunteers

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

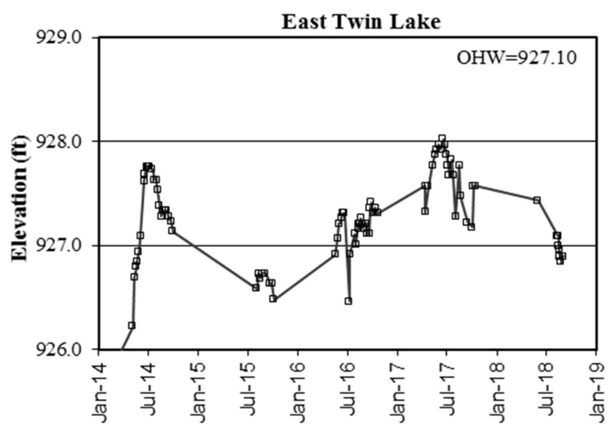
Purpose: To understand lake hydrology, including the impact of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

Locations: East Twin Lake, Lake George, Rogers Lake, Minard Lake, Coopers Lake

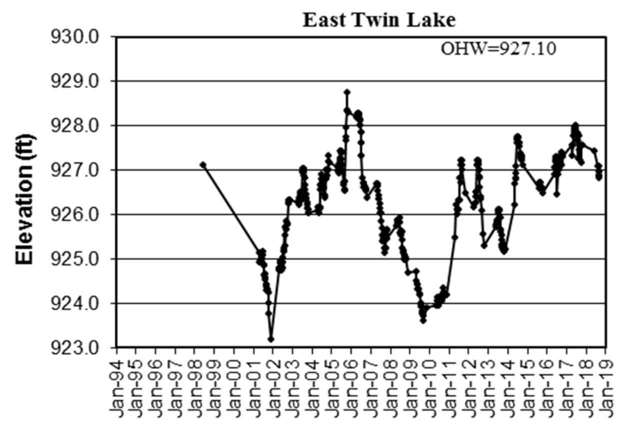
Results: Lake levels were measured by volunteers throughout the 2018 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. Lakes generally followed the expected trend of increasing water levels in spring and early summer and declining levels by mid-summer. Lakes generally experienced rebounding water levels starting in mid-September. Overall lake levels were near average though some were higher and some were lower.

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. All lakes monitored were lower than the OHW for much of the monitoring season.

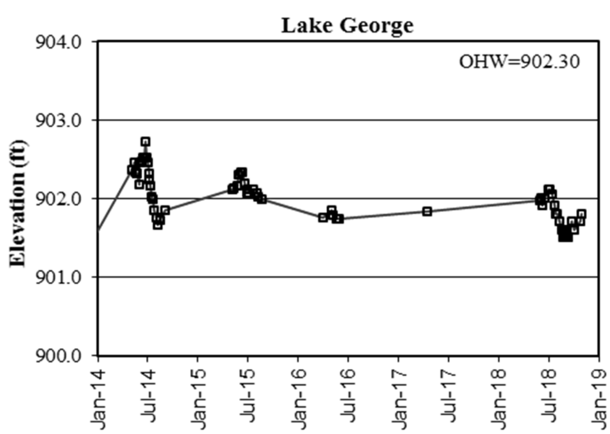
East Twin Lake Levels – last 5 years



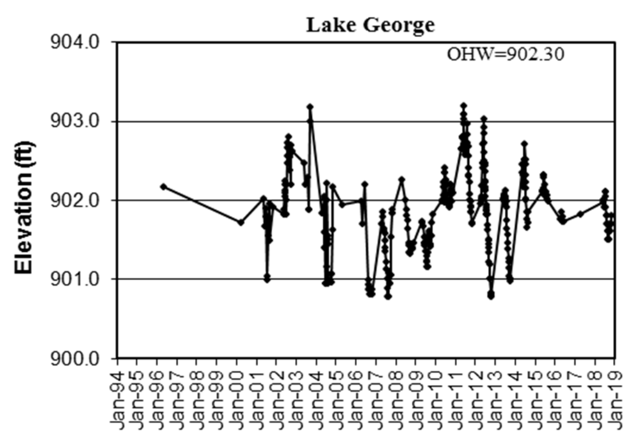
East Twin Lake Levels – last 25 years



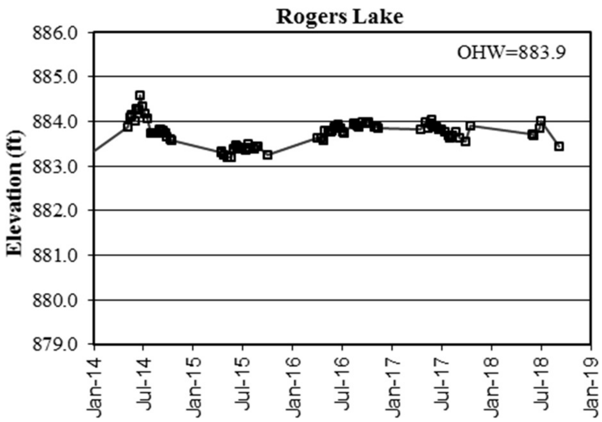
Lake George Levels– last 5 years



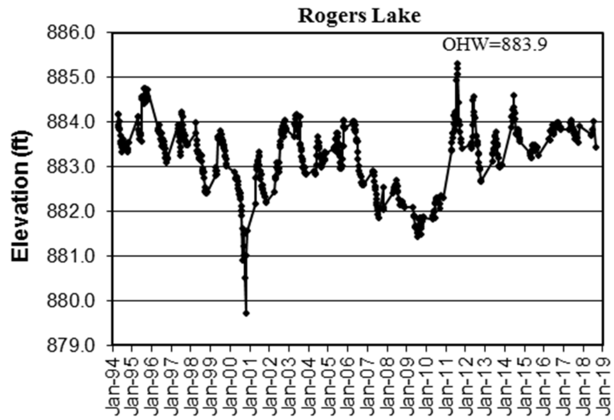
Lake George Levels – last 25 years



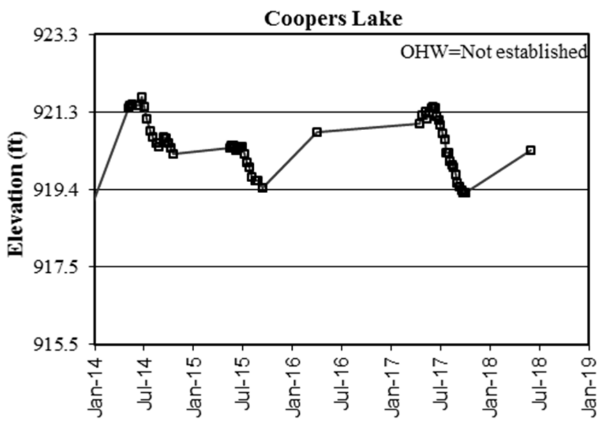
Rogers Lake Levels – last 5 years



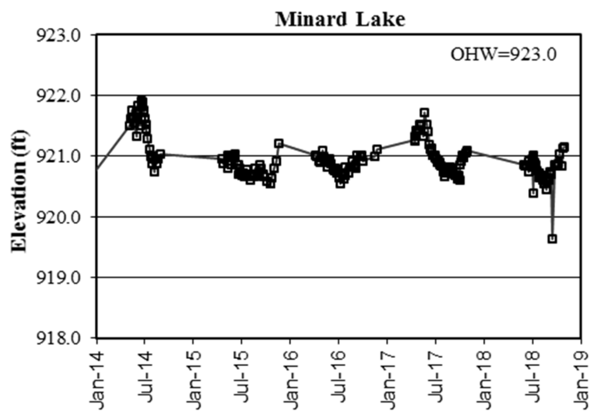
Rogers Lake Levels – last 25 years



***Coopers Lake Levels – last 5 years**



Minard Lake Levels – last 5 years



*Only one reading was obtained for Coopers Lake in 2018. A new volunteer will be pursued for 2019.

Lake Water Quality

Partners: ACD, Lake George LID

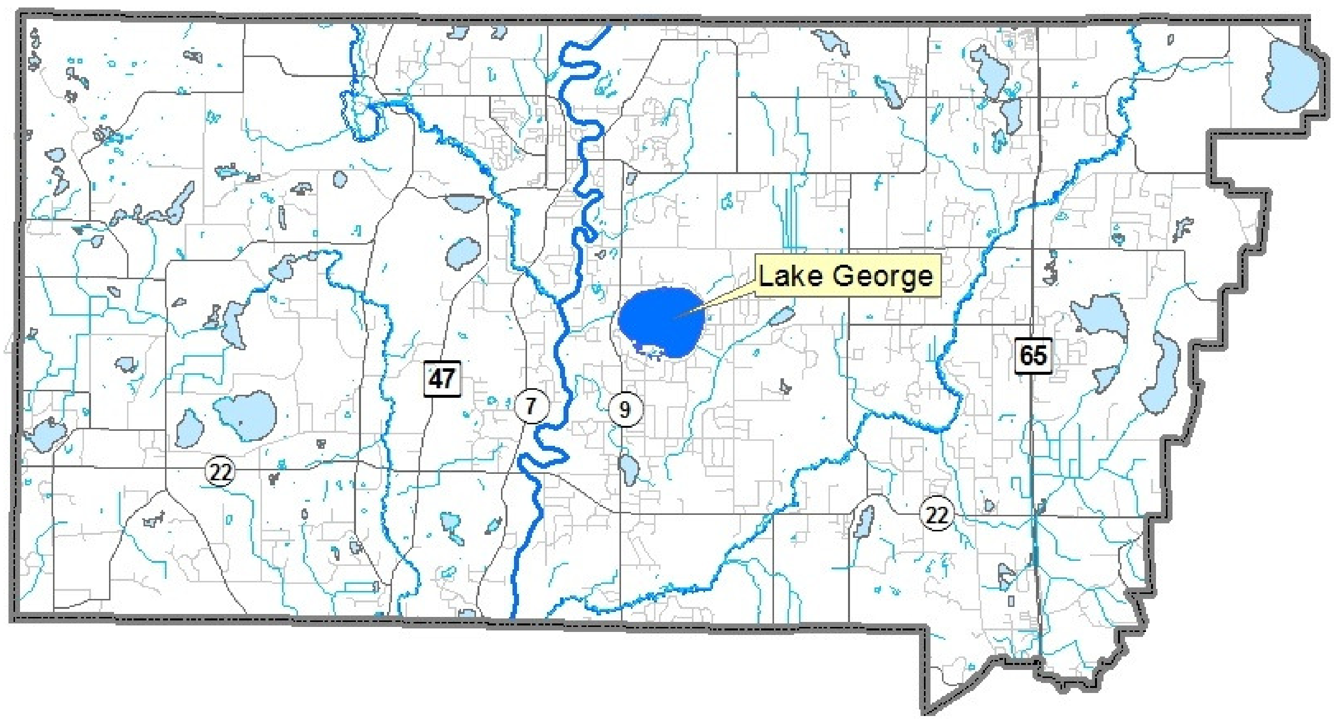
Description: May through September twice-monthly monitoring of the following parameters: total phosphorus, chlorophyll-a, Secchi transparency, dissolved oxygen, turbidity, temperature, Specific Conductivity, pH, and salinity.

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

Locations: Lake George

Results: Detailed data for Lake George is provided on the following pages, including summaries of historical conditions and trend analysis. Previous years' data are available at the MPCA's electronic data access website. Refer to Chapter 1 for additional information on interpreting the data and on lake dynamics.

Upper Rum River Watershed Lake Water Quality Monitoring Sites



Lake George

CITY OF OAK GROVE, LAKE ID # 02-0091

Background

Lake George is located in north-central Anoka County. The lake has a surface area of 535 acres with a maximum depth of 32 feet (9.75 m). Public access is from Lake George County Park on the lake's north side, where there is both a swimming beach and boat launch. About 70% of the lake is surrounded by homes; the remainder is county park land. The watershed is mostly undeveloped or vacant, with some residential areas, particularly on the lakeshore and in the southern half of the watershed. Two invasive aquatic plants are established in this lake, curly-leaf pondweed and Eurasian water milfoil. ACD does annual mapping of densities for each type of plant, and the Lake George Improvement District treats one or both with herbicide.

2018 Results

In 2018 Lake George had good water quality for this region of the state (NCHF Ecoregion), receiving an overall A letter grade and mesotrophic rating. Dating back to 2009, Lake George has maintained an overall B grade each year with the exception of 2015 and this year when a slight decline in average total phosphorus (TP) bumped the scores to an A. Total phosphorus in 2018 averaged 22.5 µg/L, tied with 2015 as the lowest since 2008. Secchi transparency was as high as 17.2 feet in May, but dropped to as low as 6.3 feet in early August. Average Secchi transparency was 9.4 feet, an improvement over recent years and more in line with averages seen a decade or more ago. Chlorophyll-a (Cl-a) averaged 6.8 µg/L, which was similar to the last 5 years, with the exception of a moderate increase in 2016 to 7.8 µg/L. Chlorophyll-a and transparency were poorest in early September, however, TP was poorest in May. All three parameters were better than State water quality standards for deep lakes in this region (<40 µg/L TP, <14 µg/L Cl-a, and >1.4 m Secchi transparency).

Trend Analysis

Twenty-nine years of water quality data have been collected by the Metropolitan Council (between 1980 and 2009) and the Anoka Conservation District (1997, 1999, 2000, 2002, 2005, 2008, 2011, 2013- 2018). During this period there is a statistically significant trend of declining Secchi transparency (one-way ANOVA $F_{1,19}$= 14.37, p=<0.05). The Rum River Watershed Restoration and Protection Strategy (WRAPS) report also found strong evidence of declining water clarity using a Kendall-Mann statistical analysis. However, an Anoka Conservation District broader analysis of overall water quality that simultaneously considers TP, Cl-a and Secchi transparency did not find a statistically significant trend looking at all years of data (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,18}$=1.62, p=0.22). Last year, when only the last 10 sampling years' worth of data since 2000 were analyzed a statistically significant increase in TP was apparent (one-way ANOVA $F_{1,19}$ =2.23, p=<0.05) as well as a trend (though not significant) towards increased Cl-a. However, when the last 10 years of sampling were analyzed again this year there were no statistically significant trends. Much of the decline in transparency has occurred since the year 2000 or slightly before. In short, from 2000 to 2017 a trend of poorer (lower) transparency was occurring and a less dramatic trend of poorer (higher) total phosphorus was occurring. Chlorophyll-a (algae) levels show no statistically significant trend of change. This year these trends have disappeared due to the best Secchi and total phosphorus readings in ten years but they could easily reappear in future years and we should not be complacent in monitoring of or managing for water quality in Lake George.

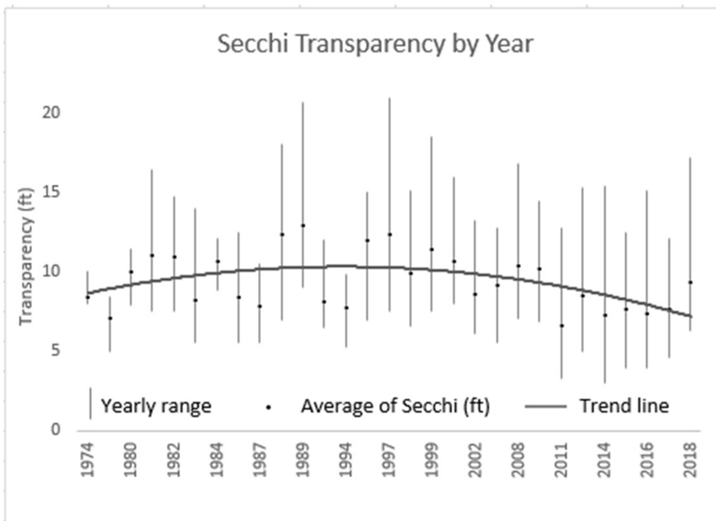
Lake George

City of Oak Grove, Lake ID # 02-0091

Discussion

Lake George remains one of the clearest of the Anoka County lakes, but its trend of declining Secchi transparency is concerning (see graph below). Lake George is a highly valued lake due to its recreational opportunities and ecological quality. The lake has a large park, many lakeshore homes, and a notably diverse plant community (most metro area lakes have 10-12 different aquatic plant species; Lake George is home to 24).

Lake George Secchi transparency trend: Includes years with partial datasets not covering all open water months. Those years are excluded from ACD's statistical analysis and graphs later in the document.



An additional concern for Lake George is noted in *the 2017 Rum River Watershed Fish-Based Lake IBI Stressor Identification Report* by the MN DNR. That report found Lake George's fish community was not impaired, but was of special concern and vulnerable. Lack of aquatic habitat and near-shore development disturbances were causes of concern.

In 2018 a special study of this lake titled "Lake George Water Quality Improvement Assessment" was completed. Work from 2016-2018 included intensive monitoring of tributaries, modeling, and evaluation of projects to correct transparency declines. The work focused on the watershed, and a "phase 2" study of in-lake processes may occur in the future.

The aforementioned study provides some insight into the causes of transparency decline and 2018 results. While a number of factors may play a role in transparency declines, more frequent wet years are the most significant driver identified. Years that are wetter than the 90th percentile result in increased volumes of runoff and nutrients into the lake from tributaries, and the lake has poorer clarity in those years. These "wet" years have been more frequent during the period that lake transparency has declined. Four of the eight years from 2010 to 2017 were "wet" with water year precipitation above the 90th percentile. 2018 was not a "wet" year, and Secchi transparency improved. There is concern that climate change and development in the watershed will drive poorer water quality in Lake George into the future. The study was funded by the Lake George Improvement District, Lake George Conservation Club, Anoka Conservation District, and a State Clean Water Fund grant.

The study recommends projects and actions to improve water quality. Among these are replacement of the deteriorating Ditch 19 weir just east of Lake George which is an important hydrological control for the lake. The weir is scheduled for replacement in 2019. This work offers modest benefits of reduced nutrient delivery to the lake in wet years, and the broader benefits of restoring lake hydrology and enhancing game fish spawning opportunities. Other actions include agricultural best practices, an iron-enhanced sand filter, public education, lakeshore restorations, enhanced stormwater standards for new developments in the lakeshed and others. While certain tributary subwatersheds do generate more nutrients than others, and therefore deserve special consideration for projects, it is also noted that some of these subwatersheds drain through large wetlands with some apparent pollutant removal ability which must be considered when siting projects. Projects nearest the lake are favored because they treat a larger upstream area and don't duplicate treatment that might already be provided by certain wetlands.

Two exotic invasive plants are present in Lake George, curly-leaf pondweed and Eurasian water milfoil. The Lake George Improvement District works to control these plants, and multiple years of localized treatments have occurred. In coordination with the MN DNR, the Lake Improvement District continually works to achieve control of these invasive plants without harming native plants or water quality. Water quality has been monitored immediately before and after herbicide treatments in some recent years, and no obvious causal relationship between weed treatment and water quality was found.

Historical Summertime Mean Values

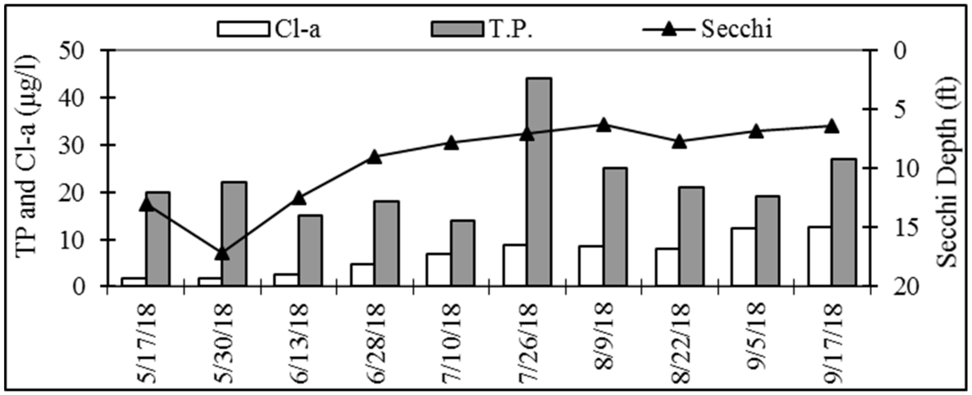
Agency	MC	MC	MC	MC	MC	MC	ACD	MC	ACD	ACD	ACD
Year	1980	1981	1982	1984	1989	1994	1997	1998	1999	2000	2002
TP	22.5	22.0	22.3	24.4	24.3	25.4	17.4	27.5	21.1	16.3	19.9
Cl-a	7.3	7.1	7.0	9.5	4.5	6.9	13.2	7.8	5.6	5.8	5.2
Secchi (m)	3.1	3.4	3.4	3.3	3.9	2.4	3.6	2.7	3.5	2.8	2.6
Secchi (ft)	10.2	11.2	11.0	10.8	12.9	7.8	11.7	9.0	11.4	10.7	8.6
Carlson's Trophic State Indices											
TSIP	49	49	49	50	50	51	45	52	48	44	47
TSIC	50	50	50	53	45	50	56	51	48	48	47
TSIS	44	42	43	43	40	48	42	45	42	45	46
TSI	48	47	47	49	45	49	48	49	46	46	47
Lake George Water Quality Report Card											
Year	1980	1981	1982	1984	1989	1994	1997	1998	1999	2000	2002
TP	A	A	A	B	B	B	A	B	A	A	A
Cl-a	A	A	A	A	A	A	B	A	A	A	A
Secchi	A	A	A	A	A	B	A	B	A	B	B
Overall	**A**	**A**	**A**	**A**	**A**	**B**	**A**	**B**	**A**	**A**	**A**

Agency	ACD	ACD	MC	MC	ACD	ACD	ACD	ACD	ACD	ACD
Year	2005	2008	2009	2011	2013	2014	2015	2016	2017	2018
TP	26.0	23.0	26.2	29.0	30.3	25.5	22.5	28.4	23.3	22.5
Cl-a	5.4	6.4	7.0	12.4	6.1	6.4	2.7	7.8	5.7	6.8
Secchi (m)	2.8	3.2	2.9	1.8	2.6	2.2	2.9	2.3	2.4	2.9
Secchi (ft)	9.1	10.4	9.5	6.7	8.6	7.4	9.4	7.4	7.7	9.4
Carlson's Trophic State Indices										
TSIP	51	49	51	53	53	51	49	52	50	49
TSIC	47	49	50	55	48	49	40	51	48	49
TSIS	45	43	45	52	46	49	45	48	48	45
TSI	48	47	49	53	49	49	45	50	48	48
Lake George Water Quality Report Card										
Year	2005	2008	2009	2011	2013	2014	2015	2016	2017	2018
TP	B	B+	B	B	B	B	A	B	B	A
Cl-a	A	A	A	B	A	A	A	A	A	A
Secchi	B	A	B	C	B	B	B	B	B	B
Overall	**B**	**A**	**B**	**B**	**B**	**B**	**A**	**B**	**B**	**A**

Lake George

CITY OF OAK GROVE, LAKE ID # 02-0091

2018 Daily Results



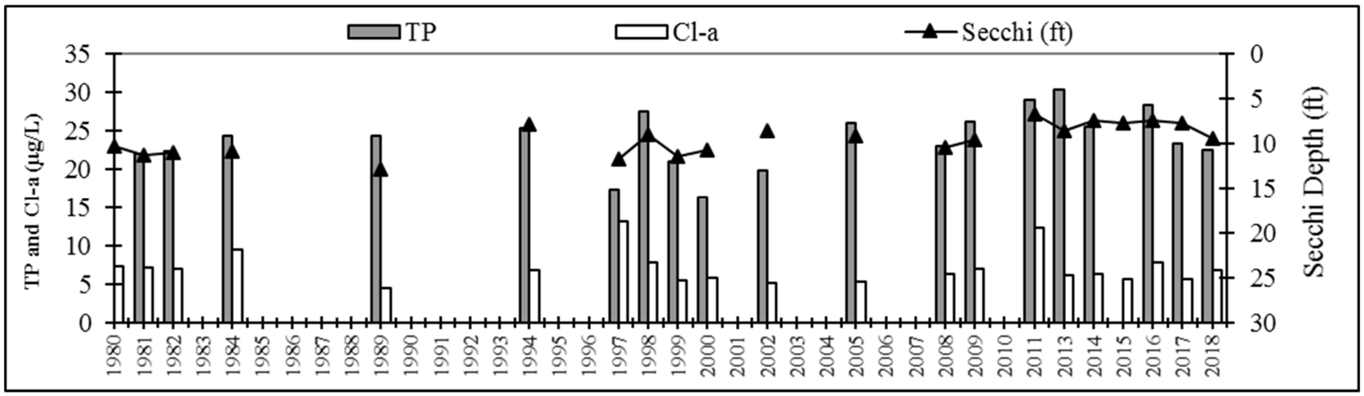
2018 Median Values

pH		8.39
Specific Conductivity	mS/cm	0.224
Turbidity	NTU	1.80
D.O.	mg/l	8.55
D.O.	%	106.15
Temp.	°F	75.3
Salinity	%	0.1
Cl-a	µg/L	7.5
T.P.	µg/l	20.5
Secchi	ft	7.8

Historical Report Card

Year	TP	Cl-a	Secchi	**Overall**
1980	A	A	A	**A**
1981	A	A	A	**A**
1982	A	A	A	**A**
1984	B	A	A	**A**
1989	B	A	A	**A**
1994	B	A	B	**B**
1997	A	B	A	**A**
1998	B	A	B	**B**
1999	A	A	A	**A**
2000	A	A	B	**A**
2002	A	A	B	**A**
2005	B	A	B	**B**
2008	B+	A	A	**A**
2009	B	A	B	**B**
2011	B	B	C	**B**
2013	B	A	B	**B**
2014	B	A	B	**B**
2015	A	A	B	**A**
2016	B	A	B	**B**
2017	B	A	B	**B**
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.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
		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			
		Time:	15:05	12:30	11:00	13:17	13:50	13:24	15:22	10:35	12:05	12:47			
pH		0.1	8.75	7.46	8.38	8.84	8.57	8.40	8.82	8.05	8.05	8.35	8.4	7.46	8.84
Specific Conductivity	mS/cm	0.01	0.246	0.249	0.219	0.209	0.233	0.242	0.210	0.212	0.211	0.228	0.2	0.21	0.25
Turbidity	NTU	1	2.00	0.00	0.00	0.00	1.60	3.900	2.30	2.50	62.00	1.00	1.5	0.00	3.90
D.O.	mg/l	0.01	9.89	7.90	8.43	8.93	8.66	9.85	9.81	6.47	7.47	8.33	8.6	6.47	9.89
D.O.	%	1	109.7	101.6	98.8	110.4	109.0	119.9	125.4	77.3	88.5	103.3	104.4	77.3	125.4
Temp.	°C	0.1	19.29	24.10	21.66	24.74	26.87	24.04	26.18	23.99	22.62	24.07	23.8	19.29	26.87
Temp.	°F	0.1	66.7	75.4	71.0	76.5	80.4	75.3	79.1	75.2	72.7	75.3	74.8	66.72	80.37
Salinity	%	0.01	0.12	0.12	0.11	0.10	0.11	0.12	0.10	0.10	0.10	0.11	0.1	0.10	0.12
Cl-a	µg/L	1	1.78	1.78	2.67	4.8	6.9	8.7	8.5	8.0	12.3	12.5	6.8	1.78	12.50
T.P.	mg/l	0.005	0.020	0.022	0.015	0.018	0.014	0.044	0.025	0.021	0.019	0.027	0.0	0.01	0.04
T.P.	µg/l	5	20	22	15	18	14	44	25	21	19	27	22.5	14.00	44.00
Secchi	ft		13.0	17.2	12.4	9.0	7.8	7.1	6.3	7.7	6.8	6.4	9.4	6.33	17.17
Secchi	m		4.0	5.2	3.8	2.7	2.4	2.2	1.9	2.3	2.1	2.0	2.9	1.93	5.23
Physical			1.0	1.0	2.0	1.0	2.0	2.0	1.0	1.0	1.0	1.0	1.3	1	2
Recreational			1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.00	1.00

*reporting limit

2018 Aquatic Invasive Vegetation Mapping

Lake George

CITY OF OAK GROVE, LAKE ID # 02-0091

Partners: Lake George LID

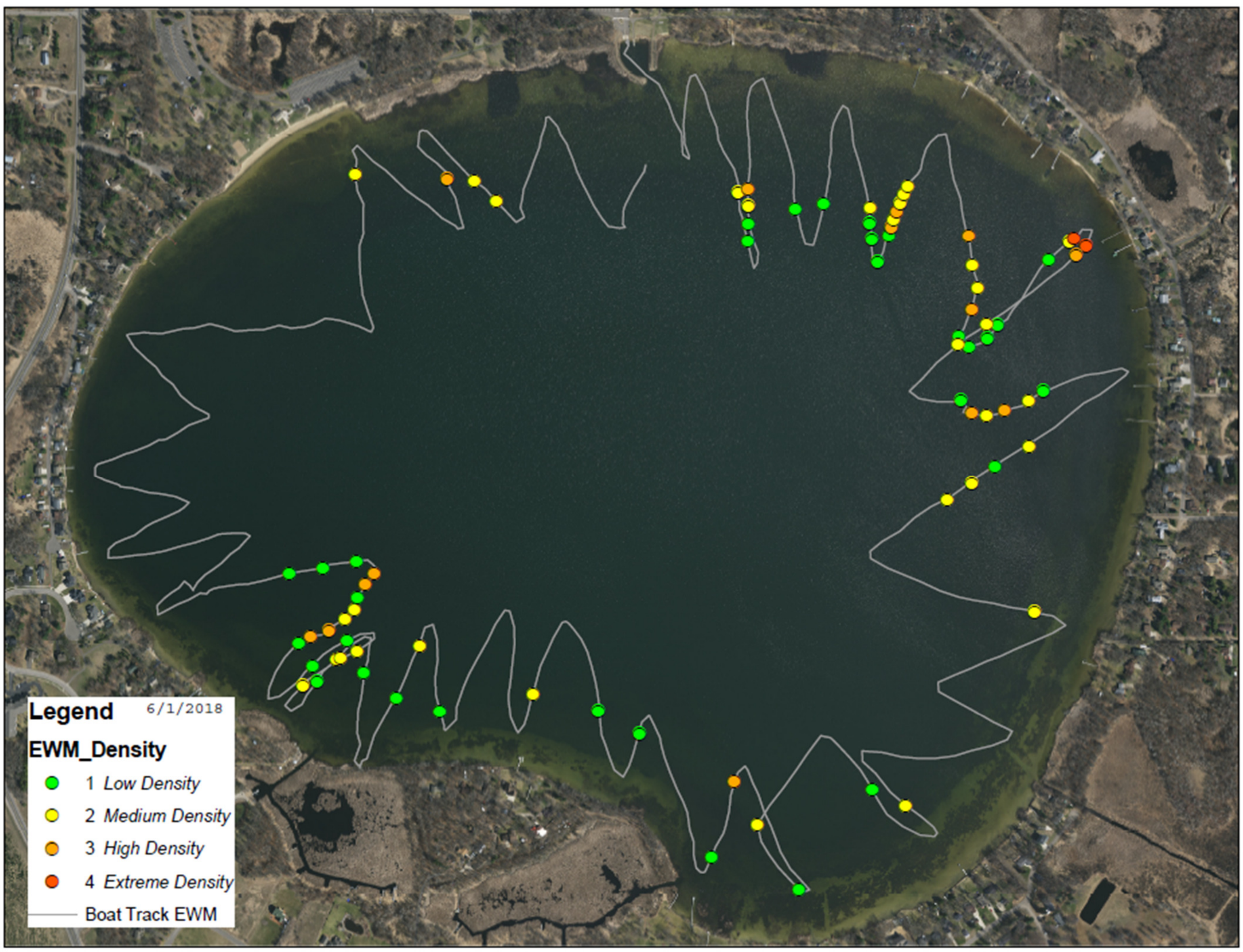
Description: The Anoka Conservation District (ACD) was contracted by the Lake George Lake Improvement District (LID) to conduct an aquatic invasive vegetation delineation.

Purpose: To map out the presence of Curly Leaf Pondweed (CLP) and Eurasian Water Milfoil (EWM) as required for MN DNR herbicide treatment permits. A goal was to map these invasive species as early as possible in the growing season to allow for herbicide treatment as early as possible for reduced impacts on native plants and lessened possible impacts on water quality.

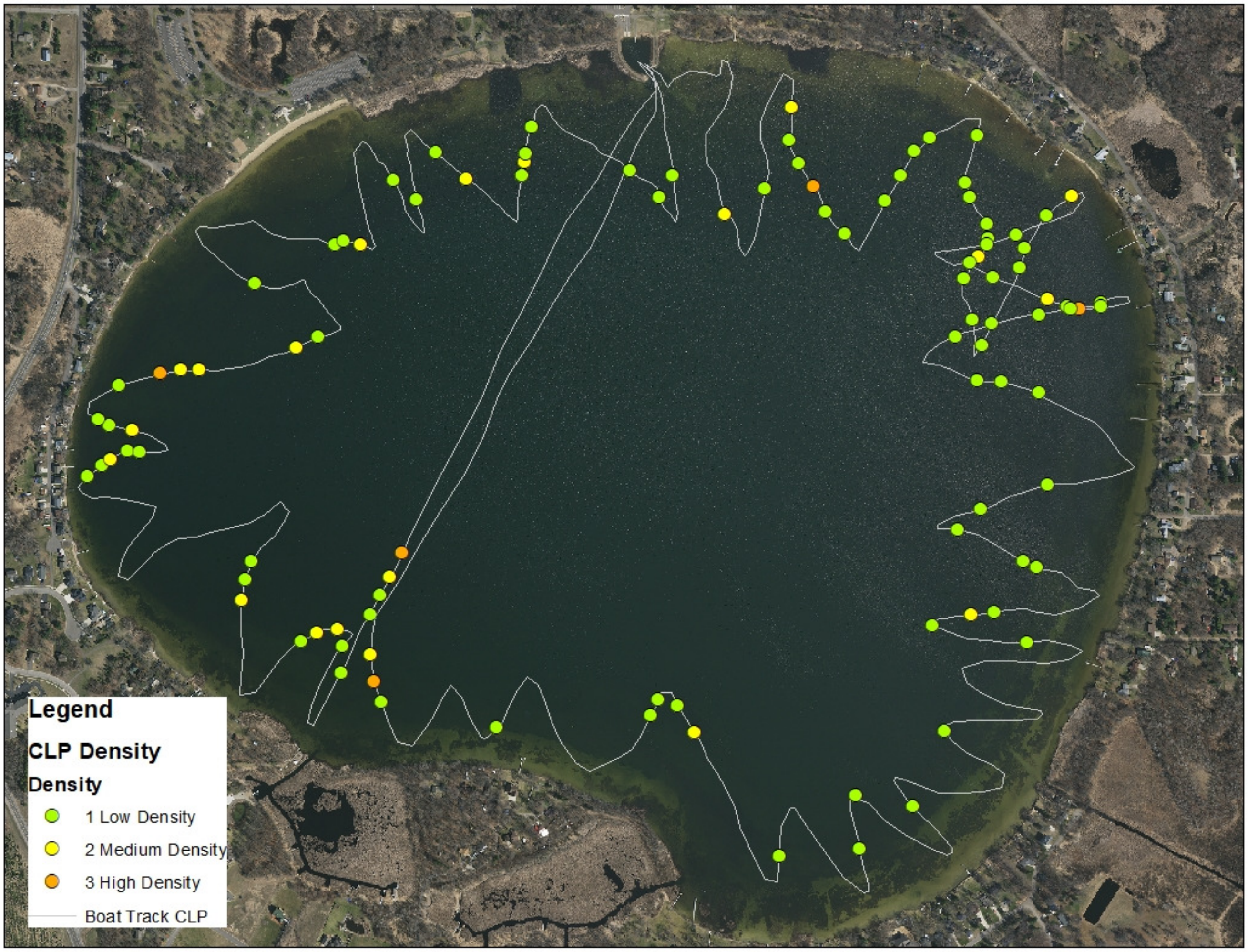
Locations: Lake George

Results: Maps presented below were delivered to the MN DNR and Lake George Improvement District within 48 hours of the field surveys. These survey points were reviewed by the MNDNR and herbicide treatment was approved for Eurasian water milfoil on 56.7 acres of Lake George. No treatment of curly-leaf pondweed occurred in 2018 due to suppressed densities and concern about native pondweeds suffering from past treatments.

June 1, 2018 Lake George Eurasian Water Milfoil (EWM) Survey



May 18, 2018 Lake George Curly Leaf Pondweed (CLP) survey



Stream Water Quality - Chemical Monitoring

Partners: MPCA, ACD

Description: The Rum River and several tributary streams were monitored in 2018. The locations of river monitoring include the approximate top and bottom of the Upper Rum River Watershed Management Organization (WMO) and at the top of the Lower Rum River WMO. Tributaries were monitored simultaneously with Rum River monitoring for greatest comparability near their outfalls into the river. Monitoring at the bottom of the Lower Rum River WMO was completed by the Metropolitan Council (Met Council). Collectively, these data allow for an upstream to downstream water quality comparison within Anoka County, as well as within each watershed organization. It also allows us to examine whether the tributaries degrade Rum River water quality.

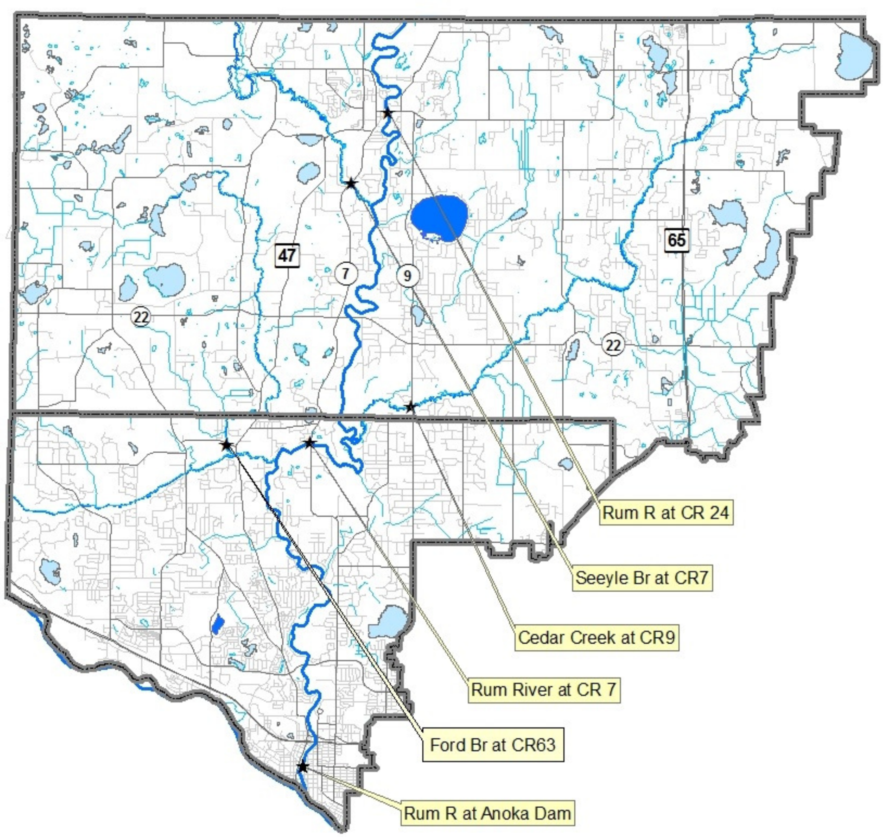
Monitoring by Anoka Conservation District occurred in May through October for each of the following parameters: total suspended solids, total phosphorus, Secchi tube transparency, dissolved oxygen, turbidity, temperature, specific conductivity, pH, and salinity. Metropolitan Council monitoring occurred weekly March to October and semi-monthly November to February. The Met Council monitors all the parameters listed above, plus several more. Met Council monitoring data can be found on their Environmental Information Management Systems (EIMS) website (**https://eims.metc.state.mn.us/**). Data from both sources are summarized in this report.

Purpose: To detect water quality trends, diagnose and identify the source of any problems, and guide management.

Locations:
Rum River at Co Rd 24
Rum River at Co Rd 7
Rum River at the Anoka Dam
Seelye Brook at Co Rd 7
Cedar Creek at Co Rd 9
Ford Brook at Co Rd 63

Results: Results are presented on the following pages.

Upper and Lower Rum River Watershed Management Organizations Stream Water Quality Sites



RUM RIVER

Rum River at Co. Rd. 24 (Bridge St), St. Francis	STORET Site ID = S000-066
Rum River at Co. Rd. 7 (Roanoke St), Ramsey	STORET Site ID = S004-026
Rum River at Anoka Dam, Anoka[1]	STORET Site ID = S003-183

[1]Located in the LRRWMO and monitored by the Metropolitan Council

Years Monitored

At Co. Rd. 24 – 2004, 2009-2011, 2014-2018

At Co. Rd. 7 – 2004, 2009- 2011, 2014-2018

At Anoka Dam – 1996-2011(MC WOMP), 2015-2018

Background

The Rum River is one of Anoka County's highest quality and most valuable water resources. It is designated as a state scenic and recreational river throughout Anoka County, except south of the county fairgrounds in Anoka. It is used for boating, tubing, and fishing. Much of western Anoka County drains to the Rum River. Subwatersheds that drain to the Rum include Seelye Brook, Trott Brook, Ford Brook, and Cedar Creek.

The extent to which water quality improves or is degraded within Anoka County has been unclear. The Metropolitan Council has monitored water quality at the Rum's outlet to the Mississippi River since 1996. This water quality and hydrologic data is well suited for evaluating the river's water quality just before it joins the Mississippi River. Monitoring elsewhere has occurred only in more recent years. Water quality changes might be expected from upstream to downstream because land use changes dramatically from rural residential in the upstream areas of Anoka County to suburban in the downstream areas.

Methods

In 2004, 2009-2011 and 2014-2018 monitoring was conducted to determine if Rum River water quality changes in Anoka County, and if so, generally where changes occur. The data is reported for all sites together for a more comprehensive analysis of the river from upstream to downstream.

In 2018 the river was monitored during both storm and baseflow conditions by grab samples. At County Road 24 (farthest upstream) only four samples were taken due to lower funding levels. At County Road 7, eight water quality samples were taken; half during baseflow and half following storms. These two sites were monitored by the Anoka Conservation District. At the Anoka Dam the river was monitored by the Metropolitan Council using a different schedule.

Monitoring was conducted during both base flow and storm conditions. Storms were generally defined as one-inch or more of rainfall in 24 hours, or a significant snowmelt event combined with rainfall. In some years, particularly drought years, smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events.

Key water quality parameters were monitored at all sites. Parameters tested with portable meters included pH, Specific conductivity, turbidity, temperature, salinity, and dissolved oxygen. Parameters tested by water samples sent to a state-certified lab included total phosphorus and total suspended solids, as well as chloride at Rum River at County Road 7. Additional parameters were monitored at the Anoka Dam by the Metropolitan Council.

Water levels or flow was observed during each water quality sampling. The Metropolitan Council monitoring station at the Anoka Dam includes automated equipment that continuously tracks water levels and calculates flows. Water level and flow data for other sites were obtained from the US Geological Survey, who maintains a hydrological monitoring site at Viking Boulevard.

The purpose of this report is to make an upstream to downstream comparison of Rum River water quality. It includes only parameters tested at all sites in 2018. It does not include additional parameters tested at the

Anoka Dam or additional monitoring events at that site. For that information, see Metropolitan Council reports at https://eims.metc.state.mn.us/. All other raw data can be obtained from the Anoka Conservation District, and is also available through the Minnesota Pollution Control Agency's EQuIS database, which is available through their website (https://www.pca.state.mn.us/data/environmental-quality-information-system-equis).

Results Summary

This report includes data from 2018 and an overview of previous year's data. The following is a summary of results.

- Dissolved constituents were measured by specific conductivity and chlorides. Specific conductivity in the Rum River is lower than other Anoka County streams. Specific conductivity increases mildly downstream, though it is slightly lower at the furthest downstream site compared to the mid-county site. Average specific conductivity for sites tested in 2018 from upstream to downstream was 0.266, 0.282, and 0.269 mS/cm, respectively. Chloride was tested at Rum River at C.R. 7 where it averaged 14 mg/L, which is low. As development continues in all parts of the Rum River watershed, efforts to prevent future problems should include minimizing road deicing salt use and utilizing new water softening technology. Other streams near the Rum River do have significant high chlorides problems.
- Phosphorus in the Rum River in recent years has been near the State water quality standard of 100 µg/L at all sampled sites. Sites exceeded the standard on three single sampling occasions in 2018, once during baseflow, and twice after a storm event. 2018 total phosphorus in the Rum River in 2018 averaged 78.8, 83.3, and 86.0 µg/L at sampled sites from upstream to downstream. This year total phosphorus increased slightly compared to the low values of 2017. The minimal increase from upstream to downstream is overall a good thing as it points to relatively small phosphorus contributions occurring in Anoka County. However, because small increases in phosphorus could cause the Rum River to exceed State standards and be declared "impaired," preventing phosphorus increases should be a focus of watershed management.
- Suspended solids and turbidity generally remained at acceptable levels in the Rum River and are lower than most other Anoka County streams. Average turbidity peaked at the mid-county site Rum River at C.R. 7 where average turbidity was 19.3 NTU. From upstream to downstream in 2018 turbidity averages were 7.2, 19.43, and 3.85 NTU, respectively. TSS levels were low in the Rum River compared to other Anoka County streams averaging 10.94, 10.1, and 5.54 mg/L from upstream to downstream. The low turbidity and TSS levels at the downstream site are likely due to settling in the pool created by the dam at Anoka. Though suspended solids remain well under state impairment thresholds in the Rum, turbidity does show a moderate increase during storm events, and stormwater runoff mitigation should be a focus of management efforts, especially as other pollutants may be associated with suspended solids.
- pH returned to more typical levels in 2018 in the Rum River after being elevated on some occasions in 2017. pH should remain between 6.5 and 8.5 to support aquatic life and meet State water quality standards. On one occasion in May 2017, all three sampled sites exceeded pH 9. However, this year there were no examples of pH exceeding 9, in fact the highest pH recorded was 8.46, within the range required to meet state standards. This decrease in pH both on average and overall is good, but concern remains because there have been a number of spikes in pH over 8.5 in recent years. pH levels over 9 are quite alkaline for natural waterways. There are a variety of potential factors leading to temporary spikes in pH, including discharge of high nutrient and algae waters to the river from lakes or wetlands. pH should continue to be monitored in the Rum River in the future.
- Dissolved oxygen remained above the state standard of 5 mg/L in 2018 and previous monitored years, however the lowest recorded level occurred this year. The lowest concentration recorded at any of the three sites in 2018 was 5.64 mg/L at Rum River at C.R. 7 compared to 6.89 mg/L at Rum River at Anoka Dam in 2017.

Below the data are presented and discussed for each parameter in greater detail. Management recommendations will be included at the conclusion of this report. The Rum River is an exceptionally important waterbody, and its protection and improvement should be a high priority.

Specific Conductivity

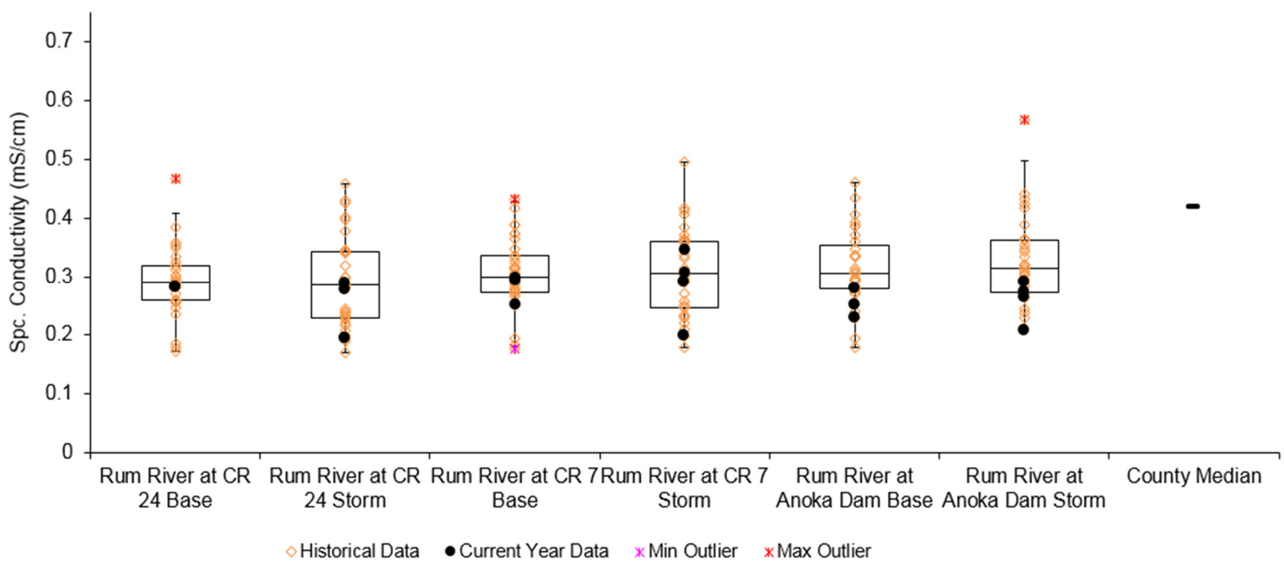
Specific conductivity and chlorides are measures of dissolved pollutants. Dissolved pollutant sources include road runoff and industrial chemicals, among many others. Metals, hydrocarbons, and road salts, as well as other pollutants are often of concern in a suburban environment. Specific Conductivity is the broadest measure of dissolved pollutants we use. It measures electrical Specific Conductivity of the water; pure water with no dissolved constituents has zero Specific Conductivity.

Specific conductivity is acceptably low in the Rum River, in the past it has shown a consistent pattern of increasing downstream (see figure below) and is usually higher during baseflow conditions. Average specific conductivity from upstream to downstream in 2018 (all conditions) did not meet these expectations with readings of 0.266 mS/cm, 0.282 and 0.269 mS/cm, respectively. All three sites are lower than the historical median for 34 Anoka County streams of 0.420 mS/cm and. The 2018 maximum observed specific conductivity in the Rum River was 0.347 mS/cm at County Road 7 during storm conditions. During storm flows there is a statistically significant trend of increasing specific conductivity from upstream to downstream when averaged over the last 5 years.

Specific conductivity is lower on average during storm events (especially at the upstream sites), suggesting that stormwater runoff contains fewer dissolved pollutants than the surficial water table that feeds the river during baseflow. High baseflow specific conductivity has been observed in most other nearby streams as well. This occurrence has been studied extensively, and the largest cause has often been found to be road deicing salts that have infiltrated into the shallow aquifer. Water softening salts and geologic materials also contribute, but to a lesser degree.

In years past, specific conductivity has increased from upstream to downstream and that is the expected trend. During baseflow, this increase from upstream to downstream likely reflects greater road densities and deicing salt application. That this pattern is not seen this year could be due to precipitation or runoff differences, or the timing of sampling. Additionally, the below the dam specific conductivity readings were atypical in 2018 in that specific conductivity was higher during storm than baseflow events, averaging 0.279 mS/cm during storms and 0.254 mS/cm during baseflow.

Specific Conductivity during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Chlorides

Chlorides are the measure of chloride salts, the most common of which are road de-icing chemicals and those used in water softening. 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. They can also be of concern because the Rum River is upstream from the Twin Cities drinking water intakes on the Mississippi River. Specific conductivity data, reported above, is partially a reflection of chlorides with higher specific conductivity corresponding to higher chlorides, generally.

In 2018 water samples for chloride analysis were taken from the Rum River at CR7. At this location average chloride was 14.7 mg/L for all events and 14.2 and 15.0 mg/L for storms and base flow conditions, respectively. This reflects the typical trend seen in specific conductivity of greater dissolved pollutants during baseflow conditions and likely reflects infiltration of road salts into the shallow aquifer. This information could be of greater value if chloride sampling occurred at all sites sampled in the Rum River watershed and, additionally, if samples were taken after snowfall events and corresponding specifically to snowmelt.

Total Phosphorus

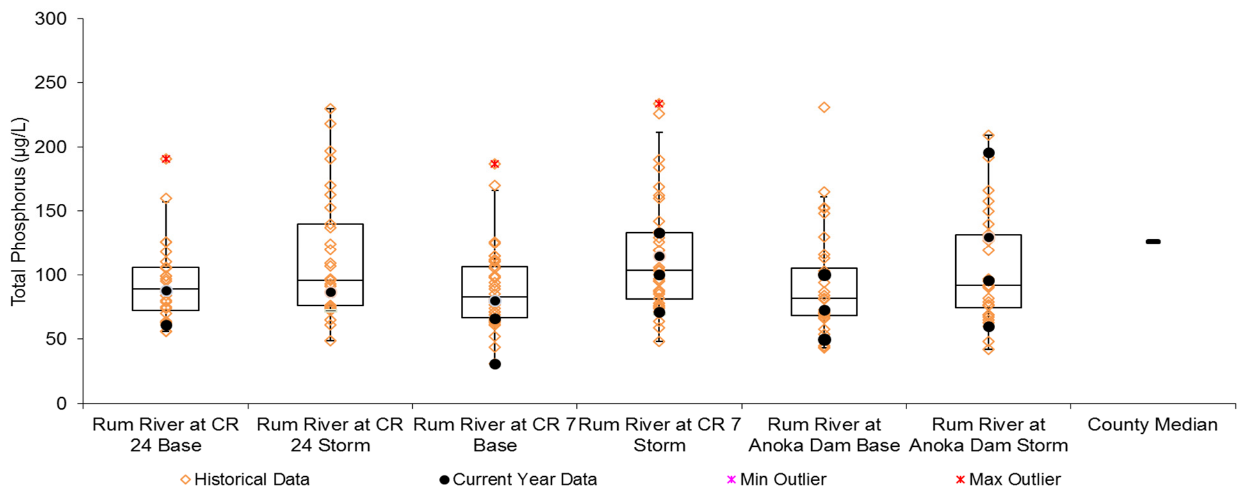
Phosphorus is one of the most common pollutants in this region, and can be associated with urban runoff, agricultural runoff, wastewater, and many other sources. It causes excessive algal growth and a number of other associated problems for aquatic life and recreation. Rum River total phosphorus is near State impairment thresholds.

The average phosphorus concentration in 2018 increased from upstream to downstream and approached State standards for impairment. At the three monitored sites phosphorus from upstream to downstream was 78.8, 83.3 and 86.0 µg/L, respectively. The watershed becomes increasingly suburbanized in the lower reaches.

In 2018, as in many years pre-2016, total phosphorus was close to exceeding State water quality standards. Four samples in 2018 yielded total phosphorus concentrations over the State standard of 100 µg/L. Of those, two occurred on July 2nd at the mid-county and downstream sites after a significant rainfall event.

Understanding that the Rum River is close to exceeding State water quality standards for phosphorus, monitoring should be continued in the future and every effort should be made to prevent phosphorus increases which would likely result in the Rum River being designated a State "impaired" water. Future upgrades to wastewater treatment plants throughout the Rum River watershed may offer phosphorus reductions. At the same time, development should include robust stormwater treatment to not just keep nutrient loading to the river the same, but reduce it. Reductions will be necessary to offset likely increases from land use changes, more intense precipitation events, upstream ditch cleaning and others forces.

Total Phosphorus during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentile (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 the refraction of a light beam passed through a water sample and is most sensitive to large particles. Total suspended solids are 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, such as phosphorus, are attached to particles. Many stormwater treatment practices such as street sweeping, sumps, and stormwater settling ponds target sediment and attached pollutants. In 2018, median turbidity and total suspended solids in the Rum River were lower than the historical median for Anoka County streams.

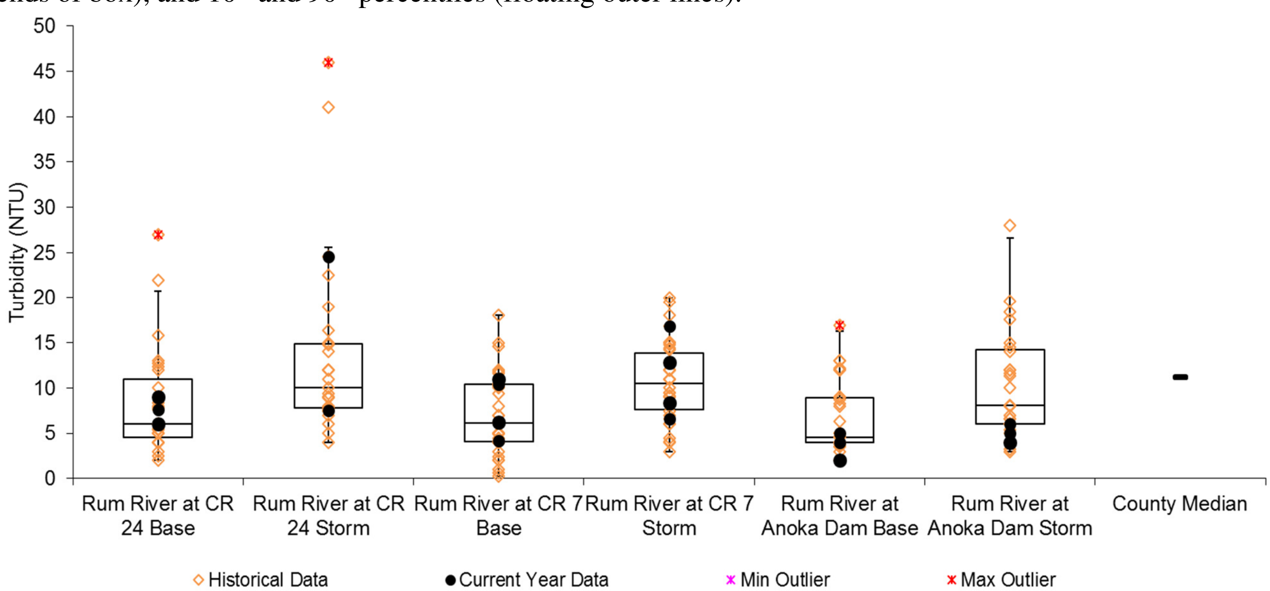
In the Rum River, turbidity is generally low but increases during storms. There is substantial variability (see figure below). There is no clear change in turbidity or suspended solids upstream to downstream. The average turbidity, in 2018 (storms and baseflow) for each site moving upstream to downstream was 7.2, 19.4, and 3.85 NTU. The historical median for Anoka County streams is 11.2 NTU. Turbidity was elevated on a few occasions, especially during and after storm events. Over the last 5 years there is a statistically significant increase in turbidity from upstream to downstream during baseflow conditions and also for all samples. This likely reflects the effect of increased erosion and contribution of sediments in the more developed southern portion of the county.

Average TSS results (all conditions) in 2018 for sites moving upstream to downstream were 10.94, 10.1, and 5.54 mg/L. These are all lower than the Anoka County stream median for TSS of 13.66 mg/L. It is also lower than State water quality standards. The State threshold for TSS impairment in the Rum River is 10% of samples April 1-September 30 exceeding 30 mg/L TSS. The highest concentration recorded in 2018 was 24 mg/L. ACD has not collected a sample over 30 mg/L TSS since May of 2010.

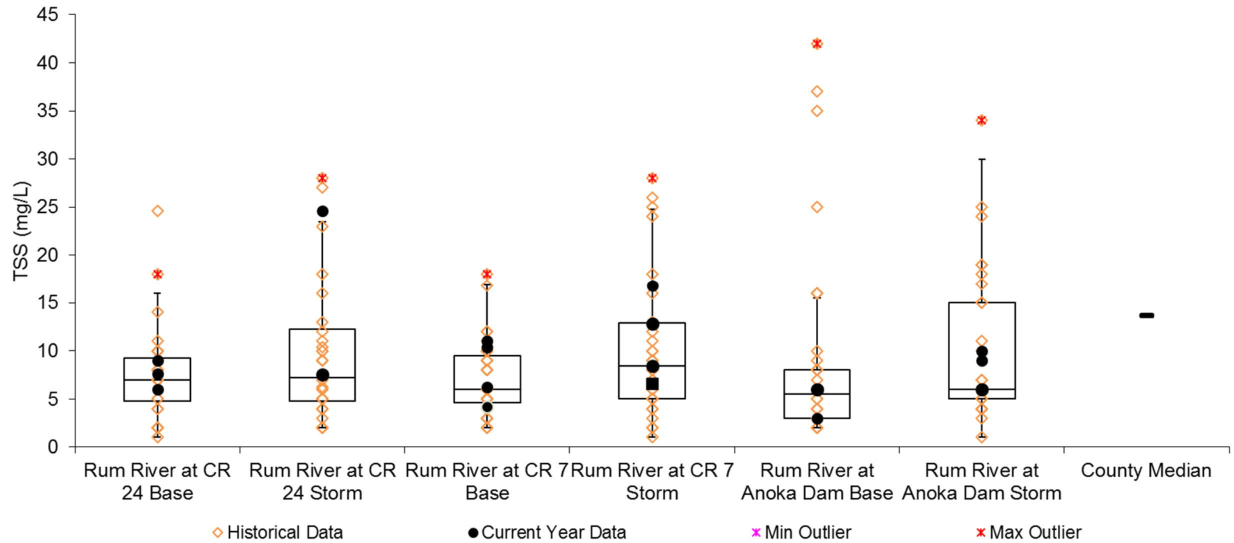
Suspended solids can come from within and outside of the river channel. Sources on land include soil erosion, road sanding, and others. Riverbank erosion and movement of the river bottom also contributes to suspended solids. A moderate amount of this "bed load" is natural and expected.

Though the Rum River remains well under the impairment threshold for TSS, rigorous stormwater treatment should occur as the Rum River watershed continues to be developed or the collective pollution caused by many small developments could seriously impact the river, especially given that stormwater carries many pollutants in addition to suspended sediments. Bringing stormwater treatment up to date in older developments is also important.

Turbidity during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2018 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 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



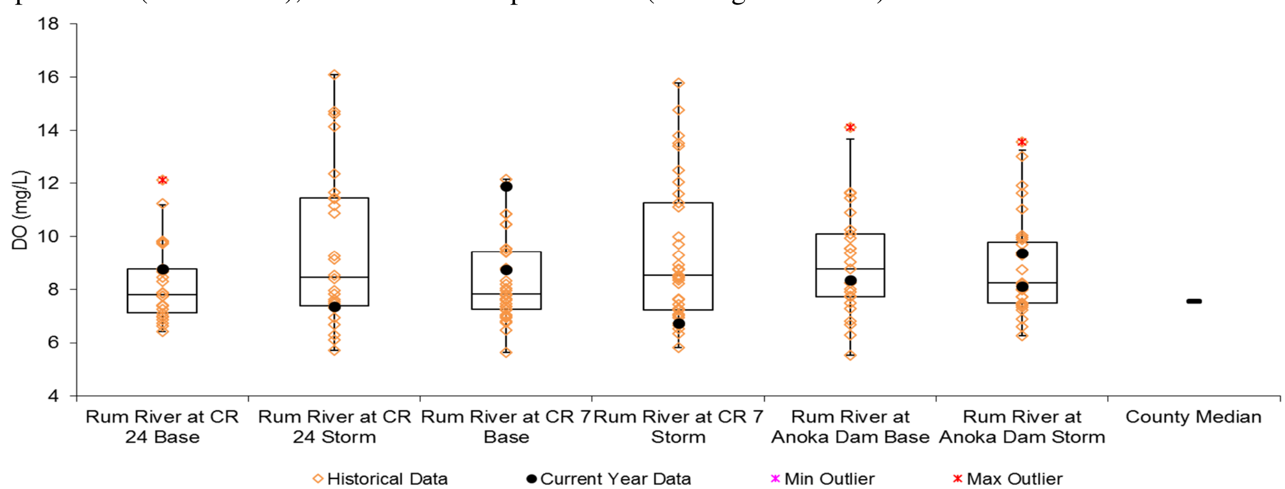
Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution causes oxygen to be consumed during decomposition. If oxygen levels fall below the state water quality standard of 5 mg/L, aquatic life begins to suffer. 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 2018, dissolved oxygen in the Rum River was always above 5 mg/L at all monitoring sites.

The lowest dissolved oxygen observed in the Rum River in 2018 was 5.64 mg/L. This is only the fifth time that a dissolved oxygen reading below 6 has occurred in the Rum River throughout the monitoring record, with the 3 most recent previous readings occurring during a single storm in 2011 when dissolved oxygen dipped below six at all three sites.

Decreases in dissolved oxygen may result from an increase in the level of nutrients in the stream. Making sure that phosphorus and nitrogen inputs to the stream are maintained or lowered is important for healthy dissolved oxygen levels. The principle sources of these nutrients are fertilizer and wastewater.

Dissolved Oxygen during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

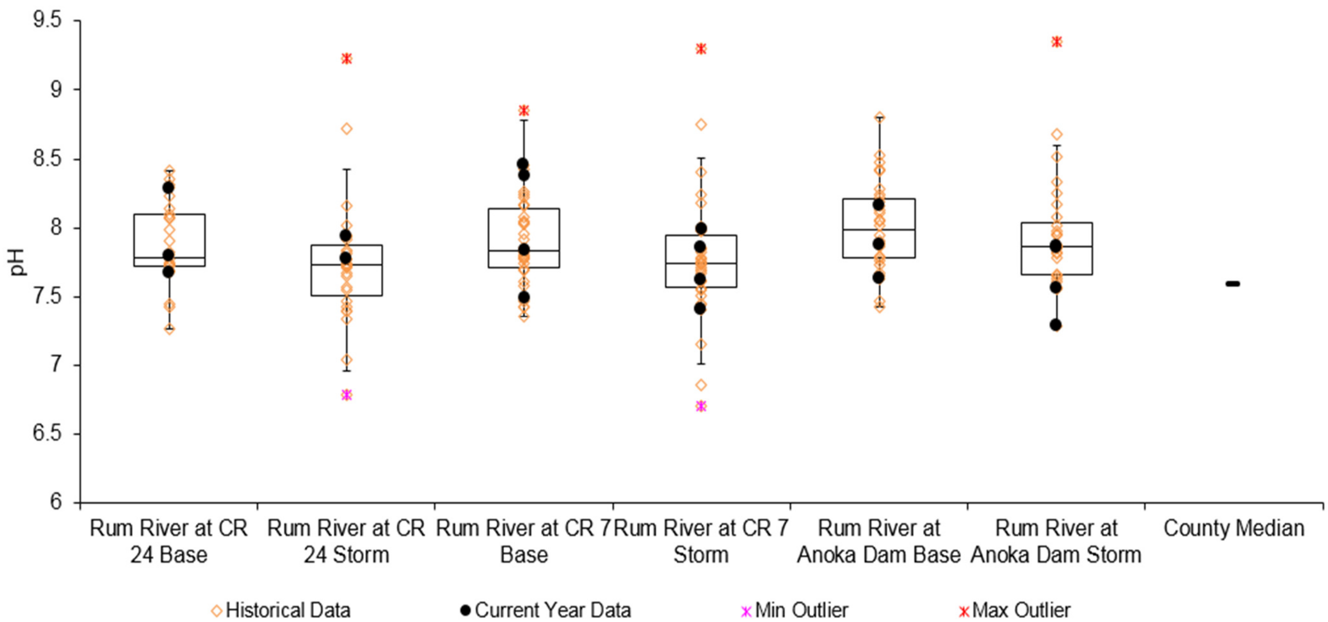


pH

pH refers to the acidity of the water. The Minnesota Pollution Control Agency's water quality standard is for pH to remain between 6.5 and 8.5. The Rum River is generally within this range, but has exceeded 8.5 on rare occasions in the past. In recent years (2015, 2017) however, exceedances of 8.5 have been commonplace at all sites. In 2017, pH levels over 9 were recorded at all three sites after a storm event on 5/18/2017. Exceedances were recorded in 2015 after a spring storm in March at the lower two sampling sites as well as at the Anoka Dam during baseflow conditions in July. This year saw a positive change with no events exceeding 8.5.

There are a variety of potential factors leading to temporary spikes in pH. It is, however, disconcerting that spikes over 8.5 seem to be happening more frequently in recent years, although it is a positive development that they did not occur this year. pH should continue to be monitored in the Rum River in the future to see if the spikes get worse or become even more common.

pH during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Summary and Recommendations

In general, the Rum River's water quality is good. However, there is typically a slight increase in specific conductivity moving downstream, phosphorus levels are near state water quality standards, and pH spikes over 8.5 have been more frequent in recent years, although they did not occur this year. The river is in need of protection now to avoid restoration becoming a necessity later.

In addition to comparing water quality in the Rum River upstream to downstream, water quality was also compared between Rum River tributaries and the Rum River main stem. For specific conductivity, total suspended solids, and total phosphorus the Rum river had better water quality

Relative changes in 3 water quality parameters in tributaries and the Rum River moving upstream to downstream. Arrows indicate difference relative to Rum River at CR 24 (top of the county).

	Specific Conductivity	Total Suspended Solids	Total Phosphorus
	Difference Relative to Rum R. at CR 24		
Rum River @ CR 24	0.266 mS/cm	10.94 mg/L	78.8 µg/L
Seelye Brook @ CR 7	+	-	+
Cedar Creek @ CR 9	+	+	+
Rum River @ CR 7	+	-	+
Ford Brook @ CR 63	+	+	+
Rum River @ Anoka Dam	=	-	+

than the tributaries, except when TSS results at Rum River at CR 24 and Seelye Brook at CR 9 were compared. For the tributaries sampled it is clear that they would be contributing to worsening water quality in the Rum River. Many of the tributaries experience frequent exceedances of state standards, especially for total phosphorus. This is important since the Rum River is already nearing exceedance of total phosphorus standards and this shows that the tributaries are likely contributing to this problem. Moving forward it is important to continue to monitor both the Rum River and its tributaries in order to prioritize management and to understand how tributary water quality effects the Rum River.

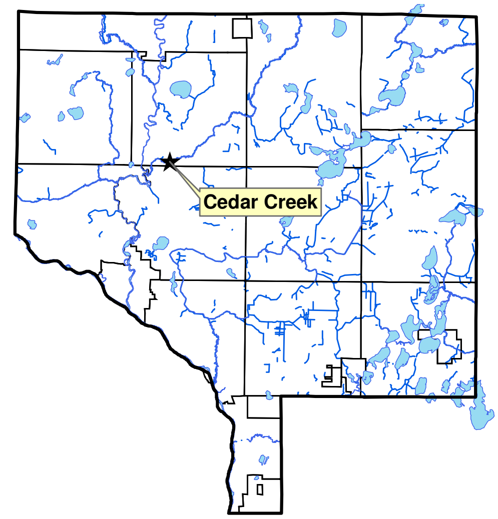
Protection of the Rum River should continue to be a high priority for local officials. Large population increases are expected to continue in the Rum River's watershed within Anoka County. This continued development has the potential to degrade water quality unless carefully planned and managed with the river in mind. Specifically, new development should follow stormwater standards designed to at least maintain, and preferably reduce, phosphorus discharge to the river. Road deicing locally, which has become more sophisticated in recent years, should focus on minimizing salt application while keeping roads safe.

Development pressure is likely to be especially high near the river because of its scenic and natural qualities. Local ordinances to preserve the scenic nature of the river do exist, and enforcement is key. Additionally, preservation of riparian parcels with high natural resources quality should be considered with easement or fee title acquisition.

Watershed-wide (Mille Lacs Lake to the Anoka Dam) coordination of Rum River management is especially active currently. A Watershed Restoration and Protection Strategies (WRAPS) was completed in 2017. It is a scientific study that identifies recommended management strategies. A "One Watershed, One Plan" (1W1P) in 2019-2020 offers multi-county planning. This plan will prioritize and coordinate action. After completion of the 1W1P a new state funding source will become available – Watershed Based Funding – to implement water quality improvement projects.

CEDAR CREEK

at Hwy 9, Oak Grove STORET Site ID = S003-203



Background

Cedar Creek originates in south-central Isanti County and flows southwest into the Rum River. In north-central Anoka County it flows through some areas of high quality natural communities, including the Cedar Creek Ecosystem Science Reserve. Habitat surrounding the stream in other areas is of moderate quality overall. However, the stream is on the State's list of impaired waters for high *E. coli* bacteria.

Cedar Creek is one of the larger streams in Anoka County. Stream widths of 25 feet and depths greater than 2 feet are common at baseflow. The stream bottom is primarily silt. The watershed is moderately developed with scattered single-family homes, and continues to develop rapidly.

Results Summary

This report includes data from 2018 and an overview of previous year's data. The following is a summary of results.

- Dissolved constituents, as measured by specific conductivity, in Cedar Creek are higher in recent years at baseflow conditions. Specific conductivity averaged 0.467 mS/cm in 2018 with the long term baseflow median now up to 0.426 mS/cm. This increase in baseflow specific conductivity is a concerning trend. Chlorides were last sampled in 2013, but sampling of chlorides should be considered again given the increase in specific conductivity levels. Road deicing salt is believed to be a large contributor to elevated chlorides.
- Phosphorus averaged poorer than the State water quality standard of 100 µg/L. Cedar Creek often exceeds the state standard, even during baseflow periods and should be a high priority management area due to the lasting effects of nutrient loading downstream including in the Rum River. Phosphorus results in Cedar Creek averaged 227 µg/L in 2018 up from 151 µg/L in 2017. Phosphorus is typically highest after storms. Much of the watershed is in an undeveloped state, and a portion of the phosphorus is likely from natural sources such as wetlands.
- Suspended solids and turbidity varied widely. Total suspended solids averaged 34.7 mg/L, and turbidity averaged 17.45 NTU. This year TSS exceeded the state standard of 30 mg/L. While a breakdown of sources is not available, some natural sources including wetlands may contribute.
- pH was within the acceptable range of 6.5-8.5. On one occasion in 2017 pH reached 8.94, the highest pH ever recorded in Cedar Creek, but in 2018 pH stayed below 8.5.
- Dissolved oxygen was within the range considered healthy for streams in this area. DO averaged 7.88 mg/L.

Methods

In 1998, 2005-2006, 2011, 2013-2018 monitoring was conducted to determine how Rum River tributary water quality compares to and affects Rum River water quality.

Monitoring was conducted during both baseflow and storm conditions. Storms were generally defined as one-inch or more of rainfall in 24 hours, or a significant snowmelt event combined with rainfall. In some years, particularly drought years, smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events.

Key water quality parameters were monitored at all sites. Parameters tested with portable meters included pH, specific conductivity, turbidity, temperature, salinity, and dissolved oxygen. Parameters tested by water samples sent to a state-certified lab included total phosphorus and total suspended solids. Water level was also recorded during each sampling event.

2018 water quality data is presented below. All other raw data can be obtained from the Anoka Conservation District, and is also available through the Minnesota Pollution Control Agency's EQuIS database on their website (https://www.pca.state.mn.us/data/environmental-quality-information-system-equis).

Cedar Creek 2018 Water Quality Data

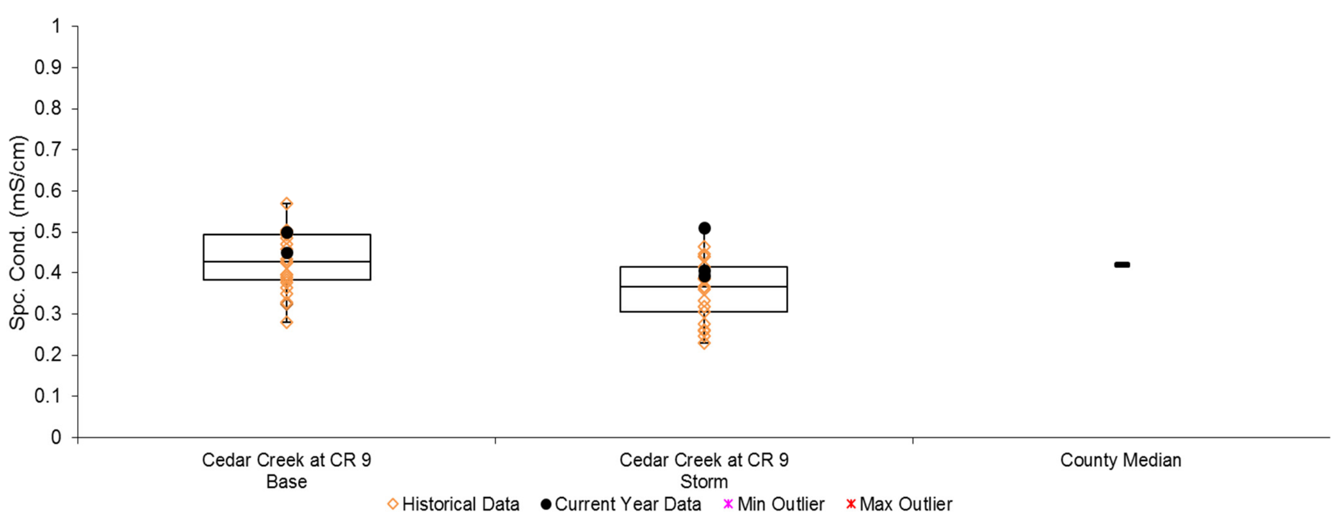
Cedar Creek 2018			5/22/2018	6/7/2018	7/2/2018	7/12/2018	8/28/2018				
	Units	R.L.*	Results	Results	Results	Results	Results	Median	Average	Min	Max
pH		0.1	8.22	7.98	7.26	7.94	7.78	7.94	7.84	7.26	8.22
Spc. Conductivity	mS/cm	0.01	0.449	0.511	0.406	0.500	0.393	0.45	0.45	0.39	0.51
Turbidity	NTU	1	9.3	23.9	19.9	16.7	0	16.70	13.96	0.00	23.90
D.O.	mg/L	0.01	7.79	7.88	5.88	7.45	7.41	7.45	7.28	5.88	7.88
D.O.	%	1	80.3	89.1	65.9	76.8	80.9	80.30	78.60	65.90	89.10
Temp.	°C	0.1	16.77	19.87	19.30	23.53	17.92	19.30	19.48	16.77	23.53
Salinity	%	0.01	0.21	0.25	0.19	0.24	0.19	0.21	0.22	0.19	0.25
T.P.	ug/L	10	134	298	284	193	121	193.00	206.00	121.00	298.00
TSS	mg/L	2	23	61	36	19	8.9	22.60	29.50	8.90	61.00
Secchi-tube	cm	100	>100	45	48	53	>100	48.00	48.67	45.00	>100
Appearance			2	0	0	0	0				

Specific Conductivity

Specific conductivity and chlorides are measures of dissolved pollutants. Dissolved pollutant sources include road runoff and industrial chemicals, among many others. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Specific conductivity is the broadest measure of dissolved pollutants we use. It measures electrical specific conductivity of the water; pure water with no dissolved constituents has zero specific 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. Historical chloride data can be obtained from the Anoka Conservation District and is also available through the Minnesota Pollution Control Agency's EQuIS database, which is available through their website.

Specific conductivity is right on par in Cedar Creek at CR 9 compared to other Anoka County streams. Median specific conductivity (all years) is 0.426 mS/cm during baseflow and 0.363 mS/cm during storm events, respectively. The long-term countywide median specific conductivity for all conditions is 0.420 mS/cm. However, this includes many heavily urbanized streams, which Cedar Creek is not.

Specific Conductivity during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Baseflow specific conductivity appears to be higher over the last few sampling years (since 2014). The median baseflow specific conductivity since 2014 is 0.485 mS/cm, above the long-term median suggesting increasing levels. However, the median storm flow specific conductivity since 2014, 0.319 mS/cm, is lower than the long-term average.

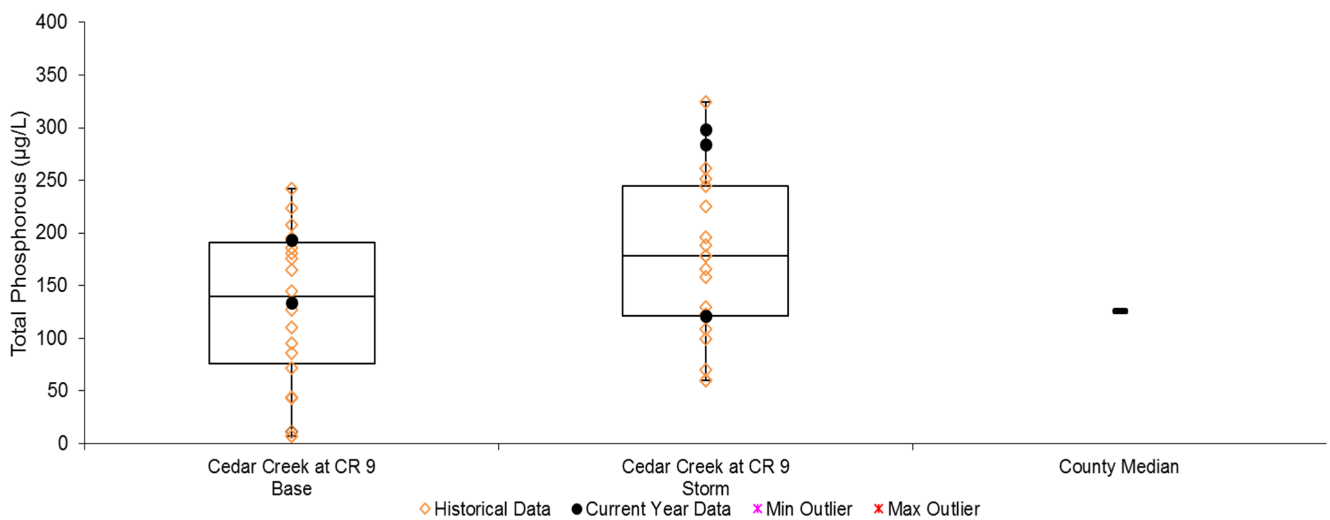
This increase in baseflow specific conductivity levels reveals some information about sources of loading into the stream. Higher levels at baseflow conditions indicate that the surficial groundwater of the watershed is being loaded with salts and other chemicals that increase specific conductivity. Some common sources of this type of pollution are road salts, water softeners, septic leaks, and agricultural chemicals. These constituents that raise specific conductivity appear to be entering the stream in higher concentrations from the local surficial groundwater. Storm runoff then dilutes specific conductivity levels during rain events.

Total Phosphorus

Total phosphorus in Cedar Creek remained high in 2018 averaging 227 µg/L during all conditions. This 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 median phosphorus concentration at Cedar Creek at CR 9 (all years) is 136 µg/L during baseflow, similar to the County stream median, and 172 µg/L during storm events. 19 of the 23 measurements taken since 2014 were >100 µg/L, the State water quality standard. In 2018, the highest observed total phosphorus concentrations were recorded during June and July at 298 µg/L and 284 µg/L. Individual results over 200 µg/L have become an annual occurrence since 2015. These recent high observances tend to inflate the long term average, so the median can be a better indicator of long term conditions. Nonetheless, phosphorus concentrations in Cedar Creek are at concerning levels and higher in recent years. Sources may include a mix of natural sources, such as wetlands, in combination with agricultural and suburban runoff.

Total Phosphorus during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2018 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)

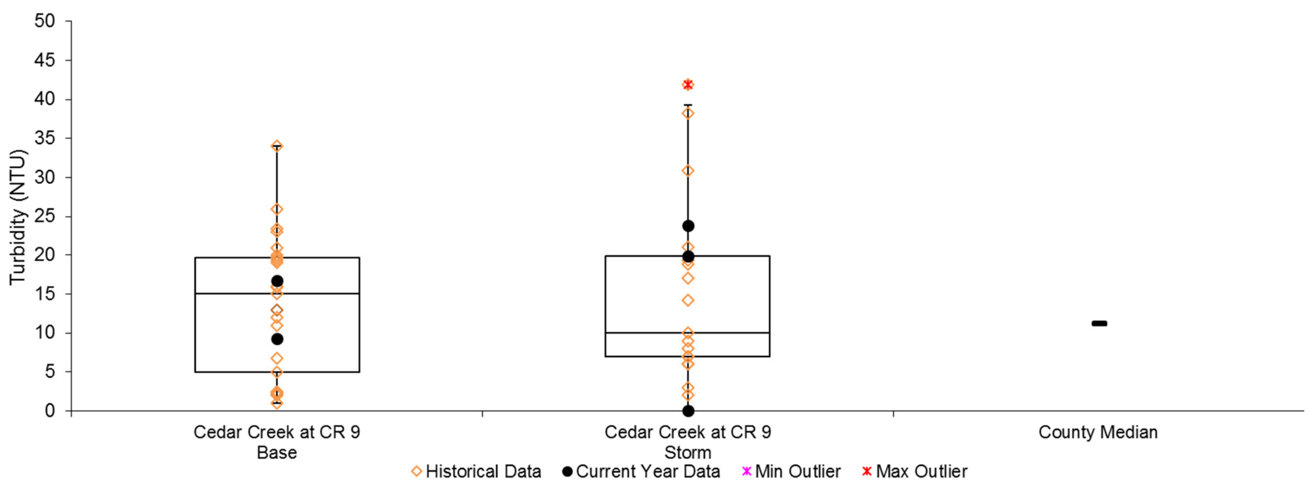
Turbidity and total suspended solids (TSS) are two different measurements of solid material suspended in the water. Turbidity is measured by refraction of a light beam passed through a water sample. It is most sensitive to large particles. Total suspended solids are measured by filtering solids from 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.

Cedar Creek turbidity in 2018 was variable amongst the four samples taken. A low storm flow result of 0 NTU in August was opposed by a high storm flow result of 23.9 in June. The average turbidity in Cedar Creek in 2018 was 17.45 NTU and median was 18.30 NTU.

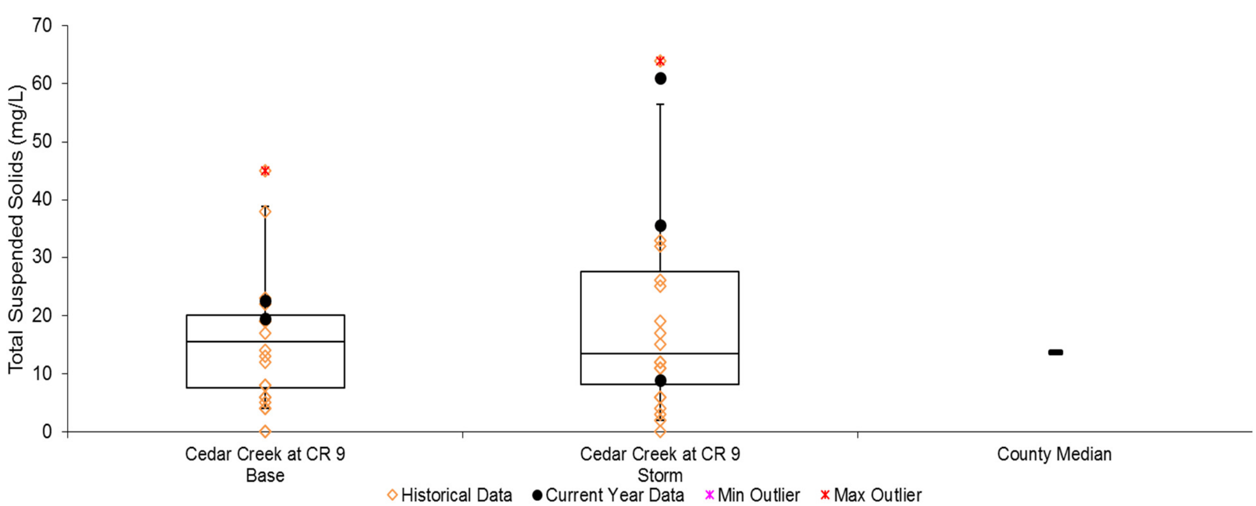
The median turbidity (all years) fell to 9.8 NTU during baseflow and to 9.0 NTU during storm events after 2018 results were added. Both are higher than the median for Anoka County streams of 8.5 NTU. The maximum turbidity measured in 2018 was 23.9 NTU.

TSS was similar to turbidity with low spring and summer results bracketing high early summer results. The median TSS concentration for Cedar Creek is 8 mg/L in 2018, lower than the median for all Anoka County streams of 14 mg/L. TSS is lower than the State water quality standard of no more than 10% of observations greater than 30 mg/L.

Turbidity during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2018 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 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

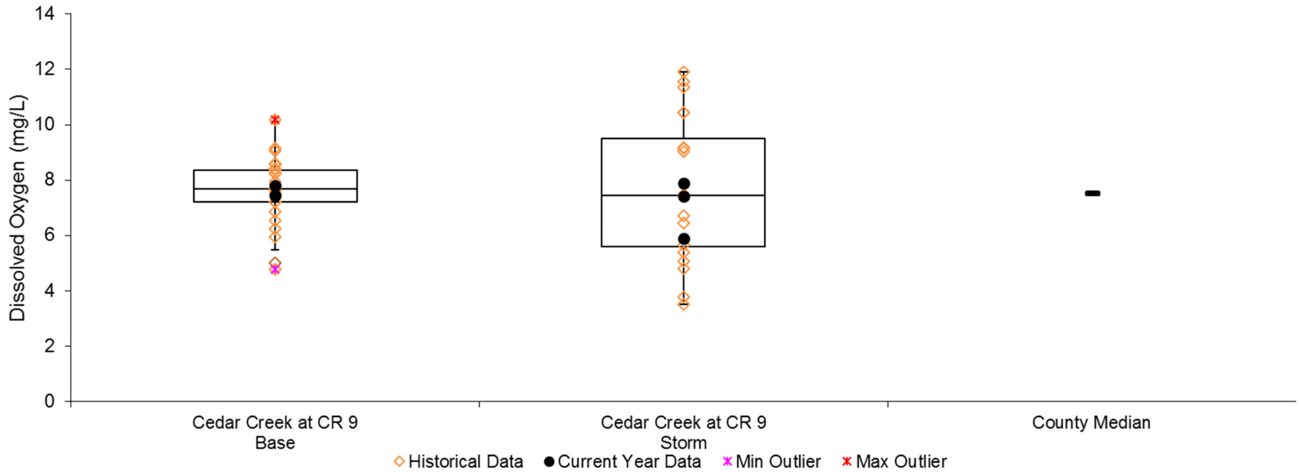


Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution consumes oxygen when it decomposes. If oxygen levels fall below the state standard of 5 mg/L aquatic life begins to suffer.

In 2018, dissolved oxygen in Cedar Creek was always above 5 mg/L. Median dissolved oxygen for all years of data is 7.48mg/L during baseflow and 7.59 mg/L during storm events. Few readings of <5 mg/L have been observed at Cedar Creek, and there is no management concern at this time.

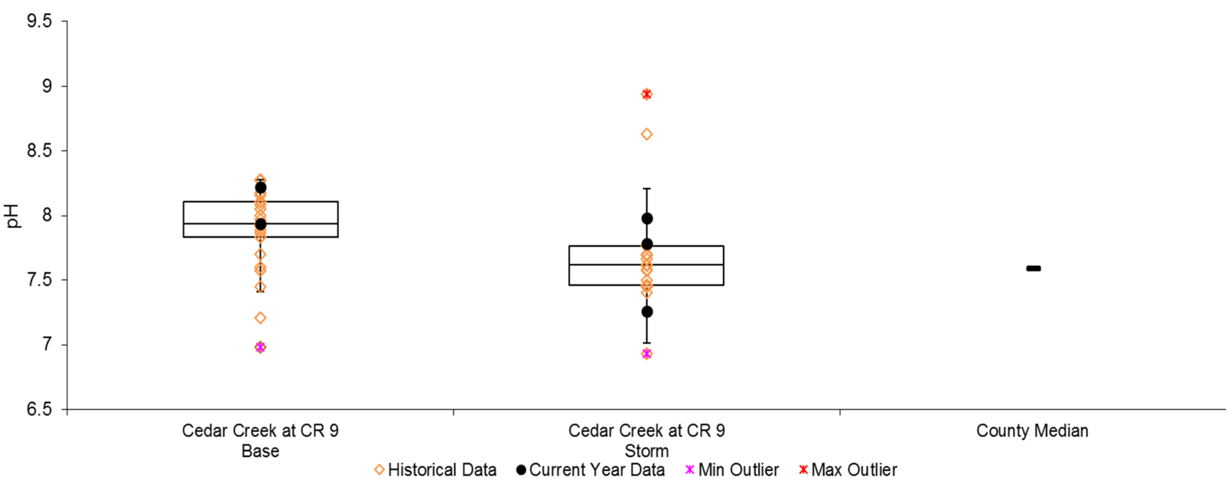
Dissolved Oxygen during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



pH

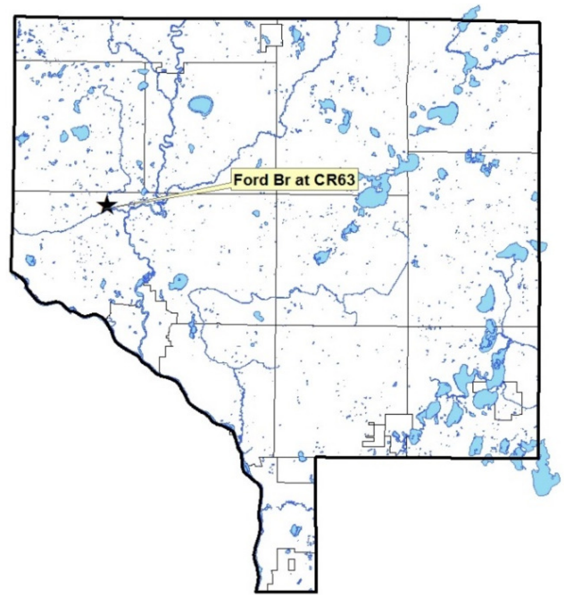
pH refers to the acid or base nature of the water. The Minnesota Pollution Control Agency's water quality standard is for pH to be between 6.5 and 8.5. Although pH has exceeded 8.5 twice in the past there were no exceedances this year. The readings were all on the high end of the acceptable range between 7.26 and 8.22. pH is generally lower during storms than during baseflow, but interestingly, the two highest pH readings historically have been high outliers during storm flows. The pH of rain is typically lower (more acidic). The rare occasion when pH exceeds the State standard should not be concerning.

pH during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



FORD BROOK

at County Road 63, Nowthen STORET Site ID = S003-200



Background

Ford Brook originates at Goose Lake in northwestern Anoka County and flows south. Ford Brook is a tributary to the Rum River. It joins Trott Brook just prior to the Rum River. The watershed is moderately developed with scattered single-family homes, but continues to be developed as large-lot residential.

Results Summary

This report includes data from 2018 and an overview of previous year's data. The following is a summary of results.

- Dissolved constituents, as measured by specific conductivity, in Ford Brook were greater in 2018 during baseflow conditions than recent years and above average when compared to similar Anoka County streams. Specific conductivity averaged 0.479 mS/cm in 2018. Levels are not highly problematic today, but could become so over time. Like many streams in the area, Ford Brook experiences its highest specific conductivity during baseflow. Specific conductivity is commonly linked to road deicing salts, and other sources like water softeners and dissolved pollutants can contribute. Periodic chloride sampling is recommended to verify if observed specific conductivity increases are due to salts. Road deicing practices and technologies continue to develop and be adopted locally, but more appear needed.
- Total phosphorus remained, on average, in excess of the MPCA water quality standard of 100 µg/L. Ford Brook often exceeds the limit, even during baseflow conditions. This is common for streams in the area. In 2018 phosphorus results in Ford Brook averaged 148 µg/L with a maximum of 184 µg/L and a minimum of 94 µg/L. This is higher than the average for all years of 92 µg/L. Modest phosphorus reduction efforts could realistically keep Ford Brook off the State list of impaired waters. New development that could increase phosphorus should utilize appropriate phosphorus reduction practices.
- Suspended solids and turbidity both averaged below (better than) State standards. Total suspended solids averaged 14.18 mg/L. Turbidity averaged 10.22 NTU. There is no current management concern.
- pH was well within the acceptable range for all readings in 2018. With a minimum value of 7.62 and a maximum of 8.21.
- Dissolved oxygen was within the health range for streams. DO averaged 7.39 mg/L (maximum of 8.32 mg/L and a minimum of 6.13 mg/L).

Ford Brook 2018 Water Quality Data

Ford Brook			5/22/2018	6/7/2018	7/2/2018	7/12/2018	8/28/2018				
	Units	R.L.*	Results	Results	Results	Results	Results	Median	Average	Min	Max
pH		0.1	8.21	8.12	7.62	7.74	7.94	7.94	7.93	7.62	8.21
Spc. Conductivity	mS/cm	0.01	0.505	0.537	0.460	0.484	0.409	0.484	0.479	0.409	0.537
Turbidity	NTU	1	1.8	10.1	24.5	9.8	4.9	9.8	10.2	1.8	24.5
D.O.	mg/L	0.01	7.20	8.11	7.17	6.13	8.32	7.20	7.39	6.13	8.32
D.O.	%	1	75.5	92.3	82.0	76.3	92.2	82.0	83.7	75.5	92.3
Temp.	°C	0.1	17.58	20.35	20.59	24.72	18.71	20.35	20.39	17.58	24.72
Salinity	%	0.01	0.24	0.26	0.22	0.23	0.19	0.23	0.23	0.19	0.26
T.P.	ug/L	10	145	94	184	162	155	155	148	94	184
TSS	mg/L	2	13	10	32	10	6.2	10	14.2	6.2	32.4
Secchi-tube	cm	100	90	50	48	>100	>100	>90	>78	48	>100

*reporting limit

Methods

In 1998, 2001, 2003-2006, 2011, 2014-2018 monitoring was conducted to determine how Rum River tributary water quality compares to and affects Rum River water quality.

Monitoring was conducted during both baseflow and storm conditions. Storms were generally defined as one-inch or more of rainfall in 24 hours, or a significant snowmelt event combined with rainfall. In some years, particularly drought years, smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events.

Key water quality parameters were monitored at all sites. Parameters tested with portable meters included pH, specific conductivity, turbidity, temperature, salinity, and dissolved oxygen. Parameters tested by water samples sent to a state-certified lab included total phosphorus and total suspended solids. Water level was also recorded during each sampling event.

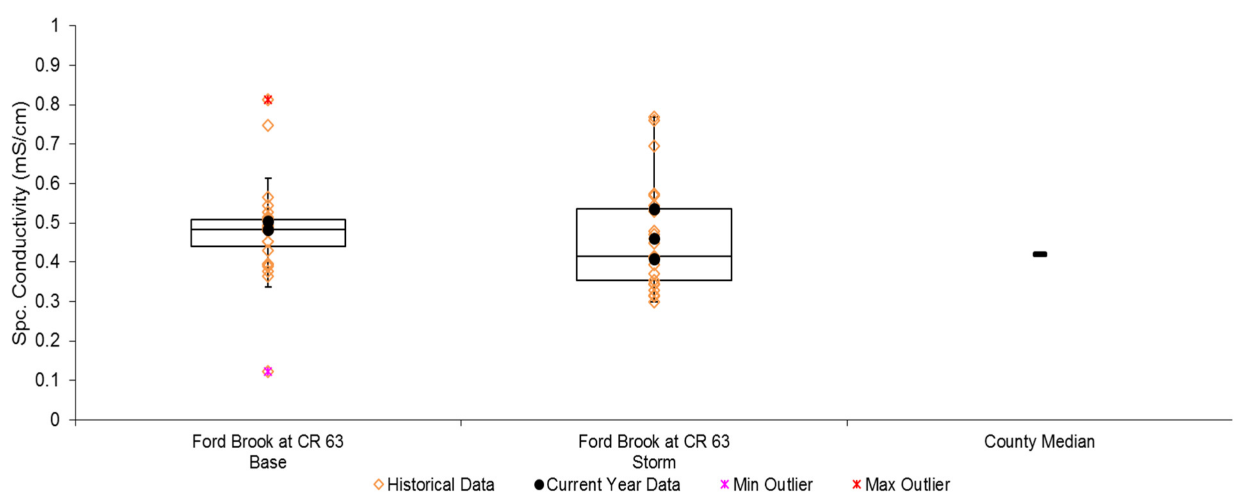
2018 water quality data is presented above. All other raw data can be obtained from the Anoka Conservation District, and is also available through the Minnesota Pollution Control Agency's EQuIS database, which is available through their website (https://www.pca.state.mn.us/data/environmental-quality-information-system-equis).

Specific Conductivity

Median specific conductivity results in Ford Brook are mildly higher than the median for other Anoka County streams. Median specific conductivity in Ford Brook is 0.484 mS/cm (all years) during baseflow conditions and 0.415 mS/cm during storms, compared to the countywide median of 0.420 mS/cm during all conditions. Baseflow specific conductivity in 2018 was higher than recent years sampled dating back to 2011 (no monitoring occurred 2004-2010). Baseflow specific conductivity levels appear to be rising throughout the county, and Ford Brook is no exception.

The baseflow vs storm flow comparison of specific conductivity lends some insight into the pollutant sources. If dissolved pollutants were only elevated during storms, stormwater runoff would be suspected as the primary contributor. If dissolved pollutants were highest during baseflow, pollution of the shallow groundwater which feeds the stream during baseflow would be suspected to be a primary contributor. In Ford Brook we find similar, but slightly lower dissolved pollutants during storms. In other words, both stormwater runoff and groundwater are sources of dissolved pollutants, with shallow groundwater contributing slightly more. While storms dilute some of the baseflow pollutants, they also carry additional pollutants, which can offset the dilution.

Specific Conductivity at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



A likely cause of the increase in specific conductivity in streams at baseflow is chlorides from road salting. Water softener discharge or dissolved pollutants can also contribute. These salts both runoff into the water and infiltrate into the shallow groundwater that feeds the stream during baseflow. Periodic chloride sampling to assess the contribution of salts to the dissolved pollutant load is recommended.

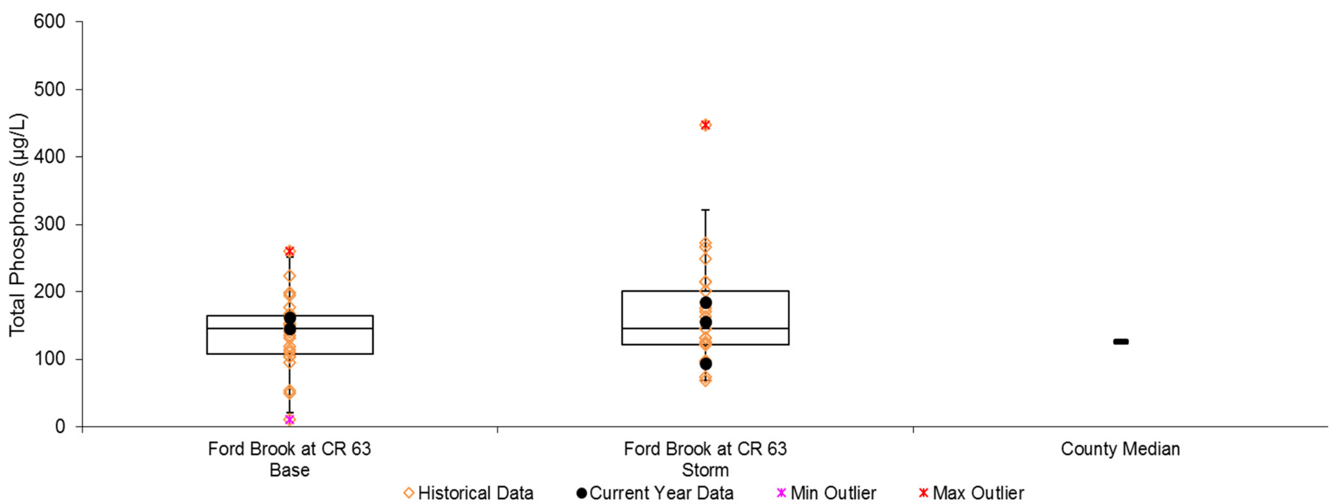
From a management standpoint, it is important to remember that the sources of both stormwater and baseflow dissolved pollutants are generally the same; it is only the timing of delivery to the stream that is different. Preventing their release into the environment and treating them before infiltration should be a high priority. Training and equipment that minimize road salting while keeping roads safe is being increasingly emphasized by watershed managers throughout the region.

Total Phosphorus

Total phosphorus (TP) is a common nutrient pollutant. It is limiting for most algal growth. In the past, total phosphorus in Ford Brook has been moderate during baseflow conditions and increased during storms (see figure below). TP levels in 2018 were similar, and regularly exceeded the State standard of 100 µg/L, with a minimum of 94 and a maximum of 184 µg/L. TP levels during storms in 2018, while still averaging higher than the State standard, were on the low end of the range historically observed in this stream.

The phosphorus levels observed are common for Anoka County streams, but do exceed the State's water quality standard. Efforts to reduce phosphorus should be considered but even higher priority should be put on ensuring robust water treatment for stormwater discharges from new development. The Ford Brook watershed is likely to experience significant development in the years to come. Most of it is currently planned as large lot residential.

Total Phosphorus at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2018 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 (TSS) and Turbidity

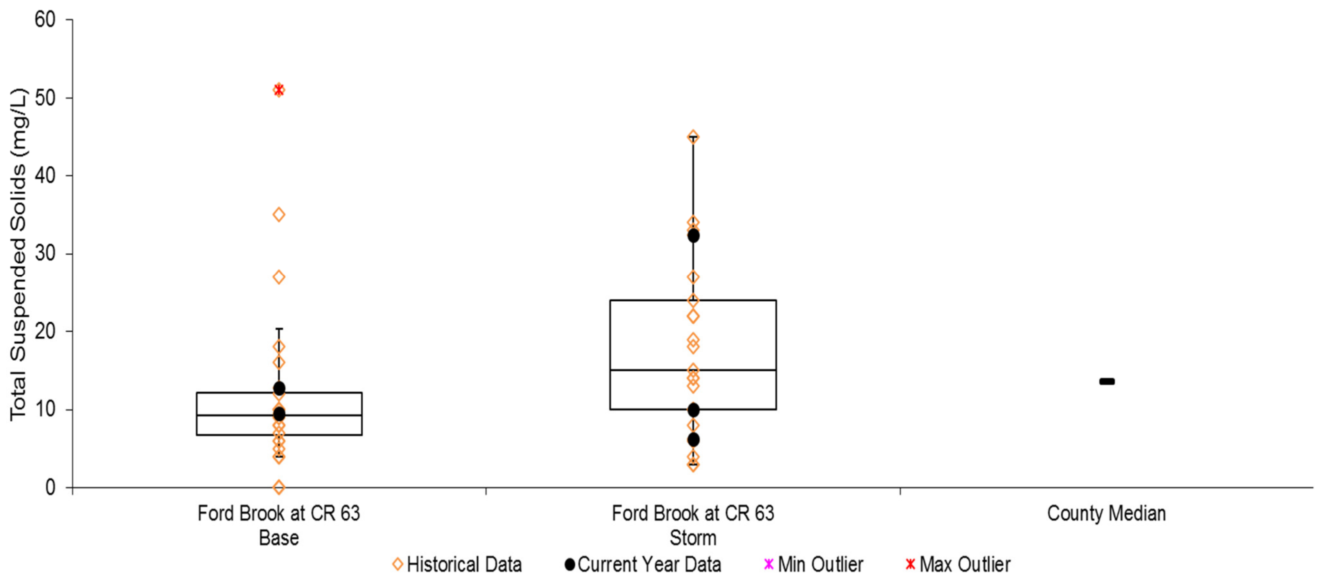
Turbidity and total suspended solids (TSS) are two different measurements of solid material suspended in the water. Turbidity is measured by refraction of a light beam passed through a water sample. It is most sensitive to large particles. Total suspended solids are measured by filtering solids from 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.

In Ford Brook, both TSS and turbidity are generally low, though considerably higher during storm events than baseflow. Overall, the levels observed are similar to other streams in the region, below (better than) State water quality standards, and not a significant management concern.

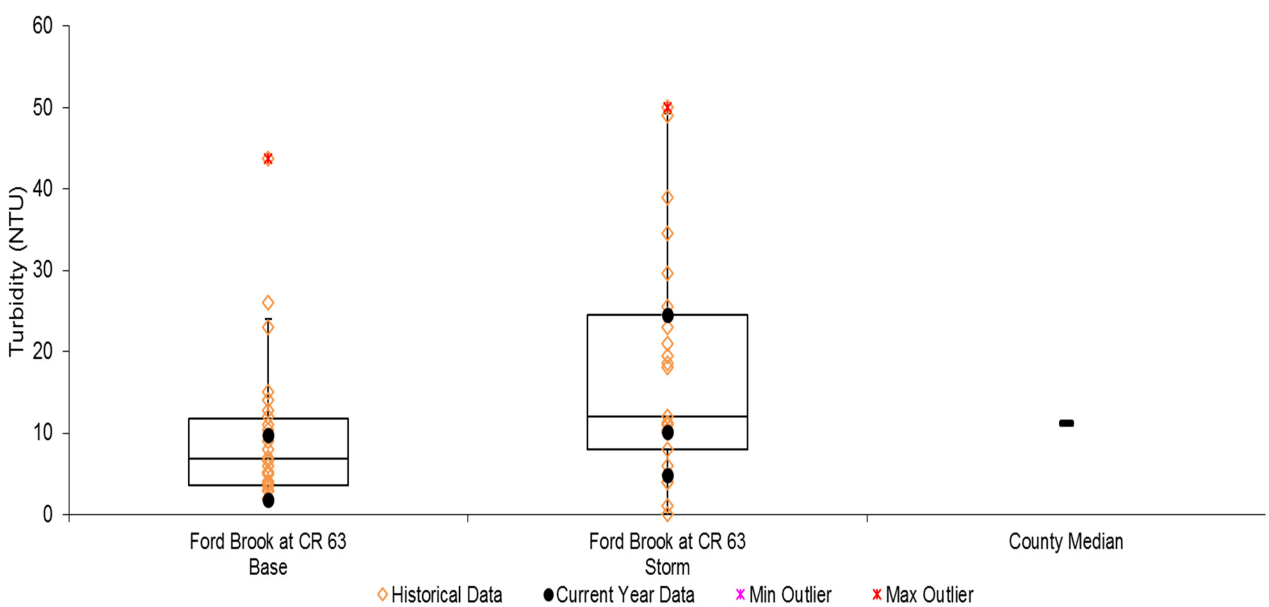
Median turbidity for Ford Brook during baseflow (all years) is 6.8 NTU. Turbidity during storm events has a median (all years) of 12 NTU. The countywide median for all streams is 11.3 NTU for all conditions. In 2018, none of the readings exceeded the MPCA's water quality threshold of 25 NTU, after two of five eclipsed it in 2016 and one did in 2017.

Average TSS in 2018 was 14.18 mg/L, and the long term median for all conditions is 13.66 mg/L. The highest TSS measurement in 2018 was 32.4 mg/L. The State TSS water quality standard is that no more than 10% of samples should exceed 30 mg/L. Ford Brook's TSS and turbidity appear to be better than State standards.

Total Suspended Solids at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



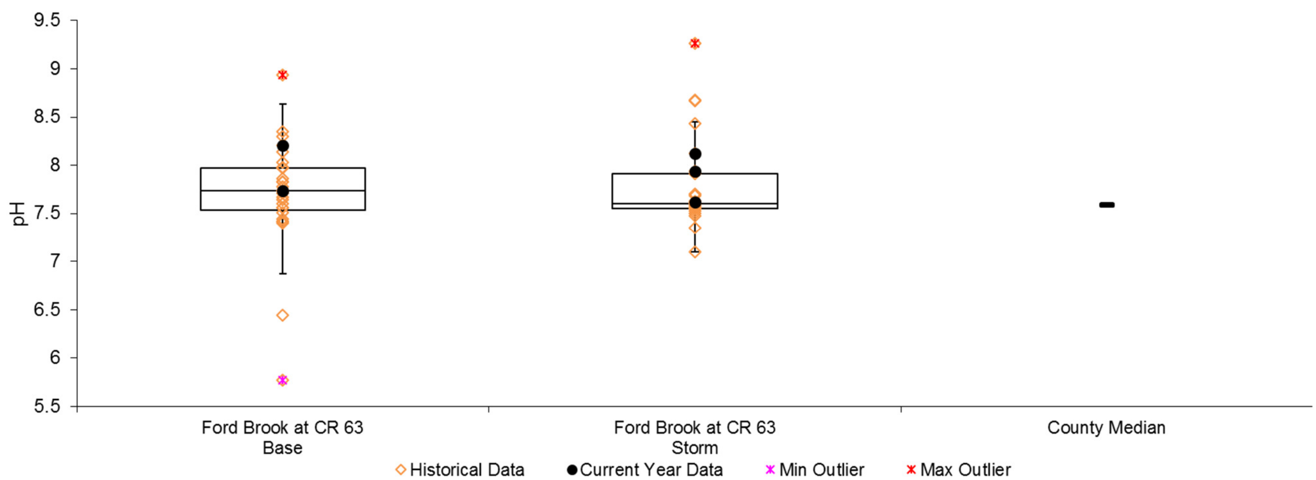
Turbidity at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



pH

pH refers to the acid or base nature of the water. The Minnesota Pollution Control Agency's water quality standard is that pH should fall between 6.5 and 8.5. pH in 2018 was always within these limits. In 2017 one storm flow sample had a pH of 9.26, the highest pH ever recorded in Ford Brook. While occasional readings outside of this range have occurred in previous years, they were not large departures that generated concern.

pH at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

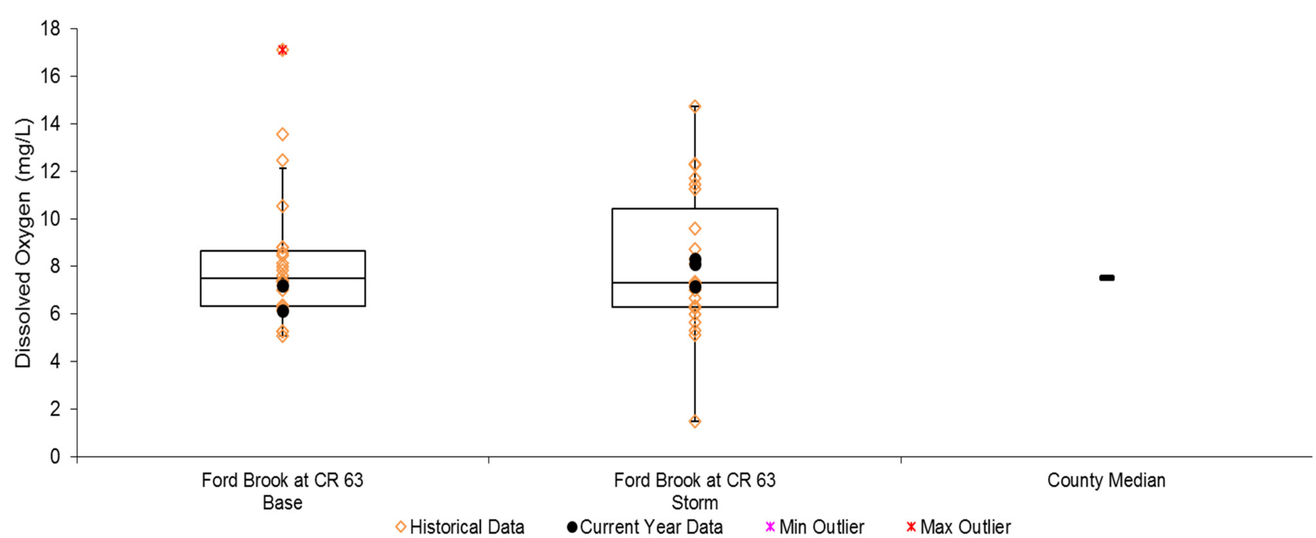


Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution causes oxygen to be consumed when it decomposes. If oxygen levels fall below the state standard of 5 mg/L, aquatic life begins to suffer.

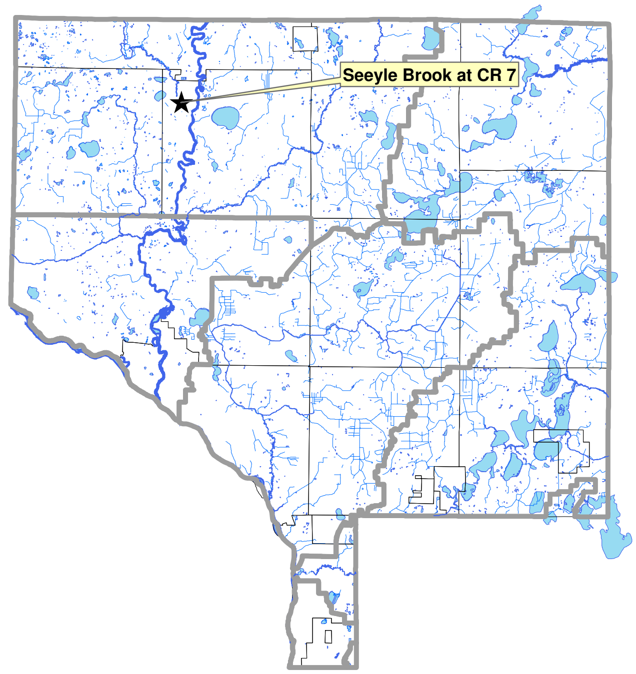
Dissolved oxygen in Ford Brook was within acceptable levels. None of the samples collected in 2018 were below the 5 mg/L State standard, when aquatic life suffers.

Dissolved Oxygen at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



SEELYE BROOK

at Co. Rd. 7, St. Francis STORET Site ID = S003-204



Background

Seelye Brook originates in southwestern Isanti County and flows south through northwest Anoka County, draining into the Rum River just east of the sampling site. This stream is low gradient, like most other streams in the area. It has a silty or sandy bottom and lacks riffle-pool sequences. It is a moderate to large stream for Anoka County, with a typical baseflow width of 20-25 feet.

The sampling site is in the road right of way of the Highway 7 crossing. Aside from the bridge footings and concrete-grouted stone around the bridge, the stream at this location has a sandy bottom. This site experiences scour during high water because flow is constricted under the bridge. Banks are steep and undercut.

Results Summary

This report includes data from 2018 and an overview of previous year's data. The following is a summary of results.

- Dissolved constituents, as measured by specific conductivity, have been rising in recent years, particularly during baseflow conditions. The baseflow median specific conductivity since 2014 is 0.446 mS/cm, pre-2014 baseflow median specific conductivity was 0.397 mS/cm. These levels are becoming concerning, and it is likely that chlorides are a cause and following suit; thus they should be monitored as well.
- Phosphorus averaged above the MPCA water quality standard of 100 µg/L, as in previous years. Seelye Brook often exceeds the limit, even during baseflow periods. Phosphorus in Seelye Brook averaged 147.20 µg/L (maximum of 177 µg/L and a minimum of 108 µg/L) in 2018.
- Suspended solids and turbidity remain quite low in Seelye Brook compared to other streams. Turbidity had an elevated reading and a very low reading. Turbidity averaged 24.24 NTU while TSS averaged 12.45 mg/L. With the high turbidity reading excluded the average turbidity was 11.0 NTU.
- Dissolved oxygen was within the healthy range for a stream. DO averaged 7.34 mg/L (maximum of 7.74 mg/L and a minimum of 6.75 mg/L).
- pH on average was within the range considered normal and healthy for streams in this area, averaging 7.84.

Seelye Brook 2018 Water Quality Data

Seelye Brook			5/22/2018	6/7/2018	7/2/2018	7/12/2018	8/28/2018				
	Units	R.L.*	Results	Results	Results	Results	Results	Median	Average	Min	Max
pH		0.1	8.12	8.16	7.67	7.46	7.80	7.80	7.84	7.46	8.16
Spc. Conductivity	mS/cm	0.01	0.464	0.535	0.433	0.519	0.431	0.464	0.476	0.431	0.535
Turbidity	NTU	1	77.3	13.6	9.6	9.1	11.6	11.6	24.2	9.1	77.3
D.O.	mg/L	0.01	7.65	7.74	6.91	6.75	7.65	7.65	7.34	6.75	7.74
D.O.	%	1	no result	84.4	79.5	80.8	83.6	82.2	82.08	79.5	84.4
Temp.	°C	0.1	15.93	18.24	20.65	23.01	17.88	18.24	19.14	15.9	23.0
Salinity	%	0.01	0.22	0.26	0.21	0.25	0.2	0.22	0.23	0.20	0.26
T.P.	ug/L	10	108	177	174	151	126	151	147	108	177
TSS	mg/L	2	9.0	15.6	10.0	18.0	6.2	10.0	11.8	6.2	18.0
Secchi-tube	cm		>100	78	90	>100	>100	>100	>94	78	>100
Appearance			2	0	0	0	0				

*reporting limit

Methods

In 1998, 2005, 2011, 2013-2018 monitoring was conducted to determine how Rum River tributary water quality compares to and affects Rum River water quality.

Monitoring was conducted during both base flow and storm conditions. Storms were generally defined as one-inch or more of rainfall in 24 hours, or a significant snowmelt event combined with rainfall. In some years, particularly drought years, smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events.

Key water quality parameters were monitored at all sites. Parameters tested with portable meters included pH, specific conductivity, turbidity, temperature, salinity, and dissolved oxygen. Parameters tested by water samples sent to a state-certified lab included total phosphorus and total suspended solids. Water level was also recorded during each sampling event.

2018 water quality data is presented above. All other raw data can be obtained from the Anoka Conservation District, and is also available through the Minnesota Pollution Control Agency's EQuIS database, which is available through their website (https://www.pca.state.mn.us/data/environmental-quality-information-system-equis).

Specific Conductivity

Specific conductivity is a broad measure of dissolved constituents in water. It measures electrical specific conductivity of the water; pure water with no dissolved constituents has zero specific conductivity. Dissolved pollutant sources include urban road runoff, industrial chemicals, deicing salts and others. Overall, baseflow specific conductivity in Seelye Brook is moderately high and rising.

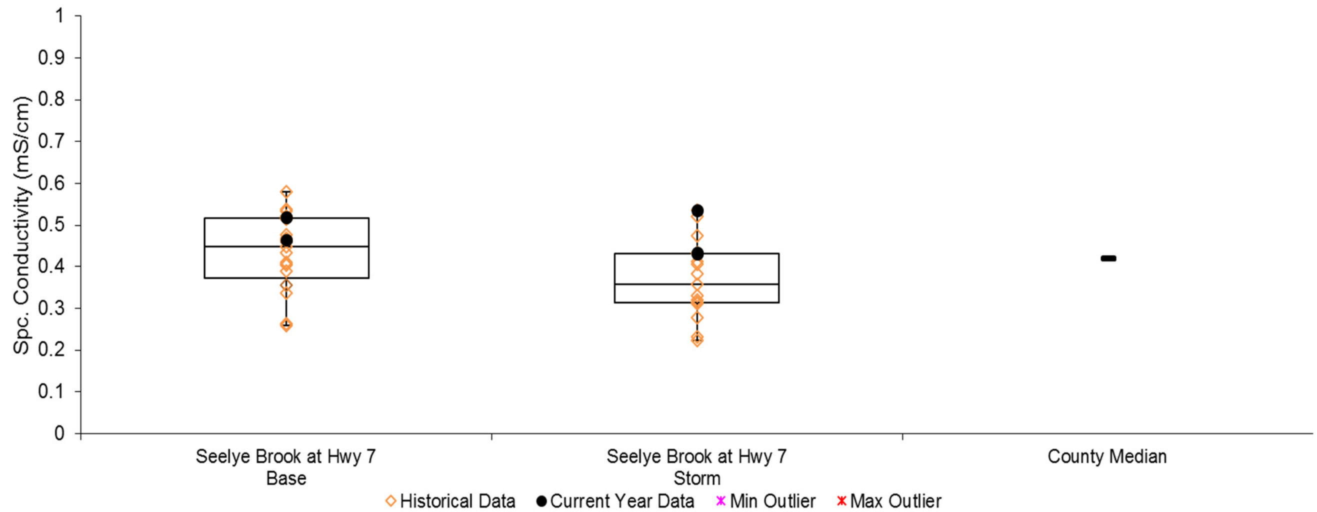
Specific conductivity has historically been low in Seelye Brook at Hwy 7, but has increased during baseflow conditions in recent years. Specific conductivity is typically higher at baseflow conditions than at stormflow conditions. Median specific conductivity (all years) is 0.446 mS/cm during baseflow and 0.357 mS/cm during storm events. The overall median for all conditions is 0.408 mS/cm, just below the median for Anoka County streams of 0.420 mS/cm, which includes many streams in very highly urbanized areas. Since August of 2014, however, the median baseflow specific conductivity is 0.515 mS/cm. Of the 2018 samples, two were at the upper quartile of historic samples exceeding 0.5 mS/cm once at baseflow and once at stormflow.

The baseflow vs storm flow comparison lends some insight into the pollutant sources. If dissolved pollutants were only elevated during storms, stormwater runoff would be suspected as the primary contributor. If dissolved pollutants were highest during baseflow, pollution of the shallow groundwater which feeds the stream during baseflow would be suspected to be a primary contributor. In Seelye Brook we find lower dissolved pollutants during storms. In other words, both stormwater runoff and groundwater are sources of dissolved pollutants, with shallow groundwater contributing more. While storms dilute some of the baseflow pollutants, they also carry additional pollutants, which can offset the dilution.

A likely cause of the increase in specific conductivity in streams is chlorides from road salting. Water softener discharge or dissolved pollutants can also contribute. These salts both runoff into the water and infiltrate into the shallow groundwater that feeds the stream during baseflow. WMOs should consider periodic chloride sampling, especially in the winter or early spring after snow events or during snowmelt to assess the contribution of salts to the dissolved pollutant load.

From a management standpoint, it is important to remember that the sources of both stormwater and baseflow dissolved pollutants are generally the same; it is only the timing of delivery to the stream that is different. Preventing their release into the environment and treating them before infiltration should be a high priority. Training and equipment that minimize road salting while keeping roads safe is being increasingly emphasized by watershed managers throughout the region.

Specific Conductivity during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2018 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

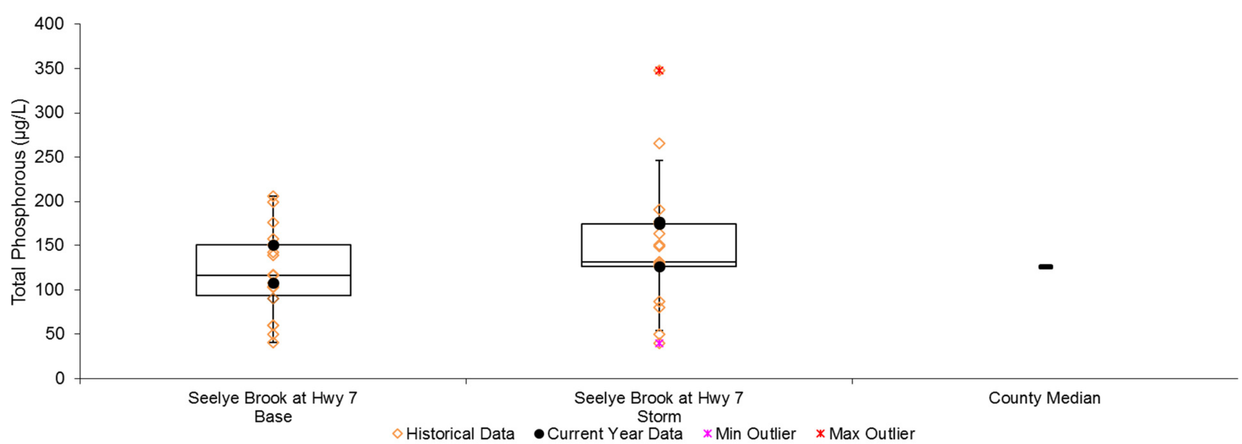
Total phosphorus (TP) is a common nutrient pollutant. It is limiting for most algal growth. Phosphorus is above desirable levels in Seelye Brook, but it is not atypical compared to other streams in the area.

Total phosphorus concentrations in Seelye Brook in 2018 were similar to many past years, but higher than 2017. It averaged over the State water quality standard of 100 µg/L (147.20 µg/L). The median phosphorus concentration at Seelye Brook at Hwy 7 (all years) is 116.5 µg/L during baseflow and 131 µg/L during storm events. Only one of sixteen samples taken since June of 2014 has resulted in TP concentrations below the State water quality standard of 100 µg/L, with some samples double the standard.

The benefits of a recent upgrade to the City of St. Francis wastewater plant are unclear in this data. The new plant went online in April 2017 with new nutrient reduction technologies. The new plant discharges entirely to Seeyle Brook; previously there were discharges to both Seelye Brook and the Rum River.

Phosphorus in Seelye Brook is at concerning levels and should continue to be an area of pollution control effort as the area urbanizes. Cooperative efforts with Isanti County and Isanti Soil and Water Conservation District would likely be helpful, given that Seelye Brook originates in Isanti County.

Total Phosphorus during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2018 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 are 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. Turbidity and TSS are low in Seelye Brook, and there are no management concerns at this time.

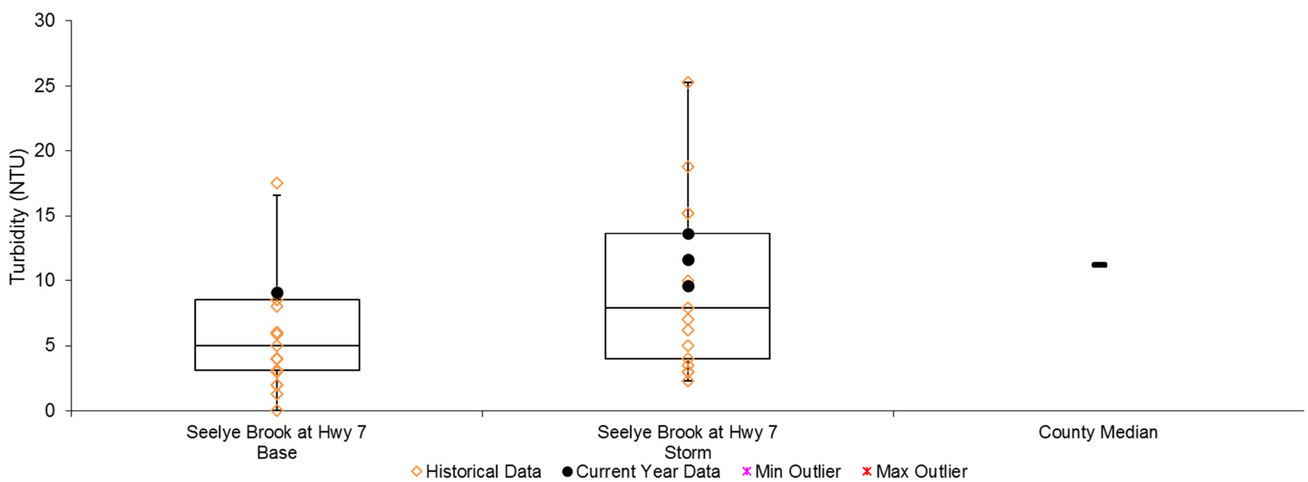
Overall, turbidity in Seelye Brook remains low compared to other streams. This is despite one high reading of 77.3 NTU in 2018. The median turbidity (all years) is 5.0 NTU during baseflow and 7.9 NTU during storm events, both lower than the median for Anoka County streams of 8.5 NTU. The State water quality standard is 25 NTU.

TSS concentrations in 2018 were low, similar to previous years. The median TSS concentration in Seelye Brook during baseflow conditions was 5.5 mg/L and the storm flow median was just 9.0 mg/L. These medians, along with the historical average of 9.1 mg/L are well below the state water quality standard of 30 mg/L.

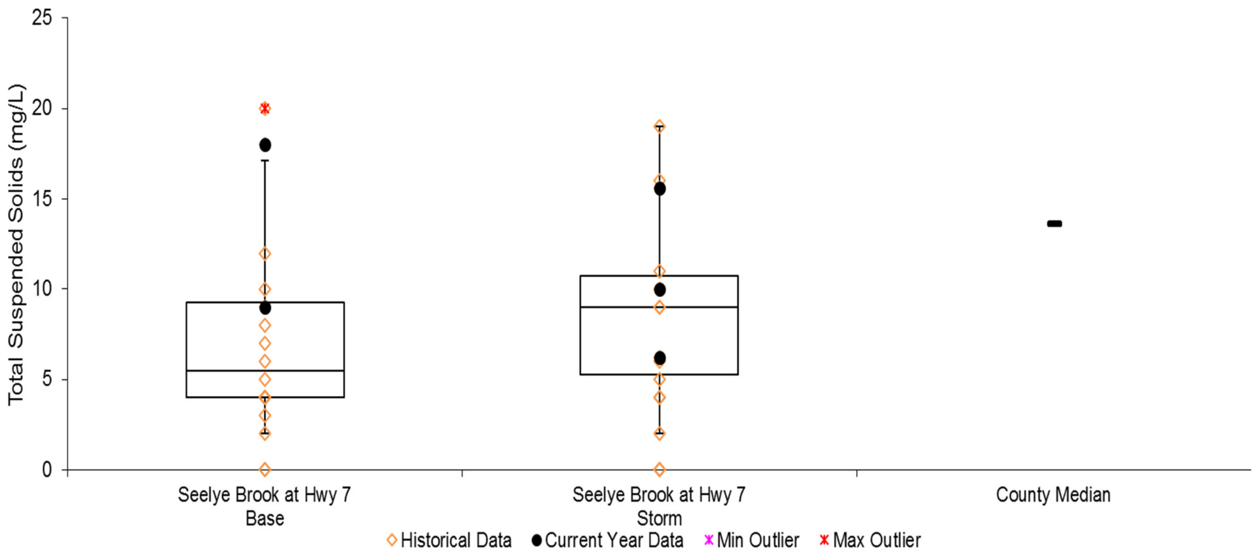
Suspended solids can come from sources within and outside of the river channel. Sources on land include soil erosion, road sanding, and others. Riverbank erosion and movement of the river bottom also contributes to suspended solids. A moderate amount of this “bed load” is natural and expected.

Both turbidity and TSS, while low, should continue to be monitored in this watershed. This monitoring can be especially important as development of the area continues and can be an indicator of poor erosion management practices.

Turbidity during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2018 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 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

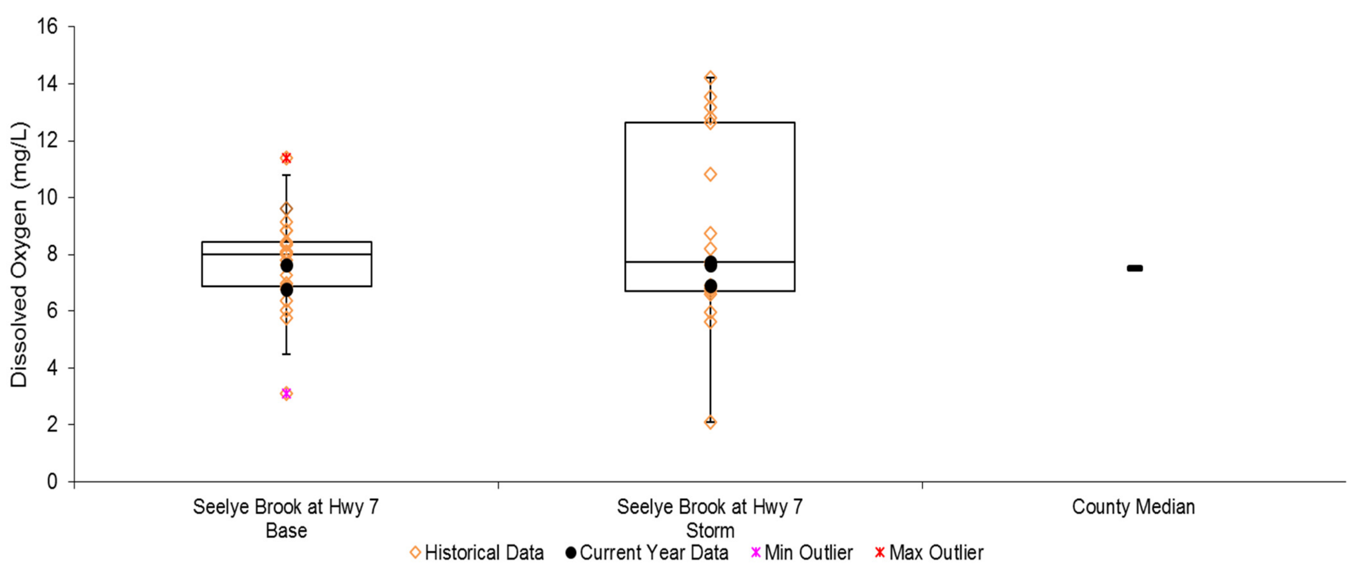


Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution causes oxygen to be consumed when it decomposes. If oxygen levels fall below the state standard of 5 mg/L, aquatic life begins to suffer.

Seelye Brook's dissolved oxygen levels are typically well above 5 mg/L, and 2018 was no exception. Median dissolved oxygen (all years) is 8.00 mg/L during baseflow and 7.74 mg/L during storm events. The average dissolved oxygen concentration in 2018 was 7.34 mg/L with a minimum reading of 6.75 mg/L.

Dissolved Oxygen during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

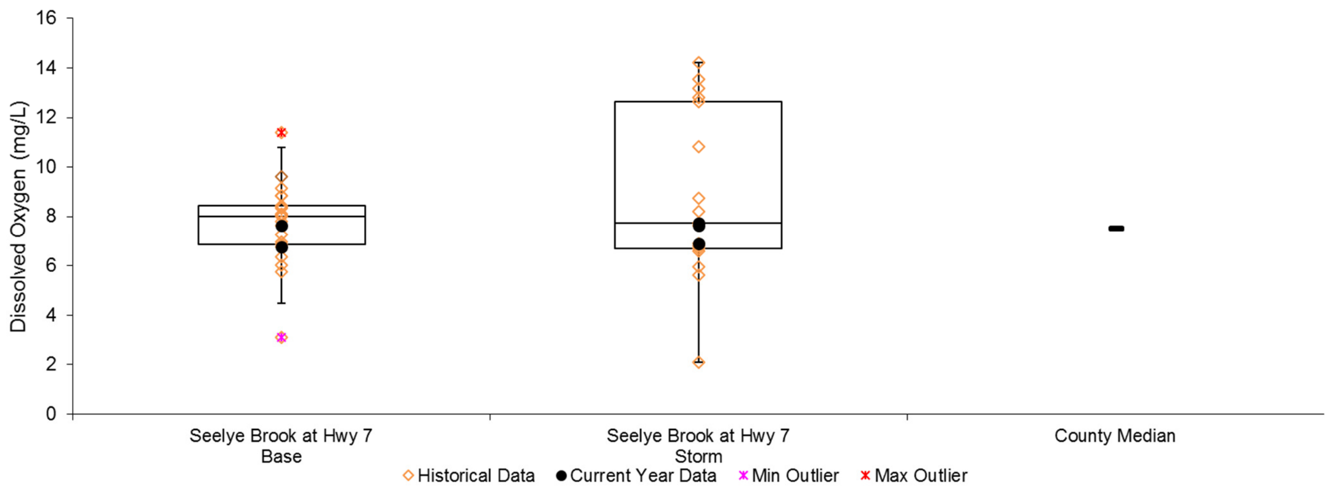


pH

pH refers to the acidity of the water. The Minnesota Pollution Control Agency's water quality standard is for pH to be between 6.5 and 8.5. Seelye Brook had not exceeded this range during any of the years the ACD has sampled it except once in 2017. It is not a concern unless additional similar readings are found in the future. Fortunately, in 2018 pH was all well within the normal range (minimum 7.46, maximum 8.16).

pH is generally slightly lower during storms than during baseflow conditions. This is because the pH of rain is typically lower (more acidic). While acid rain is a longstanding problem, its effect on this aquatic system is small.

pH during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2018 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Wetland Hydrology

Partners: URRWMO, ACD

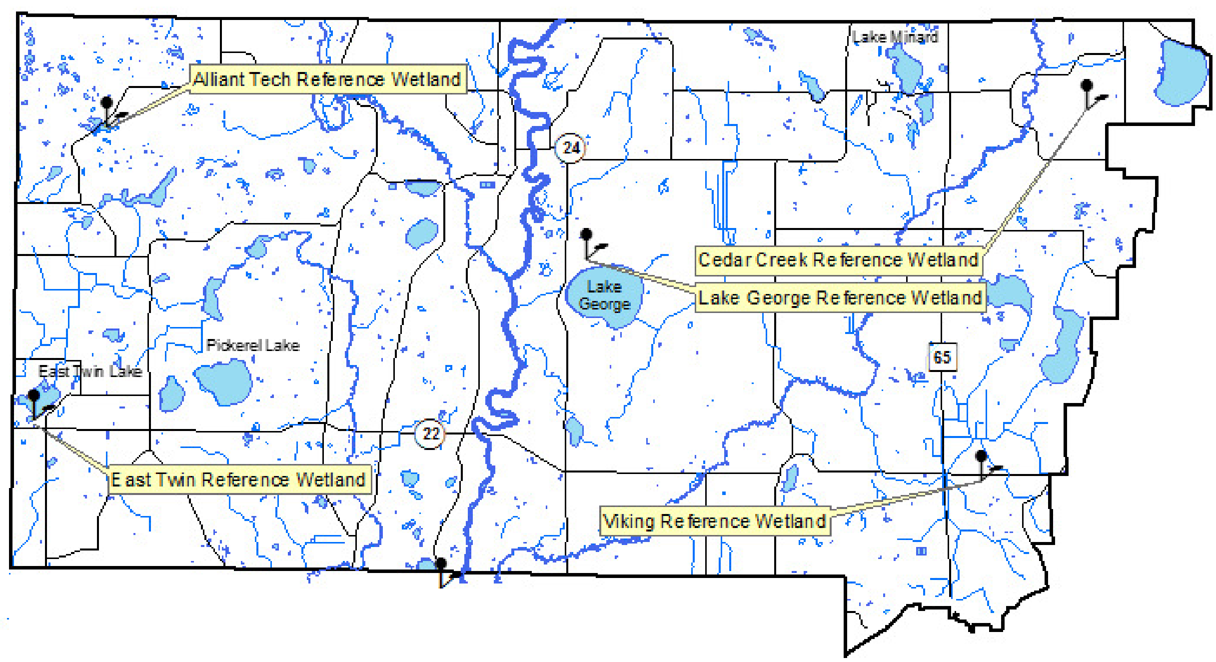
Description: Continuous groundwater level monitoring at a wetland boundary, to a depth of 40 inches. Countywide, the ACD maintains a network of 23 wetland hydrology monitoring stations.

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: Alliant Tech Reference Wetland, Alliant Tech Systems property, St. Francis
Cedar Creek, Cedar Creek Natural History Area, East Bethel
East Twin Reference Wetland, East Twin Township Park, Nowthen
Lake George Reference Wetland, Lake George County Park, Oak Grove
Viking Meadows Reference Wetland, Viking Meadows Golf Course, East Bethel

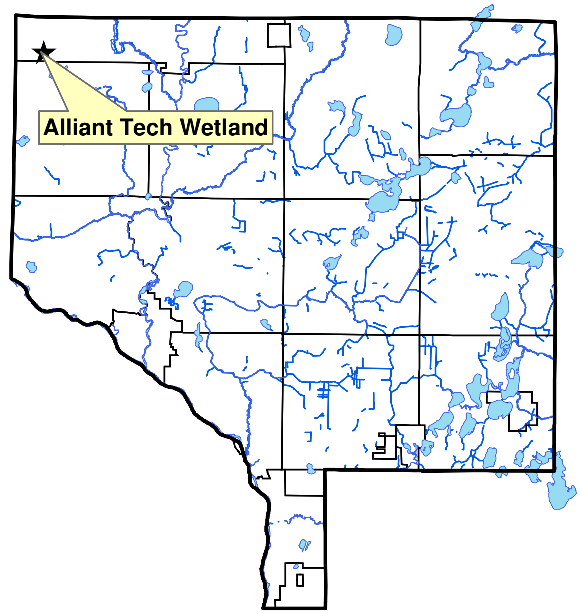
Results: See the following pages. Raw data and updated graphs can be downloaded from www.AnokaNaturalResources.com using the Data Access Tool.

Upper Rum River Watershed Wetland Hydrology Monitoring Sites



ALLIANT TECH REFERENCE WETLAND

Alliant Techsystems Property, St. Francis



Site Information

Monitored Since: 2001

Wetland Type: 5

Wetland Size: ~12 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A	0-8	N2/0	Mucky loam	-
Bg	8-35	5y5/1	Sandy loam	-

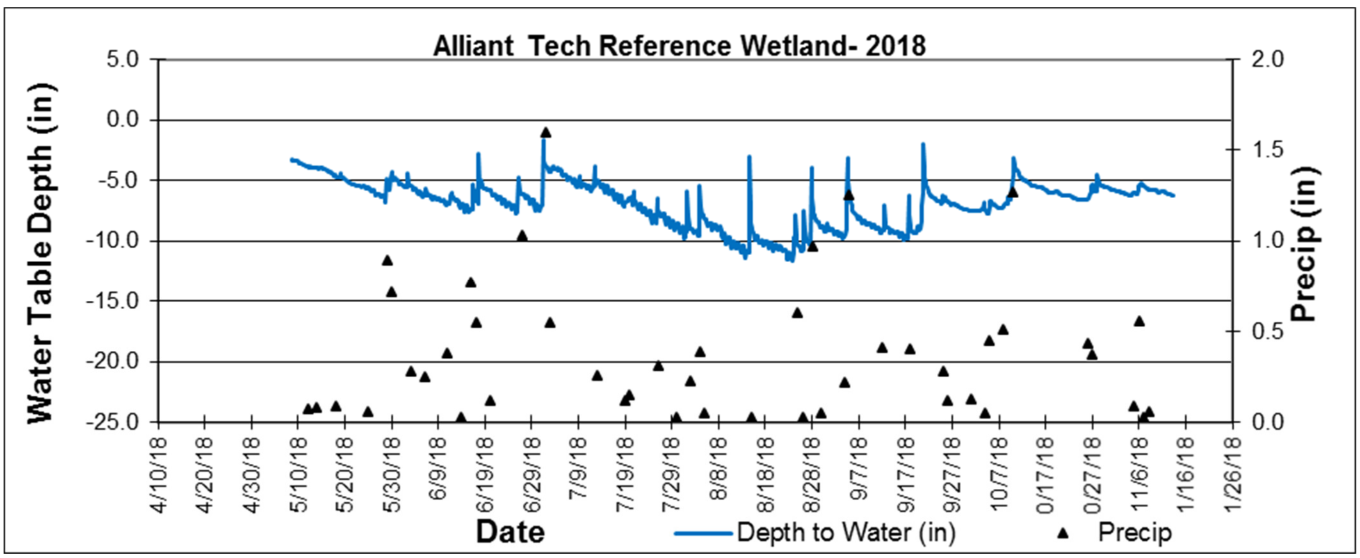
Surrounding Soils: Emmert

Vegetation at Well Location:

Scientific	Common	% Coverage
Carex Spp	Sedge undiff.	90
Lycopus americanus	American Bungleweed	20
Phalaris arundinacea	Reed Canary Grass	5

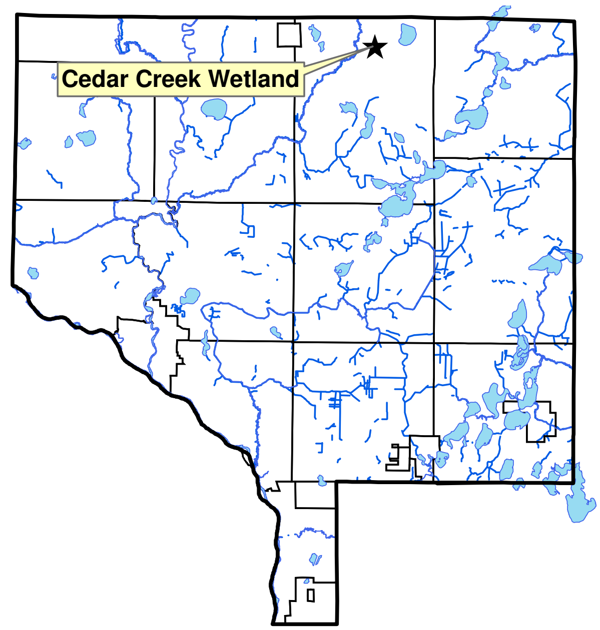
Other Notes: This wetland lies next to the highway, in a low area surrounded by hilly terrain. It holds water throughout the year, and has a beaver den.

2018 Hydrograph



CEDAR CREEK REFERENCE WETLAND

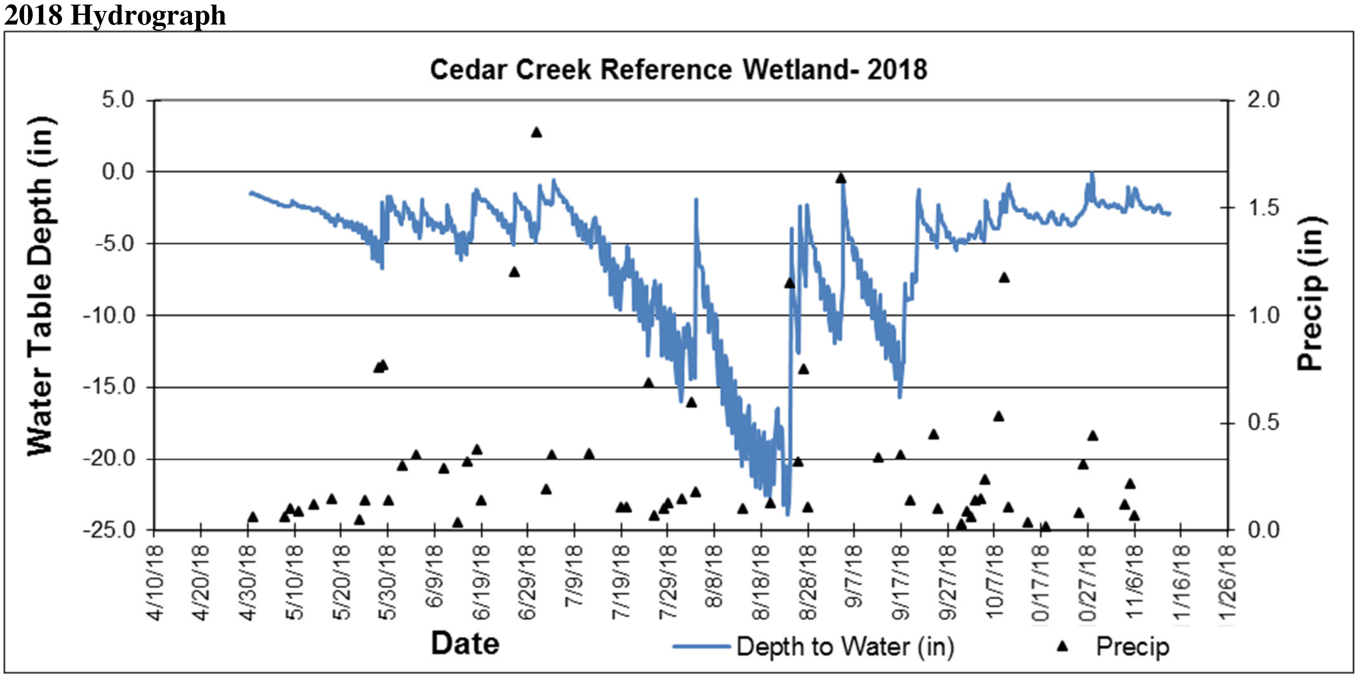
Univ. of Minnesota Cedar Creek Natural History Area, East Bethel



Site Information

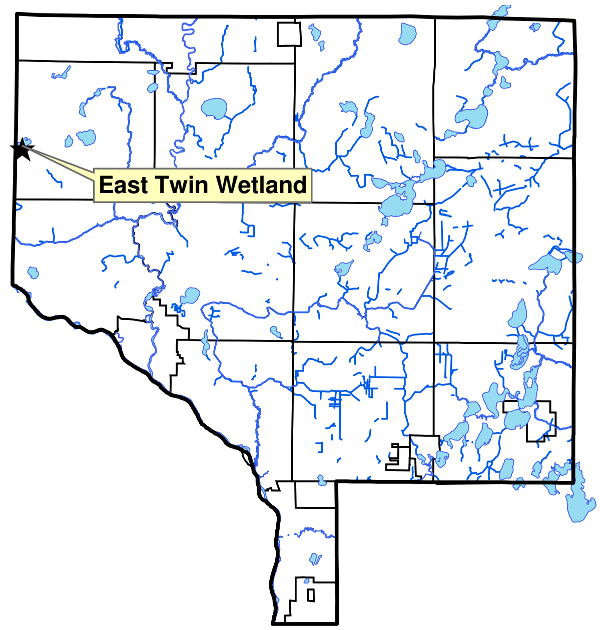
Monitored Since:	1996
Wetland Type:	6
Wetland Size:	unknown, likely >150 acres
Isolated Basin?	No
Connected to a Ditch?	No
Soils at Well Location:	not yet available
Surrounding Soils:	Zimmerman
Vegetation at Well Location:	not yet available
Other Notes:	The Cedar Creek Ecosystem Science Reserve, where this wetland is located, is a University of Minnesota research area. Much of this area, including the area surrounding the monitoring site, is in a natural state. This wetland probably has some hydrologic connection to the floodplain of Cedar Creek, which is 0.7 miles from the monitoring site.

2018 Hydrograph



EAST TWIN REFERENCE WETLAND

East Twin Lake Township Park, Nowthen



Site Information

Monitored Since: 2001

Wetland Type: 5

Wetland Size: ~5.9 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A	0-8	10yr 2/1	Mucky Loam	-
Oa	Aug-40	N2/0	Organic	-

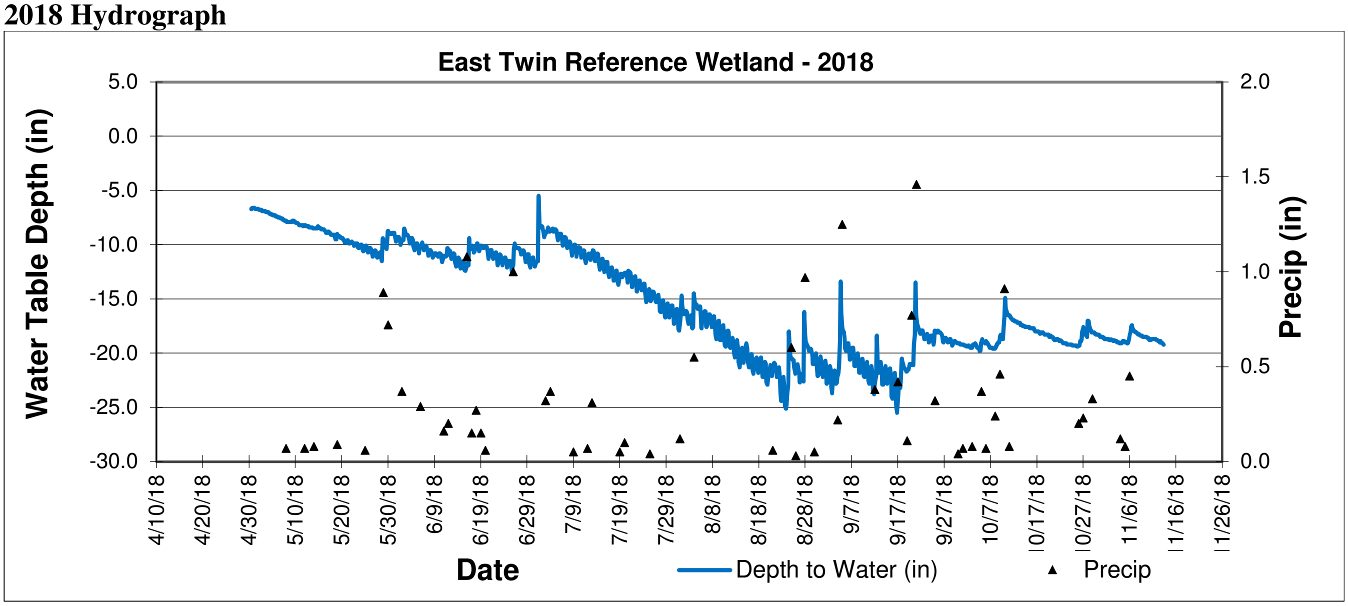
Surrounding Soils: Lake Beach, Growton and Heyder fine sandy loams

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	100
Cornus amomum	Silky Dogwood	30
Fraxinus pennsylvanica	Green Ash	30

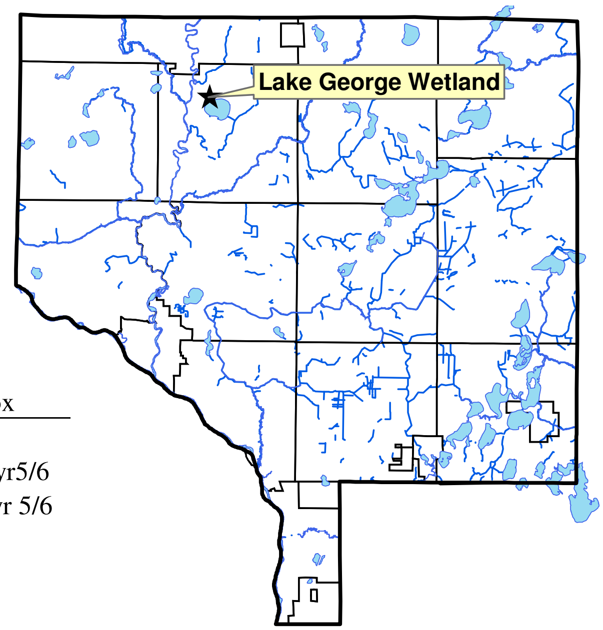
Other Notes: This wetland is located within East Twin Lake County Park, and is only 180 feet from the lake itself. Water levels in the wetland are influenced by lake levels.

2018 Hydrograph



LAKE GEORGE REFERENCE WETLAND

Lake George County Park, Oak Grove



Site Information

Monitored Since: 1997

Wetland Type: 3/4

Wetland Size: ~9 acres

Isolated Basin? Yes, but only separated from wetland complexes by roadway.

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A	0-8	10yr2/1	Sandy Loam	-
Bg	8-24	2.5y5/2	Sandy Loam	20% 10yr5/6
2Bg	24-35	10gy 6/1	Silty Clay Loam	10% 10yr 5/6

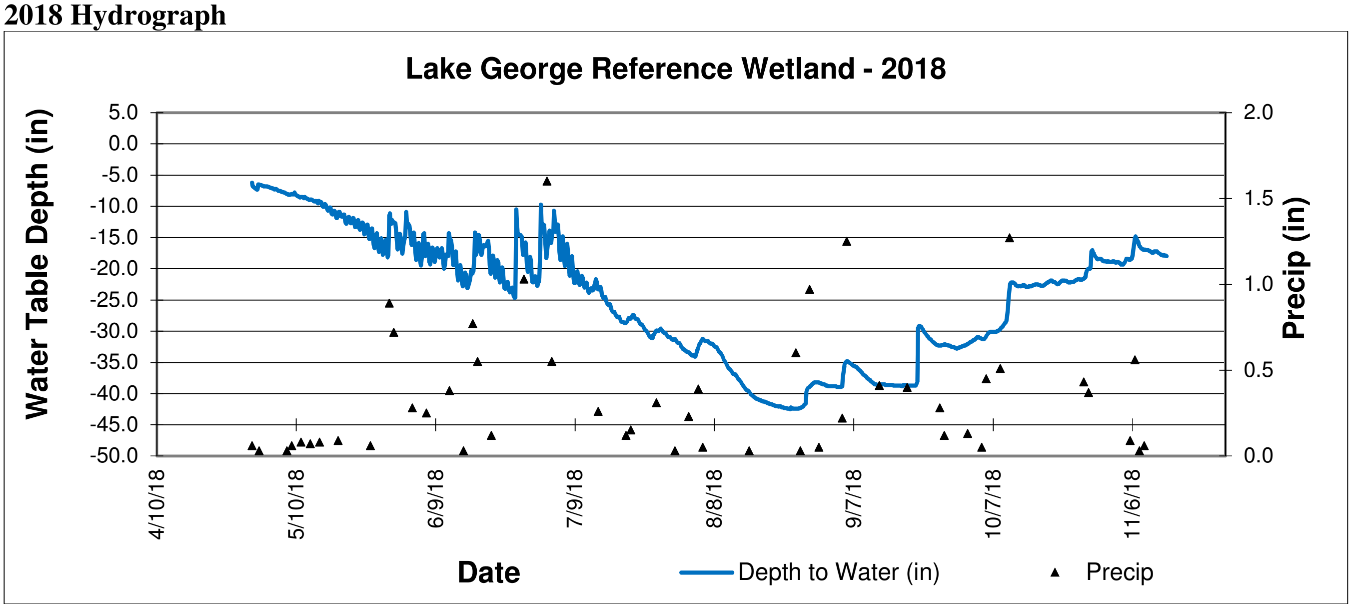
Surrounding Soils: Lino loamy fine sand and Zimmerman fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Cornus stolonifera	Red-osier Dogwood	90
Populus tremuloides	Quaking Aspen	40
Quercus rubra	Red Oak	30
Onoclea sensibilis	Sensitive Fern	20
Phalaris arundinacea	Reed Canary Grass	10

Other Notes: This wetland is located within Lake George County Park, and is only about 600 feet from the lake itself. Much of the vegetation within the wetland is cattails.

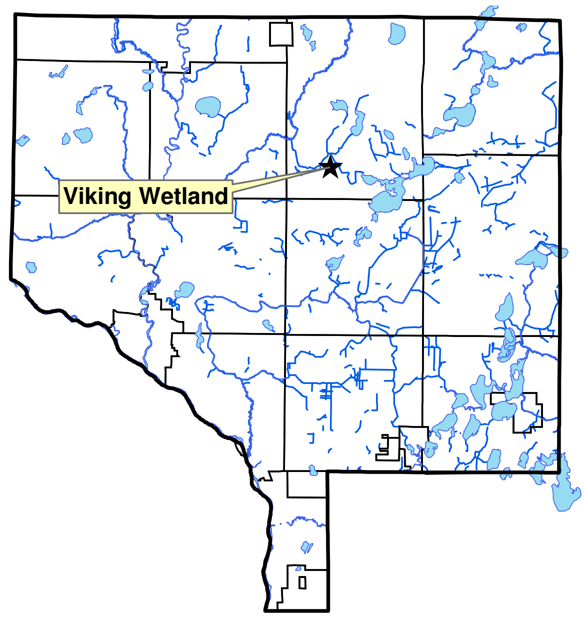
2018 Hydrograph



Wetland Hydrology Monitoring

VIKING MEADOWS REFERENCE WETLAND

Viking Meadows Golf Course, East Bethel



Site Information

Monitored Since: 1999

Wetland Type: 2

Wetland Size: ~0.7 acres

Isolated Basin? No

Connected to a Ditch? Yes, highway ditch is tangent to wetland

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A	0-12	10yr2/1	Sandy Loam	-
Ab	12-16	N2/0	Sandy Loam	-
Bg1	16-25	10yr4/1	Sandy Loam	-
Bg2	25-40	10yr4/2	Sandy Loam	5% 10yr5/6

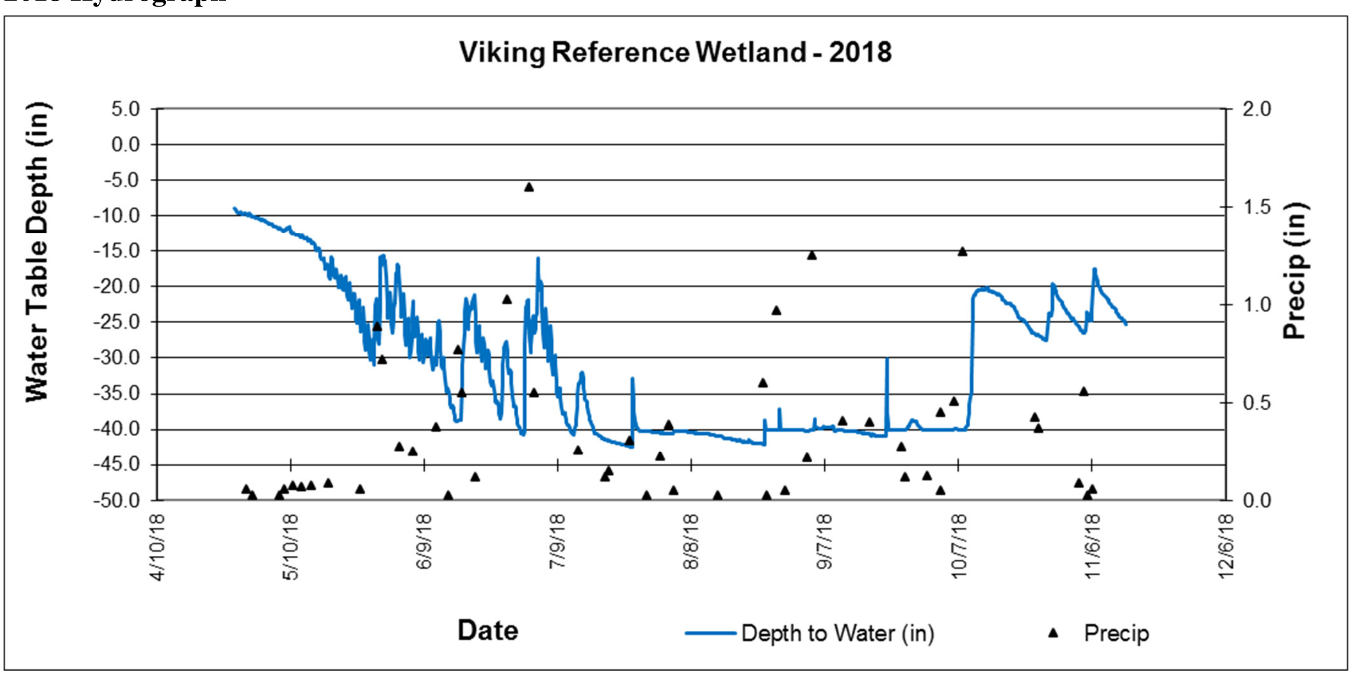
Surrounding Soils: Zimmerman fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	100
Acer rubrum (T)	Red Maple	75
Acer negundo (T)	Boxelder	20

Other Notes: This wetland is located at the entrance to Viking Meadows Golf Course, and is adjacent to Viking Boulevard (Hwy 22).

2018 Hydrograph



Lake George Water Quality Improvement Assessment

Partners: Lake George LID

Description: Lake George is a premier recreation lake in Anoka County. Water quality, especially Secchi transparency, has been declining in Lake George in the past decade. The Lake George Improvement District, Lake George Conservation Club, and Anoka Conservation District have partnered on a State Clean Water Fund grant to determine the sources of pollution to Lake George and identify specific projects to correct the lake water quality decline. Study components include monitoring, modeling, project identification and project cost effectiveness ranking. Final work products include a prioritized list of projects and concept designs.

Purpose: To guide managers to the most cost effective approaches for stopping the decline in Lake George water quality and assist in securing grant funds for project installations.

Results: **Executive Summary**

This two-part study of the Lake George lakeshed is aimed at determining the causes of, and potential solutions to, declining water clarity in Lake George. This report includes the results of monitoring and modeling of the lakeshed that lend insight into causes of declining water clarity, and actions to address that problem. Actions are ranked by their cost effectiveness at reducing nutrient loading to the lake. It is anticipated that phase 2 of this study analyzing in-lake and near-lake factors will follow in the coming years. Watershed managers and cities should use this report to guide lake water quality improvement efforts.

The first part of this study included two years of water quality and hydrology monitoring of direct drainages to Lake George. Those data informed the development of two computer models of the lakeshed, a P8 urban catchment model for water quality analysis and a Storm Water Management Model (SWMM) for hydrology analysis. These models were used to determine the lake's nutrient and water budgets, and the effects of changes within the lakeshed. These efforts helped determine drivers of lake water quality decline. Findings of monitoring and modeling included:

- Lake water quality has shown a decline since 1998 (20-year trend). Lake transparency has declined and phosphorus concentrations have increased. Both are slow incremental changes that are statistically significant.
- The lake's five subwatersheds deliver varying amounts of phosphorus to the lake. In order of most to least they are: Ditch 19, northeast, north, near lake, and northwest subwatersheds. Substantial amounts of pollutants generated in the Ditch 19 subwatershed are removed by Grass Lake, which serves as a filter or settling basin. While near lake pollutant loading is amongst the lowest in total, it is the highest on a per-acre basis and deserves attention because pollutants generated there go directly into the lake, not into wetlands that may offer some filtering.
- A cause of water quality decline is more frequent wet years driving increased runoff to the lake. Among the sources of phosphorus are large wetland complexes, which drain to the lake more during months or years of high precipitation.
- Anticipated future land use changes could significantly increase nutrient loading to the lake.
- A shifting aquatic plant community in the lake may be destabilizing shallow lake sediments and increasing phosphorus concentrations in the lake by replacing once abundant native pondweeds with invasive species.

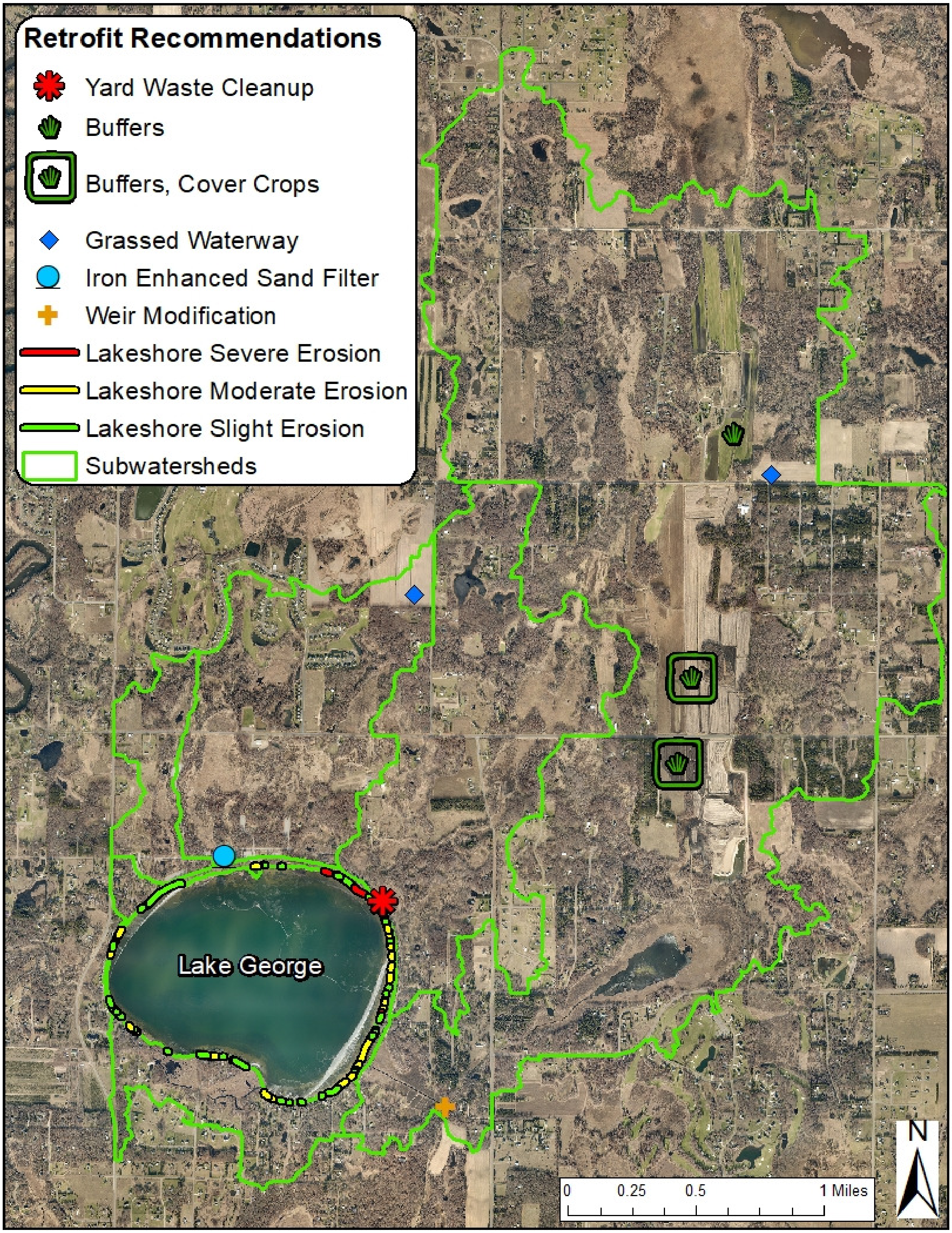
The second part of this study included identifying and ranking projects for the treatment of stormwater draining from the lakeshed to Lake George, and actions to be implemented on a broader scale to protect lake water quality. Potential projects identified during this analysis were modeled to estimate reductions in total phosphorus (TP), total suspended solids (TSS), and if possible, volume. Cost estimates were developed for each project, including up to 30 years of operations and maintenance. Projects were ranked by cost effectiveness with respect to their reduction of TP. A variety of projects were identified, including:

- Lakeshore stabilizations and/or buffer installations,
- Installation of riparian buffers, cover crops, and grassed waterways in agricultural areas,
- Reconstruction of the Ditch 19 weir,
- One iron enhanced sand filter, and
- Good housekeeping recommendations.

At Lake George, preventing future water quality declines is as important as correcting past water quality declines. For this reason, the table of prioritized actions on the following pages includes both projects to improve current water quality and actions to ensure land use change does not result in degradation. This study found that increased frequency of wet years is also a significant contributing factor to Lake George water quality declines, and given that annual precipitation is difficult to control, other offsetting actions are imperative.

This report provides conceptual sketches or photos of recommended water quality improvement projects. The intent is to provide an understanding of the approach. If a project is selected, site-specific designs must be prepared. Many of the proposed projects will require engineered plan sets if selected. This typically occurs after committed partnerships are formed to install the project. Committed partnerships must include willing landowners when installed on private property.

The map and table on the next pages summarize potential projects and actions, and groups them based on direct impact to Lake George. These projects are organized in order of cost effectiveness at reducing phosphorus delivery to the lake.


Retrofit Recommendations
Yard Waste Cleanup
Buffers
Buffers, Cover Crops
Grassed Waterway
Iron Enhanced Sand Filter
Weir Modification
Lakeshore Severe Erosion
Lakeshore Moderate Erosion
Lakeshore Slight Erosion
Subwatersheds
Lake George
0 0.25 0.5 1 Miles
N

Summary of preferred stormwater retrofit opportunities ranked by cost-effectiveness with respect to total phosphorus (TP) reduction. TSS and volume reductions are also shown. For more information on each project refer to the catchment profile pages in this report. Projects indirectly impacting the lake are those upstream of wetlands or Grass Lake which may already provide some treatment. This should be considered when comparing cost effectiveness of projects, as proximity to the lake is not considered in pollutantant reduction estimates.

Projects Directly Impacting Lake George

Project Rank	Retrofit Type (refer to catchment profile pages for additional detail)	Subwatershed	Projects Identified	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost (2018 Dollars)	Estimated Annual Operations & Maintenance (2018 Dollars)	Estimated cost/ lb-TP/year (30-year)
1	Lakeshore Stabilization- Severe Erosion	Lake Adjacent	100 Linear-ft	3.64	4,512	n/a	$16,555	$150	$193
2	Iron Enhanced Sand Filter (IESF)	North Inlet	1 (3 sizes)	20-40	488-976	n/a	$394,072-$487,844	$1,676-$3,352	$741-$490
3	Lakeshore Stabilization- Moderate Erosion	Lake Adjacent	100 Linear-ft	0.52	612	n/a	$11,555	$150	$1,035
4	Ditch 19 Weir Modification	Ditch 19	1 (2 scenarios)	-1.6-4.5	4-344	3.8-5.8	$300,000	$0	-$6,061-$2,242
5	Shoreline Buffers	Near Lake	85	0.03	8	0.03	$3,652	$66	$6,568
6	Lakeshore Stabilization- Slight Erosion	Lake Adjacent	100 Linear-ft	0.08	62	n/a	$11,555	$150	$6,982

Projects Indirectly Impacting Lake George

7	Grassed Waterway	North Inlet	1 (2 sizes)	1.3-1.6	314-337	0.51-0.74	$6,372-$7,196	$50-$100	$197-$213
8	Cropland Riparian Buffers- 50'	Ditch 19	3 variations	17.62-53.03	140.26-422.12	n/a	$16,408-$35,883	$3,524-$10,606	$223-$231
9	Cropland Riparian Buffers- 16.5'	Ditch 19	4 variations	2.08-9.10	25.52-111.65	n/a	$8,916-$16,341	$800-$3,500	$444-$528
10	Grassed Waterway	Ditch 19	1 (2 sizes)	0.3-0.4	78-84	0.13-0.19	$5,750-$5,951	$13-25	$561-$612
11	Cropland Cover Crops	Ditch 19	3 variations	19.0-56.9	203-610 (tons)	n/a	$72,547-$203,042	$68,751-$199,246	$3,618-$3,750

Summary of recommended non-structural actions to protect Lake George water quality

Stormwater Action	Importance Ranking	Description of the Action
Yard waste disposal cleanup	High	Clean up yard waste disposal identified in the Northeast watershed in this report. Take educational or other actions needed to ensure further disposal does not occur in the future.
MIDS Stormwater Standards	High	Minimal Impact Design Standards (MIDS) for stormwater focus on containing and infiltrating as much stormwater as possible. These standards are especially important as precipitation levels increase, and open areas develop. Keeping stormwater, and the pollutants it contains, on the land and allowing it to infiltrate into the ground is a key strategy. The City of Oak Grove is the land use authority, and would be responsible for any such stormwater standards with the guidance of the Upper Rum River Watershed Management Organization. A special effort with these groups to consider customized stormwater standards for the Lake George watershed is recommended.
Phase 2: In-Lake Study	High	A study to determine the effects of in-lake factors on Lake George, and recommend future management action is advised. In-lake factors that can affect water quality include game fish, rough fish, in-lake sediment stability, wave action, lake usage, aquatic vegetation, and others. While Phase 1 of this study found many water quality correlations and contributing factors from the lakeshed, there may be other in-lake factors affecting water quality as well.
Maintain or Enhance Near-Lake Wetlands	High	Wetlands through with the North and Northeast inlets to the lake drain should be protected or enhanced. These wetlands reduce pollutants coming from the upper watershed before they reach the lake. Efforts to channelize the current dispersed flow through these wetlands is not advised.
Public Education	Moderate	Ongoing outreach and education to homeowners regarding actions they can take (or shouldn't take) in order to keep the lake health is recommended. Specifically, dumping of leaves, sediment, and other yard waste near the lake can have a large impact on lake water quality. Additionally, mowing to the waters' edge and eliminated native vegetation increases shoreline erosion rates and allows stormwater to run overland umimpeeded to the lake. Over fertilization and the use of phosphorus fertilizers near a lake contribute to algal proliferation and decreased water clarity. All of these issues can be addressed by educated homeowners. The message has to be spread in an effective, informative and actionable way.
Continue AIS Management with Native Vegetation in Mind	Moderate	Herbicide treatments to control aquatic invasive species (AIS) should continue to be done in a way mindful of lake health. Certain native species of aquatic vegetation can be negatively affected by herbicide treatments targeting invasive species. These native species are important to the lake for a host of reasons, including the water quality benefit they provide. Continue selecting herbicide treatment areas, chemicals and timing in a way that minimizes impacts on native plants.
Shoreland Septic Inventory and Replacement	Low	Locate and replace non-compliant septic systems in the shoreland zone. Due to a community septic system serving much of the Lake George area, septic system concerns are lessened. However, maintenance or correction of septic systems should be a priority for all others.

Rum River Bank Stabilization

Partners: LRRWMO, URRWMO, ACD, MN DNR Conservation Partners Legacy Grant, Lessard-Sams Outdoor Heritage Council grant, landowners

Description: 12 riverbank stabilization projects were installed on the Rum River in Anoka and Isanti Counties in 2018. At these sites, cedar tree revetments and willow stakes were used to stabilize eroding banks. The projects were installed with labor from Conservation Corps Minnesota (CCM) work crews. Funding for the 4 revetments installed in Anoka County came from the Conservation Partners Legacy Grant Program from the Outdoor Heritage Fund, a Clean Water Fund CCM crew labor grant, the URRWMO and LRRWMO, and landowner contributions. Funding for 4 additional revetments in Isanti County came from the Lessard-Sams Outdoor Heritage Council, a Clean Water Fund CCM crew labor grant and landowner contribution.

Purpose: To stabilize areas of riverbank with mild to moderate erosion, in order to reduce sediment loading in the Rum River, as well as to reduce the likelihood of a much larger and more expensive corrective project in the future.

Location: Rum River Central Regional Park, 8 residential properties in Anoka County, City of Isanti, and 2 residential properties in Isanti County.

Results: Stabilized 2,223 linear feet of riverbank on the Rum River in Anoka and Isanti Counties.

Bank Stabilization Projects in Anoka County in 2018

Rum River Bank Erosion Inventory

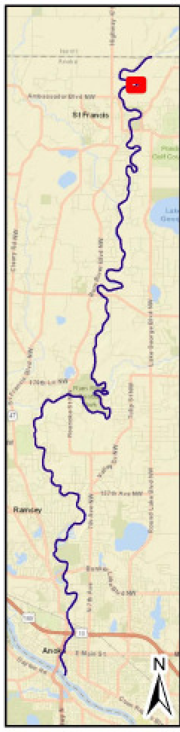
Partners: ACD

Description: The Anoka Conservation District (ACD) prepared an inventory of Rum River bank erosion using 360° photos of the riverbanks of the Rum throughout Anoka County. The photos are available through Google Maps using the Street View feature. An inventory report identifying 80 stretches of riverbank with moderate to very severe erosion is available on ACD's website. Estimated project cost and annual sediment load reduction to the river were calculated.

Purpose: To identify and prioritize riverbank stabilization sites and be used by ACD and other entities to pursue grant funds to restore or stabilize eroding stretches of Rum Riverbank.

Location: Rum River conveyance throughout Anoka County

Results: Inventory of 80 stretches of moderate to very severe erosion on banks of the Rum River.

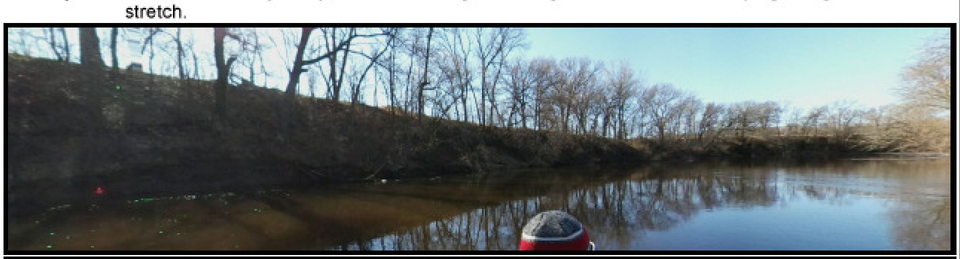


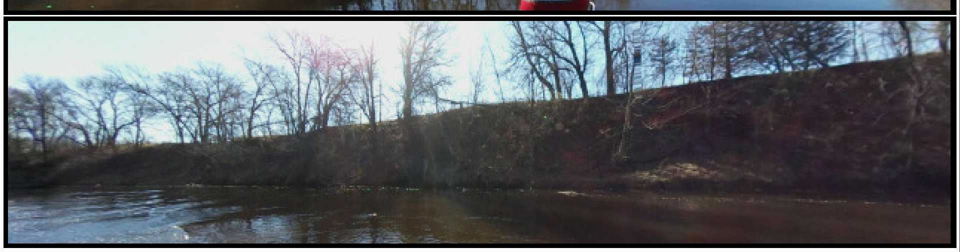
Site ID 3

Length (ft)	1270
Erosion Height (ft)	20
Recession Rate (ft/yr)	0.3
Soil Loss (tons/yr)	426.1
Ownership	Private
Number of Owners	1

Potential Stabilization Approach: Hard Armoring

Description: Most of bank very steep, but maintaining some vegetation. Periodic slumping along stretch.





URRWMO Website

Partners: URRWMO, ACD

Description: The Upper Rum River Watershed Management Organization (URRWMO) contracted the Anoka Conservation District (ACD) to design and maintain a website about the URRWMO and the Upper Rum River watershed.

Purpose: To increase awareness of the URRWMO and its programs. The website also provides tools and information that helps users better understand water resources issues in the area.

Location: www.URRWMO.org

Results: In 2018 a new URRWMO website was developed. The previous website was >10 years old and there were problems with website security. The Anoka Conservation District developed a template website and finalized it with URRWMO Board input. The new website includes:

- Directory of board members,
- Meeting minutes and agendas,
- Watershed management plan and annual reports,
- Descriptions of work that the organization is directing,
- Highlighted projects,
- Informational videos,
- Maps of the URRWMO.

The website is regularly updated throughout the year.

URRWMO Website Homepage


Upper Rum River WMO

search

Helping to Protect Our Resources

Upper Rum River Watershed Management Organization

*****November 20, 2018 Technical Advisory Committee Meeting - 10am at Oak Grove City Hall*****

The URRWMO is a joint powers organization including the Cities of St. Francis, Oak Grove, Nowthen, Bethel, and portions of East Bethel. A small corner of Ham Lake also falls within the URRWMO. The WMO Board is made up of representatives from each of these cities.

This organization seeks to maintain the quality of area lakes, rivers, streams, groundwater, and other water resources across municipal boundaries. Resources of particular importance to the URRWMO include the Rum River, Seelye Brook, Ford Brook, Cedar Creek, and numerous ditches that drain to the Rum River. This stretch of the Rum River is designated as a state Scenic and Recreational Waterway. Lake George and East Twin Lakes, the primary recreation lakes in the watershed, are also of high priority, in addition to many smaller lakes and wetlands.

URRWMO Annual Newsletter

Partners: URRWMO, ACD

Description: The URRWMO Watershed Management Plan and state rules call for an annual URRWMO newsletter in addition to the WMO website. The URRWMO produces a newsletter article including information about the URRWMO, its programs, related educational information, and the URRWMO website address. This article is provided to each member city, and they are asked to include it in their city newsletters.

Purpose: To increase public awareness of the URRWMO and its programs as well as receive input.

Locations: Watershed-wide.

Results: The Anoka Conservation District (ACD) assisted the URRWMO by drafting the annual newsletter article about the new management plan for area streams and lakes. The URRWMO Board reviewed and edited the draft article. The finalized article was posted to the URRWMO website, sent to each member community for publication in their newsletters and provided to the Independent School District 15 publication, "The Courier."

2018 URRWMO Newsletter Article

Upper Rum River
Watershed Management Organization

MEDIA RELEASE

Contact person:	**Jamie Schurbon 763-434-2030 ext. 12**
Date:	**September 10, 2018**

New Local Water Plan
Near Completion

A new local plan for the Rum River, Lake George and other local waterways is in its final stages. The plan focuses on water quality, but also addresses stormwater management, flood prevention and other topics. Once approved by the State, this management plan outlines projects that will be led by the Upper Rum River Watershed Management Organization (URRWMO) over the next 10 years.

The URRWMO is comprised of representatives from the cities of Bethel, East Bethel, Oak Grove, Nowthen, St. Francis and Ham Lake. Its purpose is to address water management issues which often cross city boundaries. The organization, and its new plan, put emphasis on implementing already-existing rules and finding the highest priority problems upon which to focus limited funding. The plan positions the organization to compete for State water quality grants to fund larger projects. Work outlined in the plan includes water quality improvement projects, fixing shoreline erosion, stormwater inspections, and regular water quality monitoring.

The Rum River and Lake George are two high priorities in the new plan. The Rum River is in relatively good condition, and a highly valued State Scenic and Recreational River. Phosphorus levels are near, but slightly better than state water quality standards. It will continue to be monitored. Lake George has good water quality for this region of the state, receiving an overall B letter grade, however declining secchi transparency is a concern. East Twin Lake, Pickerel Lake, Seelye Brook, Cedar Creek, Ford Brook and Crooked Brook are some other waterbodies also discussed in the plan.

The most updated plan draft and information about the URRWMO is available at www.URRWMO.org or contact Chuck Schwartz at 612-548-3141.

URRWMO 2017 Annual Reports to the State

Partners: URRWMO, ACD

Description: The Upper Rum River Watershed Management Organization (URRWMO) is required by law to submit an annual report to the Minnesota Board of Water and Soil Resources (BWSR). This report consists of an up-to-date listing of URRWMO Board members, activities related to implementing the URRWMO Watershed Management Plan, the status of municipal water plans, financial summaries, and other work results. The report is due annually 120 days after the end of the URRWMO's fiscal year (April 30th).

Additionally, the URRWMO is required to perform annual financial reporting to the State Auditor. This includes submitting a financial report and filling out a multi-worksheet form.

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

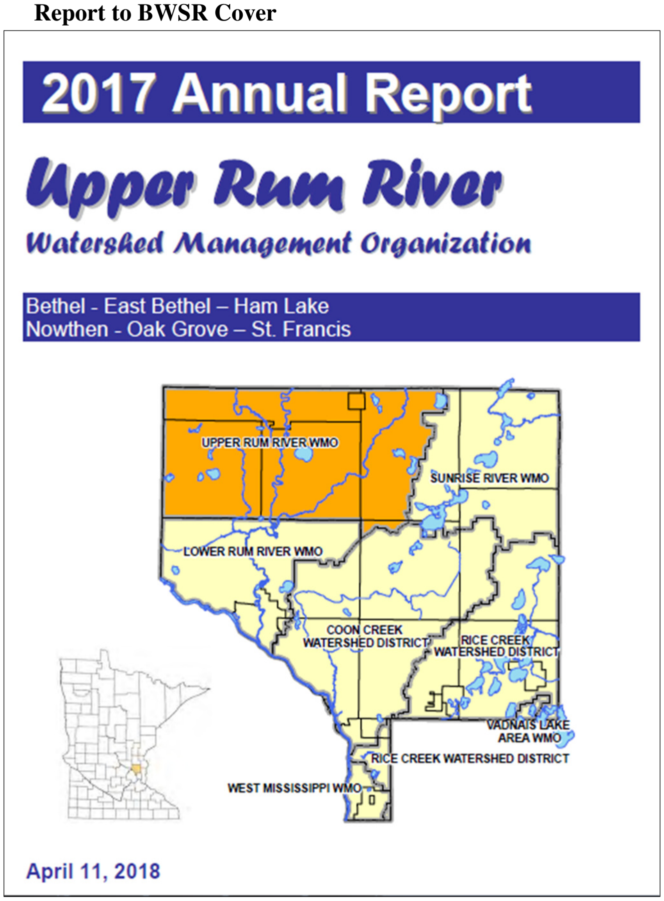
Locations: Watershed-wide

Results: The Anoka Conservation District assisted the URRWMO with preparation of a 2017 Upper Rum River WMO Annual Report to BWSR and reporting to the State Auditor. This included:

- Preparation of an unaudited financial report,
- A report to BWSR meeting MN statutes,
- State Auditor's reporting forms through the State's SAFES website.

All were completed by the end of April 2018. The report to BWSR and financial report are available on the URRWMO website.

Report to BWSR Cover


2017 Annual Report

Upper Rum River

Watershed Management Organization

Bethel - East Bethel – Ham Lake
Nowthen - Oak Grove – St. Francis

April 11, 2018

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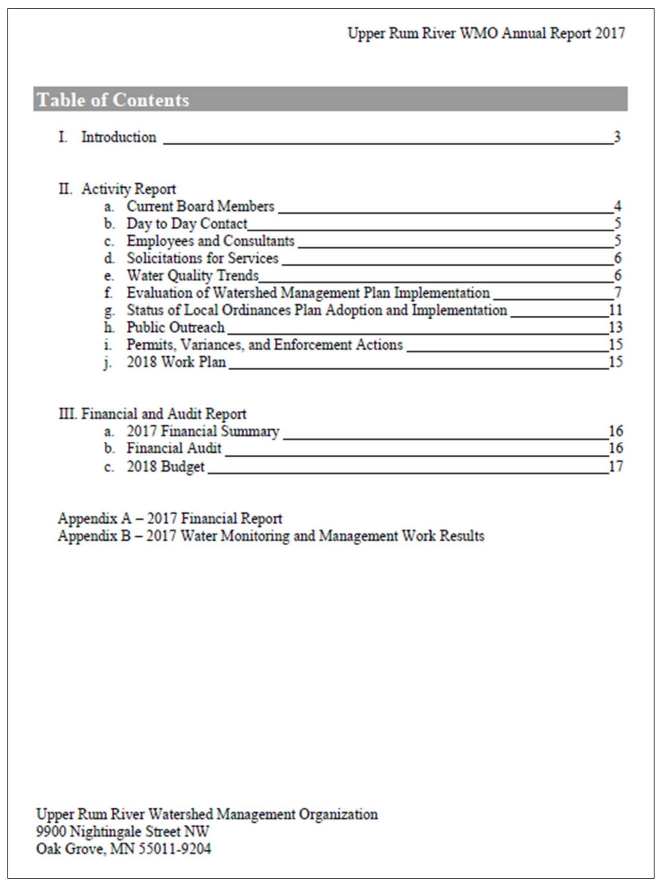
Upper Rum River WMO Annual Report 2017

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Upper Rum River Watershed Management Organization
9900 Nightingale Street NW
Oak Grove, MN 55011-9204

Financial Summary

ACD accounting is organized by program and not by customer. This allows us to track all of the labor, materials and overhead expenses for a program. 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.

Upper Rum River Watershed Financial Summary

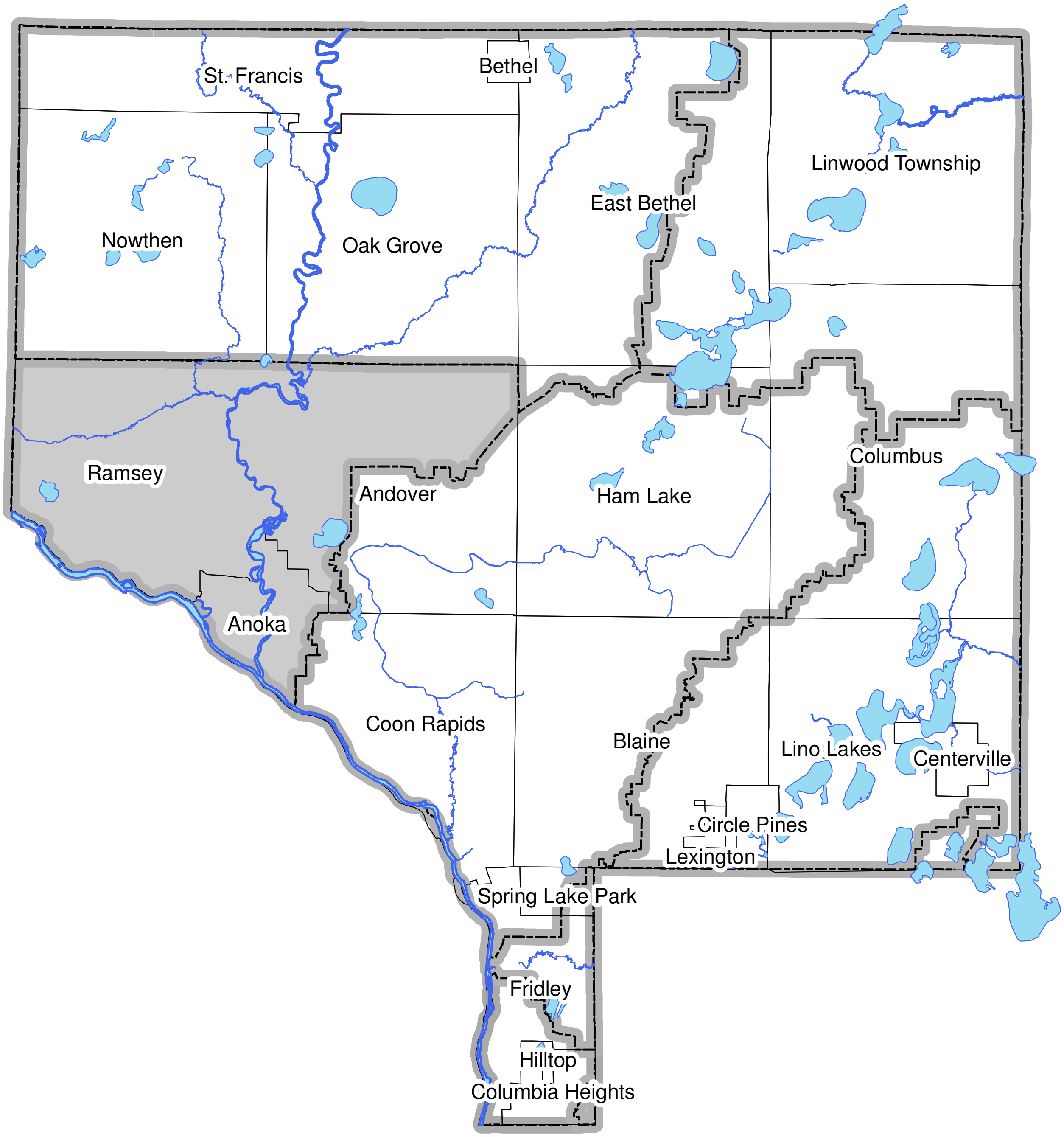
Table will be added in early 2019 to summarize 2018 finances

Recommendations

- **Ensure stormwater treatment standards for new development result in no increase, and preferably a decrease, in phosphorus.** The Rum River is just below State standards for impairment and several tributaries exceed State nutrient standards. State MS4 stormwater treatment standards are aimed at maintaining water quality only, and it may be favorable to consider Minimum Impact Development Standards (MIDS) that are aimed at pollutant reductions.
- **Participate in the Rum River One Watershed One Plan** process, resulting in prioritized management across the entire Rum River watershed.
- **Install projects identified in the 2018 Lake George Water Quality Improvement Assessment, St. Francis stormwater assessment and Rum River WRAPS.** In the Upper Rum River WMO priorities to consider include reversing the declining transparency trend in Lake George and ensuring Rum River phosphorus does not increase because it is close to State impairment thresholds.
- **Periodically monitor chlorides in streams**. Monitoring every 3 years minimum is recommended.
- **Promote practices that limit road deicing salt applications** while keeping roads safe. Streams throughout the URRWMO have increasing specific conductivity. Requiring municipal plow drivers to become certified through MN Pollution Control Agency deicing courses is recommended.
- **Monitor Lake George water quality at least every other year.** The lake has a declining trend. The Lake Improvement District has taken up monitoring every other year when the URRWMO has not funded that work, but would prefer to put their dollars into projects.
- **Promote groundwater conservation.** Metropolitan Council models predict 3+ ft. drawdown of surface waters in parts of the URRWMO by 2030, and 5+ ft. by 2050.
- **Identify subwatersheds in URRWMO for future subwatershed assessment studies.** These studies identify water quality improvement projects and rank them by cost effectiveness.

2018 Anoka Water Almanac

Chapter 4: Lower Rum River Watershed



Prepared by the Anoka Conservation District

Chapter 4: Lower Rum River Watershed

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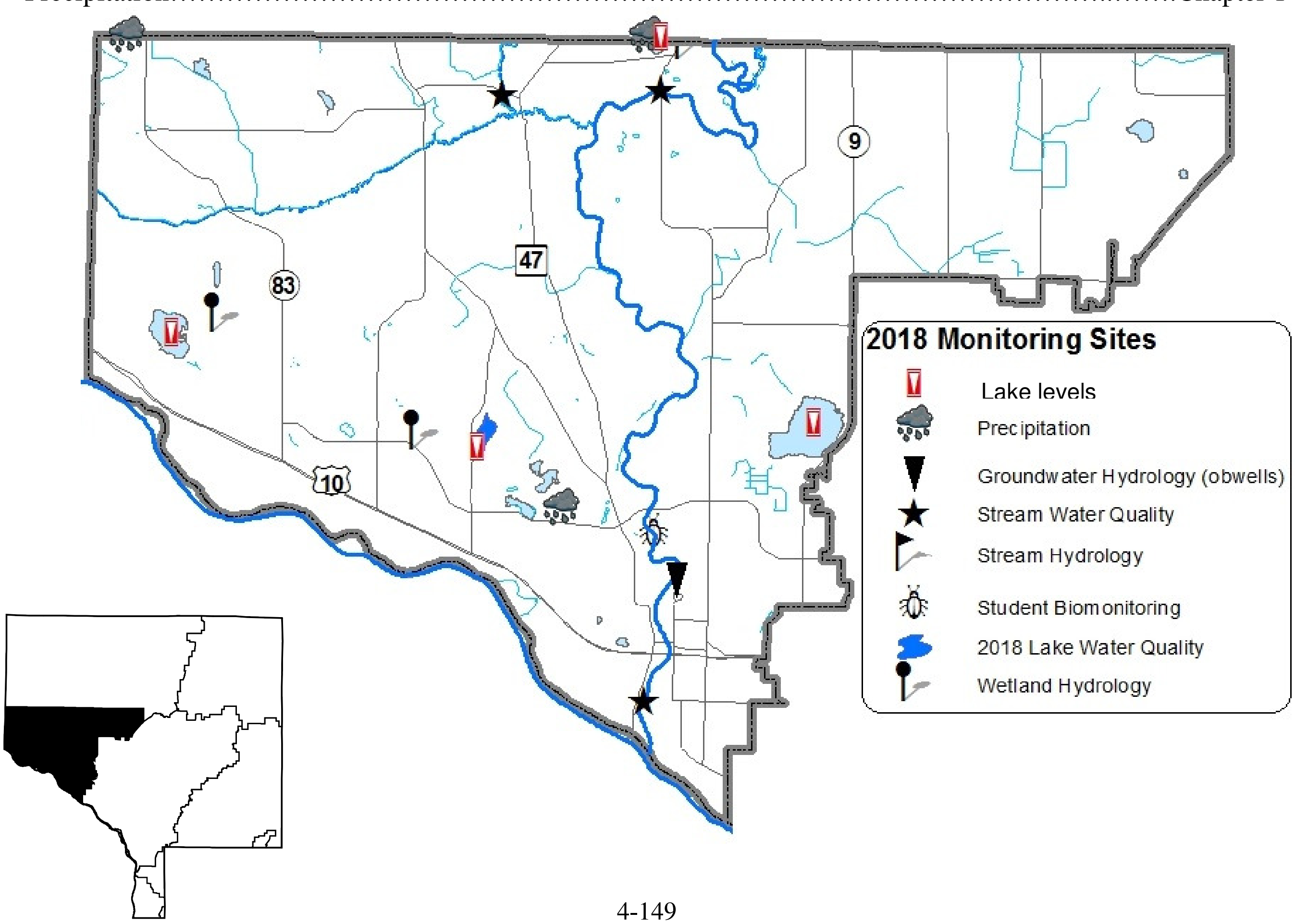


Lake Level Monitoring

Partners: LRRWMO, ACD, MN DNR, volunteers

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).

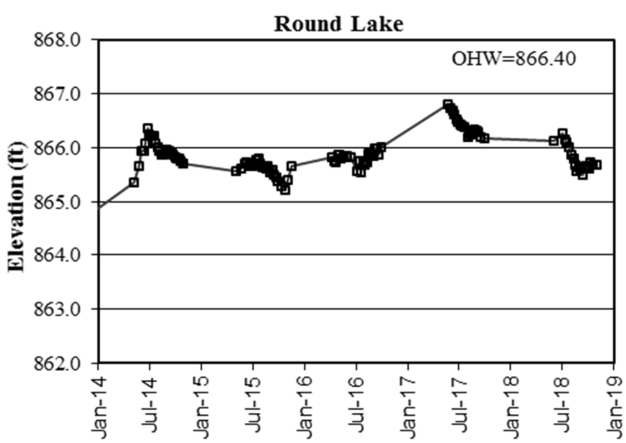
Purpose: To understand lake hydrology, including the impacts of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

Locations: Round, Rogers, Itasca, and Sunfish/Grass Lakes

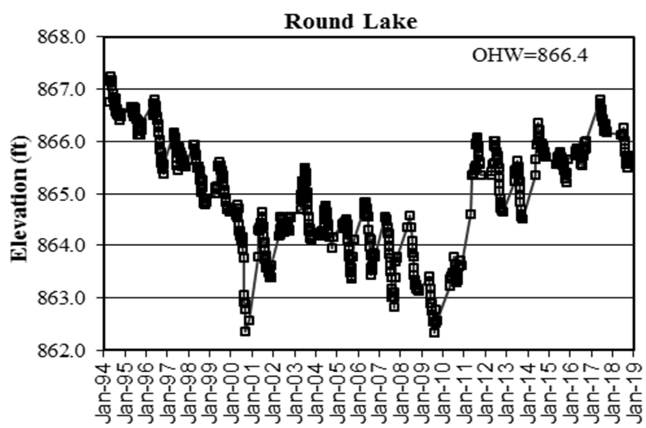
Results: Lake levels were measured by volunteers throughout the 2018 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. 2018 levels were generally lower than 2017 levels. All lakes followed the expected pattern of high levels in the spring with declining levels through summer. Sunfish Lake appears to be rising over the past 25 years, and Round Lake has almost rebounded to its 1994 levels after dropping almost five feet through 2010.

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.

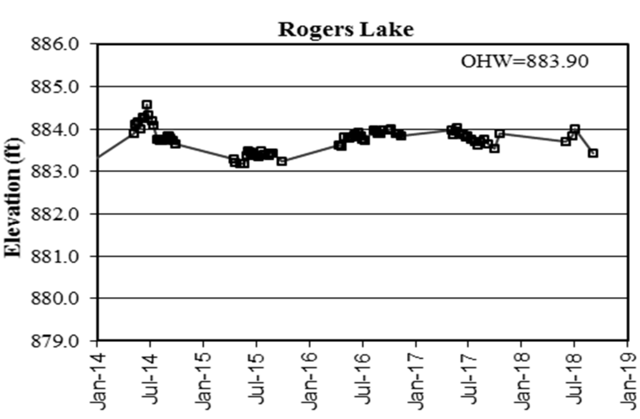
Round Lake Levels – last 5 years



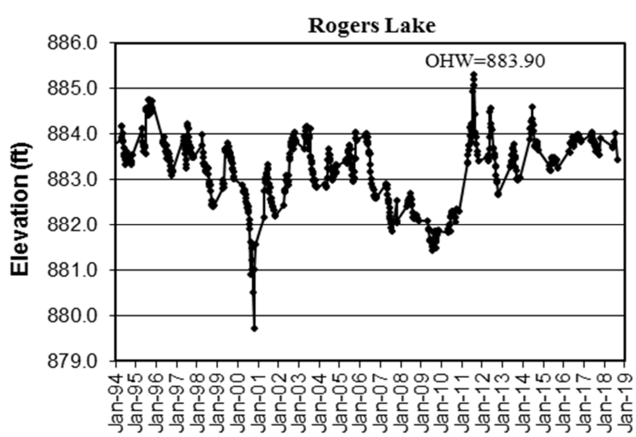
Round Lake Levels – last 25 years



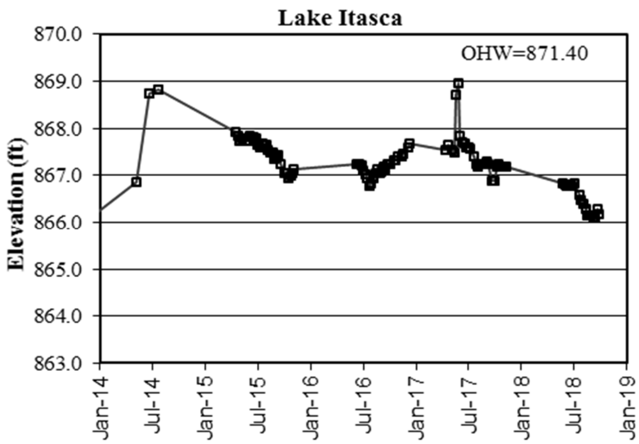
Rogers Lake Levels – last 5 years



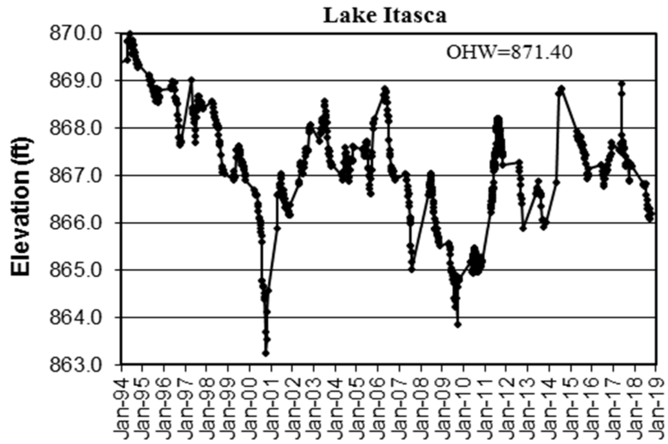
Rogers Lake Levels – last 25 years



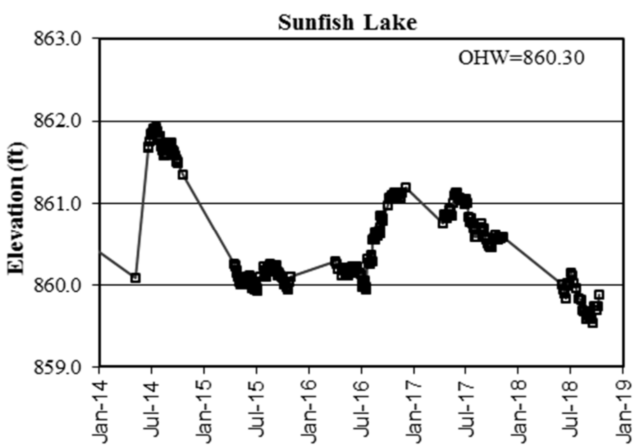
Itasca Lake Levels – last 5 years



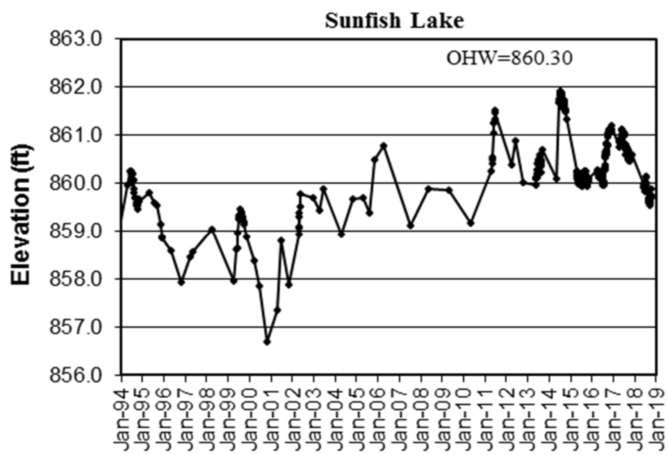
Itasca Lake Levels – last 25 years



Sunfish/Grass Lake Levels – last 5 years



Sunfish/Grass Lake Levels – last 25 years



Lake Water Quality

Partners: ACD, LRRWMO, Anoka County Ag Preserves Program

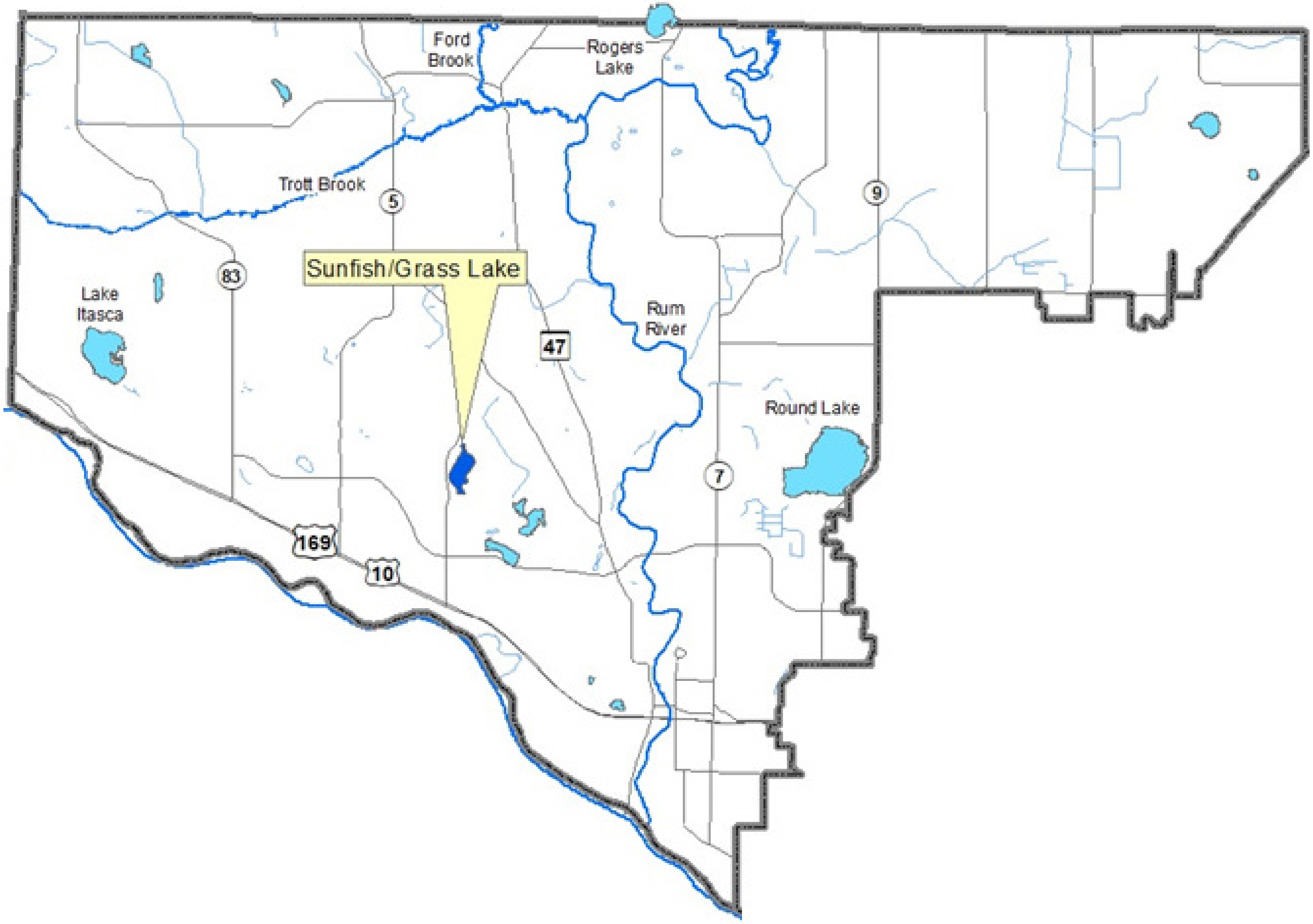
Description: May through September, every-other-week, monitoring is conducted for the following parameters: total phosphorus, chlorophyll-a, Secchi transparency, dissolved oxygen, turbidity, temperature, conductivity, pH, and salinity.

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

Locations: Sunfish/Grass 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.

LRRWMO Lake Water Quality Monitoring Sites



Sunfish/Grass Lake

City of Ramsey, Lake ID #02-0113

Background

Sunfish/Grass Lake is located in the City of Ramsey in southwestern Anoka County. It is a small lake with a surface area of 35 acres. The lake does not have a public boat landing, but can be accessed through Sunfish Lake Park on the west side of the lake. The park has a fishing pier and kayaks, which can both be used by the public. The lake is quite shallow with floating leaf, emergent, and submergent aquatic vegetation throughout. A very small portion of the shoreline is developed with most of the lake being surrounded by park or wooded land.

2018 Results

Sunfish/Grass Lake has not been extensively monitored in the past. 2018 was the third year in which the Anoka Conservation District (ACD) monitored the lake as part of the regular lake sampling efforts. The lake was previously monitored by ACD in 2016 and 2017 with four additional years of monitoring through the MPCA Citizen Lake Monitoring Program (CLMP) with varying degrees of intensity.

In 2018 Sunfish Lake's water quality was good compared with other lakes in this region (NCHF Ecoregion), receiving an overall B letter grade. Total phosphorus (TP), Chlorophyll-a (CL-a) and Secchi readings were all better than state water quality standards, but not as good as some previous years at this lake. The average total phosphorus concentration in 2018 of 33 µg/L was up from 16.6 µg/L in 2017. The average chlorophyll-a concentration of 8.09 µg/L is the highest on record. In previous years chlorophyll-a ranged from 3.1 to 7.1 µg/L. Secchi depth was obscured by vegetation on 7 of 10 sampling occasions (≥4 ft.) on the other 3 occasions it varied from 2.3 to 6.9 ft.

Trend Analysis

There is not yet enough data for a trend analysis of any parameter.

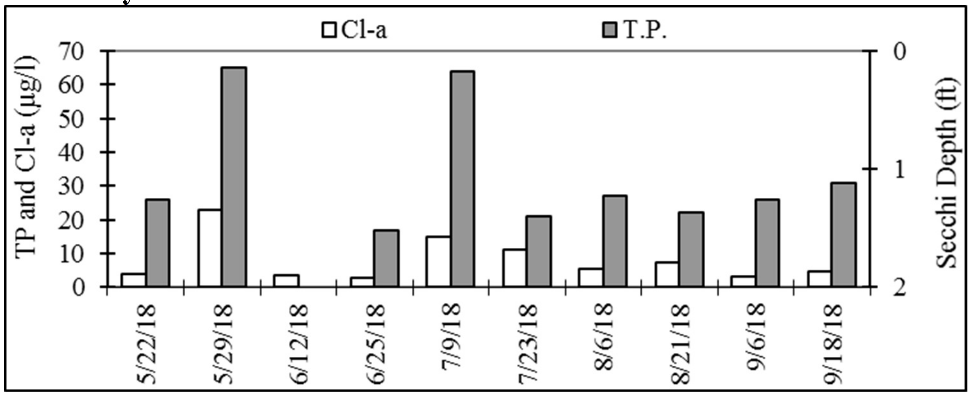
Discussion

Grass Lake looks to be in good health, returning to a B grade after receiving an overall A letter grade in 2017 and receiving B grades in each of the previous three years monitored for each parameter since 2012. This letter grade would likely be further substantiated if Secchi readings were not limited by the depth of the lake. Total phosphorus and chlorophyll-a concentrations remain well below state water quality standards for shallow lakes.

Sunfish/Grass Lake

City of Ramsey, Lake ID #02-0113

2018 Daily Results



2018 Median Results

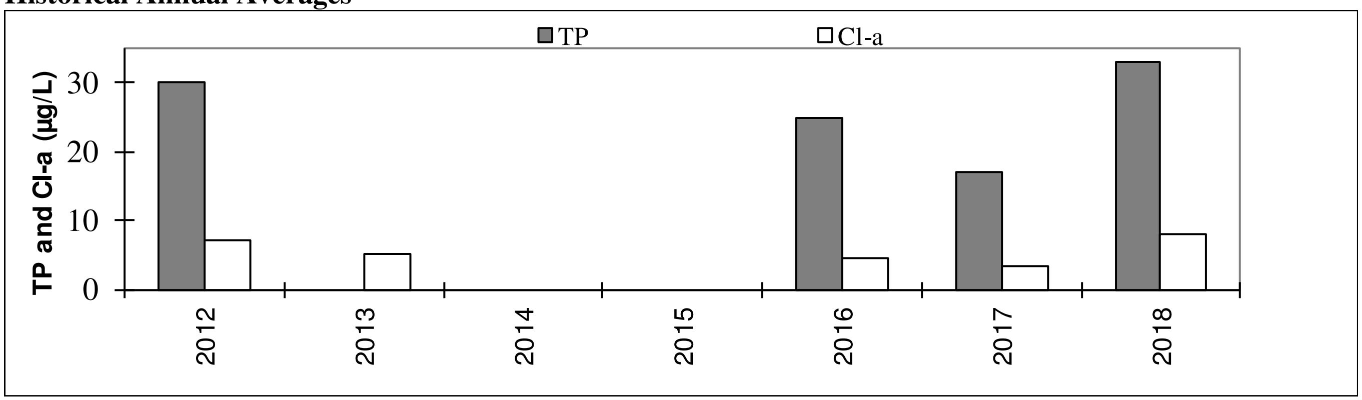
pH		7.97
Specific Conductivity	mS/cm	0.455
Turbidity	NTU	2.05
D.O.	mg/l	8.55
D.O.	%	1.02
Temp.	°F	75.9
Salinity	%	0.2
Cl-a	µg/L	5.2
T.P.	µg/l	26.0
Secchi	ft	>3

Historical Report Card

Year	TP	Cl-a	Secchi	**Overall**
2012	B	A	C	**B**
2013		A	C	**B**
2014				
2015				
2016	C	A	n/a	**B**
2017	A	A	n/a	**A**
2018	C	A	n/a	**B**
State Standards	60 µg/L	20 µg/L	>3.3 ft	

Due to Secchi transparency exceeding lake depth or being obscured by vegetation in recent years, it was not included on the graph (for recent years) or in the overall grade.

Historical Annual Averages



	Units	R.L.*	5/22/2018	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:			12:45	14:02	14:40	15:42	16:27	14:15	15:10	14:15	14:13	14:08			
pH		0.1	9.39	9.38	8.02	8.28	8.00	7.94	7.78	7.48	7.22	7.12	8.06	7.12	9.39
Specific Conductivity	mS/cm	0.01	0.317	0.308	0.990	0.411	0.463	0.515	0.432	0.450	0.460	0.474	0.482	0.308	0.990
Turbidity	NTU	1	2.1	5.5	0.0	8.0	1.2	1.2	0.3	2.0	31.0	7.0	6	0	31
D.O.	mg/l	0.01	12.05		8.35	8.58	8.67	10.11	8.52	6.48	6.15	3.1**	8.61	6.15	12.05
D.O.	%	1	139.4%		98.5%	92.0%	110.4%	128.8%	105.3%	77.3%	68.1%	36.8%**	102%	68%	139%
Temp.	°C	0.1	19.55	28.91	21.80	26.43	28.80	26.50	25.05	23.75	22.27	21.99	24.5	19.6	28.9
Temp.	°F	0.1	67.2	84.0	71.2	79.6	83.8	79.7	77.1	74.8	72.1	71.6	76.1	67.2	84.0
Salinity	%	0.01	0.16	0.15	0.49	0.20	0.22	0.25	0.21	0.22	0.22	0.23	0.24	0.15	0.49
Cl-a	ug/L	1	4.00	23.10	3.56	3.03	15.00	11.20	5.62	7.48	3.09	4.8100	8.09	3.0	23.1
T.P.	mg/l	0.005	0.026	0.065		0.017	0.064	0.021	0.027	0.022	0.026	0.031	0.033	0.017	0.065
T.P.	ug/l	5	26	65		17	64	21	27	22	26	31	33	17	65
Secchi	ft		>4	2.3	6.9	3	>4	>4.5	>4	>4	>4.33	>4		2.3	6.9
Secchi	m		>1.21	0.7	2.1	0.9	>1.21	>1.22	>1.21	>1.21	>1.3	>1.21	0.0	0.7	2.1
Physical			1	2	1	1	1	1		1	1	1	1.1	1.0	2.0
Recreational			2	2	1	2	3	2		2	2	2	2.0	1.0	3.0

*reporting limit

** excluded from calculations due to likely inaccuracy

Stream Water Quality - Chemical Monitoring

Partners: MPCA, ACD, LRRWMO

Description: The Rum River and several tributary streams were monitored in 2018. The locations of river monitoring include the approximate top and bottom of the Lower Rum River Watershed Management Organization (WMO) and at the top of the Upper Rum River WMO. Tributaries in the Upper Rum River WMO were monitored simultaneously with Rum River monitoring for greatest comparability near their outfalls into the river. Monitoring at the bottom of the Lower Rum River WMO was completed by the Metropolitan Council (Met Council) below the dam in Anoka. Collectively, these data allow for an upstream to downstream water quality comparison within Anoka County, as well as within each watershed organization. It also allows us to examine whether the tributaries degrade Rum River water quality.

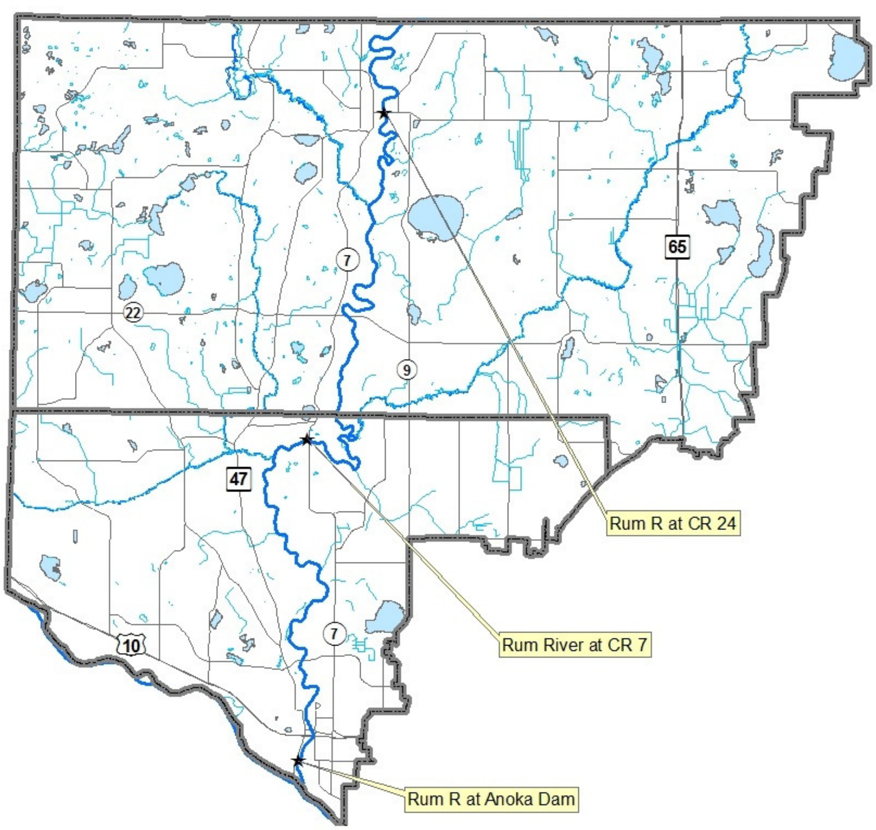
Monitoring by Anoka Conservation District occurred in May through October for each of the following parameters: total suspended solids, total phosphorus, Secchi tube transparency, dissolved oxygen, turbidity, temperature, specific conductivity, pH, and salinity. Metropolitan Council monitoring occurred weekly March to October and semi-monthly November to February. The Met Council monitors all the parameters listed above, plus several more. Met Council monitoring data can be found on their Environmental Information Management Systems (EIMS) website (**https://eims.metc.state.mn.us/**). Data from both sources are summarized in this report.

Purpose: To detect water quality trends, diagnose and identify the source of any problems, and guide management.

Locations: Rum River at County Road 24 (ACD)
Rum River at County Road 7 (ACD)
Rum River at Anoka Dam (Met Council)

Results: Results are presented on the following pages.

2018 Rum River Monitoring Sites



RUM RIVER

Rum River at Co. Rd. 24 (Bridge St), St. Francis	STORET Site ID = S000-066
Rum River at Co. Rd. 7 (Roanoke St), Ramsey	STORET Site ID = S004-026
Rum River at Anoka Dam, Anoka[1]	STORET Site ID = S003-183

[1]monitored by the Metropolitan Council

Years Monitored

At Co. Rd. 24 – 2004, 2009-2011, 2014-2018

At Co. Rd. 7 – 2004, 2009- 2011, 2014-2018

At Anoka Dam – 1996-2011(MC WOMP), 2015-2018

Background

The Rum River is one of Anoka County's highest quality and most valuable water resources. It is designated as a state scenic and recreational river throughout Anoka County, north of the county fairgrounds in Anoka. It is used for boating, tubing, and fishing. Much of western Anoka County drains to the Rum River. Subwatersheds that drain to the Rum include Seelye Brook, Ford Brook, and Cedar Creek (reported in the Upper Rum River WMO section of this Water Almanac) and Trott Brook.

The extent to which Rum River water quality improves or is degraded within Anoka County has been unclear. The Metropolitan Council has monitored water quality at the Rum's outlet to the Mississippi River since 1996. This water quality and hydrologic data is well suited for evaluating the river's water quality just before it joins the Mississippi River. Monitoring elsewhere has occurred only in more recent years. Water quality changes might be expected from upstream to downstream because land use changes dramatically from rural residential in the upstream areas of Anoka County to suburban in the downstream areas.

Methods

In 2004, 2009-2011, and 2014-2018 monitoring was conducted to determine if Rum River water quality changes in Anoka County, and if so, generally where changes occur. The data is reported for all sites together for a more comprehensive analysis of the river from upstream to downstream.

In 2018 the river was monitored during both storm and baseflow conditions by grab samples. At County Road 24 (farthest upstream) only four samples were taken due to lower funding levels. At County Road 7, eight water quality samples were taken; half during baseflow and half following storms. These two sites were monitored by the Anoka Conservation District. At the Anoka Dam the river was monitored by the Metropolitan Council using a different schedule.

Monitoring was conducted during both baseflow and storm conditions. Storms were generally defined as one-inch or more of rainfall in 24 hours, or a significant snowmelt event combined with rainfall. In some years, particularly drought years, smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events.

Key water quality parameters were monitored at all sites. Parameters tested with portable meters included pH, specific conductivity, turbidity, temperature, salinity, and dissolved oxygen. Parameters tested by water samples sent to a state-certified lab included total phosphorus and total suspended solids, as well as chloride at Rum River at County Road 7. Additional parameters were monitored at the Anoka Dam by the Metropolitan Council.

Water levels or flow was observed during each water quality sampling. The Metropolitan Council monitoring station at the Anoka Dam includes automated equipment that continuously tracks water levels and calculates flows. Water level and flow data for other sites were obtained from the US Geological Survey, who maintains a hydrological monitoring site at Viking Boulevard.

The purpose of this report is to make an upstream to downstream comparison of Rum River water quality. It includes only parameters tested at all sites in 2018. It does not include additional parameters tested at the Anoka Dam or additional monitoring events at that site. For that information, see Metropolitan Council reports at https://eims.metc.state.mn.us/. All other raw data can be obtained from the Anoka Conservation District, and is also available through the Minnesota Pollution Control Agency's EQuIS database, which is available through their website (https://www.pca.state.mn.us/data/environmental-quality-information-system-equis).

Results Summary

This report includes data from 2018 and an overview of previous year's data. The following is a summary of results.

- Specific conductivity and chlorides are measured as representatives of dissolved constituents. Specific conductivity in the Rum River is lower than other Anoka County streams. Specific conductivity increases mildly downstream, though it is slightly lower at the furthest downstream site compared to the mid-county site. Average specific conductivity for sites tested in 2018 from upstream to downstream was 0.266, 0.282, and 0.269 mS/cm, respectively.
- Chlorides were tested at Rum River at C.R. 7 where it averaged 14 mg/L, which is low. As development continues in all parts of the Rum River watershed, efforts to prevent future problems should include minimizing road deicing salt use and utilizing new water softening technology. Other streams near the Rum River do have significant high chlorides problems.
- Phosphorus in the Rum River in recent years has been near the State water quality standard of 100 µg/L at all sampled sites. Sites exceeded the standard on three single sampling occasions in 2018, once during baseflow, and twice after a storm event. 2018 total phosphorus in the Rum River in 2018 averaged 78.8, 83.3, and 86.0 µg/L at sampled sites from upstream to downstream. This year total phosphorus increased slightly compared to the low values of 2017. The minimal increase from upstream to downstream is overall a good thing as it points to relatively small phosphorus contributions occurring in Anoka County. However, because small increases in phosphorus could cause the Rum River to exceed State standards and be declared "impaired," preventing phosphorus increases should be a focus of watershed management.
- Suspended solids and turbidity generally remained at acceptable levels in the Rum River and are lower than most other Anoka County streams. Average turbidity peaked at the mid-county site Rum River at C.R. 7 where average turbidity was 19.3 NTU. From upstream to downstream in 2018 turbidity averages were 7.2, 19.43, and 3.85 NTU, respectively. TSS levels were low in the Rum River compared to other Anoka County streams averaging 10.94, 10.1, and 5.54 mg/L from upstream to downstream. The low turbidity and TSS levels at the downstream site are likely due to settling in the pool created by the dam at Anoka. Though suspended solids remain well under state impairment thresholds in the Rum, turbidity does show a moderate increase during storm events, and stormwater runoff mitigation should be a focus of management efforts, especially as other pollutants may be associated with suspended solids.
- pH returned to more typical levels in 2018 in the Rum River after being elevated on some occasions in 2017. pH should remain between 6.5 and 8.5 to support aquatic life and meet State water quality standards. On one occasion in May 2017, all three sampled sites exceeded pH 9. However, this year there were no examples of pH exceeding 9, in fact the highest pH recorded was 8.46, within the range required to meet state standards. This decrease in pH both on average and overall is good, but concern remains because there have been a number of spikes in pH over 8.5 in recent years. pH levels over 9 are quite alkaline for natural waterways. There are a variety of potential factors leading to temporary spikes in pH, including discharge of high nutrient and algae waters to the river from lakes or wetlands. pH should continue to be monitored in the Rum River in the future.
- Dissolved oxygen remained above the state standard of 5 mg/L in 2018 and previous monitored years, however the lowest recorded level occurred this year. The lowest concentration recorded at any of the three sites in 2018 was 5.64 mg/L at Rum River at C.R. 7 compared to 6.89 mg/L at Rum River at Anoka Dam in 2017.

Below the data are presented and discussed for each parameter in greater detail. Management recommendations will be included at the conclusion of this report. The Rum River is an exceptionally important waterbody, and its protection and improvement should be a high priority.

Specific Conductivity

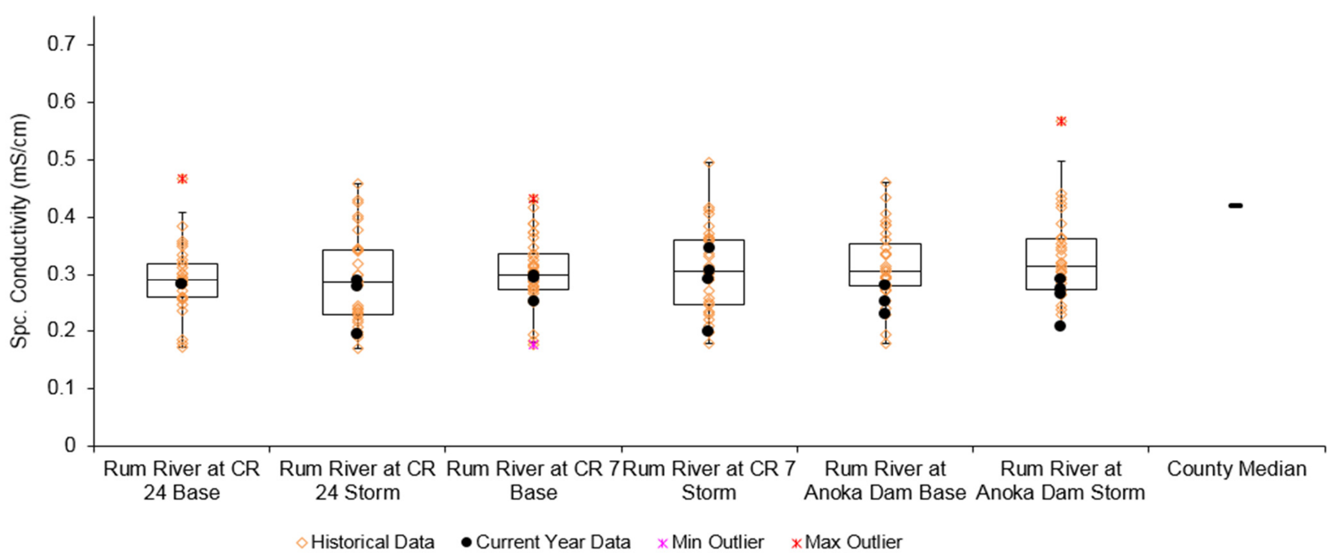
Specific conductivity and chlorides are measures of dissolved pollutants. Dissolved pollutant sources include road runoff and industrial chemicals, among many others. Metals, hydrocarbons, and road salts, as well as other pollutants are often of concern in a suburban environment. Specific Conductivity is the broadest measure of dissolved pollutants we use. It measures electrical Specific Conductivity of the water; pure water with no dissolved constituents has zero Specific Conductivity.

Specific conductivity is acceptably low in the Rum River, in the past it has shown a consistent pattern of increasing downstream (see figure below) and is usually higher during baseflow conditions. Average specific conductivity from upstream to downstream in 2018 (all conditions) did not meet these expectations with readings of 0.266 mS/cm, 0.282 and 0.269 mS/cm, respectively. All three sites are lower than the historical median for 34 Anoka County streams of 0.420 mS/cm and. The 2018 maximum observed specific conductivity in the Rum River was 0.347 mS/cm at County Road 7 during storm conditions. During storm flows there is a statistically significant trend of increasing specific conductivity from upstream to downstream when averaged over the last 5 years.

Specific conductivity is lower on average during storm events (especially at the upstream sites), suggesting that stormwater runoff contains fewer dissolved pollutants than the surficial water table that feeds the river during baseflow. High baseflow specific conductivity has been observed in most other nearby streams as well. This occurrence has been studied extensively, and the largest cause has often been found to be road deicing salts that have infiltrated into the shallow aquifer. Water softening salts and geologic materials also contribute, but to a lesser degree.

In years past, specific conductivity has increased from upstream to downstream and that is the expected trend. During baseflow, this increase from upstream to downstream likely reflects greater road densities and deicing salt application. That this pattern is not seen this year could be due to precipitation or runoff differences, or the timing of sampling. Additionally, the below the dam specific conductivity readings were atypical in 2018 in that specific conductivity was higher during storm than baseflow events, though modestly higher at that, averaging 0.279 mS/cm during storms and 0.254 mS/cm during baseflow.

Specific Conductivity during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

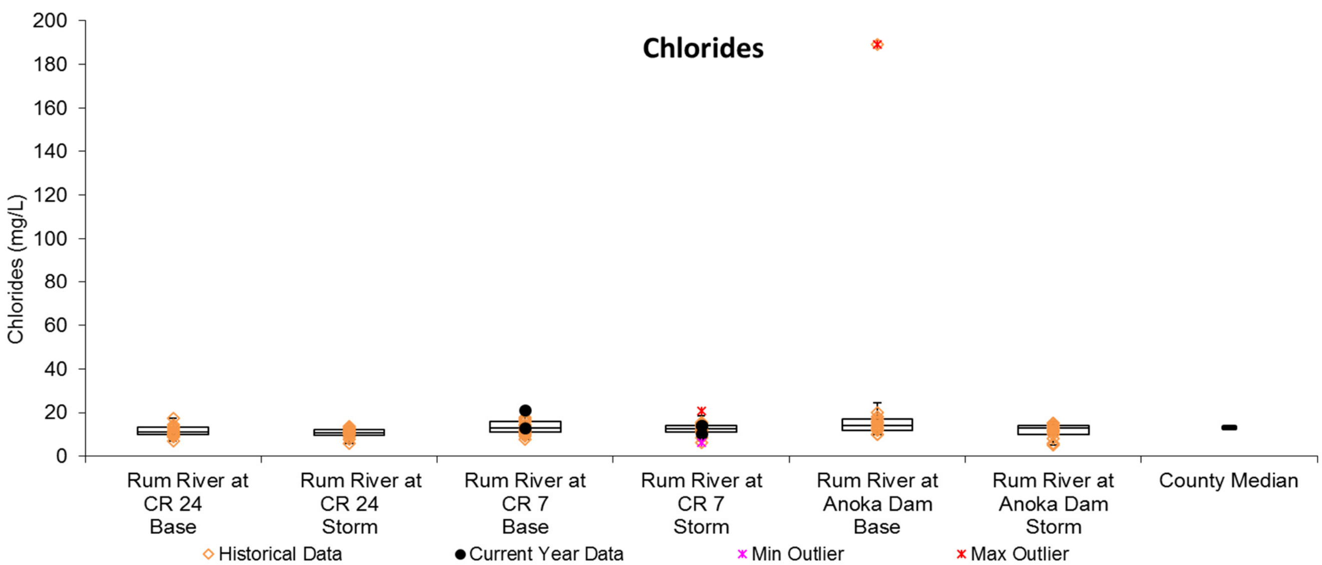


Chlorides

Chlorides are the measure of chloride salts, the most common of which are road de-icing chemicals and those used in water softening. 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. They can also be of concern because the Rum River is upstream from the Twin Cities drinking water intakes on the Mississippi River. Specific Conductivity data, reported above, is partially a reflection of chlorides with higher specific conductivity corresponding to higher chlorides, generally.

In 2018 water samples for chloride analysis were taken from the Rum River at CR7. At this location average chloride was 14.7 mg/L for all events and 14.2 and 15.0 mg/L for storms and base flow conditions, respectively. This reflects the typical trend seen in specific conductivity of greater dissolved pollutants during baseflow conditions and likely reflects infiltration of road salts into the shallow aquifer. This information could be of greater value if chloride sampling occurred at all sites sampled in the Rum River watershed and, additionally, if samples were taken after snowfall events and corresponding specifically to snowmelt.

Chlorides during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2018 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

Phosphorus is one of the most common pollutants in this region, and can be associated with urban runoff, agricultural runoff, wastewater, and many other sources. It causes excessive algal growth and a number of other associated problems for aquatic life and recreation. Rum River total phosphorus is near State impairment thresholds.

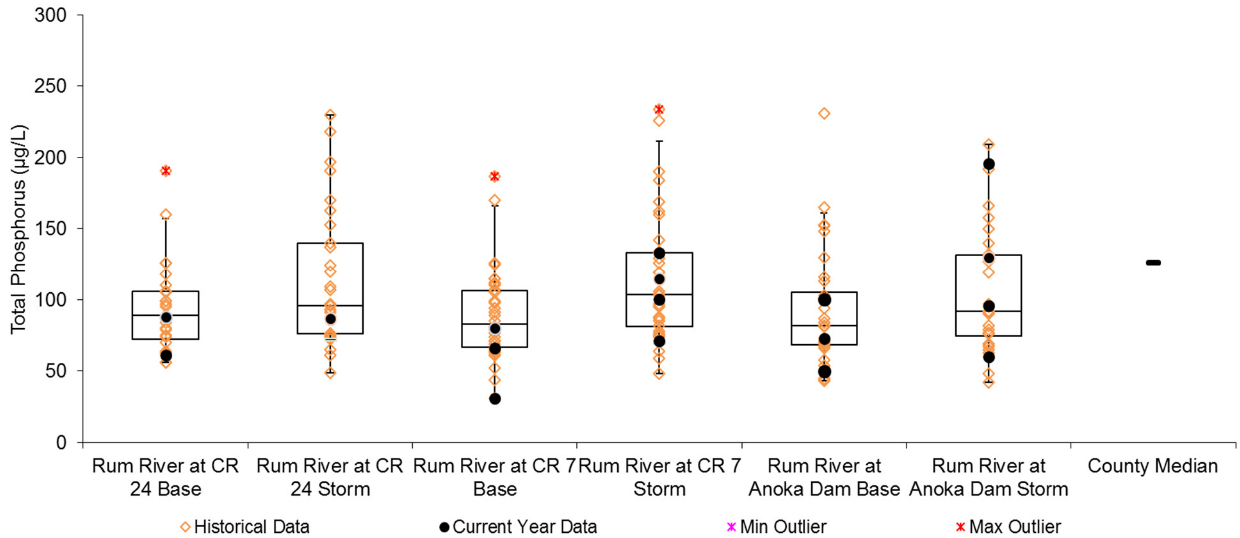
The average phosphorus concentration in 2018 increased from upstream to downstream and approached State standards for impairment. At the three monitored sites phosphorus from upstream to downstream was 78.8, 83.3 and 86.0 µg/L, respectively. The watershed becomes increasingly suburbanized in the lower reaches.

In 2018, as in many years pre-2016, total phosphorus was close to exceeding State water quality standards. Four samples among the three sites combined in 2018 yielded total phosphorus concentrations over the State standard of 100 µg/L. Of those, two occurred on July 2nd at the mid-county and downstream sites after significant rainfall.

Because the Rum River is close to exceeding State water quality standards for phosphorus, monitoring should be continued in the future, and every effort should be made to prevent phosphorus increases which may result in the

Rum River being designated as "impaired" for nutrients. Future upgrades to wastewater treatment plants throughout the Rum River watershed may offer phosphorus reductions. At the same time, development should include robust stormwater treatment to not just keep nutrient loading to the river the same, but reduce it. Reductions will be necessary to offset likely increases from land use changes, more intense precipitation events, upstream ditch cleaning and other factors.

Total Phosphorus during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentile (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 the refraction of a light beam passed through a water sample and is most sensitive to large particles. Total suspended solids are 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, such as phosphorus, are attached to particles. Many stormwater treatment practices such as street sweeping, sumps, and stormwater settling ponds target sediment and attached pollutants. In 2018, median turbidity and total suspended solids in the Rum River were lower than the historical median for Anoka County streams.

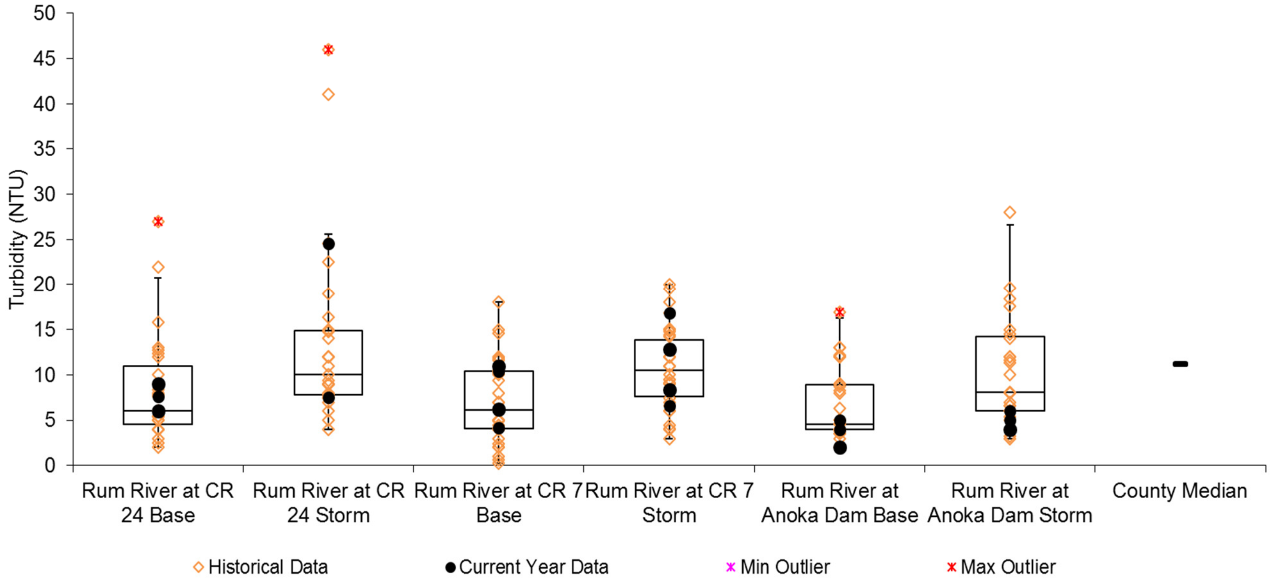
In the Rum River, turbidity is generally low but increases during storms. There is substantial variability (see figure below). There is no clear change in turbidity or suspended solids upstream to downstream. The average turbidity, in 2018 (storms and baseflow) for each site moving upstream to downstream was 7.2, 19.4, and 3.85 NTU. The historical median for Anoka County streams is 11.2 NTU. Turbidity was elevated on a few occasions, especially during and after storm events. Over the last 5 years there is a statistically significant increase in turbidity from upstream to downstream during baseflow conditions and also for all samples. This likely reflects the effect of increased erosion and contribution of sediments in the more developed southern portion of the county.

Average TSS results (all conditions) in 2018 for sites moving upstream to downstream were 10.94, 10.1, and 5.54 mg/L. These are all lower than the Anoka County stream median for TSS of 13.66 mg/L. It is also lower than State water quality standards. The State threshold for TSS impairment in the Rum River is 10% of samples April 1-September 30 exceeding 30 mg/L TSS. The highest concentration recorded in 2018 was 24 mg/L. ACD has not collected a sample in the Rum River over 30 mg/L TSS since May of 2010.

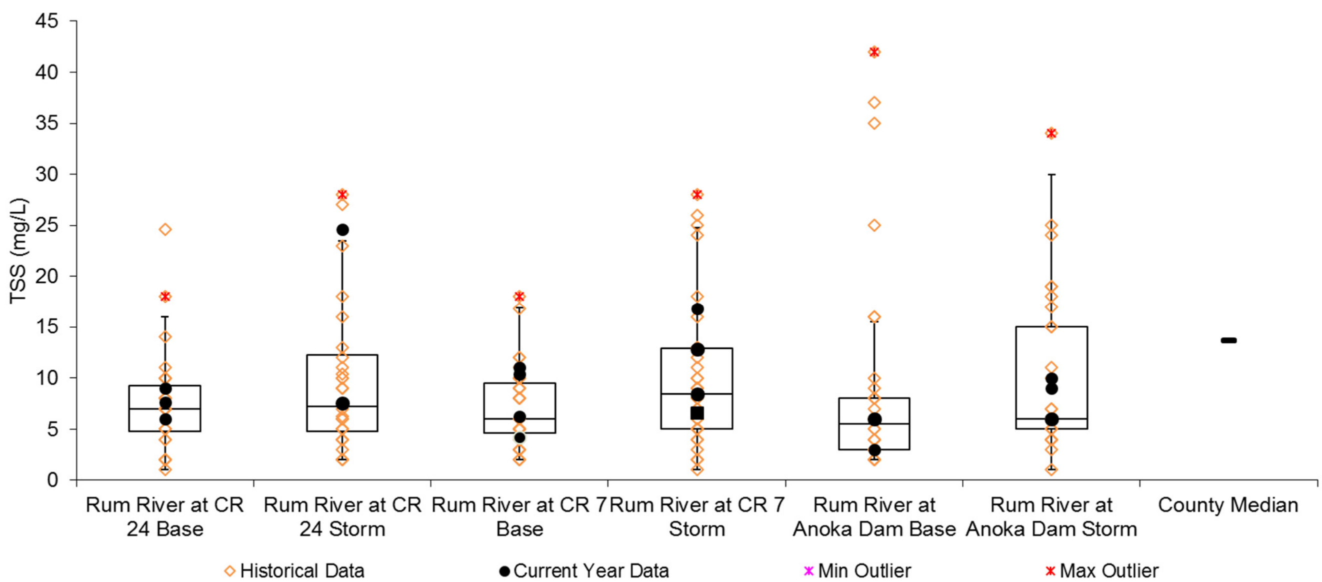
Suspended solids can come from within and outside of the river channel. Sources on land include soil erosion, road sanding, and others. Riverbank erosion and movement of the river bottom also contributes to suspended solids. A moderate amount of this "bed load" is natural and expected.

Though the Rum River remains well under the impairment threshold for TSS, rigorous stormwater treatment should occur as the Rum River watershed continues to be developed or the collective pollution caused by many small developments could seriously impact the river, especially given that stormwater carries many pollutants in addition to suspended sediments. Bringing stormwater treatment up to date in older developments is also important.

Turbidity during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2018 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 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



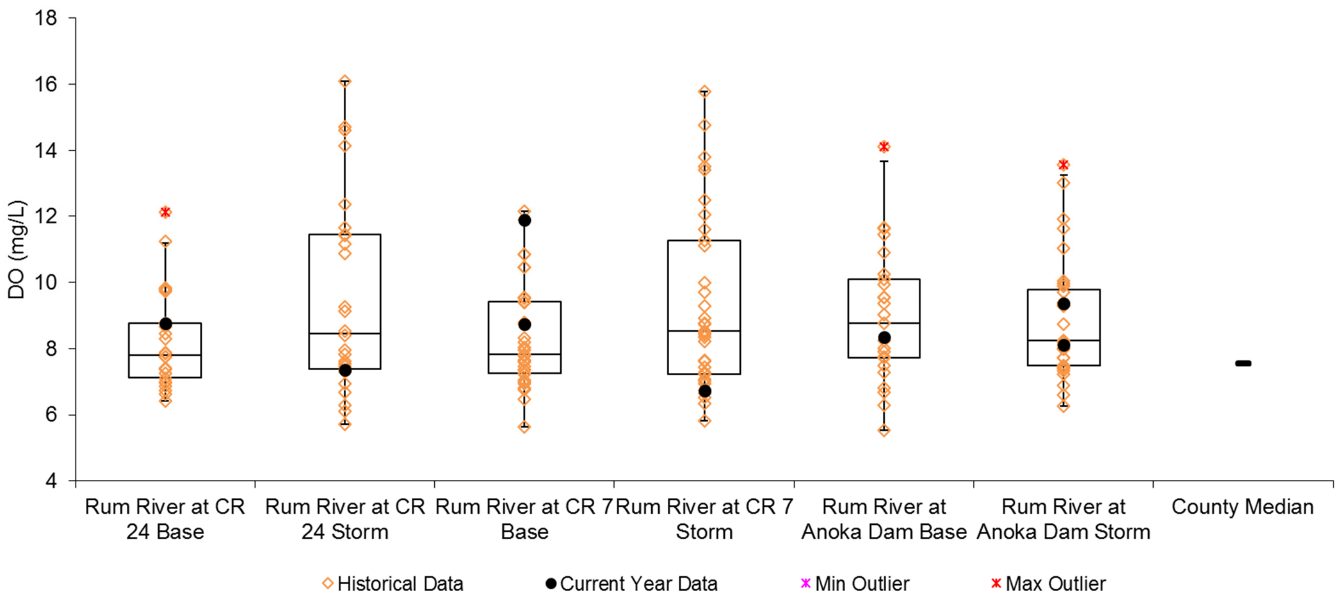
Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution causes oxygen to be consumed during decomposition. If oxygen levels fall below the state water quality standard of 5 mg/L, aquatic life begins to suffer. 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 2018, dissolved oxygen in the Rum River was always above 5 mg/L at all monitoring sites.

The lowest dissolved oxygen observed in the Rum River in 2018 was 5.64 mg/L. This is only the fifth time that a dissolved oxygen reading below 6 has occurred in the Rum River throughout the monitoring record, with the 3 most recent previous readings occurring during a single storm in 2011 when dissolved oxygen dipped below six at all three sites. The low dissolved oxygen result this year was recorded at base flow during July when water temperatures were above 77° F. Warm water holds less oxygen, therefore this low reading is likely a result of low water on a hot day, rather than pollution.

Decreases in dissolved oxygen may result from an increase in the level of nutrients in the stream. Making sure that phosphorus and nitrogen inputs to the stream are maintained or lowered is important for healthy dissolved oxygen levels. The principle sources of these nutrients are fertilizer and wastewater.

Dissolved Oxygen during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

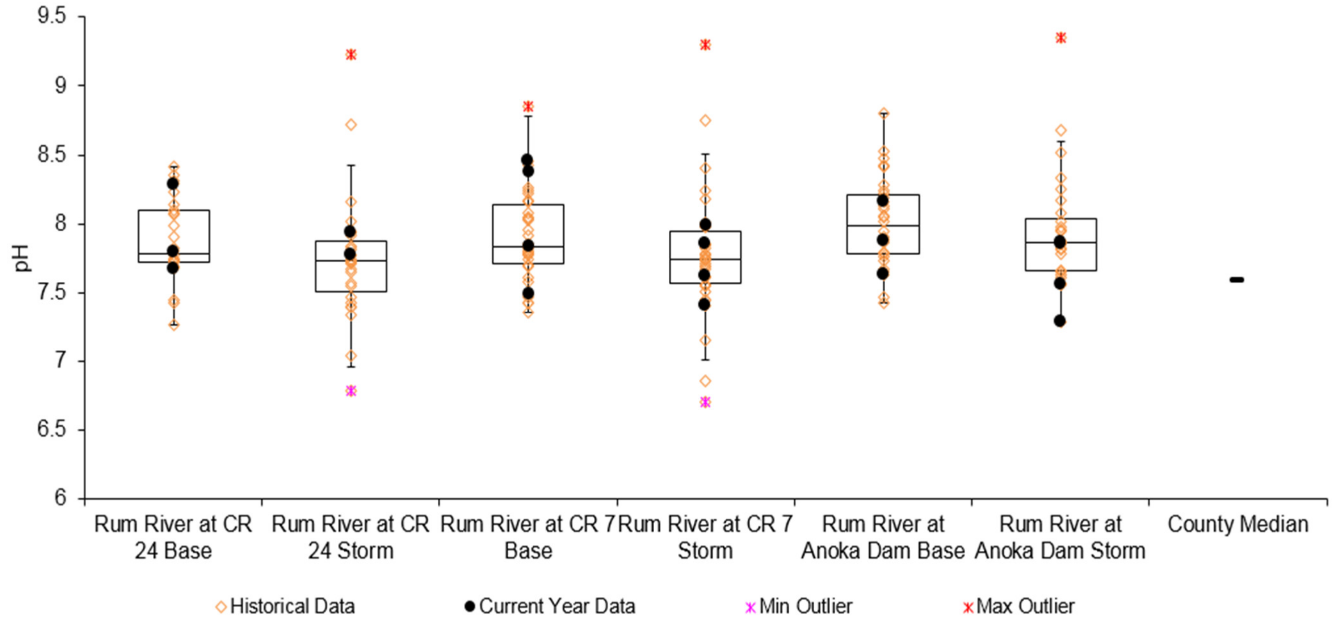


pH

pH refers to the acidity of the water. The Minnesota Pollution Control Agency's water quality standard is for pH to remain between 6.5 and 8.5. The Rum River is generally within this range, but has exceeded 8.5 on rare occasions in the past. In recent years (2015, 2017) however, exceedances of 8.5 have been commonplace at all sites. In 2017, pH levels over 9 were recorded at all three sites after a storm event on 5/18/2017. Exceedances were recorded in 2015 after a spring storm in March at the lower two sampling sites as well as at the Anoka Dam during baseflow conditions in July. This year saw a positive change with no events exceeding 8.5.

There are a variety of potential factors leading to temporary spikes in pH. It is, however, disconcerting that spikes over 8.5 seem to be happening more frequently in recent years, although it is a positive development that they did not occur this year. pH should continue to be monitored in the Rum River in the future to see if the spikes get worse or become even more common.

pH during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Summary and Recommendations

In general, the Rum River's water quality is good. However, there is typically a slight increase in specific conductivity moving downstream, phosphorus levels are near state water quality standards, and pH spikes over 8.5 have been more frequent in recent years, although they did not occur this year. The river is in need of protection now to avoid more difficult and costly restoration becoming a necessity later.

In addition to comparing water quality in the Rum River upstream to downstream, water quality was also compared between Rum River tributaries and the Rum River main stem. For specific conductivity, total suspended solids, and total phosphorus the Rum river had better water quality than the tributaries, except when TSS results at Rum River at CR 24 and Seelye Brook at CR 9 were compared. Based on these results the tributaries sampled are likely reducing water quality in the Rum River. Many of the tributaries experience frequent exceedances of state standards, especially for total phosphorus. This is important since the Rum River is already nearing exceedance of total phosphorus standards and the tributaries are likely contributing to this problem. Moving forward it is important to continue to monitor and protect both the Rum River and its tributaries in order to prevent further decline in water quality potentially leading to water quality impairments in the Rum.

Relative changes in 3 water quality parameters in tributaries and the Rum River moving upstream to downstream. Plus/minus signs indicate difference relative to Rum River at CR 24 (top of the county).

	Specific Conductivity	Total Suspended Solids	Total Phosphorus
	Difference Relative to Rum R. at CR 24		
Rum River @ CR 24	0.266 mS/cm	10.94 mg/L	78.8 µg/L
Seelye Brook @ CR 7	+	-	+
Cedar Creek @ CR 9	+	+	+
Rum River @ CR 7	+	-	+
Ford Brook @ CR 63	+	+	+
Rum River @ Anoka Dam	=	-	+

Protection of the Rum River should continue to be a high priority for local officials. Large population increases are expected to continue in the Rum River's watershed within Anoka County. This continued development has the potential to degrade water quality unless carefully planned and managed with the river in mind. Specifically, new development should follow stormwater standards designed to at least maintain, and preferably reduce, phosphorus discharge to the river. Road deicing locally, which has become more sophisticated in recent years, should focus on minimizing salt application while keeping roads safe.

Development pressure is likely to be especially high near the river because of its scenic and natural qualities. Local ordinances to preserve the scenic nature of the river do exist, and enforcement is key. Additionally, preservation of riparian parcels with high natural resources quality should be considered with easement or fee title acquisition.

Watershed-wide (Mille Lacs Lake to the Anoka Dam) coordination of Rum River management is especially active currently. A Watershed Restoration and Protection Strategies (WRAPS) was completed in 2017. It is a scientific study that identifies recommended management strategies. A "One Watershed, One Plan" (1W1P) in 2019-2020 offers multi-county planning. This plan will prioritize and coordinate action. After completion of the 1W1P a new state funding source will become available – Watershed Based Funding – to implement water quality improvement projects.

Stream Water Quality – Biological Monitoring

Partners: LRRWMO, ACD, Anoka High School

Description: This program combines environmental education and stream monitoring. Under the supervision of ACD staff, high school science classes collect aquatic macroinvertebrates from a stream, identify their catch to the family level, and use the resulting numbers to gauge water and habitat quality. These methods are based upon the knowledge that different families of macroinvertebrates have different water and habitat quality requirements. The families collectively known as EPT (Ephemeroptera, or mayflies; Plecoptera, or stoneflies; and Trichoptera, or caddisflies) are generally pollution intolerant. Other families can thrive in low quality water. Therefore, a census of stream macroinvertebrates yields information about stream health.

Purpose: To assess stream quality, both independently as well as by supplementing chemical data. To provide an environmental education service to the community.

Location: Rum River behind Anoka High School, south side of Bunker Lake Blvd, Anoka

Results: Results for each site are detailed on the following pages.

Tips for Data Interpretation

Consider all biological indices of water quality together rather than looking at each alone, because each gives only a partial picture of stream condition. Compare the numbers to county-wide averages. This gives some sense of what might be expected for streams in a similar landscape, but does not necessarily reflect what might be expected of a minimally impacted stream. Some key numbers to look for include:

Families — Number of invertebrate families. Higher values indicate better quality.

EPT — Number of families of the generally pollution-intolerant orders Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies). Higher numbers indicate better stream quality.

Family Biotic Index (FBI) — An index that utilizes known pollution tolerances for each family. Lower numbers indicate better stream quality.

FBI	Stream Quality Evaluation
0.00-3.75	Excellent
3.76-4.25	Very Good
4.26-5.00	Good
5.01-5.75	Fair
5.76-6.50	Fairly Poor
6.51-7.25	Poor
7.26-10.00	Very Poor

Population Attributes Metrics

% EPT: This measure compares the number of organisms in the EPT orders (Ephemeroptera - mayflies: Plecoptera - stoneflies: Trichoptera - caddisflies) to the total number of organisms in the sample. A high percent of EPT is good.

% Dominant Family: This measures the percentage of individuals in the sample that are in the sample's most abundant family. A high percentage is usually bad because it indicates low evenness (one or a few families dominate, and all others are rare).

RUM RIVER

Behind Anoka High School, Anoka
STORET SiteID = S003-189

Last Monitored

By Anoka High School in 2018

Monitored Since

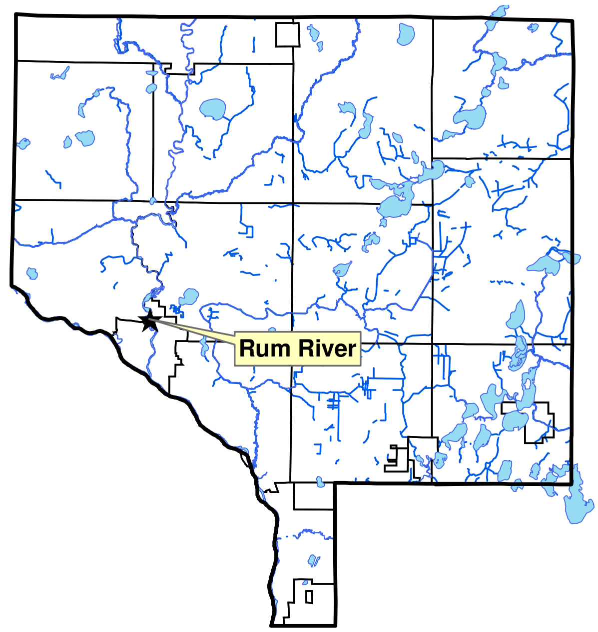
2001

Student Involvement

Over 100 students in 2018, over 1,200 total since 2001

Background

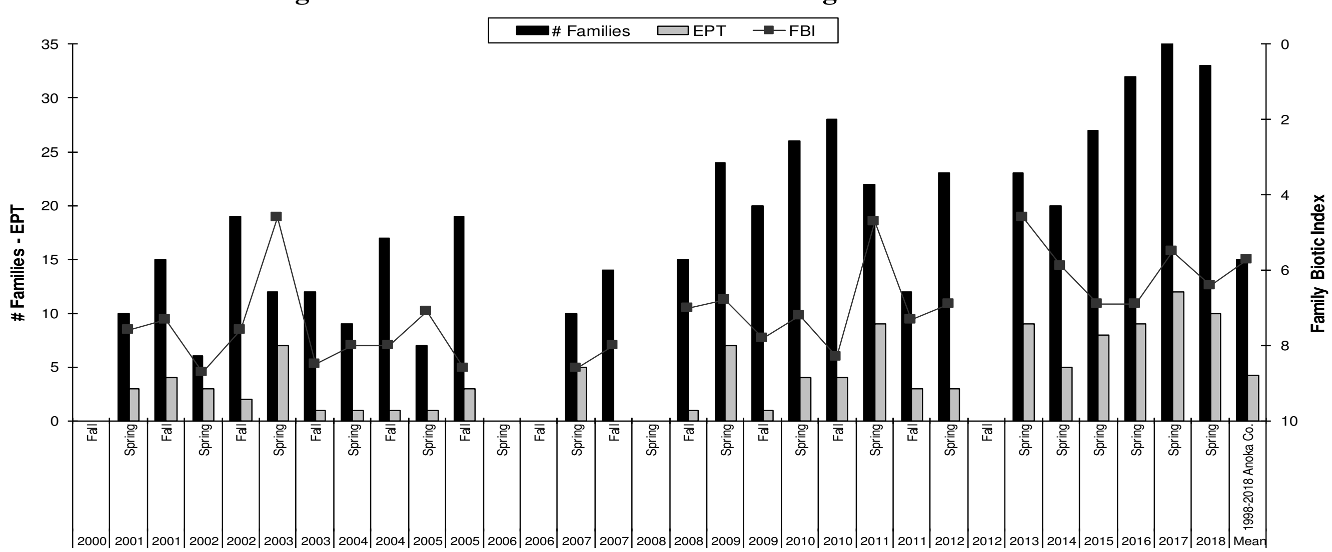
The Rum River originates from Lake Mille Lacs, and flows south through western Anoka County where it joins the Mississippi River in the City of Anoka. In Anoka County the river has both rocky riffles (northern part of county) as well as pools and runs with sandy bottoms. The River's condition is generally regarded as excellent. Most of the Rum River in Anoka County has a state "scenic and recreational" designation. The sampling site is near the Bunker Lake Boulevard bridge behind Anoka High School. Most sampling has been conducted in a backwater rather than the main channel.



Results

Anoka High school classes monitored the Rum River in spring of 2018 with Anoka Conservation District (ACD) oversight. The results for spring 2018 were better than previous years with the exception of last year (2017) which had the best results on record. Students collected 33 different families of invertebrates at this site, the second most since 2001. 10 unique families of the most sensitive taxa (Ephemeroptera, Plecoptera, and Trichoptera; EPT), were collected in 2018. The last three years of monitoring at this site (2016, 2017, and 2018) are the best three years on record. Additionally, results for family biotic index, number of families, and number of EPT taxa are all much better than the countywide mean over 21 years of data collection in numerous streams.

Historical Biomonitoring Results for Rum River behind Anoka High School



Biomonitoring Data for the Rum River behind Anoka High School - Most Recent Five Years

Year	2014	2015	2016	2017	2018	Mean
Season	Spring	Spring	Spring	Spring	Spring	1998-2018 Anoka Co.
FBI	5.90	6.90	6.90	5.50	6.40	5.7
# Families	20	27	32	41	33	15.0
EPT	5	8	9	12	10	4.3
Date	20-May	11-May	17-May	15-May	14-May	
sampling by	AHS	AHS	AHS	AHS	AHS	
sampling method	MH	MH	MH	MH	MH	
Mean # individuals	350	767	3363	1439	1648	
# replicates	4	2	1	2	3	
Dominant Family	Siphlonuridae	Siphlonuridae	Siphlonuridae	Pelecypoda	Siphlonuridae	
% Dominant Family	33.4	69.3	74.9	26.6	48.1	
% Ephemeroptera	57.8	78.9	78.7	14.9	65.1	
% Trichoptera	0.1	1.4	0	0.1	0.1	
% Plecoptera	0.5	0	0.4	26	1.9	
% EPT	58.4	80.3	79.1	41	67.1	

Discussion

Both chemical and biological monitoring indicate the good quality of this river. Habitat is ideal for a variety of stream life, and includes a variety of substrates, plenty of woody snags, riffles, and pools. Water chemistry monitoring done at various locations on the Rum River throughout Anoka County found that water quality is also good. Both habitat and water quality decline, but are still good, in the downstream reaches of the Rum River where development is more intense and the Anoka Dam creates a slow moving pool.

Historically, biomonitoring near Anoka was conducted mostly in a backwater area that, during periods of low water level, has a mucky bottom and does not receive good flow. During those conditions the area was unlikely to be occupied by families which are pollution intolerant. Recent monitoring has included sampling the main channel during an extremely low water level condition, followed by multiple years of very high water levels. The main channel and higher water levels offer opportunities for a more diverse habitat. These changes in sampling likely explain the apparent improvement in the invertebrate community in recent years.

Wetland Hydrology

Partners: LRRWMO, ACD

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.

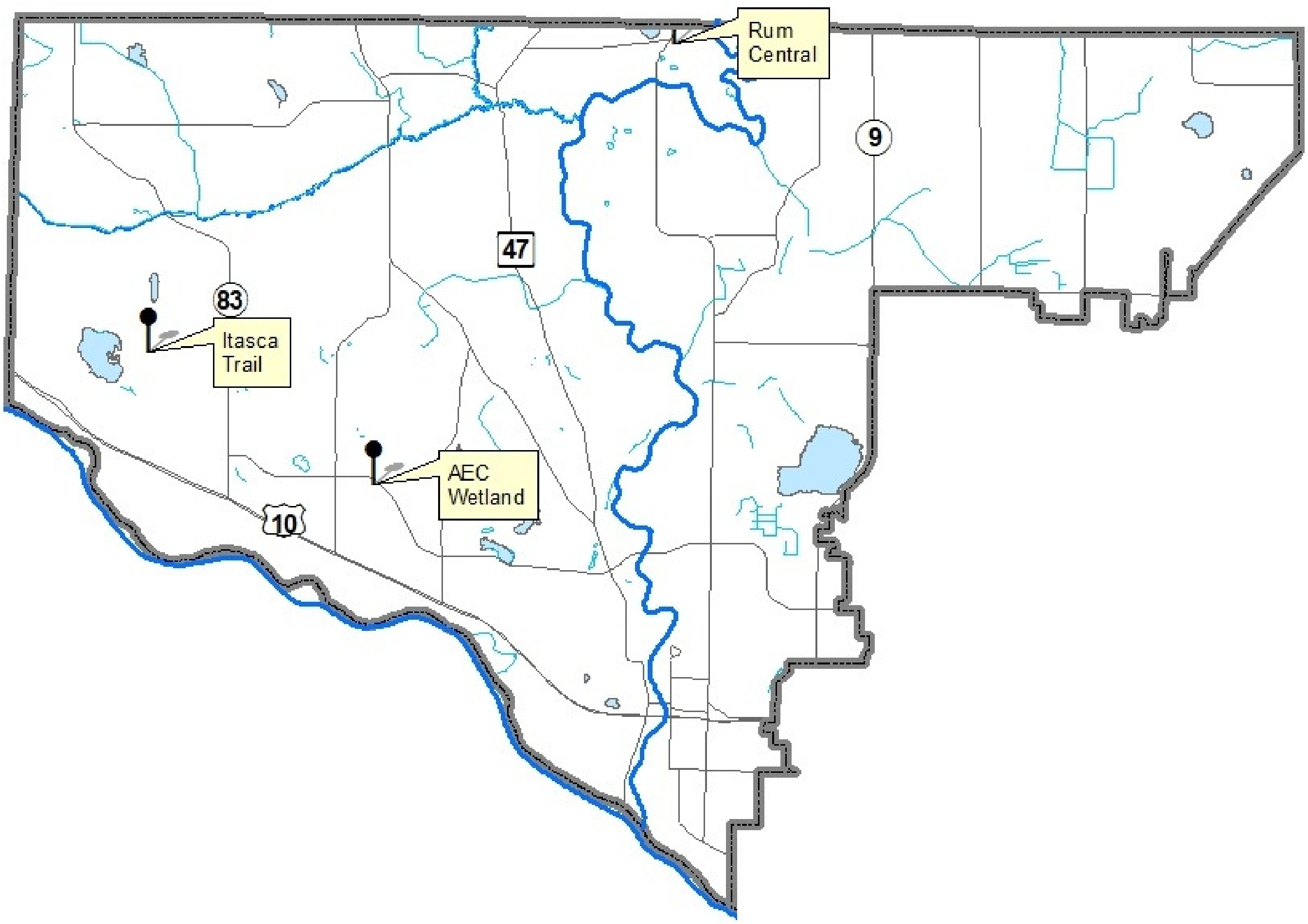
Locations: AEC Reference Wetland, Connexus Energy Property on Bunker Lake Blvd, Ramsey

Rum River Central Reference Wetland, Rum River Central Park, Ramsey

Lake Itasca Trail Reference Wetland, Lake Itasca Park, Ramsey

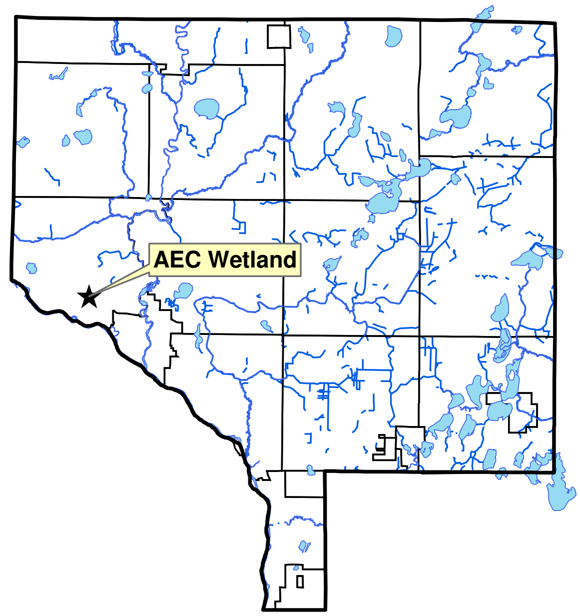
Results: Depicted on the following pages.

Lower Rum River Watershed Wetland Hydrology Monitoring Sites



AEC Reference Wetland

Cottonwood Park, adjacent to Connexus Energy Offices (formerly Anoka Electric Coop), Ramsey



Site Information

Monitored Since: 1999

Wetland Type: 3

Wetland Size: ~18 acres

Isolated Basin? No, probably receives storm water

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A	0-15	10yr2/1	Sandy Loam	-
Bw	15-40	10yr3/2	Gravelly Sandy loam	-

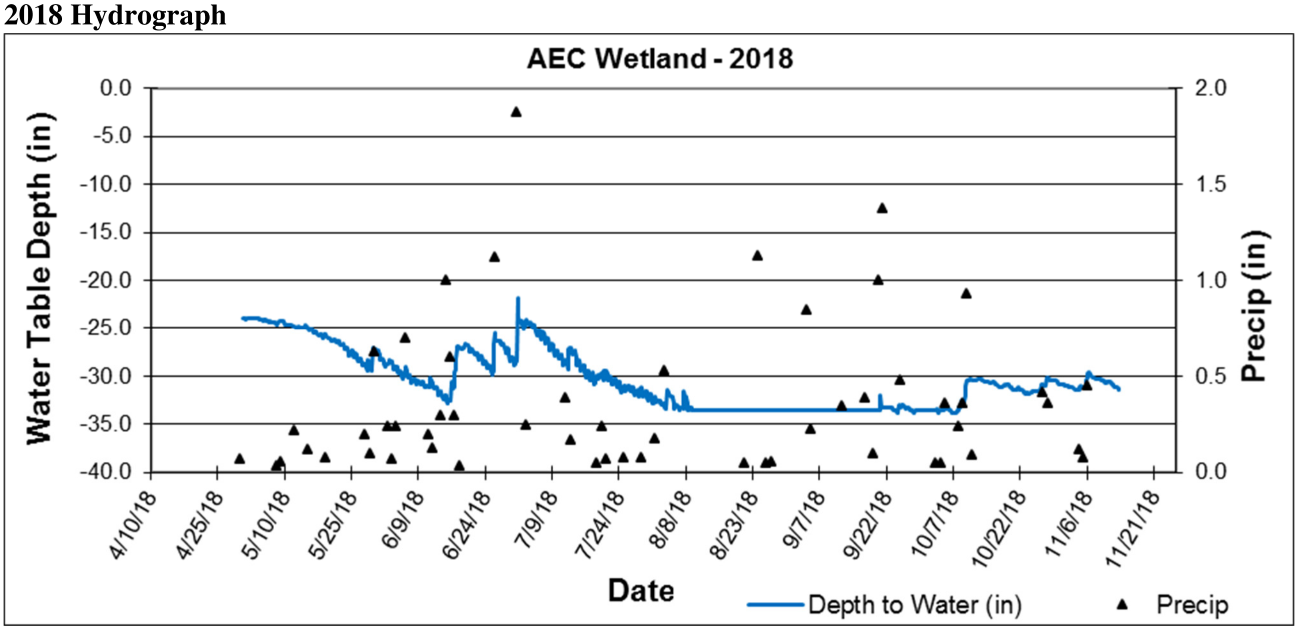
Surrounding Soils: Hubbard coarse sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Populus tremuloides	Quaking Aspen	30
Salix bebbiana	Bebb Willow	30
Carex Spp	Sedge undiff.	30
Solidago canadensis	Canada Goldenrod	20

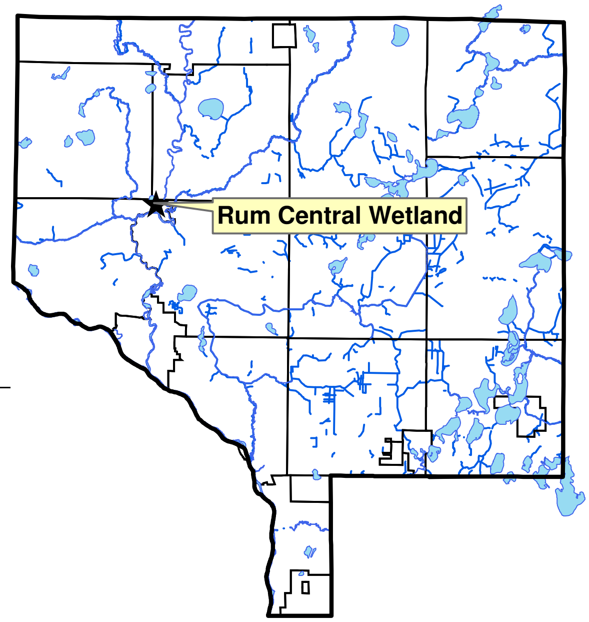
Other Notes: Well is located at the wetland boundary.

2018 Hydrograph



Rum River Central Reference Wetland

Rum River Central Regional Park, Ramsey



Site Information

Monitored Since: 1997

Wetland Type: 6

Wetland Size: ~0.8 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A	0-12	10yr2/1	Sandy Loam	-
Bg1	12-26	10ry5/6	Sandy Loam	-
Bg2	26-40	10yr5/2	Loamy Sand	-

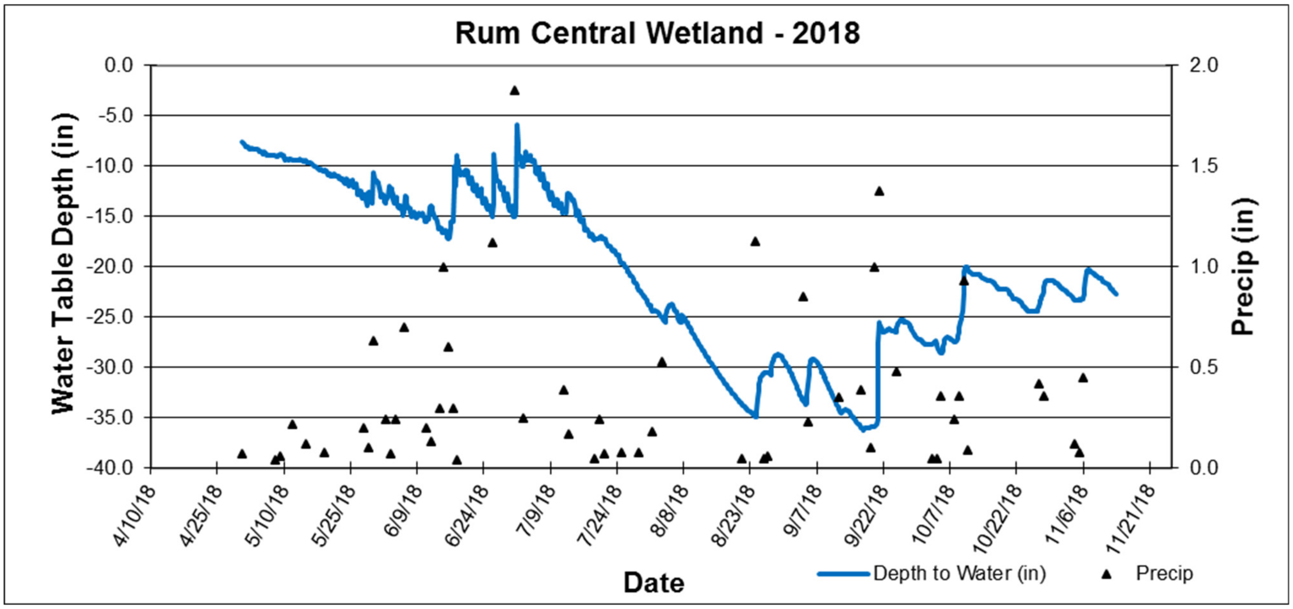
Surrounding Soils: Zimmerman fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	40
Corylus americanum	American Hazelnut	40
Onoclea sensibilis	Sensitive Fern	30
Rubus strigosus	Raspberry	30
Quercus rubra	Red Oak	20

Other Notes: Well is located at the wetland boundary.

2018 Hydrograph



Lake Itasca Trails Reference Wetland

Lake Itasca Trails Park, Ramsey

Site Information

Monitored Since: 2013

Wetland Type: 2/6

Wetland Size: ~10 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A1	0-12	10yr2/0	Mucky sand	-
A2	12-20	10ry2/1	Sand	-
B1	20-36	10yr4/1	Sand and fine gravel	-
B2	36-48	10yr6/1	Sand and fine gravel	-

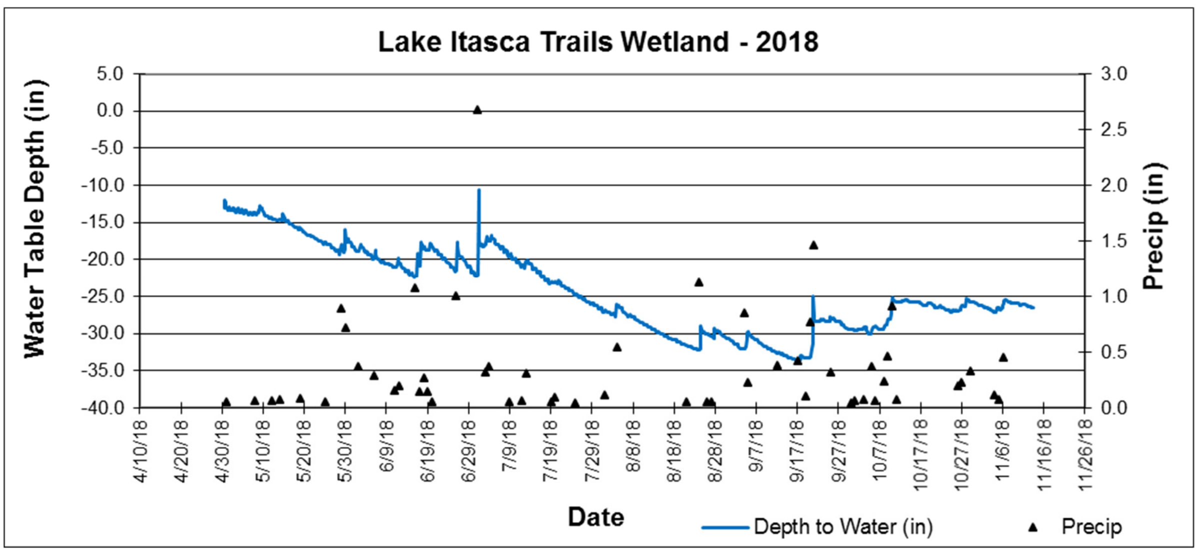
Surrounding Soils: Hubbard coarse sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Carex stricta	Hummock Sedge	80
Phalaris arundinacea	Reed Canary Grass	20
Salix sp.	Willow	20
Rubus sp.	Bristle-berry	5

Other Notes: Well is located about 10 feet east and about 6 inches downslope of the wetland boundary. DNR Public Water Wetland 2-339.

2018 Hydrograph



Water Quality Grant Fund

Partners: LRRWMO, ACD

Description: The LRRWMO provides cost share grants for projects on either public or private property that will improve water quality, such as repairing streambank erosion, restoring native shoreline vegetation, or rain gardens. This funding is administered by the Anoka Conservation District. Projects affecting the Rum River are given the priority because it is viewed as an especially valuable resource.

Purpose: To improve water quality in lakes, streams and rivers by correcting erosion problems and providing buffers or other structures that filter runoff before it reaches the water bodies.

Results: Projects reported in the year they are installed.

LRRWMO Cost Share Fund Summary

2006 LRRWMO Contribution	+	$1,000.00
2008 Expense – Herrala Rum Riverbank stabilization	-	$ 150.91
2008 Expense – Rusin Rum Riverbank stabilization	-	$ 225.46
2009 LRRWMO Contribution	+	$1,000.00
2009 Expense – Rusin Rum Riverbank bluff stabilization	-	$ 52.05
2010 LRRWMO Contribution	+	$ 0
2010 LRRWMO Expenses	-	$ 0
2011 LRRWMO Contribution	+	$ 0
2011 Expense - Blackburn Rum riverbank	-	$ 543.46
2012 LRRWMO Contribution	+	$1,000.00
2012 Expense – Smith Rum Riverbank	-	$1,596.92
2013 LRRWMO Contribution	+	$1,000.00
2013 Expense – Geldacker Mississippi Riverbank	-	$1,431.20
2014 LRRWMO Contribution	+	$2,050.00
2015 LRRWMO Contribution	+	$1,000.00
2015 Expense – Smith Rum Riverbank	-	$ 533.65
2016 LRRWMO Contribution	+	$1,000.00
2016 Expense – Brauer Rum Riverbank	-	$1,150.00
2018 LRRWMO Contribution	+	$1,000.00
2018 Expense – Rum River Revetments	--	$2,000.00
Fund Balance		**$3,366.35**

Rum River Bank Stabilizations

Partners: LRRWMO, URRWMO, ACD, MN DNR Conservation Partners Legacy Grant Program, Lessard-Sams Outdoor Heritage Council grant, landowners

Description: 12 riverbank stabilization projects were installed on the Rum River in Anoka and Isanti Counties in 2018. At these sites, cedar tree revetments and willow stakes were used to stabilize eroding banks. The projects were installed with labor from Conservation Corps Minnesota (CCM) work crews. Funding for the 4 revetments installed in Anoka County came from the Conservation Partners Legacy Grant Program from the Outdoor Heritage Fund, a Clean Water Fund CCM crew labor grant, the URRWMO and LRRWMO, and landowner contributions. Funding for 4 additional revetments in Isanti County came from the Lessard-Sams Outdoor Heritage Council, a Clean Water Fund CCM crew labor grant and landowner contribution.

Purpose: To stabilize areas of riverbank with mild to moderate erosion, in order to reduce sediment loading in the Rum River, as well as to reduce the likelihood of a much larger and more expensive corrective project in the future.

Location: Rum River Central Regional Park, 8 residential properties in Anoka County, City of Isanti, and 2 residential properties in Isanti County.

Results: Stabilized 2,223 linear feet of riverbank on the Rum River in Anoka and Isanti Counties.

Rum River Bank Erosion Inventory

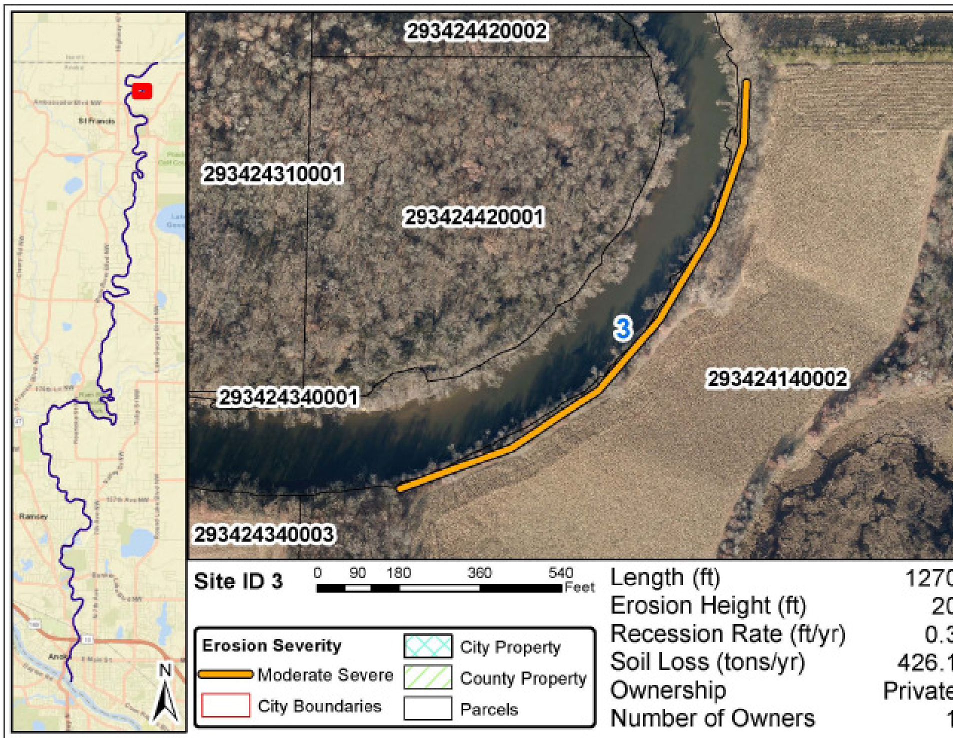
Partners: ACD

Description: The Anoka Conservation District (ACD) prepared an inventory of Rum River bank erosion using 360° photos of the riverbanks of the Rum throughout Anoka County. The photos are available through Google Maps using the Street View feature. An inventory report identifying 80 stretches of riverbank with moderate to very severe erosion is available on ACD's website. Estimated project cost and annual sediment load reduction to the river were calculated.

Purpose: To identify and prioritize riverbank stabilization sites and be used by ACD and other entities to pursue grant funds to restore or stabilize eroding stretches of Rum Riverbank.

Location: Rum River conveyance throughout Anoka County

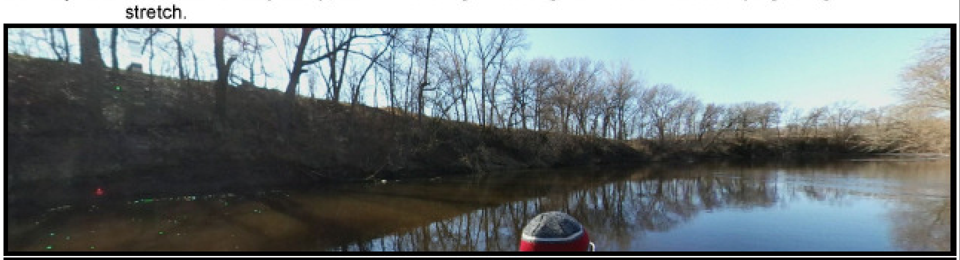
Results: Inventory of 80 stretches of moderate to very severe erosion on banks of the Rum River.

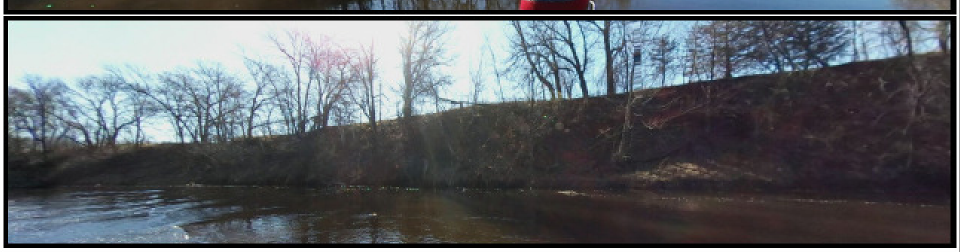


Length (ft)	1270
Erosion Height (ft)	20
Recession Rate (ft/yr)	0.3
Soil Loss (tons/yr)	426.1
Ownership	Private
Number of Owners	1

Potential Stabilization Approach: Hard Armoring

Description: Most of bank very steep, but maintaining some vegetation. Periodic slumping along stretch.





Anoka Rain Gardens

Partners: LRRWMO, ACD, grant from Metropolitan Council

Description: In 2015 and 2016 a stormwater retrofit analysis (SRA) was done on selected areas in the Cities of Ramsey and Anoka. Many potential projects were modeled and a cost-benefit analyses performed. Subsequently, in 2017 and 2018 cost-effective projects were installed. In 2017 two rain gardens were installed in Anoka. In 2018 one more rain garden was installed. This rain garden is the first in Anoka County to utilize Focal Point technology. Focal Point uses a special media to rapidly filter large amounts of stormwater in a small project footprint. It was used in 2018 due to a higher water table and trees limiting available space at an otherwise ideal project location. Funding was from Clean Water Funds through the Anoka Conservation District (ACD) and a Metropolitan Council Grant to the Lower Rum River WMO. ACD managed the project.

Purpose: To improve water quality in the Rum and Mississippi Rivers.

Location: Selected areas in the Cities of Ramsey and Anoka.

Results: Two rain gardens were installed in 2017 and one more was installed in 2018. The 2018 project is shown below.

Pre-project

Completed project without plants
(to be planted in spring 2019)

Newsletter Articles

Partners: LRRWMO, ACD

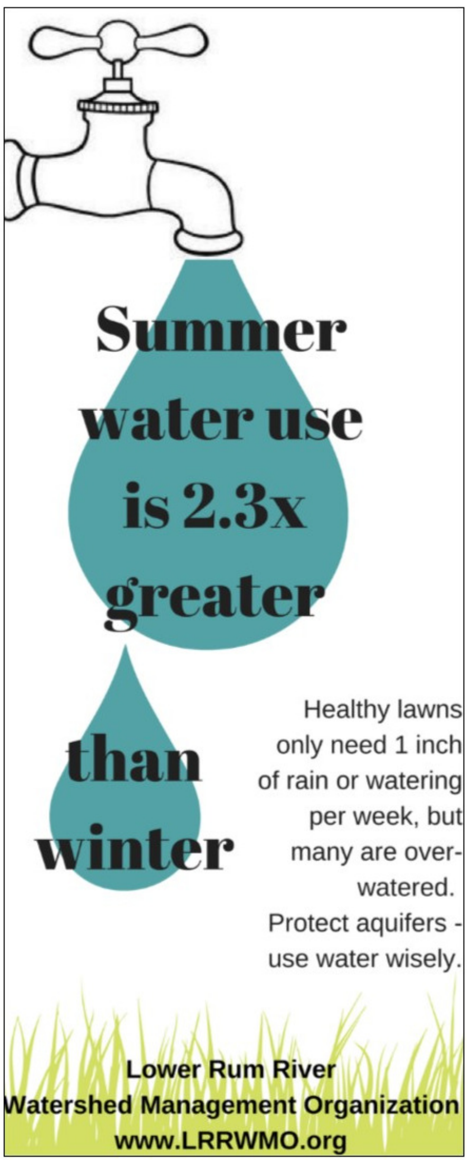
Description: The Lower Rum River Watershed Management Organization (LRRWMO) contracts the Anoka Conservation District (ACD) to create public education materials. The LRRWMO is required to distribute an annual publication under State Rules. This requirement is met through newsletters or infographics in city newsletters. This method ensures wide distribution at minimal cost.

Purpose: To improve public understanding of the LRRWMO, its functions, and accomplishments.

Location: Watershed-wide

Results: In 2018, the Anoka Conservation District (ACD) drafted three newsletter infographics and sent them to cities for inclusion in their newsletters. Two of the 2018 infographics focus on reducing water wasted during lawn irrigation. The third focuses on keeping curbside gutters clean as they are conveyances to rivers and lakes.

2018 Newsletter Infographics



LRRWMO Website

Description: The Lower Rum River Watershed Management Organization (LRRWMO) contracts the Anoka Conservation District (ACD) to design and maintain a website about the LRRWMO and the Lower Rum River watershed. The website has been in operation since 2003.

Purpose: To increase awareness of the LRRWMO and its programs. The website also provides tools and information that helps users better understand water resources issues in the area.

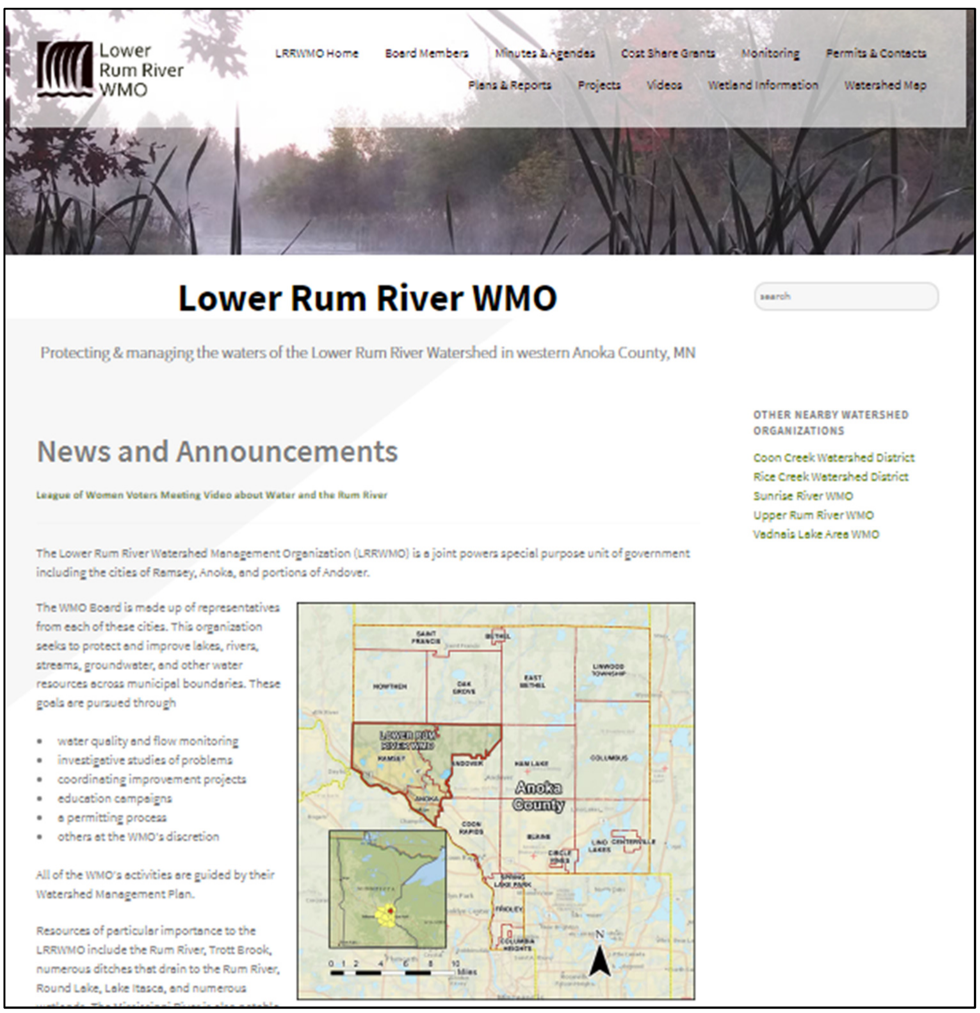
Location: LRRWMO.org

Results: In 2018 a new LRRWMO website was developed. The previous website was >10 years old and there were problems with website security. The Anoka Conservation District developed a template website and finalized it with URRWMO Board input. The new website includes:

- Directory of board members,
- Meeting minutes and agendas,
- Watershed management plan and annual reports,
- Descriptions of work that the organization is directing,
- Highlighted projects,
- Informational videos,
- Maps of the URRWMO.

The website is regularly updated throughout the year.

LRRWMO Website Homepage



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.

Lower Rum River Watershed Financial Summary

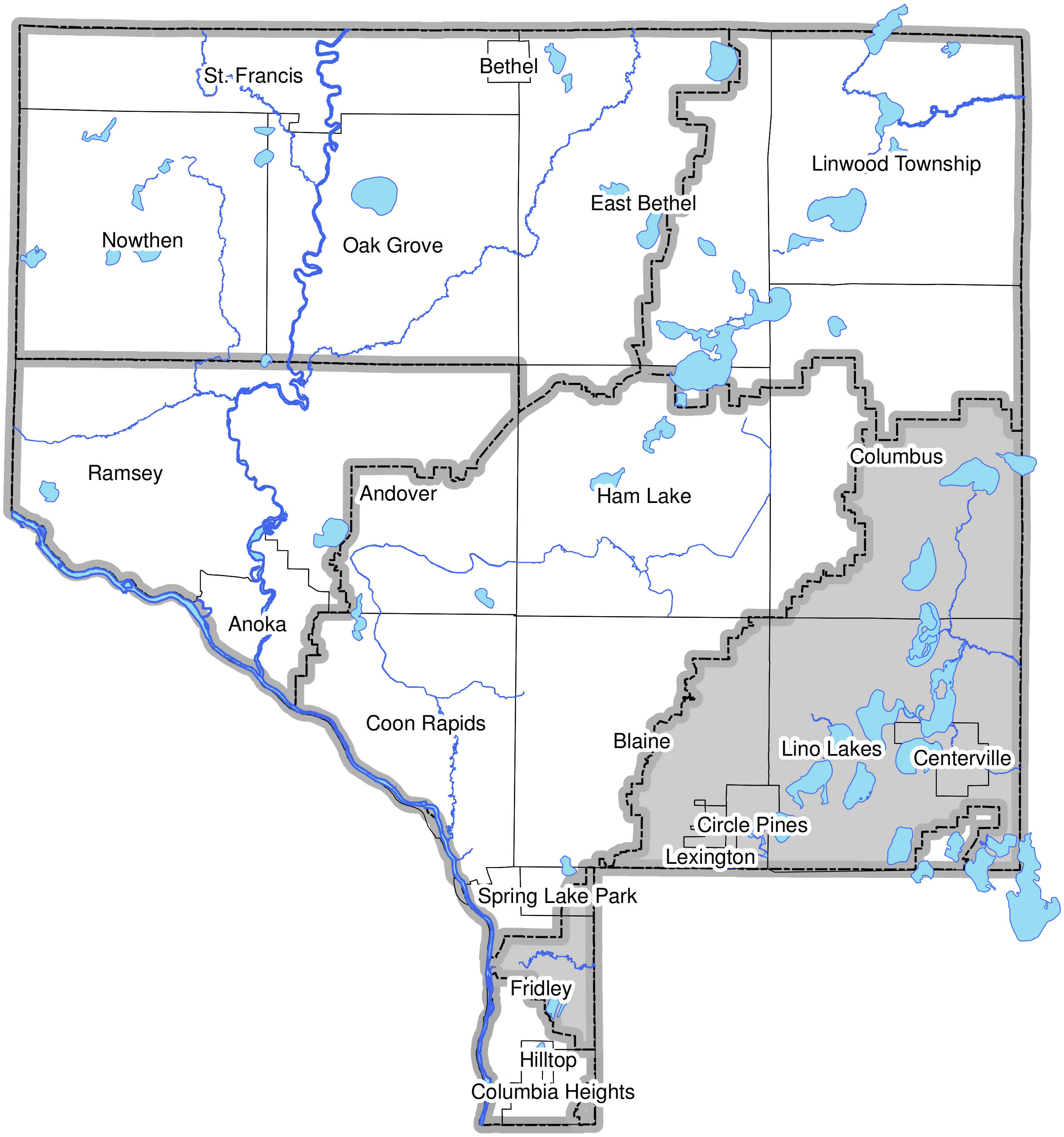
		Monitoring & Inventory									Planning & Land Protection					Technical Assistance						Resource Improvement Projects						Administrative Assistance			Outreach					
Lower Rum River Watershed	Total	Volunteer Precip	DNR Groundwater Wells	Wetland Levels	Lake Levels	Lake Water Quality	Stream Water Quality	Biomonitoring	Inventory - Rum River Erosion	Water Resources Almanac	Anoka Sandplain Partnership	1W1P Rum River	Wetland Resto Opportunities	Land Prot/Resto Strategies	Land Protection Outreach	Landowner Tech. Asst.	Project Profiles	BMP Maintenance & Inspection	WCA Enforcement	Wetland Consultation	Wetland Restoration and Banking	Anoka Nat. Pres. Restoration	Cooperative Weed Management	Rum River Revets	Rum River Stabilization Site 4	LRRWMO Retrofits	Mississippi River Park Stabilization	LRRWMO Admin/Reporting/Website	WCA Implementation	Watershed Based Funding Coordination	Video Development	Brochures & Displays	Web Blog	Web Story Map	LRRWMO Educ/Newsletter	Anoka County Outreach Program
Revenues																																				
LRRWMO	30345			1950	1200	1800	1365	900																		18135		3875							1120	
State - Other	11066		70																				1845						9152							
MPCA																																				
DNR OHF	6462																							6462												
DNR CPL																																				
BWSR - Service Grant	19958										1049		1064	375		955	300	651							12412					2190	311	591	58			
BWSR - Project Grant	24472																								22214											2258
Metro ETA & NPEAP	22212															84									13648	8480										
Regional/Local	29273					92																		23075			6106									
Anoka Conservationi District	12533								95	746	152	736		26	111	983		50	337	2927	250	879	9					1515	3369	6		60	14	183		87
County Ag Preserves/Projects	21200					269		633																	20297											
Service Fees	4866														362								219	4263					22							
TOTAL	182387		70	1950	1200	2162	1365	1533	95	746	1201	736	1064	401	473	2021	300	701	337	2927	250	879	2073	33801	68571	26614	6106	5390	12542	2196	311	651	73	183	1120	2344
Expenses-																																				
Personnel Salaries/Benefits	83879	122	152	1155	779	1660	350	1271	96	1026	1009	728	899	347	400	1765	269	562	298	2442	218	818	1534	21537	11967	9163	5930	3927	8249	1859	73	507	55	167	914	1631
Overhead	9750	16	20	133	89	199	41	166	8	137	141	67	135	41	59	208	35	70	39	338	31	85	171	2447	1444	1026	534	471	921	276	11	74	5	19	147	144
Vehicle/Mileage	1570	2	2	29	19	39	7	22	2	8	8	14	5	4	3	37	2	11	6	33	2	16	33	433	192	215	107	90	162	22	1	7	1	2	2	30
Project Direct - Supplies	11439	1		20	2	376	182								9			50		50			350	2414	1850	1547		840	3388	6	224	60	11			58
Project Direct - Capital	101					78	23																													
Project Direct - Installation	73131																							5809	52591	14731										
TOTAL	179870	142	174	1338	889	2353	604	1459	106	1171	1159	808	1039	392	470	2011	307	693	342	2864	250	919	2088	32640	68044	26682	6571	5329	12720	2163	310	647	73	188	1063	1863

Recommendations

- **Continue to install projects identified in the stormwater retrofitting studies for the Cities of Anoka and Ramsey.** Projects have been identified and ranked that would improve stormwater runoff before it is discharged to the Rum or Mississippi River. Metropolitan Council grant funds were used to construct three projects in 217-2018. Additional cost-effective projects exist, however landowner willingness and buried utilities are obstacles in many areas.
- **Engage with upstream entities creating a collaborative Rum River One Watershed, One Plan** (1W1P). As the receiving entity at the bottom of the watershed for all water flowing downstream, it is especially important to collaborate on, and prioritize, projects on a watershed scale to ensure the greatest overall benefit to the river. 1W1P planning happens in 2019-2020.
- **Implement the MPCA Rum River WRAPP (Watershed Restoration and Protection Plan).** This WRAPP was an assessment of the entire Rum River watershed. It outlines regional priorities and management strategies, and attempts to coordinate them across jurisdictions. It should be especially useful as the Lower Rum River WMO updates its 10-year watershed management plan beginning in 2019.
- **Maintain or reduce Rum River phosphorus.** Phosphorus levels are close to State water quality standards. It may be appropriate to review development and stormwater discharge ordinances to ensure phosphorus does not increase in coming years.
- **Implement groundwater conservation measures** throughout the watershed and promote them metro-wide. Depletion of shallow groundwater is a concern region-wide.
- **Continue surveillance water monitoring** at a frequency sufficient to detect changes and trends.
- **Consider chloride sampling at all sites on a rotating basis.** Chloride sampling has not been done in recent years. Conductivity levels are rising in the entire county, and this may be due to chlorides.
- **Consider supporting a Rum riverbank stabilization grant application** that the Anoka Conservation District and Anoka County are considering pursuing from the Lessard-Sams Outdoor Heritage Council.
- **Use the photo inventory of Rum Riverbanks collected by the ACD to identify stabilization projects.** Photos are viewed using the "StreetView" function in GoogleMaps.

2018 Anoka Water Almanac

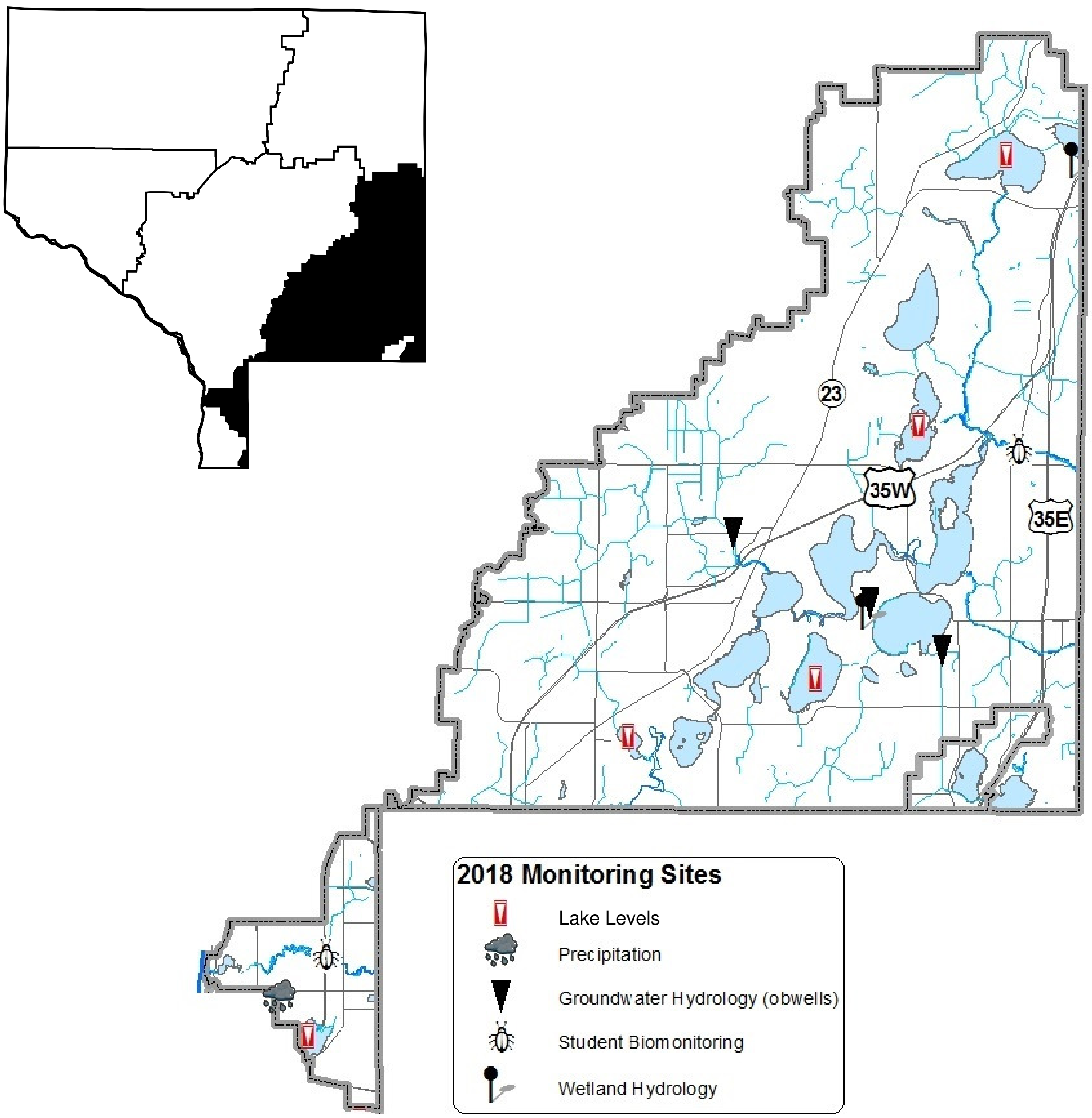
Chapter 5: Rice Creek Watershed



Prepared by the Anoka Conservation District

Rice Creek Watershed

Table of Contents



Lake Levels

Partners: RCWD, ACD, volunteers

Description: Weekly water level monitoring in lakes. Graphs for the past five years as well as historical data from the last 25 years are shown below. All data are available on the Minnesota DNR website using the “LakeFinder” feature (www.dnr.mn.us.state\lakefind\index.html).

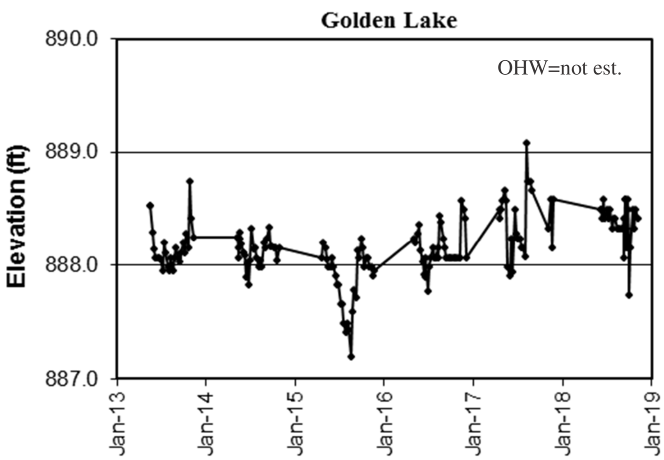
Purpose: To understand lake hydrology, including the impact of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

Locations: Golden Lake, Howard Lake, Moore Lake, Reshanau Lake, and Rondeau Lake

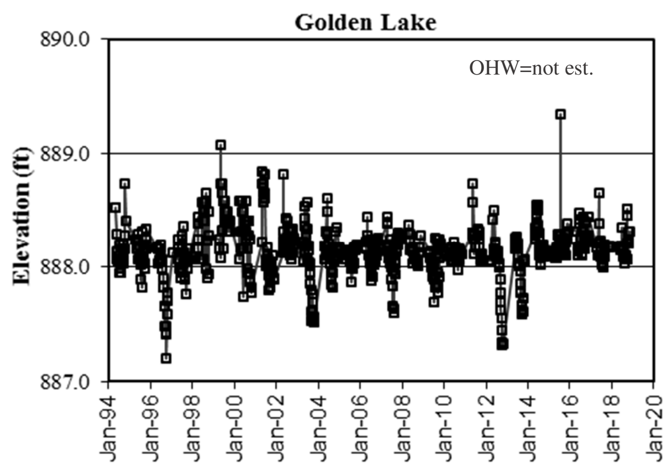
Results: Lake levels were measured by volunteers throughout the 2018 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. Lakes typically followed the expected pattern of increasing water levels through spring and early summer, followed by a decline through late summer and early fall. Overall, lake levels averaged at or slightly above long term averages in 2018.

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.

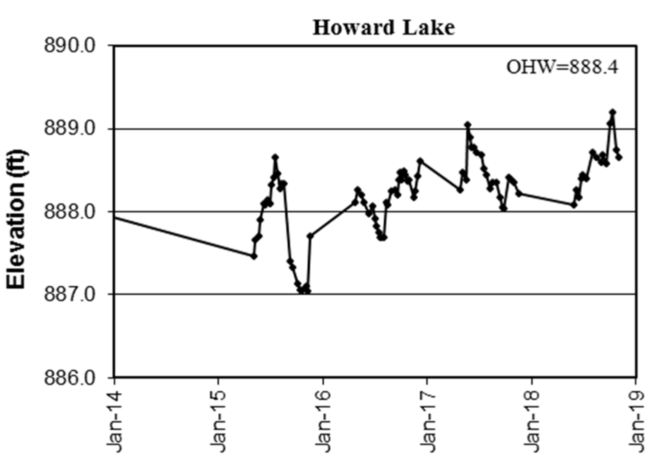
Golden Lake Levels- Last 5 Years



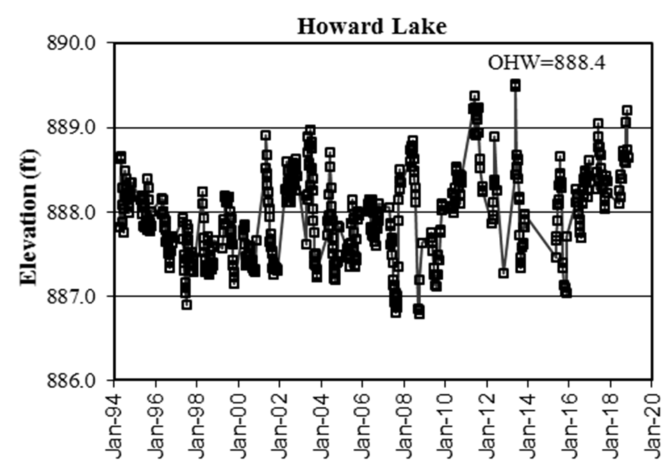
Golden Lake Levels- Last 25 Years



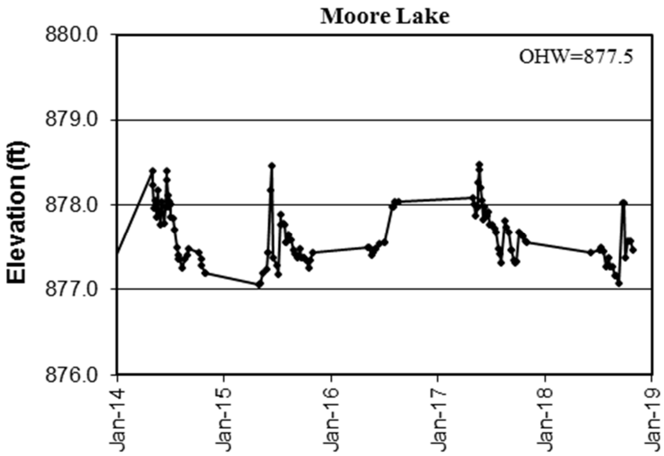
Howard Lake Levels- Last 25 Years



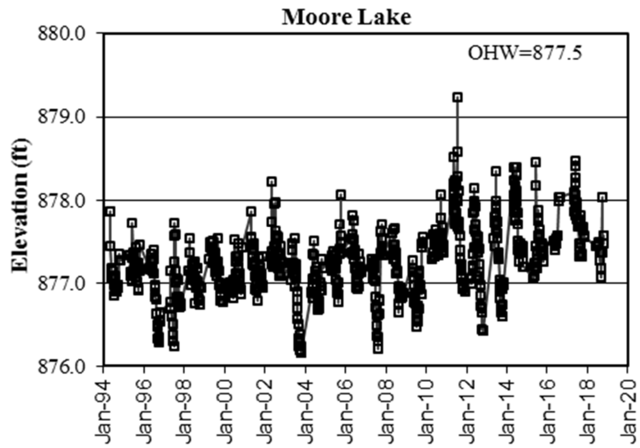
Howard Lake Levels- Last 5 Years



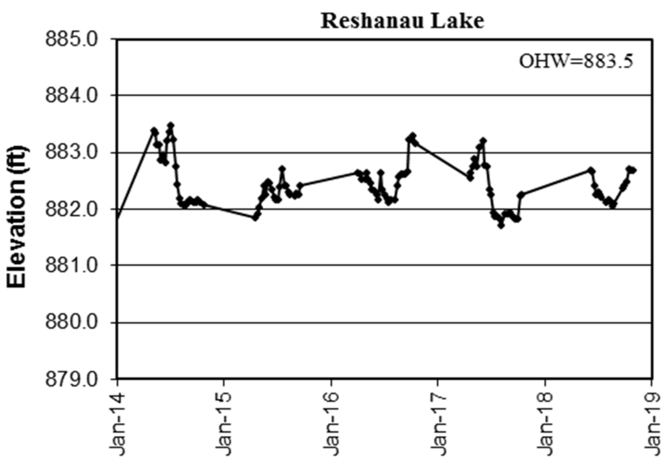
Moore Lake Levels- Last 5 Years



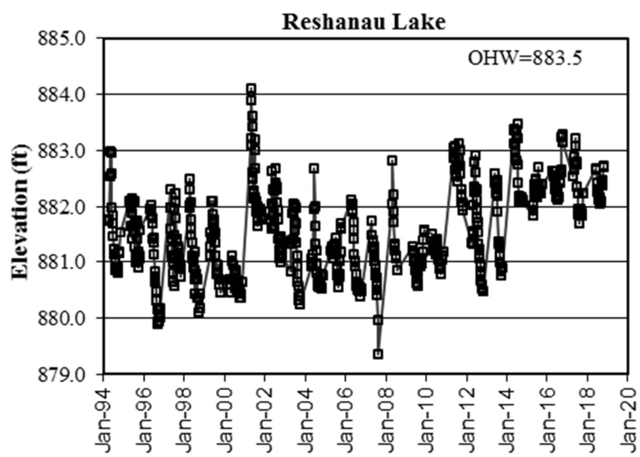
Moore Lake Levels- Last 25 Years



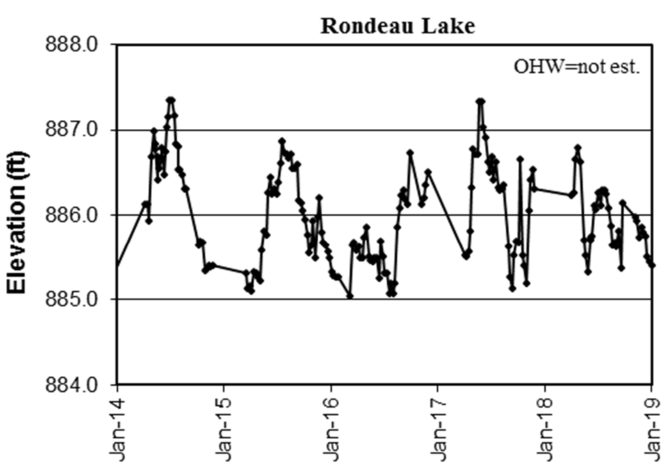
Reshanau Lake Levels- Last 5 Years



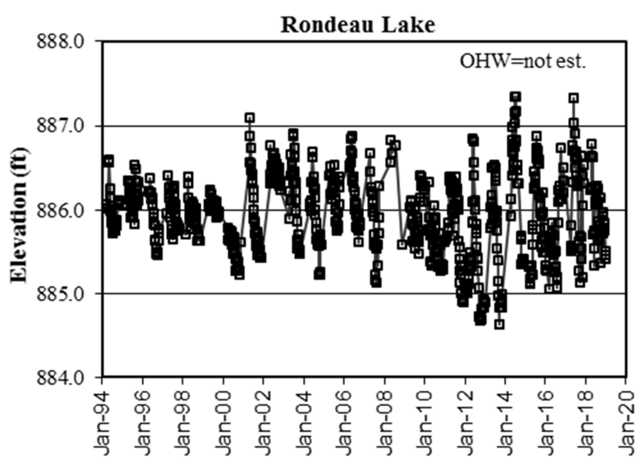
Reshanau Lake Levels- Last 25 Years



Rondeau Lake Levels- Last 5 Years



Rondeau Lake Levels- Last 25 Years



Wetland Hydrology

Partners: RCWD, ACD

Description: Continuous groundwater level monitoring at a wetland boundary, to a depth of 40 inches. County-wide, the ACD maintains a network of 23 wetland hydrology monitoring stations.

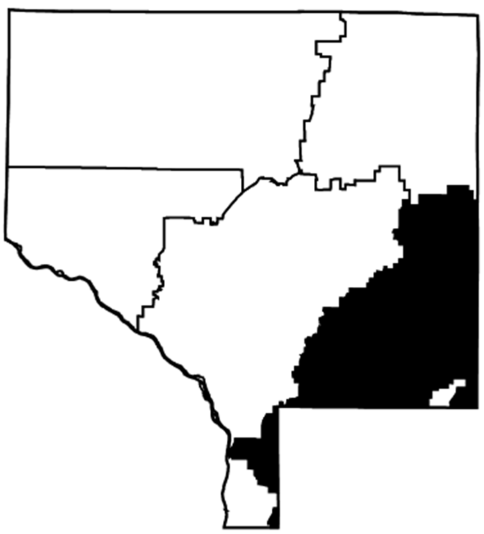
Purpose: To provide an understanding of wetland hydrology, including the impact of climate and land use. These data aid in delineation of nearby wetlands by documenting hydrologic trends including the timing, frequency, and duration of saturation.

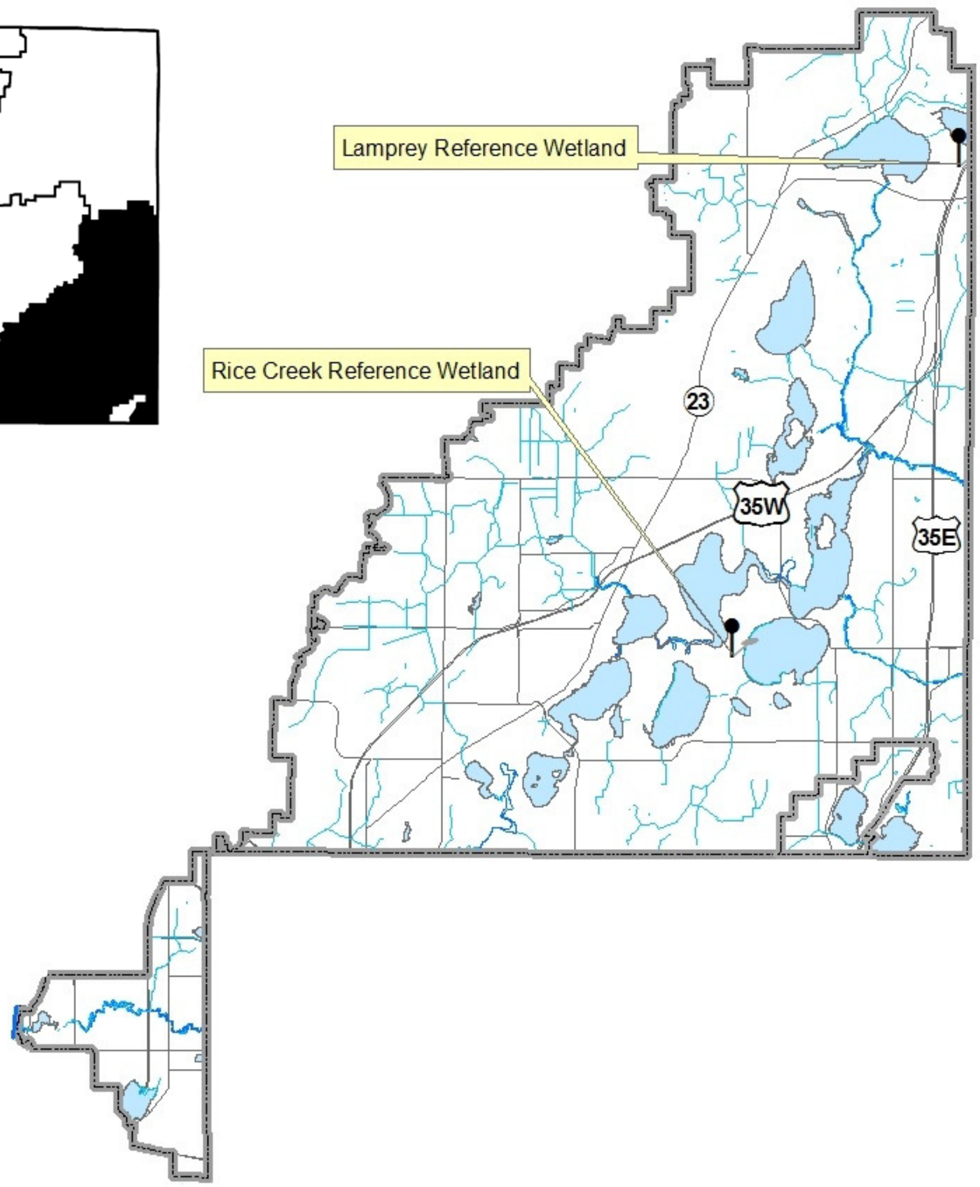
Locations: Lamprey Reference Wetland, Lamprey Pass Wildlife Management Area, Columbus

Rice Creek Reference Wetland, Rice Creek Chain of Lakes Regional Park Reserve

Results: See the following pages.

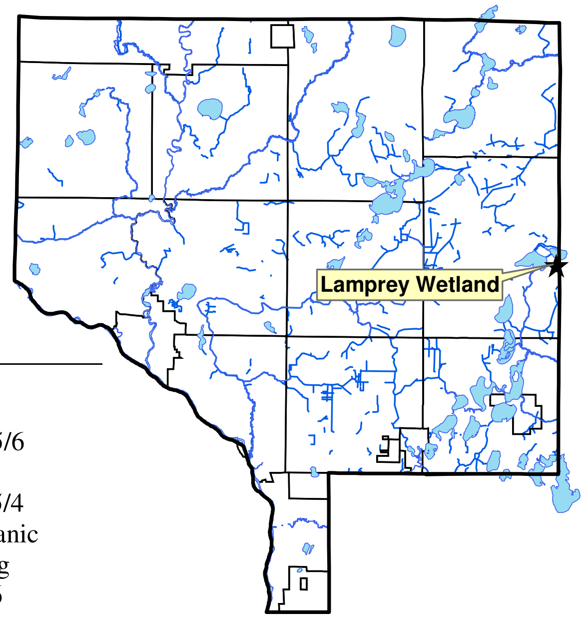
Rice Creek Watershed Wetland Hydrology Monitoring Sites





LAMPREY REFERENCE WETLAND

Lamprey Pass Wildlife Mgmt Area, Columbus



Site Information

Monitored Since: 1999

Wetland Type: 4

Wetland Size: ~0.5 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A	0-9	10yr 2/1	Fine Sandy Loam	-
AB	9-19	10yr 2/1	Fine Sandy Loam	2% 10yr 5/6
Bw	19-35	10ry 3/1	Loam	2% 10ty 5/4
2C1	35-42	5y 5/2	Clay Laom	5y 3/1 Organic Streaking
2C2	42-48	2.5y 5/1	Sandy Loam	2.5y 5/6

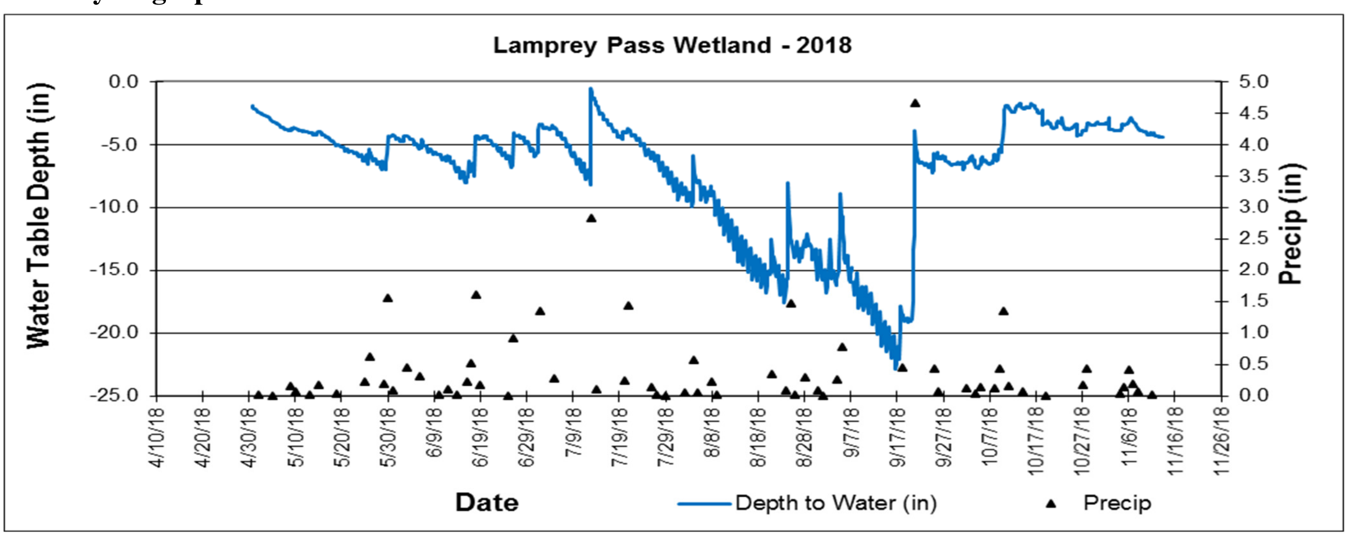
Surrounding Soils: Braham loamy fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Carex pennsylvanica	Pennsylvania Sedge	50
Cornus stolonifera (S)	Red-osier Dogwood	20
Fraxinus pennslyvanicum (T)	Green Ash	40
Xanthoxylum americanum	Pricly Ash	20
Bare Ground		20

Other Notes: Wetland is about 200 feet west of Interstate Highway 35, but within a state wildlife management area. Well is located at the wetland boundary.

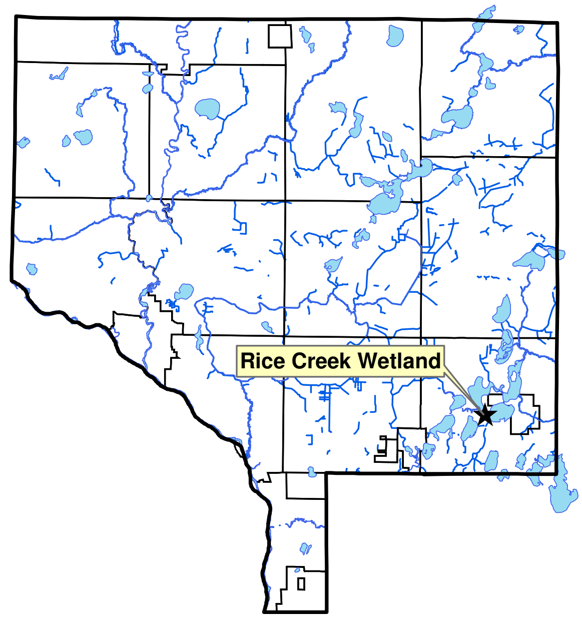
2018 Hydrograph



RICE CREEK REFERENCE WETLAND

Rice Creek Chain of Lakes Regional Park, Lino Lakes

Site Information



Monitored Since: 1996

Wetland Type: 7

Wetland Size: ~0.5 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A	0-12	10yr 3/1	Sandy Loam	-
Ab	12-16	10yr 2/1	Sandy Loam	-
Bg1	16-21	10yr4/1	Sandy Loam	-
Bg2	21-35	10yr5/2	Sandy Loam	5% 10yr 5/6
2Cg	35-42	2.5y 5/2	Silt Loam	5% 10yr 5/6

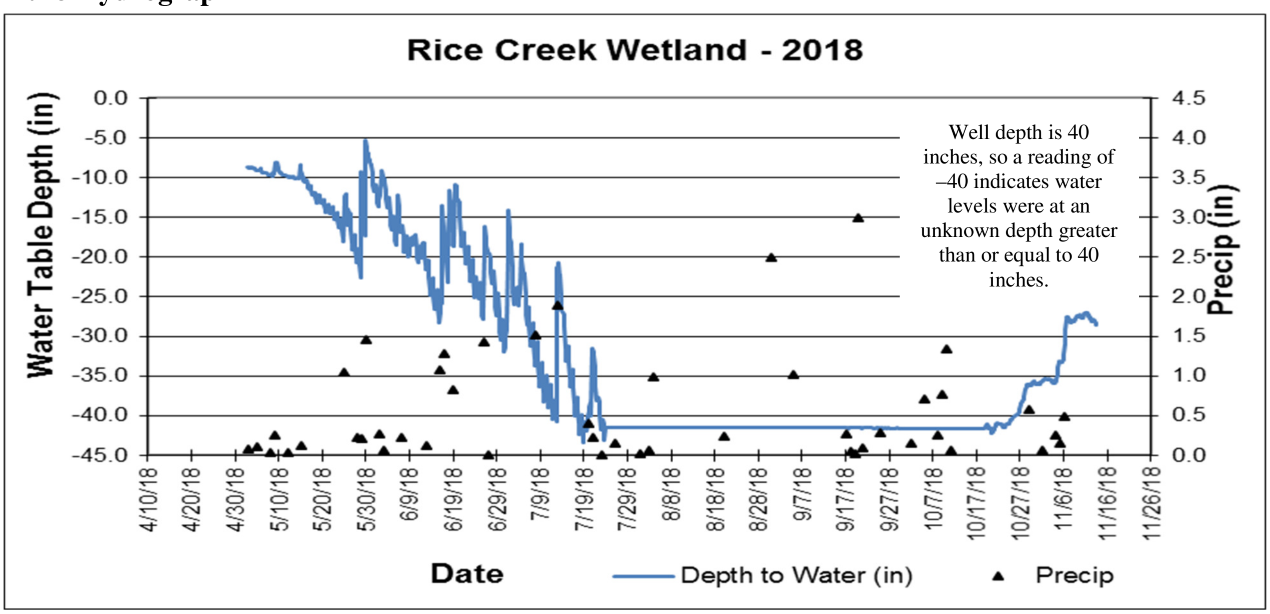
Surrounding Soils: Nessel fine sandy loam and Blomford loamy fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Rubus strigosus	Raspberry	30
Onoclea sensibilis	Sensitive Fern	20
Fraxinus pennsylvanica	Green Ash	40
Amphicarpa bracteata	Hog Peanut	20

Other Notes: This is an intermittent, forested wetland within the regional park between Centerville and George Watch Lakes. It is about 900 feet from George Watch Lake and 800 feet from Centerville Lake. Well is at wetland boundary.

2018 Hydrograph



Stream Water Quality – Biological Monitoring

Description: This program combines environmental education and stream monitoring. Under the supervision of the ACD staff, high school science classes collect aquatic macroinvertebrates from a stream, identify their catch to the family level, and use the resulting numbers to gauge water and habitat quality. These methods are based upon the knowledge that different families of macroinvertebrates have different water and habitat quality requirements. The families collectively known as EPT (Ephemeroptera, or mayflies; Plecoptera, or stoneflies; and Trichoptera, or caddisflies) are generally pollution intolerant. Other families can thrive in low quality water. Therefore, a census of stream macroinvertebrates yields information about stream health.

Purpose: To assess stream quality, both independently as well as by supplementing chemical data. To provide an environmental education service to the community.

Location: Rum River behind Anoka High School, south side of Bunker Lake Blvd, Anoka

Results: Results for each site are detailed on the following pages.

Tips for Data Interpretation

Consider all biological indices of water quality together rather than looking at each alone, because each gives only a partial picture of stream condition. Compare the numbers to county-wide averages. This gives some sense of what might be expected for streams in a similar landscape, but does not necessarily reflect what might be expected of a minimally impacted stream. Some key numbers to look for include:

Families — Number of invertebrate families. Higher values indicate better quality.

EPT — Number of families of the generally pollution-intolerant orders Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies). Higher numbers indicate better stream quality.

Family Biotic Index (FBI) — An index that utilizes known pollution tolerances for each family. Lower numbers indicate better stream quality.

FBI	Stream Quality Evaluation
0.00-3.75	Excellent
3.76-4.25	Very Good
4.26-5.00	Good
5.01-5.75	Fair
5.76-6.50	Fairly Poor
6.51-7.25	Poor
7.26-10.00	Very Poor

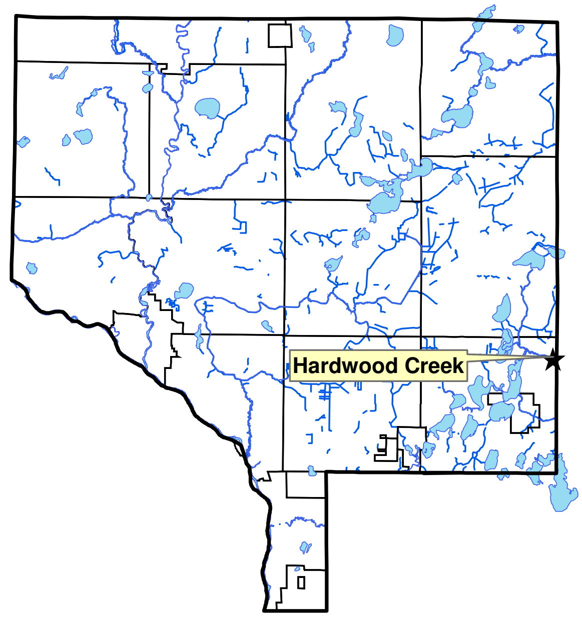
Population Attributes Metrics

% EPT: This measure compares the number of organisms in the EPT orders (Ephemeroptera - mayflies: Plecoptera - stoneflies: Trichoptera - caddisflies) to the total number of organisms in the sample. A high percent of EPT is good.

% Dominant Family: This measures the percentage of individuals in the sample that are in the sample's most abundant family. A high percentage is usually bad because it indicates low evenness (one or a few families dominate, and all others are rare).

HARDWOOD CREEK

see list of monitoring locations below



Last Monitored

By Forest Lake Area Learning Center in fall of 2018

Monitored Since

1999 to fall 2007 at Hwy 140
Fall 2007 at 165th Ave NW
2008 SW of intersection of 170th St and Fenway Ave
2009-2018 at Cecelia LaRoux property 600 m W of I-35

Student Involvement

6 students in 2018, approximately 276 since 2001

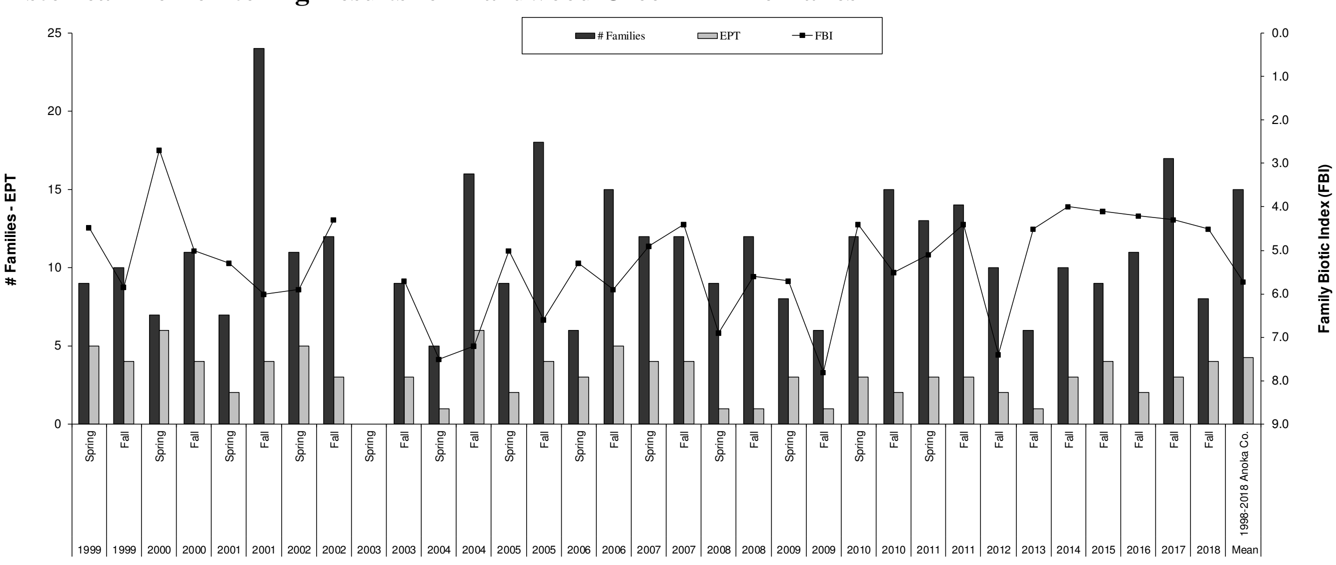
Background

Hardwood Creek originates in Washington County and flows west to Rice Creek and the Rice Creek Chain of Lakes. This is a small creek with a width at baseflow of approximately 10-15 feet and depth of approximately 6-12 inches. The surrounding land use is primarily agricultural, with some residential areas. The stream bottom is sand, gravel, and some cobble in some locations such as at Highway 140 where the creek was monitored until fall 2007. The current monitoring site was the subject of a stream restoration project in 2008. All other monitoring sites have had poor habitat.

Results

A Forest Lake Area Learning Center class monitored Hardwood Creek in the fall of 2018, facilitated by the Anoka Conservation District. This site was the subject of a stream restoration project that included rock veins, brush bundles and willow staking. A rather poor invertebrate community was observed 2018, but this was likely due to completely flooded conditions at the creek. Woodland floodplain areas adjacent to the creek were under 3 feet of standing water. Four of the sensitive EPT taxa were collected, but only a total of 38 individual invertebrates were collected. Gammarid amphipods are extremely numerous at this site and have been the dominant taxa most recent years.

Historical Biomonitoring Results for Hardwood Creek in Lino Lakes



Biomonitoring Data for Hardwood Creek in Lino Lakes- Previous Five Years

Year	2014	2015	2016	2017	2018	Mean	Mean
Season	Fall	Fall	Fall	Fall	Fall	Fall	1998-2018 Anoka Co.
FBI	4.0	4.1	4.2	4.3	4.5	4.5	5.7
# Families	10	9	11	17	8	8.0	15.0
EPT	3	4	2	3	4	4.0	4.3
Date	10-Oct-14	8-Oct-15	10-Oct-16	11-Oct-17	11-Oct-18		
Sampled By	FLALC	FLALC	FLALC	FLALC	FLALC		
Sampling Method	MH	MH	MH	MH	MH		
Mean # Individuals/Rep.	359	158	469	264	38		
# Replicates	1	1	1	1	11		
Dominant Family	Gammaridae	Gammaridae	Gammaridae	Gammaridae	Gammaridae		
% Dominant Family	97.2	62.7	91.7	79.5	65.8		
% Ephemeroptera	0.8	32.3	2.3	6.1	10.5		
% Trichoptera	0.3	0.6	0	0.4	5.3		
% Plecoptera	0.0	0.0	0.0	0.0	0.0		
% EPT	1.1	32.9	2.3	6.5	15.8		

Discussion

Hardwood Creek is on the Minnesota Pollution Control Agency's 303(d) list of impaired waters for impaired biota and dissolved oxygen. The Rice Creek Watershed District has conducted a TMDL investigative study. Our biological monitoring does indicate a below average biological community but lends only modest insight into what might be causing this impairment. Habitat seems to be an important factor. Biological indices of stream health have improved at the stream restoration site. High water conditions during sampling have also been a factor.

Three sites on this creek have been monitored and provided differing results. The earliest monitoring until 2007 was on the north side of Highway 140 (170th St, W crossing), where habitat was moderate to good and invertebrate communities indicated the best stream health. In spring 2008 it was monitored farther to the east on Highway 140 near Fenway Ave, and conditions were somewhat poorer. Since that time monitoring has been just north of Hwy 140, one third mile east of County Road 20 on the C. LaRoux Property, where conditions have been mid-range. Substantial variation among samplings is seen at all sites, but overall the invertebrate biota is indicative of substandard stream health.

FLALC students at Hardwood Creek from a previous year (left) and 2018 flooded conditions (right).

RICE CREEK

at Hwy 65, Locke Park, Fridley

Last Monitored

By Totino Grace High School in fall 2018

Monitored Since

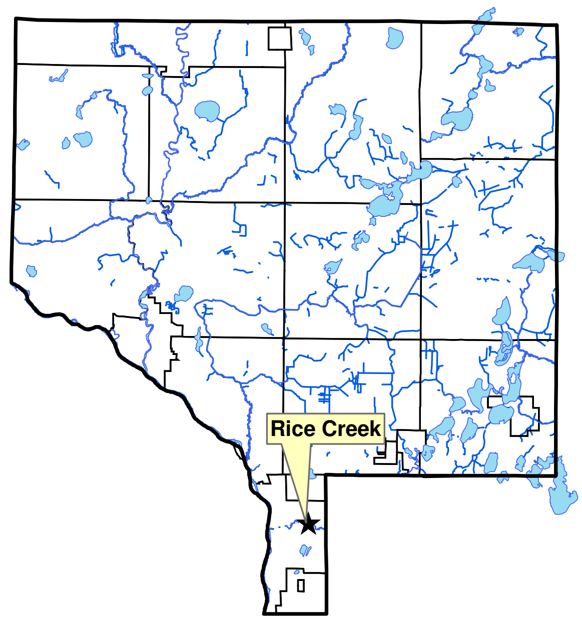
1999

Student Involvement

60 students in 2018, approximately 1,260 since 2001

Background

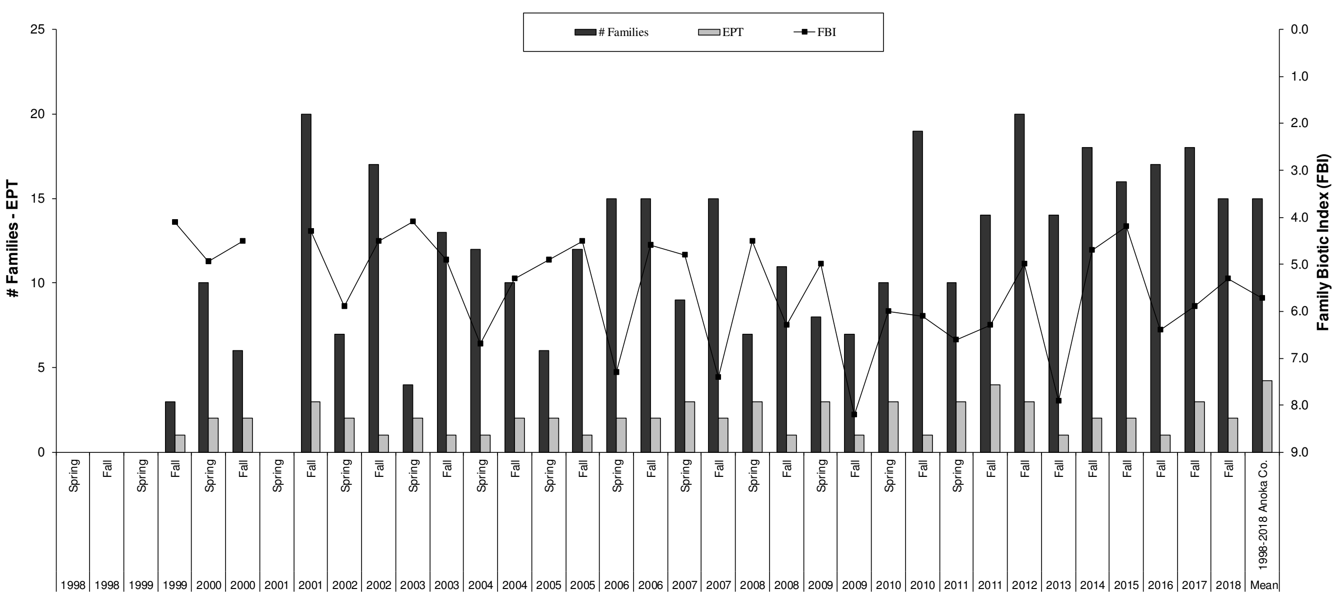
Rice Creek originates from Howard Lake in east-central Anoka County and flows south and west through the Rice Creek Chain of Lakes and eventually to the Mississippi River. Sampling is conducted in Locke Park, which encompasses a large portion of the stream's riparian zone in Fridley. This site is forested. Outside of this forested buffer, the watershed is urbanized and the stream receives runoff from a variety of urban sources. The stream has a rocky bottom with pools and riffles, some due to stream bank stabilization projects.



Results

Totino Grace High School monitored this stream in fall of 2018, facilitated by the Anoka Conservation District. At this site, Rice Creek has a macroinvertebrate community indicative of poor stream health. While the number of families present has been similar to, or above the long-term average for Anoka County streams on several occasions, most of these are generalist species that can tolerate polluted conditions. The most dominant family four of the past five years in a generalist family of the Trichopera order, Hydropshychidae. The number of EPT families present has been below the county average in all years. EPT are generally pollution-sensitive, but the caddisfly family Hydropsychidae, is an exception to that rule. It thrives in relatively poor environmental conditions. Only one other EPT taxa was collected in 2018, the mayfly family Baetidae.

Summarized Biomonitoring Results for Rice Creek at Hwy 65, Fridley



Biomonitoring Data for Rice Creek at Hwy 65, Fridley- Previous Five Years

Year	2014	2015	2016	2017	2018	Mean	Mean
Season	Fall	Fall	Fall	Fall	Fall	Fall	1998-2018 Anoka Co.
FBI	4.7	4.2	6.4	5.9	5.3	5.3	5.7
# Families	18	16	17	18	15	15.0	15.0
EPT	2	2	1	3	2	2.0	4.3
Date	16-Oct-14	13-Oct-15	18-Oct-16	17-Oct-17	15-Oct-18		
Sampled By	TGHS	TGHS	TGHS	TGHS	TGHS		
Sampling Method	MH	MH	MH	MH	MH		
# Individuals	670.5	730	272	545	509		
# Replicates	2	1	1	1	1		
Dominant Family	Hydropsychidae	Hydropsychidae	Hydropsychidae	Simuliidae	Hydropsychidae		
% Dominant Family	76.7	92.6	41.5	65.2	24.6		
% Ephemeroptera	0.1	0.4	0	2	14.5		
% Trichoptera	76.7	92.6	41.5	12.3	24.6		
% Plecoptera	0.0	0.0	0	0	0		
% EPT	76.8	93.0	41.5	14.3	39.1		

Discussion

The poor macroinvertebrate community in this creek is likely due to poor water quality and flashy flows during storms, not poor habitat. Habitat at the sampling site and nearby is good, in part because of past stream habitat improvement projects. The stream has riffles, pools, and runs with a variety of snags and rocks. The area immediately surrounding the stream is wooded, with walking trails. However, outside of this natural corridor around the stream, the watershed is urbanized and storm water inputs are likely the cause of degraded water quality. During storms, water levels in the creek can rise sharply.

Totino Grace High School students at Rice Creek.

Water Quality Grant Administration

Description: RCWD contracted ACD to provide technical assistance for the RCWD Water Quality Grant Program. Tasks could include landowner outreach and education, site reviews, site visits, project evaluations, BMP design, cost-share application assistance, contractor selection assistance, construction oversight, long-term project monitoring, and other services as needed.

Purpose: To assist property owners within the Rice Creek watershed with the design and installation of water quality improvement BMPs.

Results: Below is a summary of technical assistance provided in 2018.

2018 Highlights

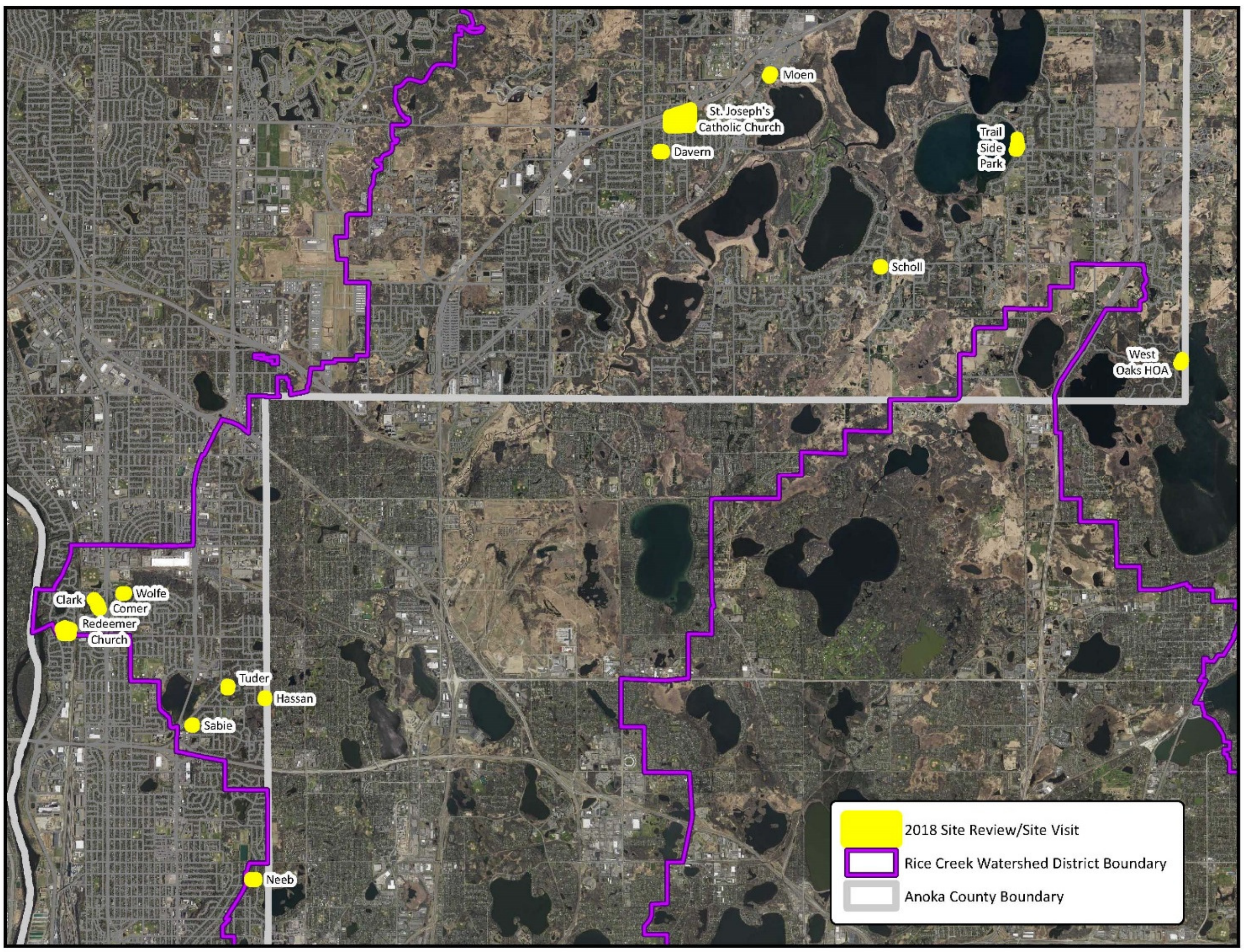
Formal property reviews/site visits were conducted at 14 sites throughout the Rice Creek watershed in Anoka County (see overview map below for specific locations). Project types included eight rain gardens, two shoreline stabilizations, three streambank stabilizations, and one swale. Notable projects included:

- Rain Gardens
  - Construction oversight and final project closeout for a residential curb-cut rain garden in Columbia Heights (Silver Lake).

- Shoreline Stabilizations
  - Design, cost-share coordination, construction oversight, and final project closeout for 678 linear feet of lakeshore stabilization in Trail Side Park in the City of Centerville (Centerville Lake).

- Streambank Stabilizations
  - Construction oversight and final project closeout for a streambank stabilization in the City of Fridley (Rice Creek).

Sites within the Rice Creek watershed at which ACD provided technical assistance in 2018.



Financial Summary

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

Rice Creek Watershed Financial Summary

		Monitoring					Analysis & Planning					Technical & Administrative Assistance								Resource Improvement Projects			Outreach				
Rice Creek Watershed	Total	Volunteer Precip	DNR Groundwater Wells	Wetland Levels	Lake Levels	Biomonitoring	Water Resources Almanac	Anoka Sandplain Partnership	Wetland Resto Opportunities	Land Prot/Resto Strategies	Land Protection Outreach	Landowner Tech. Asst.	Project Profiles	BMP Maintenance & Inspection	WCA Enforcement	Wetland Consultation	Wetland Restoration and Banking	WCA Implementation	Watershed Based Funding Coordination	Cooperative Weed Management	Golden Lake IESF	SSTS - Fix-Up	Video Development	Brochures & Displays	Web Blog	Web Story Map	Anoka County Outreach Program
Revenues																											
RCWD	15516			1300	1500	1800						10916															
State - Other	11346		350															9152		1845							
MPCA	15577																					15577					
DNR OHF																											
DNR CPL																											
BWSR - Service Grant	7546							1049	1064	375		955	300	651					2190				311	591	58		
BWSR - Project Grant	397405																				395147						2258
Metro ETA & NPEAP	84											84															
Regional/Local	41895																				41895						
Anoka Conservationi District	9237						597	152		26	111	983		50	337	2927	250	3369	6	9	41	35		60	14	183	87
County Ag Preserves/Projects	1267					1267																					
Service Fees	603										362							22		219							
TOTAL	500475		350	1300	1500	3067	597	1201	1064	401	473	12937	300	701	337	2927	250	12542	2196	2073	437084	15612	311	651	73	183	2344
Expenses-																											
Personnel Salaries/Benefits	50364	122	759	770	974	2541	821	1009	899	347	400	11094	269	562	298	2442	218	8249	1859	1534	11134	1629	73	507	55	167	1631
Overhead	6127	16	98	89	111	332	110	141	135	41	59	1473	35	70	39	338	31	921	276	171	1211	176	11	74	5	19	144
Vehicle/Mileage	836	2	12	19	24	44	6	8	5	4	3	157	2	11	6	33	2	162	22	33	203	36	1	7	1	2	30
Project Direct - Supplies	34058	1		14	3						9			50		50		3388	6	350	29834		224	60	11		58
Project Direct - Capital																											
Project Direct - Installation	408987																				395147	13840					
TOTAL	500372	142	869	892	1112	2917	937	1159	1039	392	470	12724	307	693	342	2864	250	12720	2163	2088	437531	15681	310	647	73	188	1863

Recommendations

- **Continue to install cost effective projects** identified in previously completed Subwatershed Retrofit Analyses and prioritized in newly completed sub-catchment analyses. Install and maintain water quality improvement projects.

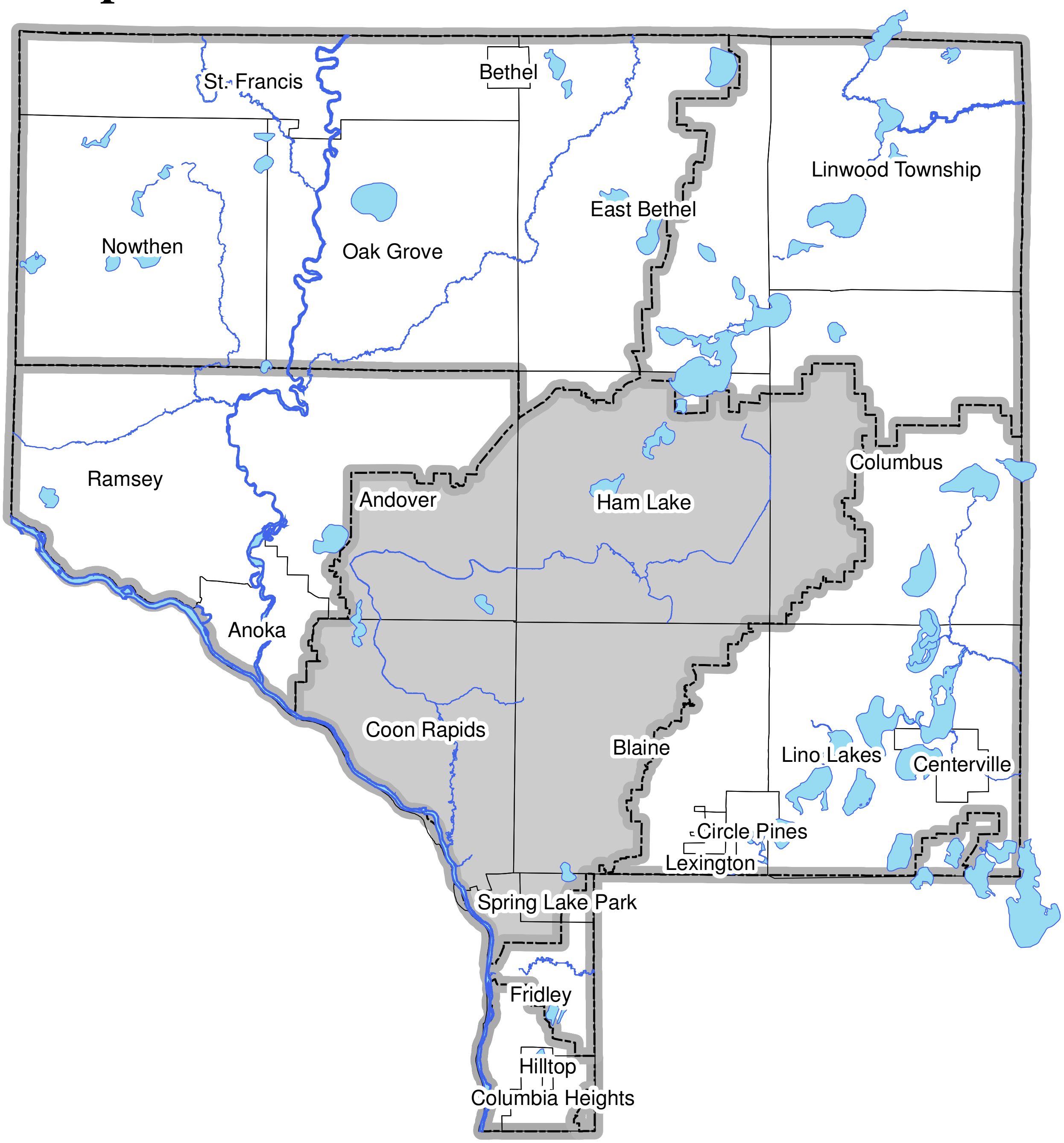
- **Continue work to improve the ecological health of Clearwater, Hardwood, and Rice Creeks.** Clearwater Creek is designated as impaired for aquatic life based on fish and invertebrate IBIs. Hardwood Creek is impaired based on invertebrate data and low dissolved oxygen. Rice Creek is impaired for both fish and invertebrate IBIs downstream of Baldwin Lake in Anoka County. The Anoka County invertebrate data for Rice Creek continue to indicate a depleted invertebrate community.

- **Continue efforts to reduce road salt use.** Chlorides are pervasive throughout shallow aquifers and the streams that feed them. Conductivity readings are increasing throughout the County, and it is likely that stream chloride concentrations are following suit.

- **Continue the biomonitoring program** with area schools. This program provides dual benefits in contributing to a long-term bio-indicator dataset as well as educating local youth on their natural resources.

2018 Anoka Water Almanac

Chapter 6: Coon Creek Watershed



Prepared by the Anoka Conservation District

Coon Creek Watershed

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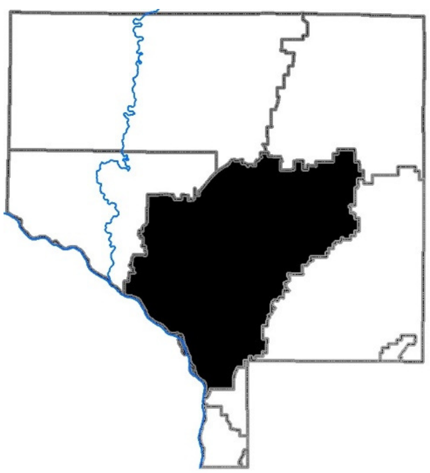
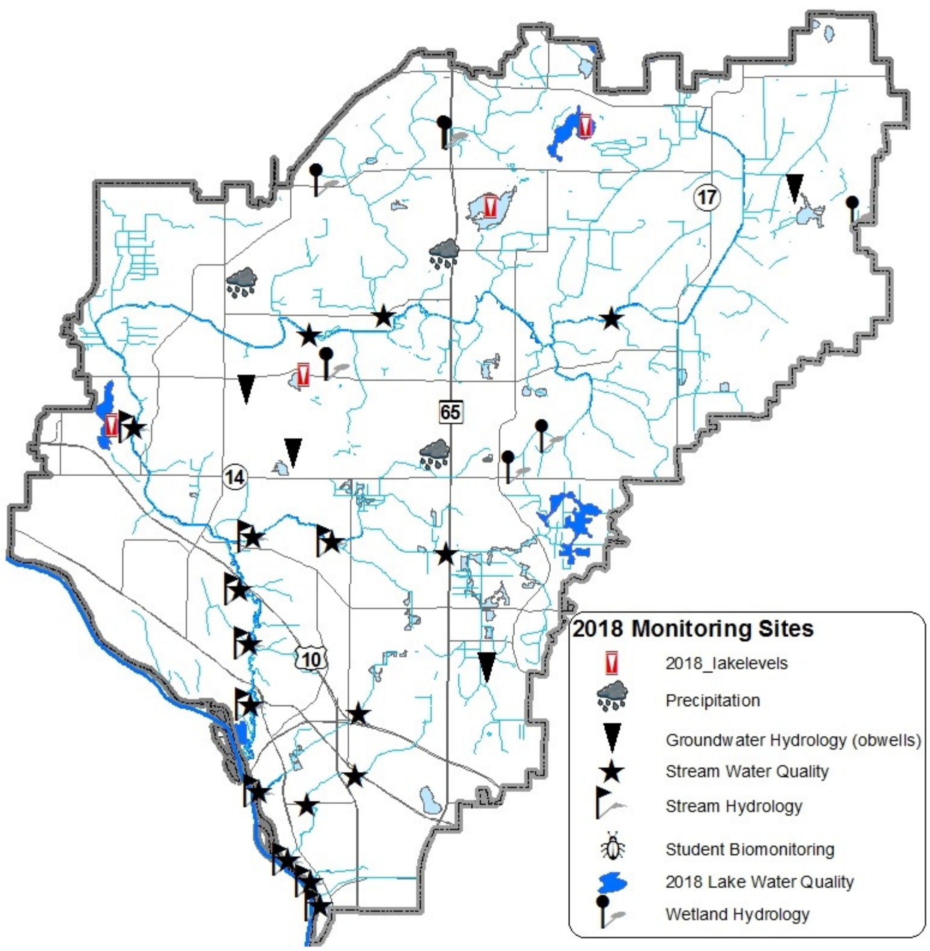




Summary of Findings

Description:

This is a brief summary of new findings and notable results from 2018. Detailed analyses for all individual sites can be found below in the appropriate section of the work results.

Precipitation:

- No tipping bucket data was collected in 2018. Volunteer data and online resources showed a near average precipitation year overall with a particularly dry August and wet September.

Lake Levels:

- Levels were generally near average after a late deploy of gages in early June. A new volunteer is needed for Laddie Lake.

Lake Water Quality:

- Crooked Lake water quality has significantly improved since the 1980s and continues to meet state water quality standards despite some interannual variation. Phosphorus and Chlorophyll-a rose in 2017 before falling slightly in 2018. Chlorophyll-a is higher the last 2 years after being at an all-time low in 2015. Secchi transparency has decreased on average for the last three sampling seasons.
- Crooked Lake temperature and dissolved oxygen profiles were recorded for the first time this year. Despite being a relatively shallow lake, these profiles clearly show strong stratification during the summer months (mid-May to mid-September) and nearly complete mixing by the end of September. It is unclear as of yet if stratification and mixing results in significant in-lake cycling of phosphorus in Crooked Lake.
- Sunrise Lake was monitored for the first time this year. It had good water quality overall, earning a B grade.
- Cenaiko Lake was monitored for the first time since 2012. It also had good water quality receiving an A- composite letter grade.
- Lake Netta continues to have good water quality.

Lake AIS Surveys

- Two patches of invasive phragmites (*Phragmites australis* subsp. australis) were identified this year on the shores of Ham Lake and Sunrise Lake.
- Purple loosestrife was found in Lake Netta on a floating island and in the vegetation on either side of the boat launch.
- Curlyleaf pondweed was detected in Sunrise lake as well as a stand of watermilfoil with intermediate characteristics between the native (*Myriophyllum sibiricum*) and nonnative species (*M. spicatum*). A picture of the collected milfoil was sent to DNR staff who indicated that genetic analysis would be necessary to distinguish whether this population is native or invasive (incl. hybrid).

Stream Hydrology:

- Rating Curves were developed for two new monitoring sites (Coon Creek at 111th Ave. and Ditch 52 at Robinson Park), as well as Springbrook at 79th Way.
- Stream stages were near, or slightly below, average in 2018.

Stream Water Quality:

- In general, elevated phosphorus is an issue throughout the watershed and the county as a whole.
- Many smaller tributary streams have very high baseflow specific conductance.
- Many smaller tributary streams appear to have problematic *E. coli* levels.

Recommendations

- **Consider refining *E. coli* sampling**, particularly where previously found to be high, to match requirements of State standards. At least five samples in a calendar month are required.

- **Continue YSI continuous water quality monitoring of creeks.** This continuous Data are useful for diagnosing pollutant magnitudes, sources, and developing management strategies, especially at sites not previously monitored.

- **Continue updating and adding stream rating curves.** Coon Creek at Vale Street last had rating curve measurements in 2010. Stonybrook and Oak Glen Creek have not had rating curves developed. Curves at many monitored sites were last updated in 2013. Changes in stream morphology necessitate periodic updates by manually measuring flow and stage under a variety of water levels. In 2018, three rating curves were developed (Coon Creek at 111th Ave, Ditch 52 at Robinson Park, and Springbrook at 79th Way).

- **Continue specially timed storm sampling of Stonybrook and Oak Glen Creek** to capture true storm flow water quality. Storm flows are brief due to the small, urbanized watershed. Special sampling trips have been moderately successful at capturing storm water quality, but data from a continuously deployed water quality sonde indicates that there is still a lot of improvement to be made in sampling efforts. An automated sampler may be necessary at these locations.

- **Continue YSI continuous water quality monitoring of creeks during storm events.** These continuous data are useful for diagnosing pollutant magnitudes, sources, and developing management strategies, especially at sites not previously monitored.

- **Continue implementing water quality monitoring at new sites,** or sites not monitored for a number of years, where upstream to downstream analysis indicates an influx of pollutants. In 2019, Ditch 60 and Ditch 39 will be monitored before their confluences with Sand Creek to assess the effect of those streams on Sand Creek water quality. The last and only time those two sites were monitored was in 2009.

- **Continue pursuing funding for priority water quality improvement projects.** Recent projects like the Oak Glen Creek pond expansion Iron Enhanced Sand Filter in Fridley, and the lower Sand Creek bank and meander restoration project will help the watershed as a whole comply with TMDL loads and state water quality standards. Watershed Based Funding will open up even more opportunities to partner with cities and other entities on important and effective water quality projects.

- **Promote the availability of reference wetland data** among wetland regulatory personnel as well as consultants as a means for efficient, accurate wetland determinations. We're finding these data to be more and more helpful in developing areas and have seen demand for data increase accordingly.

Precipitation

Description: Continuous monitoring of precipitation with one data logging rain gauge located at the Anoka Conservation District office, and daily monitoring of two cylinder rain gauges read by volunteers. Additional data from the NWS, DNR, and the backyard rain gauge network are presented. Rain gauges are placed around the watershed in recognition that rainfall totals and storm phenology are spatially variable, and these differences are critical to understanding local hydrology, including flood prediction.

Purpose: To aid in all types of hydrologic analyses, predictions, and regulatory decisions within the watershed.

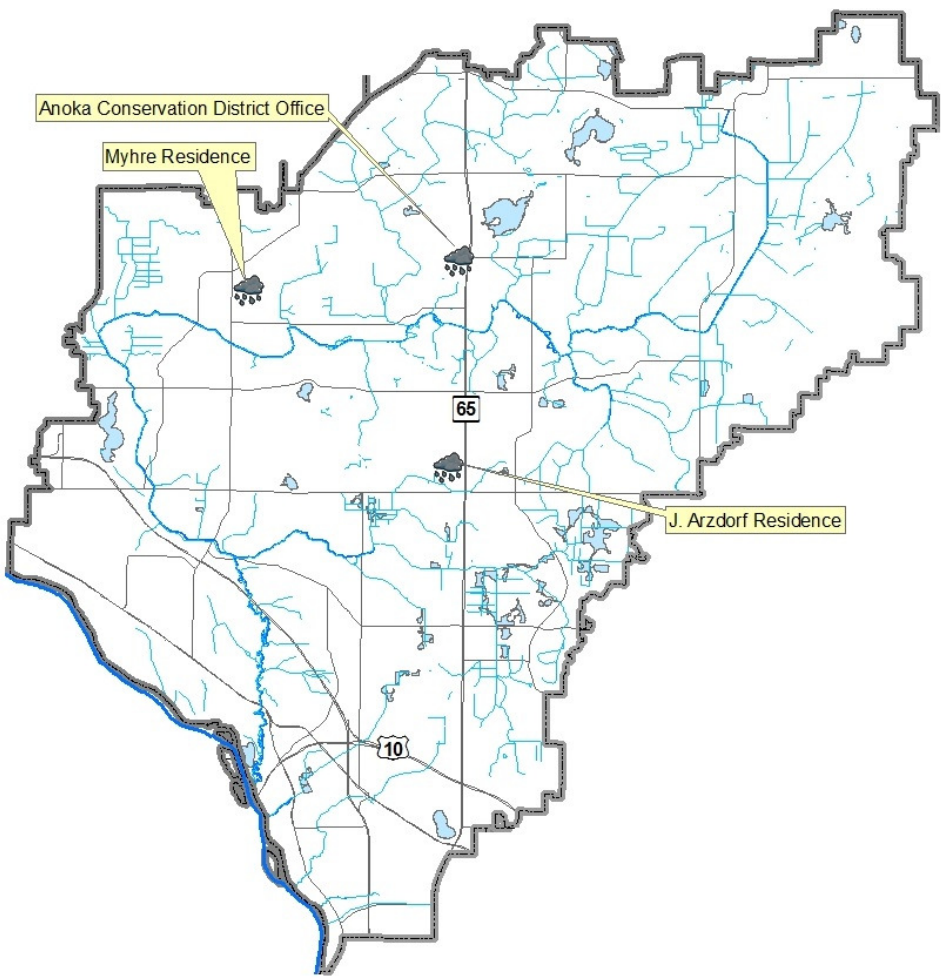
Locations:

Type	Site	City
Data Logging	Anoka Conservation District Office	Ham Lake
Cylinder - Volunteer	Arzdorf residence	Blaine
Cylinder – Volunteer	Myhre residence	Andover

Note: Countywide precipitation summaries can be found in Chapter 1.

Results: A summary table and graph are presented on the following page.

Coon Creek Watershed 2018 Precipitation Monitoring Sites

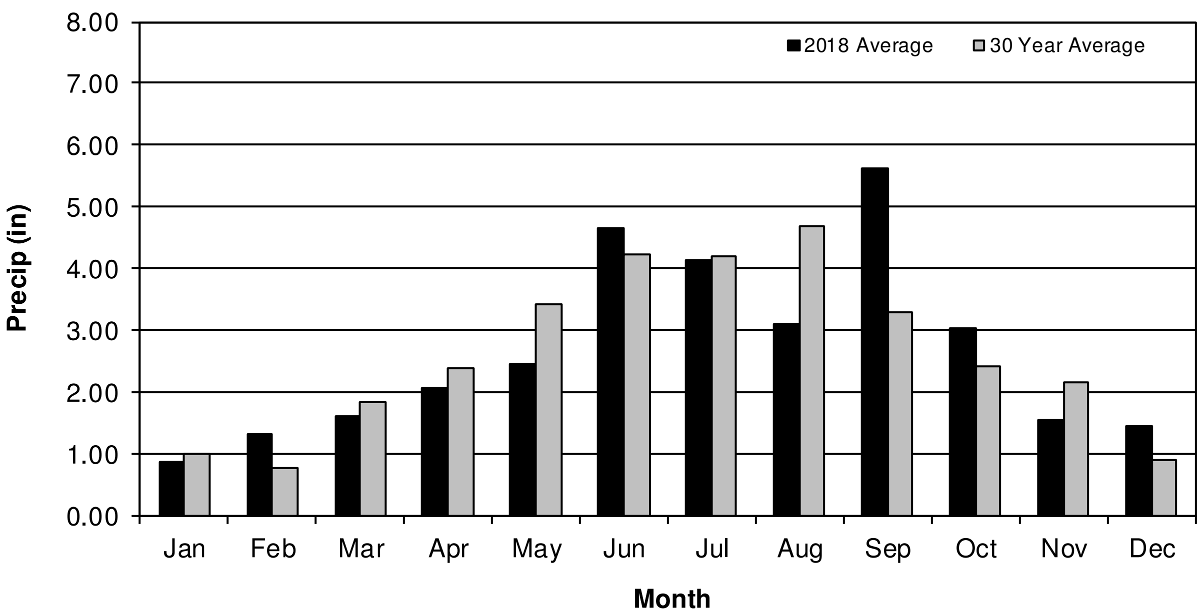


Coon Creek Watershed 2018 Precipitation Summary Table and Graph

Location or Volunteer	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total	Growing Season (May-Sept)
BYRG, DNR, and NWS data															
30N 24W 3 DNR	Fridley	1.29	1.53	1.66	2.77	2.44	4.23	4.35	3.9	5.58	2.96	1.53	1.72	33.96	20.50
30 24 14 BYRG	Fridley	0.82	1.27	1.19	1.84	2.68	3.54	3.44	3.53	6.87	2.92	1.44	1.32	30.86	20.06
32 24 23 NWS	Andover	0.46	1.19	2.33	2.15	1.87	5.00	4.09	2.58	5.04	2.35	1.42	*	28.48	18.58
Tipping bucket, datalogging rain gauges (Time and date of each 0.01" is recorded)															
Anoka Cons. District office	Ham Lake			*	*	1.91	5.94	5.73	2.99	5.79	3.5	*		25.86	22.36
Cylinder rain gauges (read daily)															
N. Myhre	Andover	0.73	1.37	1.51	1.72	2.58	6.30	3.58	2.52	4.88	3.01	1.87	1.30	30.53	24.99
K. Ackerman	Fridley	1.05	1.29	1.36	1.87	2.56	3.36	3.71	3.45	6.49	3.17	1.53		29.84	19.57
J. Arzdorf	Blaine					3.07	4.14	3.96	2.82	4.78	3.36			31.89	26.45
2018 Average	CCWD-wide	0.87	1.33	1.61	2.07	2.44	4.64	4.12	3.11	5.63	3.04	1.56	1.45	31.88	19.96
30 Year Average	Cedar	0.99	0.76	1.84	2.40	3.43	4.22	4.21	4.70	3.29	2.44	2.18	0.90	31.36	19.85

precipitation as snow is given in melted equivalents

*Incomplete monthly data not included in averages



Precipitation Analyses

Description: **Long Term Precipitation Trend Analysis:** Monthly rainfall deviations from normal for preceding 6 months, 12 months, and two years were graphed for all months 1986 to present. Data utilized were from the "Coon Creek-211785" National Weather Service (NWS) station until 2005 when that station was abandoned. Thereafter, the NWS station "Andover-210190" was used. Normal precipitation totals for each month are from the NWS Cedar station. Deviation from normal during the preceding 6, 12, and 24-month time periods were calculated and graphed. This is presented on the following page.

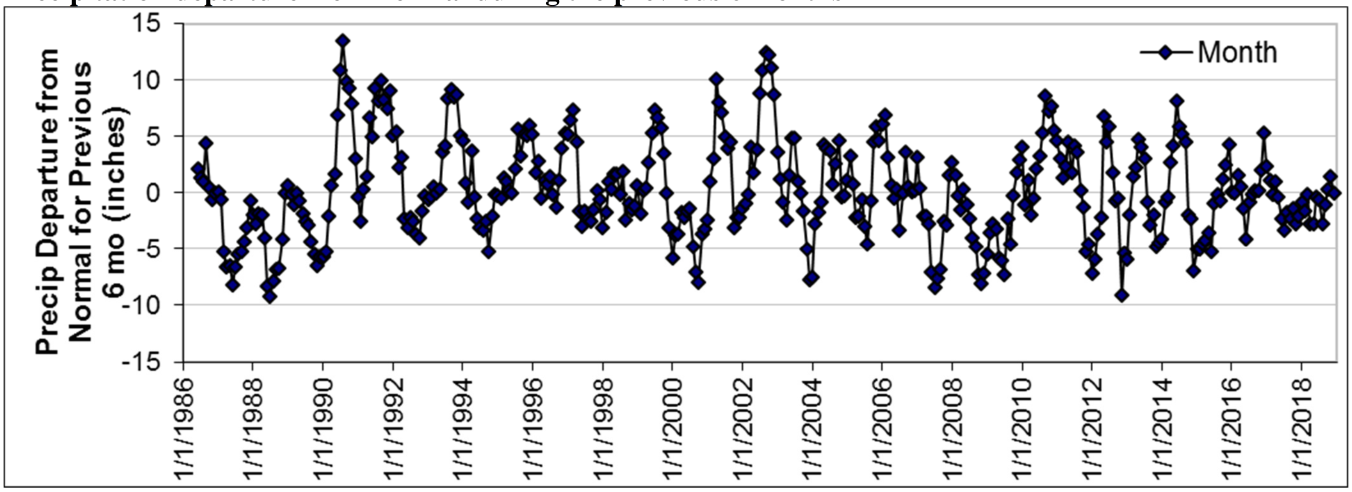
Purpose: To aid in hydrologic modeling of the watershed. Also useful for all types of hydrologic analyses, predictions, and regulatory decisions within the watershed.

Results: Long-term precipitation trend analysis is reported on the following pages.

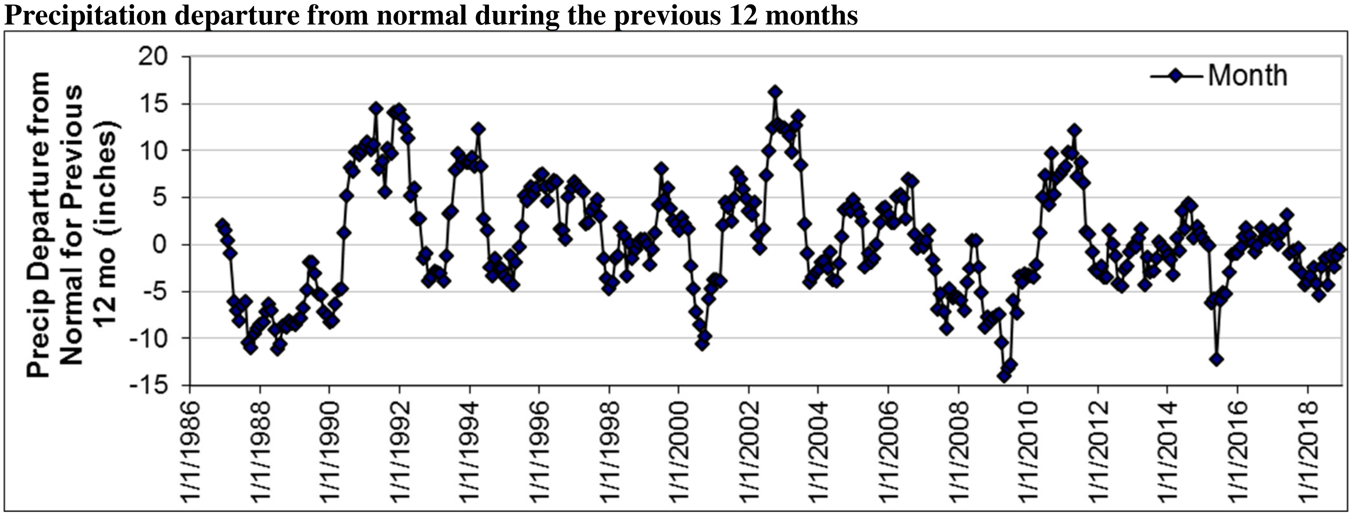
Long Term Precipitation Trends

Notes: Period is 1986 to present. Monthly precipitation totals are from the NWS station nearest the center of the Coon Creek Watershed District with available data (MN State Climatology website). Normal precipitation totals for each month are from the NWS Cedar station.

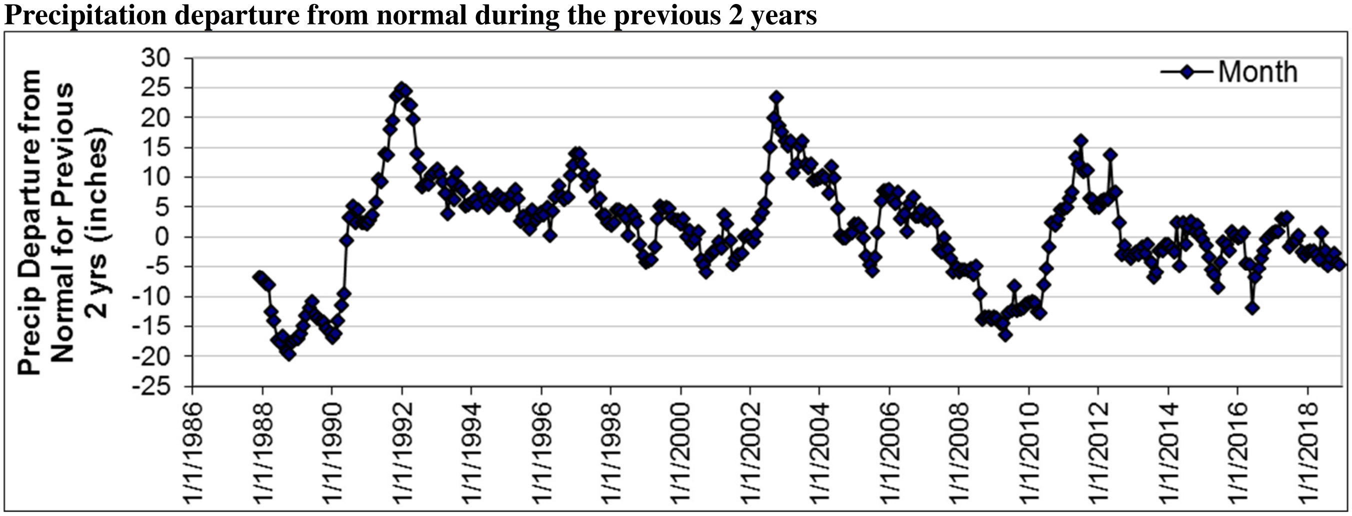
Precipitation departure from normal during the previous 6 months



Precipitation departure from normal during the previous 12 months



Precipitation departure from normal during the previous 2 years



Lake Levels

Description: Weekly water level monitoring in lakes. The past five years are shown 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:

Site	City
Bunker Lake	Andover
Crooked Lake	Andover/Coon Rapids
Ham Lake	Ham Lake
Lake Netta	Ham Lake
Laddie Lake	Blaine
Sunrise Lake	Blaine

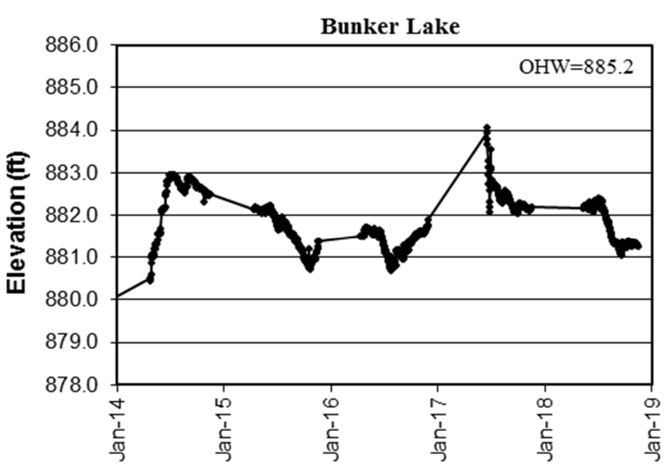
Results: In 2018, lake levels were measured by volunteers 51 times at Ham Lake, 24 times at Lake Netta, 22 times at Crooked Lake, and by the DNR and ACD staff 1 time at Laddie Lake. Levels in Bunker Lake were monitored May through November using an electronic gauge, which resulted in 189 days of measurements generated by averaging six readings from each day.

Overall, lakes had increasing water levels in spring and early summer that declined into mid-summer. Higher rainfall amounts in the fall caused a small increase in lake levels into the end of the year. Levels did not fluctuate greatly, and were generally near average in 2018.

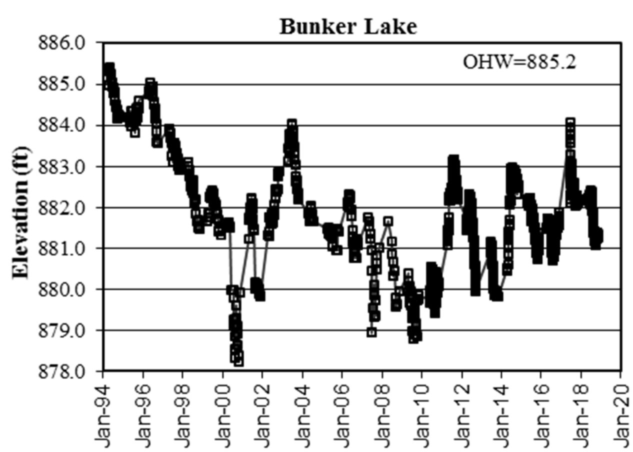
Ordinary High Water Level (OHW), the elevation below which a DNR permit is needed to perform work, is listed for each lake on the corresponding graphs below.

Coon Creek Watershed 2018 Lake Level Monitoring Sites

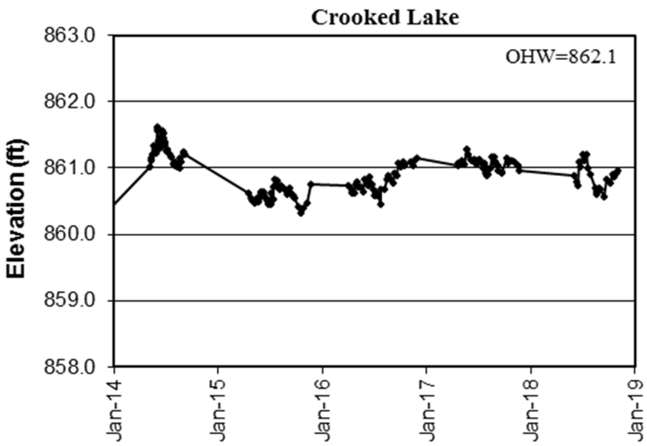
Bunker Lake Levels – last 5 years



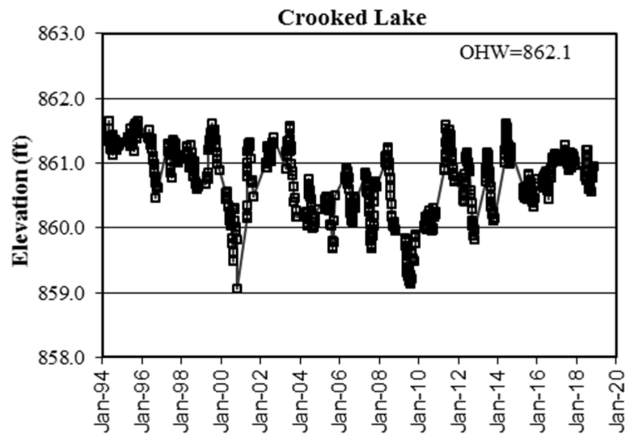
Bunker Lake Levels- last 25 years



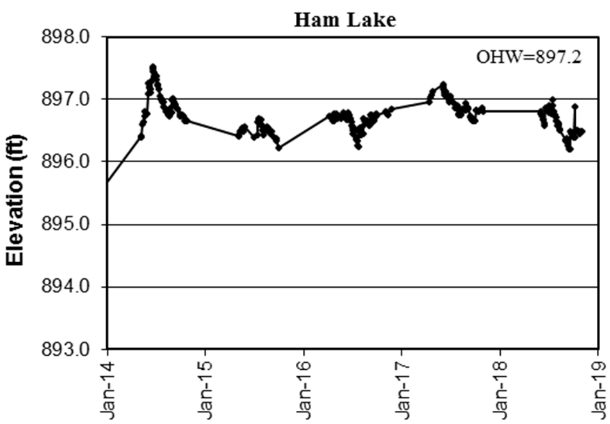
Crooked Lake Levels- last 5 years



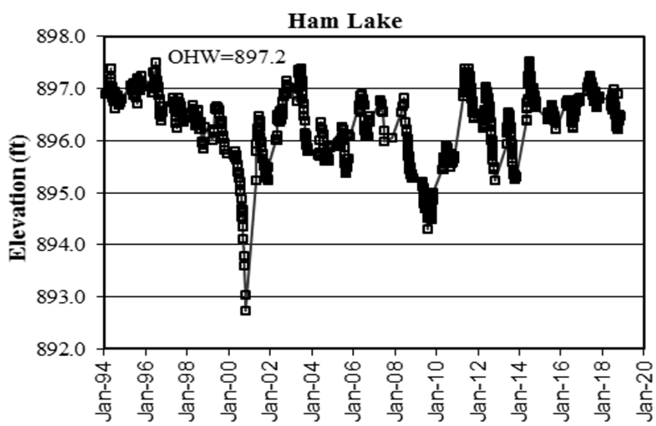
Crooked Lake Levels- last 25 years



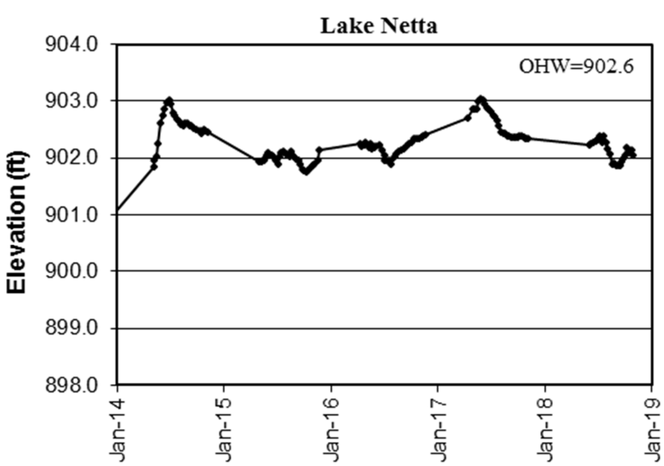
Ham Lake Levels- last 5 years



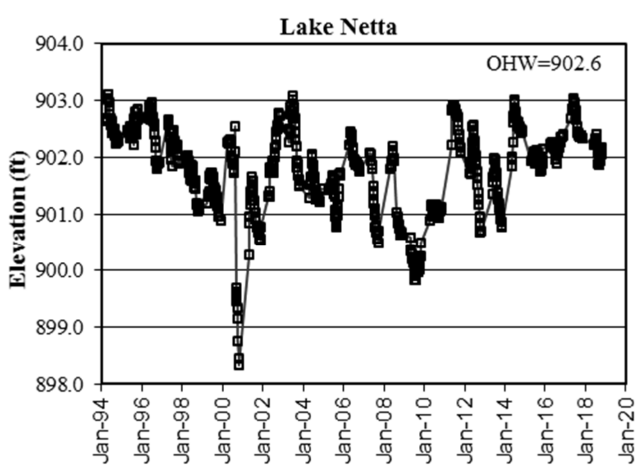
Ham Lake- Last 25 years



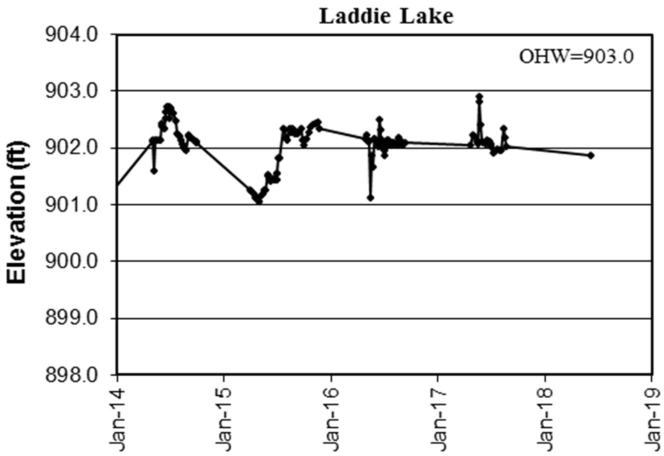
Lake Netta Levels- last 5 years



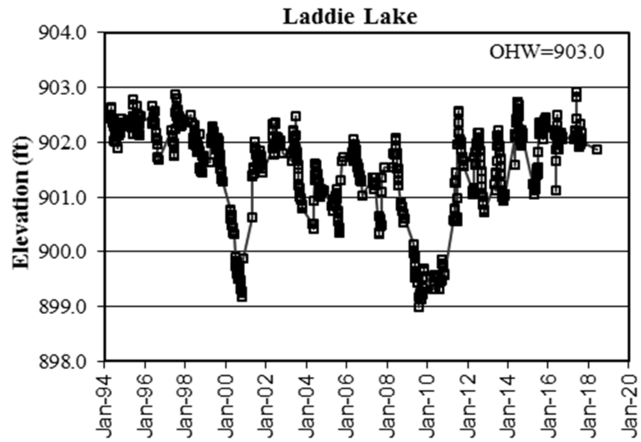
Lake Netta Levels- last 25 years



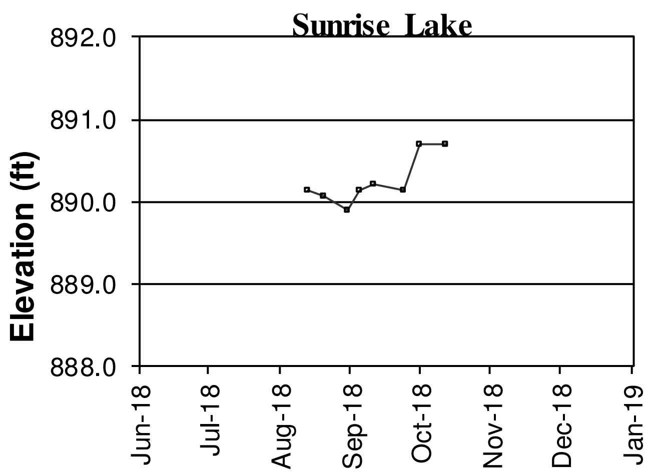
Laddie Lake Levels- last 5 years



Laddie Lake Levels- last 25 years



Sunrise Lake Levels- 2018



Annual average, minimum, and maximum levels for each of the past 5 years

Lake	Year	Average	Min	Max
Bunker	2014	882.4	880.45	882.96
	2015	881.61	880.72	882.23
	2016	881.37	880.7	881.88
	2017	882.42	882.05	884.07
	2018	881.07	881.73	882.4
Crooked	2014	861.28	861	861.62
	2015	860.58	860.33	860.83
	2016	860.77	860.45	861.09
	2017	861.06	860.89	861.29
	2018	860.87	860.56	861.2
Ham	2014	896.97	896.39	897.53
	2015	896.49	896.23	896.69
	2016	896.64	896.24	896.84
	2017	896.91	896.65	897.24
	2018	896.6	896.21	896.99

Lake	Year	Average	Min	Max
Netta	2014	902.56	901.84	903.02
	2015	901.97	901.76	902.14
	2016	902.16	901.89	902.35
	2017	902.62	902.34	903.04
	2018	902.13	901.86	902.4
Laddie	2014	902.30	901.59	902.73
	2015	901.83	901.05	902.45
	2016	902.07	901.12	902.50
	2017	902.16	901.92	902.92
	2018			
Sunrise	2018	890.3	889.9	890.69

Only one reading taken on Laddie Lake in 2018

Lake Water Quality

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

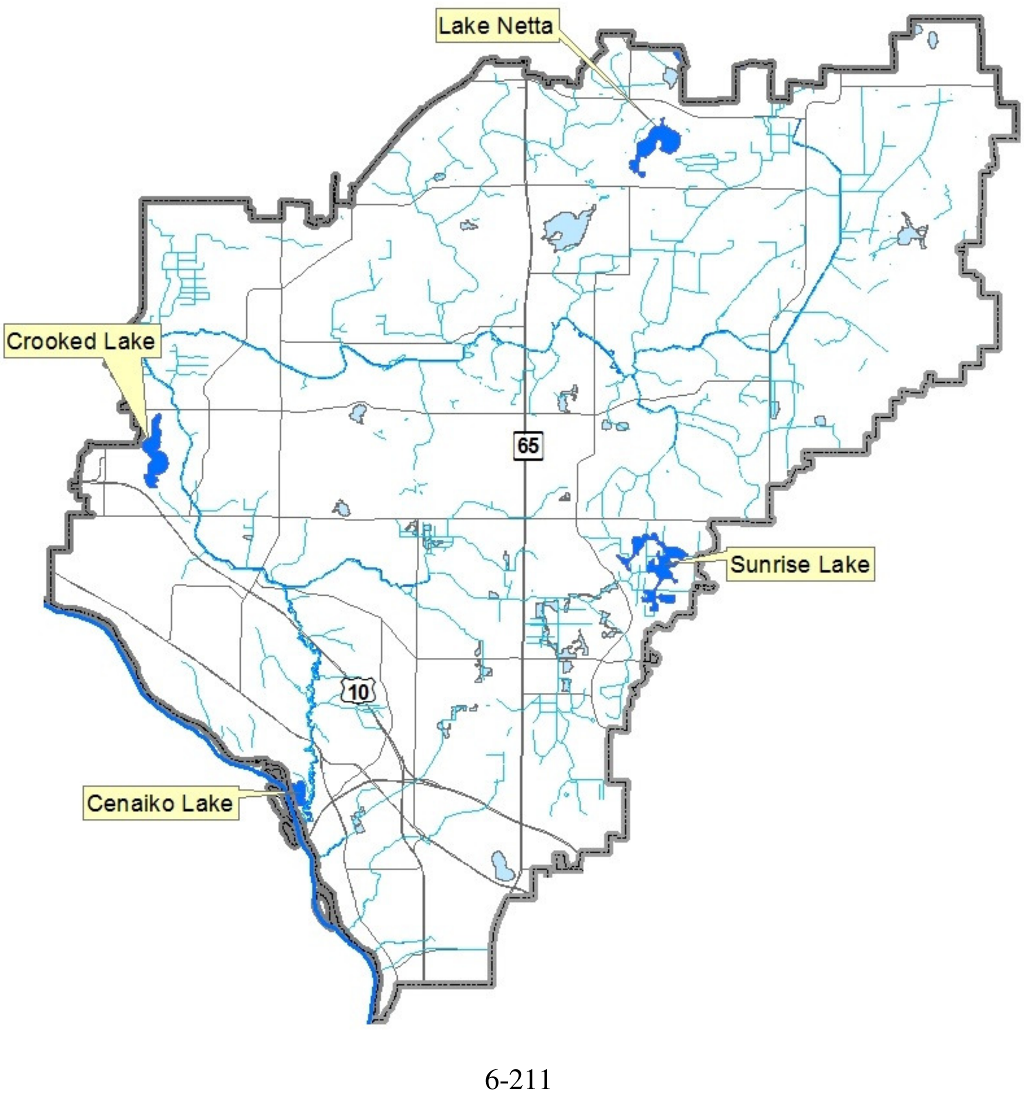
Purpose: To detect water quality trends and diagnose the cause of changes.

Locations:

Site	City
Crooked Lake	Andover/Coon Rapids
Lake Netta	Ham Lake
Sunrise Lake	Blaine
Cenaiko Lake	Coon Rapids

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 interpreting the data and on lake dynamics.

Coon Creek Watershed 2018 Lake Water Quality Monitoring Sites



Crooked Lake

Cities of Andover and Coon Rapids, Lake ID # 02-0084

Background

Crooked Lake is located half in the City of Andover and half in Coon Rapids. It has a surface area of 117.5 acres with a maximum depth of 26 ft. (7.9 m). Public access is from two locations, at a City of Coon Rapids park on the east side of the lake where a fishing pier and beach are located, and at the boat launch off Bunker Lake Boulevard at the lake's northernmost point. The lake is used extensively by recreational boaters and fishers. The 236-acre watershed is developed and primarily comprised of residential land use.

In 1990 Eurasian Water Milfoil (EWM) was discovered in the lake. Many treatment attempts have ensued to control this invasive plant, which flourishes to nuisance levels in Crooked Lake and creates dense surface matts in late summer. In the 1990s and early 2000s, two whole lake treatments with fluridone temporarily controlled most of the EWM, but were harmful to native vegetation. From 2010 through 2015, spot treatments with the herbicides triclopyr and 2-4 D minimized native plant damage, but were less effective lake-wide in controlling EWM. In 2016, an experimental treatment using low-dose granular fluridone was implemented and resulted in reduction of EWM (confirmed to be hybrid EWM) from 60% occurrence in the littoral zone to less than 1% occurrence in 2017. In 2018, ACD found seven areas of EWM growth, primarily in the southern portions of the lake. The invasive curlyleaf pondweed is also present in Crooked Lake. Populations of this plant were suppressed in 2018, likely due to late ice out.

2018 Results

In 2018 Crooked Lake had above-average water quality for this region of the state (NCHF Ecoregion) receiving an overall B+ letter grade. The lake had received overall A- grades from 2012-2015, then B+ in 2017 and 2018. In 2018 total phosphorus (TP) averaged 25.0 µg/L and chlorophyll-a (Cl-a) was 7.5 µg/L. Cl-a in 2018 had the highest average since 2011 and more than double the averages from 2014-2015. In 2018, Secchi transparency averaged 7.5 ft, tied with 2017 as the poorest average since 2009, but still much better than historical averages. Historically, average Secchi increased to an average of 9.5 ft by 2011 from averages of just 3-4 ft in the early 1990s, but have since plateaued, or slightly declined.

Trend Analysis

Twenty-one years of water quality data including the full suite of total phosphorus, Cl-a, and Secchi transparency have been collected between 1983 and 2018. There have been four additional years of TP and eight additional years of transparency measurements by citizens. Using all historical data, water quality has shown a significant improvement from 1983 to 2018 (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,18} = 4.42$, $p = <0.0001$). The most dramatic improvements in water quality occurred between 1989 and 1994. However, if only data after 1993 are examined a statistically significant trend of improvement is still found (same MANOVA, $F_{2,15} = 16.06$, $p =< 0.01$). Examining the trend during this period (1994-2018) for each individual parameter (one-way ANOVA) we found statistically significant trends toward improvements for all 3 parameters: TP – $F_{1,17} = 5.51$, p= <0.05, Cl-a – $F_{1,16} = 24.32$, p= <0.001, and Secchi transparency – $F_{1,17} = 47.78$, p=<0.0001.

Discussion

Water quality in Crooked Lake is quite good considering its urbanized watershed and intensely manicured shorelines. 2012-2015 was the best stretch of water quality in Crooked Lake on record. 2017 and 2018 have not been as good, but the fluctuations are small. Total phosphorus, which had earned A grades from 2012 to 2015, slipped to a B in 2017 and 2018 due to only a slight increase (3 µg/L) in average total phosphorus pushing it over the grading threshold. Continued efforts to improve stormwater draining to the lake and implement shoreline restorations are encouraged.

For the first time this year, temperature and dissolved oxygen (DO) profiles were recorded during each sampling day. These consisted of DO and temperature measurements being taken at every foot from one-foot depth to the lake bottom (about 26 ft). Profile graphs are shown on page 13. Crooked Lake displays characteristics of a lake that mixes fully twice a year. This is reflected in the September 26th profile when DO and temperature were constant to nearly the full depth of the lake showing that the lake waters were nearly fully mixed. This lack of stratification should also be evident in the spring but is not reflected in our data because it likely occurred before our earliest sampling date on May 22. On all other sampling occasions, the lake was well stratified with DO declining to zero between 16 and 18 ft below the surface.

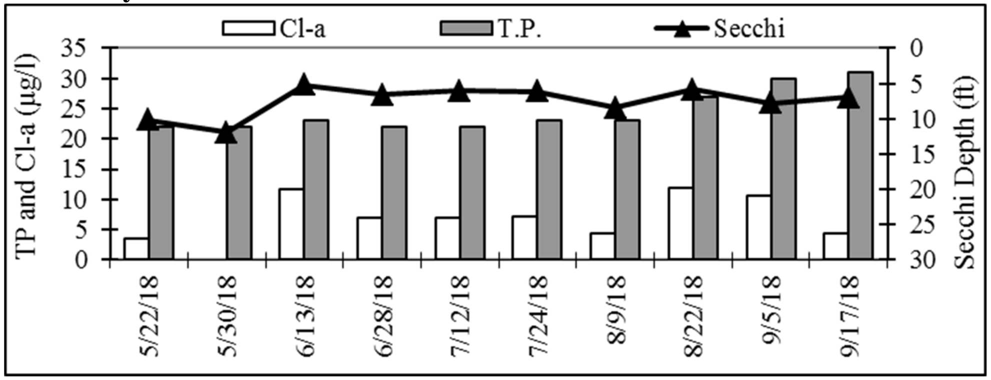
In some lakes mixing corresponds to spike in phosphorus due to the upwelling of hypolimnetic phosphorus from lake sediment loading during redox conditions. In Crooked Lake, the highest total phosphorus did occur at the end of the sampling season but was similar on both September 5th (30 µg/L, highly stratified) and on September 17th (31 mg/L, no profile due to weather). September 17 was the last planned sampling day, but ACD staff were chased off the lake by a storm before the profile could be recorded. It is likely that the lake was still stratified on this date, so the upwelling of phosphorus would not have occurred yet. Even had phosphorus sampling occurred on September 26th it is unclear if in lake cycling would have been reflected since DO levels still reached zero near the lake bottom. Continued monitoring of temperature and DO profiles paired with water quality sampling, particularly in the hypolimnion, should help develop an understanding of in-lake phosphorus loading.

Invasive aquatic plants continue to be a challenge in Crooked Lake.. Native plants like coontail and macroalgae are present in some areas, and could heighten resident frustrations about abundant plants hampering recreation. Caution is urged when managing non-native plants to avoid impacting native plants and water quality. The 2008 lake management plan (updated in 2014) provides direction for protecting water quality and managing plants and should continue to be referenced.

Crooked Lake

Cities of Andover and Coon Rapids, Lake ID # 02-0084

2018 Daily Results



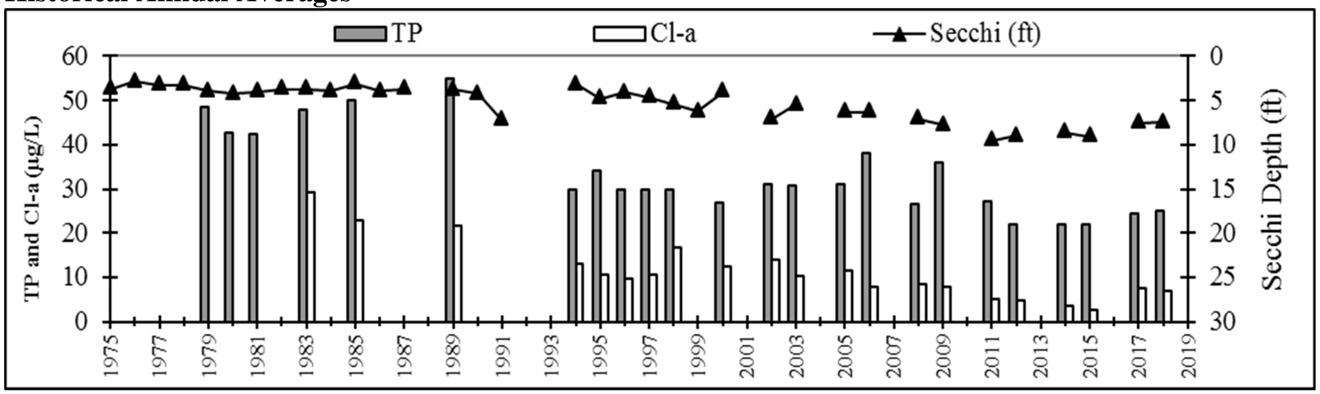
2018 Median Results

pH		8.18
Specific Conductivity	mS/cm	0.535
Turbidity	NTU	3.20
D.O.	mg/l	8.83
D.O.	%	1.07
Temp.	°F	76.2
Salinity	%	0.3
Cl-a	µg/L	6.9
T.P.	µg/l	23.0
Secchi	ft	6.8

Historical Report Card

Year	TP	Cl-a	Secchi	**Overall**
1994	B	B	C	**B-**
1995	C	B	C	**C+**
1996	B	A	C	**B**
1997	B	B	C	**B-**
1998	B	B	C	**B-**
1999			C	
2000	B	B	C	**B-**
2002	B	B	C	**B-**
2003	B	B	C	**B-**
2005	B	B	C	**B-**
2006	C	A	C	**B-**
2008	B	A	B	**B+**
2009	C	A	B	**B**
2011	B	A	B	**B+**
2012	A	A	B	**A-**
2014	A	A	B	**A-**
2015	A	A	B	**A-**
2016				
2017	B	A	B	**B+**
2018	B	A	B	**B+**
State Standards	40 µg/L	14 µg/L	>4.6 ft	

Historical Annual Averages

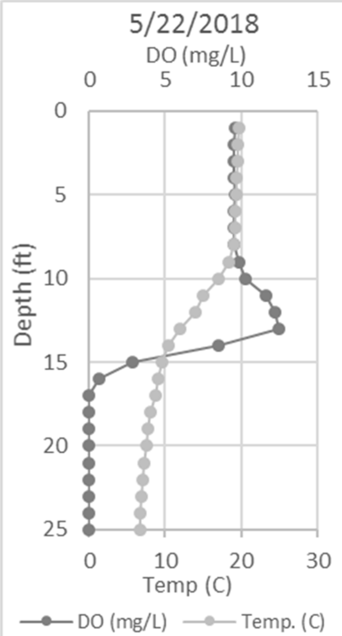


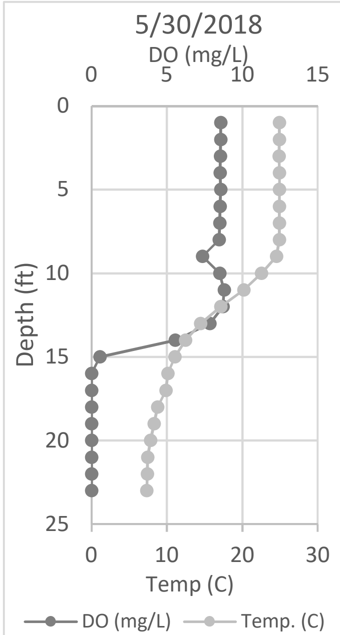
2018 Water Quality Data

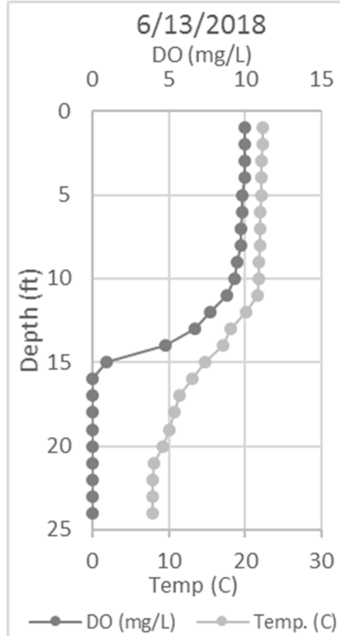
	Units	R.L.*	5/22/2018	5/30/2018	6/13/2018	6/28/2018	7/12/2018	7/24/2018	8/9/2018	8/22/2018	9/5/2018	9/17/2018	Average	Min	Max
Time:			11:15	10:45	9:20	14:15	10:10	12:50	14:10	9:15	12:51	13:30			
pH		0.1	8.73	7.85	8.41	8.80	7.95	8.61	8.55	7.91	7.92	7.95	8.3	7.85	8.80
Specific Conductivity	mS/cm	0.01	0.586	0.600	0.542	0.503	0.523	0.603	0.526	0.528	0.517	0.554	0.5	0.50	0.60
Turbidity	NTU	1	1.90	33.30	6.60	0.00	6.70	3.600	0.20	3.20		2.30	11.8	0.00	60.50
D.O.	mg/l	0.01	9.23	8.54	9.32	9.33	8.20	9.42	9.12	6.75	6.92	8.16	8.5	6.75	9.42
D.O.	%	1	103.5%	111.3%	110.8%	117.3%	102.3%	120.1%	120.7%	80.3%	83.9%	102.1%	105.2%	80.3%	120.7%
Temp.	°C	0.1	19.27	24.88	22.13	25.60	26.75	26.24	26.58	24.28	23.01	24.12	24.3	19.27	26.75
Temp.	°F	0.1	66.9	76.8	71.8	78.1	80.2	79.2	79.8	75.7	73.4	75.4	75.7	66.69	80.15
Salinity	%	0.01	0.28	0.31	0.26	0.24	0.25	0.30	0.25	0.26	0.25	0.27	0.3	0.24	0.31
Cl-a	µg/L	1	3.56	<1	11.60	6.9	6.9	7.1	4.5	11.9	10.7	4.3	6.8	<1	11.90
T.P.	mg/l	0.005	0.022	0.022	0.023	0.022	0.022	0.023	0.023	0.027	0.030	0.031	0.0	0.02	0.03
T.P.	µg/l	5	22	22	23	22	22	23	23	27	30	31	24.5	22.00	31.00
Secchi	ft		10.2	11.9	5.3	6.6	6.1	6.2	8.4	5.8	7.8	6.9	7.5	5.25	11.92
Secchi	m		3.1	3.6	1.6	2.0	1.9	1.9	2.6	1.8	2.4	2.1	2.3	1.60	3.63
Physical			1	2	3	2	2	3	2	3	2	1	2	1	3
Recreational			1	1	2	1	1	2	1	1	1	1	1	1	2

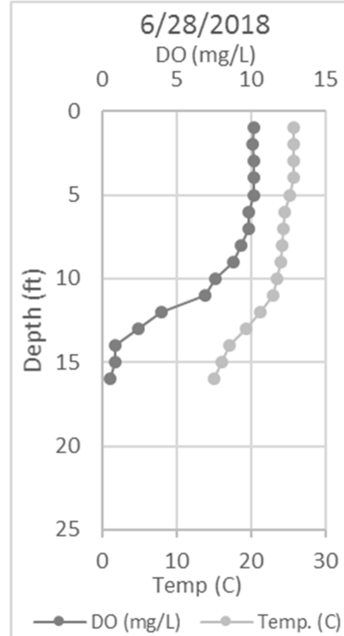
*reporting limit

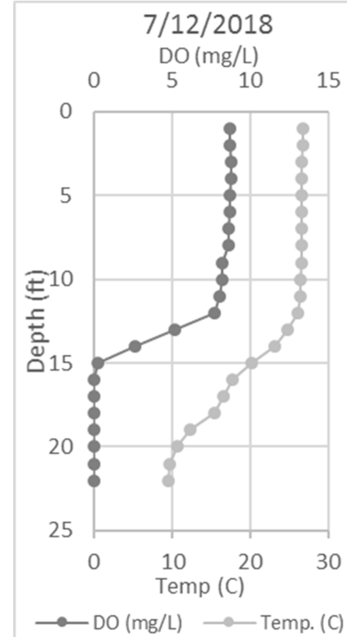
Crooked Lake Profiles

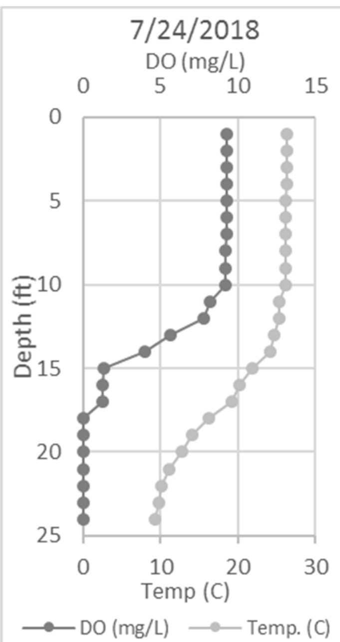


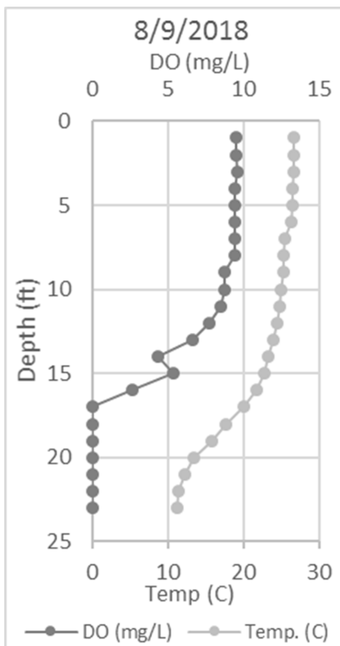


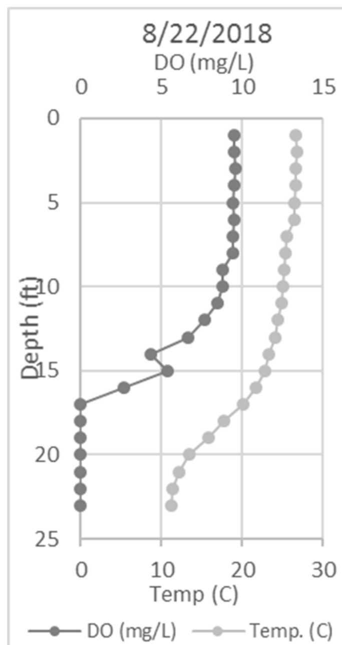


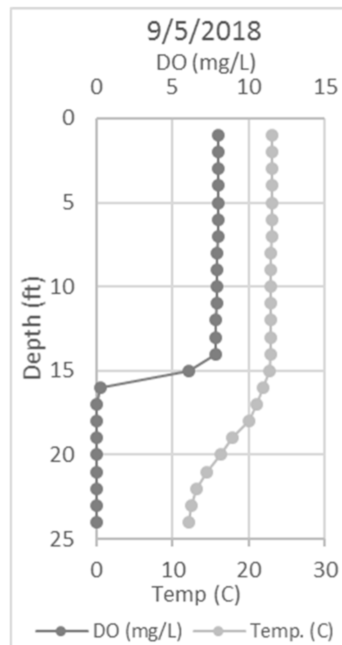


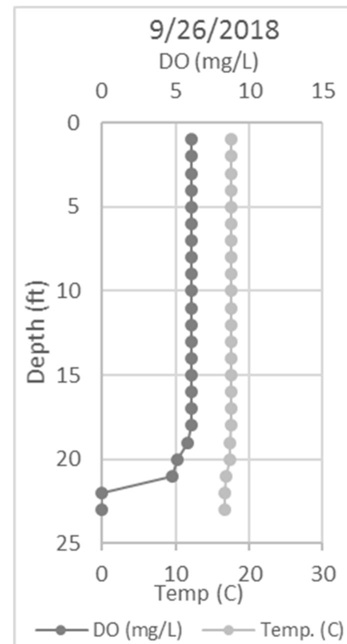












Lake Netta

City of Ham Lake, Lake ID # 02-0052

Background

Lake Netta is located in the central portion of Anoka County, southwest of Coon Lake. It has a surface area of 168 acres and a maximum depth of 19 ft. (5.8 m). There is a small, steep, public canoe access on the west side of the lake in the Gladys Jones neighborhood park. The lake receives little recreational use due to the difficulty of public access. The lakeshore is partially developed, with houses along the east and southeast portions of the lake. The watershed is a mixture of residential, commercial, and vacant land, but is under development pressure. An invasive species survey was conducted in 2018 throughout the littoral zone and high priority areas of Lake Netta. For the first time an invasive species, purple loosestrife, was found on a floating island and near the access. Samples were collected and documentation was submitted to the DNR as required.

2018 Results

Lake Netta once again had above-average water quality for this region of the state (NCHF Ecoregion) in 2018, achieving an overall A letter grade for the fourth consecutive monitoring year since 2013. This overall high mark was driven by low concentrations of total phosphorus and chlorophyll-*a* as well as high Secchi transparency. The 2018 average for total phosphorus (18 µg/L) was the second lowest recorded since intensive monitoring began in 1997. The lowest average on record occurred in 2015. Chlorophyll-a concentrations have been low in Lake Netta since 1999. In 2018, the average chlorophyll-a concentration was just 3.6 µg/L. Secchi transparency averaged 10.9 ft. in 2018, the highest on record for this lake. Other water quality parameters were similar to previous years indicating the stability of the clear water and healthy submerged vegetation community in this system.

Trend Analysis

Fifteen years of water quality data have been collected by the Anoka Conservation District (1997-1999, 2001, 2003-2004, 2006-2007, 2009-2010, 2012-2013 and 2015-2016, 2018), along with Secchi depth measurements by citizens five additional years. Lake water quality has fluctuated between "A" and "B" letter grades overall. In 2016 and 2018, statistically significant changes became apparent. In 2016 there was a statistically significant improvement in water quality (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,11} = 3.87$, $p = 0.05$). In 2018 when the same analyses were performed they appeared statistically significant ($F_{2,12} = 4.28$, $p =<0.05$), however, upon further analysis it was revealed that the data distribution was not normal for TP or Chl-A and therefore the results of the MANOVA are not validated. If Lake Netta continues to have very good water quality in future years, it is likely the lake will show a stronger statistical improvement. In the meantime, there is nothing to be concerned about water quality-wise in the lake.

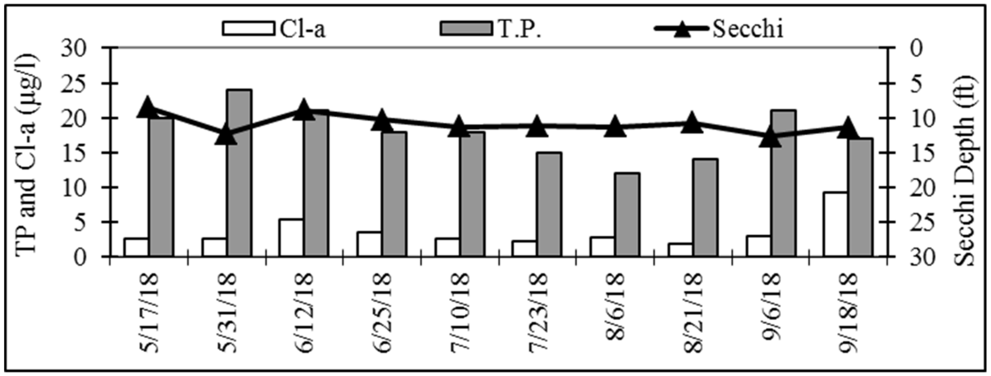
Discussion

Good water quality in Lake Netta has been maintained since 1997, when ACD began regularly monitoring water quality. Good water quality in this lake is due in part to its small watershed; it receives little direct runoff, and no streams of any consequence enter this lake. Primary production in the lake is dominated by a robust submerged macrophyte (large plant) community instead of by algae. The plants are essential to maintaining good water quality because they sequester nutrients from the water column, making them unavailable to algae. They also minimize sediment disturbance by wind or boats and provide refuges for zooplankton, particularly daphnia, which consume algae. Maintaining good water quality in this lake will be, in large part, dependent upon protecting the in-lake aquatic vegetation, the lake's excellent water clarity, as well as maintenance of vegetated buffers near the water's edge by property owners.

LAKE NETTA

City of Ham Lake, Lake ID # 02-0052

2018 Results



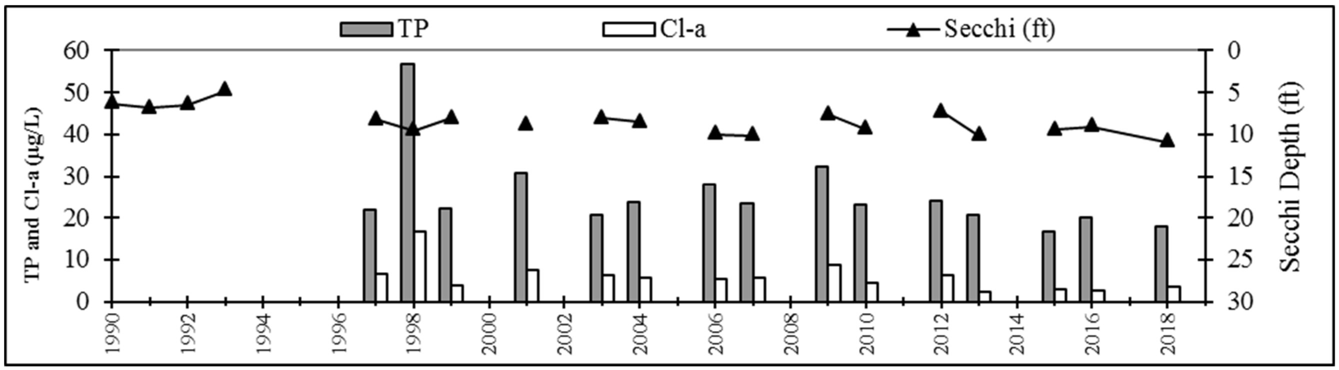
2018 Median Values

pH		7.43
Specific Conductivity	mS/cm	0.238
Turbidity	NTU	0.50
D.O.	mg/l	7.62
D.O.	%	90.20
Temp.	°F	75.2
Salinity	%	0.1
Cl-a	µg/L	2.8
T.P.	µg/l	18.0
Secchi	ft	11.2

Historical Report Card

Year	TP	Cl-a	Secchi	**Overall**
1975			B	
1990			C	
1991			C	
1992			C	
1993			C	
1997	A	A	B	**B**
1998	C	B	B	**B**
1999	A	A	B	**A**
2001	B	A	B	**B**
2003	A	A	B	**A**
2004	B	A	B	**A**
2006	B	A	B	**B+**
2007	B	A	A	**B+**
2009	C	A	B	**B**
2010	A	A	B	**A-**
2012	B	A	B	**B+**
2013	A	A	A	**A**
2015	A	A	B	**A**
2016	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.*	5/17/2018	5/31/2018	6/12/2018	6/25/2018	7/10/2018	7/23/2018	8/6/2018	8/21/2018	9/6/2018	9/18/2018	Average	Min	Max
Time:			9:20	8:50	11:55	13:08	9:05	11:40	12:11	11:25	11:33	11:10			
pH		0.1	8.29	7.44	8.08	7.90	6.95	7.41	7.76	7.11	7.30	7.42	7.6	6.95	8.29
Specific Conductivity	mS/cm	0.01	0.260	0.269	0.240	0.247	0.235	0.240	0.201	0.198	0.212	0.219	0.2	0.20	0.27
Turbidity	NTU	1	1.40	0.50	0.00	1.40	10.00	0.300	0.00	0.20		12.10	6.2	0.00	29.90
D.O.	mg/l	0.01	8.29	7.20	7.31	8.12	7.97	7.93	8.33	6.22	5.92	7.17	7.4	5.92	8.33
D.O.	%	1	94.4	86.0	85.0	100.2	101.5	98.8	97.8	75.1	66.2	78.7	88.4	66.2	101.5
Temp.	°C	0.1	20.06	24.60	21.84	24.54	26.71	25.34	23.64	24.31	21.71	22.04	23.5	20.06	26.71
Temp.	°F	0.1	68.1	76.3	71.3	76.2	80.1	77.6	74.6	75.8	71.1	71.7	74.3	68.11	80.08
Salinity	%	0.01	0.12	0.13	0.00	0.12	0.11	0.12	0.10	0.10	0.10	0.10	0.1	0.00	0.13
Cl-a	µg/L	1	2.67	2.67	5.34	3.6	2.7	2.3	2.8	2.0	3.1	9.3	3.6	1.97	9.27
T.P.	mg/l	0.005	0.020	0.024	0.021	0.018	0.018	0.015	0.012	0.014	0.021	0.017	0.0	0.01	0.02
T.P.	µg/l	5	20	24	21	18	18	15	12	14	21	17	18.0	12.00	24.00
Secchi	ft		8.5	12.3	8.9	10.3	11.3	11.2	11.3	10.8	12.7	11.4	10.9	8.50	12.67
Secchi	m		2.6	3.8	2.7	3.1	3.4	3.4	3.4	3.3	3.9	3.5	3.3	2.59	3.86
Physical			1	2	3	2	2	3	2	3	2	1	2	1	3
Recreational			1	1	2	1	1	2	1	1	1	1	1	1	2

*reporting limit

Sunrise Lake

City of Blaine, Lake ID # 00-147

Background

Sunrise Lake is a 160 acre constructed lake that was dug in 2004-2005 as part of The Lakes development in Blaine. The lake is a series of many bays surrounded by high density housing developments. The bays are irregularly shaped with many peninsulas to maximize lakefront property potential. Sunrise Lake is a private lake offering access only to residents. On the north side of the lake's largest bay there is a public park with a beach operated by the City of Blaine. A community boat launch exists on the northwest side of the lake's second largest, and northernmost, basin. Only electric trolling motors are allowed on Sunrise Lake.

The lake serves as a point of confluence for many individual laterals of County Ditch 41, which eventually becomes Sand Creek. Monitoring occurred at the deepest point in the second largest bay across from the community access. This site was selected because it is one of the deepest points in the basin complex (16-17 feet), it is downstream of the largest bay, which contains the public beach, and it is near the community access making it accessible by paddling on the motor-restricted lake. 2018 was the first year that ACD monitored the water quality of Sunrise Lake. Bi-weekly lake water quality data was collected from May through September.

2018 Results

In 2018 Sunrise Lake received an overall letter grade of B- on the grading scale for natural lakes in this ecoregion (NCHF). The average total phosphorus was 31.0 µg/L. The average chlorophyll-a concentration was 14.7 µg/L. Secchi transparency averaged 5.9 ft. Other than Chlorophyll-a, these parameters would comply with state water quality standards if Sunrise Lake were a natural public waterbody. Chlorophyll-a averaged just above the state standard of 14 µg/L, but it is impossible to know yet whether 2018 had typical conditions for this lake.

ACD also performed an AIS survey in 2018 on the two largest bays of Sunrise Lake. The invasive plant, curly-leaf pondweed was present throughout the littoral areas of the bays. The most abundant plant noted during the late summer assessment was the native plant spiny naiad (*Najas marina*). Spiny naiad is native to this part of Minnesota, but was growing to very thick, potentially nuisance levels throughout many areas of the bays. Sunrise Lake is a unique aquatic micro-culture considering the unnatural basin was dug just over a decade ago, and access is not granted to the public. It is possible that spiny naiad was able to flourish in this lake, unlike in natural lakes, due to the lack of other plants, and thus competition, that has occurred over thousands of years in natural lakes. Sunrise Lake is home to a few other native macrophyte species but is likely very vulnerable to the infestation of additional invasive species because of its unnatural origin and the dominance of its macrophyte community by one species. A stand of invasive *Phragmites australis* was spotted near the Lakes Parkway bridge, and a stand of milfoil with intermediate traits of both native milfoil and EWM was discovered in the southeastern arm of the large bay.

Trend Analysis

This was the first year of water quality data collection at Sunrise Lake so trend analysis is not possible.

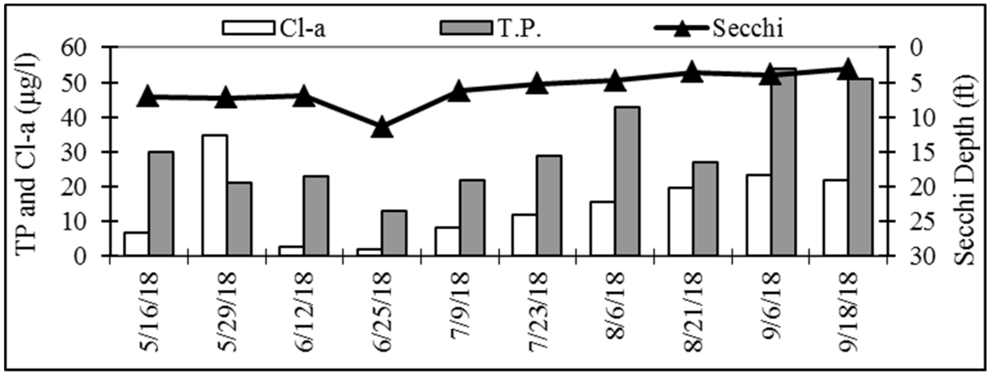
Discussion

Sunrise Lake had relatively good water quality considering the high level of development on its immediate shoreline and beyond. To maintain water quality in this basin, it is important to promote shoreline buffers, minimize the effects of sand erosion on public and private beaches, and treat stormwater before it flows into the lake. Curly-leaf pondweed was dense in some areas of Sunrise Lake in a year that populations were greatly suppressed in other lakes due to late ice out. It is possible that this invasive plant will be a recreation, and potentially a water quality, issue in the near future.

Sunrise Lake

City of Blaine, Lake ID # 00-147

2018 Results



2018 Median Values

pH		7.98
Specific Conductivity	mS/cm	0.992
Turbidity	NTU	2.90
D.O.	mg/l	9.00
D.O.	%	112.34
Temp.	°F	75.5
Salinity	%	0.5
Cl-a	µg/L	13.8
T.P.	µg/l	28.0
Secchi	ft	5.7

Historic Report Card

Year	TP	Cl-a	Secchi	**Overall**
2018	B	B	C	**B-**
State Standards	40 µg/L	14 µg/L	>4.6 ft	

2018 Water Quality Data

	Units	R.L.*	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:			14:45	12:00	12:45	13:54	14:18	12:30	13:05	12:25	12:23	12:30			
pH		0.1	8.67	8.46	8.02	8.10	8.13	7.94	7.81	7.49	7.36	7.46	7.9	7.36	8.67
Specific Conductivity	mS/cm	0.01	0.993	1.057	0.990	1.060	1.084	1.096	0.919	0.923	0.961	0.984	1.0	0.92	1.10
Turbidity	NTU	1	2.90	1.20	0.00	1.30	2.10	4.900	6.30	5.70		12.10	7.4	0.00	37.50
D.O.	mg/l	0.01	13.73	9.82	8.35	8.63	9.60	9.93	9.36	8.52	7.02	8.37	9.3	7.02	13.73
D.O.	%	1	154.4	122.9	98.5	110.1	121.1	128.0	114.6	104.7	81.7	98.5	113.4	81.7	154.4
Temp.	°C	0.1	21.46	24.43	21.80	24.33	27.57	25.73	24.03	24.63	22.10	22.33	23.8	21.46	27.57
Temp.	°F	0.1	70.6	76.0	71.2	75.8	81.6	78.3	75.3	76.3	71.8	72.2	74.9	70.63	81.63
Salinity	%	0.01	0.49	0.52	0.49	0.52	0.54	0.55	0.45	0.46	0.47	0.49	0.5	0.45	0.55
Cl-a	µg/L	1	6.68	34.70	2.67	1.9	8.4	11.9	15.6	19.8	23.2	22.0	14.7	1.91	34.70
T.P.	mg/l	0.005	0.030	0.021	0.023	0.013	0.022	0.029	0.043	0.027	0.054	0.051	0.0	0.01	0.05
T.P.	µg/l	5	30	21	23	13	22	29	43	27	54	51	31.3	13.00	54.00
Secchi	ft		7.1	7.3	6.9	11.4	6.3	5.2	4.8	3.6	3.9	3.1	5.9	3.08	11.42
Secchi	m		2.2	2.2	2.1	3.5	1.9	1.6	1.4	1.1	1.2	0.9	1.8	0.94	3.48
Physical			2	2	1	1	2	1	1	1	2	2	2	1	2
Recreational			2	2	1	1	1	1	1	1	1	1	1	1	2

*reporting limit

Cenaiko Lake

City of Coon Rapids, Lake ID # 00-451

Background

Cenaiko Lake is a 29 acre constructed lake within the Coon Rapids Dam Regional Park. The lake reaches a maximum depth of 36 feet and is stocked with rainbow trout. Cenaiko Lake is a designated trout lake with more stringent water quality standards than other lakes in the area. The lake has a very small contributing drainage area with Coon Creek passing immediately by the east side of the lake, and the Mississippi River to the west. There is a small parking lot on the east side of the lake and a walking trail with a fishing pier on the west side. There is no boat access to the lake, though it is a popular shore-fishing destination. An additional trout stamp is required to legally fish on Cenaiko Lake, and fishing is only allowed during the trout fishing season. From 1997 to 2012, the Met Council monitored Cenaiko Lake annually. Since then, no data was collected until 2018. During 2018, biweekly lake water quality data was collected from May through September.

2018 Results

Cenaiko Lake had good water quality, receiving an overall A- letter grade in 2018 when graded on Met Councils scale for natural lakes in this ecoregion of the state (NCHF). The average total phosphorous concentration was 13.0 µg/L, well below the trout lake state water quality standard of 20 µg/L. Chlorophyll-a averaged 3.1 µg/L, compared to the trout lake state standard of 6 µg/L. The average Secchi transparency was 9.6 ft. (2.9 meters). While total phosphorus and chlorophyll-a concentrations each earned an A letter grade individually, Secchi transparency was given a B letter grade being just 0.1 m under the threshold of 3.0 m on average. The the 2.9 meter average Secchi transparency also complies with the trout lake state standard of 2.5 meters.

Trend Analysis

There are 17 years of Secchi transparency and phosphorus data for Cenaiko Lake and 13 years of chlorophyll-a data. A MANOVA was performed for the 17 years of Secchi and phosphorus data and then on the 13 years of Secchi, phosphorus, and chlorophyll-a data. In both cases no statistically significant trend was found**.** The lack of a trend is not a bad thing for a lake with very good water quality. It appears that Cenaiko Lake’s track record of good water quality is not compromised.

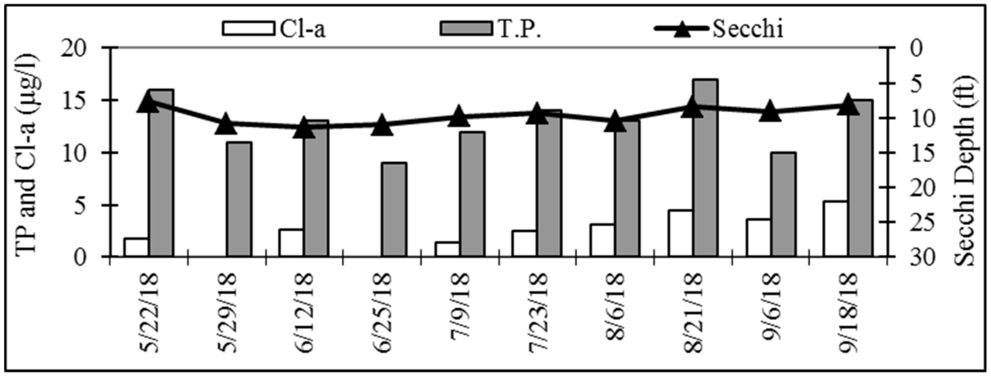
Discussion

There has been no water quality data collection in Cenaiko Lake since 2012. Prior to 2012 the lake had good water quality scoring either an A or a B for all years monitored. The only poorly performing metric was average Secchi transparency which was no more than 6.4 ft. (2 m.) from 2008-2012, earning a C for that particular parameter. In 2018 the lake had good water quality throughout the monitoring season, but the littoral areas became choked out by the invasive macroyphyte Eurasian watermilfoil. This year, as in years past, chlorophyll-a and phosphorus were very low for a lake in this region.

Cenaiko Lake

City of Coon Rapids, Lake ID # 00-451

2018 Results



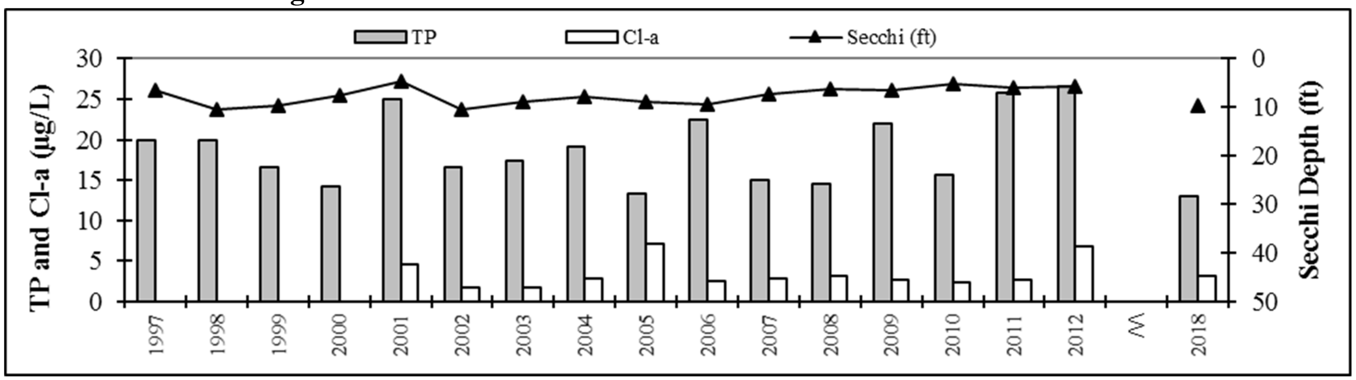
2018 Median Results

pH		8.57
Specific Conductivity	mS/cm	0.493
Turbidity	NTU	1.20
D.O.	mg/l	9.24
D.O.	%	111.50
Temp.	°F	75.4
Salinity	%	0.2
Cl-a	µg/L	2.9
T.P.	µg/l	13.0
Secchi	ft	9.6

Historical Report Card

Year	TP	Cl-a	Secchi	Overall
1997	A		C	
1998	A		A	
1999	A		B	
2000	A		B	
2001	B	A	C	**B**
2002	A	A	A	**A**
2003	A	A	B	**A**
2004	A	A	B	**A**
2005	A	A	B	**A**
2006	A	A	B	**A**
2007	A	A	B	**A**
2008	A	A	C	**B**
2009	A	A	C	**B**
2010	A	A	C	**B**
2011	B	A	C	**B**
2012	B	A	C	**B**
/\/\				
2018	A	A	B	**A**
State Standards	20 µg/L	6 µg/L	>8.2 ft	

Historic Annual Averages



2018 Water Quality Data

	Units	R.L.*	5/22/2018	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:			14:18	13:03	13:40	14:45	15:15	13:20	14:00	13:20	13:20	13:15			
pH		0.1	8.49	8.51	8.35	8.77	9.14	9.23	9.07	8.62	8.10	8.03	8.6	8.03	9.23
Specific Conductivity	mS/cm	0.01	0.594	0.570	0.438	0.500	0.497	0.506	0.424	0.428	0.463	0.489	0.5	0.42	0.59
Turbidity	NTU	1	3.60	1.10	0.00	1.20	0.00	1.600	0.80	2.00		11.50	2.4	0.00	30.90
D.O.	mg/l	0.01	9.87	9.62	--	9.67	8.67	9.24	9.51	7.98	7.57	7.56	8.9	7.56	9.87
D.O.	%	1	110.0	120.5	--	111.5	111.9	116.6	115.9	97.5	86.4	86.5	106.3	86.4	120.5
Temp.	°C	0.1	19.77	26.00	22.01	25.15	27.65	26.23	23.78	24.39	21.82	22.06	23.9	19.77	27.65
Temp.	°F	0.1	67.6	78.8	71.6	77.3	81.8	79.2	74.8	75.9	71.3	71.7	75.0	67.59	81.77
Salinity	%	0.01	0.28	0.28	0.21	0.24	0.24	0.25	0.21	0.21	0.22	0.23	0.2	0.21	0.28
Cl-a	µg/L	1	1.78	<1	2.67	<1	1.4	2.5	3.1	4.5	3.7	5.3	2.7	<1	5.34
T.P.	mg/l	0.005	0.016	0.011	0.013	0.009	0.012	0.014	0.013	0.017	0.010	0.015	0.0	0.01	0.02
T.P.	µg/l	5	16	11	13	9	12	14	13	17	10	15	13.0	9.00	17.00
Secchi	ft		7.7	10.8	11.4	11.0	9.8	9.3	10.5	8.4	9.1	8.2	9.6	7.67	11.42
Secchi	m		2.3	3.3	3.5	3.4	3.0	2.8	3.2	2.6	2.8	2.5	2.9	2.34	3.48
Physical			2	2	2	2	2	2	2	1	2	2	2	1	2
Recreational			2	2	1	1	1	2	2	2	3	3	2	1	3

*reporting limit

Stream Hydrology and Rating Curves

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.

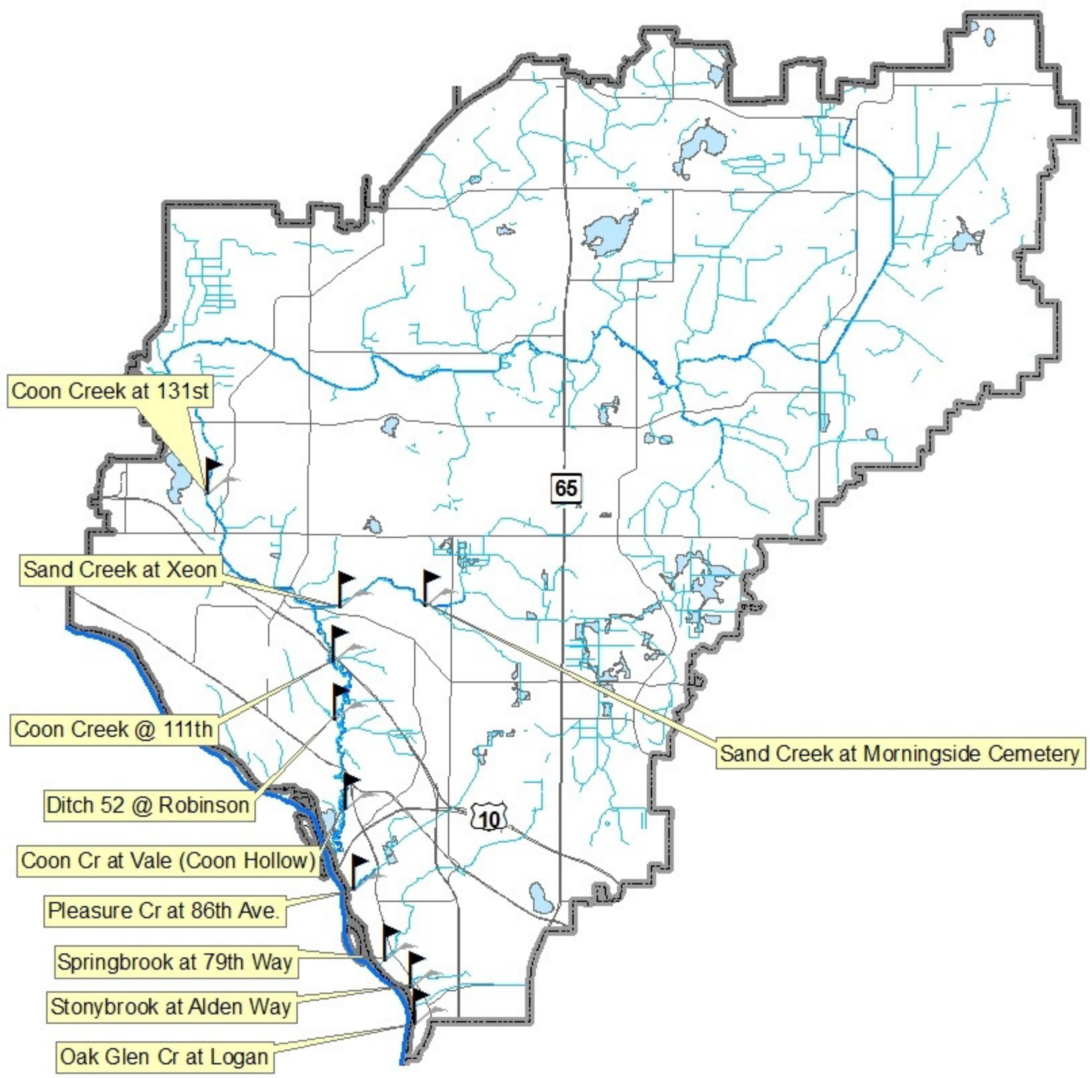
Locations:

Stream	Location	City
Coon Creek	131st St.	Coon Rapids
Coon Creek	111th Ave. NW	Coon Rapids
Coon Creek	Coon Hollow	Coon Rapids
Sand Creek	Morningside Cemetery	Coon Rapids
Sand Creek	Xeon St.	Coon Rapids

Stream	Location	City
Pleasure Creek	86th Ave. NW	Coon Rapids
Ditch 52	Robinson Park	Coon Rapids
Springbrook	79th Way NE	Fridley
Stonybrook	Alden Way	Fridley
Oak Glen Cr.	Logan Pkwy.	Fridley

Results: Results for each site are on the following pages.

Coon Creek Watershed 2018 Stream Hydrology and Rating Curves Monitoring Sites



Stream Hydrology Monitoring

COON CREEK

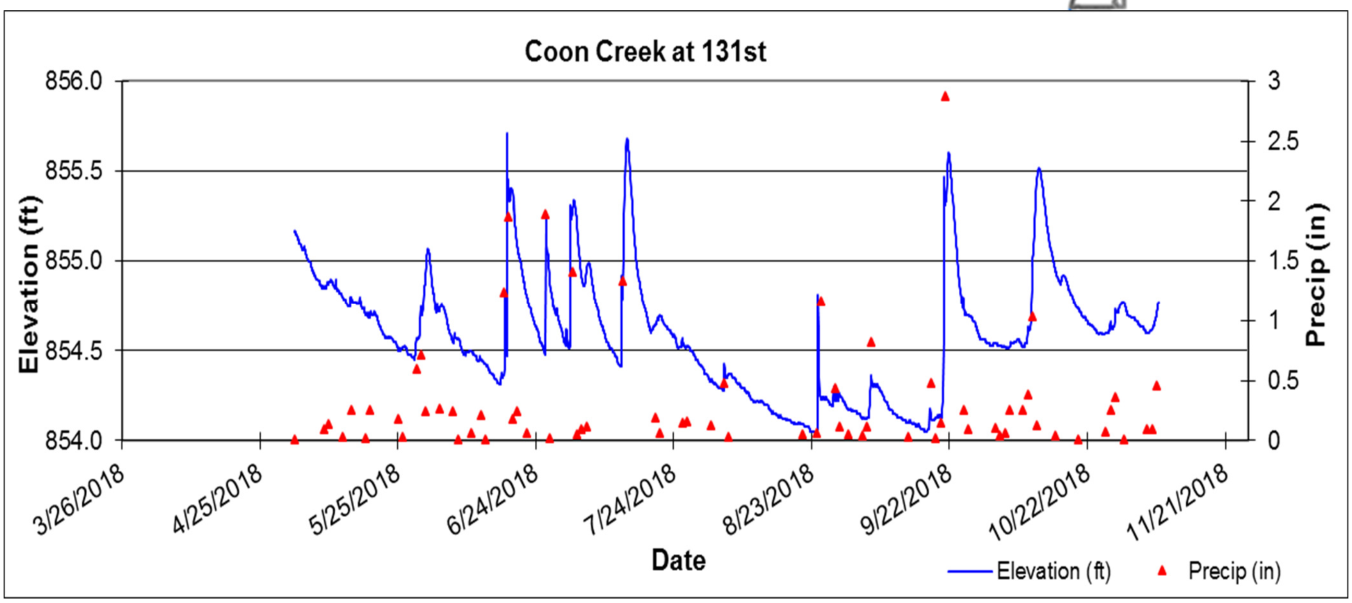
at 131st St. NE, Coon Rapids

Notes

Coon Creek is a major drainage through central Anoka County. This monitoring location is within a residential neighborhood in Coon Rapids, located just downstream of 131st Street NE. Land use in the upstream watershed ranges from rural residential to highly urbanized. The creek is approximately 35 ft. wide and 1.5 to 2 ft. deep at the monitoring site during baseflow.

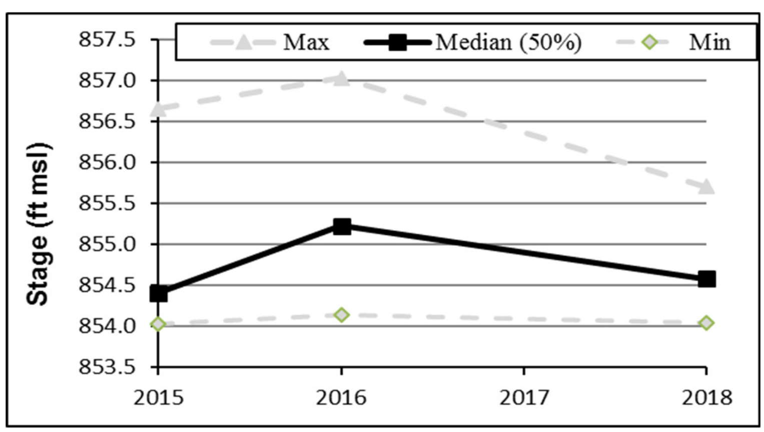
Stream levels were monitored for the first time at this site in 2015. This site does not show a great deal of variation. In 2018 water levels only varied by 1.67 ft. A rating curve has not been developed for this site

2018 Hydrograph



Summary of All Monitored Years

Percentiles	2015	2016	2018
Min	854.03	854.14	854.04
2.5%	854.09	854.32	854.08
10.0%	854.16	854.45	854.13
25.0%	854.27	854.71	854.32
Median (50%)	854.41	855.23	854.58
75.0%	854.68	855.65	854.76
90.0%	855.03	855.88	855.02
97.5%	855.79	856.19	855.40
Max	856.66	857.04	855.71

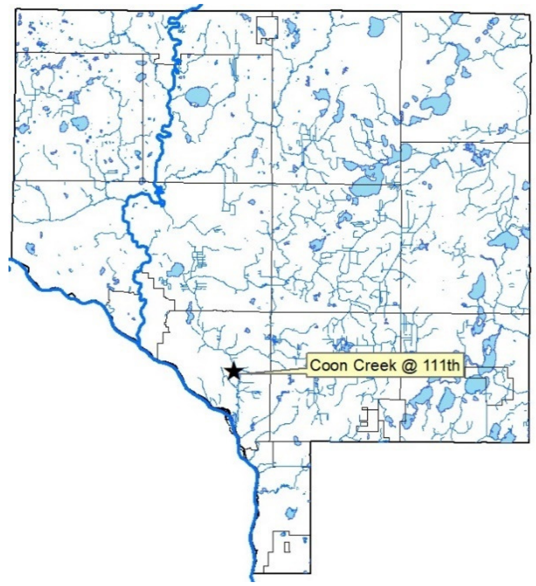


COON CREEK

at 111th Ave. NW, Erlandson Park, Coon Rapids

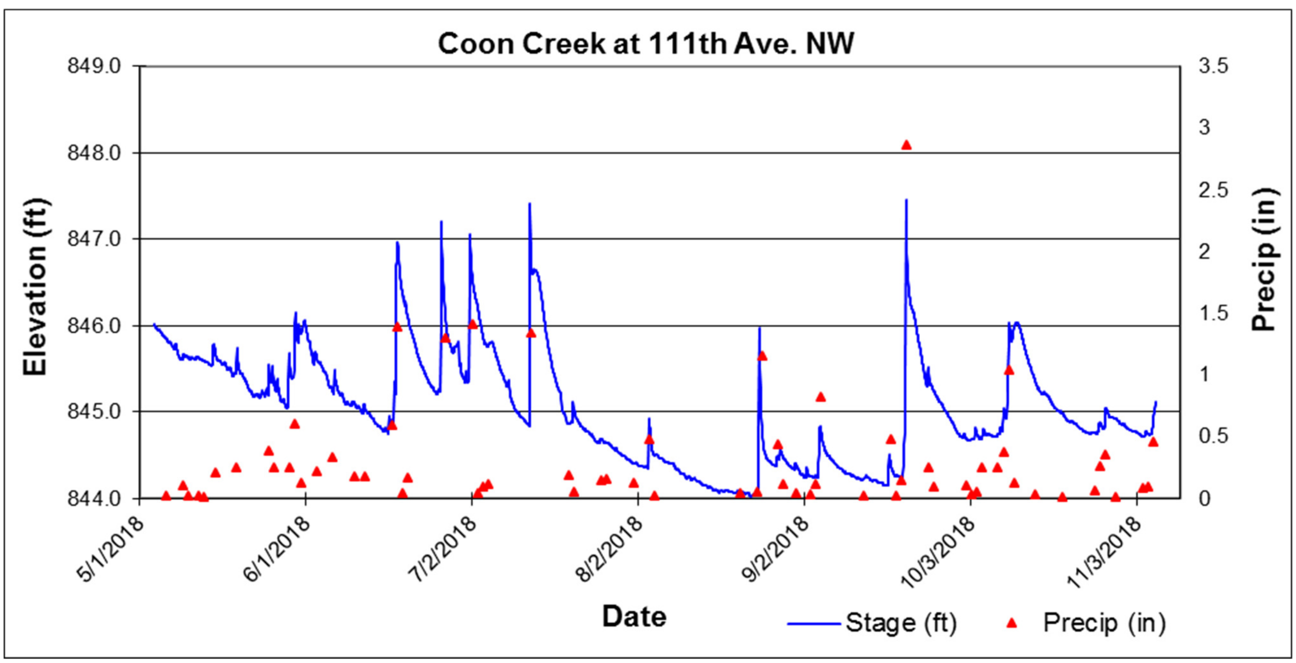
Notes

Coon Creek is a major drainage through central Anoka County. This site is located on the north side of Erlandson Park in the City of Coon Rapids about 1 mile downstream of the Sand Creek confluence with Coon Creek. It is also upstream of the Ditch 52 and Woodcrest Creek confluences with Coon Creek. This site was added in 2018 to assess the influence of Sand Creek, and the two systems joining downstream, on Coon Creek. The stream is approximately 35 feet wide and 1.5 to 2 feet deep during baseflow.



Stage at this site is flashy in response to storms, and the stage increase for a given storm event is about double that of Coon Creek at 131st St upstream when comparing feet of rise. During the largest storm of 2018 (2.87 inches on 9/20) stage at this site rose two feet between consecutive readings taken two hours apart. A rating curve was developed for this site in 2018 and is displayed below.

2018 Hydrograph



COON CREEK

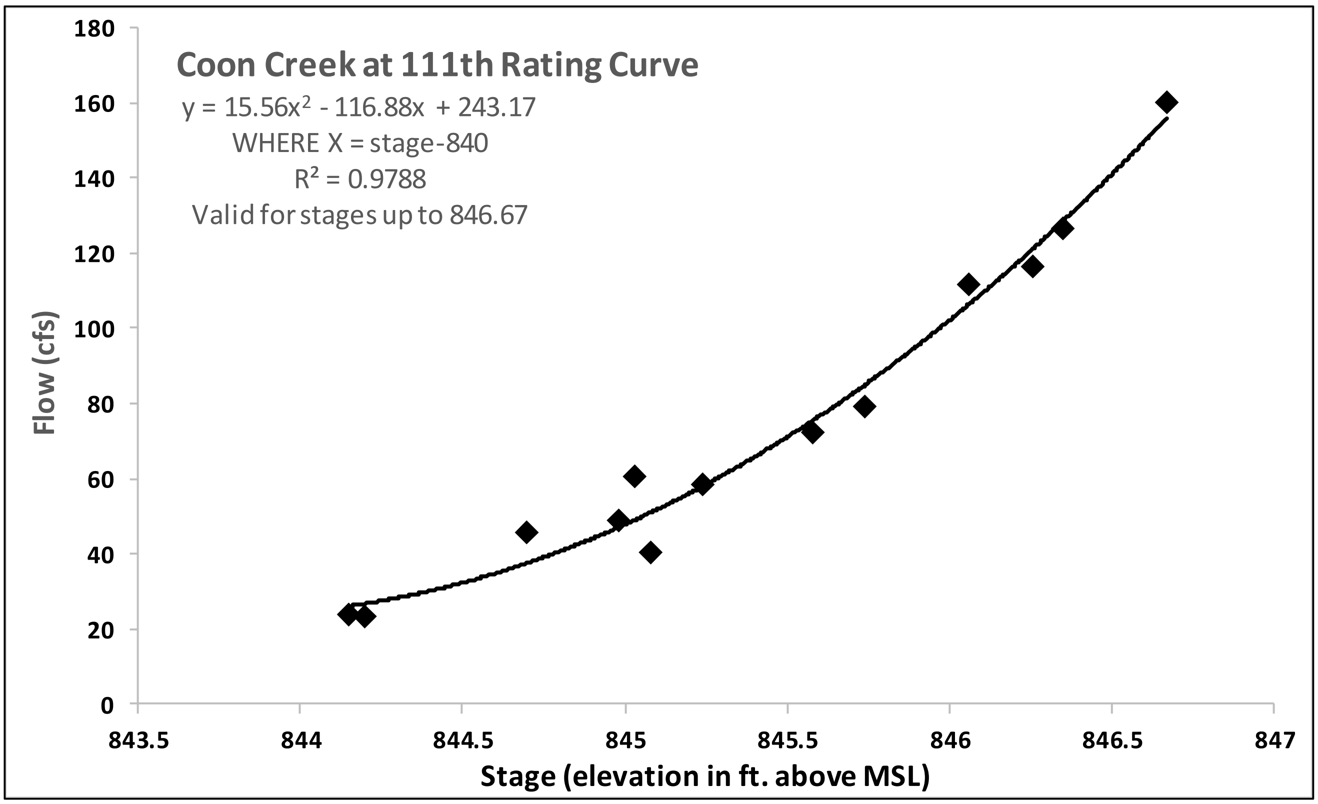
at 111th Ave. NW, Erlandson Park, Coon Rapids

Summary of All Monitoring Years*

Percentiles	2018
Min	844.02
2.5%	844.08
10.0%	844.24
25.0%	844.50
Median (50%)	844.94
75.0%	845.51
90.0%	845.88
97.5%	846.45
Max	847.46

*this is the first year of monitoring at this site.

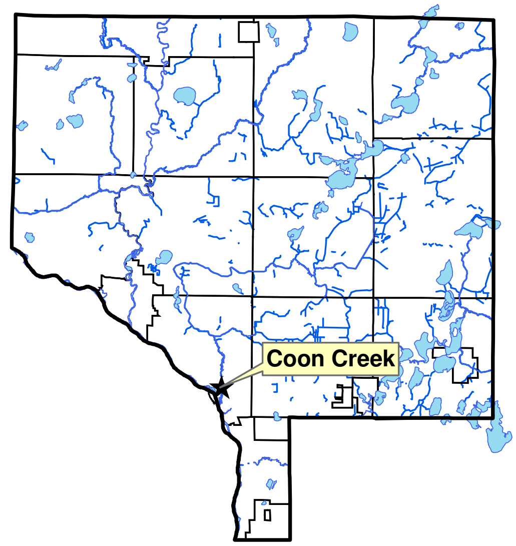
Rating Curve - 2018



COON CREEK

at Coon Creek Hollow, Vale Street, Coon Rapids

Notes

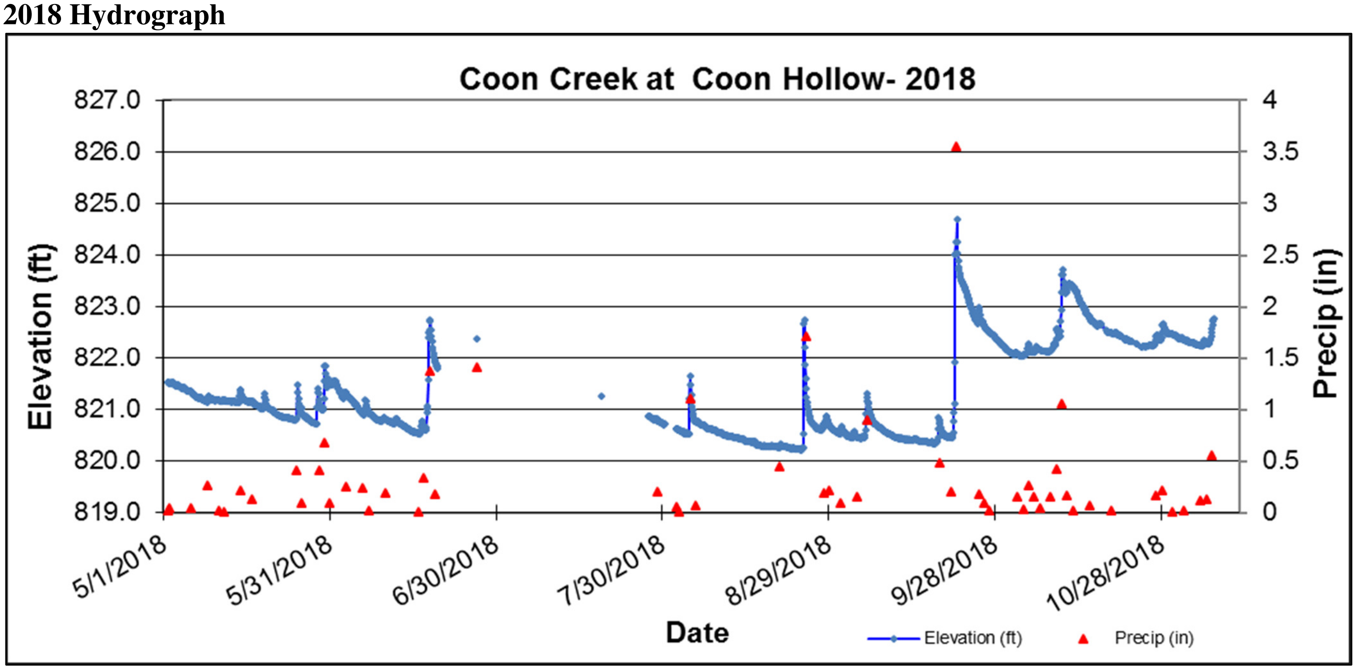


Coon Creek is a major drainage through central Anoka County. This monitoring location was chosen because it is the furthest downstream site that is accessible and does not have backwater effects from the Mississippi River downstream. It is approximately 1.5 river miles upstream of the confluence. Land use in the upstream watershed ranges from rural residential upstream to highly urbanized downstream. The creek is about 30 ft. wide and 1.5 to-2 ft. deep at the monitoring site during baseflow. Both water levels and flow are available for this site.

In 2018, Coon Creek water levels had a range of 4.47 ft. at Vale St. The maximum observed stream level (824.69 ft.) was recorded in September after a 3.56 in. rainfall event. The minimum level (820.22 ft.) was recorded in late August after a midsummer that featured primarily very small rainfall events. One large rainfall event in late September, followed by numerous smaller rainfalls kept stream levels above baseflow until freeze up. There was a data logger malfunction from late June through July at this site.

Coon Creek has flashy responses to storms, water levels rise quickly in response to precipitation, but return to baseflow conditions more slowly. The quick, intense response to rainfall is likely due to runoff from the urbanized portions of the lower watershed. The slower return to baseflow is probably due, in large part, to water being released more slowly from the less-developed upstream portions of the watershed. Several storms in 2006-2018 serve to illustrate this. In the few hours following larger storms, water levels can rise four feet or more. A 3.56 inch rainfall event in September 2018 caused stage to rise 2.11 feet in just 2 hours, and 4.23 feet overall.

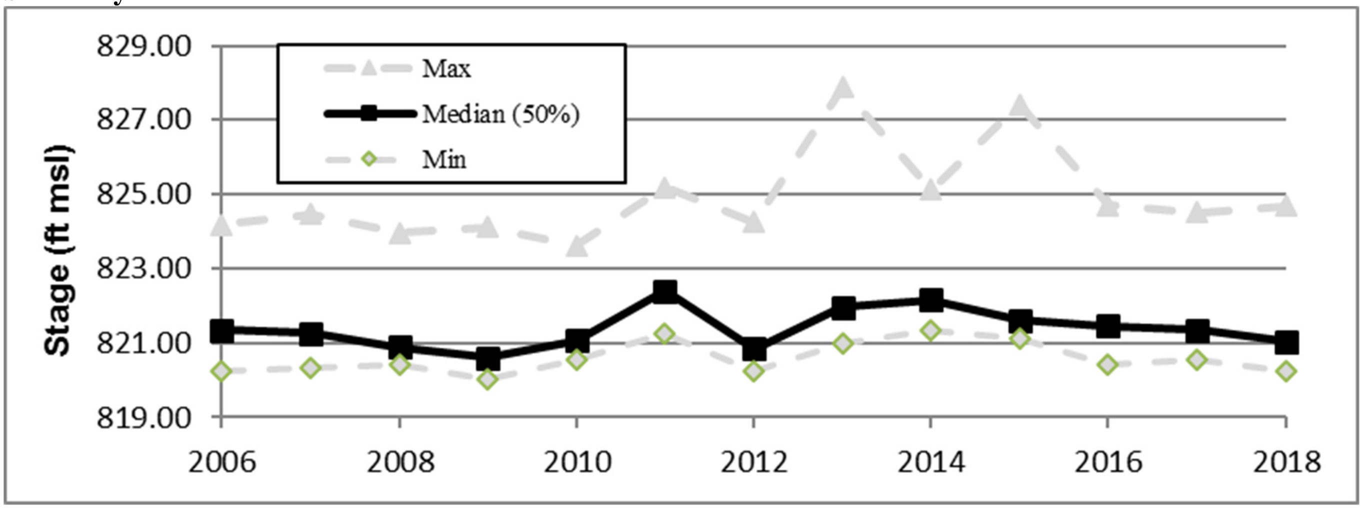
2018 Hydrograph



COON CREEK

at Coon Creek Hollow, Vale Street, Coon Rapids

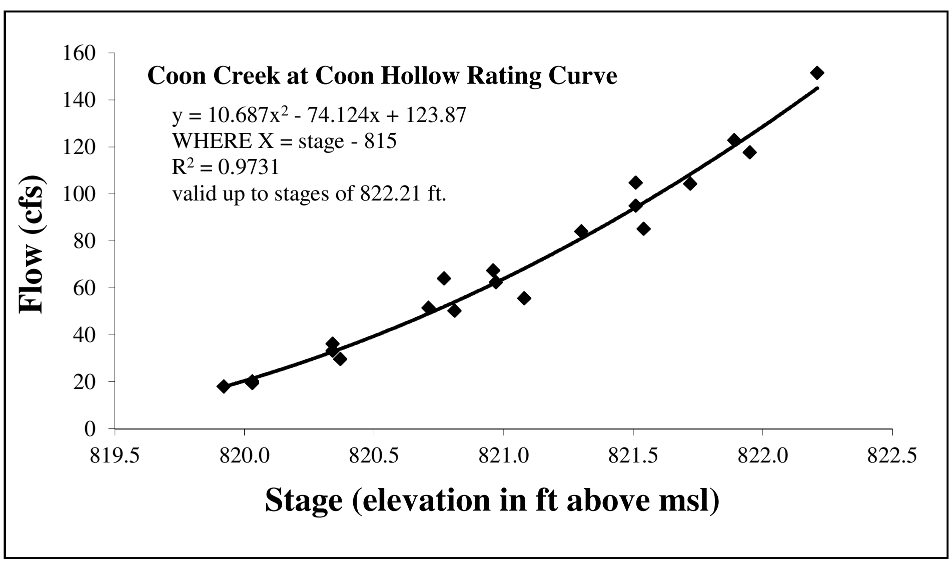
Summary of All Monitored Years



Summary of All Monitored Years

Percentiles	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Min	820.04	820.26	820.33	820.43	820.03	820.54	821.23	820.22	820.97	821.35	821.13	820.39	820.54	820.22
2.5%	820.06	820.42	820.40	820.52	820.12	820.64	821.27	820.28	820.99	821.47	821.19	820.58	820.70	820.28
10.0%	820.19	820.53	820.53	820.57	820.20	820.73	821.31	820.33	821.00	821.51	821.31	820.78	820.84	820.40
25.0%	820.57	820.78	820.73	820.63	820.35	820.85	821.83	820.45	821.20	821.67	821.41	820.99	821.08	820.60
Median (50%)	820.91	821.35	821.25	820.88	820.61	821.05	822.38	820.85	821.95	822.15	821.60	821.44	821.34	821.03
75.0%	821.26	821.78	821.88	821.78	820.93	821.32	822.99	821.28	827.87	823.33	821.92	821.91	821.72	822.21
90.0%	821.77	822.27	822.63	822.26	821.31	821.68	823.70	821.89	827.87	824.38	822.30	822.24	822.25	822.56
97.5%	822.92	822.76	823.21	822.79	822.05	822.33	824.56	823.60	827.87	824.87	823.08	822.76	823.84	823.33
Max	823.26	824.18	824.47	823.96	824.11	823.62	825.18	824.25	827.87	825.13	827.42	824.70	824.51	824.69

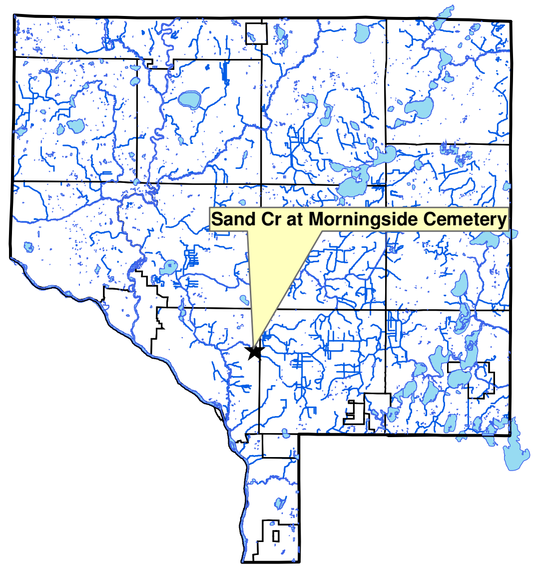
Rating Curve (2010 - updated)



SAND CREEK

at Morningside Cemetery, Coon Rapids

Notes



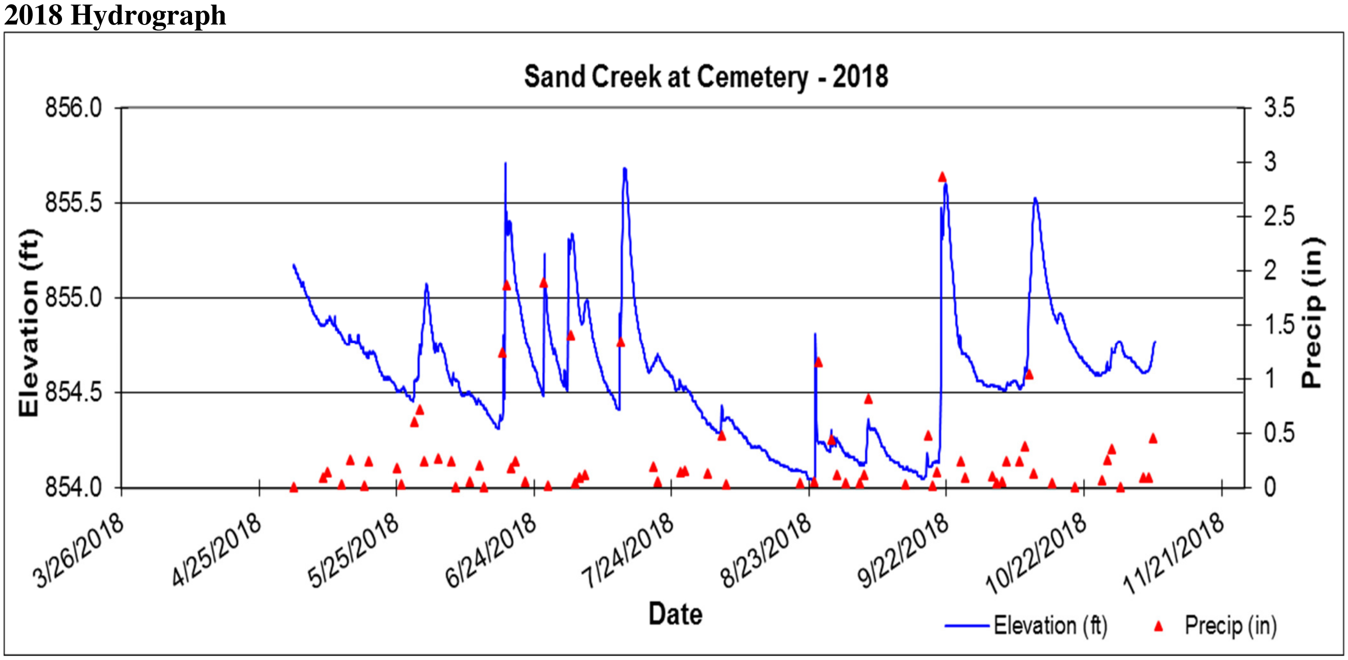
Sand Creek is the largest tributary to Coon Creek. It drains suburban residential, commercial, and retail areas throughout northeastern Coon Rapids and western Blaine. The stream is approximately 8 ft. wide and 3 ft. deep at the monitoring site during baseflow.

Sand Creek at Morningside Cemetery was first monitored in 2010. The site was added because of its position between the cities of Blaine and Coon Rapids, which provides an estimate of the flow contributions from Blaine. In addition, the site is located immediately downstream of the confluence of Ditch 39 with Sand Creek.

At this site, creek levels often rise more than downstream at Xeon Street following rainstorms. In 2018, this site fluctuated 2.24 ft. throughout the year, with the site further downstream at Xeon St. only fluctuating 1.91 ft. It is likely that flow volumes are similar or less at the cemetery, but because the channel is narrower, the vertical rise in water levels is greater. Equipment was pulled in early November, 2018 with freeze up imminent.

No rating curve exists at this site.

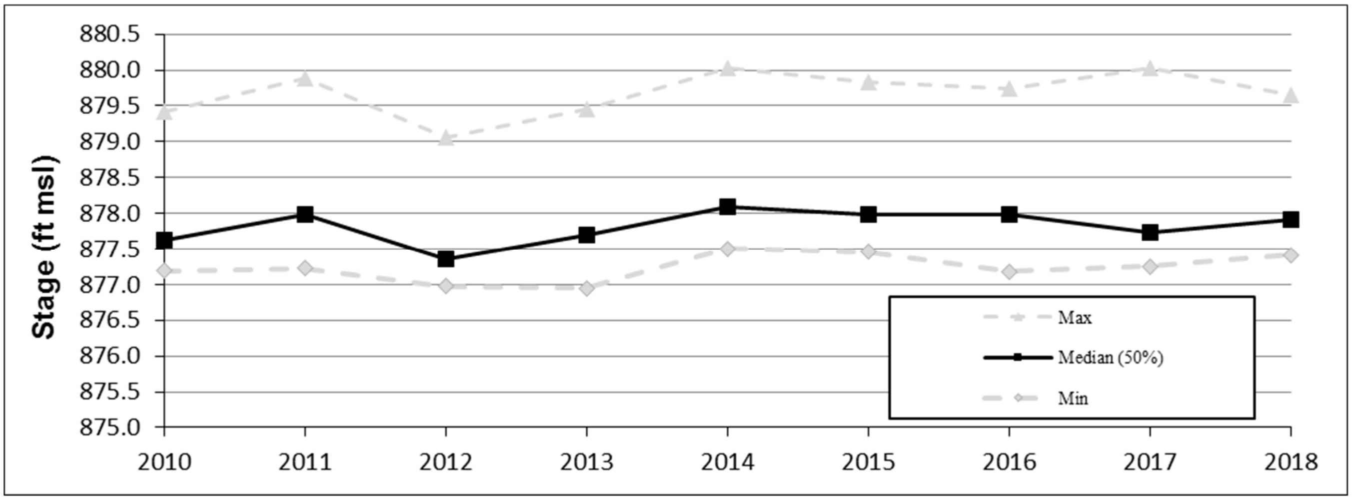
2018 Hydrograph



SAND CREEK

at Morningside Cemetery, Coon Rapids

Summary of All Monitored Years



Summary of All Monitored Years

Percentiles	2010	2011	2012	2013	2014	2015	2016	2017	2018
Min	877.19	877.22	876.98	876.95	877.51	877.46	877.18	877.25	877.41
2.5%	877.27	877.28	877.00	877.18	877.56	877.52	877.49	877.34	877.49
10.0%	877.36	877.36	877.03	877.28	877.62	877.66	877.58	877.41	877.68
25.0%	877.45	877.72	877.15	877.38	877.81	877.80	877.70	877.53	877.80
Median (50%	877.62	877.98	877.35	877.69	878.10	877.99	877.98	877.73	877.92
75.0%	877.79	878.22	877.65	877.93	878.43	878.19	878.26	877.96	878.10
90.0%	877.95	878.55	877.94	878.42	878.72	878.39	878.54	878.27	878.34
97.5%	878.26	878.86	878.38	878.75	879.16	878.70	878.93	878.80	878.60
Max	879.41	879.89	879.06	879.46	880.02	879.82	879.73	880.02	879.65

SAND CREEK

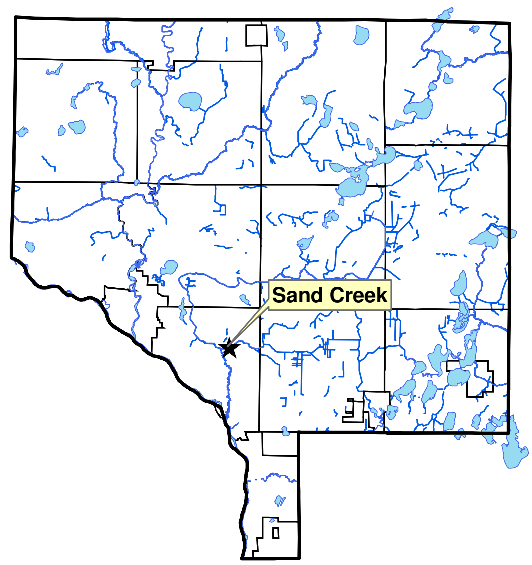
at Xeon Street, Coon Rapids

Notes

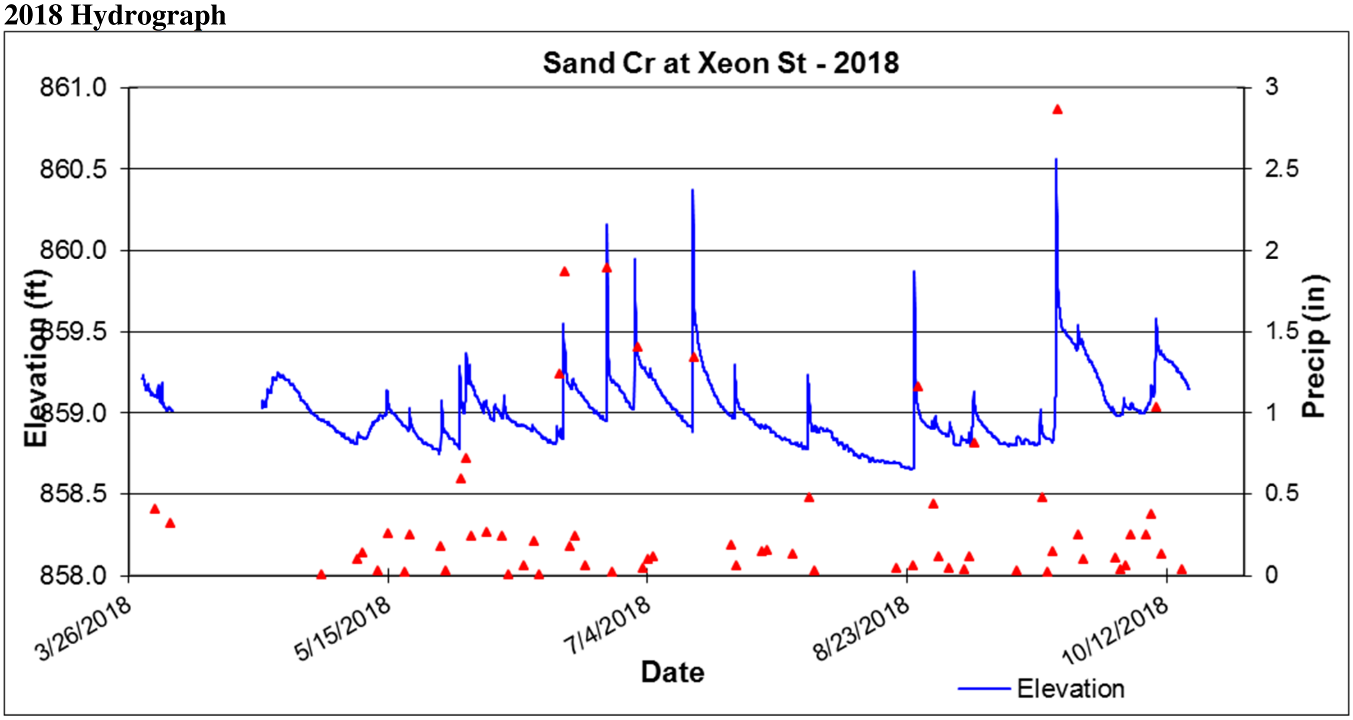
Sand Creek is the largest tributary to Coon Creek. It drains suburban residential, commercial, and retail areas throughout northeastern Coon Rapids and western Blaine. The stream is about 15 ft. wide and 3 ft. deep at the monitoring site during baseflow.

In most years, Sand Creek shows little variation in water levels. Occasionally, large storms cause water level increases of up to two feet, but these are generally short-lived. Individual storms also cause much smaller fluctuations at this site than at the further upstream site at Morningside Cemetery, with less than 2 feet of range the entire season. In 2018, this site ranged just 1.91 feet from minimum to maximum compared to 2.24 feet at Morningside Cemetery. Sand Creek maintains a similar depth throughout most of its lower watershed, and spreads out wider to accommodate its flow. Because of this, far smaller fluctuations in stage occur downstream.

A rating curve for this site was last updated in 2013 and is presented below.



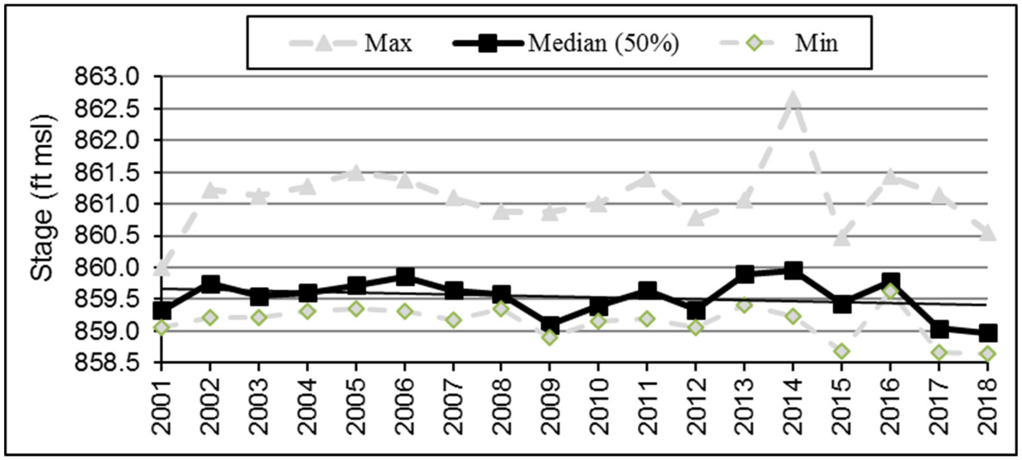
2018 Hydrograph



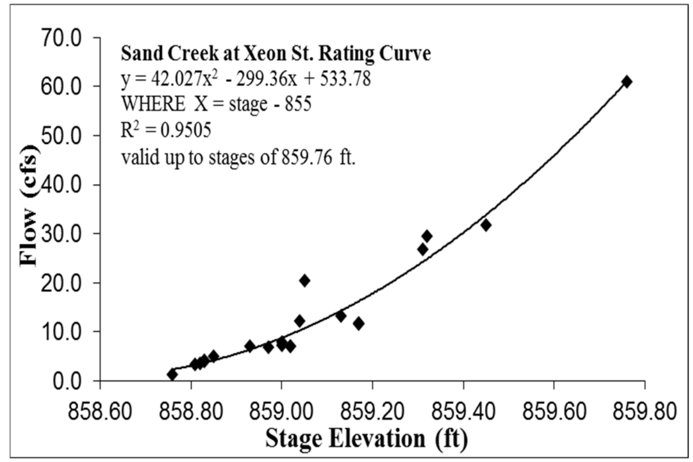
SAND CREEK

at Xeon Street, Coon Rapids

Summary of All Monitored Years



Rating Curve



Summary of All Monitored Years

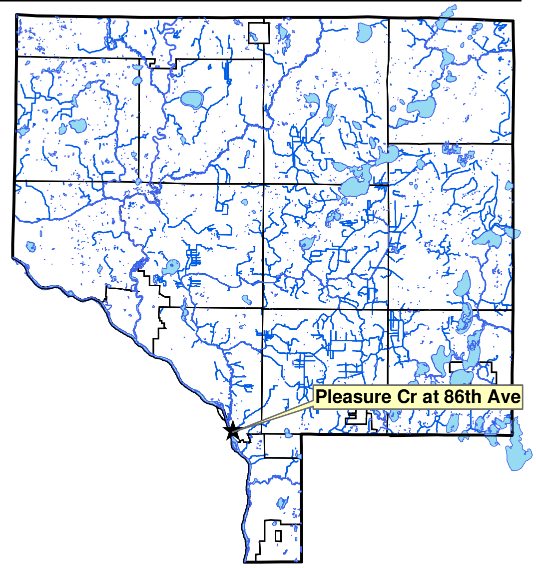
Percentiles	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Min	859.06	859.22	859.21	859.31	859.35	859.32	859.17	859.35	858.91	859.15	859.19	859.06	859.40	859.23	858.69	859.64	858.66	858.65
2.5%	859.09	859.44	859.26	859.33	859.41	859.43	859.30	859.44	858.99	859.24	859.22	859.07	859.53	859.42	858.96	859.67	858.69	858.69
10.0%	859.15	859.48	859.32	859.40	859.45	859.54	859.41	859.48	859.03	859.28	859.28	859.11	859.60	859.61	859.03	859.70	858.84	858.80
25.0%	859.23	859.61	859.41	859.46	859.55	859.70	859.47	859.53	859.05	859.33	859.47	859.18	859.70	859.79	859.16	859.73	858.94	858.85
Median (50%)	859.33	859.75	859.55	859.60	859.72	859.86	859.64	859.58	859.10	859.40	859.65	859.33	859.90	859.96	859.44	859.78	859.04	858.97
75.0%	859.49	859.93	859.75	859.80	859.97	860.01	859.81	859.78	859.29	859.52	859.89	859.53	860.04	860.28	859.66	859.84	859.36	859.11
90.0%	859.54	860.09	860.00	860.03	860.21	860.12	859.98	859.94	859.38	859.60	860.08	859.76	860.18	861.08	859.82	860.00	859.57	859.26
97.5%	859.65	860.32	860.28	860.32	860.51	860.27	860.11	860.13	859.54	859.75	860.33	860.11	860.37	861.93	860.04	860.38	859.96	859.47
Max	860.00	861.22	861.13	861.27	861.50	861.38	861.10	860.88	860.87	861.01	861.40	860.78	861.06	862.65	860.48	861.43	861.15	860.56
	0.94	2.00	1.92	1.96	2.16	2.06	1.92	1.53	1.96	1.86	2.22	1.72	1.66	3.42	1.79	1.79	2.48	1.91

PLEASURE CREEK

at 86th Ave, Coon Rapids

Notes

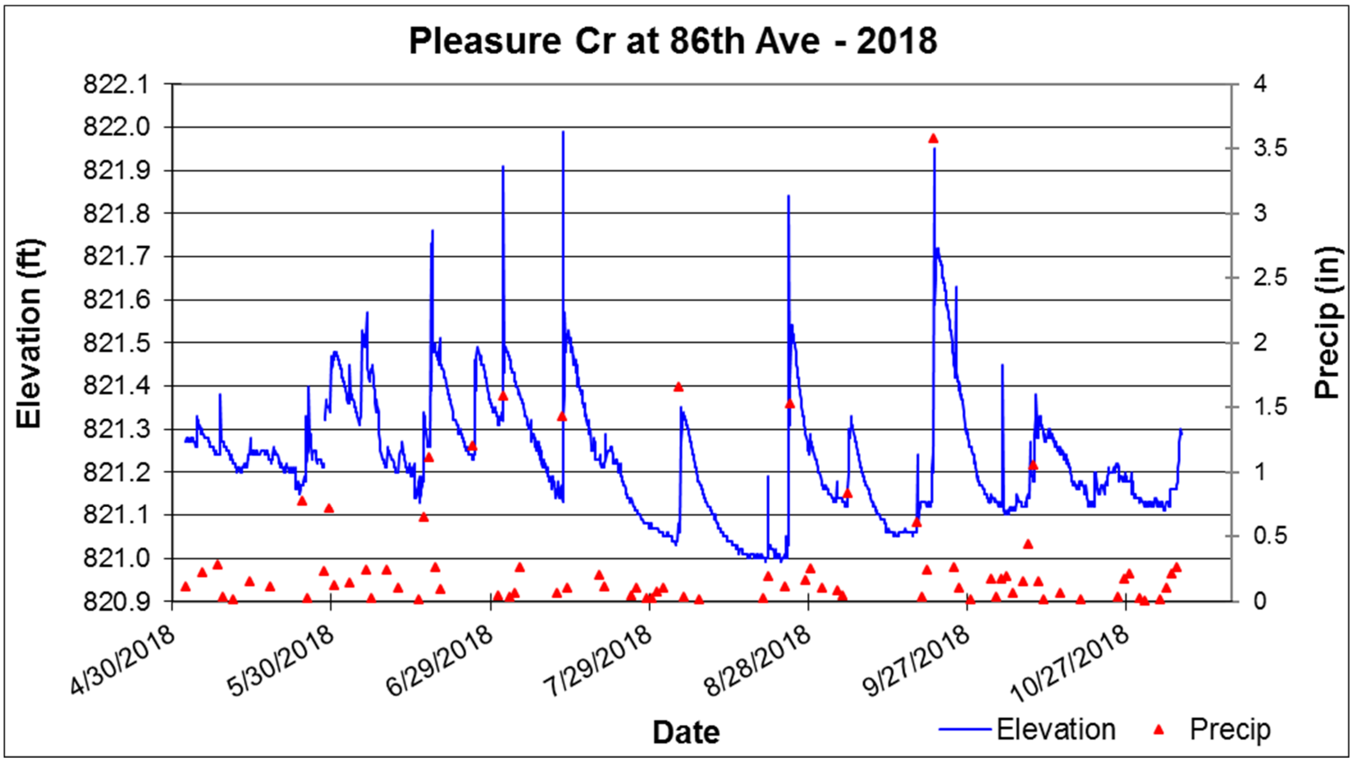
Pleasure Creek flows through the southwestern portion of Blaine and southern Coon Rapids. The watershed is urbanized. The creek is about 8-10 feet wide and 0.5 to 1 feet deep during baseflow. It flows through an interconnected network of stormwater ponds in the upper part of the watershed.



Variations in the water level at Pleasure Creek are seldom more than one foot and happen with extreme rapidity. Water level increases due to intense storm events generally peak within 2 hours of the storm's onset. A September 2018 storm of 3.58 inches caused stage to increase 0.69 feet in only 2 hours. Similar, and more drastic, jumps have been recorded in the past.

A rating curve for this site was last updated in 2013 and is presented below. The rating curve R^2 value of 0.86 is not as robust as desired and additional flow measurements should be considered to refine this rating curve.

2018 Hydrograph



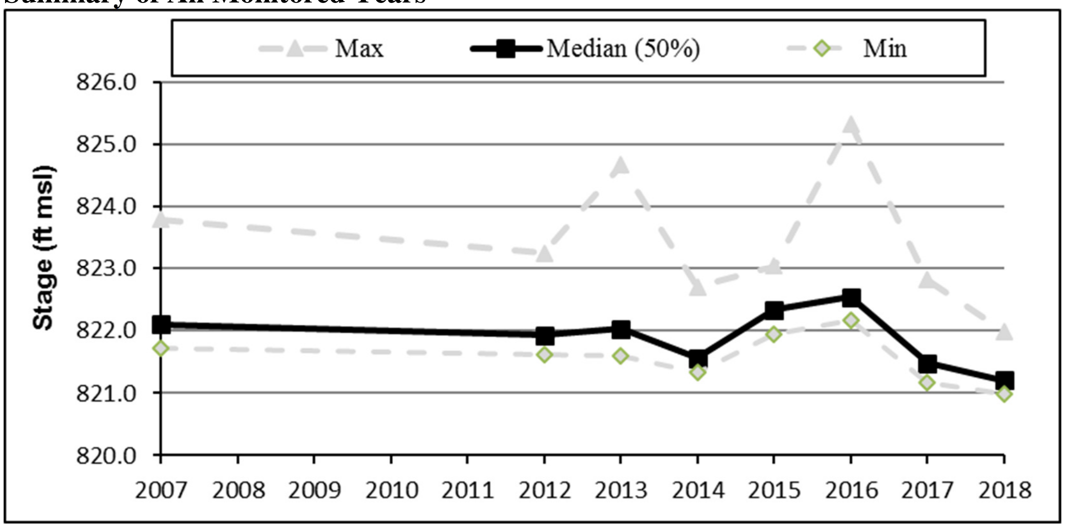
PLEASURE CREEK

at 86th Ave, Coon Rapids

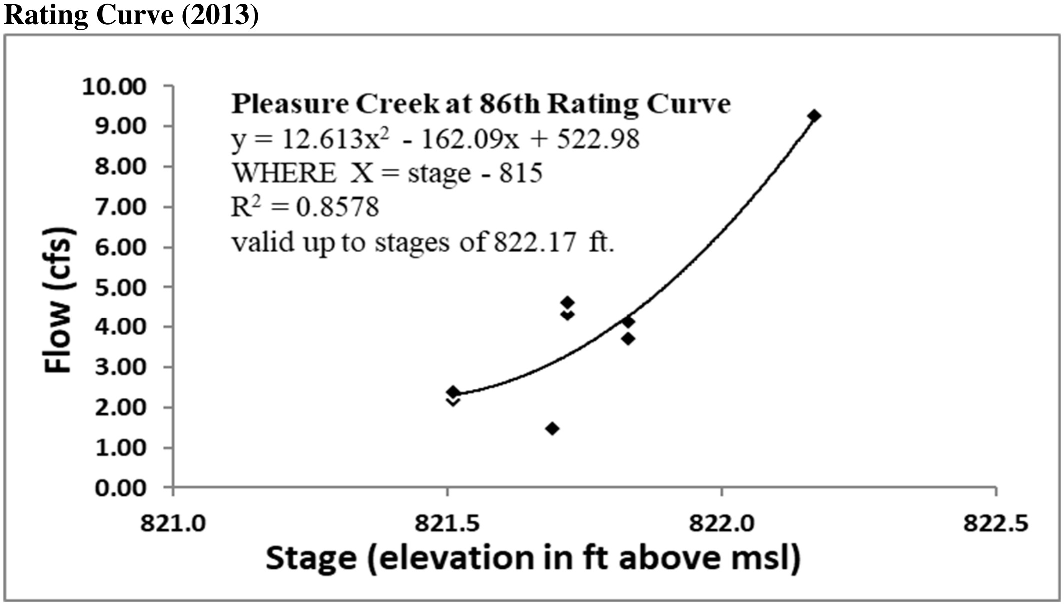
Summary of All Monitored Years

Percentiles	2007	2012	2013	2014	2015	2016	2017	2018
Min	821.73	821.63	821.60	821.34	821.95	822.17	821.18	820.99
2.5%	821.77	821.69	821.63	821.38	821.98	822.20	821.26	821.01
10.0%	821.84	821.77	821.73	821.42	822.02	822.27	821.31	821.06
25.0%	821.95	821.80	821.78	821.45	822.26	822.46	821.40	821.13
Median (50%)	822.10	821.93	822.04	821.57	822.34	822.54	821.48	821.21
75.0%	822.32	822.04	824.67	821.82	822.46	822.61	821.59	821.29
90.0%	822.49	822.19	824.67	821.98	822.56	822.70	821.69	821.43
97.5%	822.63	822.33	824.67	822.19	822.61	822.81	821.82	821.52
Max	823.79	823.25	824.67	822.70	823.04	825.33	822.81	821.99

Summary of All Monitored Years



Rating Curve (2013)



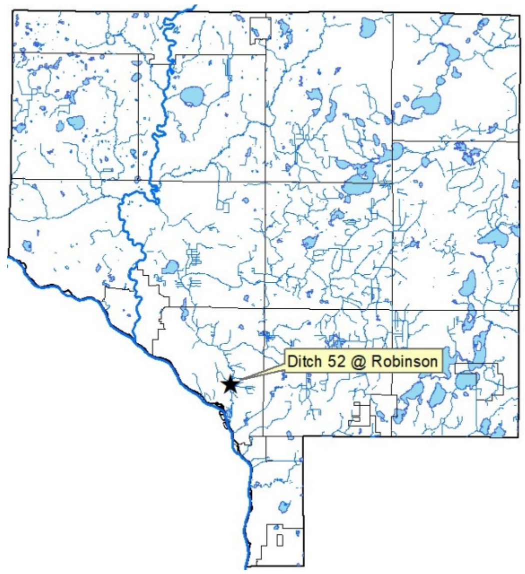
DITCH 52

at Robinson Park, Coon Rapids

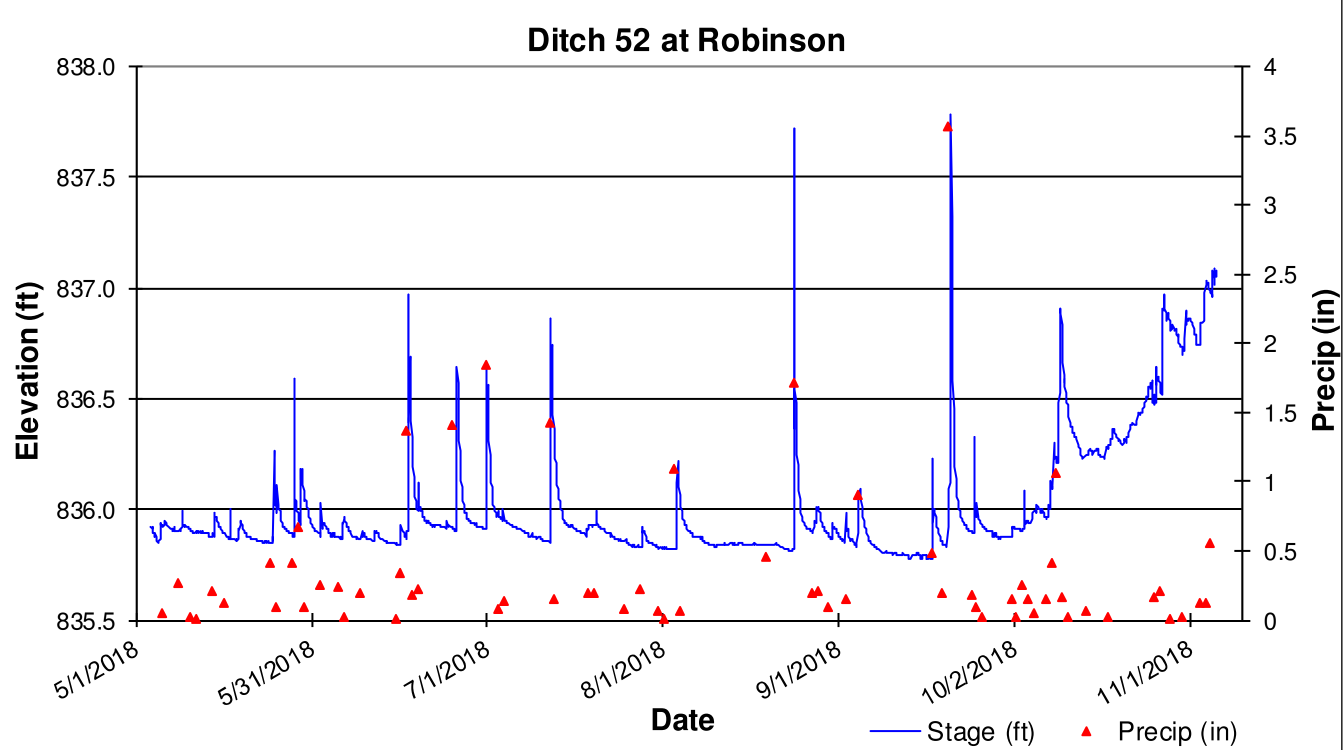
Notes

Ditch 52 drains primarily medium density residential neighborhoods in central Coon Rapids. The ditch joins Coon Creek in the northern portion of Robinson Park approximately 400 feet south of Egret Blvd NW. The monitoring site is located about 400 feet upstream of the confluence with Coon Creek. At baseflow, Ditch 52 is about 6 feet wide with 6 inches or less of depth. Depths increased up to 2.5 feet during storms in 2018.

Ditch 52 is very flashy and increased up to two feet during storm events in 2018, a significant increase from 6 inches of water pre-storm. A rating curve was developed for this site in 2018 and is displayed below.



2018 Hydrograph



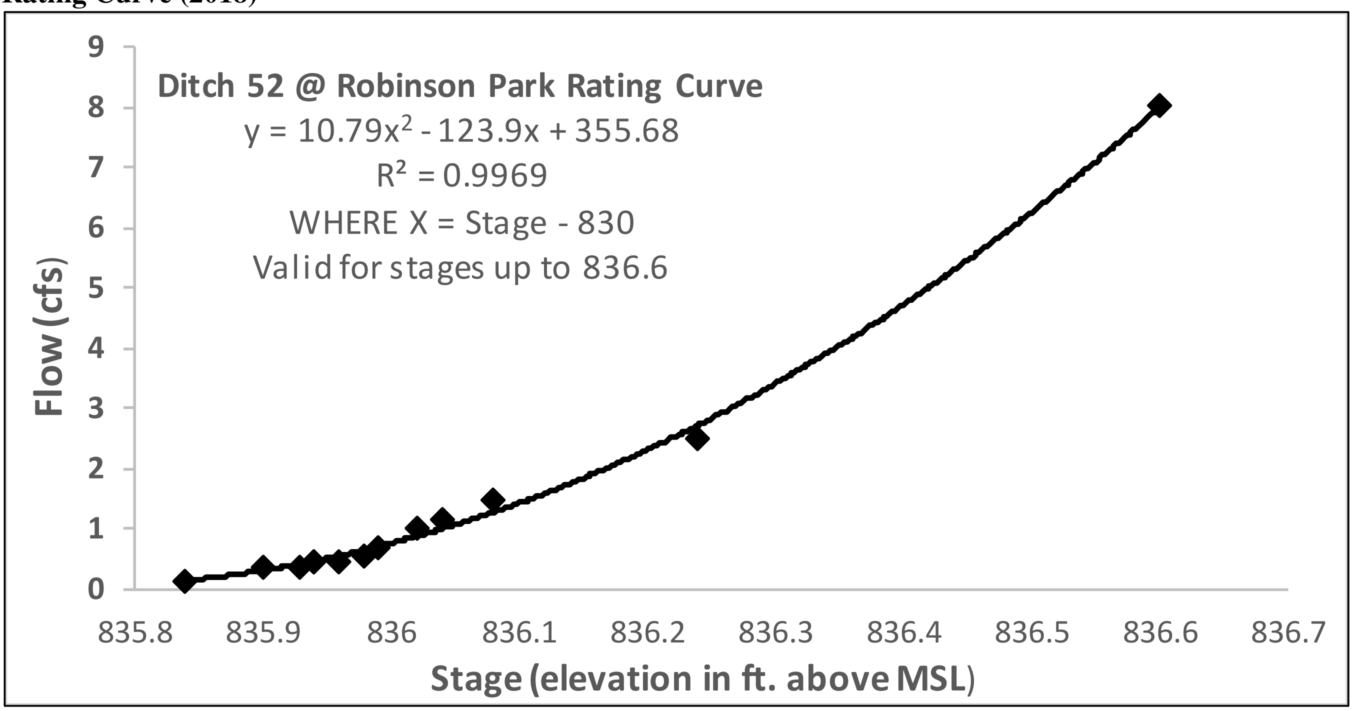
DITCH 52

at Robinson Park, Coon Rapids

Summary of All Monitored Years

Percentiles	2018
Min	835.78
2.5%	835.79
10.0%	835.84
25.0%	835.86
Median (50%)	835.91
75.0%	835.99
90.0%	836.39
97.5%	836.85
Max	837.78

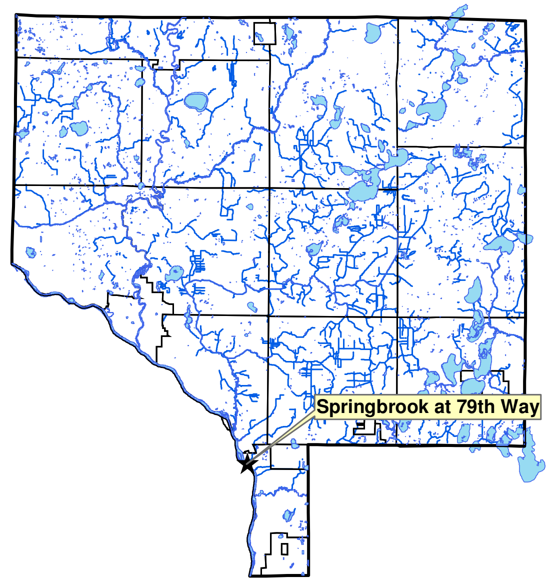
Rating Curve (2018)



SPRINGBROOK

at 79th Way, Fridley

Notes

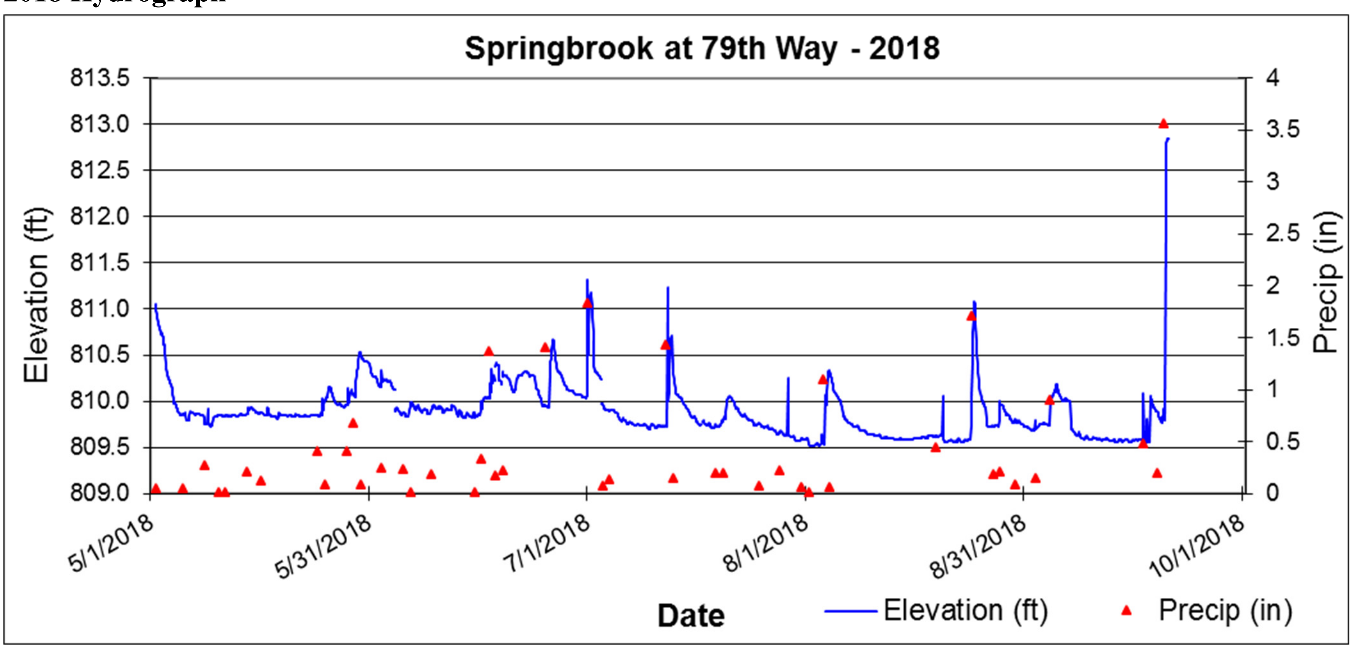


Springbrook is a small waterway draining an urbanized and highly modified watershed. The watershed includes portions of the cities of Blaine, Coon Rapids, Spring Lake Park, and Fridley. Several tributaries or stormwater systems contributing to the creek join at the Springbrook Nature Center Impoundment. From the outlet of the Nature Center, the creek flows a short distance to the Mississippi River. At its outlet, Springbrook is about 10 ft. wide and one foot deep at baseflow.

Springbrook at 79th Way was monitored for the first time in 2012. The stream is flashy, with water levels that increase quickly following rainfall and quickly recede thereafter despite the possible dampening effect of the stream flowing through the Springbrook Nature Center impoundment just upstream. A September 2018 storm of 3.76 inches caused an increase in stage of more than three feet before flooding out the data logger preventing further measurement. An additional aspect which makes this site unique is its proximity to the Mississippi River. Influence of the river occurred in 2012-2014 when the river water levels rose to such an elevation that backflow into Springbrook occurred. These events resulted in the highest water level of the season and held for a period of time until the river receded. It is also common for the outlet to the Mississippi to become clogged with debris resulting in an artificial backup of water. Because of this influence the true maximum water level is still unknown. In 2018 both Mississippi backup and debris clog backup occurred. Additionally, the graph terminates where high water flooded the gauge. It is expected that in 2019 the equipment at this site will be replaced with a data logger that can better handle high water fluctuations

A rating curve was developed in 2018 and is presented below.

2018 Hydrograph

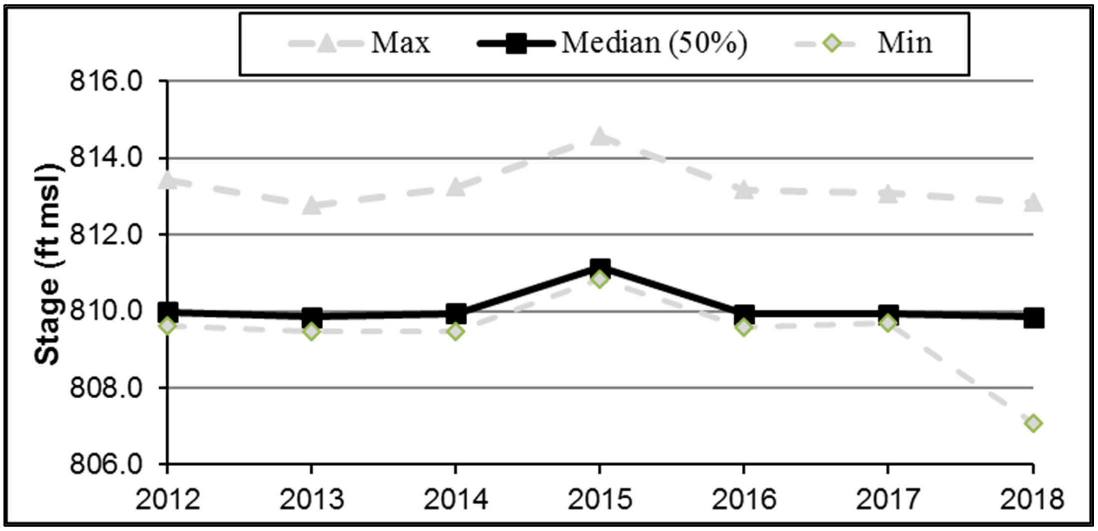


SPRINGBROOK

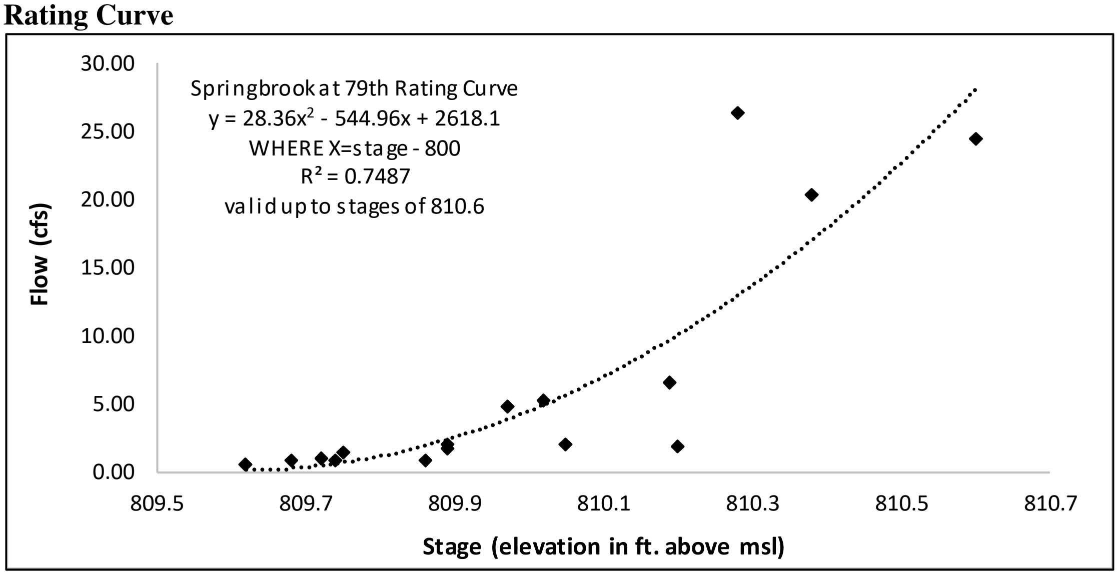
at 79th Way, Fridley

Summary of All Monitored Years

Percentiles	2012	2013	2014	2015	2016	2017	2018
Min	809.62	809.47	809.46	810.85	809.59	809.6883	807.10
2.5%	809.65	809.54	809.63	810.91	809.67	809.7217	809.56
10.0%	809.69	809.60	809.66	810.96	809.74	809.78	809.59
25.0%	809.76	809.67	809.72	811.04	809.79	809.83	809.71
Median (50%)	809.97	809.84	809.93	811.13	809.93	809.9133	809.85
75.0%	810.29	810.08	811.62	811.30	810.13	810.0967	810.01
90.0%	811.24	810.71	812.99	811.73	810.50	810.41	810.27
97.5%	812.87	812.17	813.18	812.63	811.28	811.5063	810.63
Max	813.43	812.76	813.25	814.57	813.16	813.0717	812.85



Rating Curve

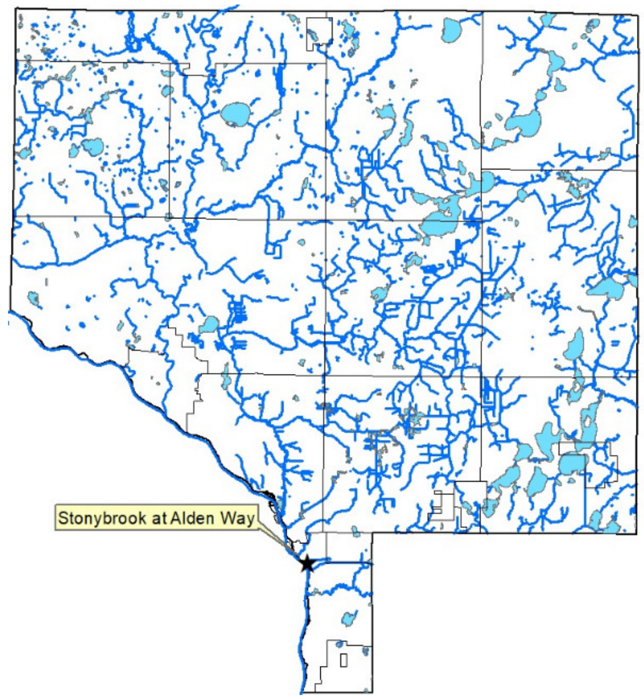


STONYBROOK

at Alden Way, Fridley

Notes

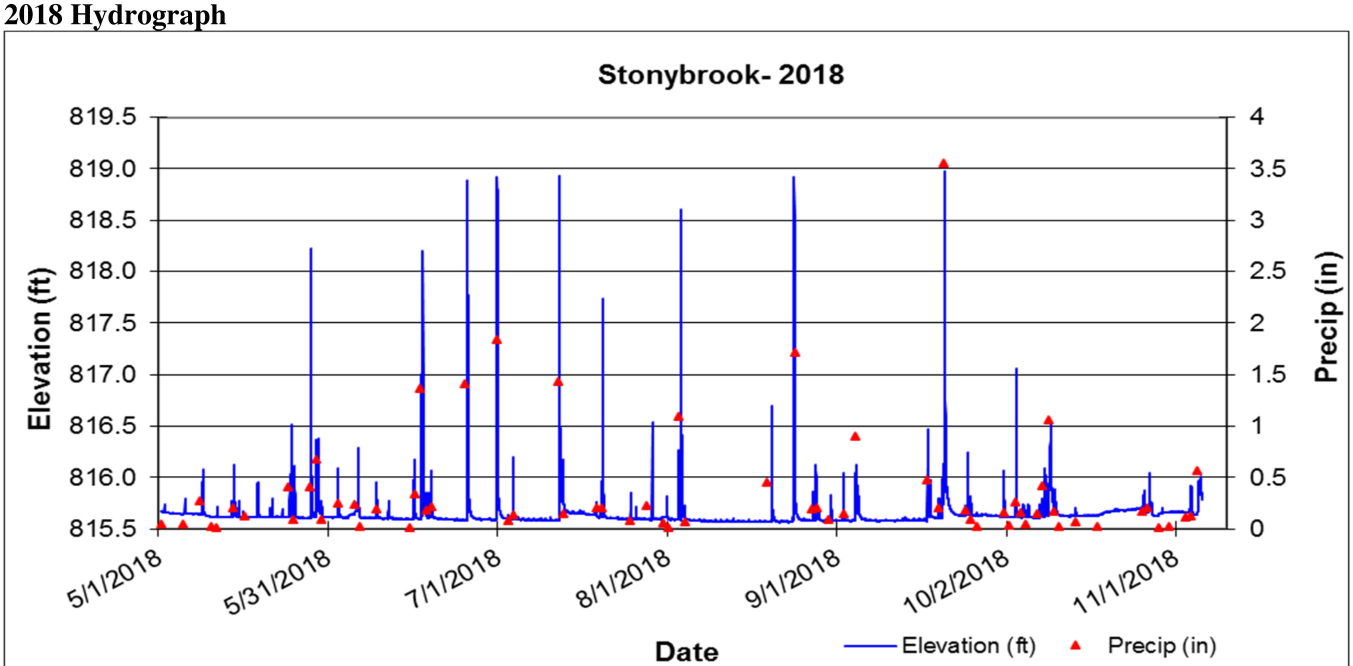
Stonybrook is a small waterway that drains a mostly urbanized and industrial watershed in northern Fridley and western Spring Lake Park. The stream's contributing area starts about one mile east of the Mississippi River as a storm sewer. The last 1/3 of the one-mile watershed is an open, deeply cut channel that descends 40 ft. to the Mississippi River. The sampling site is located about 250 ft. upstream of the confluence, just east of Alden Way. The creek is only about 10 ft. wide and 6 in. deep during baseflow conditions at the sampling site.



Not surprisingly, given its size and channelized characteristics, Stonybrook has extremely flashy reactions to rain events, with virtually instantaneous spikes and plummets of stage. 2017 was the first year in which stage was recorded for Stonybrook. After missing stage fluctuations using 2 hour, then 0.5 hour recording intervals in 2017, new equipment was installed at this site and set to 15 minute recording intervals for 2018. This year stage varied 3.42 ft. with the peak occurring as the result of a 3.76 in. rainfall. On this occasion water levels rose 3.12 ft. in just 2.25 hours.

No rating curve has been developed at this site.

2018 Hydrograph

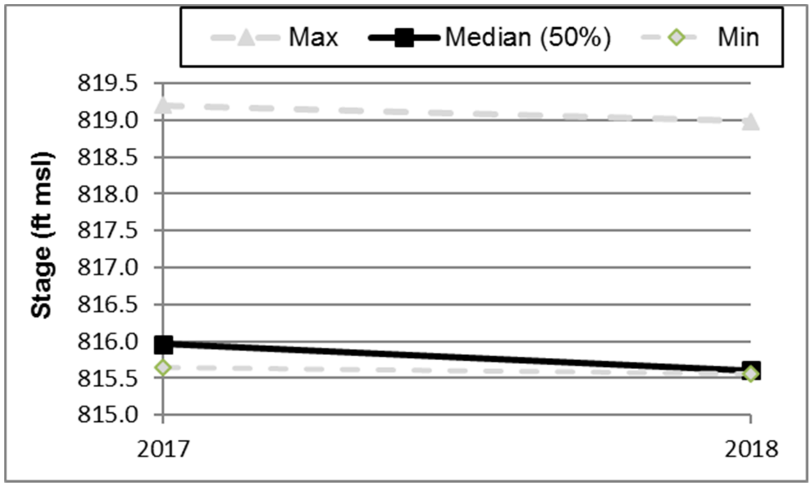


STONYBROOK

at Alden Way, Fridley

Summary of All Monitored Years

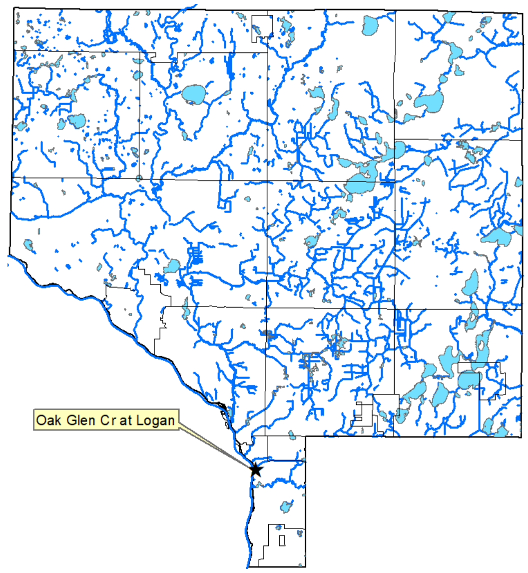
Percentiles	2017	2018
Min	815.65	815.56
2.5%	815.80	815.57
10.0%	815.91	815.58
25.0%	815.93	815.59
Median (50%)	815.96	815.61
75.0%	816.00	815.64
90.0%	816.07	815.69
97.5%	816.30	815.92
Max	819.20	818.98



OAK GLEN CREEK

at Logan Parkway, Fridley

Notes

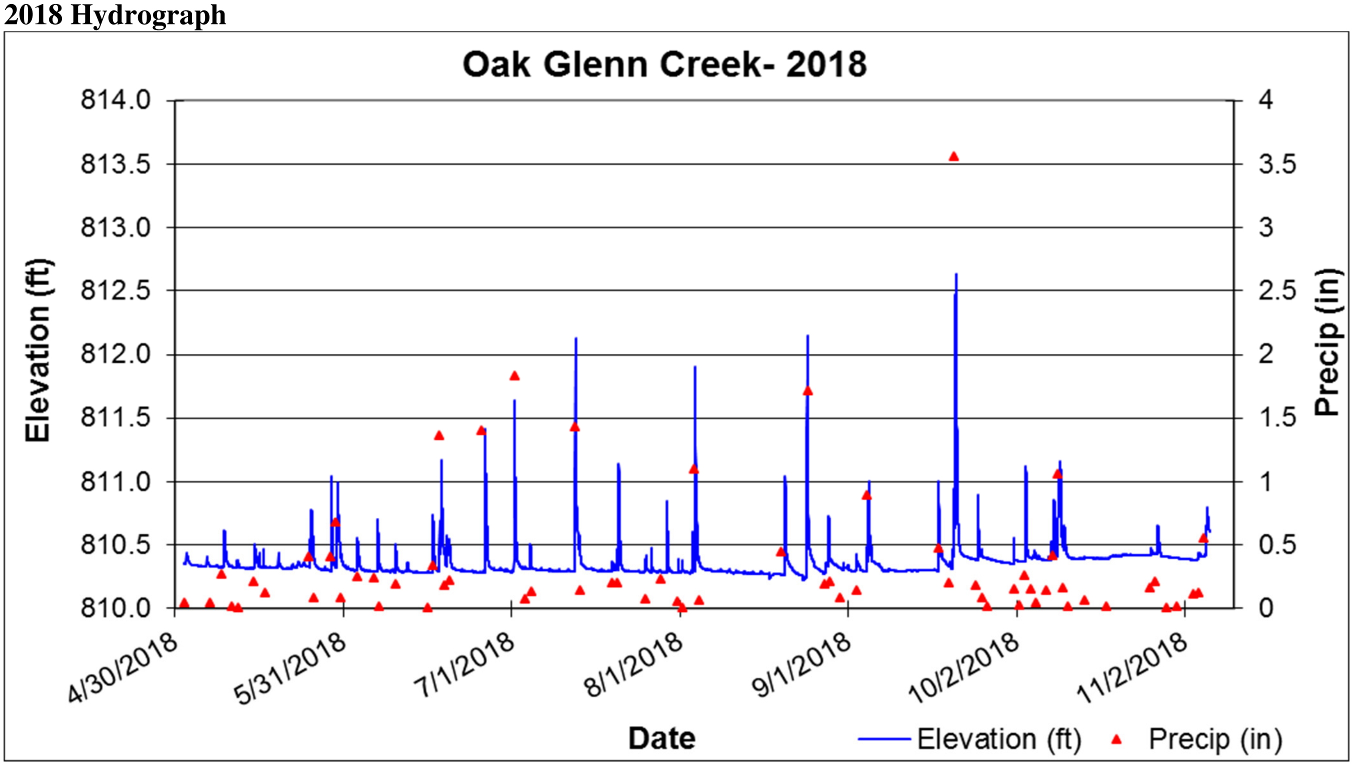


Oak Glen Creek is a small waterway that drains directly to the Mississippi River. The Oak Glen watershed is approximately 660 acres of mostly commercial development and dense residential land use. The watershed boundaries are Highway 65 to the east, Osborne Road to the north, and 71st Avenue to the south. The creek exists as an open channel for approximately 1,400 ft. between East River Road and the Mississippi River. The channel is deeply cut and narrow, descending about 40 ft. to the River. In 2017, a stormwater pond just east of East River road treating water from this watershed was expanded and had an iron enhanced sand filter added for additional water quality benefit.

2017 was the first year in which Oak Glen Creek was monitored for stage. The sampling site is located about 500 feet upstream of the confluence with the Mississippi. Due to its size and watershed characteristics, the creek reacts very quickly to rain events. Similarly to nearby Stonybrook, a new data logger was set to record 15 minute intervals in 2018. The creek fluctuated a total of 2.42 feet for the year, but covered most of that range multiples in short order frequently during storm events. The largest event in September 2018 dropping 3.76 inches of rain caused a rise of 2.01 feet in five hours.

There is no rating curve for this site.

2018 Hydrograph

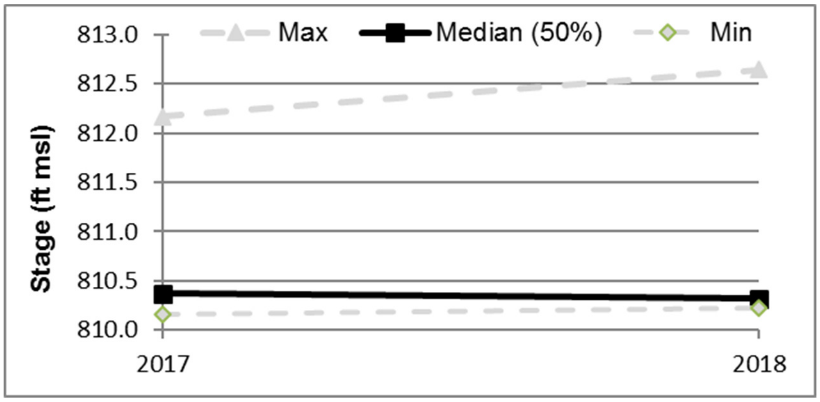


OAK GLEN CREEK

at Logan Parkway, Fridley

Summary of All Monitoring Years

Percentiles	2017	2018
Min	810.15	810.22
2.5%	810.23	810.27
10.0%	810.28	810.28
25.0%	810.31	810.29
Median (50%)	810.37	810.32
75.0%	810.42	810.39
90.0%	810.49	810.43
97.5%	810.74	810.72
Max	812.17	812.64



Stream Water Quality – Chemical Monitoring

Description: Each site was monitored eight times during the open water season; four times during baseflow and four times following storm events. Storm events were defined as an approximately one inch of rainfall within 24 hours, though totals vary from location to location. Each stream was tested for pH, specific conductance, turbidity, dissolved oxygen, temperature, total suspended solids, total phosphorus and *E. coli* bacteria.

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

Locations:

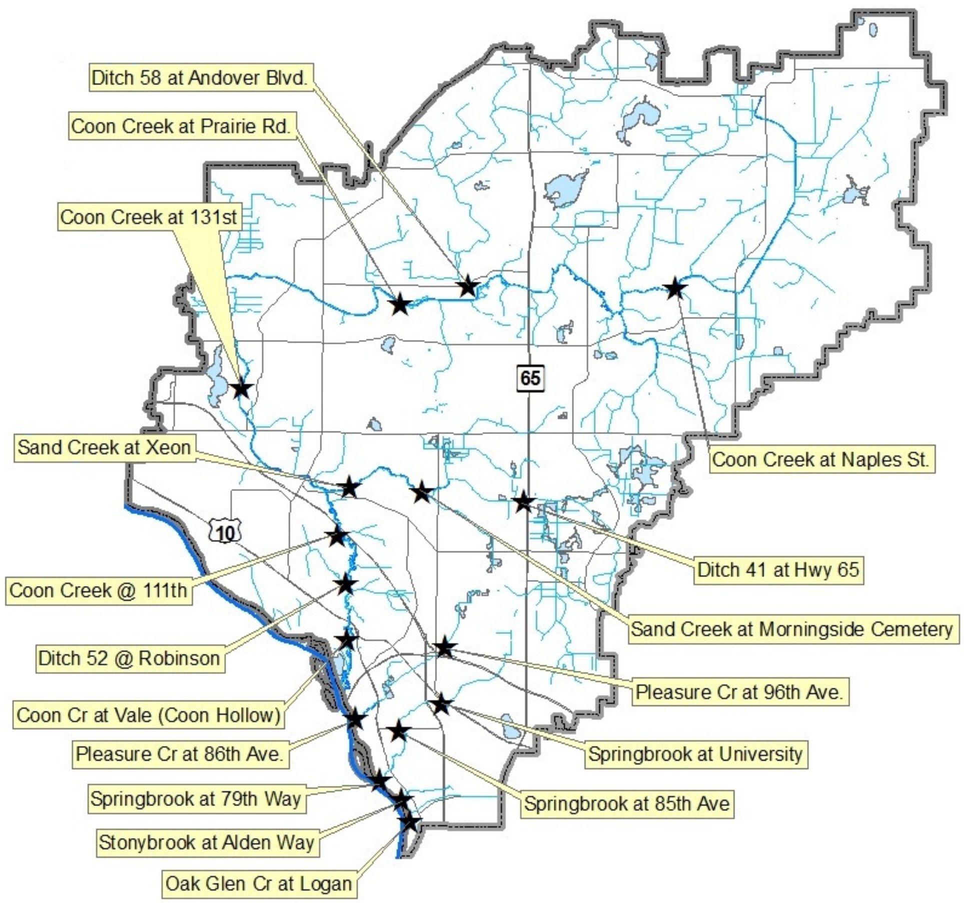
Stream	Location	City
Coon Creek	Naples St.	Ham Lake
Ditch 58	Andover Blvd	Ham Lake
Coon Creek	Prairie Rd.	Andover
Coon Creek	131st Ave.	Coon Rapids
Coon Creek	111th Ave.*	Coon Rapids
Ditch 52	Robinson Park*	Coon Rapids
Coon Creek	Coon Hollow	Coon Rapids
Stonybrook	Alden Way	Fridley
Oak Glen Cr	Logan Pkwy.	Fridley

Stream	Location	City
Ditch 41	Highway 65	Blaine
Sand Creek	Morningside	Coon Rapids
Sand Creek	Xeon Street	Coon Rapids
Pleasure Cr.	96th Ave.	Blaine
Pleasure Cr.	86th Ave.	Coon Rapids
Springbrook	University	Blaine
Springbrook	85th Ave.	Fridley
Springbrook	79th Way	Fridley

* New site in 2018

Results: Results for each stream are presented on the following pages.

Coon Creek Watershed 2018 Stream Water Quality Monitoring Sites



Median pollutant concentrations for waterways in the Coon Creek Watershed District. The reader is warned that differing amounts of sampling have been done at each stream as well as in a varying number of locations in each stream system. Also, in some cases, the extreme measurements are more important than the median values presented. Please see detailed results from each stream for more insight.

For streams listed below with multiple monitoring sites, all readings from all sites within the subwatershed are included. All data through 2018 is included.

	Springbrook Creek sub watershed	Pleasure Creek sub watershed	Sand Creek sub watershed	Coon Creek sub watershed	Stony Brook	Oak Glen Creek	Median for Anoka Co Streams	State Water Quality Standard
Specific conductance (mS/cm)	0.896	1.056	0.794	0.581	1.19	1.37	0.420	none
Chlorides* (mg/L)	159	125	67	40	n/a	n/a	13.29	860- acute 230-chronic
Turbidity (NTU)	4.3	10	7.3	14	9.35	8.45	11.39	None
Total Suspended Solids (mg/L)	5	9	6	10	5	5	14	30
Total Phosphorus (µg/L)	101	70	59	119	83.5	67.5	119	100
Dissolved Oxygen (mg/L)	8.37	8.23	7.82	7.79	9.38	8.9	7.52	≥5
pH	7.76	8.02	7.73	7.63	7.63	7.76	7.56	6.5-8.5

*Chlorides not sampled in CCWD since 2012

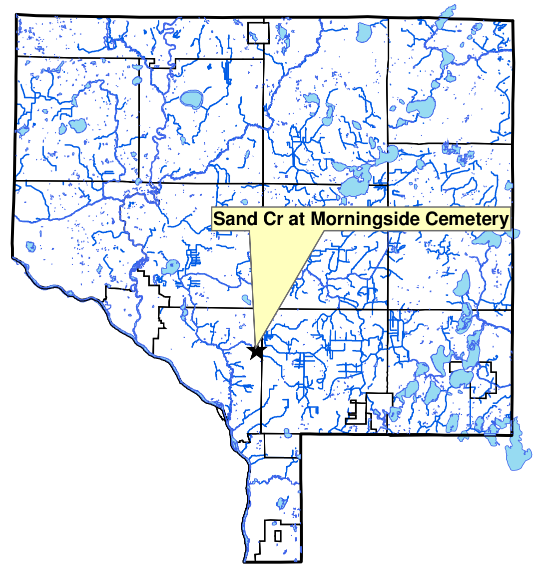
YSI Continuous Stream Water Quality Monitoring

Sand Creek

at Morningside Cemetery, Coon Rapids

Years Monitored

2017, 2018



Background

Sand Creek is the largest tributary to Coon Creek. It drains suburban residential, commercial, and retail areas throughout northeastern Coon Rapids and western Blaine. Sand Creek at Morningside Cemetery is monitored because of its position between the cities of Blaine and Coon Rapids, which provides an estimate of the flow contributions from Blaine. In addition, the site is located immediately downstream of the confluence with Ditch 39.

This site has been monitored for storm and baseflow water quality using grab samples, as well as continuous hydrology, since 2010. That data is presented elsewhere in this chapter. Only continuous storm event water quality monitoring is presented in this section.

2018 was the second year in which continuous water quality was monitored during storm events in Sand Creek using a YSI EXO data sonde. The purpose of continuous water quality monitoring is to document water quality changes throughout a storm event. This helps diagnose water quality problems and analyze differences in runoff from upper and lower parts of the watershed.

Methods

The site was monitored immediately before, during, and after storms with a YSI EXO data sonde. The sonde was suspended inside a PVC pipe with a locked lid. The PVC pipe was secured to a metal fence post. The sonde sensors protruded from the bottom of the pipe approximately 6-12 inches from the stream bottom, ensuring they would stay submerged even during low flows. The sonde was programmed to take readings every 30 minutes. Readings included pH, salinity, specific conductance, temperature, dissolved oxygen, and turbidity. The sonde was calibrated before each deployment.

The YSI data sondes were deployed into streams when at least 0.5 inches, of rain was forecasted. In some instances, water level was already high before the storm and remains high after the storm. At other times, predicted rain does not fall and we monitor baseflow conditions. In all instances, the YSI data sondes are left in the field for several days.

Water levels were continuously monitored throughout the open water season. An Ott Orpheus Mini water level monitoring device recorded water levels every hour. This stream stage data is presented with the water quality data. It would be preferable to present flow, but a rating curve does not exist for this site. To make graphs from all storms comparable, stage is displayed on a constant axis.

Precipitation data are provided with the water quality results. These data were taken from volunteer collected rain gauge data.

A variety of storm sizes were analyzed. Rainfall during the monitored time periods ranged from 0.61 to 3.53 inches. The wide distribution is helpful in discerning the creek's response to different storms.

Only 2018 individual storm results are presented in this report. The individual storm results for other locations and previous years are available upon request from the Anoka Conservation District. Each year the findings of storm analysis are reviewed and re-evaluated.

On the following pages, results from each storm monitored are shown. The graphs show daily precipitation totals as well as the stream hydrograph for the duration of the storm, and ideally, 24 hours before and after rainfall began and ceased. Separate graphs show each water quality parameter. The text below summarizes findings across all storms for each parameter.

Results and Discussion

Turbidity

- Turbidity data is spotty for storm analysis in Sand Creek for 2018. Suspended debris got trapped in the sensor guard and affected measurements on multiple deployments, and on one occasion leaches were found on the sensors.
- In general, there were very rapid turbidity increases at the beginning of storms, sometimes before stage even increased. These increases sometimes reached quite high levels (thousands of NTUs). In general turbidity did decrease after the storm event, but sometimes it took days rather than hours. In cases where turbidity never returns to low levels, this may have been a result of debris on the sensors.

Specific Conductance

- Specific conductance, a measure of dissolved pollutants which conduct electricity in water, decreases during storm events in Sand Creek. When creek stage rises due to storm runoff, conductance drops. During brief, intense rainfall the stream conductance drops sharply. This relationship indicates that the shallow groundwater that feeds the stream during baseflow has higher specific conductance than stormwater runoff. Infiltration of road deicing salts is a likely source of high conductance in streams at baseflow year round due to contamination of the surficial groundwater that feeds the streams.

Dissolved Oxygen

- The recorded dissolved oxygen concentrations in Sand Creek generally were within the healthy range, >5mg/L. The exception was during two summer deployments when dissolved oxygen dropped to nearly zero. During both occasions, water temperatures were greater than 70° F.
- Warmer water holds less dissolved oxygen. It is likely that aquatic life in this stream suffers during late summer months when water temperatures are highest.
- Water temperatures may not fully explain low DO in Sand Creek, and investigative monitoring of the contributing ditch systems is planned for 2019.

Temperature

- Water temperature is generally not considered a concern in Sand Creek because there are no trout or other temperature sensitive resources. Though poor oxygen concentrations related to higher water temperatures may negatively affect life that is present in this stream.

pH

- pH typically declines during storm events in Sand Creek. When water levels rise due to storm runoff, pH declines. This is because rainwater has a lower pH than that of local shallow groundwater feeding baseflows.
- pH stayed within the desired range of 6.5 to 8.5 that is specified in state water quality standards and is not presently a concern at this site.

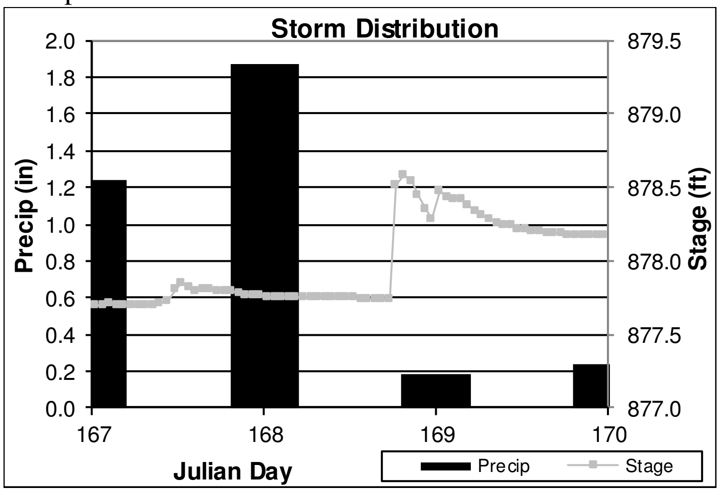
YSI Continuous Monitoring
Storm 1 – June 16th to June 19th

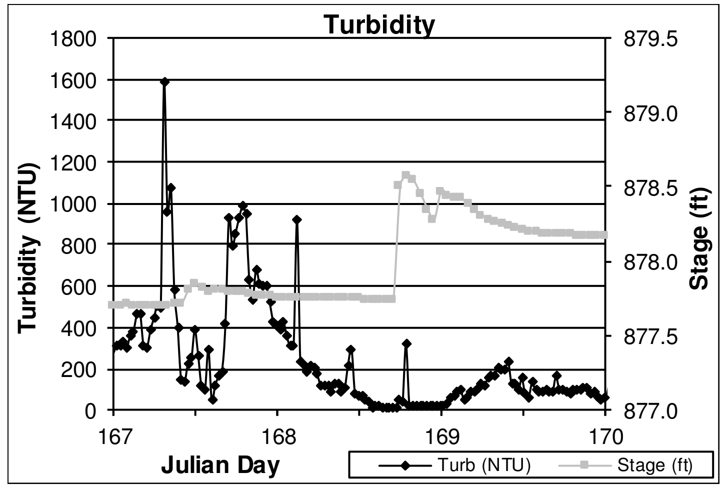
Sand Creek at Morningside Cemetery

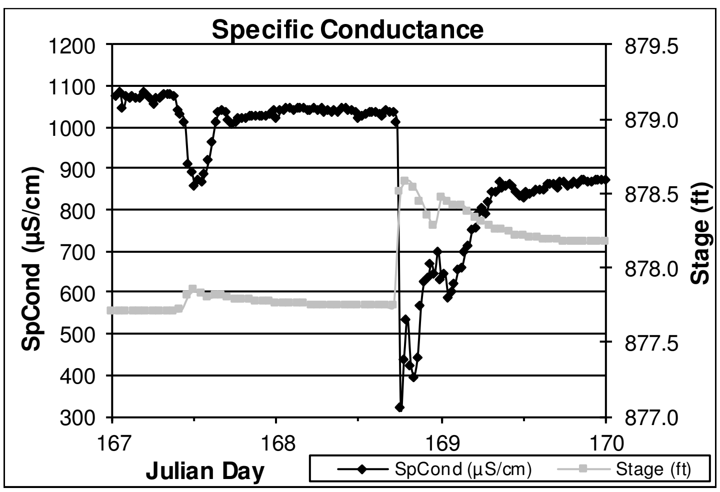
<u>Storm Summary:</u>

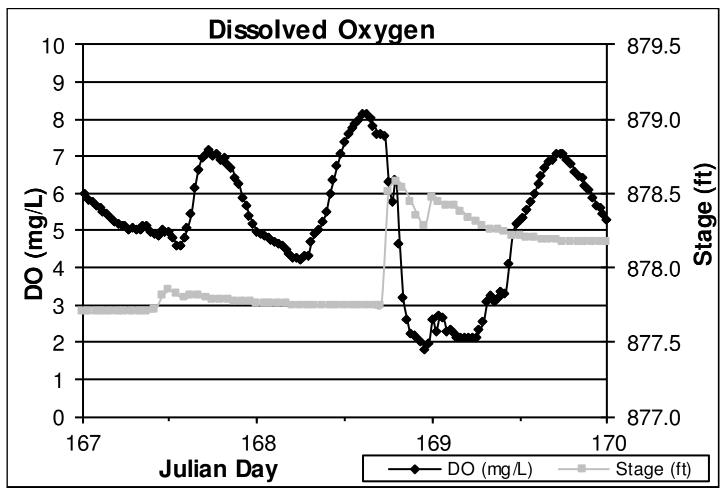
Dates: 16 June 2018 (Day 167) to June 19 2018 (Day 170)

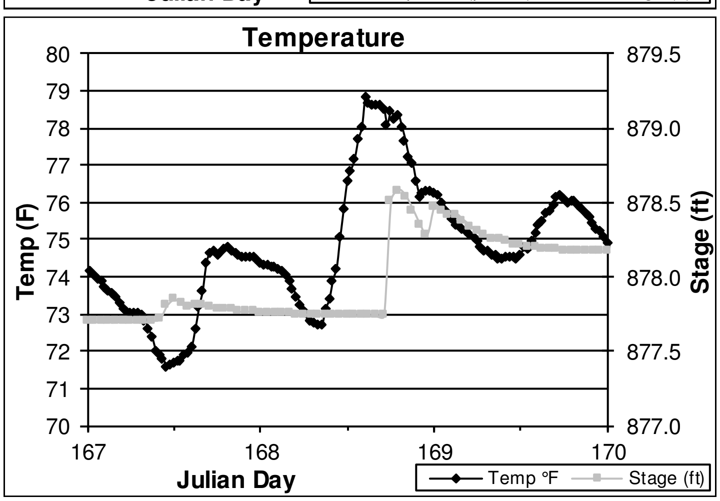
Precipitation: 3.53 in.

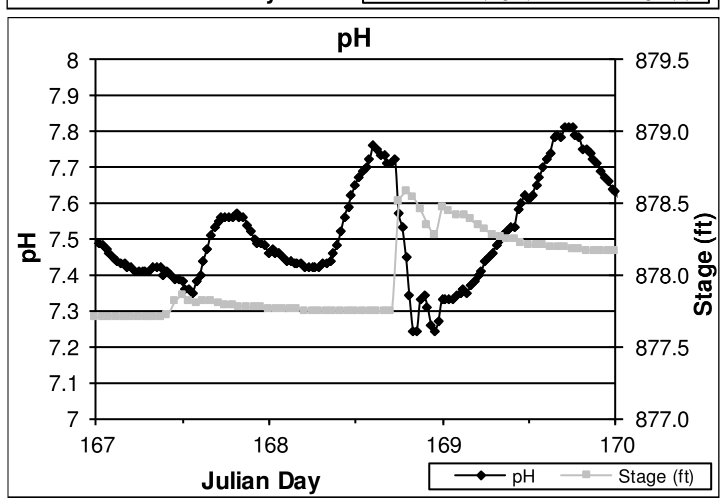












Note: Dissolved oxygen dropped below (>5 mg/L)

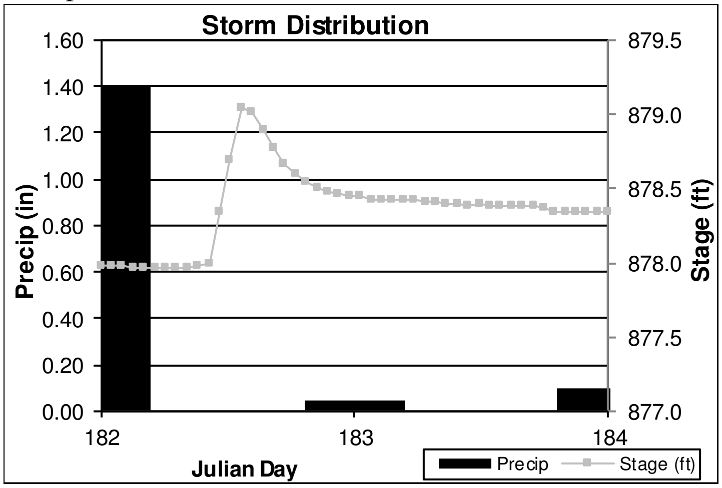
YSI Continuous Monitoring
Storm 2 – July 1st to July 3rd

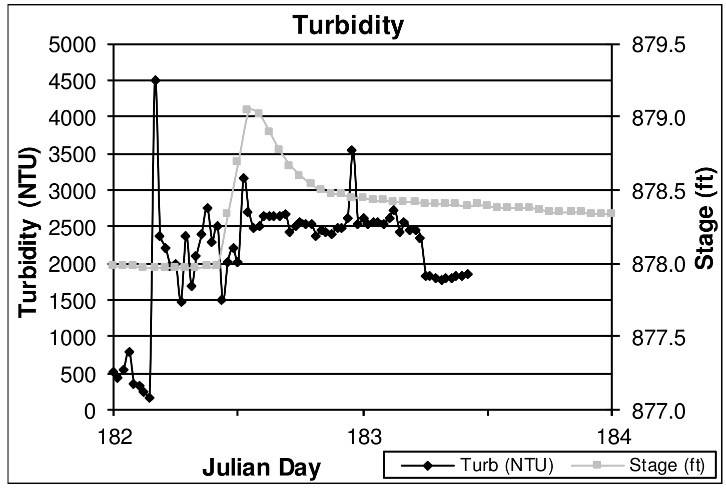
Sand Creek at Morningside Cemetery

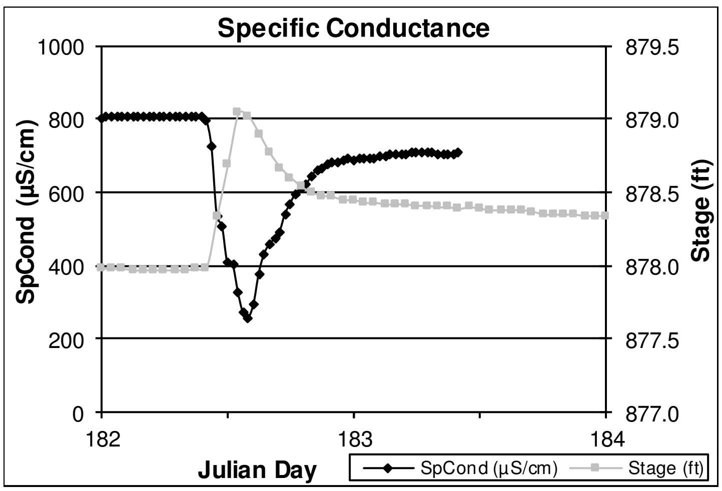
Storm Summary:

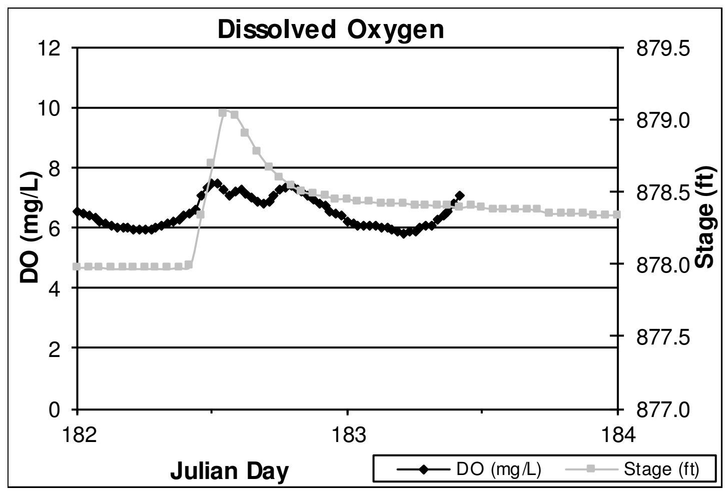
Dates: 1 July 2018 (day 182) to 3 July 2018 (day 184)

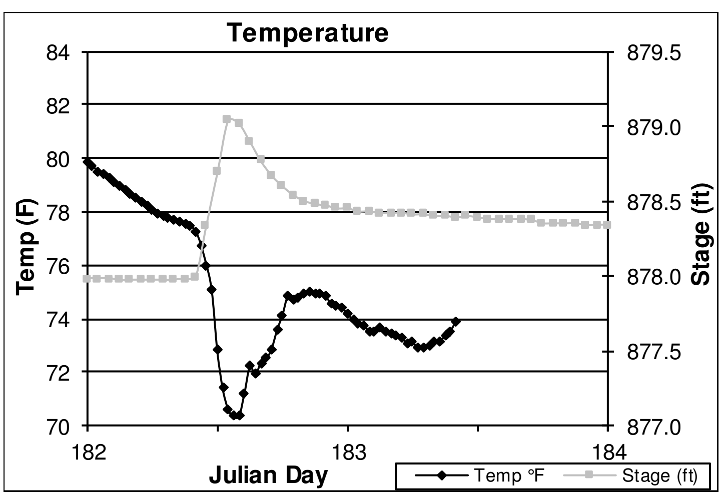
Precipitation: 1.56 in.

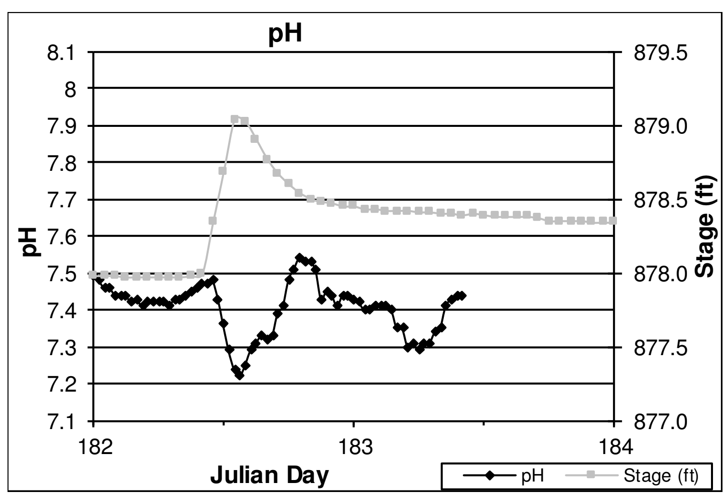












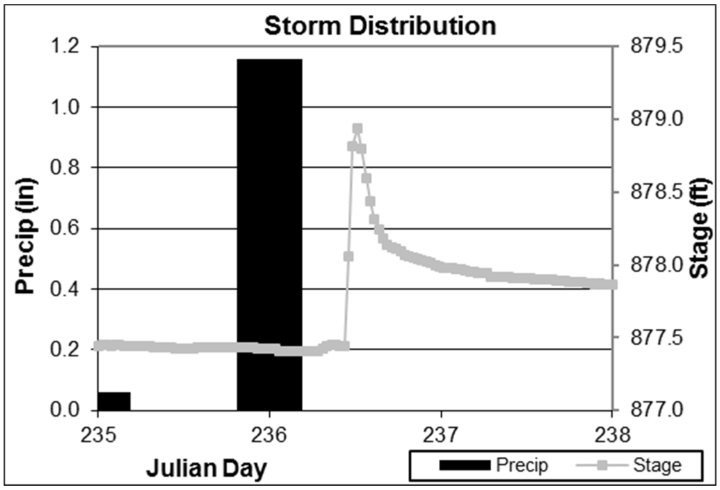
YSI Continuous Monitoring
Storm 3 – August 23rd to 26th

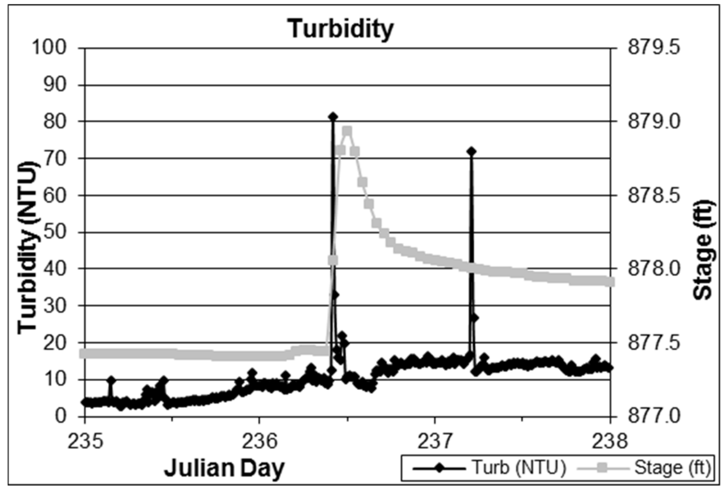
Sand Creek at Morningside Cemetery

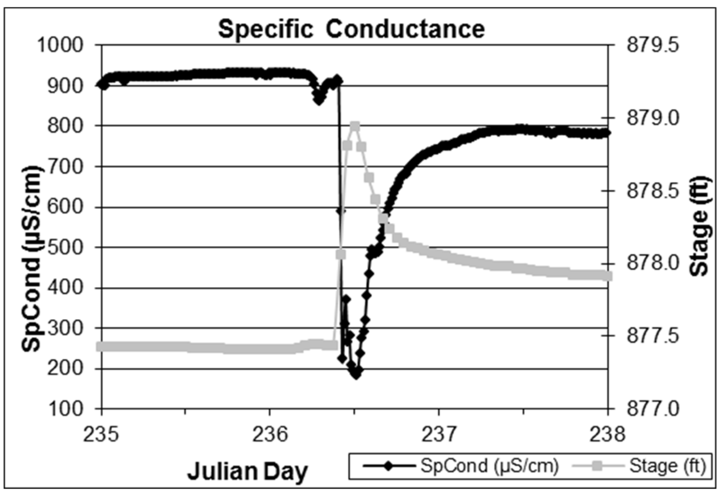
Storm Summary:

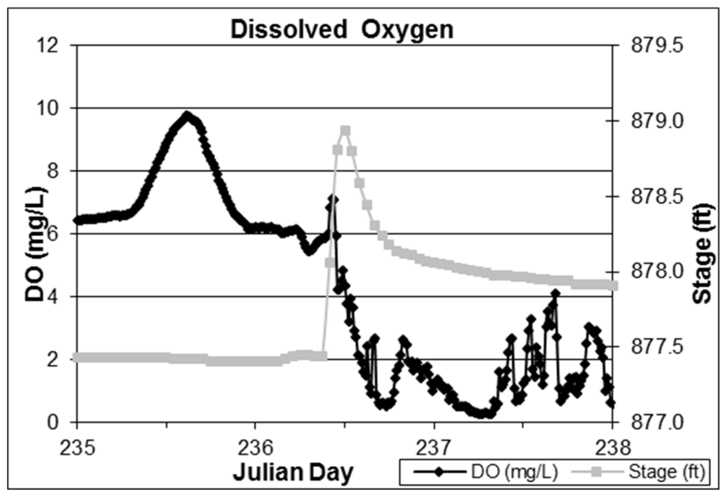
Dates: 23 August 2018 (day 235) to 26 August 2018 (day 238)

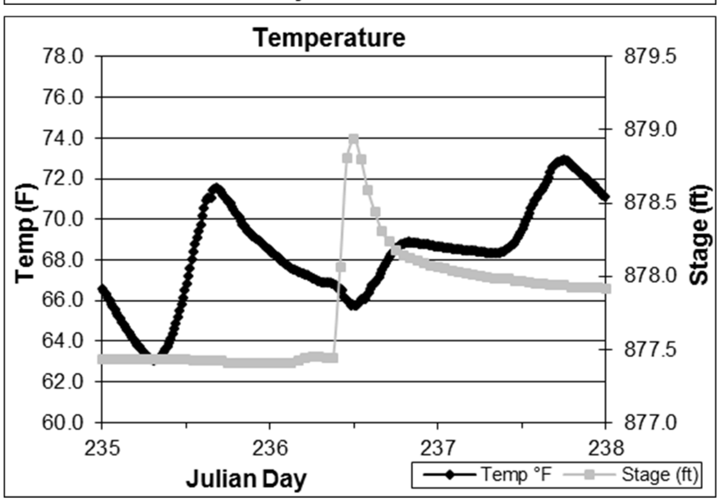
Precipitation: 1.22 in.

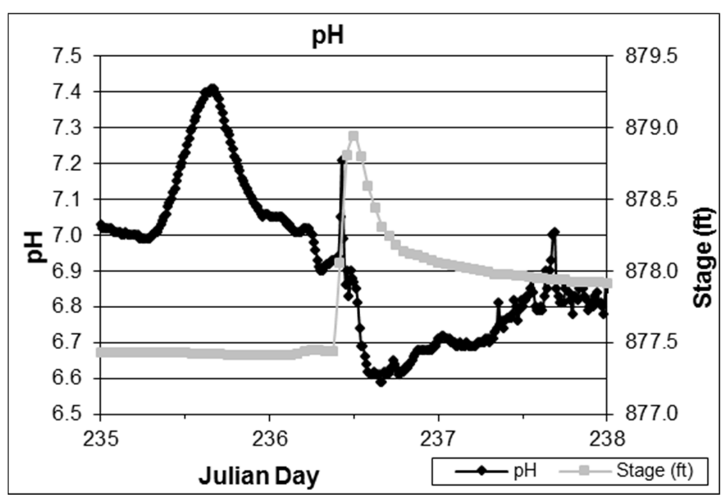












Note: The second turbidity spike may be due to debris on the turbidity sensor.

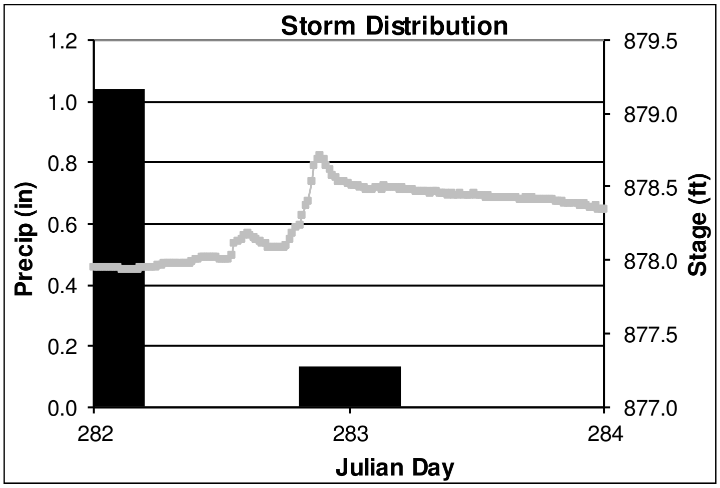
Storm 4 – October 9th to 11th

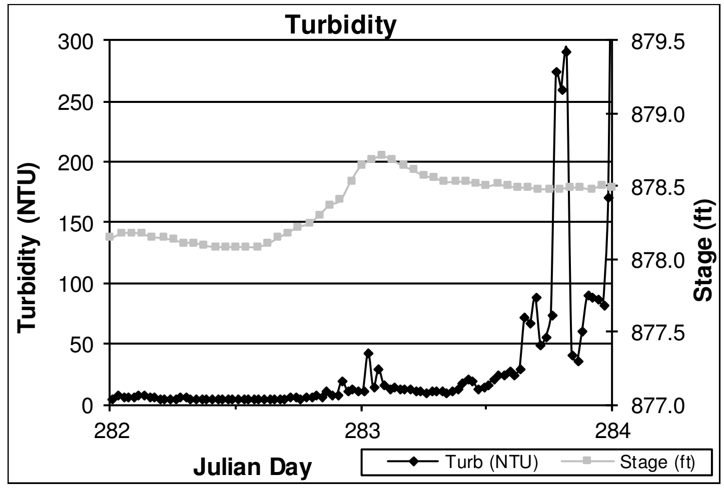
Sand Creek at Morningside Cemetery

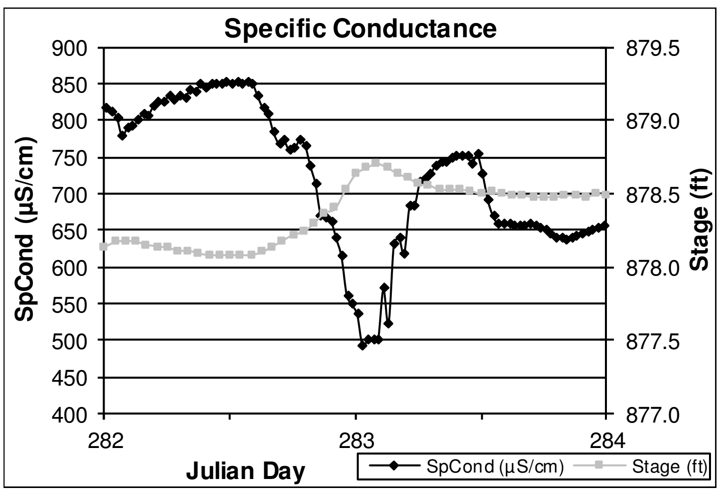
<u>Storm Summary:</u>

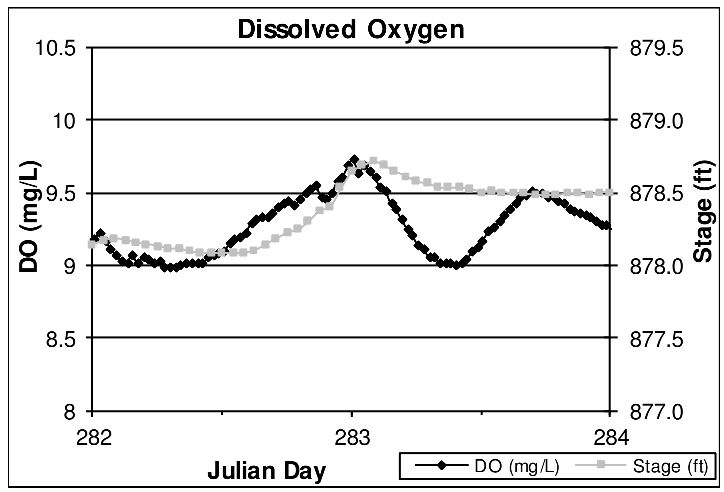
Dates: 9 October 2018 (day 282) to 11 October 2018 (day 284)

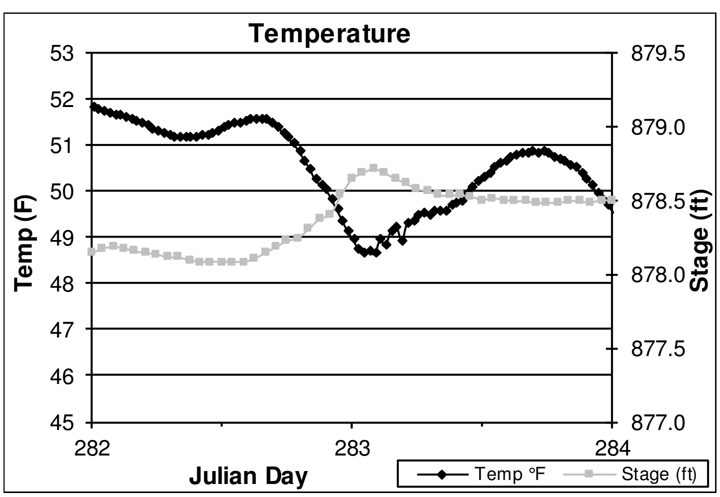
Precipitation: 1.17 in

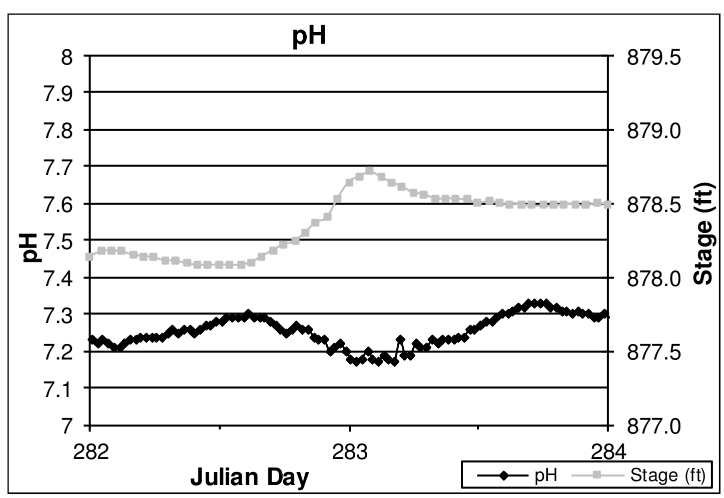












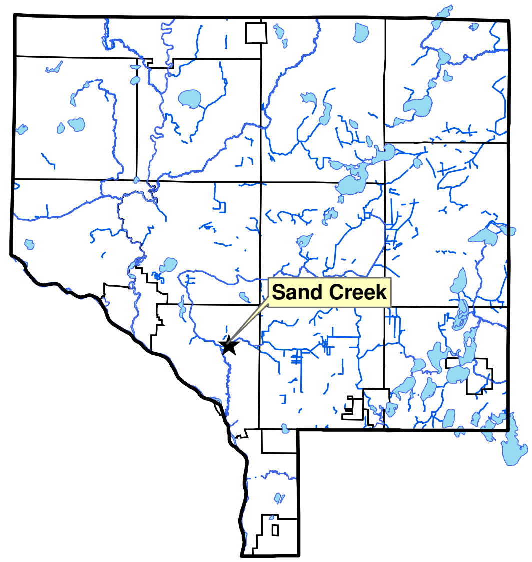
SAND CREEK

at Xeon Street, Coon Rapids

Years Monitored

2017, 2018

Background



Sand Creek is the largest tributary to Coon Creek. It drains suburban residential, commercial, and retail areas throughout northeastern Coon Rapids and western Blaine. The stream is about 15 ft. wide and 3 ft. deep at the monitoring site during baseflow. Sand Creek was added to the state list of impaired waters for aquatic life, specifically macroinvertebrate populations (2006) and for aquatic recreation due to elevated levels of *E. coli* (2016).

Sand Creek at Xeon Street was selected for monitoring because it is near the confluence with Coon Creek, about 0.5 mile upstream. As the biggest tributary to Coon Creek, understanding of water quality conditions in Sand Creek near the confluence is very important.

This site has been monitored for storm and baseflow water quality with grab samples, as well as continuous hydrology, since 2010. That data is presented later in this chapter. Only continuous storm event water quality results are presented in this section.

2018 was the second year in which continuous water quality was monitored during storm events in Sand Creek using a YSI EXO data sonde. The purpose of continuous water quality monitoring is to document water quality changes throughout a storm. This helps diagnose water quality problems and analyze differences in runoff from upper and lower parts of the watershed. Runoff that passes the monitoring site most immediately following a storm is from the lower, urbanized part of the watershed while later runoff is mostly from upper portions of the watershed.

Methods

The site was monitored immediately before, during, and after storms with a YSI EXO data sonde. The sonde was suspended inside a PVC pipe with a locked lid. The PVC pipe was secured to a metal fence post. The sonde sensors protruded from the bottom of the pipe approximately 6-12 inches from the stream bottom, ensuring they would stay submerged even during low flows. The sonde was programmed to take readings every 30 minutes. Readings included pH, salinity, specific conductance, temperature, dissolved oxygen, and turbidity. The sonde was calibrated before each deployment.

The YSI data sondes were deployed into streams when at least 0.5 inches, of rain was forecasted. In some instances, water level was already high before the storm and remains high after the storm. At other times, predicted rain does not fall and we monitor baseflow conditions. In all instances, the YSI data sondes are left in the field for several days.

Water levels were continuously monitored throughout the open water season. An Ott Orpheus Mini water level monitoring device recorded water levels every hour. This stream stage data is presented with the water quality data. To make graphs from all storms comparable, stage is displayed on a constant axis.

Precipitation data are provided with the water quality results. These data were taken from the rain data compiled by the DNR, specifically the Anoka-Coon Rapids-Northdale rain gauge. All precipitation data is compiled by the DNR and then pulled from the State Climatology Office precipitation data tool.

A variety of storm sizes were analyzed. Rainfall during the monitored time periods ranged from 1.17 to 3.53 inches. The wide distribution is helpful in discerning the creek's response to different storms.

Only 2018 individual storm results are presented in this report. The individual storm results for this, and other locations in Coon Creek Watershed District, from previous sampling years are available upon request from the Anoka Conservation District. Each year the findings of storm analysis are reviewed and re-evaluated.

On the following pages, results from each storm monitored are shown. The graphs show daily precipitation totals as well as the stream hydrograph for the duration of the storm, and ideally, 24 hours before and after rainfall began and ceased. Separate graphs show each water quality parameter. The text below summarizes findings across all storms for each parameter.

Results and Discussion

Turbidity

- Intense, rapid turbidity increases are observed near the time that stage begins to rise during storms. These increases appear to be slightly less flashy at this site compared to the site upstream at Morningside Cemetery.
- Turbidity increases were not as extreme in 2018 as in 2017. The highest turbidity recorded was under 1000 NTU, whereas last year turbidity peaked above 1000 NTU. Turbidity was also much less flashy at this site compared to the Morningside Cemetery site upstream.

Specific Conductance

- Specific conductance, a measure of dissolved pollutants which conduct electricity in water, decreases during storm events in Sand Creek. When creek stage rises due to storm runoff, conductance drops. . During brief, intense rainfall the stream conductance drops sharply. This relationship indicates that the shallow groundwater that feeds the stream during baseflow has higher specific conductance than stormwater runoff. Infiltration of road deicing salts is a likely source of high conductance in streams at baseflow year round due to contamination of the surficial groundwater that feeds the streams.

Dissolved Oxygen

- The observed dissolved oxygen concentrations in Sand Creek generally were within the healthy range, >5mg/L.
- Dissolved oxygen dropped to <5 mg/L only during storm 3 in August 2018. This is likely due to the high temperature of the stream at this time. Warm water can hold less oxygen.

Temperature

- Water temperature is generally not considered a concern in Sand Creek because there are no trout or other temperature sensitive resources.
- Cycles of day warming and night cooling are apparent in the data.

pH

- pH typically declines during storm events in Sand Creek. When water levels rise due to storm runoff, pH declines. This is because rainwater has a lower pH than that of local shallow groundwater feeding baseflows.
- pH stayed within the desired range of 6.5 to 8.5 that is specified in state water quality standards and is not presently a concern at this site.

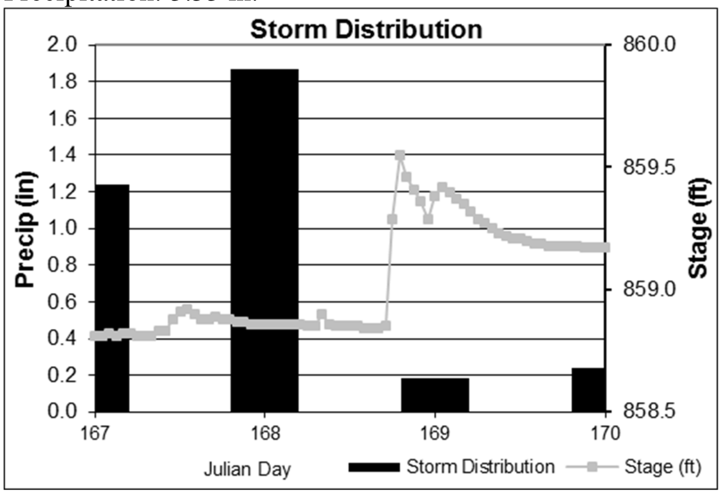
YSI Continuous Monitoring
Storm 1 – June 16th to 19th

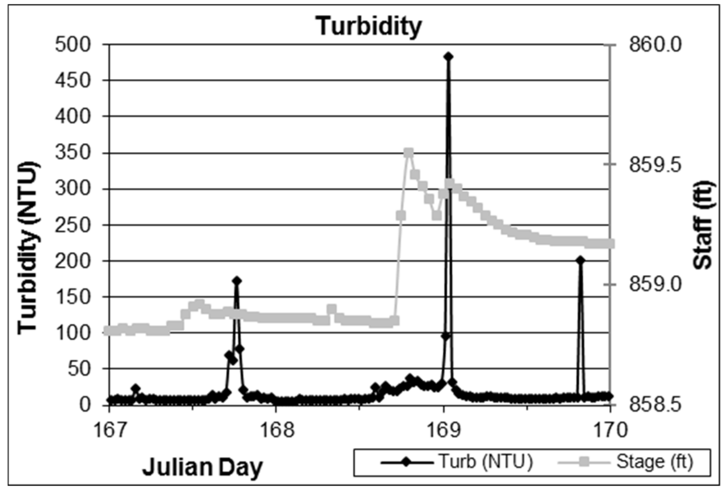
Sand Creek at Xeon Street

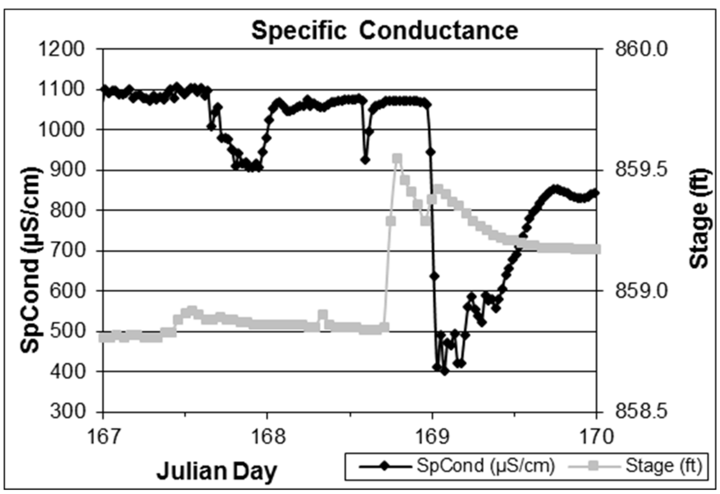
<u>Storm Summary:</u>

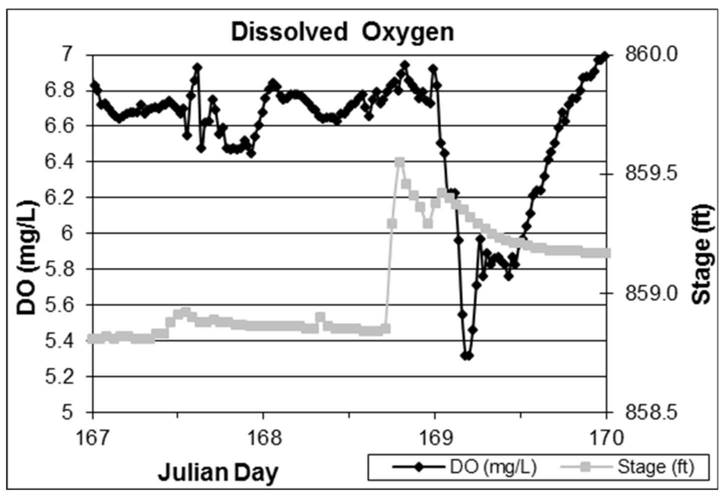
Dates: 16 June 2018 (day 167) to 19 June 2018 (day 170)

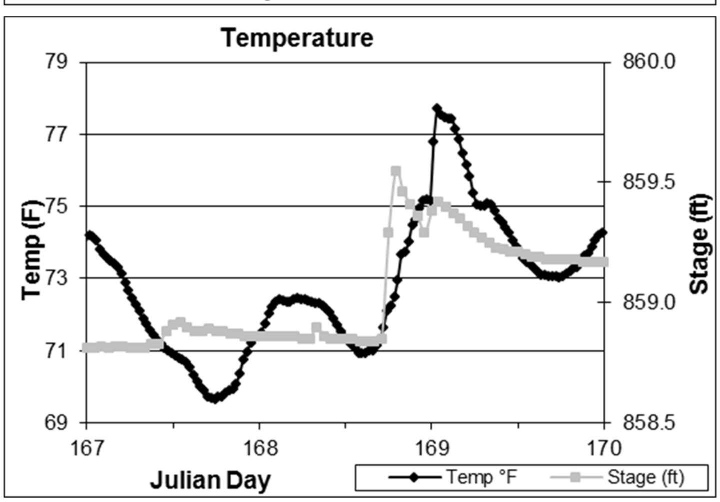
Precipitation: 3.53 in.

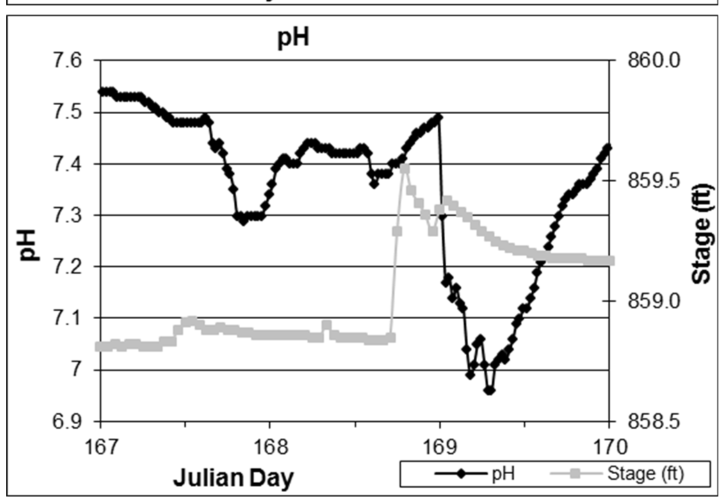






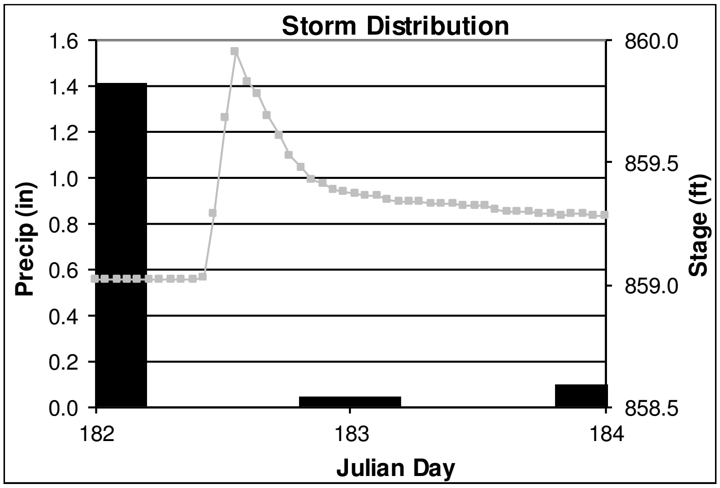


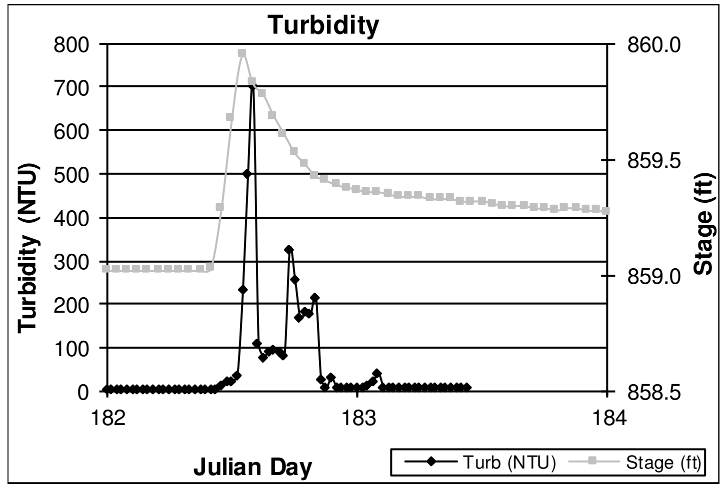


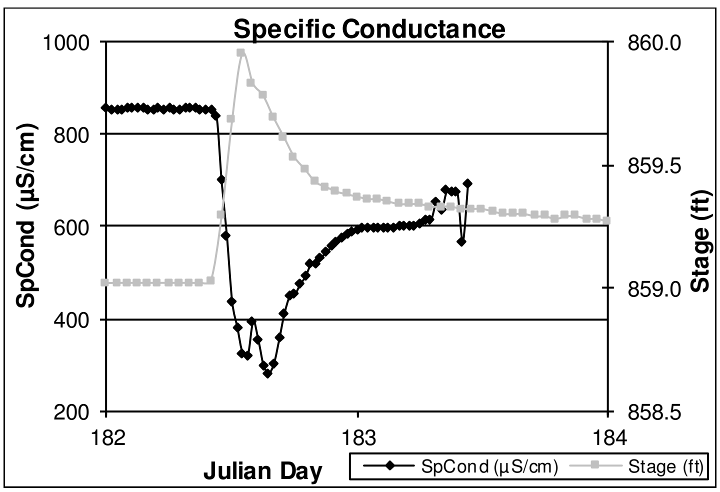


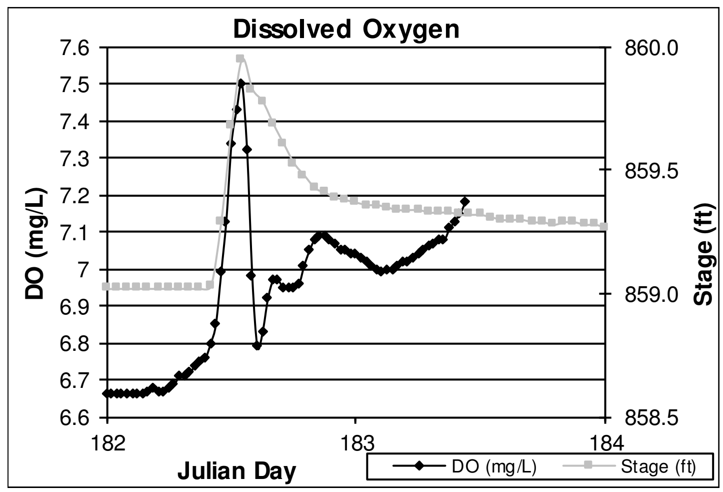
YSI Continuous Monitoring
Storm 2 – July 1st to July 3rd

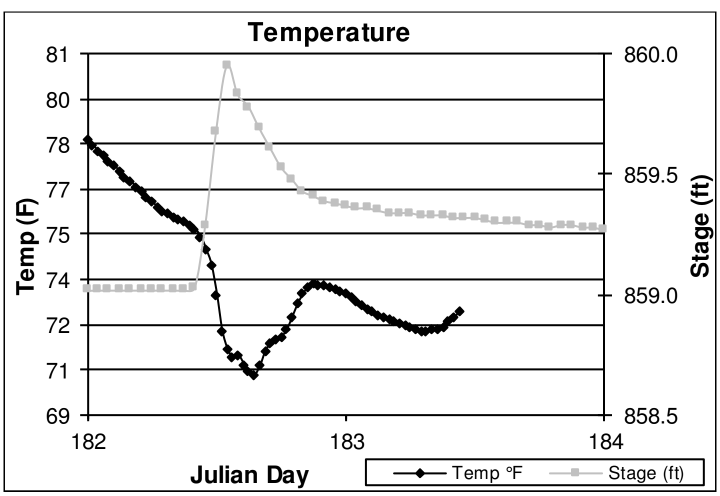
Sand Creek at Xeon Street
<u>Storm Summary:</u>
Dates: 1 July 2018 (day 182) to 3 July 2018 (day 184)
Precipitation: 1.56 in.

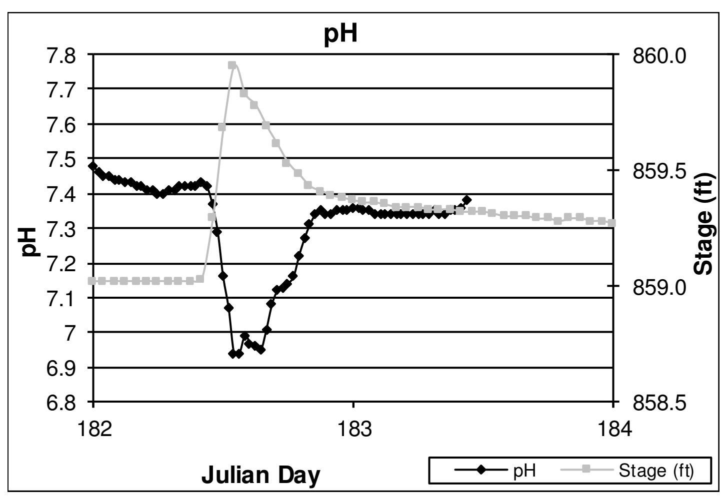












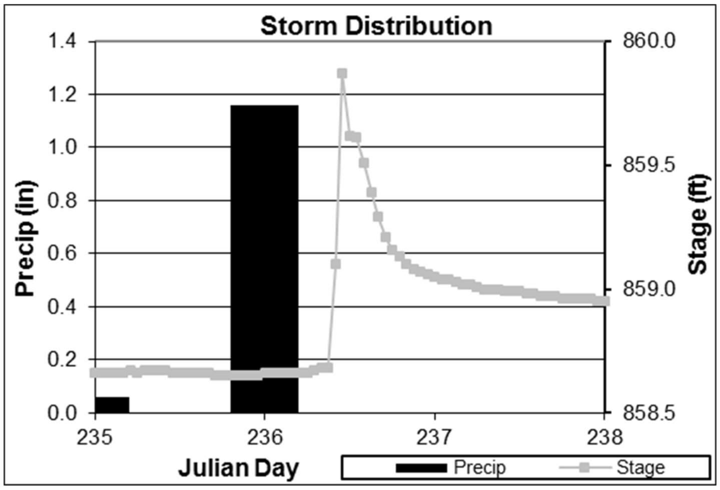
YSI Continuous Monitoring
Storm 3 – August 23rd to 26th

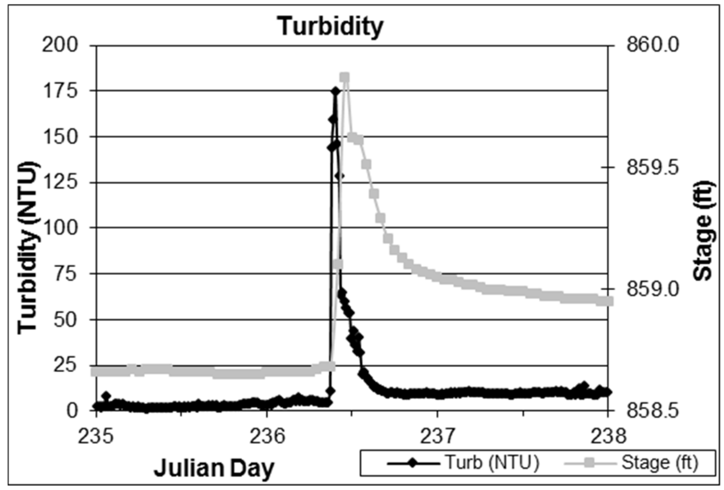
Sand Creek at Xeon Street

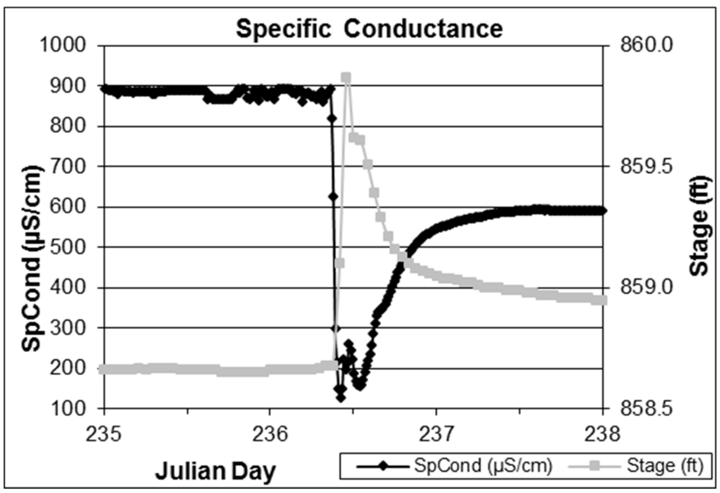
<u>Storm Summary:</u>

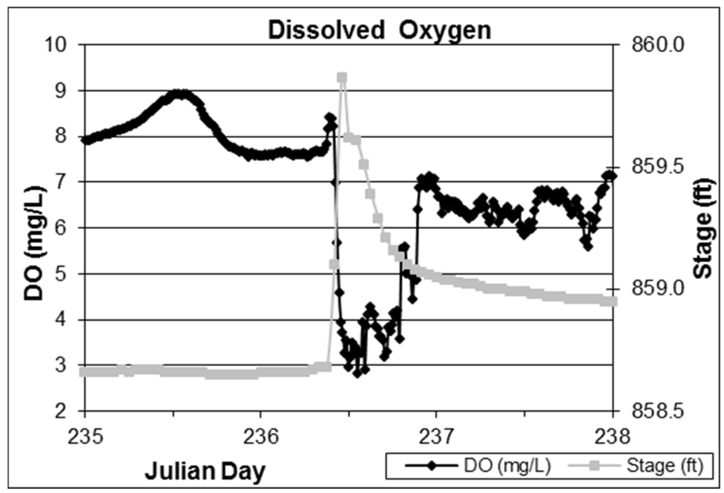
Dates: 23 August 2018 (day 235) to 26 August 2018 (day 238)

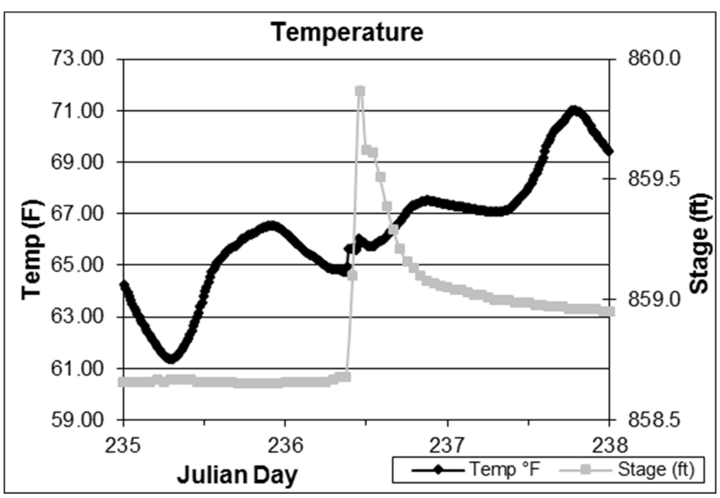
Precipitation: 1.22 in.

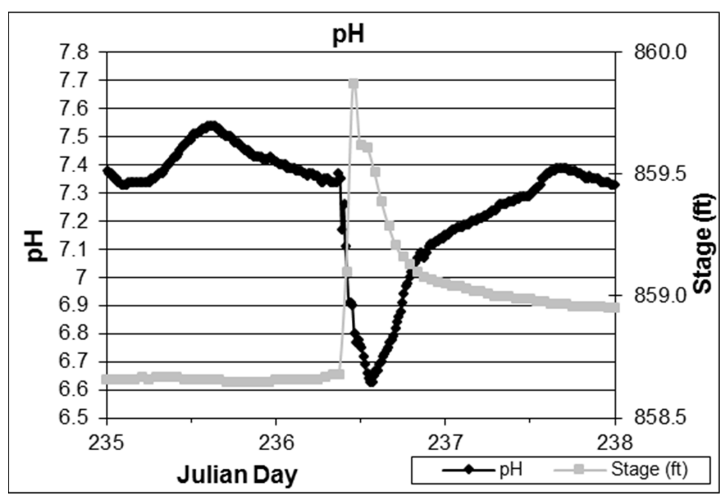












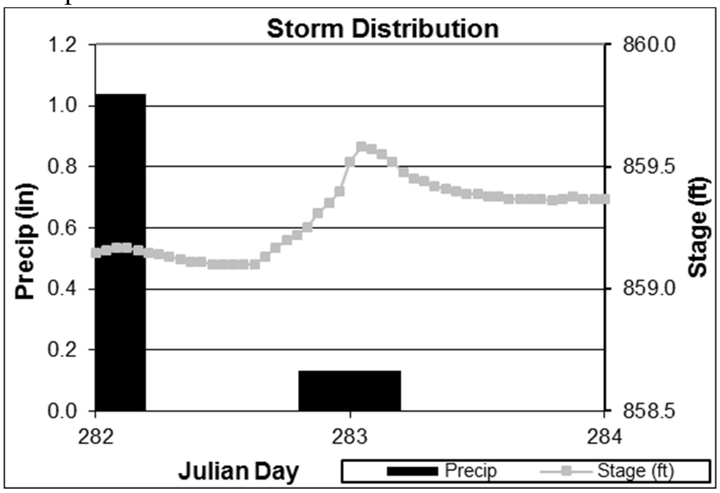
YSI Continuous Monitoring
Storm 4 – Oct. 9th to 11th

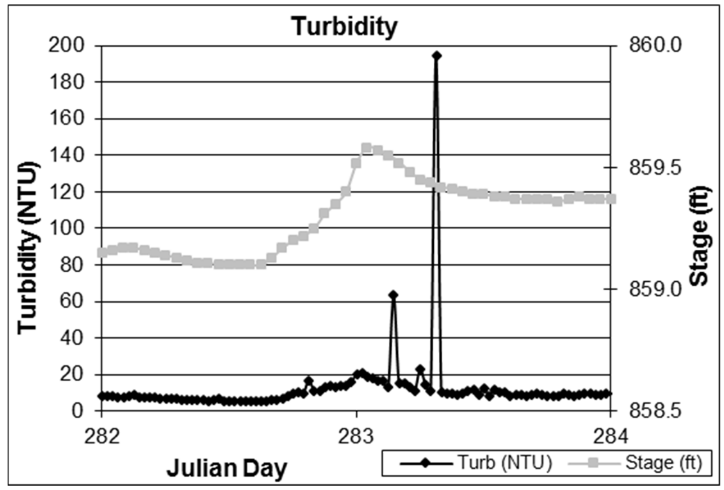
Sand Creek at Xeon Street

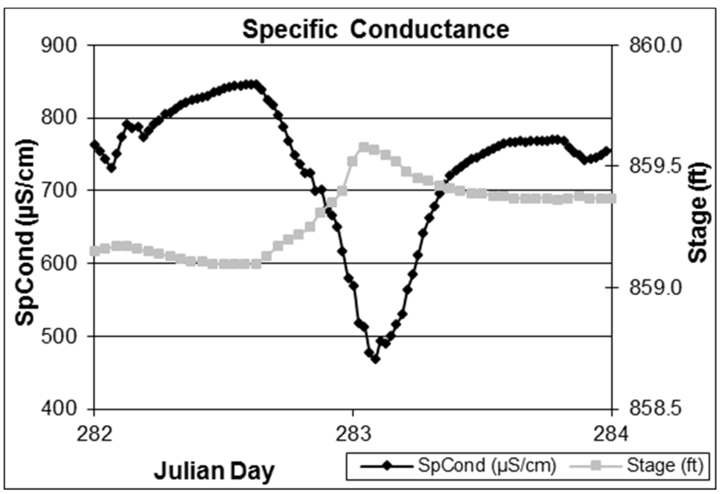
Storm Summary:

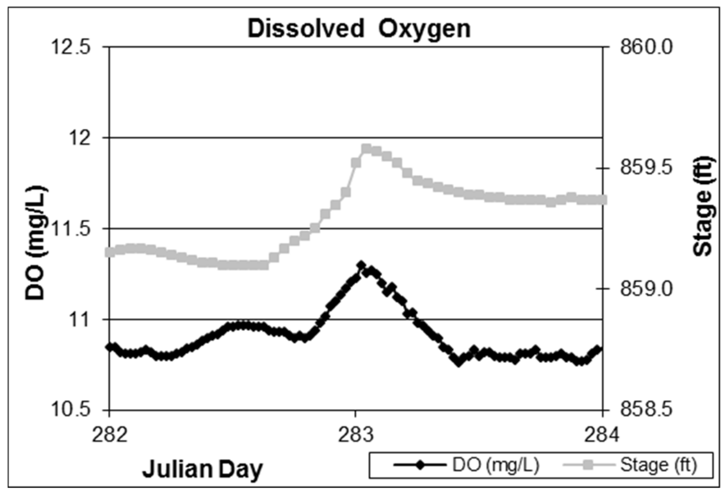
Dates: 9 October 2018 (day 282) to 11 October 2018 (day 284)

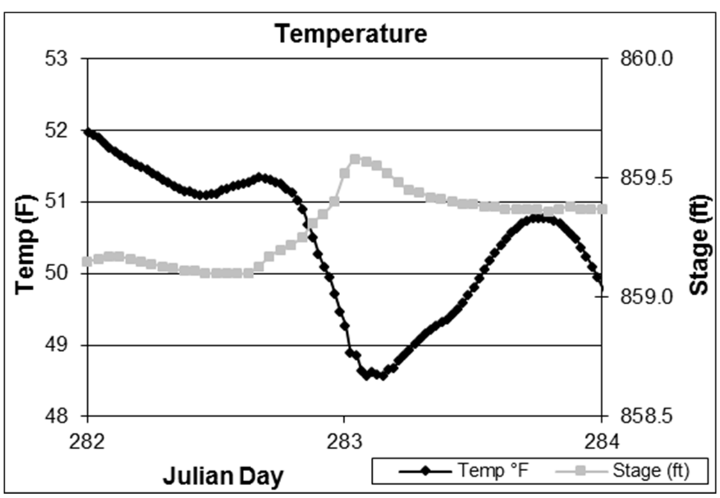
Precipitation: 1.17 in.

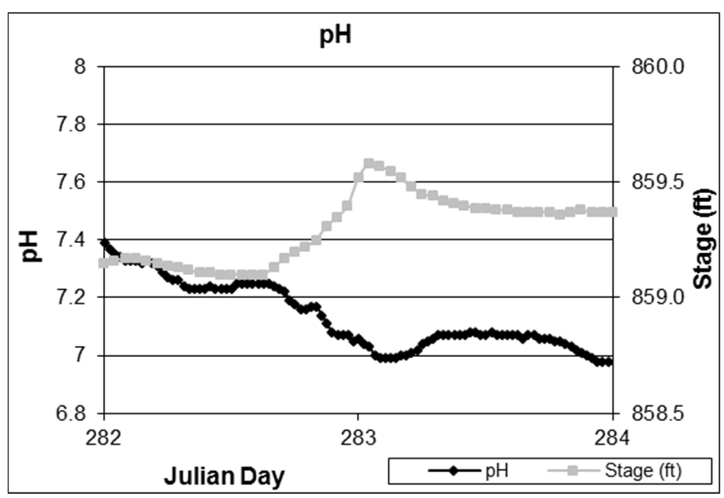










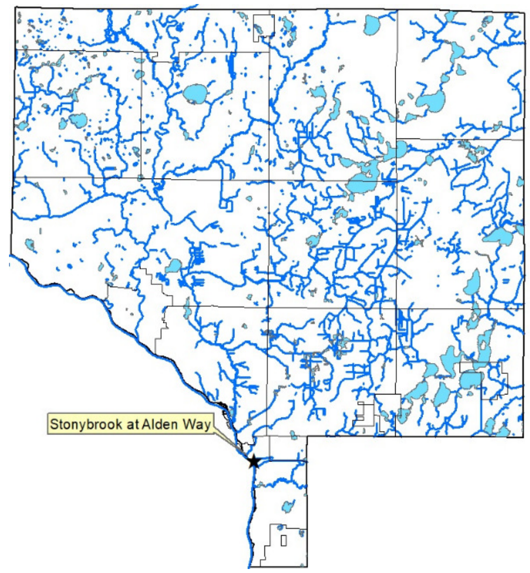


YSI Continuous Stream Water Quality Monitoring

STONYBROOK

at Alden Way, Fridley

Years Monitored
2017, 2018



Background
Stonybrook is a small waterway that drains a mostly urbanized and industrial watershed in northern Fridley and western Spring Lake Park. The stream's contributing area starts about one mile east of the Mississippi River as a storm sewer. The last 1/3 of the one-mile watershed is an open, deeply cut channel that descends 40 ft. to the Mississippi River. The sampling site is located about 250 ft. upstream of the confluence, just east of Alden Way. The creek is only about 10 ft. wide and 6 in. deep during baseflow conditions at the sampling site. Rain events frequently cause the stage to jump over 3 feet.

2018 was the second year in which continuous water quality was monitored during storm events in Stonybrook using a YSI EXO data sonde. The purpose of continuous water quality monitoring is to document water quality changes throughout storm events. This helps diagnose water quality problems and reflect differences in runoff between larger, less flashy systems, such as Sand Creek and flashy, subterranean/storm drain systems such as Stonybrook and Oak Glen. Runoff from within the watershed passes the monitoring site quickly following a storm.

Methods

Stonybrook was monitored with both continuous storm water quality and storm and baseflow grab samples. This site was newly added for all monitoring in 2017 to better understand conditions of smaller drainages within the Coon Creek Watershed District that flow directly to the Mississippi River. Only continuous water quality monitoring of storms is presented in this section; grab sample water quality and continuous hydrology data are presented elsewhere in this chapter.

The site was monitored immediately before, during, and after four storms with a YSI EXO data sonde. The sonde was suspended inside a PVC pipe with a locked lid. The PVC pipe was secured to a metal fence post. The sonde sensors protruded from the bottom of the pipe approximately 3 inches from the stream bottom, ensuring they would stay submerged even if flow was low. The sonde was programmed to take readings every 15 minutes. Readings included pH, salinity, specific conductance, temperature, dissolved oxygen, and turbidity. The sonde was calibrated before each deployment.

The YSI data sondes were deployed into streams when at least 0.5 inches, of rain was forecasted. In some instances, water level was already high before the storm and remains high after the storm. At other times, predicted rain does not fall and we monitor baseflow conditions. In all instances, the YSI data sondes are left in the field for several days.

Water levels were continuously monitored throughout the open water season. An Ott Orpheus Mini water level monitoring device recorded water levels every 15 minutes. This stream stage data is presented with the water quality data. To make graphs from all storms comparable, stage is displayed on a constant axis.

Precipitation data are provided with the water quality results. A DNR volunteer precipitation reader in Fridley collected these data 1.2 miles north of the stream monitoring site.

Results and Discussion

Ideally, a variety of storm sizes are analyzed. Monitored 2018 stormed ranged from 0.3 to 3.76 inches. This broad distribution gives a very good picture of the storm water quality for a variety of storm sizes. It especially emphasizes the flashy hydrology of this stream.

On the following pages, results from each storm monitored are shown. The graphs show precipitation and the stream hydrograph approximately one day before through one day after each storm. Separate graphs show each water quality parameter. The text below discusses summarizes findings across all storms for each parameter.

<u>Turbidity</u>

- Stonybrook was hydrologically flashy with intense turbidity increases, sometimes going from single digit turbidity to nearly 900 NTU in minutes. Turbidity never surpassed 1,000 NTU in 2018 after doing so during two of four storms in 2017.
- In 2017 when two rainfall events occurred in close proximity the turbidity spiked more after the first rainfall, compared to the second. In 2018, this is not as evident with several turbidity peaks of similar magnitude following each of three consecutive days of rainfall. This suggests "first flushes" of debris from the landscape re-accumulates very quickly.

<u>Specific Conductance</u>

- Specific conductance, a measure of dissolved pollutants which conduct electricity in water, decreases during storm events in Stonybrook. When creek stage rises due to storm runoff, conductance drops.. During brief, intense rainfall the stream conductance drops sharply. This relationship indicates that the shallow groundwater that feeds the stream during baseflow has higher specific conductance than stormwater runoff. Infiltration of road deicing salts is a likely source of high conductance in streams at baseflow year round due to contamination of the surficial groundwater that feeds the streams.
- The drops in specific conductance are observed during very small events (0.1 inch or less). This indicates that almost all of the water that falls on this subwatershed is sent immediately downstream as stormwater instead of infiltrating.

<u>Dissolved Oxygen</u>

- Dissolved oxygen levels were quite high (>7.5 mg/l).
- Dissolved oxygen levels did not follow the diel oscillations (DO declining during nighttime, and increasing through the day) typically observed in most streams and instead were correlated to movements in water stage. This is likely due to the fact that the system is so small, and increased water from storms rushes down the steep watershed turbulently, becoming aerated and causing dissolved oxygen to go up.

<u>Temperature</u>

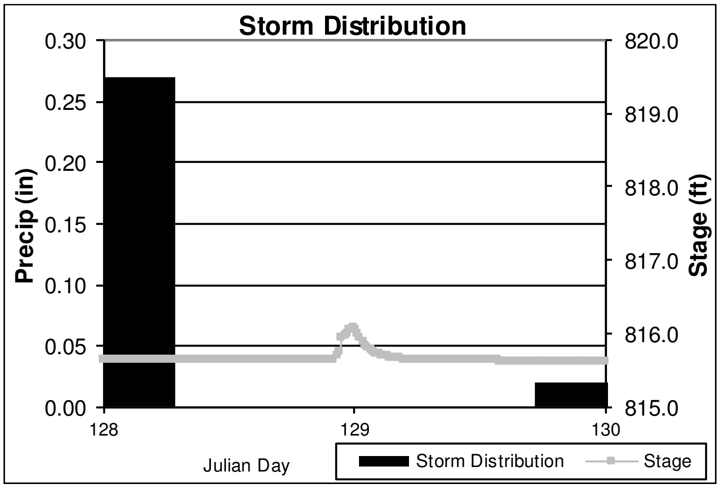
- Water temperature is generally not considered a concern in Stonybrook because there are no trout or other temperature sensitive resources.
- Temperatures increased with water levels during all storms monitored in 2018. This dynamic is likely due to groundwater being the main contributor to the small level of baseflow in the stream. Summer storms then introduce large flushes of warmer surface runoff, raising the stream's temperature. The effect is likely opposite when temperatures are colder and surface runoff is cooler than the surficial groundwater.

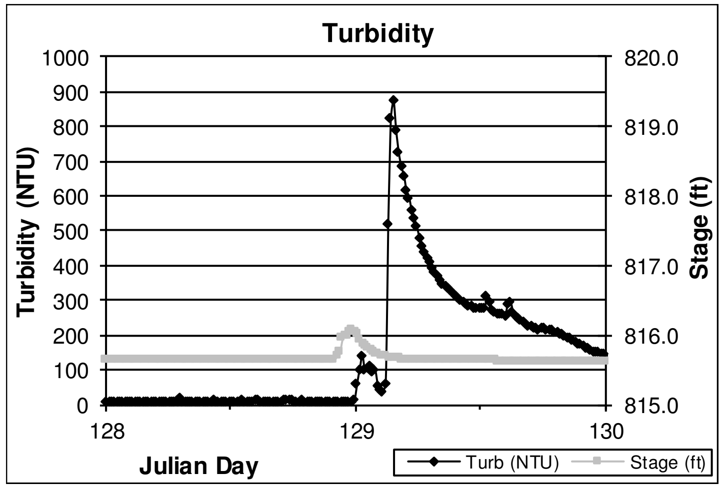
<u>pH</u>

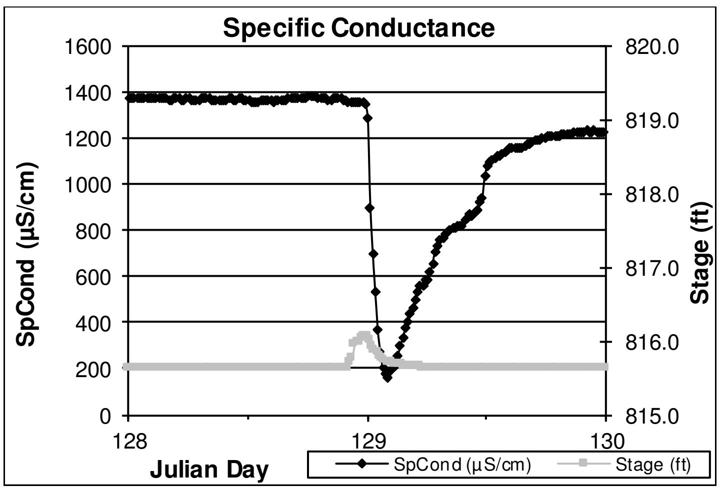
- pH typically declines during storm events in Stonybrook. When water levels rise due to storm runoff, pH declines. This is because rainwater has a lower pH than local shallow groundwater.
- pH remained within the desired range of 6.5 to 8.5 that is specified in state water quality standards

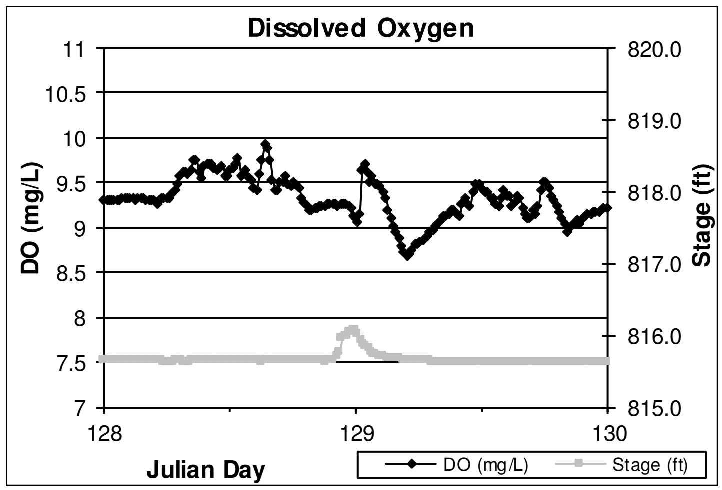
YSI Continuous Monitoring
Storm 1 – May 8th to 10th

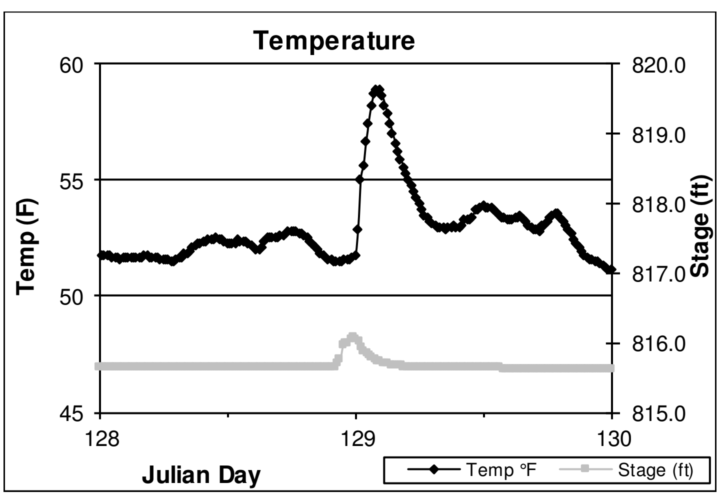
Stonybrook at Alden Way
Storm Summary:
Dates: 8 May 2018 (day 128) to 10 May 2018 (day 130)
Precipitation: 0.3 in.

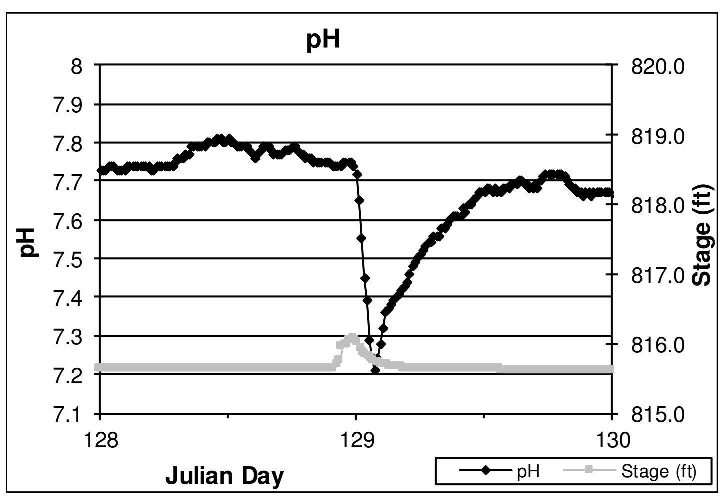












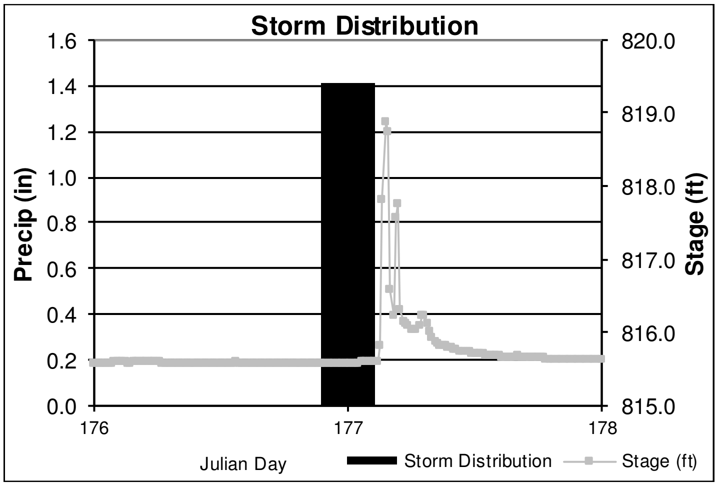
YSI Continuous Monitoring
Storm 2 – June 25th to 27th

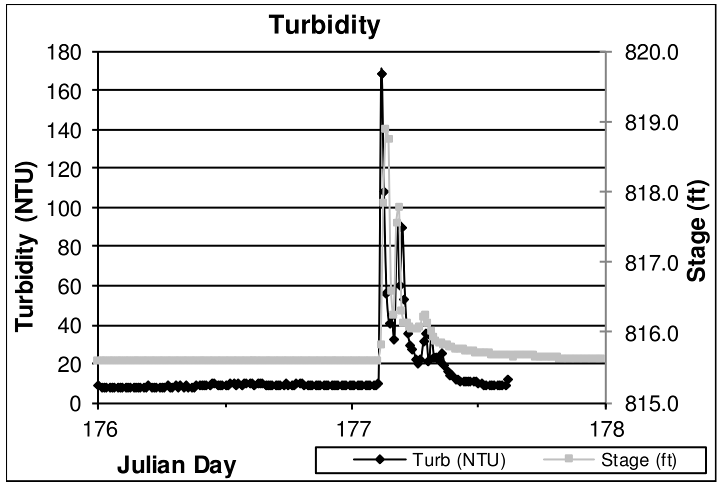
Stonybrook at Alden Way

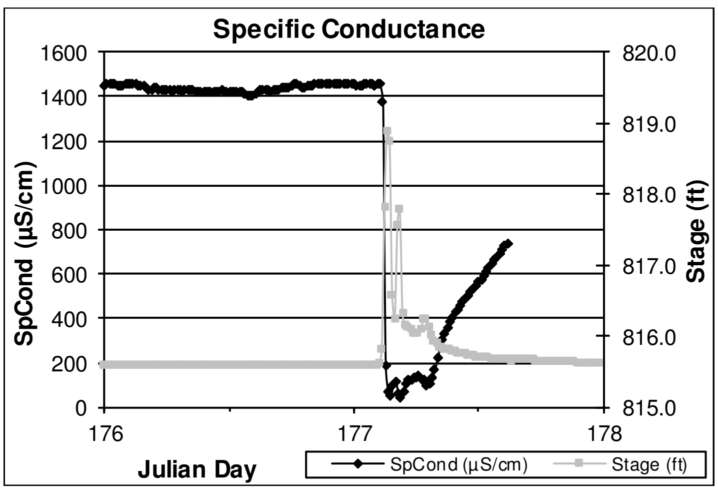
<u>Storm Summary:</u>

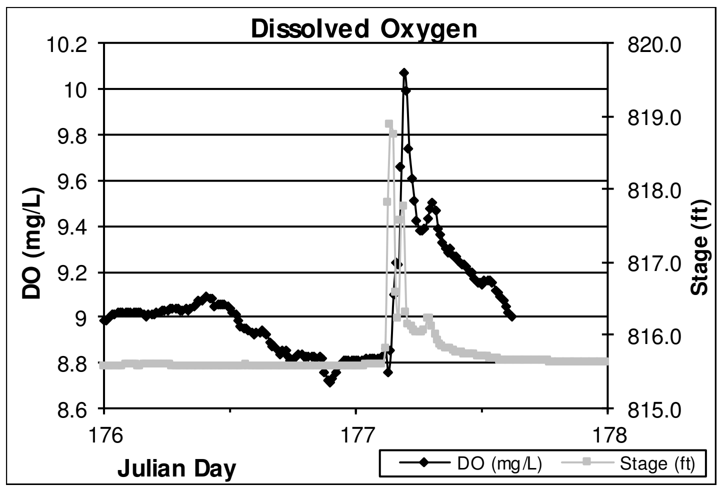
Dates: 25 June 2018 (day 176) to 27 June 2018 (day 178)

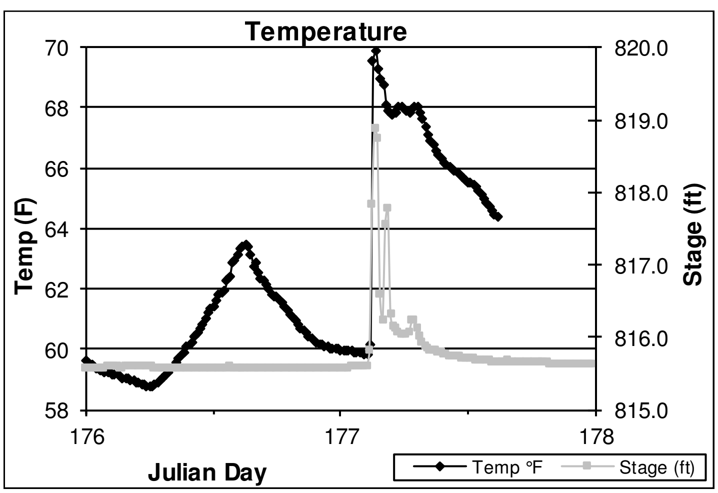
Precipitation: 1.41 in.

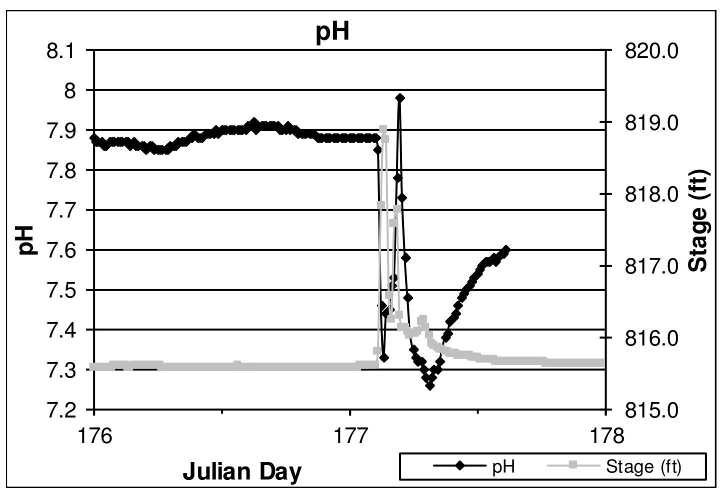












Note: YSI was pulled before return to baseflow water quality conditions. Stage returned to baseflow.

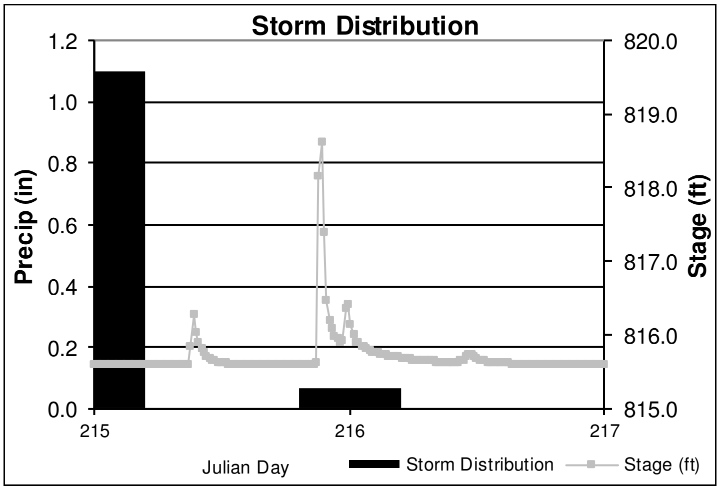
YSI Continuous Monitoring
Storm 3 – August 3rd to 5th

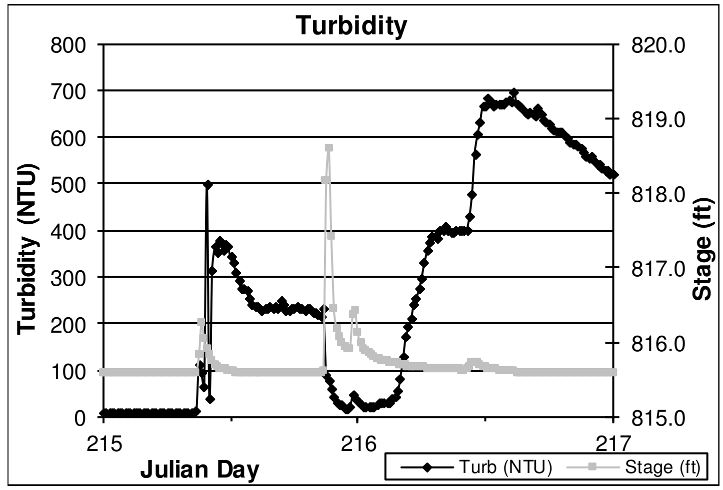
Stonybrook at Alden Way

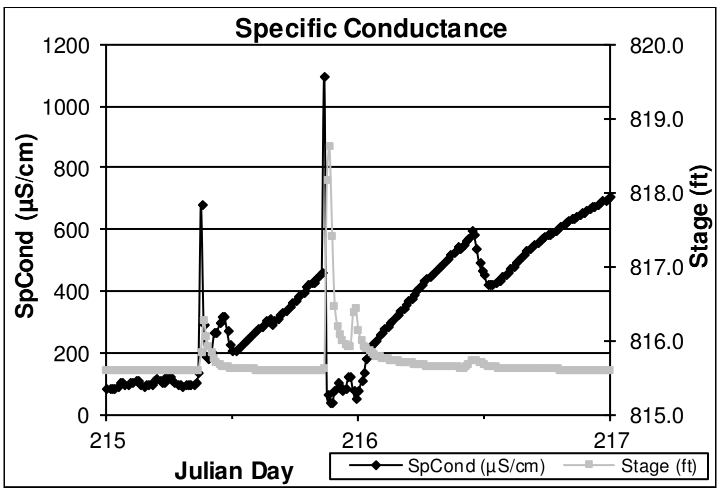
<u>Storm Summary:</u>

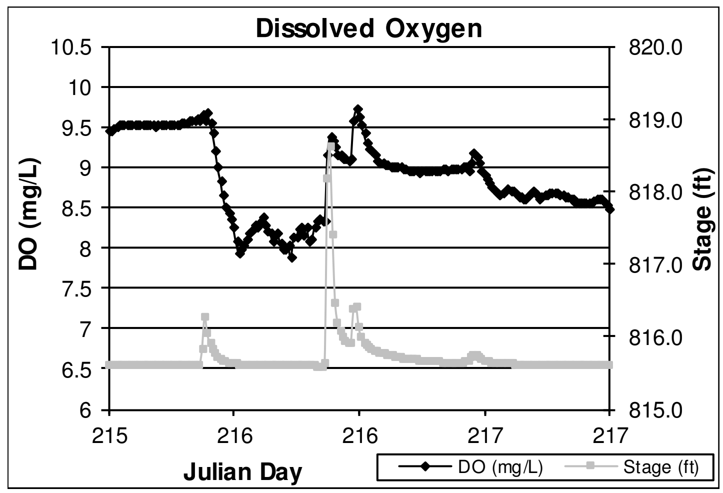
Dates: Dates: 3 August 2018 (day 215) to 5 August 2018 (day 217)

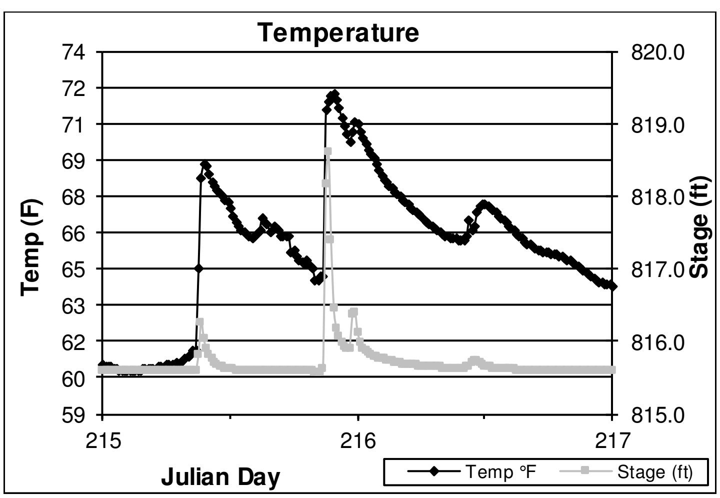
Precipitation: 1.17 in.

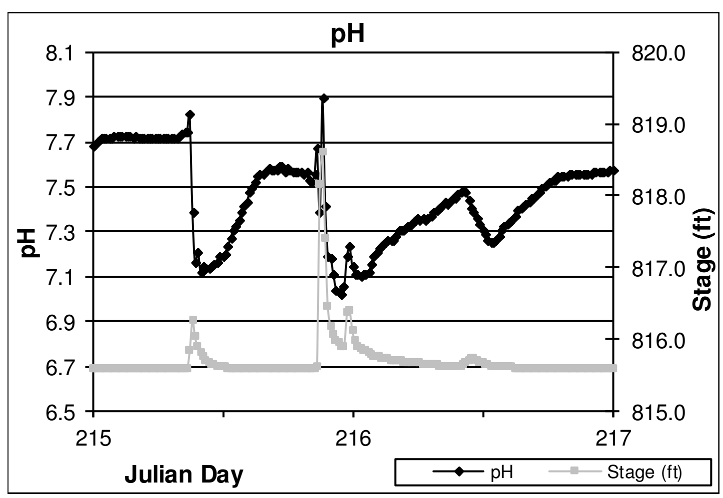












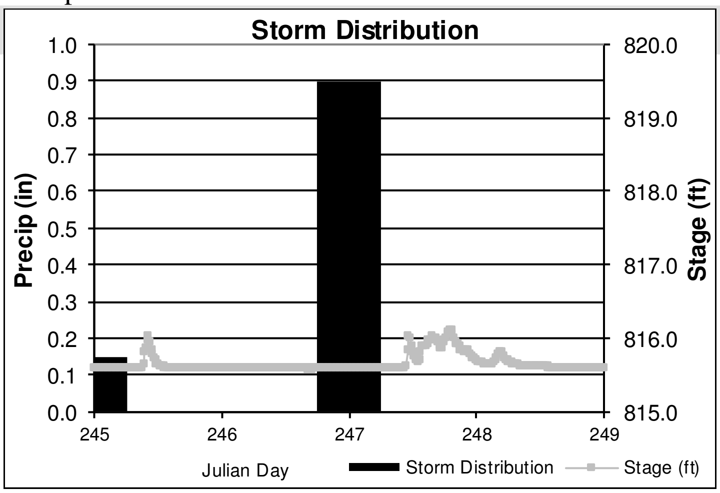
YSI Continuous Monitoring
Storm 4 – September 2nd to September 6th

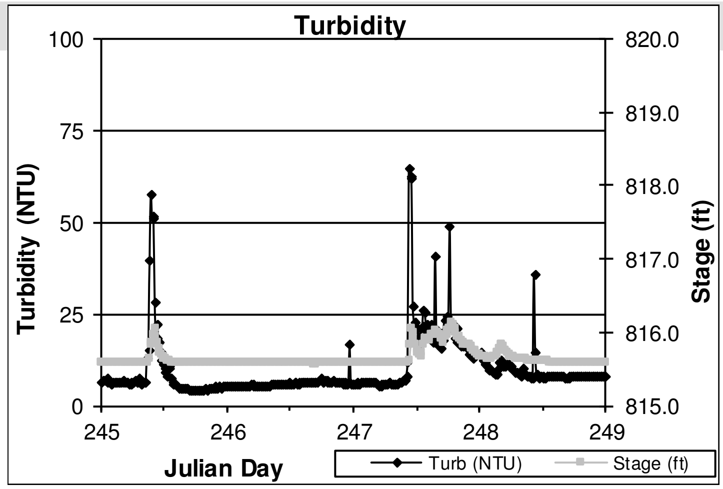
Stonybrook at Alden Way

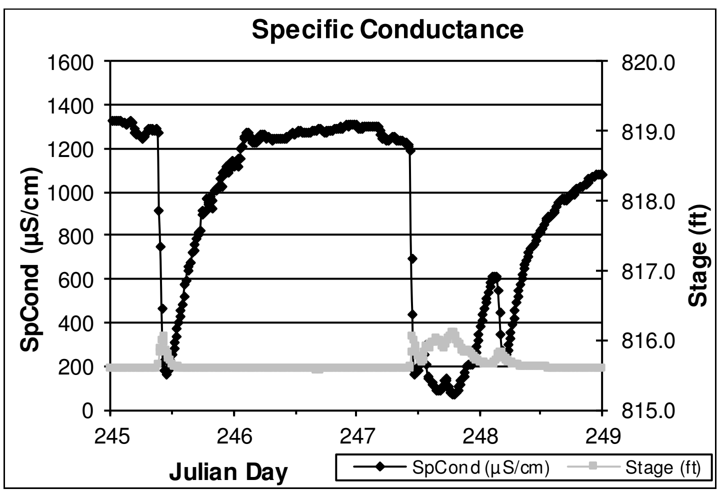
Storm Summary:

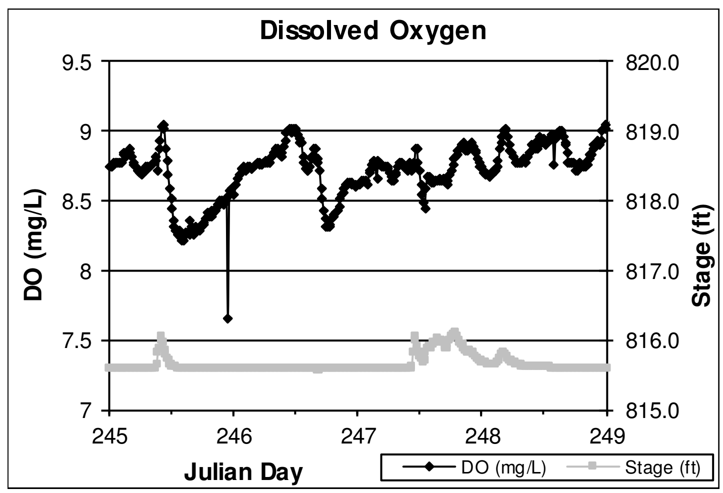
Dates: 2 September 2018 (day 245) to 6 September 2018 (day 249)

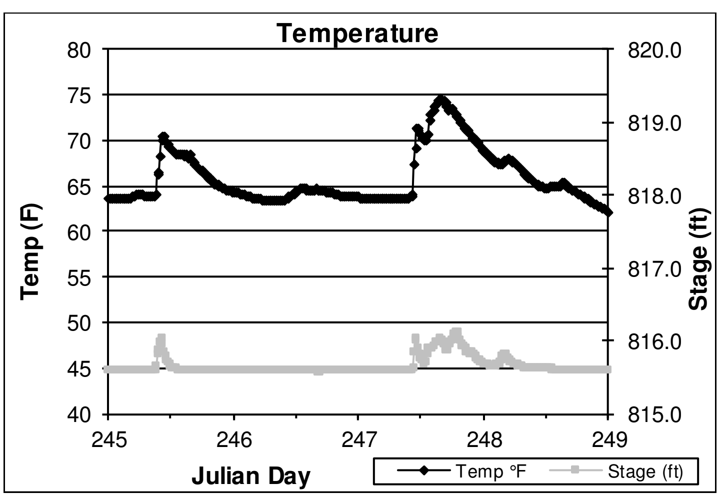
Precipitation: 1.05 in.

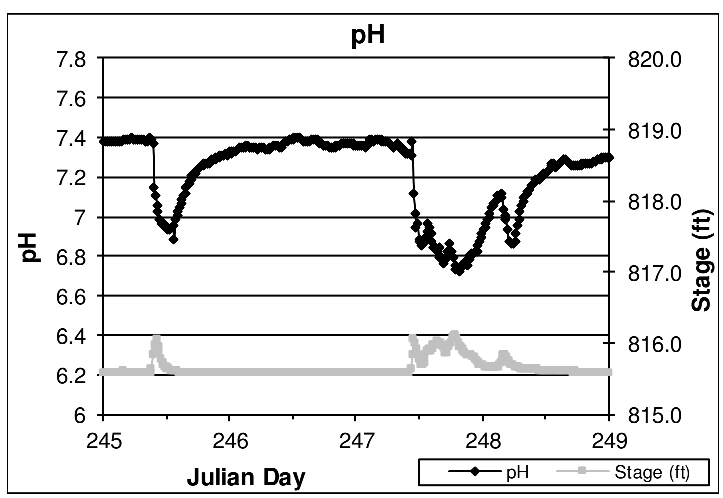












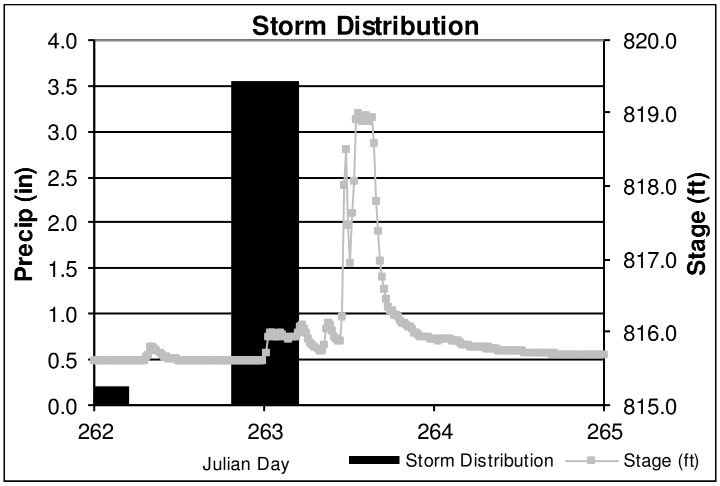
YSI Continuous Monitoring
Storm 5 –September 19th to 22nd

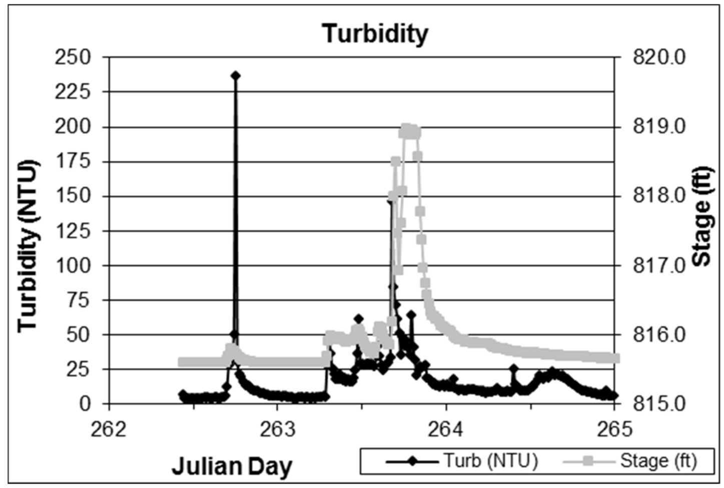
Stonybrook at Alden Way

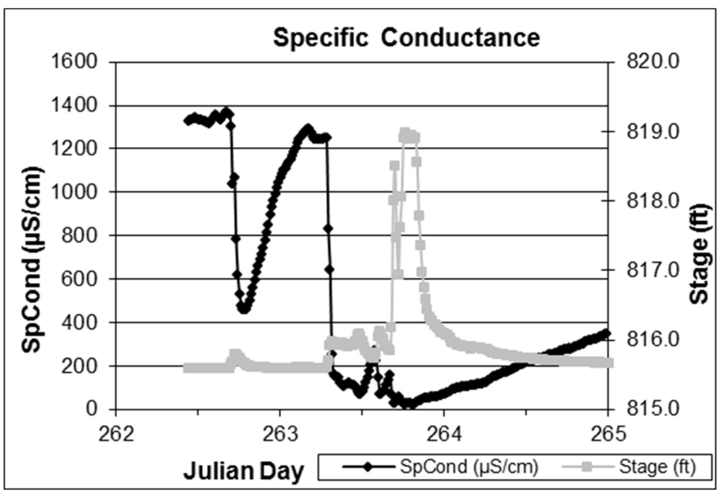
<u>Storm Summary:</u>

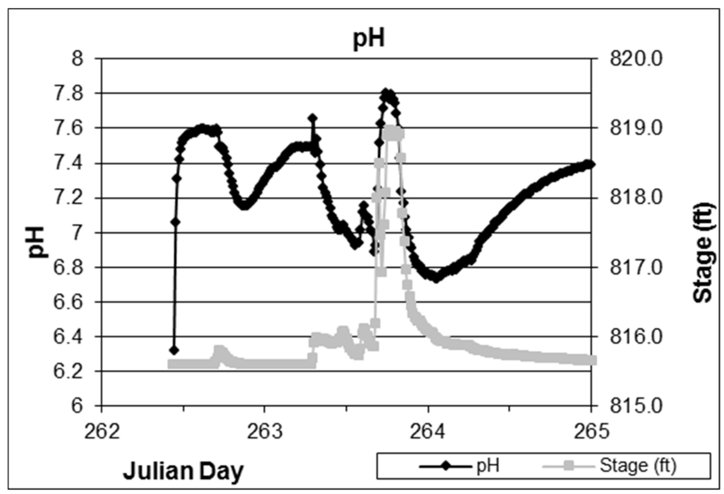
Dates: 19 September 2018 (day 262) to 22 September 2018 (day 265)

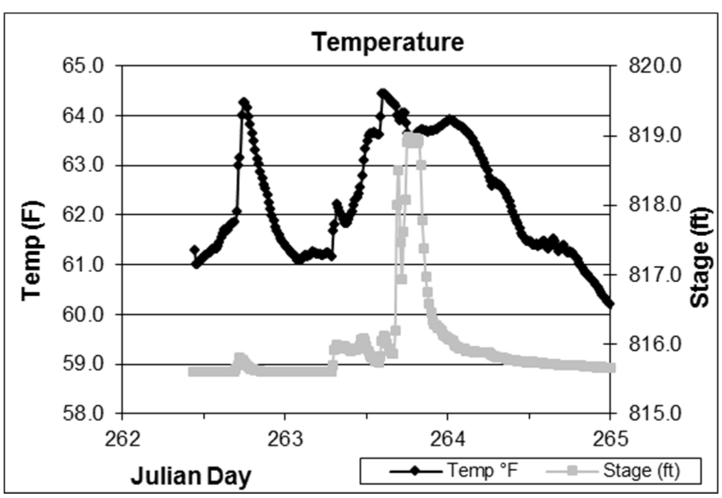
Precipitation: 3.76 in.

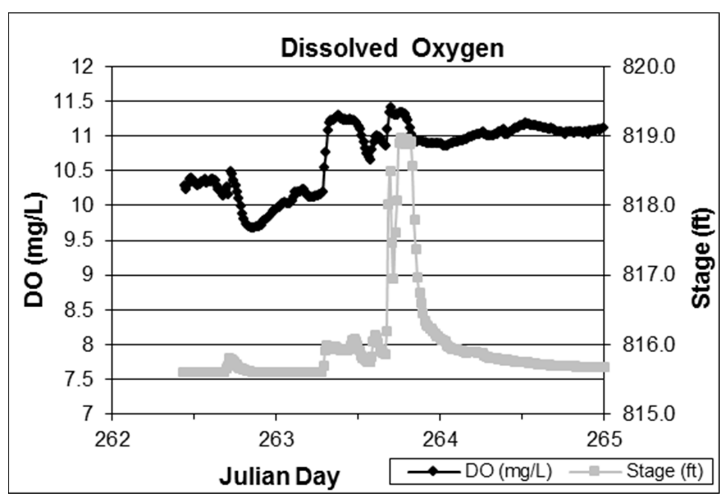






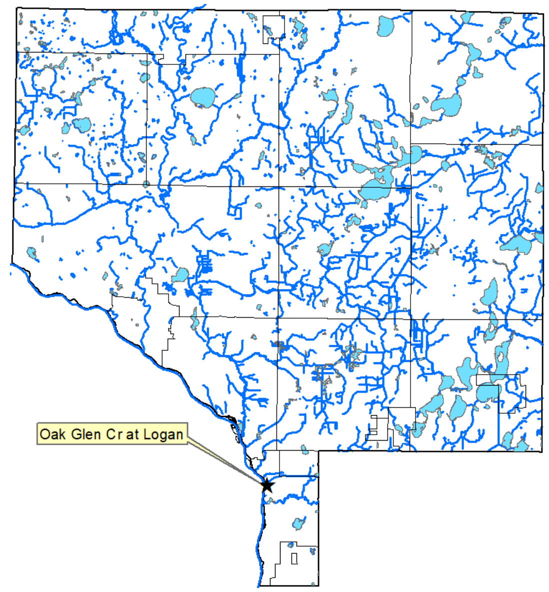






OAK GLEN CREEK

at Logan Parkway, Fridley



Years Monitored

2017, 2018

Background

Oak Glen Creek is a small waterway that drains directly to the Mississippi River. The Oak Glen watershed is approximately 660 acres of mostly commercial development and dense residential land use. The watershed boundaries are Highway 65 to the east, Osborne Road to the north, and 71st Avenue to the south. The creek exists as an open channel for approximately 1,400 ft. between East River Road and the Mississippi River. The channel is deeply cut and narrow, descending about 40 ft. to the River. In 2017, a stormwater pond just east of East River road treating water from this watershed was expanded and had an iron enhanced sand filter added for additional water quality benefit.

2018 was the second year in which continuous water quality was monitored during storm events in Oak Glen Creek using a YSI EXO data sonde. The purpose of continuous water quality monitoring is to document water quality changes throughout storm events. This helps diagnose water quality problems and reflect differences in runoff between small, primarily storm water fed streams and larger streams such as Sand Creek. Runoff from the watershed passes the monitoring site quickly following a storm.

YSI EXO water quality sonde casing (white) and an OTT continuous water level monitoring device casing (brown) in Oak Glen Creek. There is a staff gage on the green post facing the other direction.

Methods

Oak Glen Creek was monitored for both continuous storm water quality and storm and baseflow grab samples. This site was newly added for all monitoring in 2017 to better understand conditions of smaller drainages in the Coon Creek Watershed District where data was lacking, as well as to gather baseline data to assess the future effect of water quality projects being implemented in the watershed. Only continuous water quality monitoring of storms is presented in this section; grab sample and hydrology data are presented elsewhere in this chapter.

The site was monitored immediately before, during, and after four storms with a YSI EXO data sonde. The sonde was suspended inside a PVC pipe with a locked lid. The PVC pipe was secured to a metal fence post. The sonde sensors protruded from the bottom of the pipe approximately 3 inches from the stream bottom, ensuring they would stay submerged even if flow was low. The sonde was programmed to take readings every 15 minutes. Readings included pH, salinity, specific conductance, temperature, dissolved oxygen, and turbidity. The sonde was calibrated before each deployment

The YSI data sondes were deployed into streams when at least 0.5 inches, of rain was forecasted. In some instances, water level was already high before the storm and remains high after the storm. At other times, predicted rain does not fall and we monitor baseflow conditions. In all instances, the YSI data sondes are left in the field for several days.

Water levels were continuously monitored throughout the open water season. An Ott Orpheus Mini water level monitoring device recorded water levels every 15 minutes. This stream stage data is presented with the water quality data. It would be preferable to present flow, but a rating curve does not exist for this site. To make graphs from all storms comparable, stage is displayed on a constant axis.

Precipitation data are provided with the water quality results. A DNR volunteer precipitation reader in Fridley collected these data 1.75 miles north of the stream monitoring site.

Results and Discussion

Ideally, a variety of storm sizes are analyzed. Monitored 2018 stormed ranged from 0.3 to 3.76 inches. This broad distribution gives a very good picture of the storm water quality for a variety of storm sizes. It especially emphasizes the flashy hydrology of this stream.

On the following pages, results from each storm monitored are shown. The graphs show precipitation and the stream hydrograph approximately one day before through one day after each storm. Separate graphs show each water quality parameter. The text below discusses summarizes findings across all storms for each parameter.

<u>Turbidity</u>

- Many storms caused multiple, brief turbidity increases of various intensities in Oak Glen Creek. It seems that particulate debris from different parts of the watershed are washed into the creek at different rates.
- Large initial turbidity increases in some storms happen as soon as the rain starts and before stream water levels begin to rise, suggesting a large amount of particulate debris immediately washing into the lower portions of the watershed. However, some of the secondary turbidity increases were actually larger, indicating debris washing in from further up in the watershed.

<u>Specific Conductance</u>

- Specific conductance, a measure of dissolved pollutants which conduct electricity in water, decreases during storm events in Stonybrook. When creek stage rises due to storm runoff, conductance drops. Typically, baseflow specific conductance is high, and storm flushes decrease it. In Oak Glen Creek, this relationship between stage and specific conductance does happen, but usually after an incredibly high spike of specific conductance (12,000+ µS/cm) that occurs at the very beginning of some storms. The magnitude of the conductance spikes in Oak Glen Creek far surpasses anything ever recorded by ACD in the past. It indicates some quite concentrated pollutant staging where it immediately washes into and through the creek before stage even rises.

<u>Dissolved Oxygen</u>

- Dissolved oxygen levels were generally high, and never dropped below the state standard of 5 mg/L.
- Dissolved oxygen did display diel fluctuations oscillations (DO declining during nighttime, and increasing through the day) indicating internal photosynthetic activity is occurring in the watershed. This was less evident towards the end of the growing season (late September storm).

<u>Temperature</u>

- Water temperature is generally not considered a concern in Oak Glen Creek because there are no trout or other temperature sensitive resources.

<u>pH</u>

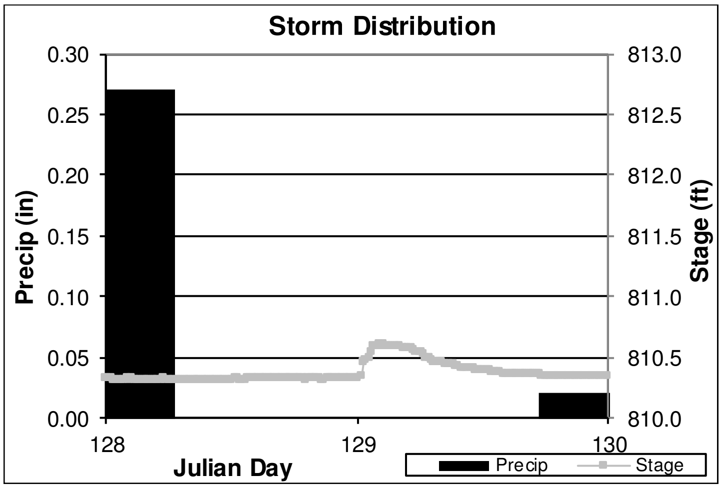
- pH typically declines during storm events in Oak Glen Creek. When water levels rise due to storm runoff, pH declinesThis is because rainwater has a lower pH than that of local shallow groundwater.
- pH dropped just below the desired range of 6.5 to 8.5 during each storm from August through September briefly during peak stage. This is below the state water quality standard but is probably not cause for concern due to the brevity of these occurrences.

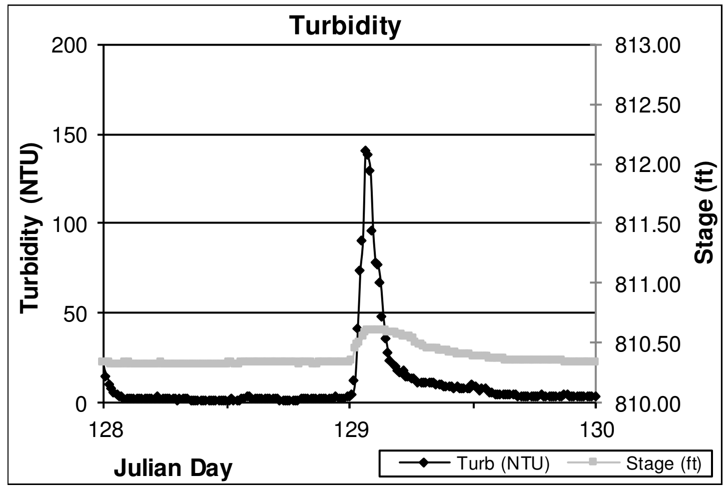
YSI Continuous Monitoring
Storm 1 – May 8th to 10th

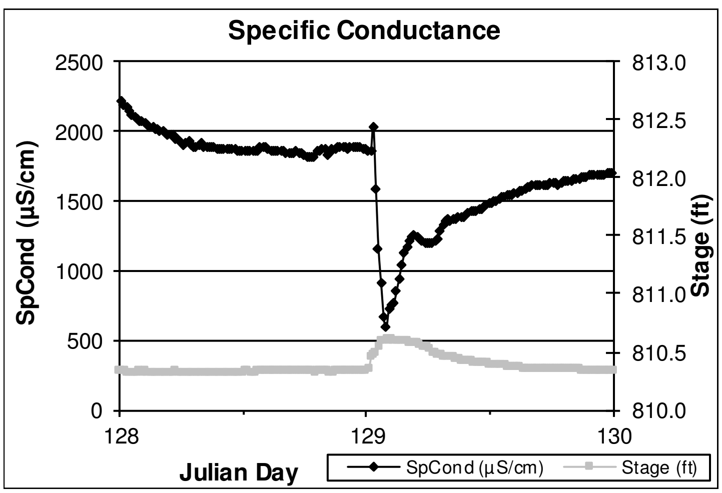
Oak Glen Creek at Logan Parkway

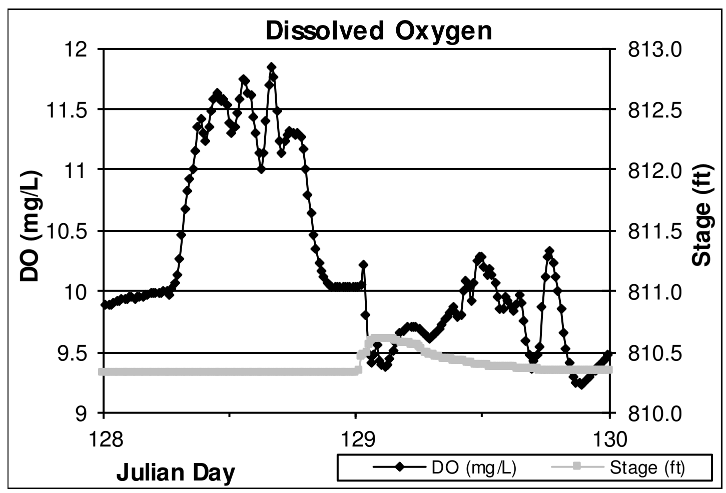
Storm Summary:

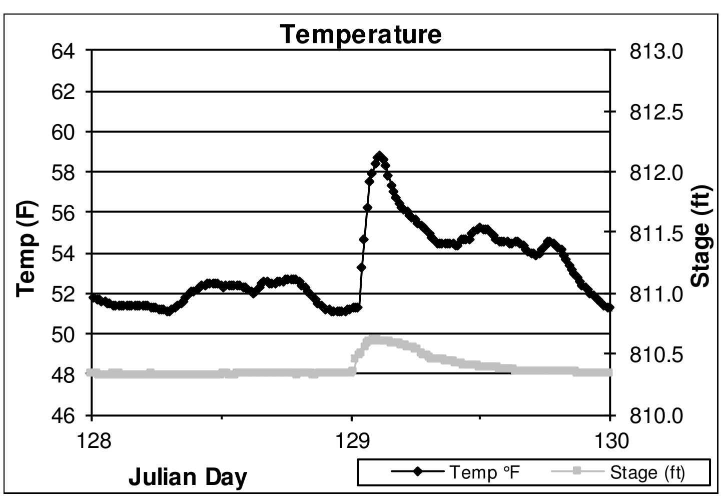
Dates: 8 May 2018 (day 128) to 10 May 2018 (day 130)
Precipitation: 0.3 in.

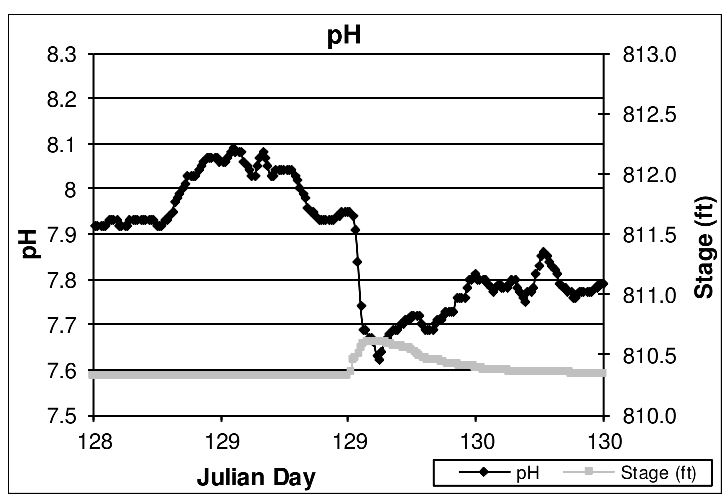












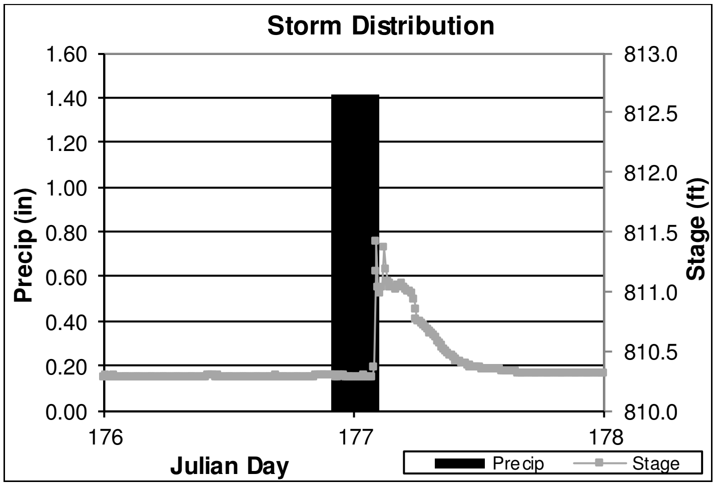
YSI Continuous Monitoring
Storm 2 – June 25th to 27th

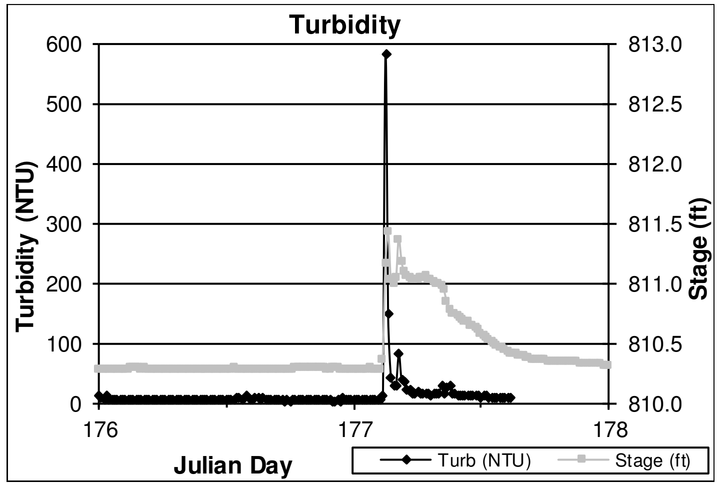
Oak Glen Creek at Logan Parkway

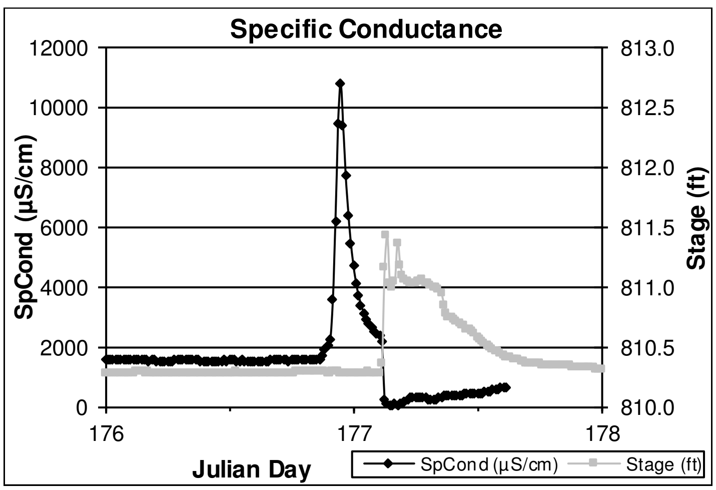
Storm Summary:

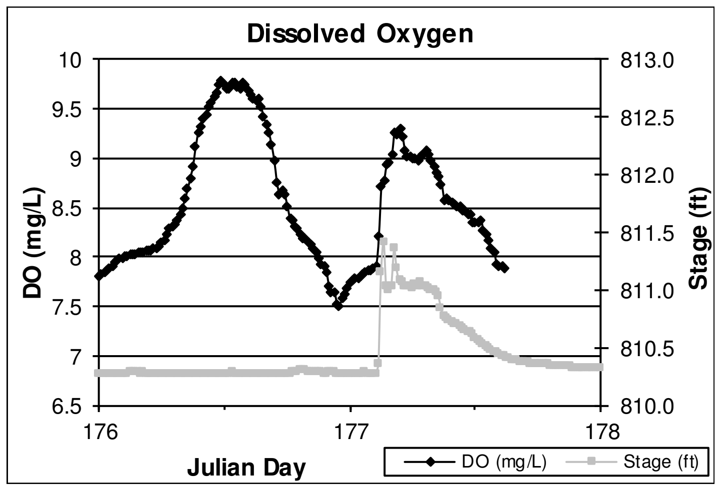
Dates: 25 June 2018 (day 176) to 27 June 2018 (day 178)

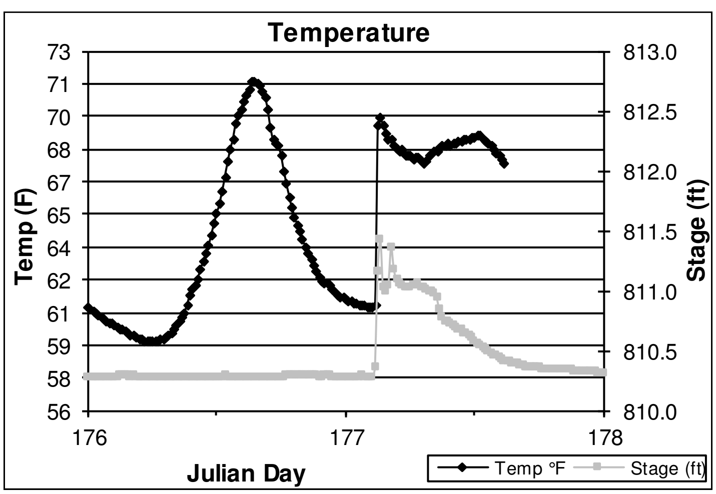
Precipitation: 1.41 in.

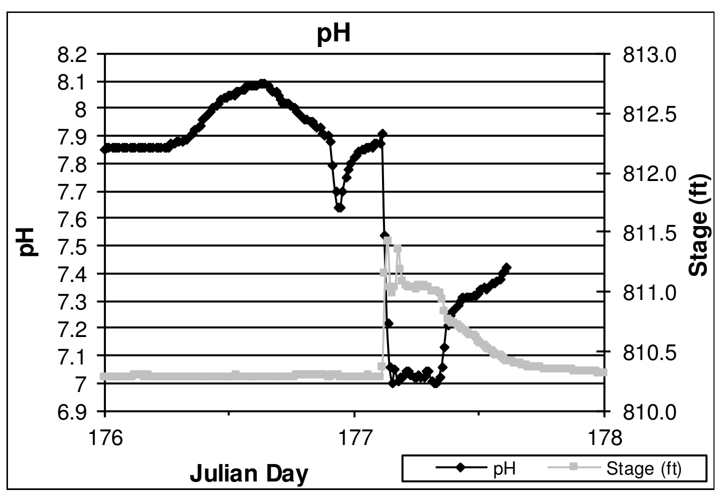












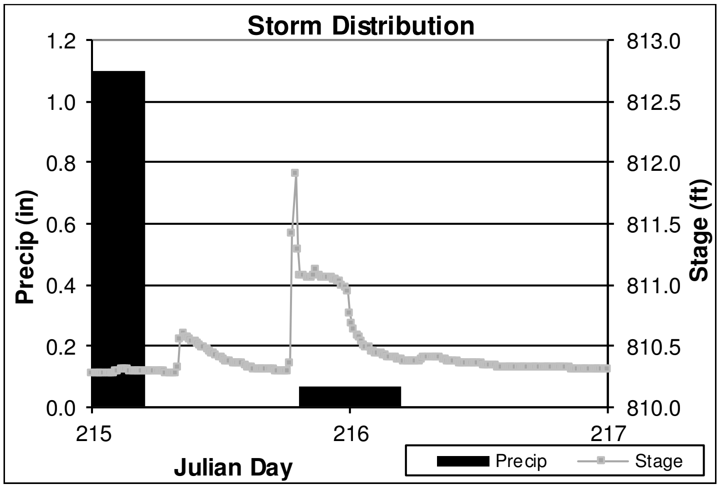
YSI Continuous Monitoring
Storm 3 – August 3rd to 5th

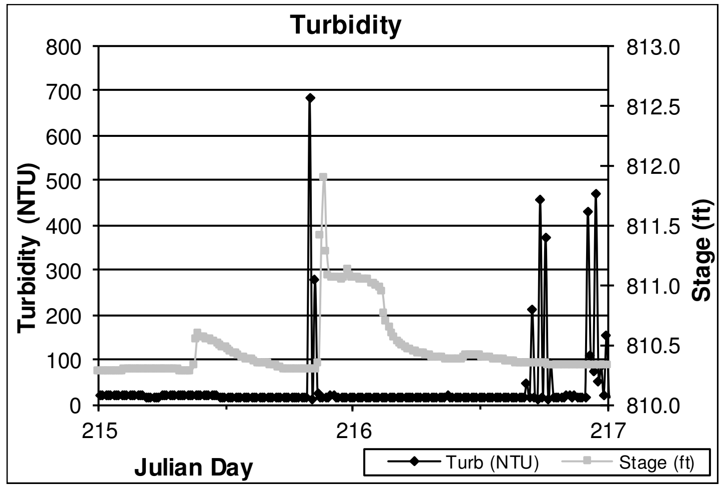
Oak Glen Creek at Logan Parkway

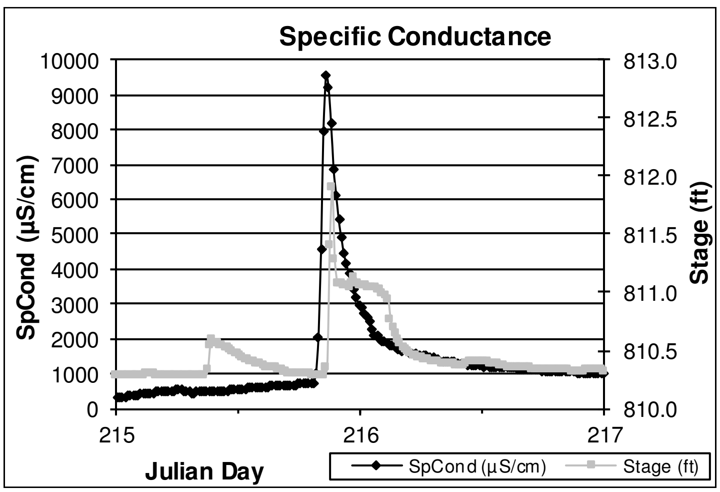
<u>Storm Summary:</u>

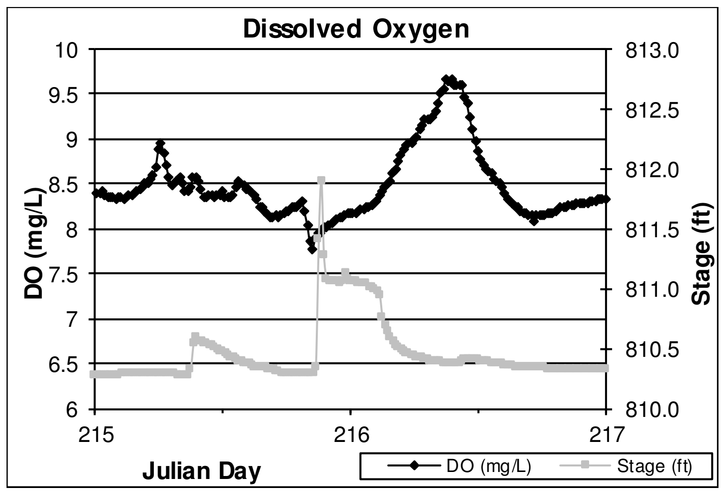
Dates: 3 August 2018 (day 215) to 5 August 2018 (day 217)

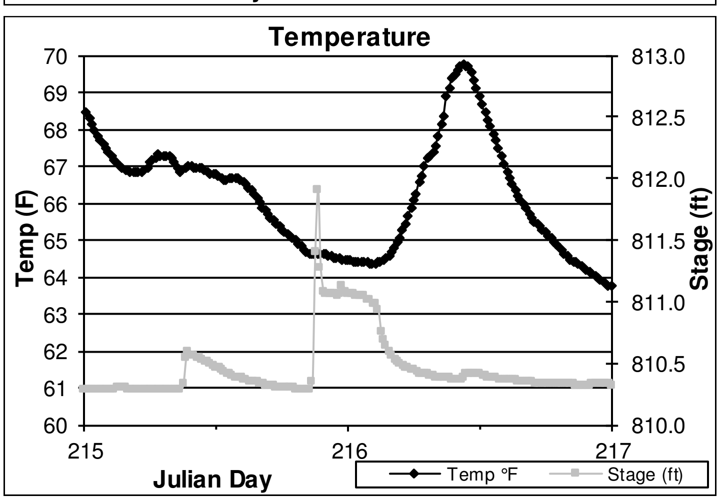
Precipitation: 1.17 in.

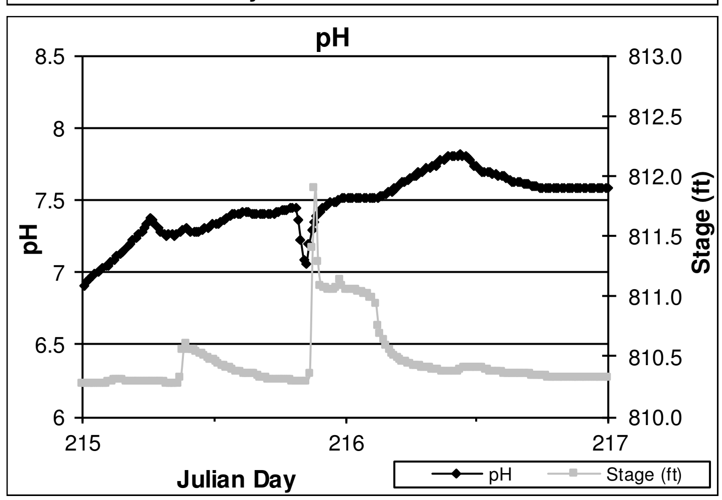












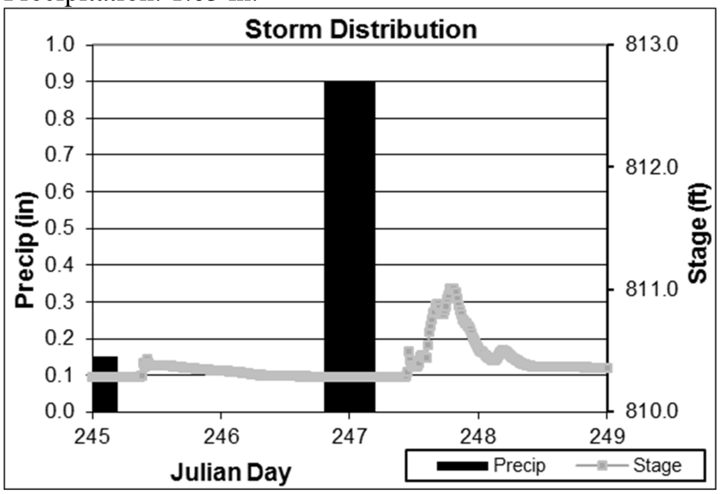
YSI Continuous Monitoring
Storm 4 – September 2nd to 6th

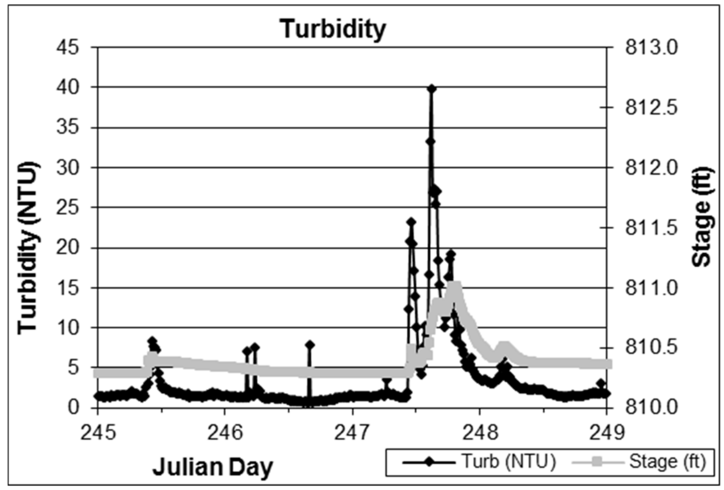
Oak Glen Creek at Logan Parkway

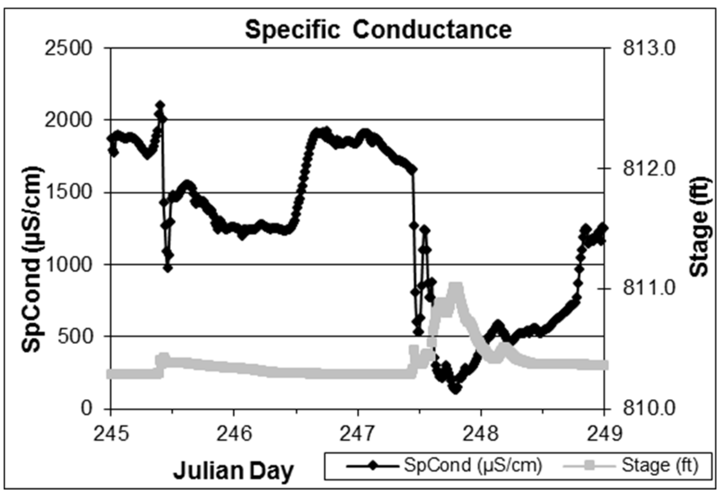
Storm Summary:

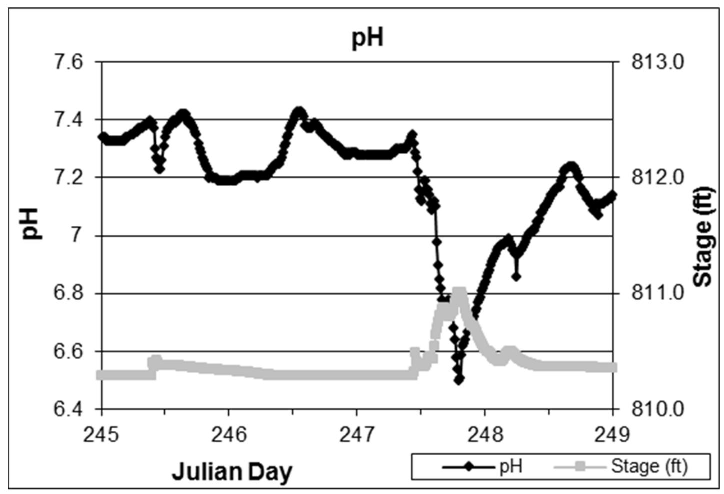
Dates: 2 September 2018 (day 245) to 6 September 2018 (day 249)

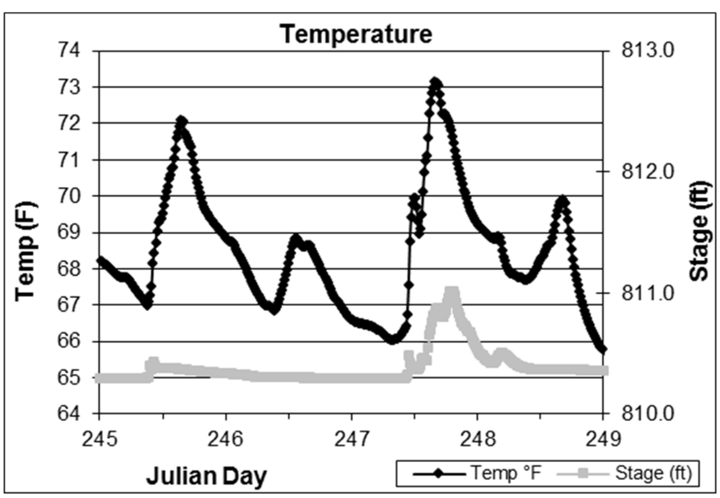
Precipitation: 1.05 in.

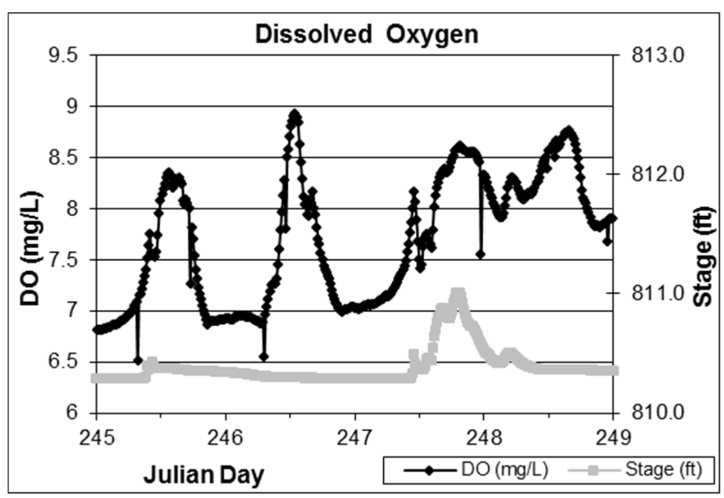












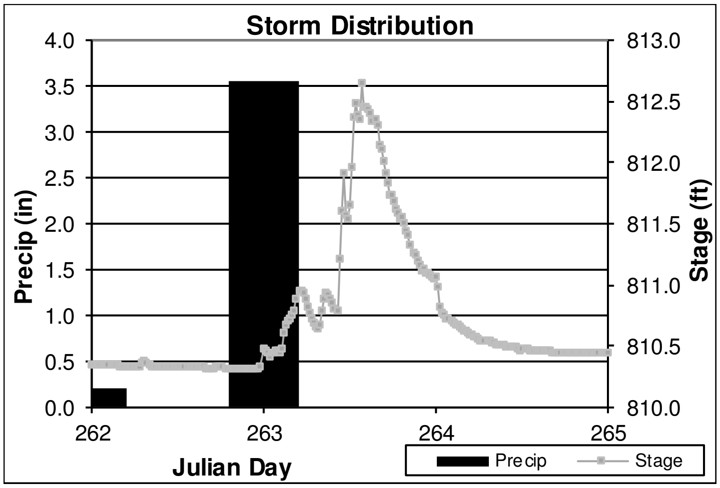
YSI Continuous Monitoring
Storm 5 – September 19th to 22nd

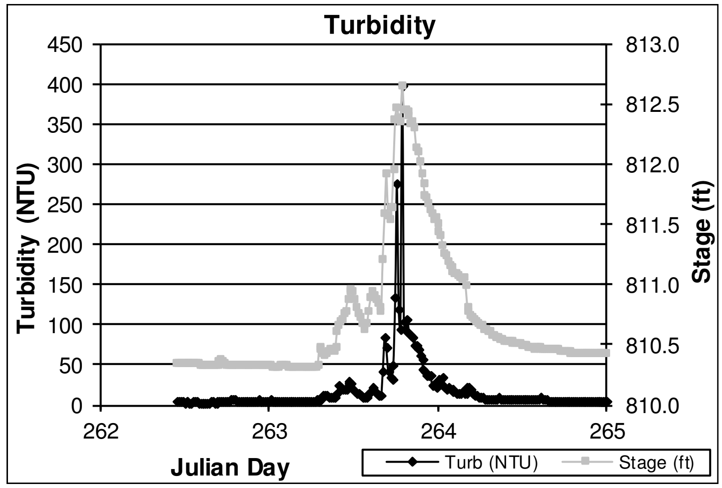
Oak Glen Creek at Logan Parkway

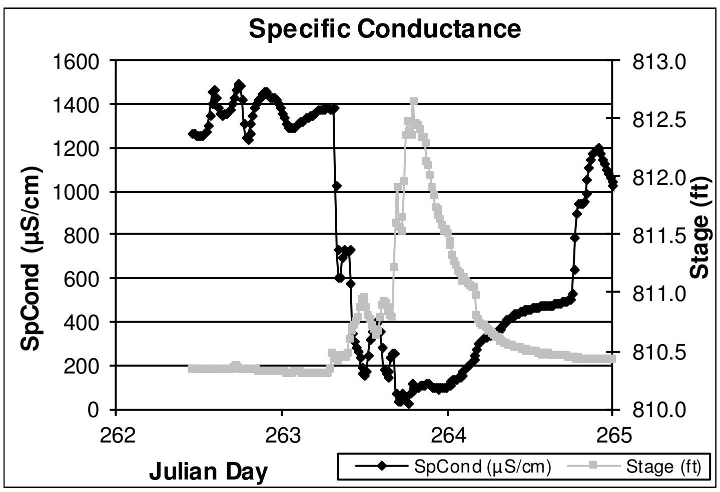
Storm Summary:

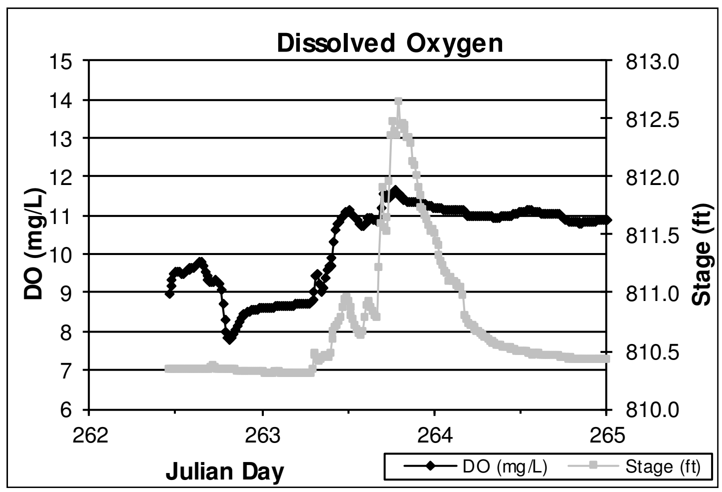
Dates: 19 September 2018 (day 262) to 22 September 2018 (day 265)

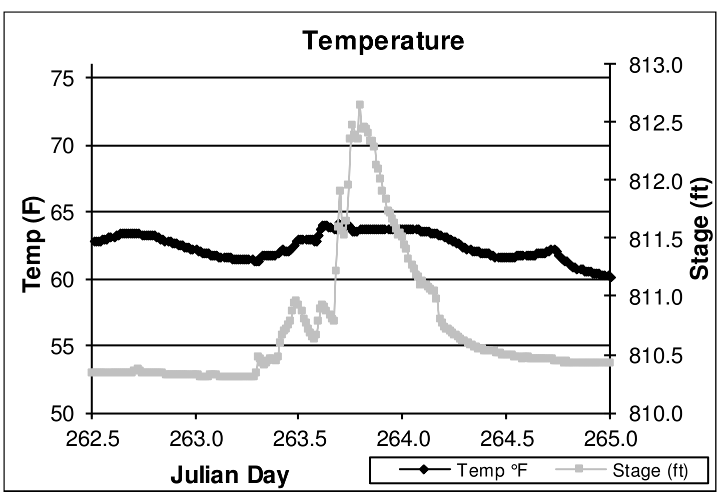
Precipitation: 3.76 in.

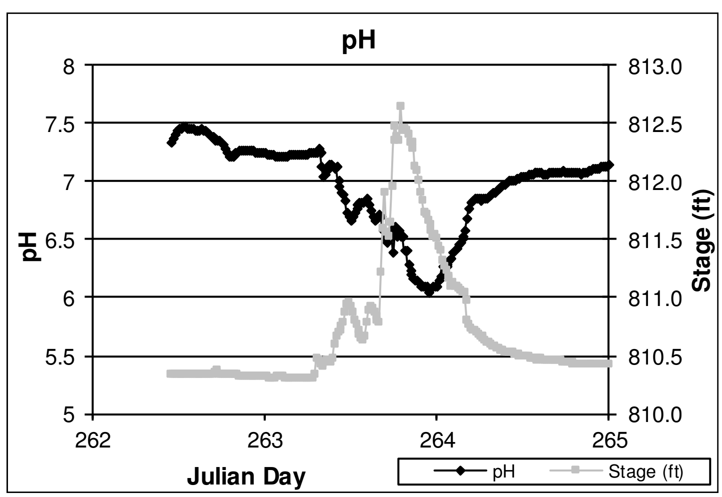












Stream Water Quality Monitoring – Grab Sampling

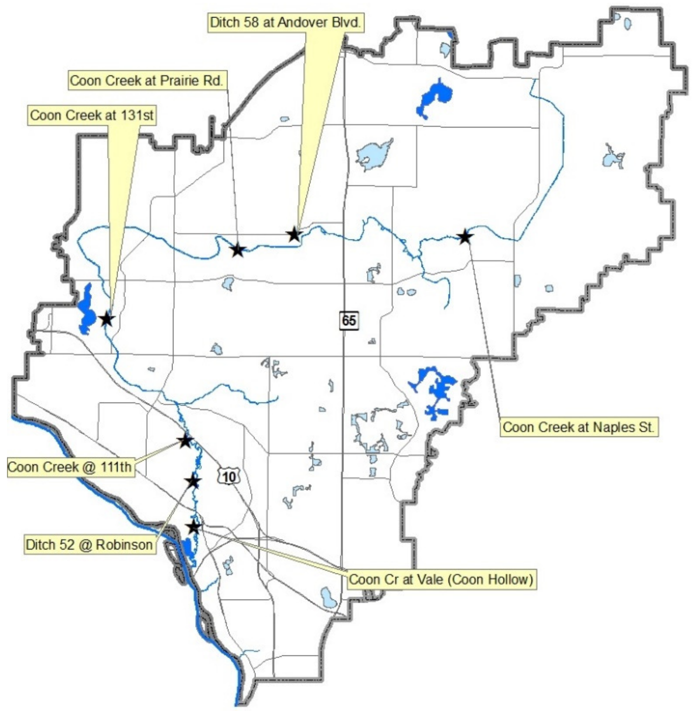
COON CREEK

Coon Creek at Naples Street, Ham Lake	STORET SiteID = S007-057
Ditch 58 at Andover Blvd, Ham Lake	STORET SiteID = S005-830
Coon Creek at 131st Avenue, Coon Rapids	STORET SiteID = S005-257
Coon Creek at 111th, Coon Rapids	STORET SiteID = S007-559
Ditch 52 at Robinson Park, Coon Rapids	STORET SiteID = S007-559
Coon Creek at Vale Street, Coon Rapids	STORET SiteID = S003-993

Years Monitored

Coon Cr at Lexington	2013-2016
Ditch 11 at 149st Ave	2013-2017
Coon Cr at Naples St	2012-**2018**
Ditch 58 at Andover Blvd	2013-**2018**
Coon Cr at Shadowbrook Townhomes	2007-2016
Coon Cr at Prairie Rd.	2013, 2017, **2018**
Coon Cr at 131st Ave	2010-**2018**
Coon Cr at Lions Park (Hanson Blvd)	2007-2017
Coon Creek at 111th	**2018**
Ditch 52 at Robinson	**2018**
Coon Cr at Vale St	2005-**2018**

Additional, intermittent data available at some other sites. Only sites monitored in 2018 are displayed on the map.



Background

Coon Creek is a major drainage through central Anoka County. Development in the watershed ranges from rural residential to urbanized. Upstream reaches were ditched in the early 1900's for agriculture. There are many ditch tributaries in the upper reaches. Lower reaches of the creek were not ditched. The entire creek serves as an important stormwater conveyance for the cities of Andover, Blaine, Columbus, Coon Rapids, and Ham Lake. Coon Creek outlets into the Mississippi River and is listed as an Impaired Water for recreation due to elevated levels of *E. coli* bacteria and invertebrate biota.

Methods

Coon Creek was monitored during both storm and baseflow conditions by grab samples. Eight water quality samples were collected 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. In some years smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events.

Ten water quality parameters were tested. Parameters tested with portable meters included pH, specific conductance, turbidity, temperature, salinity, and dissolved oxygen. Beginning in 2009, transparency tube measurements were added and are reported to MPCA. Parameters tested by water samples sent to a state-certified lab included total phosphorus, total suspended solids, and *E.coli* bacteria.

During every sampling event the water level (stage) was recorded using a staff gauge surveyed to sea level elevations. Stage was also continuously recorded using continuous data logging gauges at various sites. Those data can be found in the hydrology section of this chapter.

Results and Discussion

This report includes data from all years and all sites to provide a broad view of Coon Creek's water quality under a variety of conditions. Water quality assessments are based on upstream-to-downstream comparisons, a comparison of baseflow and storm conditions, and an overall assessment compared to other Anoka County streams and state water quality standards. Mean and median results for each parameter at the furthest downstream site (Vale Street) are tabulated for comparison to state standards. All results for all years are graphed in box and whisker style plots. Following is a summary, including a management discussion:

- Dissolved pollutants, as measured by specific conductance and chlorides, in Coon Creek were high compared to other more rural Anoka County streams, especially near the outlet during baseflow conditions, but low compared to other streams in the more urbanized portions of the county. Coon Creek was well below the state water quality standard for chlorides in 2012; chlorides have not been sampled since.

  Management discussion: Dissolved pollutants enter the stream both directly through surface runoff and also by infiltrating into the shallow groundwater that feeds the stream during baseflow. A variety of sources appear to be likely, including road deicing salts, agricultural chemicals, and road runoff. Because these are difficult to remove, every effort should be made to minimize their release into the environment.

- Phosphorus concentrations are higher during storm flows than baseflow with exceedances of the 100 µg/L state standard during both baseflow and stormflow. During storm flow conditions, Coon Creek exceeds the State standard threshold over 90% of the time at Vale Street, and commonly at levels 3-7 times that standard. Phosphorus is slightly higher in downstream reaches than upstream, but certain upstream tributaries such as Ditch 11 appear to be large phosphorus sources. Ditch 52 was monitored for the first time this year and phosphorus exceeded 100 µg/L for all samples. This is a small ditch but may have an outsized effect on downstream phosphorus levels in Coon Creek. It is possible that other small tributary ditches in the northern portions of the watershed are large sources also, but have not been sampled.

  Management discussion: Phosphorus needs to be reduced in both the upper and lower watershed, though the sources are likely different. A major source upstream appears to be the agricultural land that Ditch 11 flows through. In the developed lower watershed, phosphorus is likely transported in concert with particulate debris from impervious surfaces and storm sewer systems. Efforts to trap and remove phosphorus from each of these major sources should remain a management focus.

- Suspended solids and turbidity were lower upstream and during baseflow, but increased both during stormflows and moving downstream. During baseflow, suspended solids were generally below State standards, but increased drastically during storms, with a long term storm flow median at Vale Street exceeding the State water quality standard of 30 mg/L. Suspended solids are higher at all sites during storms, though the source likely differs in different parts of the watershed. Both baseflow and storm event median values for all years approximately double from upstream to downstream for turbidity, with TSS tripling. While bed load is a concern, continuous storm monitoring has shown that turbidity does not follow stream flow volumes, suggesting is it not the primary source.

  Management discussion: There are at least two sources of suspended solids and turbidity that seem to be impacting Coon Creek. These will require a variety of management techniques to address. First, suspended solids and turbidity are greatest during storms and in the lower, developed part of the watershed, suggesting that stormwater treatment is an important way to address this problem. Storms greater than one inch produce the worst creek water quality, so practices aimed at reducing suspended solids and phosphorus entering the creek during those storms are especially important. Most stormwater practices were designed to treat storms up to one inch in size.

  Secondly, there are likely near and in-stream sediment sources, like bed load and streambank erosion. High flows are a common aggravator of this type of sediment source. We would anticipate near and in-stream sources to be impacting Coon Creek because much of it is ditched, and ditches generally have unstable banks. Soils in the watershed are highly erodible. Yet continuous monitoring of turbidity in previous years with a Hydrolab/YSI during storms and in the days after storms paints a more complex picture. Turbidity does rise quickly during storms (presumably runoff from the lower watershed). Turbidity then increases slowly and continuously after the storms (presumably sediment from the upper watershed). The Hydrolab/YSI found it was common for turbidity to increase for several days after a storm, even when flows were dropping. We would expect bed load and streambank erosion to increase with flow and then decrease once flows abate.

- pH: pH levels generally remain within the range considered normal and healthy for streams in this area. In spring 2018 the desired range of 6.5-8.5 was exceeded once at Vale St.
- Dissolved oxygen levels are quite poor in the monitored ditched upper portions of the watershed. Neither pH nor DO are of particular concern watershed-wide however, with levels of both being normal in most of the watershed most of the time. In 2018, DO fell below the state standard of >5 mg/L at least once at all main stem sites. Several tributaries to Coon Creek in the upstream portions of the watershed have not been monitored and may have issues with low DO.
- *E. coli* bacteria are high throughout Coon Creek, and an approved TMDL exists for the impairment. During baseflow, *E. coli* is periodically above the state standard thresholds, though not sampled frequently enough for threshold calculations, and this primarily occurs in the lower portion of the watershed. *E. coli* is generally low in the upper watershed during baseflow. During storms, *E. coli* was much higher in all locations and is extremely high in the lower watershed.

  Management discussion: Because *E. coli* is pervasive in the environment, there will be difficulty reducing *E. coli* levels below state water quality standards. Addressing *E. coli* should be part of an effort to improve overall water quality.

Specific conductance and Chlorides

Specific conductance, chlorides, and salinity are all measures of a broad range of dissolved pollutants. Dissolved pollutant sources include urban road runoff, industrial effluent, and other sources. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Specific conductance is the broadest measure of dissolved pollutants we use. It measures the electrical specific conductance of water; pure water with no dissolved constituents has zero specific conductance. Chlorides test for 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, however, it is also noteworthy that Coon Creek is upstream from the drinking water intakes on the Mississippi River for the Twin Cities. Note that chlorides have not been sampled since 2012.

The historical median specific conductance in Coon Creek at Vale Street (farthest downstream site) ishigher than the median for all Anoka County streams. The median specific conductance in Coon Creek at Vale St. is 0.655 mS/cm compared to the countywide median of 0.420 mS/cm (see table and figures below).

Dissolved pollutants were higher in downstream reaches of Coon Creek, where there is more impervious area (see figures below). Median specific conductance increases gradually from upstream (0.437 mS/cm) to downstream (0.662 mS/cm) during baseflow conditions. Median specific conductance (all years) for storm events shows a smaller difference between upstream and downstream, ranging from 0.411 to 0.506 mS/cm.

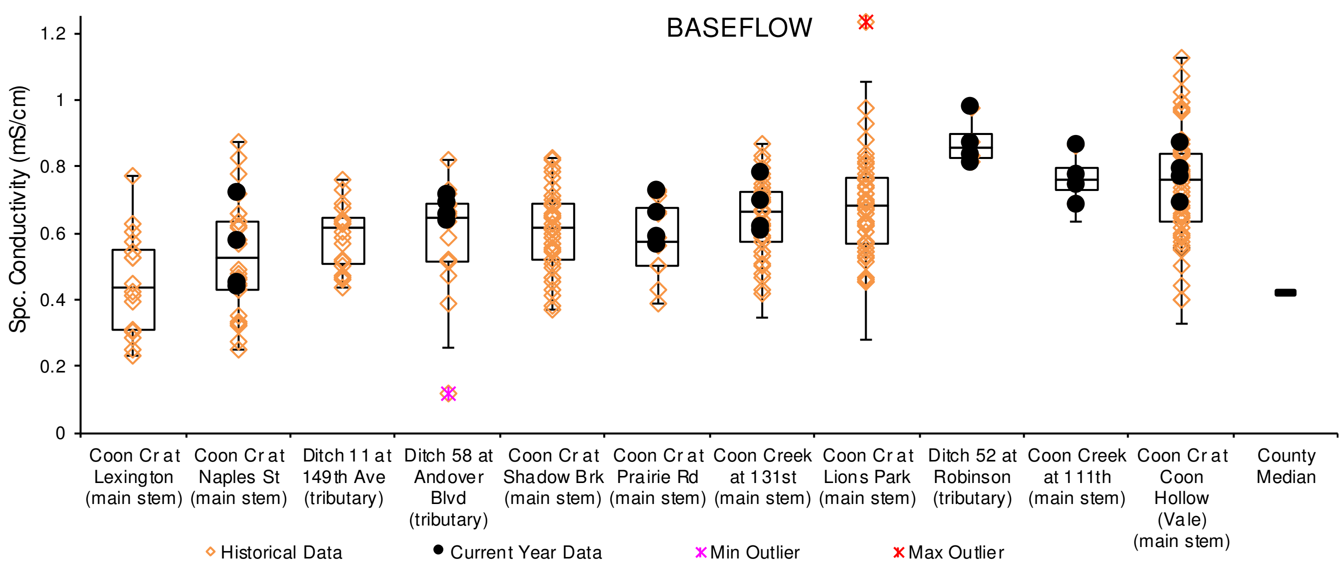
This lends some insight into the pollutant sources. If dissolved pollutants were only elevated during storms, stormwater runoff would be suspected as the primary contributor. Because dissolved pollutants are highest during baseflow, pollution of the shallow groundwater which feeds the stream during baseflow is suspected to be a primary contributor. In Coon Creek, especially further downstream, specific conductance is higher during baseflow conditions, meaning the local groundwater is a significant source of dissolved pollutants. The increase in specific conductance upstream to downstream also indicates that the pollution of the feeding groundwater system increases moving downstream.

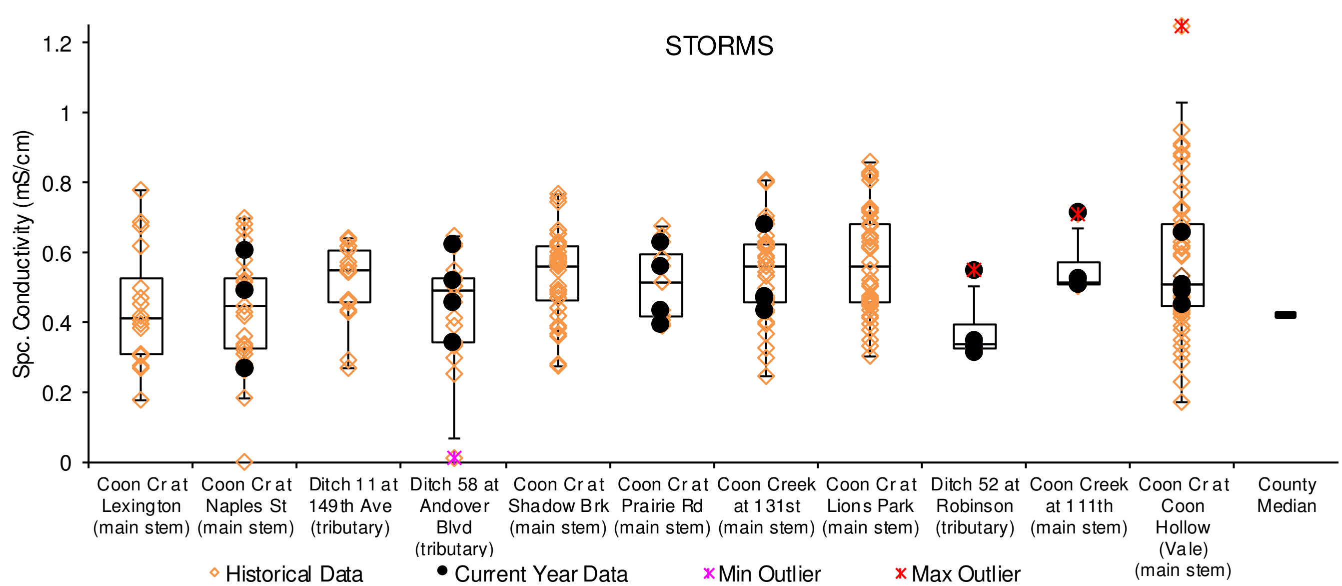
Storm flows dilute some of the pollutant load, making the increase from upstream to downstream much smaller. However, upstream median values during all conditions are still higher in Coon Creek than other Anoka County streams. Prevention measures to reduce specific conductance (such as reduced road salting) should be a focus of management. Chloride sampling should also occur more regularly to verify the extent to which high specific conductance is due to high chlorides.

Median specific conductance and chlorides in Coon Creek Data is from Vale St for specific conductance all years through 2018 and for chlorides all years through 2012.

	Specific conductance (mS/cm)	Chlorides (mg/L)	State Standard	N
Baseflow	0.760	64.7	Specific conductance – none Chlorides 860 mg/L acute, 230 mg/L chronic	55
Storms	0.506	52.25		56
All	0.655	60.5		111
Occasions > state standard				0

Specific conductance at Coon Creek Orange diamonds are historical data from previous years and black circles are 2018 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) is a common nutrient pollutant and is usually the limiting factor for most algae growth in freshwater systems. Total phosphorus in Coon Creek was generally lower in the main stream during baseflow conditions and increases substantially during storms. The State TP water quality standard for streams in this region is 100 µg/L, and Coon Creek eventually may be designated as impaired for exceeding it often, especially during storms. Best management practices for this stream are needed to address stormwater phosphorus loading along the entire monitored stream length. A potentially important source of TP into the upstream reaches of the system is Ditch 11, where high phosphorus concentrations are regularly observed.

During baseflow conditions in 2018, the seven monitored Coon Creek sites had a composite median TP of 102 µg/L. Individually, all six sites downstream of Coon Creek at Naples St. averaged greater than 100 µg/L at baseflow, all in exceedance of state standards. Near the outlet at Vale Street 20 of 55 (36%) baseflow measurements, and of 51 of 56 (91%) of storm flow measurements taken since 2005 had >100 µg/L total phosphorus. Levels 3-7 times the state standard are frequently measured, especially during stormflows.

The tributary Ditch 11, which was last monitored in 2017, may be an important source of TP in the upstream reaches of Coon Creek, and vastly exceeds the State water quality standards in every storm sample collected as well as 14 of 20 (70%) of baseflow samples. The composite average of 40 samples collected in Ditch 11 at 149th Avenue is more than double the State standard at 210 µg/L.

Ditch 52, a tributary that enters Coon Creek in Robinson Park, was monitored for the first time this year. Like Ditch 11, Ditch 52 routinely has high phosphorus. Median phosphorus at this site was 162.5 µg/L. Of eight samples collected, five exceeded state standards. Although discharge from this stream is fairly low (median: ; maximum recorded: 8.03 cfs), this stream may have a disproportionately large impact on phosphorus levels in Coon Creek (include discharge stats at nearest downstream site).

Coon Creek at 111th Ave. in Coon Rapids was also sampled for the first time in 2018. Two of four baseflow samples, and three of four storm flow samples exceeded 100 µg/L. Average concentrations during baseflow (136 µg/L) and during storm flow (207 µg/L) exceeded state standards.

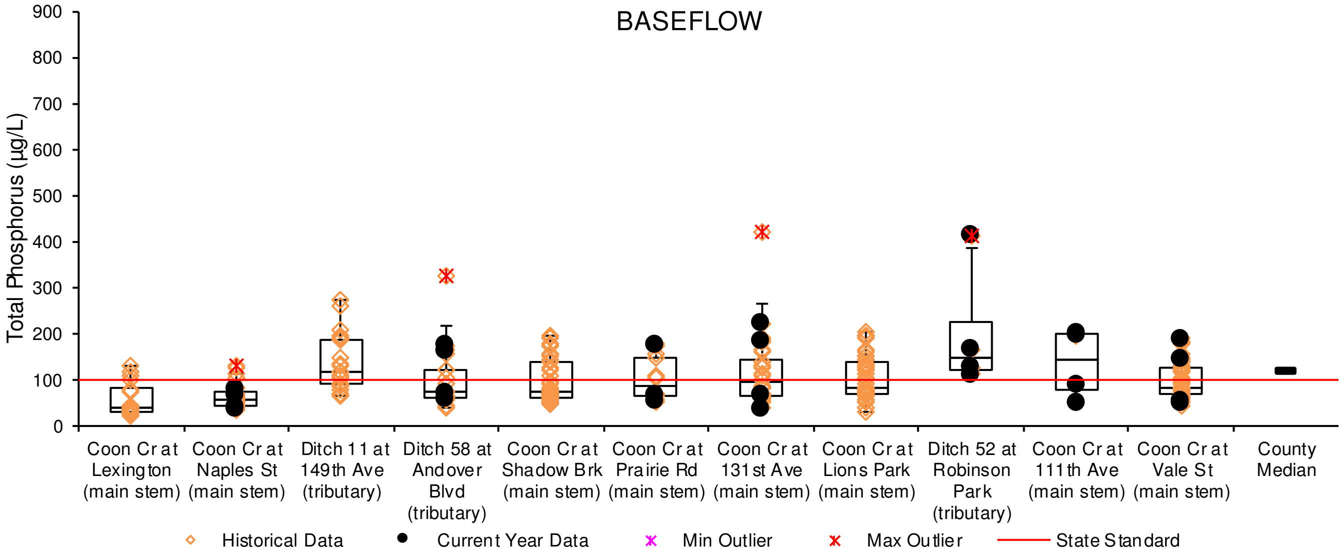
The dominant phosphorus source is likely different in upstream and downstream stream reaches. Upstream portions of the watershed are less developed, and most development has occurred more recently with more stringent stormwater treatment requirements. Here, mobilization of in-stream sediments and agricultural runoff are likely important phosphorus sources. Drained, organic wetland soils may be another source. Downstream portions of the watershed are fully developed, with some areas developed before modern-day stormwater treatment requirements. Here, flows are often higher and flashy, so mobilization of in-stream sediments may be important, but stormwater runoff from impervious surfaces is likely a major pollutant source.

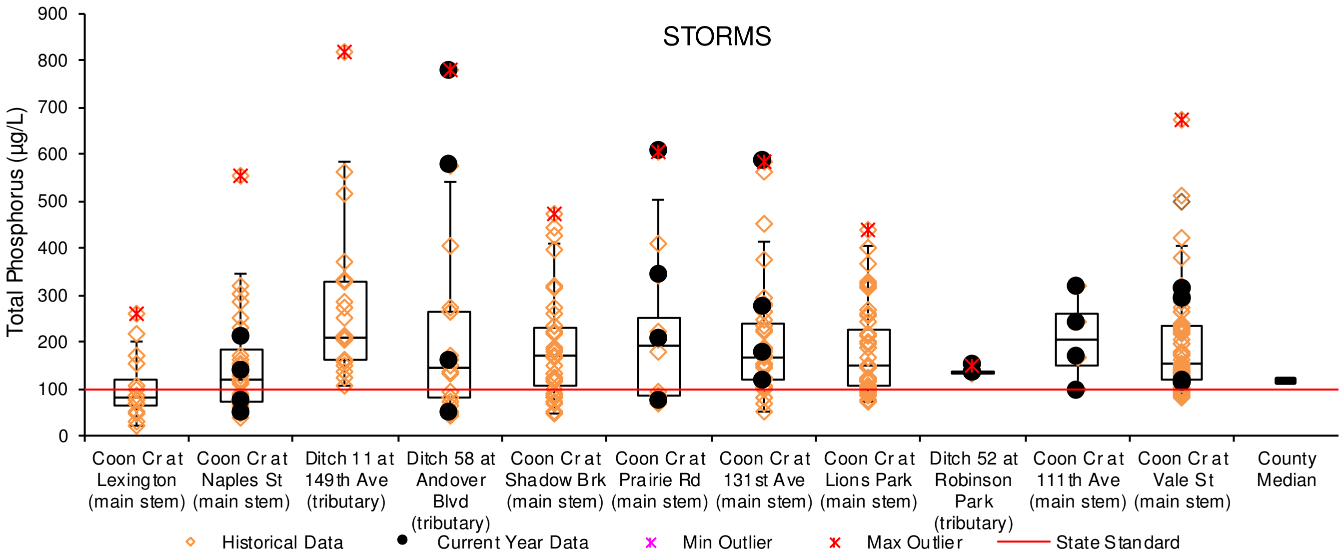
Phosphorus reduction needs to occur throughout the watershed. The highest priority should be addressing phosphorus from urban stormwater runoff in the lower portion of the watershed, and agricultural and drained wetland inputs in the upper watershed. These are likely the sources of other pollutants too, such as particle-bound phosphorus from in-stream or near stream sediment sources. Coon Creek already has a TP and TSS load allocation as part of an approved TMDL, butithout a downward shift in phosphorus concentrations, Coon Creek will be listed as impaired for nutrients soon.

Average and median total phosphorus in Coon Creek Data is from Vale St for all years through 2018.

	Average Total Phosphorus (µg/L)	Median Total Phosphorus (µg/L)	State Standard	N
Baseflow	97.7	83	100 µg/L	55
Storms	198.5	152.5		56
All	148.5	127		111
Occasions > state standard				71 (64%) (51 storms, 20 baseflow)

Total Phosphorus at Coon Creek Orange diamonds are historical data from previous years and black circles are 2018 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 and Turbidity

Total suspended solids (TSS) and turbidity both measure solid particles in the water. TSS measures these particles by weighing dried materials filtered out of the water. Turbidity is measured by the diffraction of a beam of light sent though the water sample, and is therefore most sensitive to large particles.

In Coon Creek TSS and turbidity are generally lower upstream and increase during storms and in downstream reaches (see figures below). The state water quality standard for TSS in the Central River Nutrient Region is 30 mg/L. The stream often exceeds the state water quality standard at Vale Street during storm events.

During baseflow conditions, both turbidity and TSS are generally low in the upstream reaches and increase moving downstream. Median total suspended solids of all main stem samples collected through 2018 during baseflow from upstream to downstream range from 3 mg/L at Naples St to 15.5 mg/L at Vale St. These levels are generally lower than the countywide median for all Anoka streams of 14.4 mg/L, and the state water quality standard. At Vale St only 2 of 57 (3.5%) baseflow TSS measurements exceeded the water quality standard of 30 mg/L since 2005. During storm flow, however, 28 of 56 (50%) TSS samples at Vale St. have exceeded 30 mg/L since 2005. Median storm flow TSS ranged from 14.7 mg/L at Naples St. to 77.2mg/L at Vale St.

During storms, TSS and turbidity are elevated throughout Coon Creek, and the effect is exacerbated moving from upstream to downstream reaches. The long-term median turbidity for all samples collected is about twice as high during storms compared to baseflow for individual sites, and nearly doubles again moving upstream to downstream from 16 NTU at Naples St to 26 NTU at Vale St. Long-term median TSS is proportionately even higher during storms with medians tripling upstream to downstream from 10 mg/L at Naples St. to 31 mg/L at Vale St. The long-term median TSS concentration during storm samples at Vale St. of 31 mg/L and the long-term average of 50 mg/L both exceed state standards.

Bank erosion, bed load transport, and stormwater runoff are likely all important sources of suspended solids. Their relative contributions likely differ across the watershed. However, given that suspended solids seem to increase proportionately throughout the watershed, the loading is likely not geographically isolated.

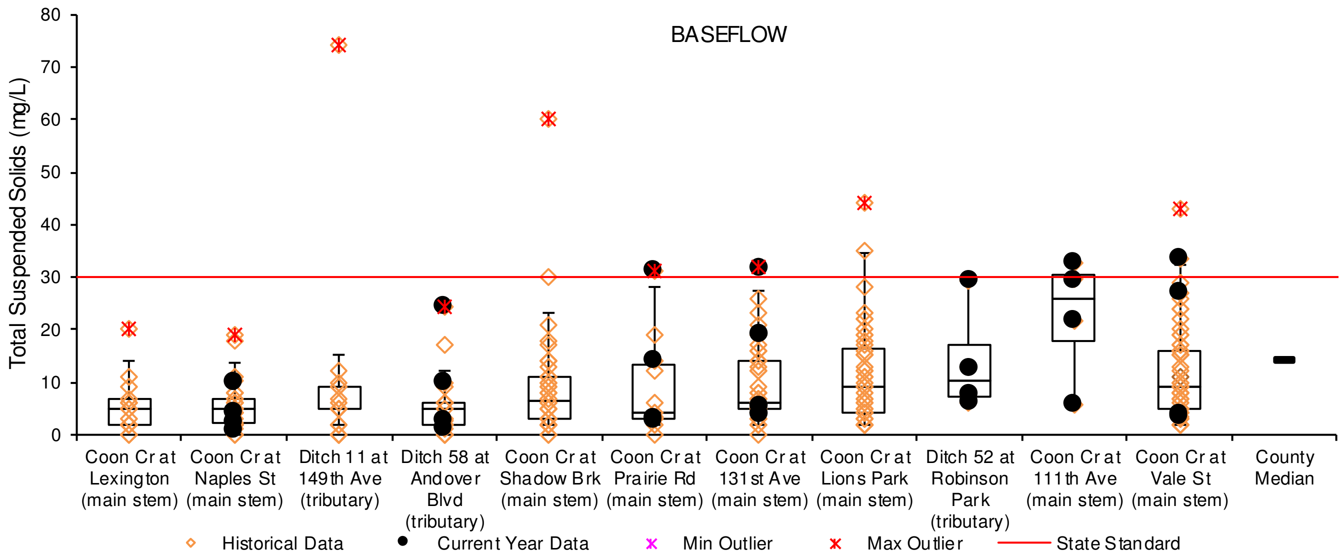
Research could be considered to determine the extent to which bed load sediment transport is contributing to high turbidity and TSS. It appears that it has the potential to be important. Instances of high suspended solids in the upper watershed, where land uses are rural residential and sod fields, is surprising given that these are not often large sources of suspended solids. Near-channel and in-channel sources may be important in the upper watershed.

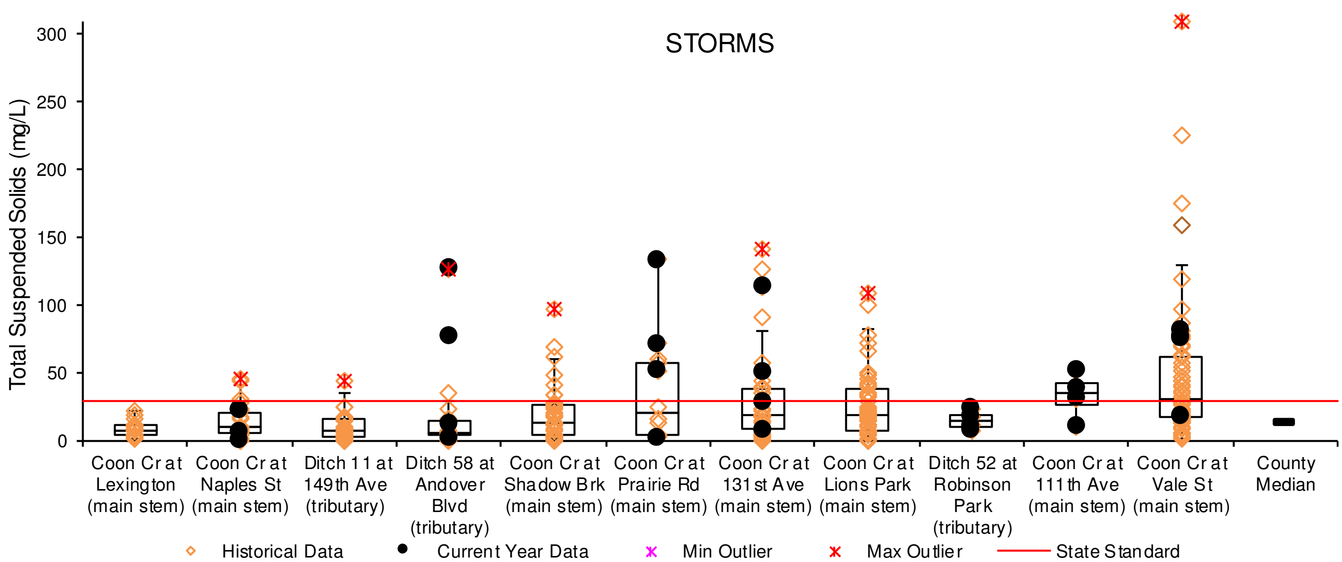
In the lower portions of the watershed continuous storm monitoring has found that turbidity does not increase as flow increases, as would be expected if bed load were dominant. Instead, it spikes immediately following rain commencement, indicating high loads of runoff contribution. This would also match the trend of increasing TSS and turbidity throughout the watershed moving downstream. Stormwater TSS capture and containment should be a management focus in the lower, more developed portions of the watershed.

Average and median suspended solids in Coon Creek Data is from Vale St for all years through 2018.

	Average TSS (mg/L)	Median TSS (mg/L)	State Standard	N
Baseflow	11.7	9.0	30 mg/L	56
Storms	49.8	31.0		56
All	30.7	16.5		112
Occasions > state TSS standard				30 (28 during storm flows)

Total Suspended Solids at Coon Creek Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

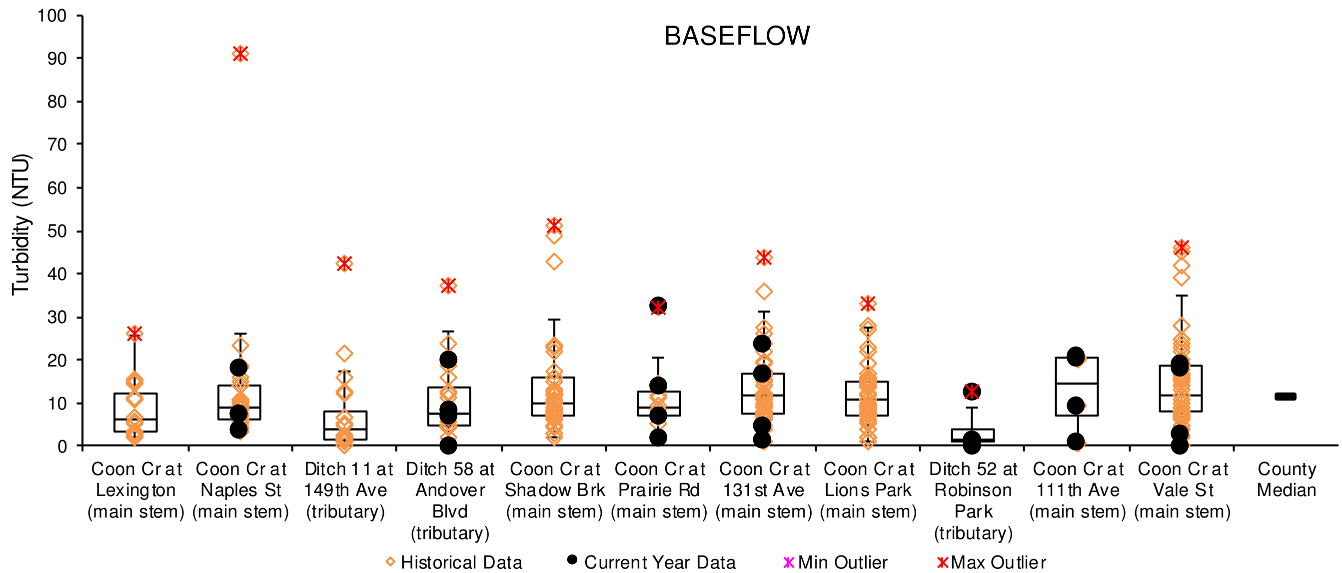


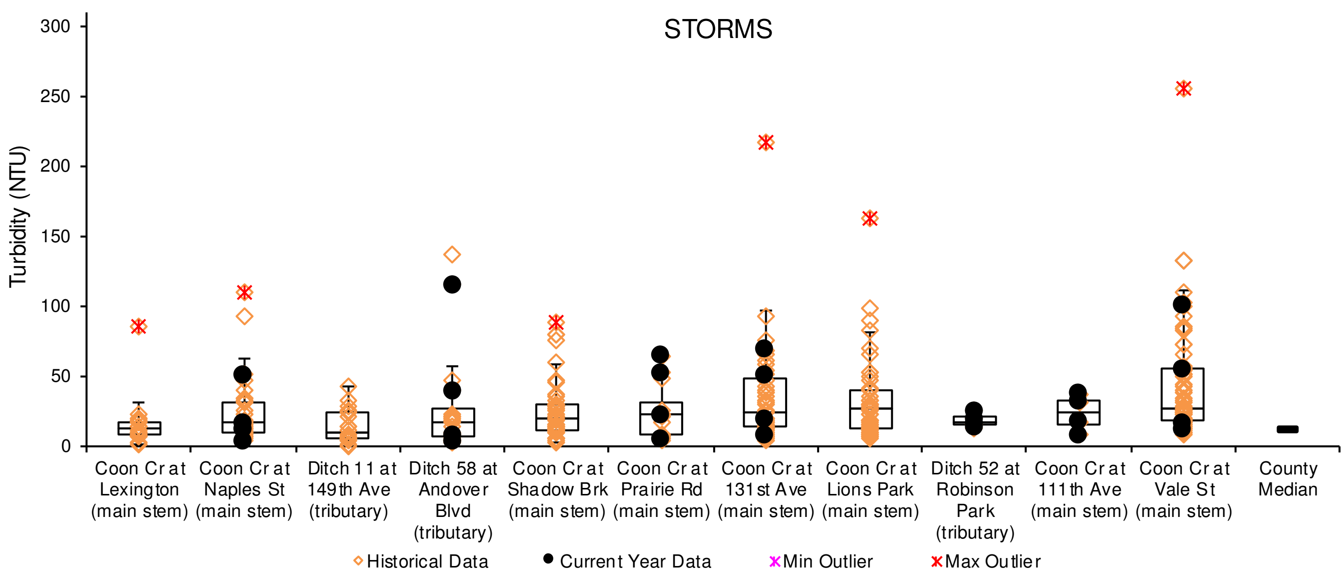


Average and median turbidity in Coon Creek Data is from Vale St for all years through 2018

	Average Turbidity (NTU)	Median Turbidity (NTU)	State Standard	N
Baseflow	14.7	12.0	N/A	55
Storms	44.9	26.3		55
All	30.0	18.7		110

Turbidity at Coon Creek Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





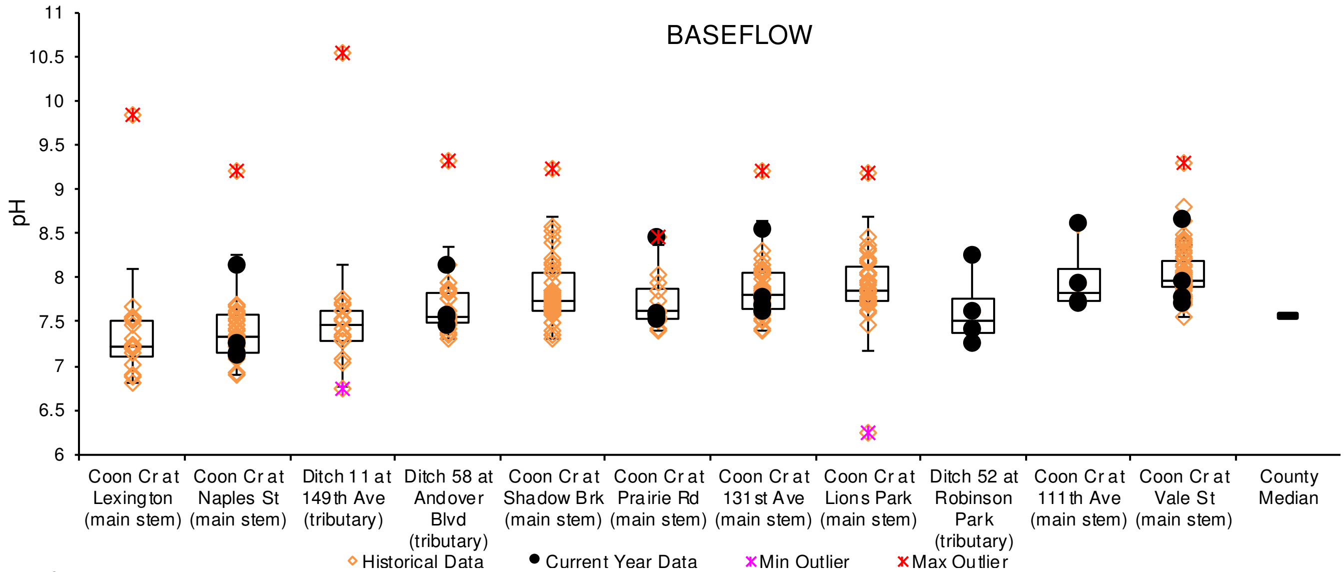
pH

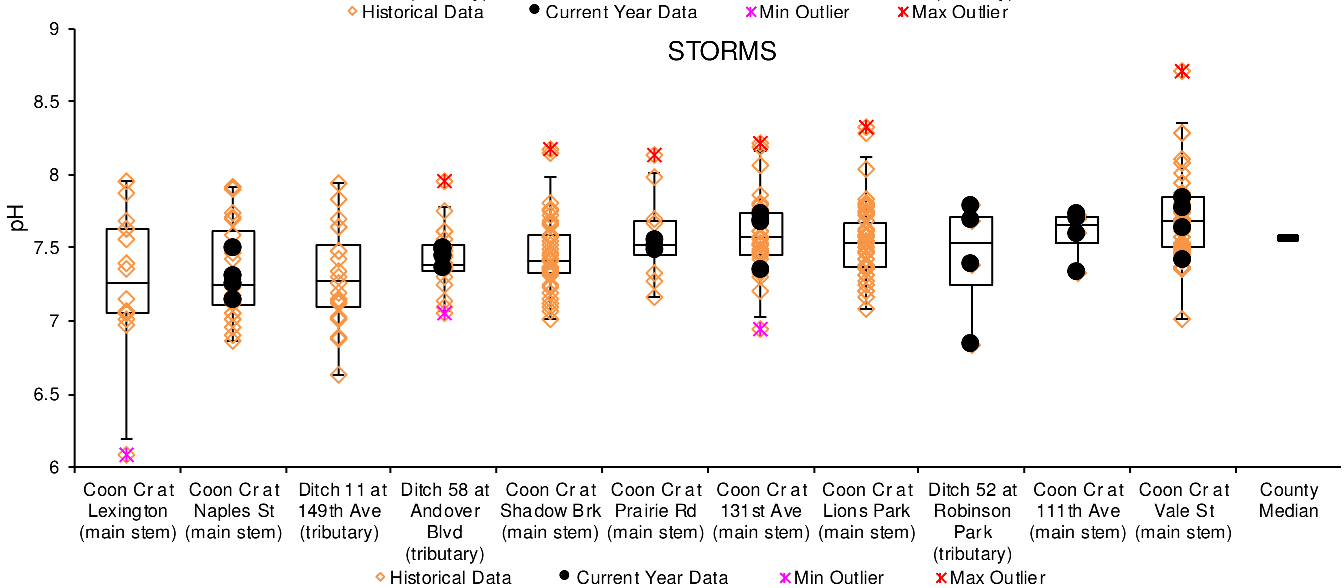
pH exceeded the state water quality standard upper range of 8.5 once at Vale St. during a baseflow sample in May of 2018 that resulted in 8.65 pH. Typically, pH is lower during storm events because rainfall has a lower pH and the creek serves as a stormwater conveyance for four cities. Although a couple of exceedances of state standards have occurred, these occurrences are rare and short lived.

Average and median pH in Coon Creek Data is from Vale St for all years through 2018.

	Average pH	Median pH	State Standard	N
Baseflow	8.05	7.97	6.5-8.5	55
Storms	7.70	7.68		52
All	7.88	7.86		107
Occasions outside state standard				4 (3 during baseflow)

pH at Coon Creek Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





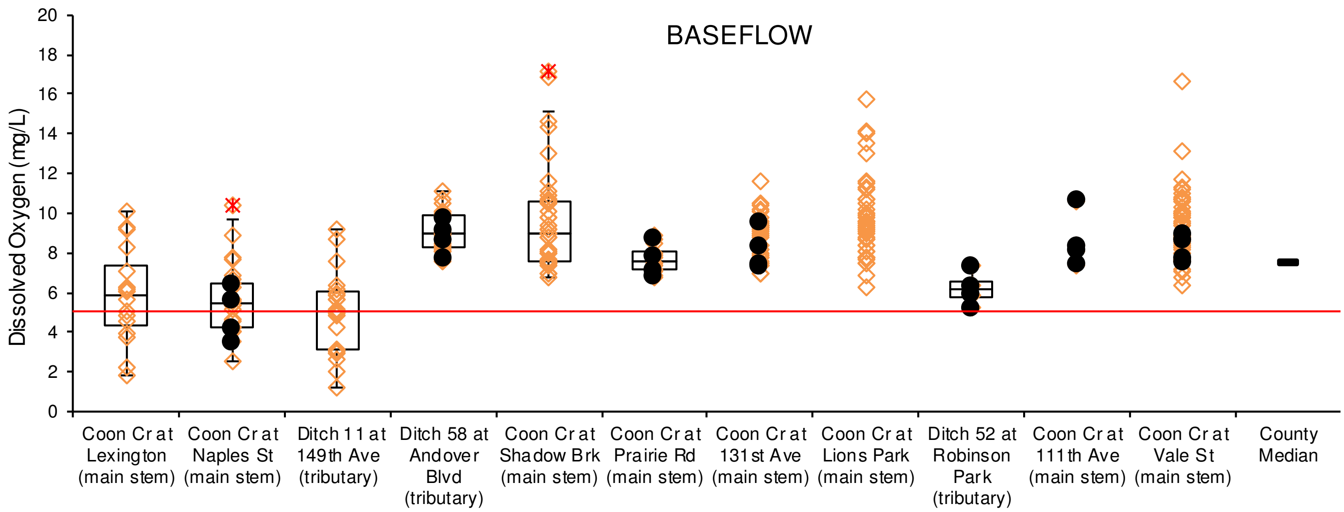
Dissolved Oxygen

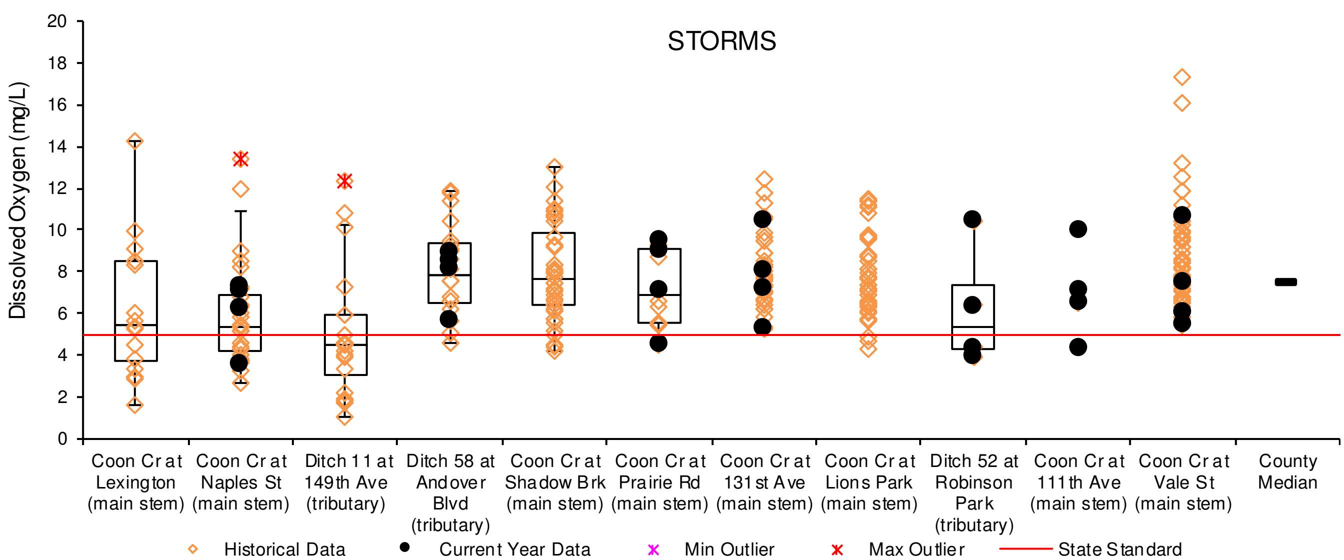
Low dissolved oxygen levels are generally not an issue in Coon Creek, especially in the downstream reaches. Observed low readings have all occurred in the upstream reaches of the main stem and Ditch 11. There is a marked increase in DO levels between these sites and the site near the Shadowbrook development. It is likely that DO is higher in the larger and more natural channel further downstream than the small ditched channels upstream. Coon Creek is impaired for invertebrate biota, with DO as a major stressor along with suspended solids, nutrients, altered hydrology, and poor habitat.

Average and median dissolved oxygen in Coon Creek Data is from Vale St for all years through 2018.

	Average Dissolved Oxygen (mg/L)	Median Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	9.17	8.75	5 mg/L daily minimum	52
Storms	8.55	7.80		54
All	8.86	8.57		106
Occasions <5 mg/L				0

Dissolved oxygen at Coon Creek Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





E. coli

E. coli is a bacteria found in the feces of warm-blooded animals. *E. coli* is an easily measurable indicator of pathogens that are associated with fecal contamination. The Minnesota Pollution Control Agency sets *E. coli* standards for contact recreation (swimming, etc.). A stream is designated as "impaired" if 10% of measurements in a calendar month are >1260 most probable number (MPN) of colony forming units per 100 milliliters of water, or if the geometric mean of five samples taken within 30 days is greater than 126 MPN.

Sampling by the MPCA has found Coon Creek exceeds State standards for *E. coli* bacteria. Data collected by local agencies to date are not sufficient to re-calculate if the MPCA standards are met or exceeded. Per ACD stream sampling methodology for all parameters, eight samples are collected throughout the summer, often with only 1-2 samples each month. This is too low a number of samples to make calculation of a monthly geometric mean or to reasonably say that 10% of samples in a month were in exceedance. However, other examinations of the data presented below verify that *E. coli* abundance is high.

During baseflow conditions, *E. coli* were generally lower in the upstream Coon Creek system and higher downstream. Median *E. coli* for all years at sites moving upstream to downstream ranges from 34 MPN at Lexington Ave to 150 MPN at Vale St during baseflow conditions. In storm flow conditions, the long-term medians range from Lexington Ave to Vale St is 236 MPN to 1078 MPN. Though the sampling frequency requirements were not met, bacteria levels during baseflow generally fell below the 126 MPN state water quality standard in the upper watershed. In all sites downstream of the Shadowbrook development long-term median and average results are all higher than the 126 MPN geometric mean standard during baseflow, suggesting that this standard is likely exceeded most of the time. Coon Creek is listed as impaired for *E. coli* in these reaches, and a TMDL study has been approved.

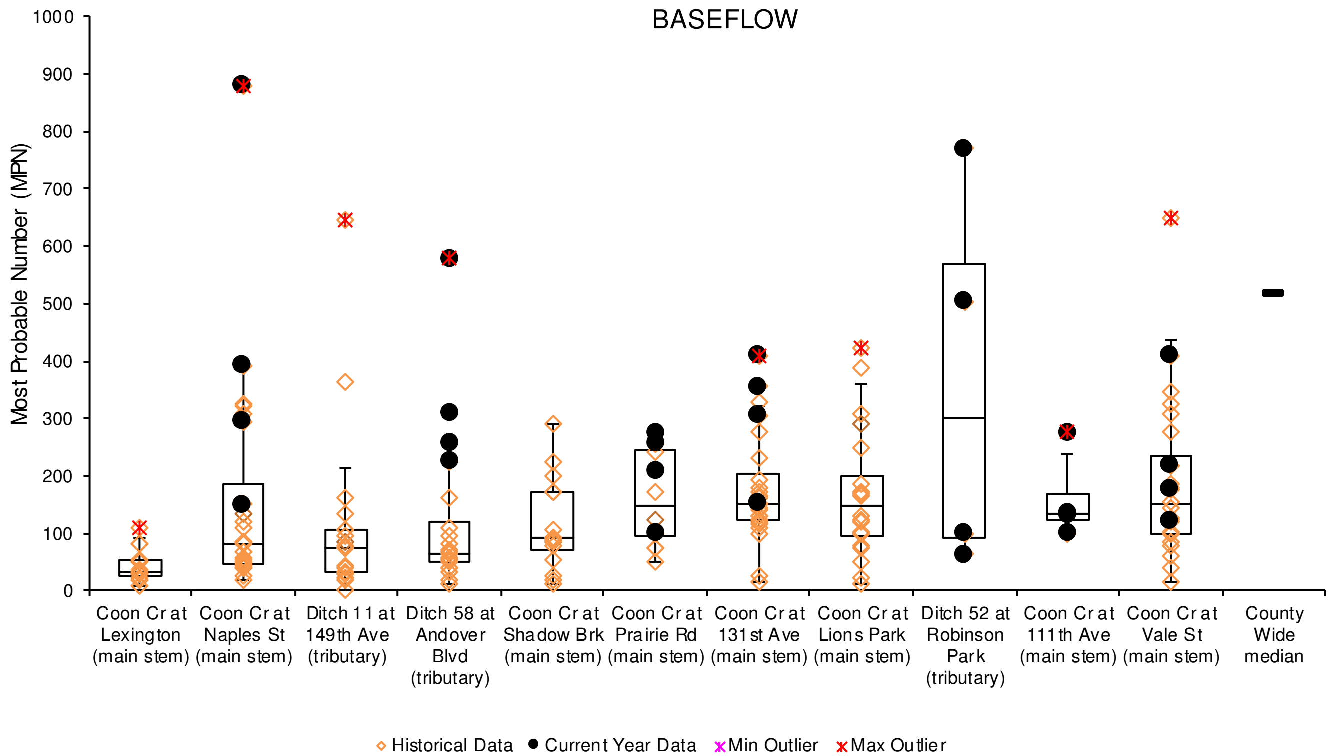
During storms, *E. coli* were significantly higher and more variable (note the order of magnitude difference in Y-axis scales in the graphs below). A large part of this variability is likely due to the intensity and phenology of each storm and when the storm the sampling took place. Median *E. coli* during storms from upstream to downstream ranges from 236 MPN at Lexington Ave. to 1078 MPN at Vale St.

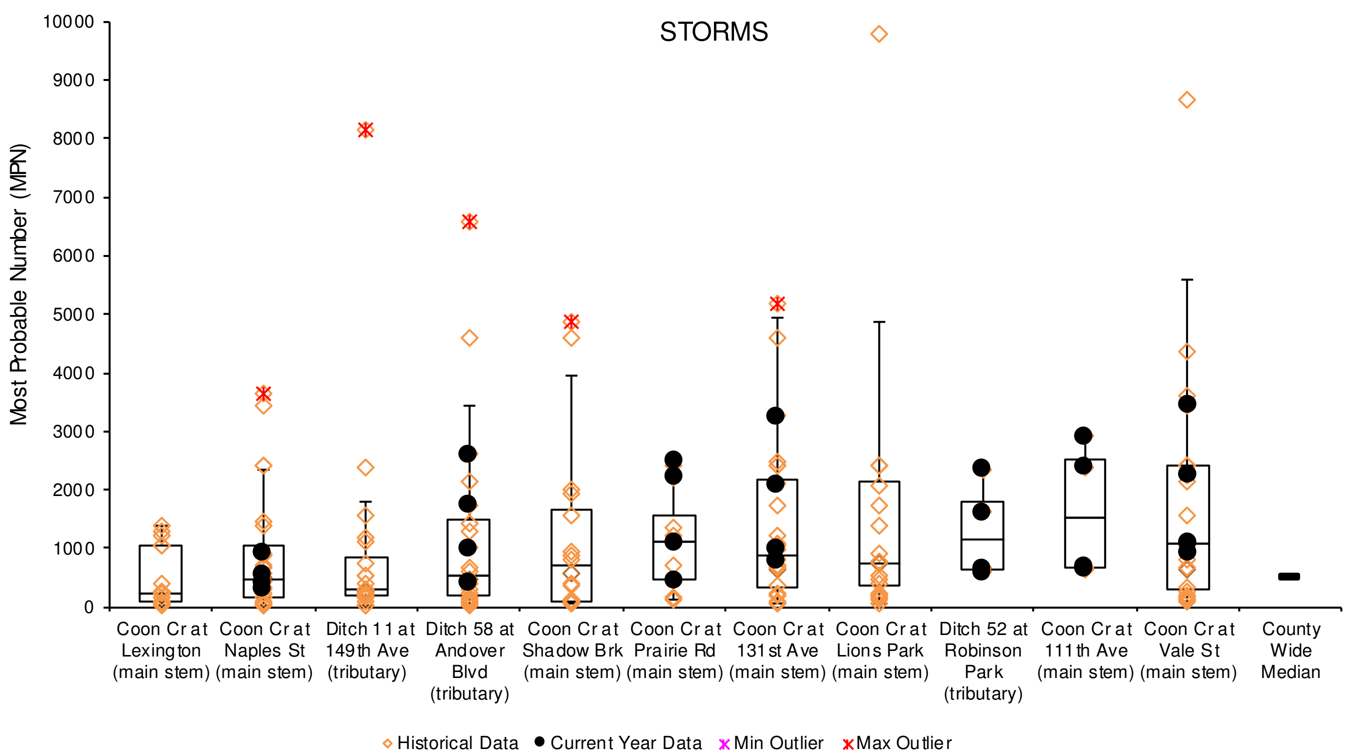
Though the sampling frequency requirements are again not met, bacteria levels during storms often exceed the higher 1260 MPN state water quality standard. Two of four storm samples at each site sampled downstream of Naples St. in 2018 exceeded this level.

Average and median *E. coli* in Coon Creek Data is from Vale St. 2013-2018.

<table>
<tr><th></th><th>Average E. coli (MPN)</th><th>Median E. coli (MPN)</th><th>State Standard</th><th>N</th></tr>
<tr><td>Baseflow</td><td>189</td><td>150</td><td rowspan="2">Monthly Geometric Mean >126</td><td>24</td></tr>
<tr><td>Storms</td><td>2,199</td><td>1,078</td><td>24</td></tr>
<tr><td>All</td><td>1,194</td><td>262</td><td rowspan="2">Monthly 10% average >1260</td><td>48</td></tr>
<tr><td>Occasions >126 MPN
Occasions >1260 MPN</td><td></td><td></td><td>14 baseflow (58%), 22 storm (92%)
0 baseflow, 11 storm (46%)</td></tr>
</table>

***E. coli* at Coon Creek** Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





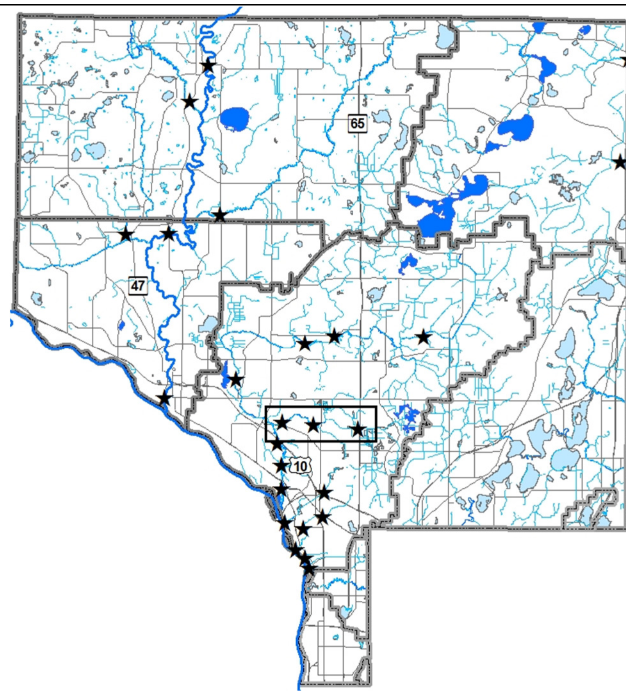
Stream Water Quality Monitoring – Grab Sampling

SAND CREEK SYSTEM

Sand Cr (Ditch 41) at Radisson Rd, Blaine	STORET SiteID = S006-421
Sand Cr (Ditch 41) at Highway 65, Blaine	STORET SiteID = S005-639
Sand Cr at Happy Acres Park, Blaine	STORET SiteID = S005-641
Ditch 60 at Happy Acres Park, Blaine	STORET SiteID = S005-642
Sand Cr at University Avenue, Coon Rapids	STORET SiteID = S005-264
Ditch 39 at University Avenue, Coon Rapids	STORET SiteID = S005-638
Sand Cr at Morningside Mem. Gardens Cemetery, Coon Rapids	STORET SiteID = S006-420
Sand Cr at Xeon Street, Coon Rapids	STORET SiteID = S004-619

Years Monitored

Sand Cr (Ditch 41) at Radisson Rd	2010-2017
Sand Cr (Ditch 41) at Highway 65	2009-**2018**
Sand Cr at Happy Acres Park	2009
Ditch 60 at Happy Acres Park	2009
Sand Cr at University Avenue	2008
Ditch 39 at University Avenue	2009
Sand Cr at Morningside Cemetery	2010-**2018**
Sand Cr at Xeon Street	2007-**2018**



Sand Creek system area. All stream water quality sites county-wide are represented by stars.

Background

Sand Creek is the largest tributary to Coon Creek. It drains suburban residential, commercial, and retail areas throughout northeastern Coon Rapids and western Blaine. In upper portions of the watershed (upstream of Hwy 65), the creek flows through a network of man-made ponds and lakes which serve stormwater treatment and aesthetic purposes. These areas were developed recently, all after 1995. Farther downstream there are no in-line ponds and developments are older. A number of ditched tributaries exist throughout the watershed, and many reaches of Sand Creek itself have been ditched.

Sand Creek drains into Coon Creek, which then drains into the Mississippi River. At its confluence with Coon Creek, Sand Creek is about 15 ft. wide and 2.5-3 ft. deep during baseflow. Sand Creek is impaired for *E. coli* and invertebrate biota downstream of Morningside Memorial Gardens.

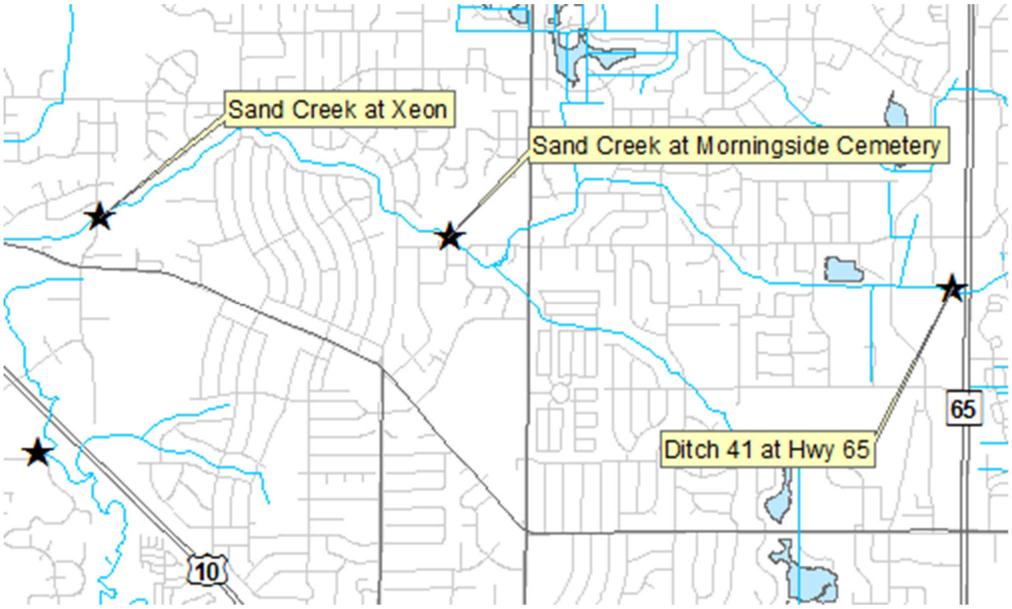
Methods

Sand Creek was monitored during both storm and baseflow conditions by grab samples. Eight water quality samples were collected 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. In some years smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events.

Ten water quality parameters were tested. Parameters tested with portable meters included pH, specific conductance, turbidity, temperature, salinity, and dissolved oxygen. Beginning in 2009, transparency tube measurements were added and are reported to MPCA. Parameters tested by water samples sent to a state-certified lab included total phosphorus, total suspended solids, and *E.coli* bacteria.

During every sampling event the water level (stage) was recorded using a staff gauge surveyed to sea level elevations. Stage was also continuously recorded using electronic continuous data logging gauges at the Morningside Cemetery and Xeon Street stream crossing (farthest downstream).

Sand Creek Monitoring Sites



Results and Discussion

This report includes data from all years and all sites to provide a broad view of Sand Creek's water quality under a variety of conditions. Water quality assessments are based on upstream-to-downstream comparisons, a comparison of baseflow and storm conditions, and an overall assessment compared to other Anoka County streams and state water quality standards. Median results for each parameter at the furthest downstream site (Xeon St.) are tabulated for comparison to state standards as near the confluence as possible. All results for all years are graphed in box and whisker style plots. Following is a summary, including a management discussion:

- Dissolved pollutants, as measured by specific conductance and chlorides, are substantially higher in Sand Creek than other streams in Anoka County. Median conductivity levels at Xeon Street are approximately double the county-wide median. There is a slight decrease from upstream to downstream. Readings for conductivity are markedly higher during baseflow than storms, indicating pollutants migrating through the shallow water table are a large source to the stream. Dissolved pollutants are at a higher concentration in Sand Creek than Coon Creek downstream. Chlorides, a likely component of conductivity, were last monitored in 2012 and will be monitored again in 2019. Chlorides can be elevated due to road deicing salts and other factors.

  Management discussion: Dissolved pollutants enter the stream both directly through surface runoff and also by infiltrating into the shallow groundwater that feeds the stream during baseflow. A variety of sources appear to be likely, including road deicing salts, agricultural chemicals, and road runoff.

- Phosphorus is lower in Sand Creek than other streams in the region, including Coon Creek, but on occasion it exceeds the State standard of 100 µg/L, particularly during storm flows at the furthest downstream site (Xeon St.). Phosphorus concentrations do increase upstream to downstream indicating loading is occurring throughout the watershed. The largest increase is after the confluence of the three ditch systems. In past monitoring, Ditches 39 and 60 had higher phosphorus concentrations than Ditch 41, and they may still be large contributors of phosphorus to Sand Creek. Targeting phosphorus in Sand Creek could be an effective management practice to reduce the total phosphorus load to the lower reaches of Coon Creek after the confluence.

Management discussion: Some stormwater treatment retrofits, including stormwater ponds and a network of rain gardens installed in 2012 among other practices, will be helpful in lowering storm-related phosphorus in Sand Creek. These projects have a beneficial effect on Coon Creek downstream which has even higher phosphorus. It may be worth considering monitoring Ditches 39 and 60 again to assess the extent to which the degrade Sand Creek water quality.

- Suspended solids and turbidity are low in Sand Creek, with the exception of occasional higher readings during storms further downstream. Median TSS is low compared to the state water quality standard of 30 mg/L.

  Management discussion: Because TSS approaches state standards during storms, and because it flows into Coon Creek, which has high suspended solids concentrations, continued efforts should be made to lower these pollutants in Sand Creek. Projects that target TSS and phosphorus reduction are usually similar and would likely have a large benefit on Coon Creek downstream.

- pH and dissolved oxygen remain within the range considered normal and healthy for streams in this area.
- *E. coli* bacteria are high throughout Sand Creek during storms, and the problem increases downstream. One deviation from the upstream-to-downstream trend it that *E. coli* declines sharply before the sampling site at Highway 65, presumably due to treatment in ponds just upstream.

  Management discussion: Because *E. coli* is pervasive in the environment and neighborhoods there will be difficulty reducing *E. coli* levels below State water quality standards. Addressing *E. coli* should be part of an effort to improve overall water quality.

Specific conductance and Chlorides

Specific conductance, chlorides, and salinity are all measures of a broad range of dissolved pollutants. Dissolved pollutant sources include urban road runoff, industrial, and other sources. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Specific conductance is the broadest measure of dissolved pollutants we use. It measures the electrical specific conductance of water; pure water with no dissolved constituents has zero specific conductance. Chlorides are a common cause of high specific conductance. The most common chloride salt source locally is 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, however, it is also noteworthy that Coon Creek is upstream from the drinking water intakes on the Mississippi River for the Twin Cities. Chlorides have not been sampled since 2012.

Sand Creek dissolved pollutant levels are often double the level typically found in Anoka County streams, and are consistently higher than levels in Coon Creek, which Sand Creek drains into. Considering all sites for all years under all conditions, median specific conductance in Sand Creek is almost double the median for all Anoka County streams (0.769 mS/cm compared to 0.420 mS/cm for the county overall).

It is not surprising that Sand Creek, which lies in a suburban area, would have greater dissolved pollutants than the countywide median. The county spans rural to urban areas. Sand Creek's watershed is primarily suburban residential with the unique characteristic of many man-made and densely developed basins at the headwaters of one of the three main contributing ditches. The watershed has an abundance of roads, which are treated regularly with deicing salts. Urban stormwater runoff, which is most abundant in the lower watershed, also contains a variety of dissolved pollutants. Stormwater treatment practices such as catch basins and settling ponds are relatively ineffective at removing dissolved pollutants. Streams near Sand Creek in similar land use settings have similar dissolved pollutant levels.

From upstream to downstream there is little change in dissolved pollutants in Sand Creek (see figures below), although there is a slight decline in long-term median values moving upstream to downstream. This suggests dissolved pollutant concentrations in all parts of the watershed are similar with upstream portions contributing more.

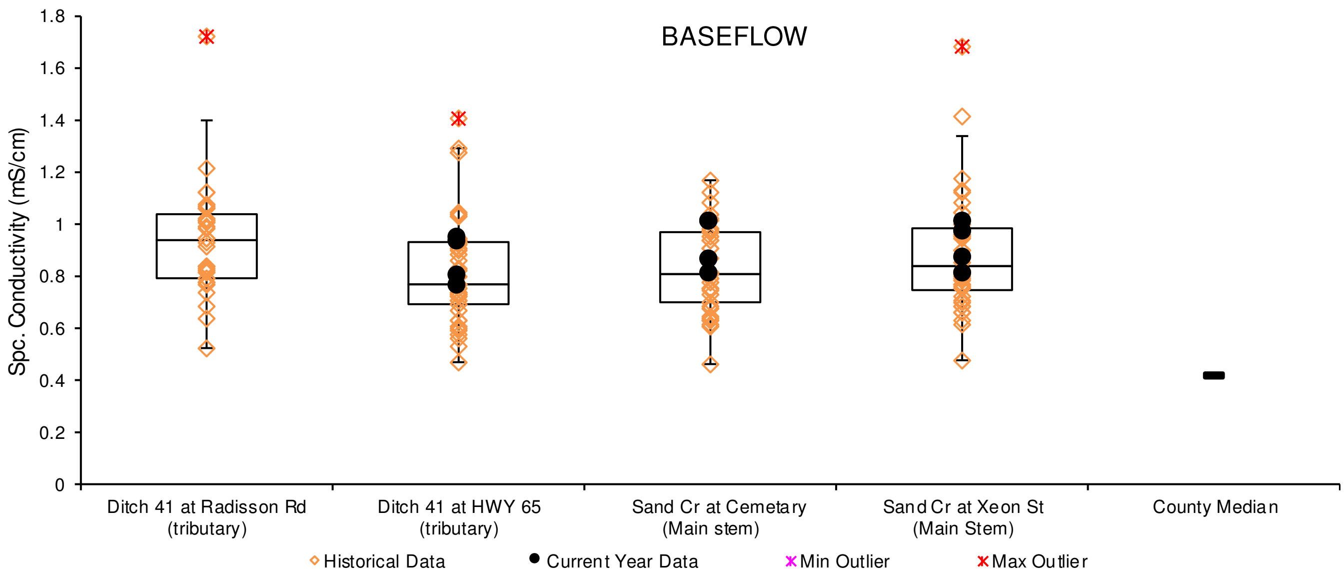
Dissolved pollutants are lower during storms than during baseflow conditions. Dissolved pollutants can easily infiltrate into the shallow groundwater that feeds streams during baseflow, causing continuous high levels of specific conductance. If road runoff was the primary dissolved pollutant source, then readings would be higher during storms. When chlorides were monitored at Xeon Street during baseflow the median levels were 18% higher than during storms. This is not to say that storm runoff is free of dissolved pollutants; rather the concentration is lower than in the shallow groundwater. From a management standpoint, it is important to remember that the sources of both stormwater and baseflow dissolved pollutants are generally the same, and preventing their release into the environment should be a high priority.

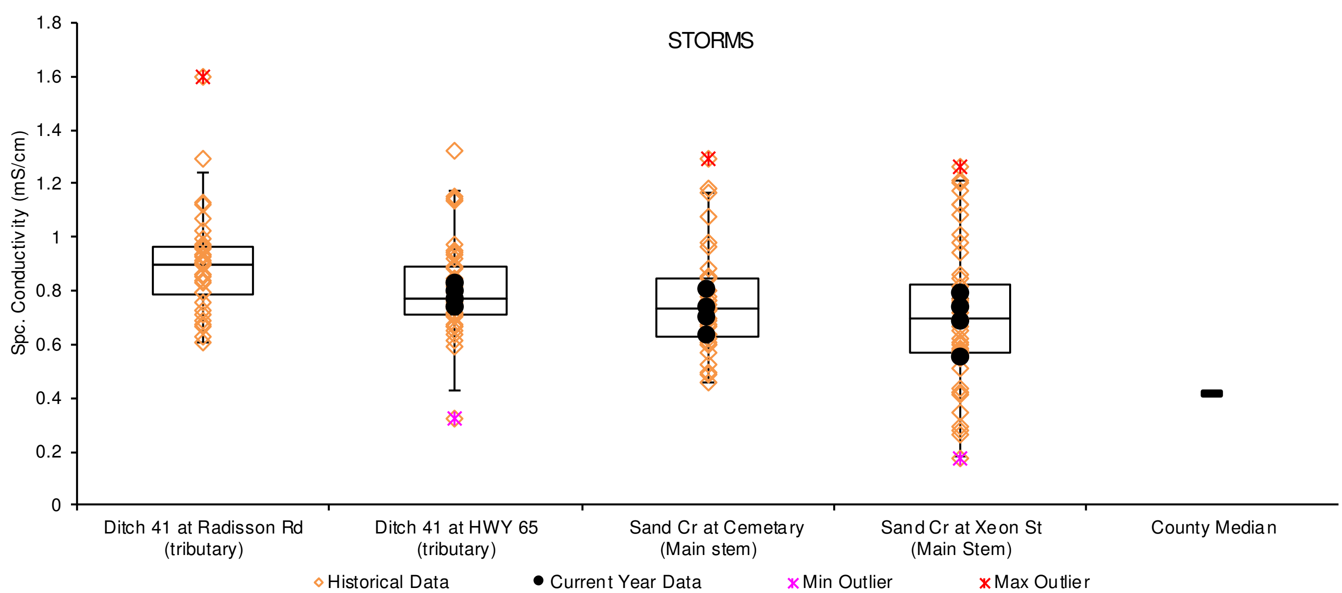
Sand Creek degrades Coon Creek with dissolved pollutants. Both creeks were monitored just before they join (Coon Cr at Lions Park and Sand Cr at Xeon). Across all years monitored, Sand Creek's median specific conductance is 32% higher than Coon Creek (0.714 vs 0.543 mS/cm) before this junction. Sand Creek's median chlorides when last monitored were 42% higher than Coon Creek (74 vs 52 mg/L).

Average and median specific conductance and median chlorides in Sand Creek Data is from Xeon St for specific conductance all years through 2018, for chlorides all years through 2012.

	Average Specific conductance (mS/cm)	Median Specific conductance (mS/cm)	Median Chlorides (mg/L)	State Standard	N (Sp Cond.)
Baseflow	0.882	0.840	75	Specific conductance – none Chlorides 860 mg/L acute, 230 mg/L chronic	48
Storms	0.709	0.693	63.45		48
All	0.796	0.769	71.65		96
Occasions > state standard					0

Specific conductance at Sand Creek Orange diamonds are historical data from previous years and black circles are 2018 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) is a common nutrient pollutant and is the limiting factor for most algae growth. Median TP is below the state standard of 100 µg/L in Sand Creek (see table and figures below). Median TP in Sand Creek at Xeon (all years) is 61 µg/L during baseflow and 89 µg/L during storm events. However, Sand Creek at Xeon samples during storm events average 109 µg/L, higher than the state standard. Phosphorus is a common nutrient pollutant in Anoka County, and Sand Creek remains below the median for all Anoka County streams (119 µg/L).

While generally low, Sand Creek phosphorus levels have occasionally exceeded state standards, usually during storm events. Since 2007, storm event samples collected at Xeon Street have exceeded the State standard 38% of the time. Phosphorus loading occurs throughout the Sand Creek watershed with median concentrations increasing upstream to downstream during both baseflow and storm flow conditions. The most obvious uptick in TP concentrations is between the Ditch 41 at Highway 65 site and Sand Creek at Morningside Memorial Gardens. Retrofitting stormwater treatment for improved phosphorus capture should continue to be a focus of management throughout the watershed in northwestern Blaine.

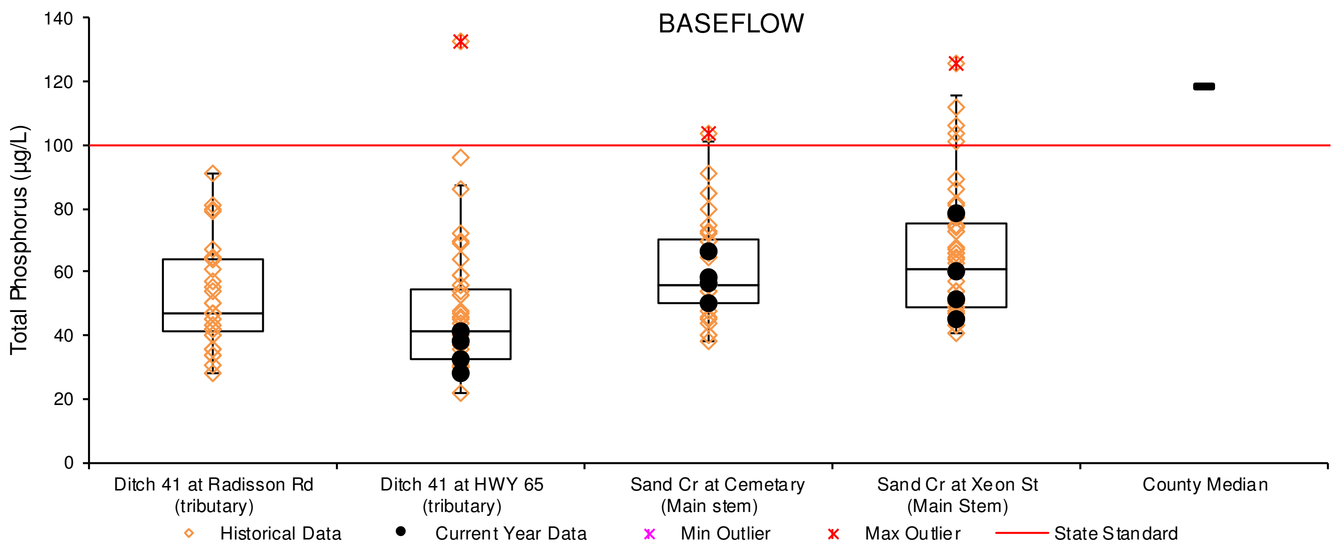
Because the Ditch 41 portion of the Sand Creek watershed flows through a series of highly developed constructed lakes, managing total phosphorus loading to these lakes will help maintain low concentrations in Sand Creek as well. While Sunrise Lake in 2018 averaged just 31 µg/L, under state standards for lakes, there was a large increase in the September samples, which were both over 50 µg/L. There is one more bay downstream of the sampled bay in Sunrise Lake before Ditch 41 flows under Radisson Road at the sampling site. Flow then continues through a series of golf course ponds, and finally another large and highly developed series of basins (Club West Ponds) before flowing under Highway 65 to the next sampling site. Total phosphorus tends to decrease between the Radisson Road sampling site and the Highway 65 sampling site, indicating that the functioning as intended to reduce phosphorus..

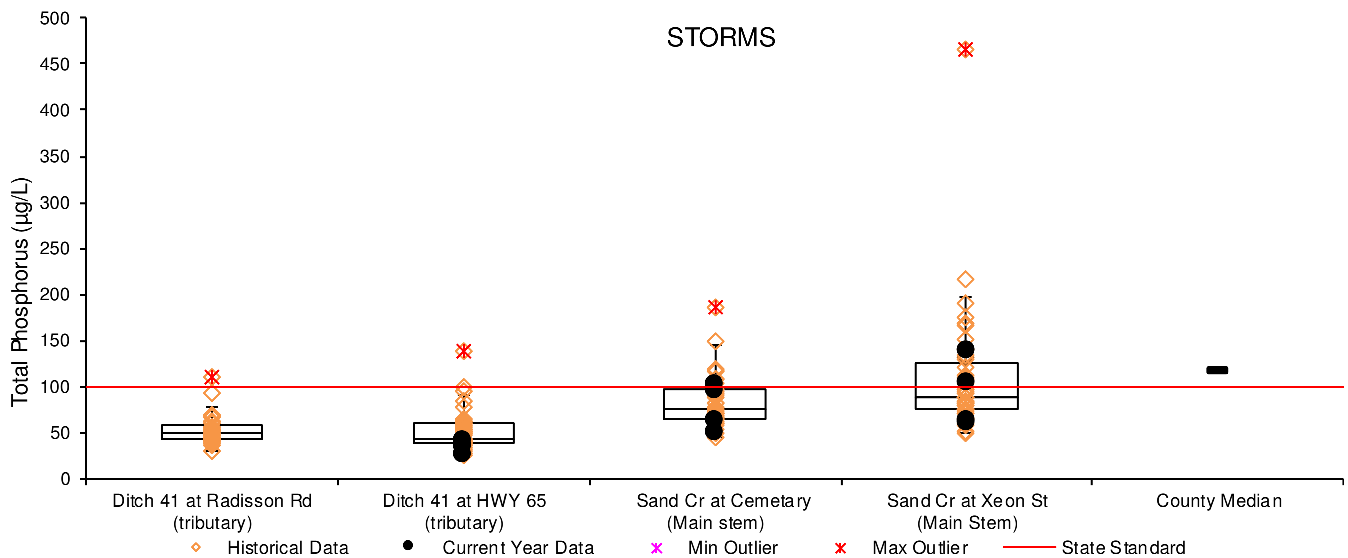
There is a noticeable uptick in phosphorus between the Ditch 41 at Highway 65 site and Morningside Memorial Gardens (Cemetery) site. The area between the two is primarily medium density residential with two additional ditch systems joining Ditch 41 to become Sand Creek. Ditch 60 joins from the north in Happy Acres Park after draining the stormwater from the Crescent Ponds development. Ditch 39 joins from the south immediately upstream of the sampling site in Morningside Memorial Gardens after draining a swath of medium density residential areas of western Blaine. The three ditches together drain the entire northwest quadrant of Blaine before joining as Sand Creek and continuing west through Coon Rapids. Ditches 39 and 60 were only sampled in 2009. When that sampling occurred, both of those ditches had much higher total phosphorus concentrations than Ditch 41 prior to joining. Decreasing phosphorus in Sand Creek will help reduce the total load to downstream reaches of Coon Creek, though Sand Creek does have lower total phosphorus concentrations than Coon Creek when they merge, and likely provides a very small dilution factor. Additional sampling and management efforts for the Ditch 60 system may be prudent given the noticeable uptick in phosphorus after they adjoin.

Average and median total phosphorus in Sand Creek Data is from Xeon St for all years through 2018.

	Average Total Phosphorus (µg/L)	Median Total Phosphorus (µg/L)	State Standard	N
Baseflow	65.1	61	100	48
Storms	109.1	89		47
All	86.9	75		95
Occasions > state standard				18 (38%) storm 5 (10%) baseflow

Total phosphorus at Sand Creek Orange diamonds are historical data from previous years and black circles are 2018 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 and Turbidity

Total suspended solids (TSS) and turbidity are both measures of solid particles in the water. TSS measures these particles by weighing materials filtered out of the water. Turbidity measures the diffraction of a beam of light sent though the water sample and is most sensitive to large particles. The state standard for TSS in streams in the central nutrient region is 30 mg/L.

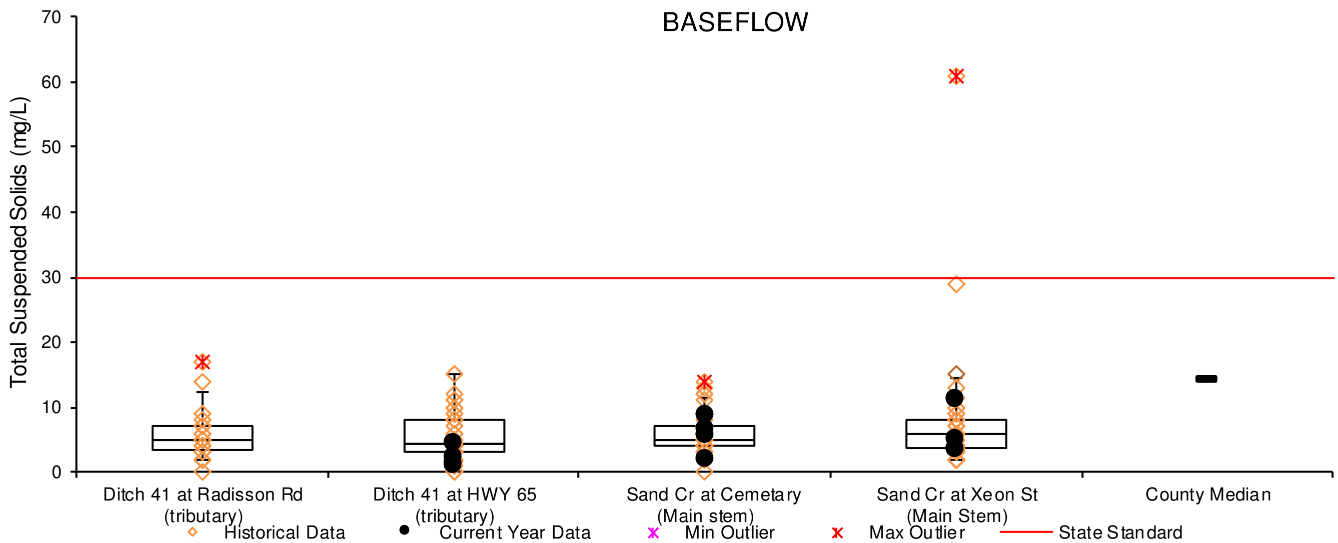
TSS and turbidity are reasonably low in Sand Creek, with the exception of occasional higher readings during storms at Xeon Street (farthest downstream). At Xeon Street, median TSS (all years) during baseflow is 6 mg/L, but it is 12 mg/L during storms. Both are low compared to the state water quality standard of 30 mg/L, but that standard was exceeded in six individual samples (7%) historically. None of these exceedances occurred in 2018.

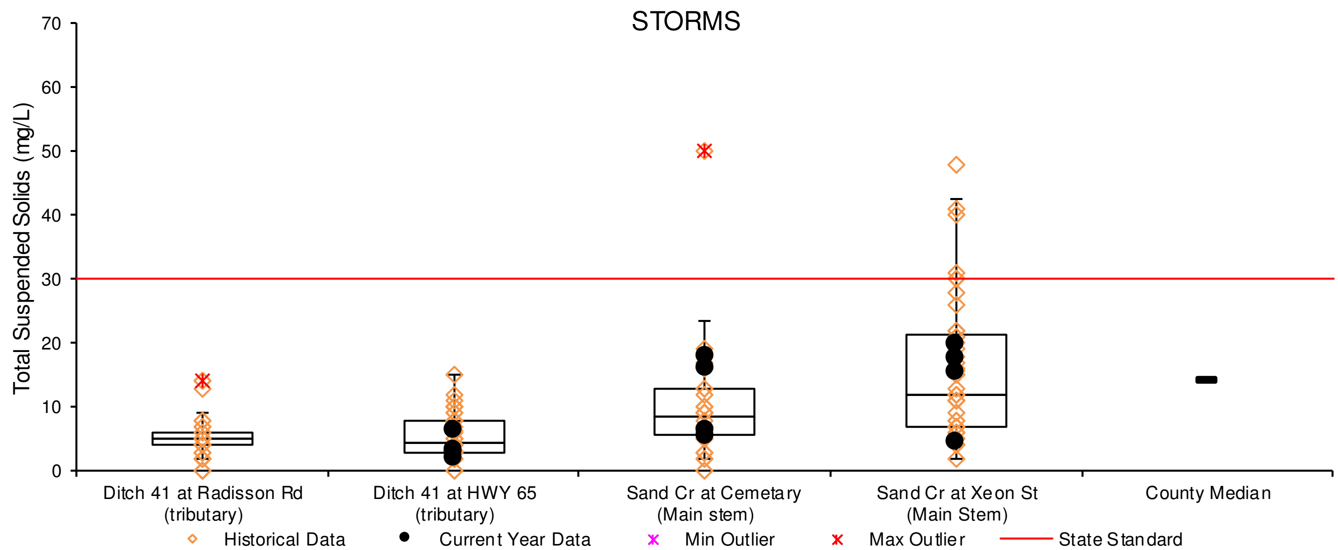
Because TSS levels in Sand Creek occasionally approach the water quality standard, and because Sand Creek flows into Coon Creek which has high suspended solids, efforts should be made to lower these pollutants in Sand Creek. Similar to total phosphorus concentrations, there is a notable uptick in TSS concentrations after the confluence of Ditches 39 and 60. This particulate pollution would likely be reduced through efforts to curb phosphorus loading from all the individual ditch drainages contributing to Sand Creek.. TSS should also be reduced in the lower reaches of Sand Creek through ongoing efforts to stabilize eroding streambanks.

Average and median total suspended solids in Sand Creek Data is from Xeon St for all years through 2018.

	Average Total Suspended Solids (mg/L)	Median Total Suspended Solids (mg/L)	State Standard	N
Baseflow	7.4	6.0	30 mg/L TSS	48
Storms	17.4	12.0		48
All	12.4	7.5		96
Occasions > state TSS standard				5 (10%) storm 1 (2%) baseflow

Total suspended solids at Sand Creek Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

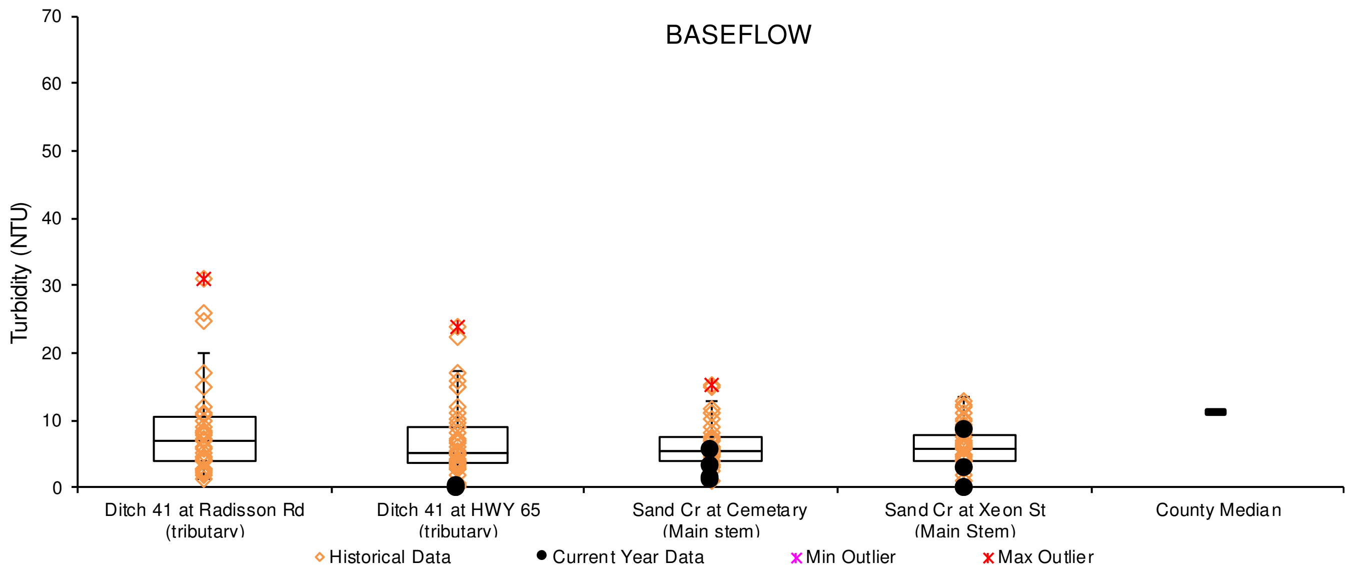


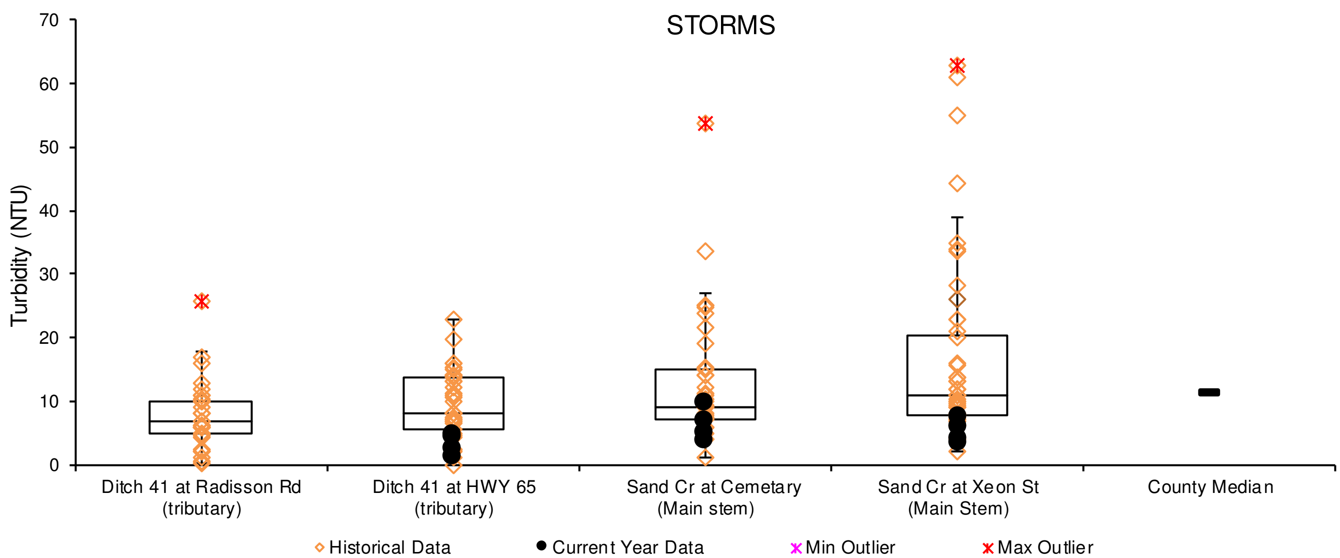


Average and median turbidity in Sand Creek Data is from Xeon St for all years through 2018.

	Average Turbidity (NTU)	Median Turbidity (NTU)	State Standard	N
Baseflow	9.2	5.8	n/a	47
Storms	16.5	11.0		48
All	12.9	7.9		95

Turbidity at Sand Creek Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





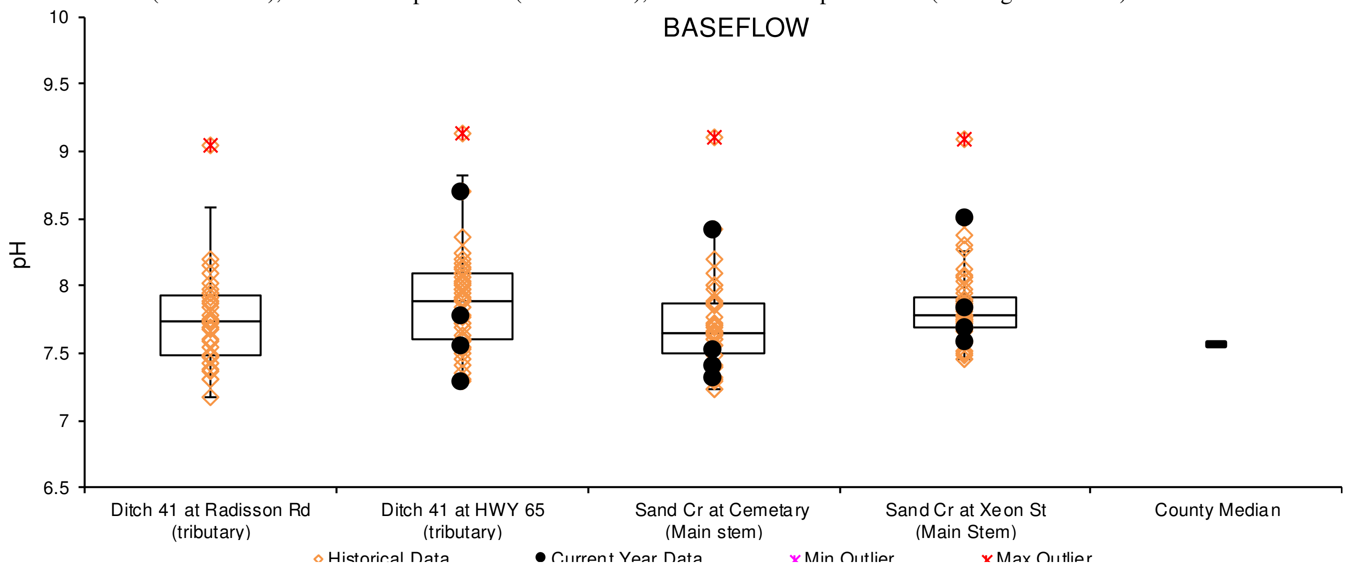
pH

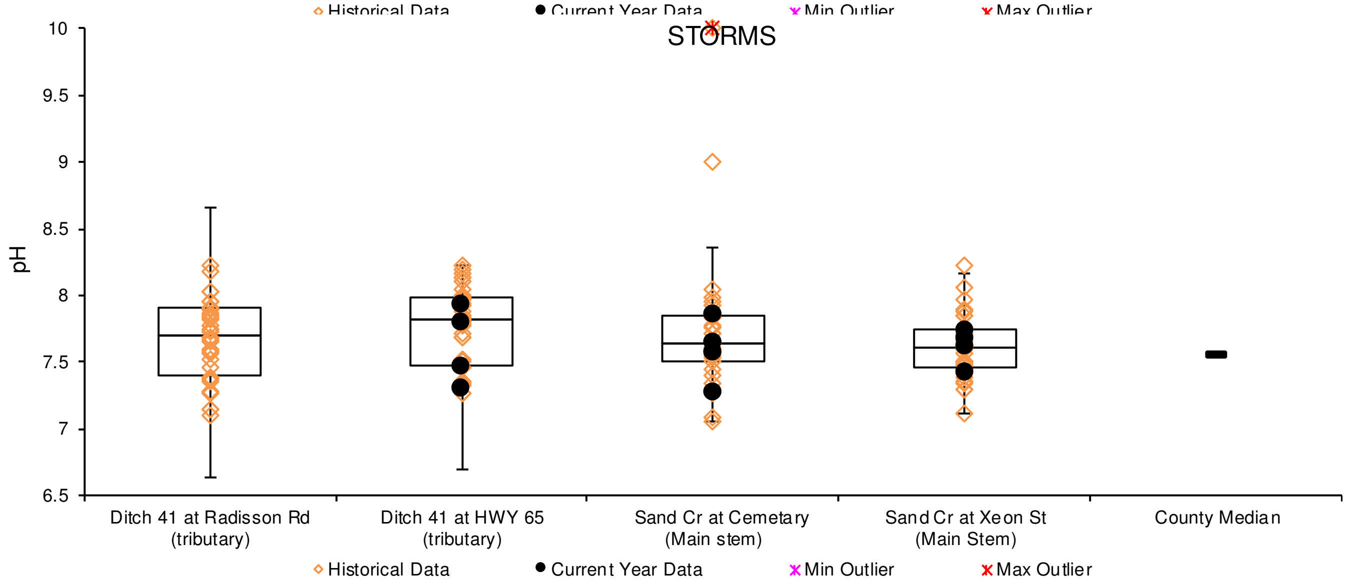
Sand Creek pH remained within the acceptable range at all sites and during all conditions in 2018. Individual outliers have caused a couple of very high readings in the monitoring history. These may be due to a poor calibration of the sampling equipment. The median for all conditions at Xeon is 7.73. The Minnesota Pollution Control Agency water quality standards set a range for pH to remain between 6.5 and 8.5. pH is lower during storms because rainwater has a lower pH. pH seems to be within a healthy range in Sand Creek.

Average and median pH in Sand Creek Data is from Xeon St for all years through 2018.

	Average pH	Median pH	State Standard	N
Baseflow	7.85	7.78	6.5-8.5	47
Storms	7.84	7.61		48
All	7.84	7.73		95
Occasions outside state standard				1 baseflow (2%) 2 storm (4%)

pH at Sand Creek Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





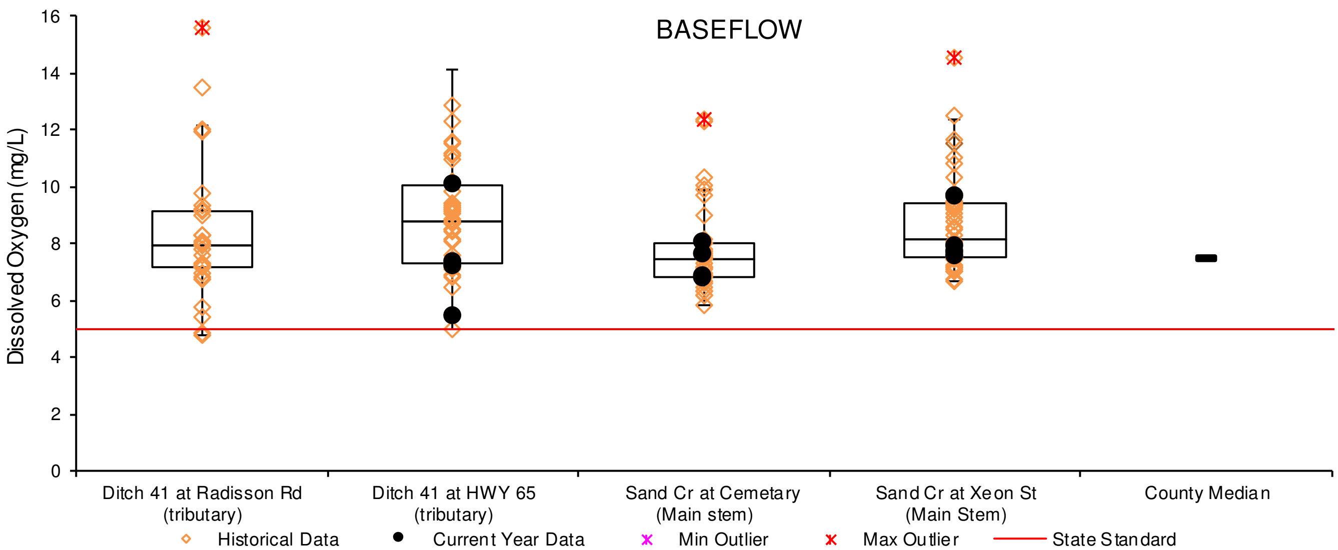
Dissolved Oxygen

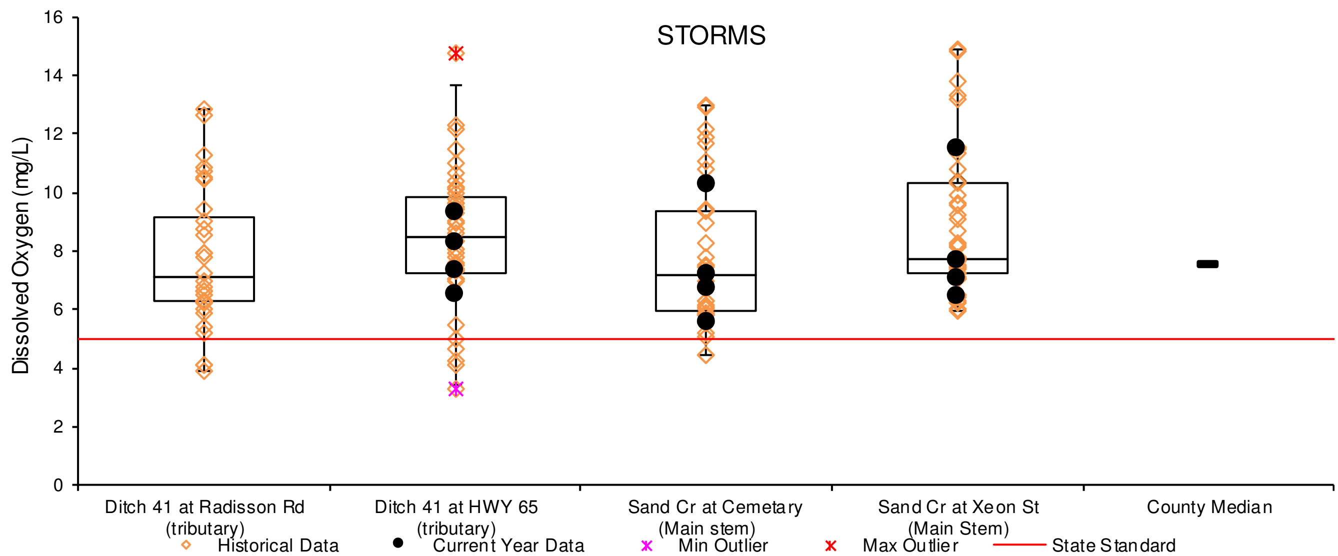
Dissolved oxygen (DO) is essential for aquatic life. Fish, invertebrates, and other aquatic life suffer if DO falls below 5 mg/L. Low DO can be a result of organic pollution, the decomposition of which consumes oxygen. Dissolved oxygen is healthy in lower reaches of Sand Creek, and has never been recorded below 5 mg/L at Xeon St. However, on 13 of 208 (6%) sampling occasions across all monitored years at other upstream sites, DO dropped below 5 mg/L. Overall, there are no significant management concerns about dissolved oxygen levels in Sand Creek, but it will continue to be monitored.

Average and median dissolved oxygen in Sand Creek. Data is from Xeon St for all years through 2018.

	Average Dissolved Oxygen (mg/L)	Median Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	8.72	8.17	5 mg/L daily minimum	44
Storms	8.84	7.74		48
All	8.78	7.97		92
Occasions <5 mg/L				0 at Xeon St., 13 at other sites

Dissolved Oxygen at Sand Creek. Orange diamonds are historical data from previous years and black circles are 2018 readings. Bo x plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating lines).





E. coli

E. coli is bacteria found in the feces of warm-blooded animals. *E. coli* is an easily measureable indicator of all pathogens that are associated with fecal contamination. The Minnesota Pollution Control Agency sets *E. coli* standards for contact recreation (swimming, etc.). A stream is designated as “impaired” if 10% of measurements in a calendar month are >1260 most probable number (MPN) of colony forming units per 100 milliliters of water, or if the geometric mean of five samples taken within 30 days is greater than 126 MPN.

Sampling by the MPCA has found Sand Creek exceeds State standards for *E. coli* bacteria, and it is listed as impaired for this parameter. Data collected by local agencies to date are not sufficient to re-calculate if the MPCA standards are met or exceeded. We took samples throughout the summer, often with only 1-2 samples each month, too little for calculation of a monthly geometric mean, or to reasonably say that 10% of samples in a month were in exceedance. However, other examinations of the data presented below verify that *E. coli* abundance is high.

During all conditions, *E. coli* was similarly high at all monitoring sites except the site at Highway 65. Though the furthest upstream Ditch 41 site (Radisson Road) was not monitored in 2018, there is consistently a sharp decrease in *E. coli* between Radisson Road and Highway 65, and a sharp return to high levels by Morningside Memorial Gardens Cemetery. In 2018, *E. coli* levels at the Highway 65 site were again very low compared to other sampled sites. Presumably, this is due to treatment by ponds just upstream of Highway 65.

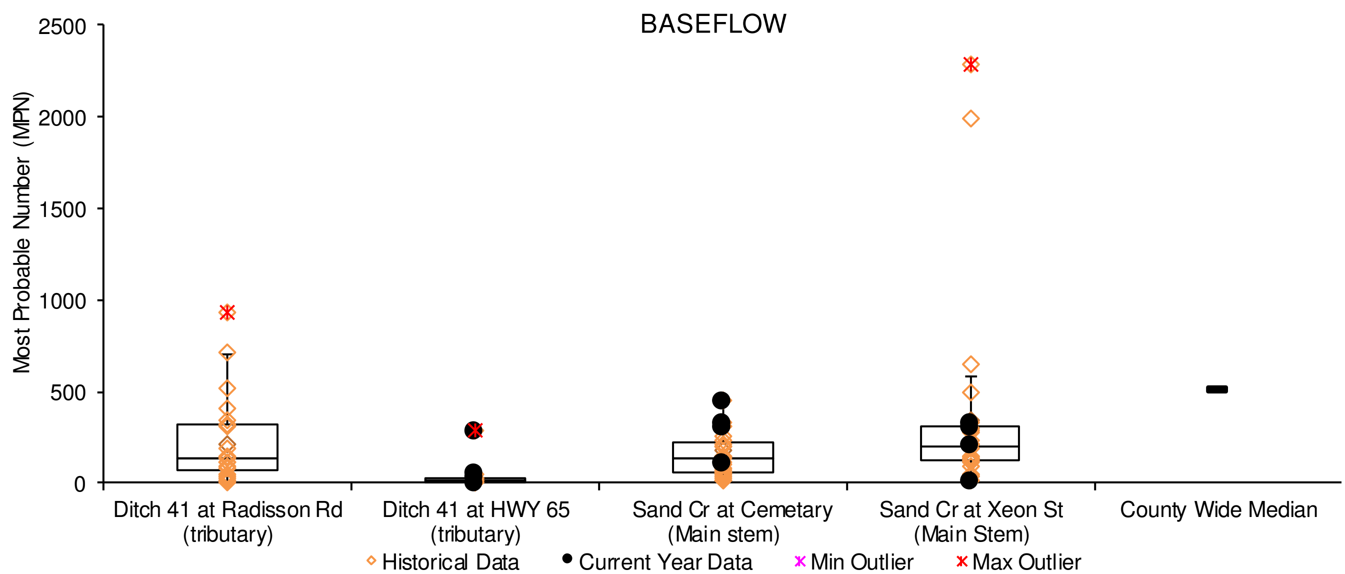
During storms, *E. coli* is significantly higher and more variable at all sites other than Ditch 41 at Highway 65, and there is an increase in long-term median from upstream to downstream (Morningside Cemetery site median= 386 MPN, Xeon Street site median= 609 MPN). Note the Y-axis scale between the baseflow graph and storm flow graph below. As with baseflow conditions, there is a sharp decline between Radisson Road and Highway 65 with the long term median dropping from 345 to 48 MPN between those two sites. The median increases back up to 386 MPN at the next site downstream at Morningside Memorial Gardens.

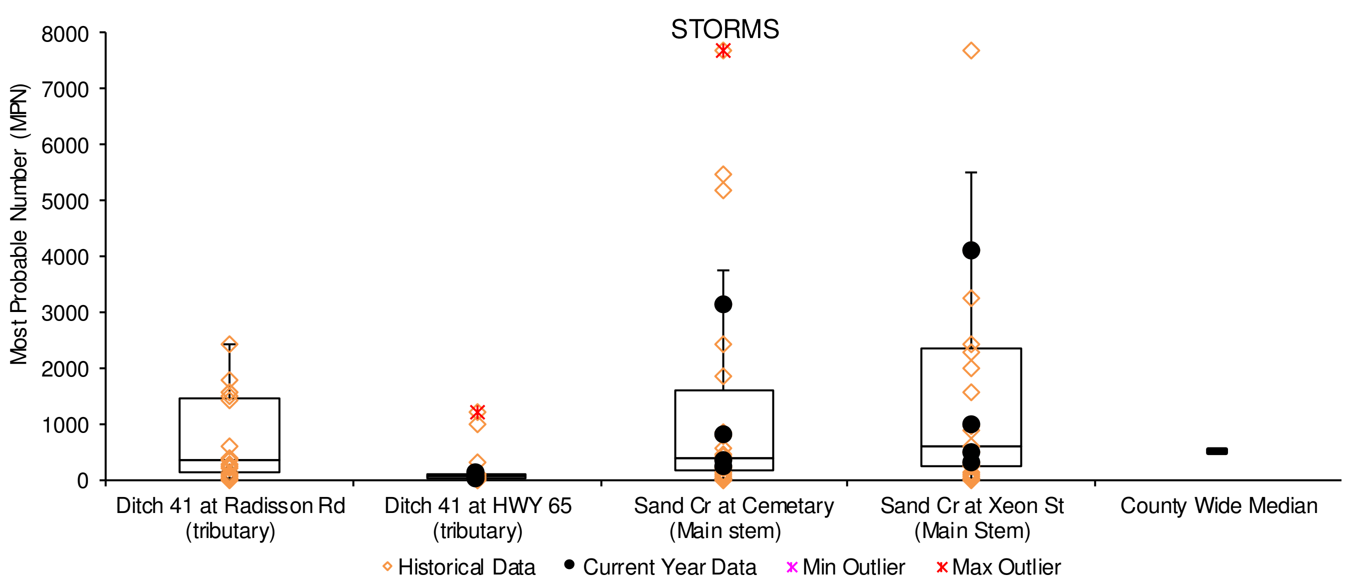
Aside from the sharp decline in *E. coli* near Highway 65, levels are generally high in Sand Creek and should remain a focus of management effort. Further study is needed to determine the cause of low *E. coli* at Highway 65 given that the sites upstream and downstream consistently have much higher *E. coli*. Management efforts should be focused between Highway 65 and Morningside Memorial Gardens where a large increase occurs.

Average and median *E. coli* in Sand Creek. Data is from Xeon St. for all years through 2018.

	Average *E. coli* (MPN)	Median *E. coli* (MPN)	State Standard	N
Baseflow		88.5	Monthly Geometric Mean >126	20
Storms		609		20
All		127.4		40
Occasions >126 MPN **Occasions >1260 MPN**			Monthly 10% average >1260	14 (70%) baseflow, 15 (75%) storm 2 (10%) baseflow, 8 (40%) storm

***E. coli* at Sand Creek.** Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating lines).





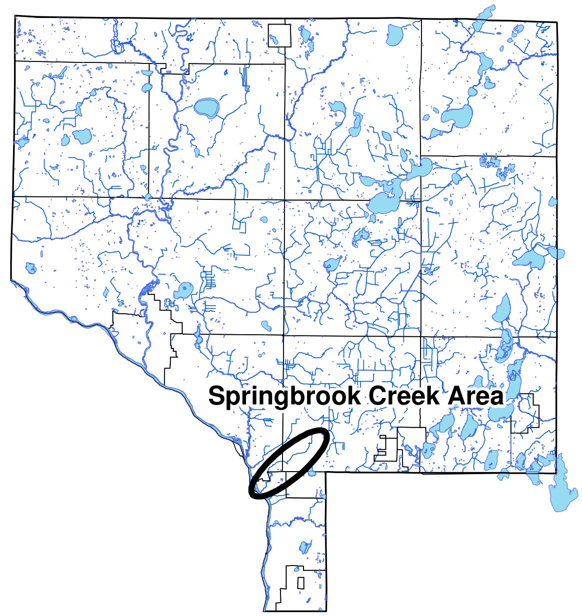
SPRINGBROOK CREEK

Springbrook at University, Blaine	STORET SiteID = S007-542
Springbrook at 85th Avenue, Fridley	STORET SiteID = S007-543
Springbrook at 79th Way, Fridley	STORET SiteID = S006-140

Years Monitored

Springbrook at University 2013-**2018**
Springbrook at 85th Avenue 2013-**2018**
Springbrook at 79th Way 2012-**2018**

Other sites around the Springbrook Nature Center were monitored on a few occasions in the early 2000s but are not included in this report.



Background

Springbrook Creek is a small waterway draining an urbanized and highly modified subwatershed. The watershed includes portions of the Cities of Blaine, Coon Rapids, Spring Lake Park and Fridley. Several tributaries and stormwater systems contributing to the creek join at the Springbrook Nature Center Impoundment. From the outlet of the nature center, the creek flows a short distance to the Mississippi River. At its outlet, Springbrook is about 10 ft. wide and 1 foot deep at baseflow. The stream is flashy, with water levels that increase dramatically following rainfall and quickly recede thereafter.

In the early 2000s Springbrook was the subject of a multi-partner project to monitor and improve water quality. Funding support came from a MN Pollution Control Agency grant and the City of Fridley. During that effort, several projects to better treat stormwater and rehabilitate the nature center impoundment were initiated. Water quality monitoring at that time produced little data, but enough to indicate sizable water quality and hydrology problems existed. More recently, the Coon Creek Watershed District has renewed a monitoring program and is planning water quality improvement projects.

Springbrook Creek is listed as "impaired" by the MN Pollution Control Agency for excessive *E. coli* bacteria and poor invertebrate biota. New standards (Tiered Aquatic Life Standards) currently under development will likely take into consideration the fact that the creek is a public ditch (Ditch 17) and therefore will likely lower aquatic life expectations, at least in some reaches. While recent monitoring data is insufficient to officially assess Springbrook for other impairments, the data to date suggest that other impairment designations are possible in the future.

Methods

Springbrook Creek is monitored during both storm and baseflow conditions by grab samples. Eight water quality samples are collected 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. In some years smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events.

Eleven water quality parameters were tested. Parameters tested with portable meters included pH, specific conductance, turbidity, temperature, salinity, and dissolved oxygen. Beginning in 2009, transparency tube measurements were added and are reported to MPCA. Parameters tested by water samples sent to a state-certified lab included total phosphorus, total suspended solids, and *E.coli* bacteria.

During every sampling event, the water level (stage) was recorded using a staff gauge surveyed to sea level elevations. Stage was also continuously recorded using an electronic continuous data logging device at 79^{th} Way, shortly before the outlet to the Mississippi River.

Results and Discussion

Springbrook Creek has some prominent water quality concerns. While it is currently listed as impaired by the State for *E. coli* bacteria and invertebrate biota, monitoring data suggests that other impairments exist. Chlorides, phosphorus, and suspended solids all approach or exceed state standards at least occasionally.

Following is a parameter-by-parameter summary and management discussion:

- Dissolved pollutants, as measured by specific conductance and chlorides, are high in Springbrook Creek. Specific conductance has reached four times the median for Anoka County streams in past years, while chlorides have reached nine times the county median when measured in past years. The long-term specific conductance median is more than double that of all streams Anoka County-wide. Both parameters are high during storms and baseflow conditions, but consistently higher specific conductance is recorded during baseflow. On one of eight past monitoring occasions the state chronic standard for chlorides was exceeded.

  Management discussion: Dissolved pollutants enter the stream both directly through surface runoff and also by infiltrating into the shallow groundwater that feeds the stream during baseflow. A variety of sources appear to be likely, including road deicing salts and road runoff. Preventing their release into the environment is important because they are not easily removed.

- Phosphorus is moderate to high in Springbrook Creek. Phosphorus is high during storm events and lower during baseflow at the furthest downstream site. During baseflow, phosphorus concentrations decrease from upstream to downstream, indicating effective removal in wetlands and stormwater treatment practices. During storm flows, it appears these practices are overwhelmed, and phosphorus levels do not decrease from upstream to downstream. Storm flow samples frequently exceed state standards. Although this stream has not yet been designated as impaired, and TP load allocation has been set as part of the greater CCWD approved TMDL. *Management discussion*: Additional treatment within the stormwater conveyance system is suggested to help reduce phosphorus to levels below state water quality standards during storms and prevent a future "impairment" designation. This will also help reduce the loading into the Mississippi River.

- Suspended solids and turbidity are quite low in Springbrook Creek during baseflow, but increase moving downstream during storms. Similar to phosphorus there is a marked increase in TSS during storm flows at the 79^{th} Way site. Examining potential improvements to stormwater treatment infrastructure between 85^{th} Ave. and 79^{th} Way is suggested.

  Management discussion: Additional treatment within the stormwater conveyance system will help reduce suspended solids, which will in turn reduce storm flow phosphorus concentrations.

- pH and dissolved oxygen are with the range considered normal and healthy for streams in this area.

- *E. coli* bacteria are high in Springbrook Creek, especially during storm events. While recent sampling frequencies do not allow for state standard exceedance calculations, samples do support MPCA findings that Springbrook Creek is impaired for *E. coli*.

  Management discussion: Because *E. coli* is pervasive in the environment there will be difficulty reducing *E. coli* levels below state water quality standards. Addressing *E. coli* should be part of an effort to improve overall water quality.

Specific conductance and Chlorides

Specific conductance and chlorides are measures of a broad range of dissolved pollutants. Dissolved pollutant sources include urban road runoff, industrial sources, agricultural chemicals, and others. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Specific conductance is the broadest measure of dissolved pollutants we use. It measures the electrical specific conductance of water; pure water with no dissolved constituents has zero specific conductance. Chloride monitoring measures for 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; however, it is also noteworthy that Springbrook Creek discharges into the Mississippi River just upstream from drinking water intakes for the Twin Cities.

Springbrook dissolved pollutant levels are multi-fold higher than the concentrations typically found in Anoka County streams and approaching levels that affect stream biota. The long-term median specific conductance in Springbrook at 79th Way is 0.905 mS/cm, more than double the median for all Anoka County streams of 0.42 mS/cm. Median specific conductance at 79th Way (all years) is high during both storm events (0.849 mS/cm) and baseflow conditions (1.028 mS/cm).

Chlorides, when sampled, were nine times higher than the average of other Anoka County streams. The Springbrook median chlorides at 79th Way (all years) was 159 mg/L compared to 17 mg/L for other Anoka County streams. Median chlorides during storms (216 mg/L) was higher than during baseflow (129 mg/L). During one storm event, chlorides were 253 mg/L, which exceeds the Minnesota Pollution Control Agency's chronic water quality standard of 230 mg/L. No monitoring occurred during snowmelt or mid-winter, when chlorides may have been higher. Chlorides were last monitored in 2012.

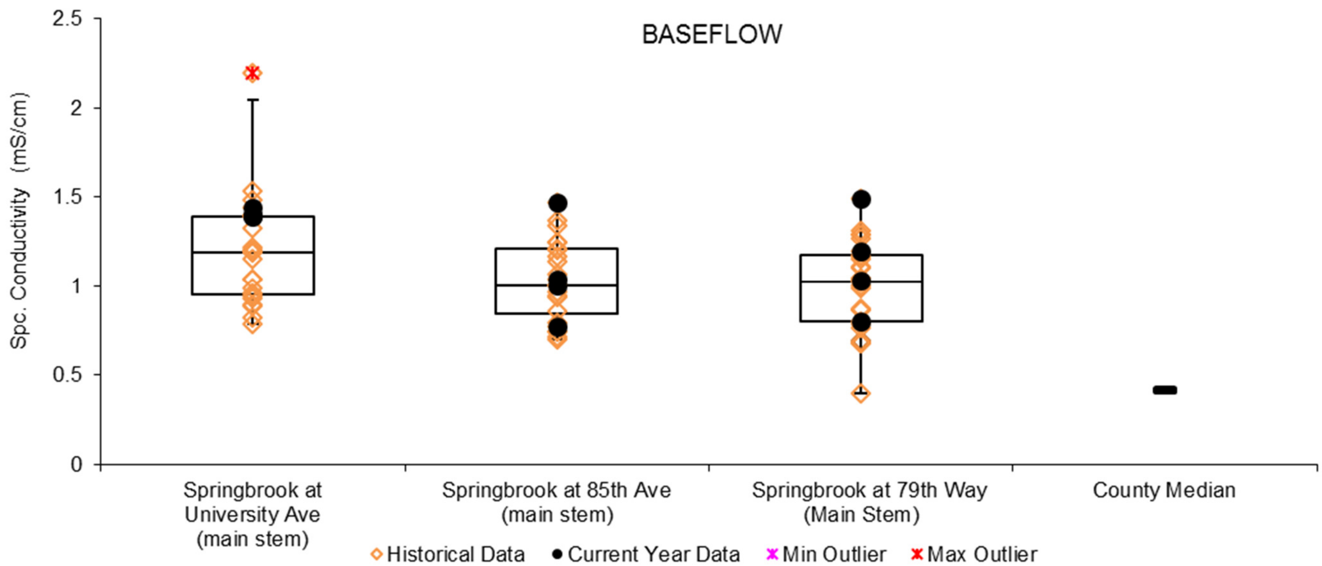
Springbrook's high dissolved pollutants are lower during storm flows, suggested that the local shallow groundwater is a source. Road deicing salts is an often cited contributor when similar conditions are found elsewhere in the region. Greater road densities and a long history of road salting contribute to high chlorides. Chlorides are persistent in the environment and not effectively broken down by stormwater treatment or time. They migrate into the shallow groundwater that feeds the stream during baseflow. Still, during storm flows Springbrook also carries high concentrations of dissolved pollutants, suggested that runoff from impervious surfaces directly to the stream is also problematic..

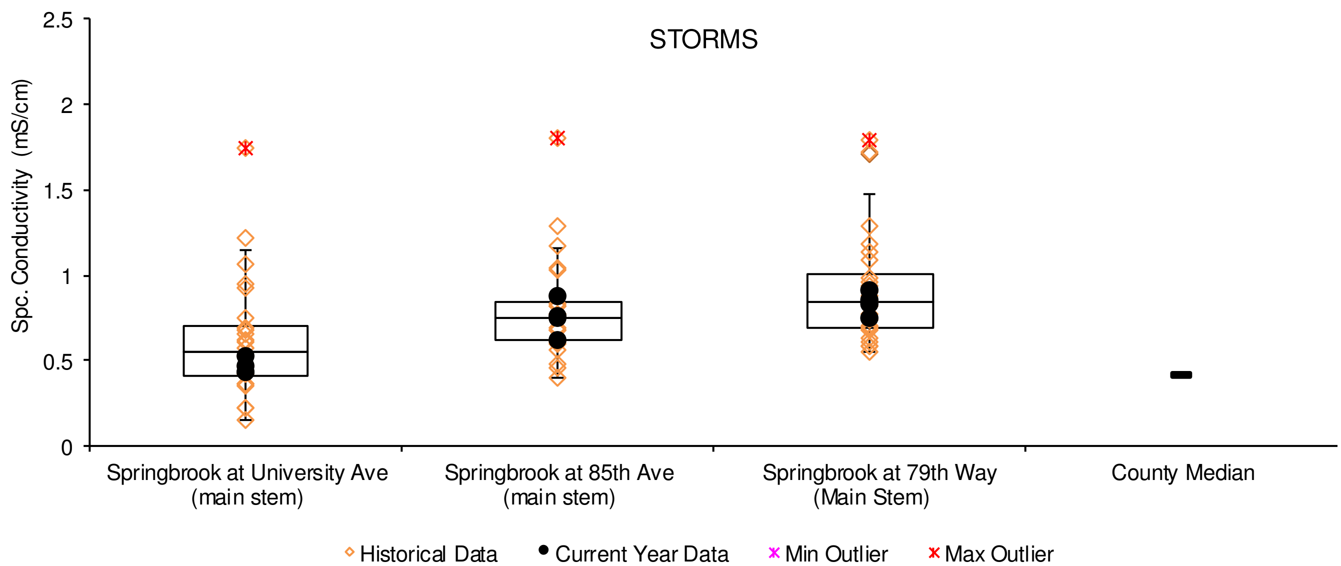
Dissolved pollutants are especially difficult to manage once in the environment. They are not removed by stormwater settling ponds. Infiltration practices can provide some treatment through biological processes in the soil, but also risk contaminating groundwater. The first approach to dissolved pollutant management must be to minimize their release into the environment.

Average and median specific conductance and chlorides in Springbrook Creek. Data is from 79th Way for specific conductance all years through 2018, for chlorides all years through 2012.

	Average Specific Conductance (mS/cm)	Median Specific Conductance (mS/cm)	Median Chlorides (mg/L)	State Standard	N (Spc. Cond)
Baseflow	0.993	1.028	129	Specific conductance – none Chlorides 860 mg/L acute, 230 mg/L chronic	28
Storms	0.928	0.849	216		28
All	0.960	0.905	159		56

Specific conductance at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2018 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) is a common nutrient pollutant and is the limiting factor for most algae growth. Springbrook Creek often exceeds, but does not grossly exceed, the State water quality standard of 100 µg/L during stormflows at all sites and during baseflow conditions in the upstream sites. Baseflow phosphorus was lower than during storms.

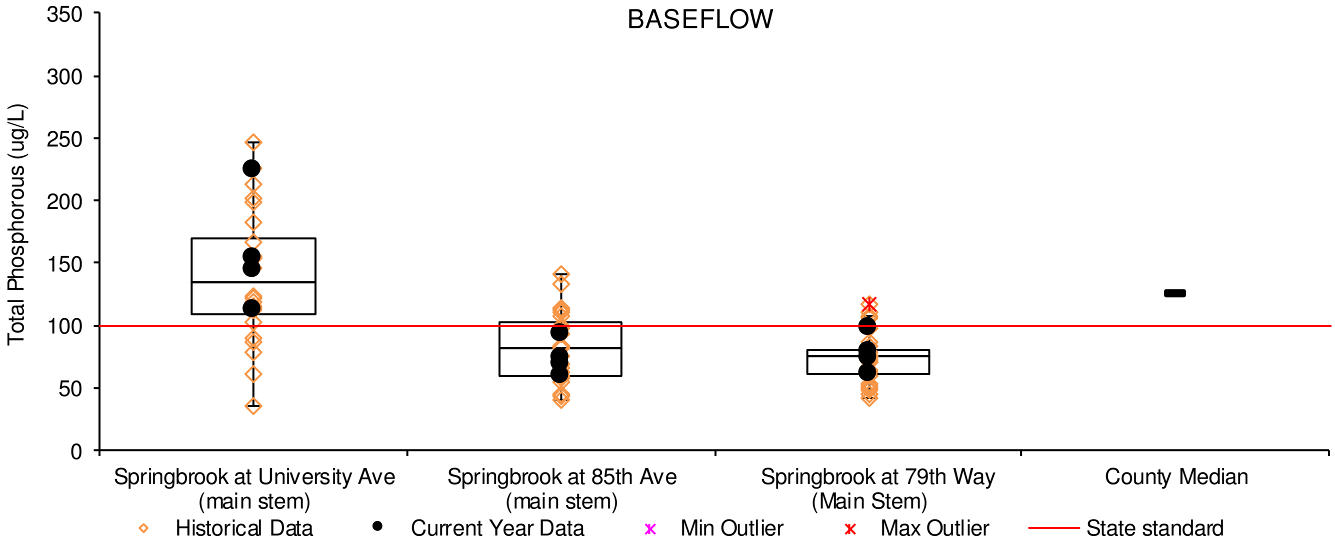
It is interesting to note that there was a marked decrease in baseflow total phosphorus moving from upstream to downstream. Long-term median concentrations at the three sites are 134, 83, and 74.5 µg/L respectively. This suggests that water quality projects and practices are doing a good job of removing phosphorus from the system throughout the watershed. A likely treatment source is the large wetland complex of the Springbrook Nature Center, although a decrease is also occurring between the two sites prior. Overall, the system is doing a decent job of treating baseflow total phosphorus concentrations to levels below state standards.

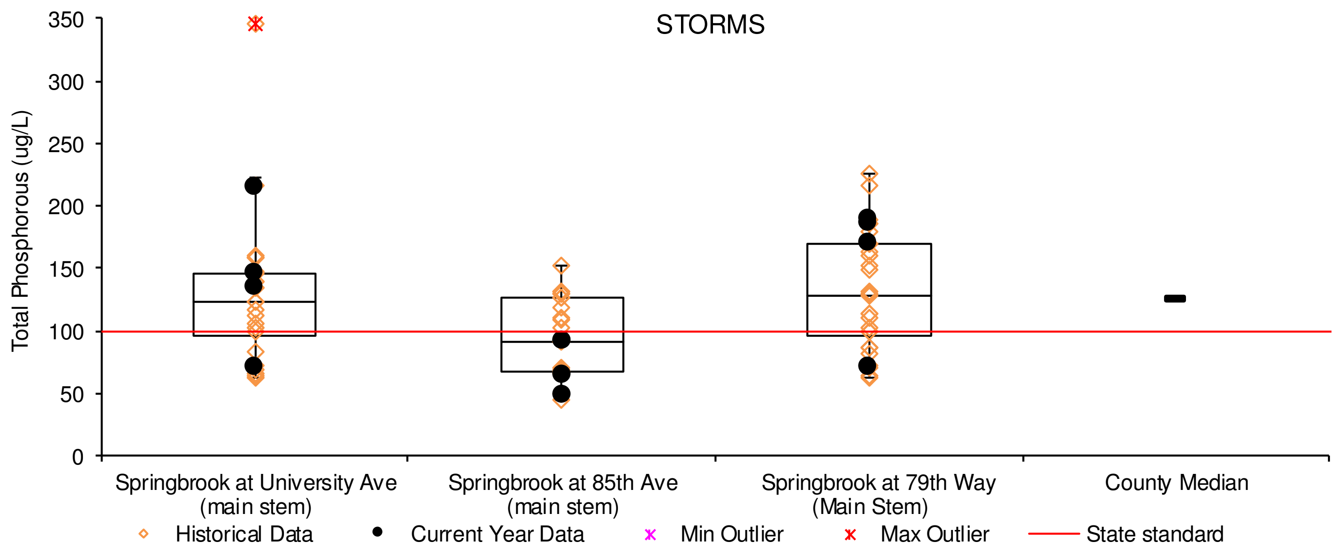
During storms, however, there was no decrease in total phosphorus concentrations moving upstream to downstream. Generally, it appears that the nature center wetlands and other practices are undersized or overwhelmed by the volume of water or pollutants produced by the watershed. Adding additional treatment capacity is advised, but the limited available space can make this a challenge. Understanding whether the increase in TP flushed through this complex during storms is predominantly dissolved or particulate phosphorus would better inform a potential retrofit to the system. Following storm events, phosphorus concentrations at the site near 79th Way exceed state standards 68% of the time.

Average and median total phosphorus in Springbrook Creek. Data is from 79th Way for all years through 2018.

	Average Total Phosphorus (µg/L)	Median Total Phosphorus (µg/L)	State Standard	N
Baseflow	74.1	75.0	100	28
Storms	131.9	128.5		28
All	102.6	82.5		56
Occasions > state standard				4 (14%) Baseflow 19 (68%) storm

Total phosphorus at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2018 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 and Turbidity

Total suspended solids (TSS) and turbidity both measure solid particles in the water. TSS measures these particles by weighing materials filtered out of the water. Turbidity is measured by the diffraction of a beam of light sent though the water sample and is most sensitive to large particles. Suspended solids are important because they carry other pollutants, affect water appearance and clarity, and can harm stream biota.

TSS and turbidity in Springbrook Creek were both low during baseflow and higher during storms. TSS concentrations are low during baseflow conditions at all sites, and remain low following storm events at the two upstream sites. Interestingly, there is a large increase in storm flow TSS concentrations between 85th Ave. and 79th Way. The area between the two contains the wetland complex of Springbrook Nature Center. These wetlands are potentially getting filled in with sediment that is then flushed through during storm events. TSS concentrations at 79th way exceed the 30 mg/L state standard 25% of the time following storm events.

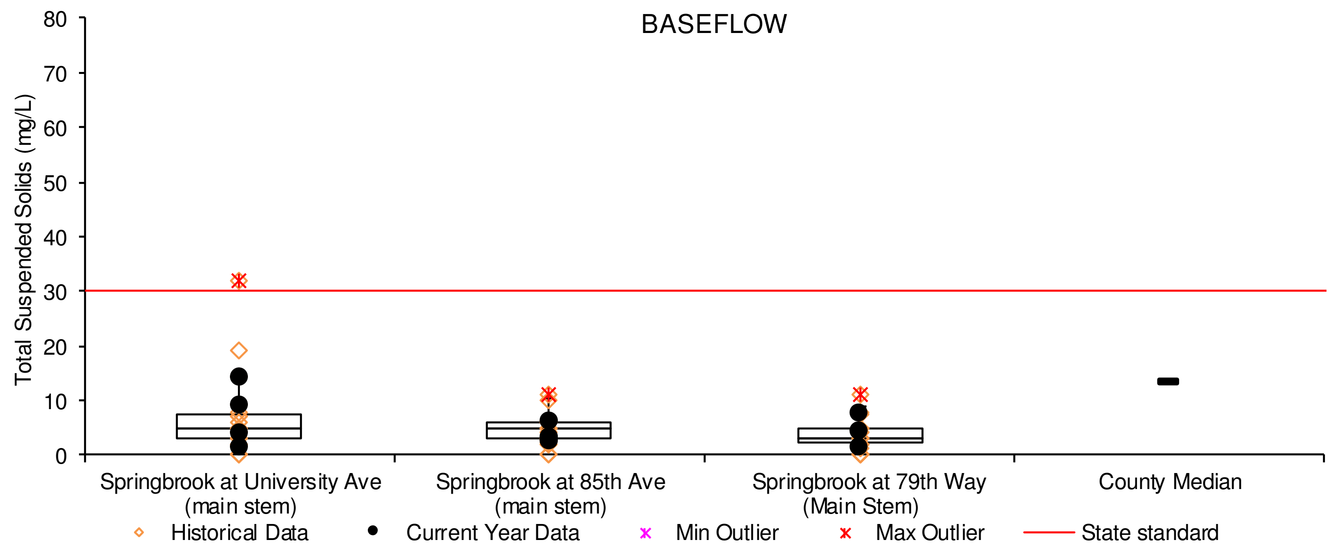
Based on long-term median concentrations, TSS does not increase moving upstream to downstream during baseflow conditions but does during storm flows. The long-term (all years) median TSS concentrations moving upstream to downstream were 3, 9, and 16 mg/L, respectively. The similarity of TSS among sites during baseflow suggests that internal loading of the system through bank erosion and bed suspension is minimal. The largest likely contributor of TSS in Springbrook Creek is solids transported by stormwater conveyances from impervious surfaces.

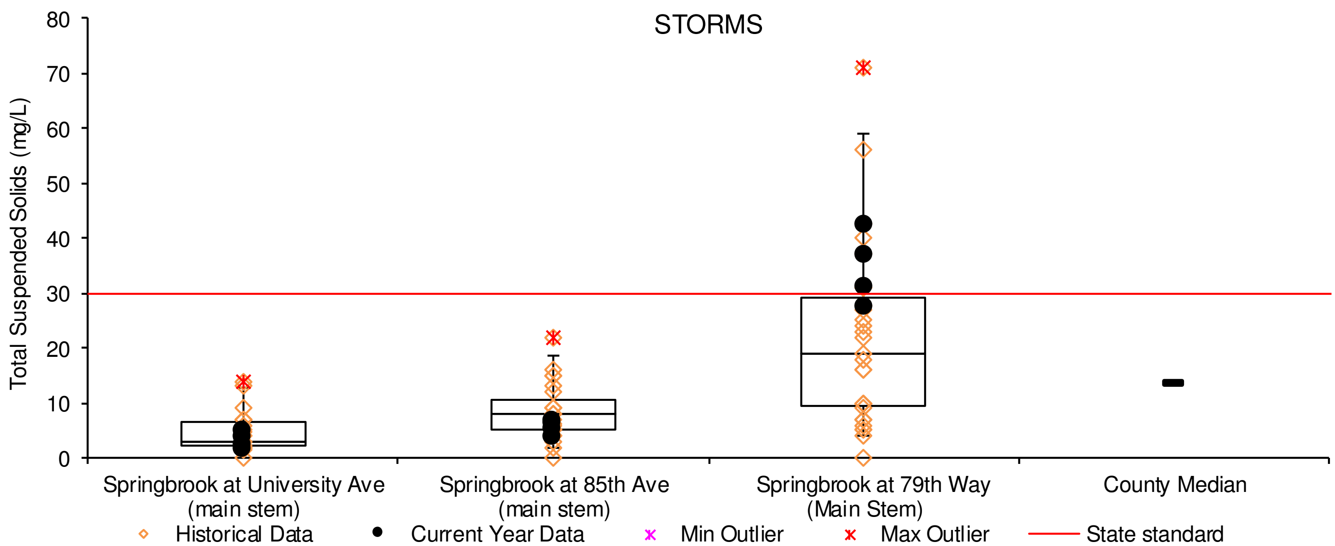
During baseflow conditions, turbidity is similarly low, only exceeding 5 NTU twice at 79th Way since 2012. Turbidity does, however, increase during storm flows and follows the same trend of increasing downstream. The long-term median storm flow turbidity at each site is 5.5, 9.8, and 14 NTU respectively from upstream to downstream. This indicates the same pollutant loading of downstream stormwater as TSS indicates.

Average and median total suspended solids in Springbrook Creek. Data is from 79th Way for all years through 2018.

	Average Total Suspended Solids (mg/L)	Median Total Suspended Solids (mg/L)	State Standard	N
Baseflow	3.5	3	30 mg/L TSS	28
Storms	21.4	18.5		28
All	12.5	5		56
Occasions > state TSS standard				0 baseflow 7 (25%) storm

Total suspended solids at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

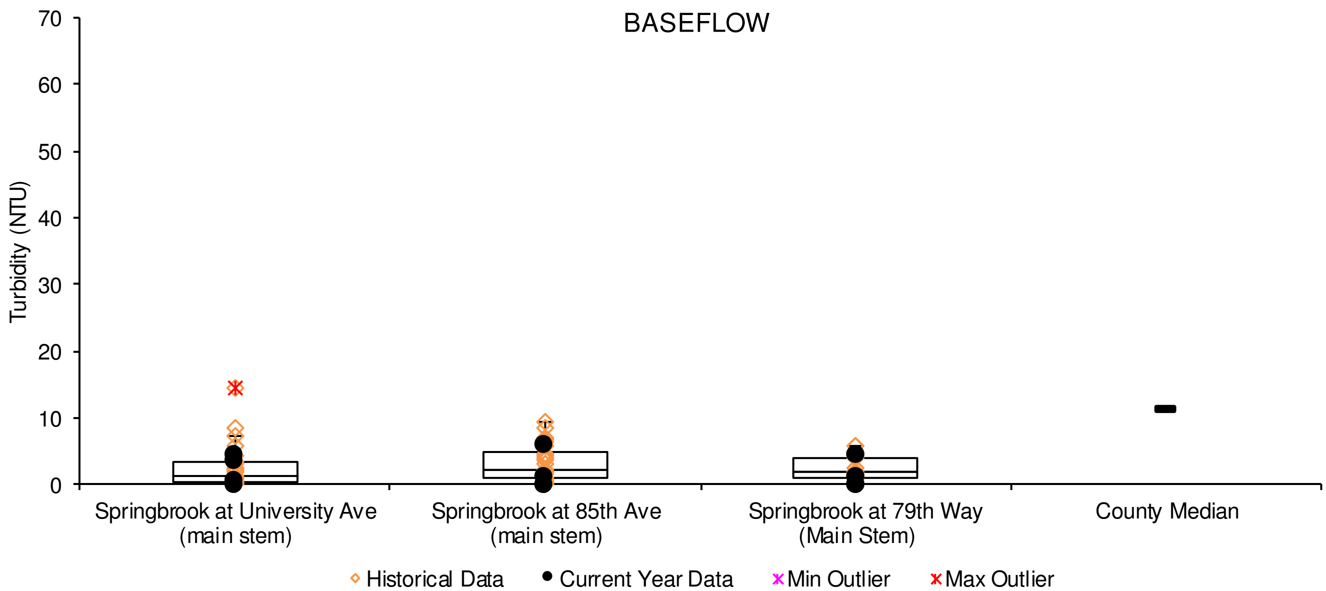


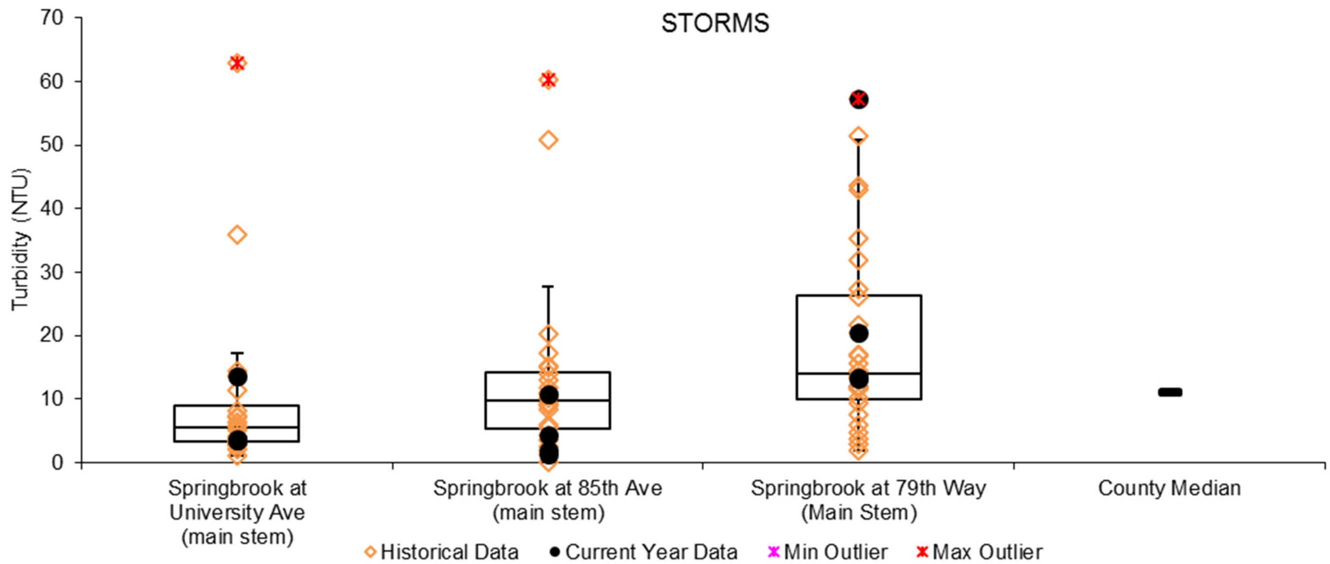


Average and median turbidity in Springbrook Creek. Data is from 79th Way for all years through 2018.

	Average Turbidity (NTU)	Median Turbidity (NTU)	State Standard	N
Baseflow	2.2	1.8	n/a	28
Storms	19.4	14.0		28
All	10.8	4.7		56

Turbidity at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





pH

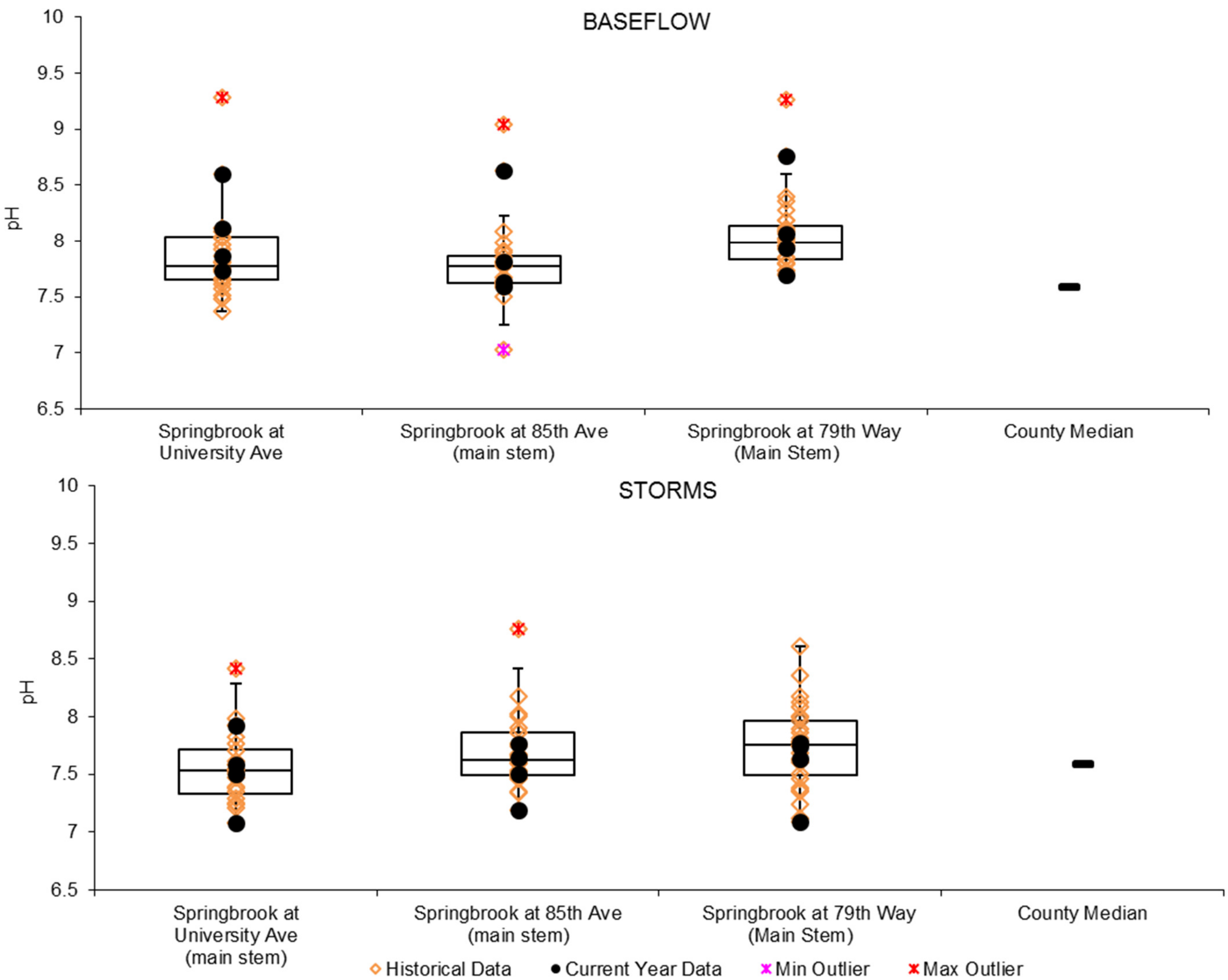
Springbrook Creek generally maintains healthy pH levels within the state water quality standard range of 6.5-8.5. Two exceedances of the acceptable range have occurred, but neither is a management concern. One of those exceedances was in September 2014 and likely attributable to a bad sensor calibration given that all sites monitored that day with the same instrument were far above their normal range.

Average and median pH in Springbrook Creek. Data is from 79th Way for all years through 2018.

	Average pH	Median pH	State Standard	N
Baseflow	8.05	7.99	6.5-8.5	28
Storms	7.74	7.76		28
All	7.90	7.88		56
Occasions outside state standard				2*

**one result questionable*

pH at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



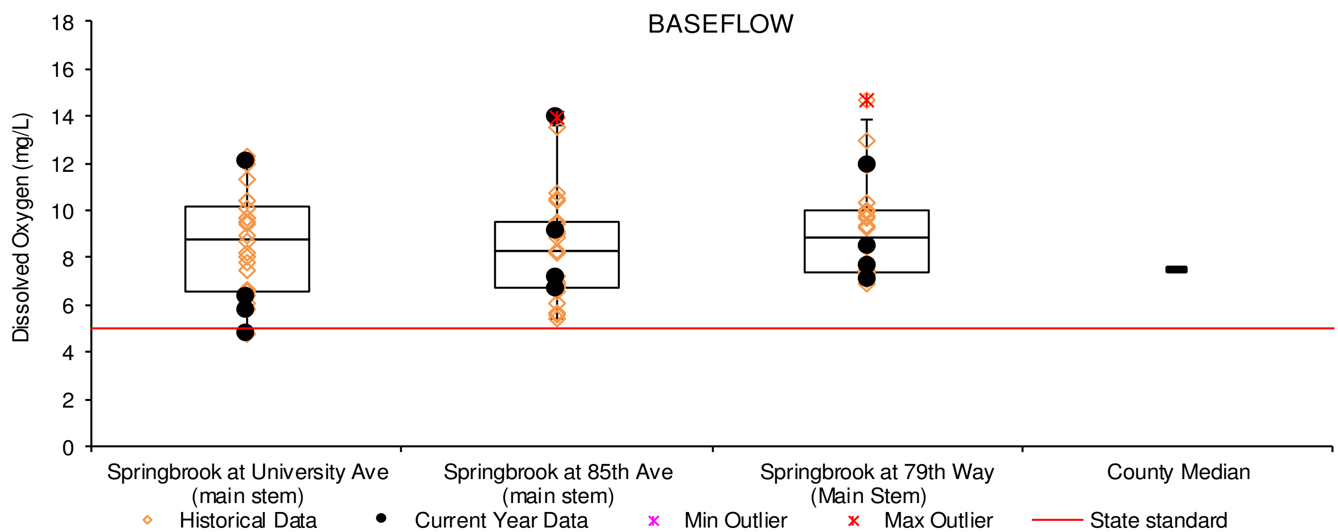
Dissolved Oxygen

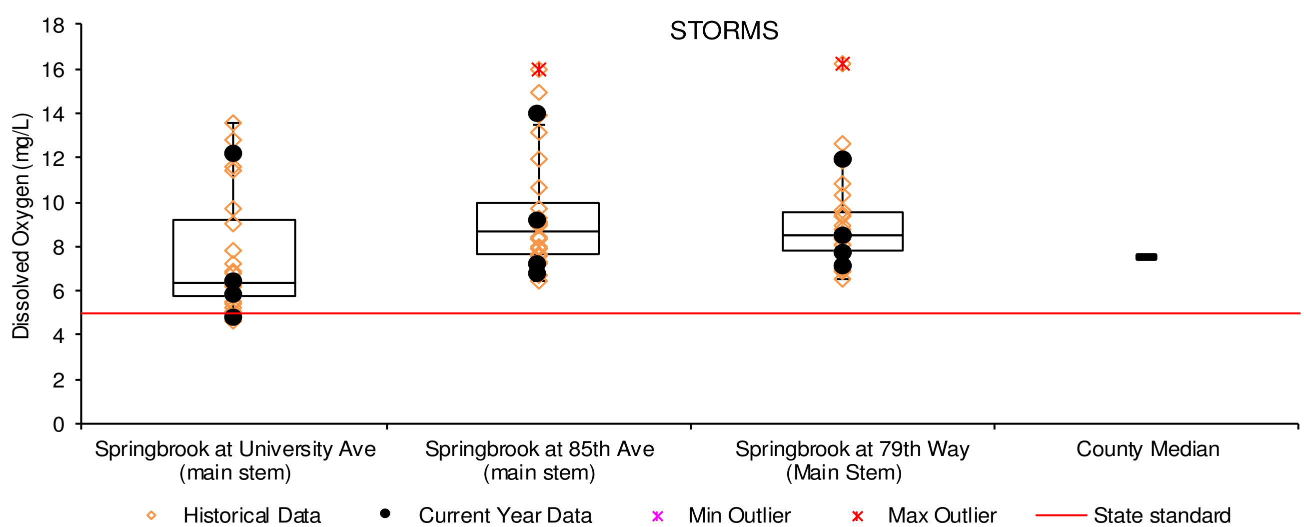
Dissolved oxygen (DO) is essential for aquatic life. Fish, invertebrates, and other aquatic life suffer if DO falls below the state standard of 5 mg/L. Low DO can be the result of organic pollution, the decomposition of which consumes oxygen. DO concentrations in Springbrook Creek are generally high and in a healthy range. There have been a few instances since 2012 at the furthest upstream site (University Ave.) that have been below or near the standard, but DO is not a concern in general in Springbrook Creek.

Median dissolved oxygen in Springbrook Creek. Data is from 79th Way for all years through 2018.

	Average Dissolved Oxygen (mg/L)	Median Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	9.04	8.90	5 mg/L daily minimum	26
Storms	9.04	8.50		28
All	9.04	8.54		54
Occasions <5 mg/L				0

Dissolved Oxygen at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





E. coli

E. coli is bacteria found in the feces of warm-blooded animals. *E. coli* is an easily measureable indicator of all pathogens that are associated with fecal contamination. The Minnesota Pollution Control Agency sets *E. coli* standards for contact recreation (swimming, etc.). A stream is designated as "impaired" if 10% of measurements in a calendar month are >1260 most probable number (MPN) of colony forming units per 100 milliliters of water, or if the geometric mean of five samples taken within 30 days is greater than 126 MPN.

Sampling by the MPCA has found Springbrook Creek is exceeding State standards for *E. coli* bacteria. Data collected by local agencies to date are not sufficient to re-calculate if the MPCA standards are met or exceeded. We took samples throughout the summer, often with only 1-2 samples each month, too little for calculation of a monthly geometric mean or to reasonably say that 10% of samples in a month were in exceedance. But other examinations of the data presented below verify that *E. coli* abundance is high.

E. coli levels during baseflow are generally near the chronic standard of 126 MPN in all sites, but in 72 baseflow samples taken at all sites since 2013, *E. coli* has only exceeded the acute standard of 1260 MPN once (September, 2018 at University Ave.). Over half of the samples taken at 79th Way during baseflow conditions have exceeded 126 MPN.

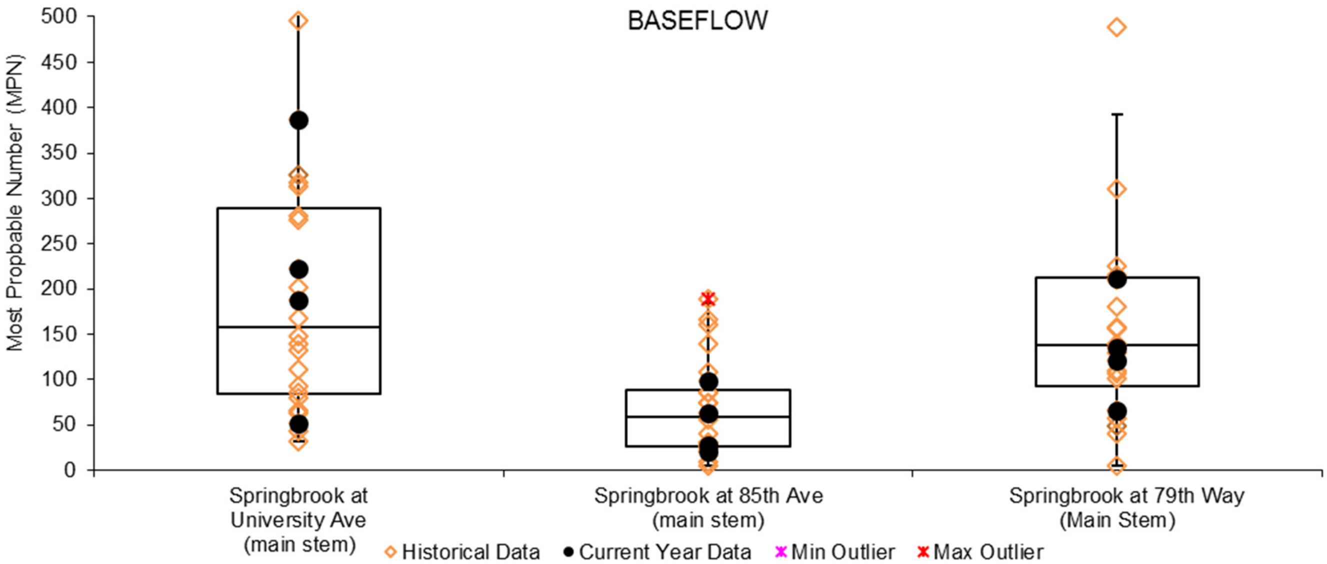
Interestingly, during baseflow conditions the median *E. coli* concentrations since 2013 decrease between University Ave. (157.5 MPN) and 85 Ave. (59.5). It seems that the ponds and wetlands between University Avenue and 85th Avenue sites are providing some level of baseflow treatment. Levels tend to rebound again between 85th Avenue and 79th Way, however.

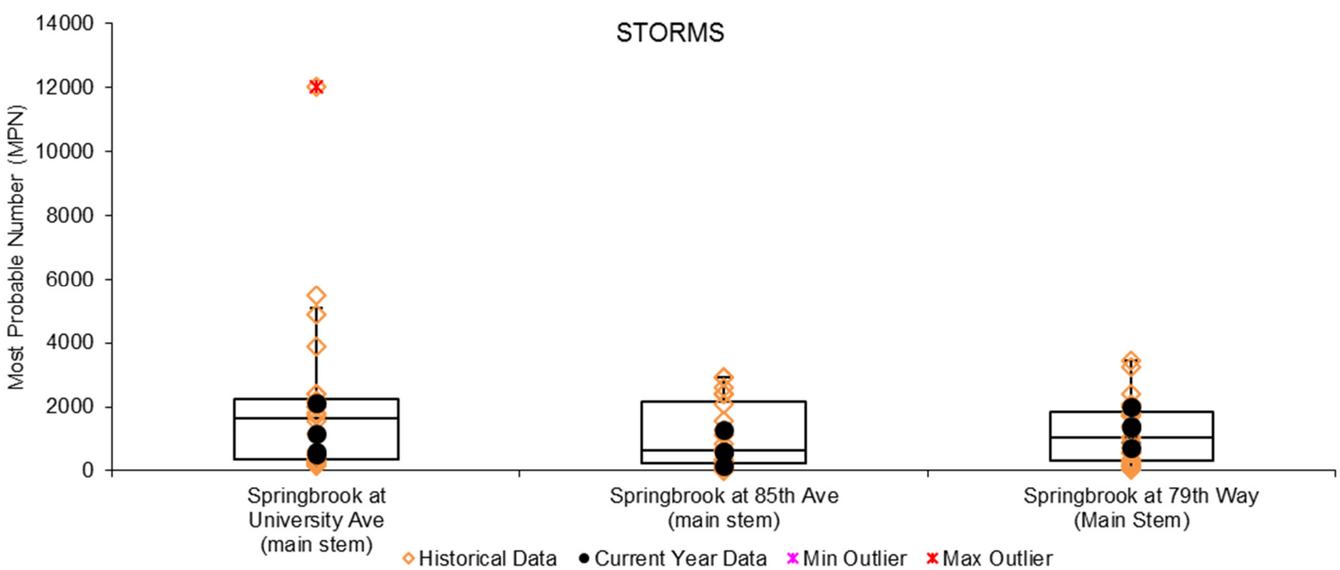
During storms *E. coli* tends to be significantly higher (note the difference in scale on the charts below), but the same pattern remains with the middle site (85th Ave.) having much lower levels than University Ave. upstream. Median *E. coli* concentrations following storms for all years from upstream to downstream are 1638, 659, and 1,046 MPN, respectively. These levels are all quite high, and 92% of storm samples collected at 79th Way have exceeded 126 MPN/100ml. Almost half of the samples collected at 79th way during storms have exceeded the acute standard of 1260 MPN.

Average and median *E. coli* in Springbrook Creek. Data is from 79th Way for all years through 2018

	Average *E. coli* (MPN)	**Median *E. coli* (MPN)**	**State Standard**	**N**
Baseflow	187.4	137.5	Monthly Geometric Mean >126 Monthly 10% average >1260	24
Storms	1,225.5	1,046.0		24
All	706.4	225.5		48
Occasions >126 MPN **Occasions >1260 MPN**				14 (58%) baseflow, 22 (92%) storm 0 baseflow, 11 (46%) storm

***E. coli* at Springbrook.** Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



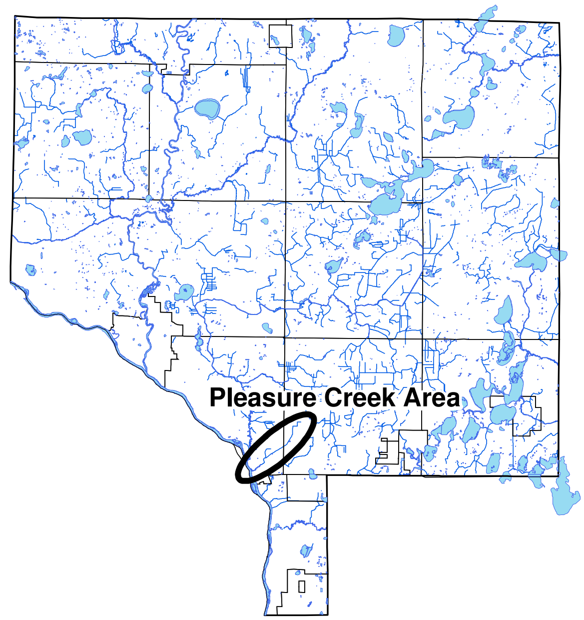


PLEASURE CREEK

Pleasure Cr at Pleasure Cr Parkway, N side of loop	STORET SiteID = S005-636
Pleasure Cr at 99th Ave	STORET SiteID = S005-637
Pleasure Cr at 96th Lane	STORET SiteID = S005-263
Pleasure Creek at 86th Avenue, Coon Rapids	STORET SiteID = S003-995

Years Monitored

Pleasure Cr at Pleasure Cr Parkway	2009
Pleasure Cr at 99th Ave	2009
Pleasure Cr at 96th Lane	2008, **2018**
Pleasure Cr at 86th Ave	2006, 2007, 2012-**2018** And 1-2 measurements per year in 2002, 2003, 2004, 2005, 2008



Background

Pleasure Creek flows through the southwestern portion of Blaine and southern Coon Rapids. The watershed is urbanized. The creek is about 8-10 ft. wide and 0.5 to 1 foot deep near the outlet to the Mississippi River during baseflow. It flows through an interconnected network of stormwater ponds in the upper part of the watershed.

Monitoring near the creek's outlet to the Mississippi River in 2006-2007 found high levels of dissolved pollutants and *E. coli*. In 2008, monitoring was moved upstream to begin determining the sources of pollutants, and particularly *E. coli*. In 2009, monitoring moved even farther upstream to further diagnose pollutant sources. In 2012 monitoring was moved back to the lower portions of the watershed to continue overall water quality assessment near the outfall.

Pleasure Creek is listed as an impaired water by the MN Pollution Control Agency for invertebrate biota and *E. coli* bacteria. New Tiered Aquatic Life Use (TALU) standards currently under development may take into consideration the fact that the creek is a public ditch and therefore has lower aquatic life expectations, at least in some reaches.

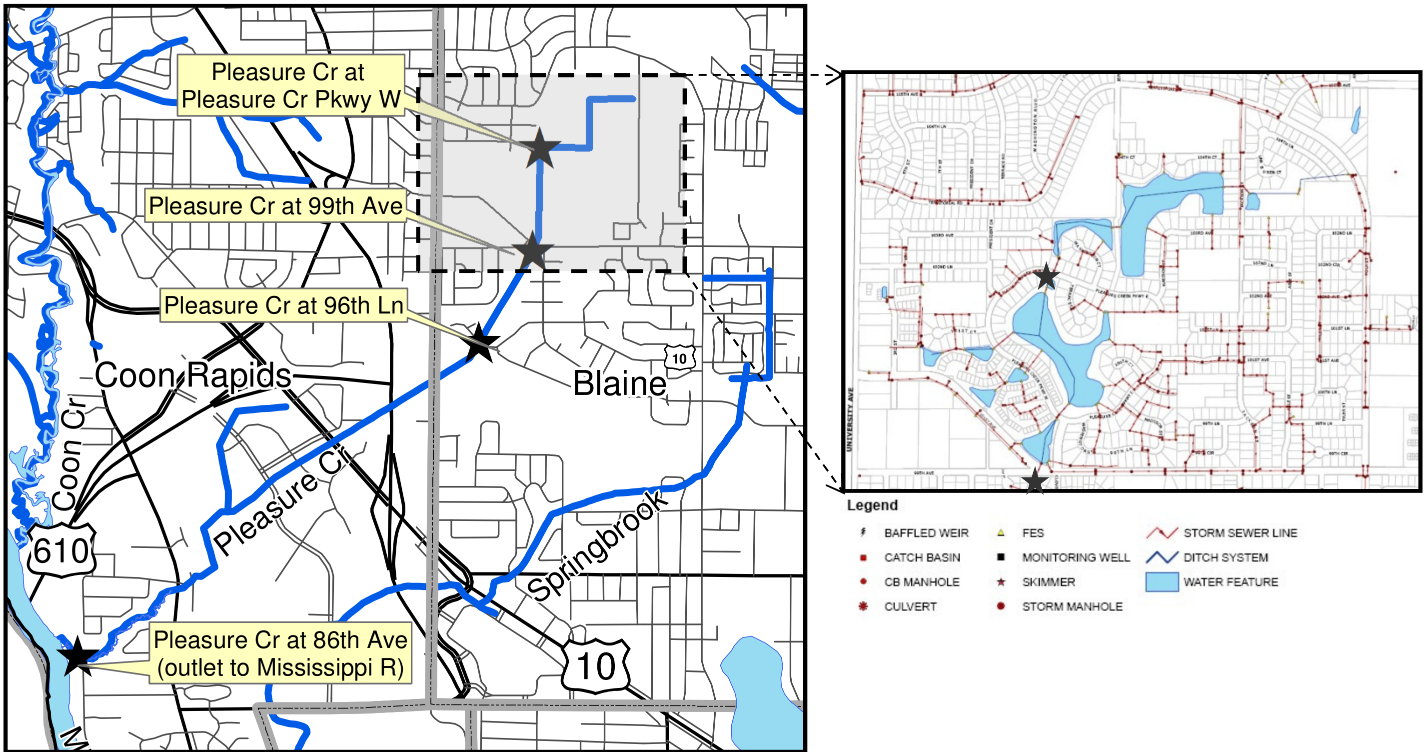
Methods

Pleasure Creek was monitored during both storm and baseflow conditions by grab samples. Eight water quality samples were collected each year; half during baseflow and half following storms. Storms were generally defined as one-in. or more of rainfall in 24 hours or a significant snowmelt event combined with rainfall. In some years, particularly during drought, smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events.

Eleven water quality parameters were tested. Parameters tested with portable meters included pH, specific conductance, turbidity, temperature, salinity, and dissolved oxygen. Beginning in 2009, transparency tube measurements were added and are reported to MPCA. Parameters tested by water samples sent to a state-certified lab included total phosphorus, total suspended solids, chlorides, hardness, and sulfate. Hardness and sulfate were monitored only in 2012. Chlorides have not been monitored since 2012.

During every sampling event, the water level (stage) was recorded using a staff gauge surveyed to sea level elevations. Stage was also continuously recorded using an electronic data logging device at the 86th Avenue stream crossing (farthest downstream).

Pleasure Creek Monitoring Sites



Results and Discussion

Pleasure Creek has some prominent water quality concerns. Pleasure Creek is currently listed as impaired by the State for poor invertebrate biota and high *E. coli*. A TMDL exists for these impairments.

The following is a parameter-by-parameter summary of water quality including management discussions:

- Dissolved pollutants, as measured by specific conductance and chlorides, are high in Pleasure Creek, and much higher than other Anoka County monitored streams. The highest specific conductance has been observed in recent years, both at Pleasure Creek and other streams, indicating a regional problem that is worsening and most severe at Pleasure Creek.

  Management discussion: Dissolved pollutants enter the stream both directly through surface runoff and also by infiltrating into the shallow groundwater that feeds the stream during baseflow. A variety of sources appear to be likely, including road deicing salts and road runoff. Preventing their release into the environment is important because they are not easily removed.

- Phosphorus is generally low in Pleasure Creek during baseflow and slightly higher during storms. Due to the higher readings during storms, Pleasure Creek sometimes exceeds the State standard of 100 µg/L. Long term median levels remain lower in Pleasure Creek than other Anoka County streams.

  Management discussion: Additional treatment within the stormwater conveyance system would help but is probably a lower priority than other area streams where phosphorus is higher.

- Suspended solids and turbidity were both low during baseflow and higher during storm events. Storm samples exceed state TSS standards 40% of the time at the 86th Ave. monitoring location. The most robust existing stormwater treatment is upstream of East River Road. Any new treatment might target the neighborhoods downstream of that point.

Management discussion: Additional treatment within the stormwater conveyance system, particularly downstream of East River Road, would help but is probably a lower priority than other area streams where these pollutants are higher.

- pH is higher in Pleasure Creek than most other streams in the area. An exceedance of the state standard upper range of pH 8.5 occurred in 2018, the first such exceedance since 2014. Average baseflow conditions for pH in the Pleasure Creek are above pH 8, with rain decreasing the pH slightly during storm events. Only eight exceedances have occurred since 2002, but it is something that should continue to be monitored for in this stream.
- Dissolved oxygen is generally above 5 mg/L in Pleasure Creek and does not appear to be an issue.
- *E. coli* bacteria are high, and problematic throughout Pleasure Creek, especially during storm events. Investigative monitoring has been done, and a TMDL has been approved. Stormwater runoff and stormwater ponds themselves are likely sources of the bacteria, but identifying sources can be very difficult.

  Management discussion: Because *E. coli* is pervasive in the urban environment, urban neighborhoods will have difficulty reducing *E. coli* levels below state water quality standards. Addressing *E. coli* should be part of an effort to improve overall water quality.

Specific conductance and Chlorides

Specific conductance and chlorides are measures of a broad range of dissolved pollutants. Dissolved pollutant sources include urban road runoff, industrial sources, agricultural chemicals, and others. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Specific conductance is the broadest measure of dissolved pollutants we use. It measures electrical specific conductance of the water; pure water with no dissolved constituents has zero specific conductance. Chlorides tests measure for 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; however, it is also noteworthy that Pleasure Creek discharges into the Mississippi River just upstream from drinking water intakes for the Twin Cities.

Specific conductance and chlorides in Pleasure Creek are high. Median baseflow specific conductance for all years at the 86th Ave. site is 1.114 mS/cm. By comparison, the median for all streams in Anoka County is 0.362 mS/cm. The median specific conductance for storm flow samples in Pleasure Creek is even higher at 1.149 mS/cm at 86th Ave.

Chlorides are a common dissolved pollutant, most often associated with road deicing salts. Chlorides have not been monitored since 2012, but those results are still informative. Chlorides increased at the downstream site even more dramatically than specific conductance. Median chlorides (all years) at the three upstream sites were 70, 71, and 67 mg/L (upstream to downstream). At the downstream site (86th Ave.) median chloride concentrations were 159 mg/L, more than double. The median for all streams in Anoka County is 13.3 mg/L. The State water quality standards for chlorides are 230 mg/L (chronic) and 860 mg/L (acute). While Pleasure Creek has only been observed to exceed the chronic standard once (262 mg/L), no monitoring occurred during snowmelt when chlorides are potentially the highest.

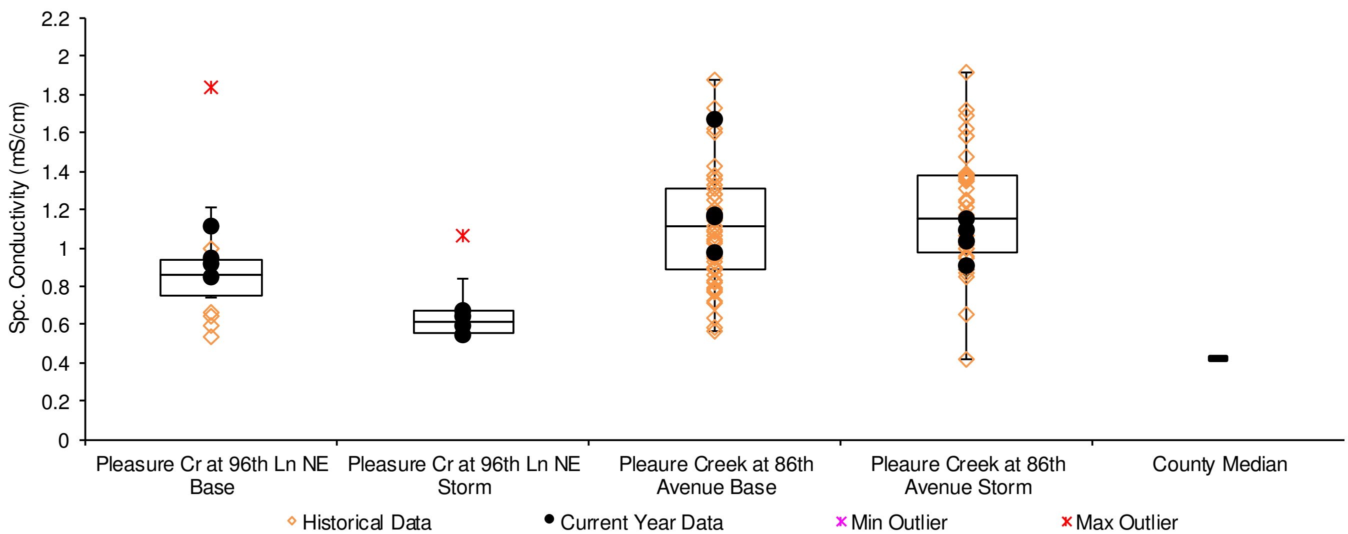
Both specific conductance and chlorides are slightly higher during storms than baseflow conditions. This is the opposite of most other area streams. At those other streams road deicing salt infiltration to the shallow water table that feeds stream base flows is an often-suspected source. This same problem may be occurring at Pleasure Creek, as evidenced by high baseflow specific conductance. However, storm runoff directly to the stream has even higher dissolved pollutants, indicating that there is likely a large amount of dissolved pollutants on the landscape as well as contaminating the shallow ground water.

Dissolved pollutants are especially difficult to manage once in the environment. They are not readily removed by stormwater settling ponds. Infiltration practices can provide some treatment through biological processes in the soil, but also risk contaminating groundwater. The first approach to dissolved pollutant management must be to minimize their release into the environment.

Average and median specific conductance and chlorides in Pleasure Creek at 86th Ave. for specific conductance all years through 2018, for chlorides all years through 2012.

	Average specific conductance (mS/cm)	Median specific conductance (mS/cm)	Median Chlorides (mg/L)	State Standard	N
Baseflow	1.118	1.114	146.5	Specific conductance – none Chlorides 860 mg/L acute, 230 mg/L chronic	45
Storms	1.185	1.149	178		39
All	1.149	1.147	158.5		84

Specific conductance at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



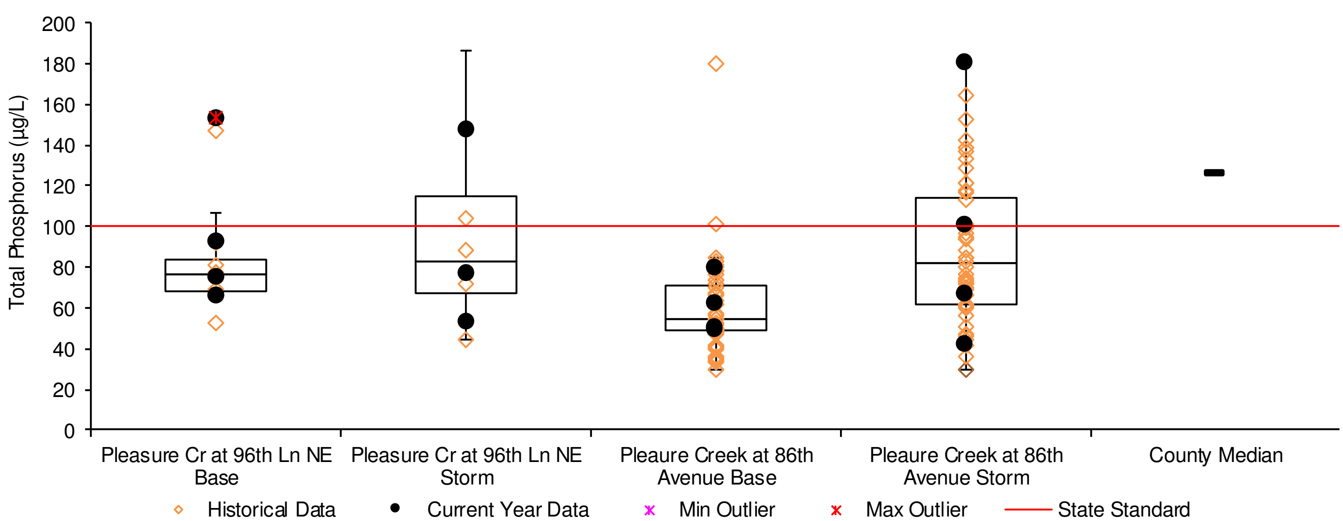
Total Phosphorus

Total phosphorus (TP) is a common nutrient pollutant and is the limiting factor for most algae growth. TP is generally low in Pleasure Creek during baseflow and slightly higher during storms. In all conditions, TP is lower than other streams in Anoka County with a composite median of 69.5 µg/L compared to the overall countywide median of 126 µg/L. Pleasure Creek has exceeded the state standard phosphorus concentration of 100 µg/L during 31% of storm samples, but never at baseflow conditions. Two of the four storm samples collected in 2018 exceeded 100 µg/L.

Median TP in Pleasure Creek. Data is from the 86th Avenue site and all years through 2018.

	Average Total Phosphorus (µg/L)	Median Total Phosphorus (µg/L)	State Standard	N
Baseflow	57.6	54.0	100	40
Storms	87.9	81.5		48
All	74.8	68.0		88
Occasions > state standard				0 baseflow 15 (31%) storms

Total phosphorus at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2018 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 and Turbidity

Total suspended solids (TSS) and turbidity both measure particles in the water. TSS measures these particles by weighing materials filtered out of the water. Turbidity is measured by the diffraction of a beam of light sent though the water sample and is most sensitive to large particles. Suspended solids are important because they carry other pollutants, affect water appearance and clarity, and can harm stream biota.

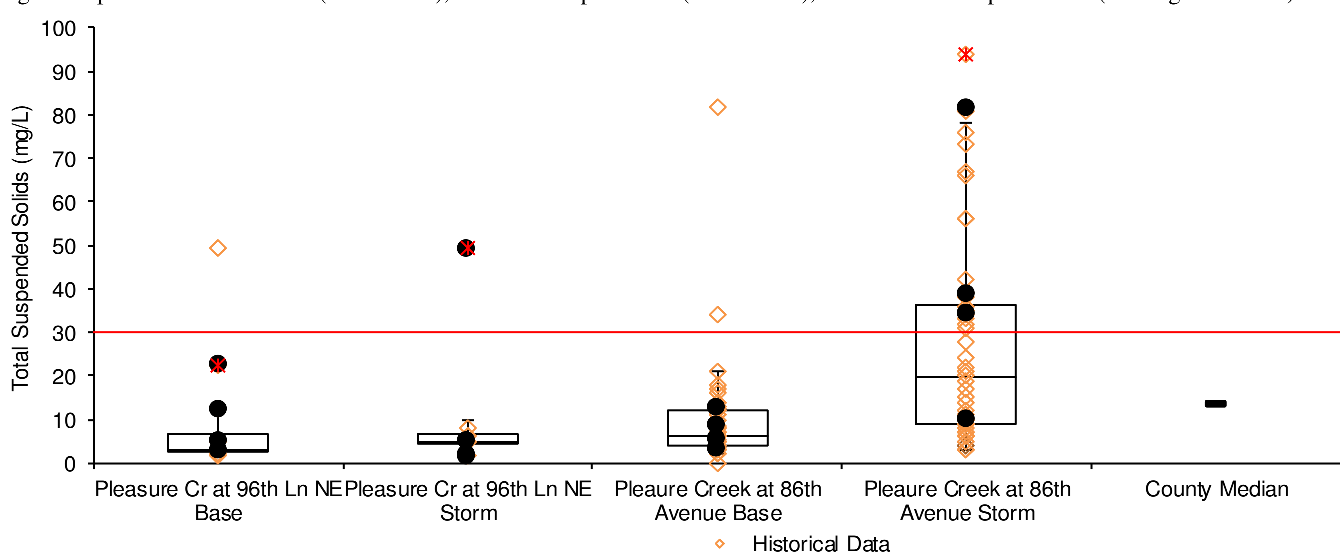
TSS and turbidity are both generally low during baseflow conditions and higher during storm events. The MN Pollution Control Agency State standard for TSS is 30mg/L in this region. Near the outfall to the Mississippi River, Pleasure Creek exceeds this standard 40% of the time following storms, but rarely approaches it during baseflow conditions. Storm results vary widely, as storm conditions are highly variable. Three of four storm samples in 2018 exceeded the state standard.

The low baseflow turbidity and TSS potentially reflect the effectiveness of large stormwater ponds just upstream of East River Road. Increases in both parameters during some storms, particularly larger storms, is not unexpected for any stream. Additional stormwater treatment near, and downstream of, East River Road would likely be most helpful at improving water quality in Pleasure Creek because treatment upstream of that location is already more robust.

Average and median total suspended solids in Pleasure Creek. Data is from the 86th Avenue site and all years through 2018.

	Average Total Suspended Solids (mg/L)	Median Total Suspended Solids (mg/L)	State Standard	N
Baseflow	8.0	6.0	30 mg/L TSS	40
Storms	27.7	19.5		48
All	18.6	10.0		87
Occasions > state TSS standard				0 baseflow 19 (40%) storm

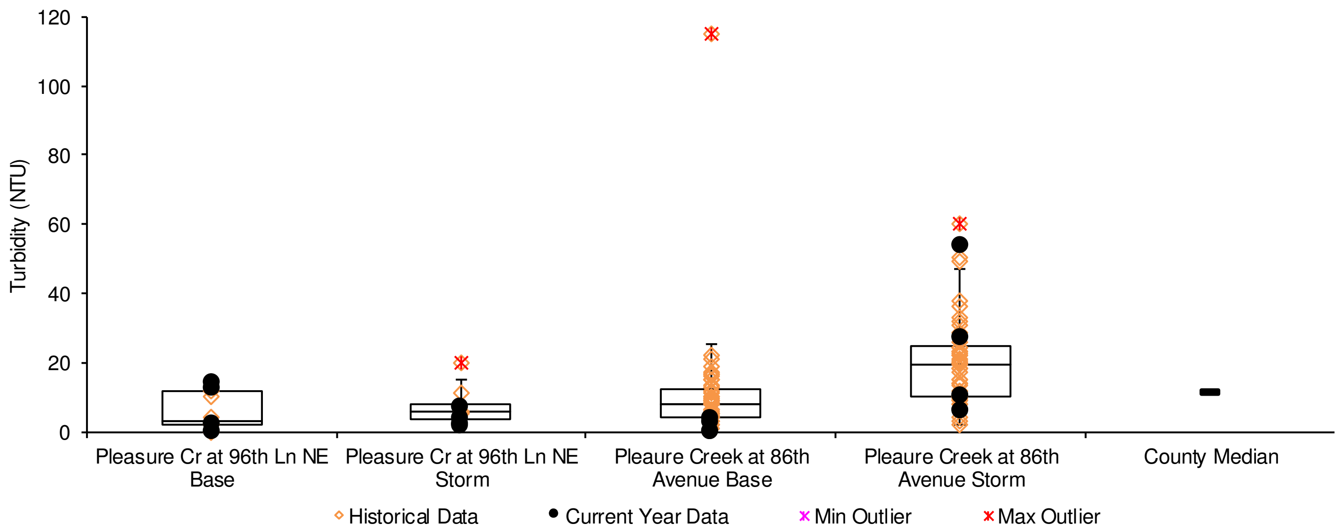
Total suspended solids at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Average and median turbidity in Pleasure Creek. Data is from the 86th Avenue site and all years through 2018.

	Average Turbidity (NTU)	Median Turbidity (NTU)	State Standard	N
Baseflow	10.5	7.7	n/a	51
Storms	20.4	19.2		51
All	16.4	13.8		102
Occasions > state TSS standard				

Turbidity at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



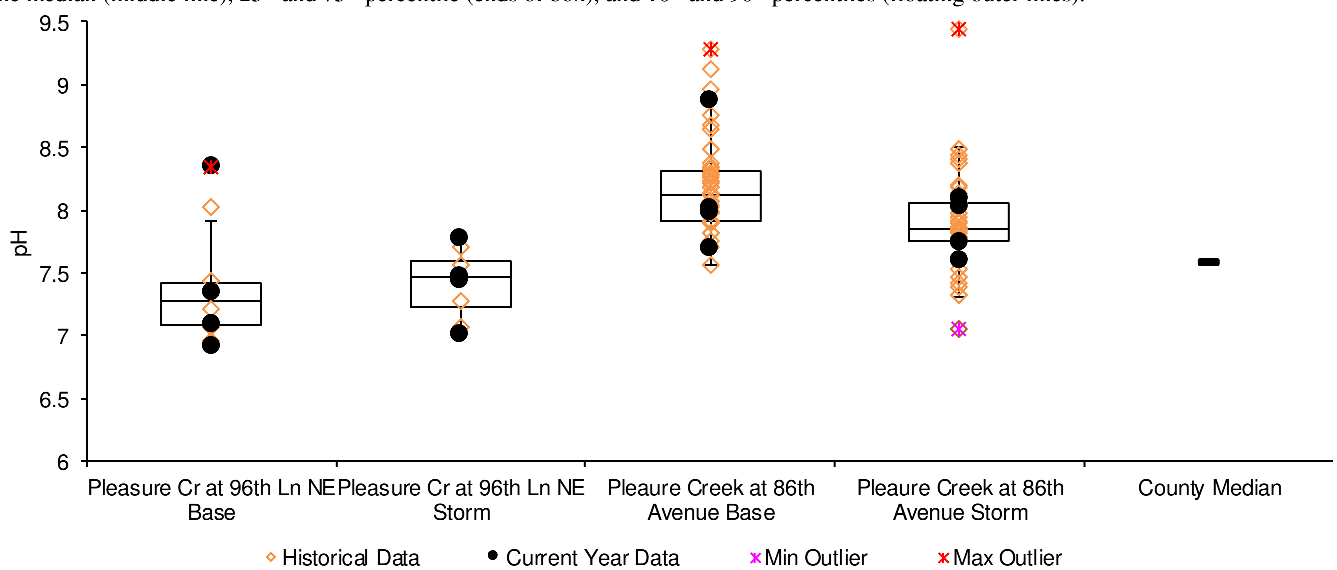
pH

Pleasure Creek pH has generally remained within the state water quality standard of 6.5-8.5, but median and average values are at the higher end of that range and higher than the long-term median for all Anoka County streams. In May of 2018, a baseflow sample of 8.87 was the first recorded exceedance of the state standard at 86th Avenue since 2014. Eight exceedances of pH 8.5 have occurred in 101 samples collected since 2002. Seven of these eight exceedances have occurred during baseflow conditions. This is not surprising given that rain is typically slightly acidic. Interestingly, pH decreased throughout the year in 2018 at both sites under both baseflow and post-storm conditions. This decrease throughout the season has not been a trend at this site in past monitoring years, but is worth noting.

Average and Median pH in Pleasure Creek. Data is from the 86th Avenue site and all years through 2016.

	Average pH	Median pH	State Standard	N
Baseflow	8.17	8.12	6.5-8.5	52
Storms	7.92	7.85		49
All	8.08	8.05		101
Occasions outside state standard				7

pH at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



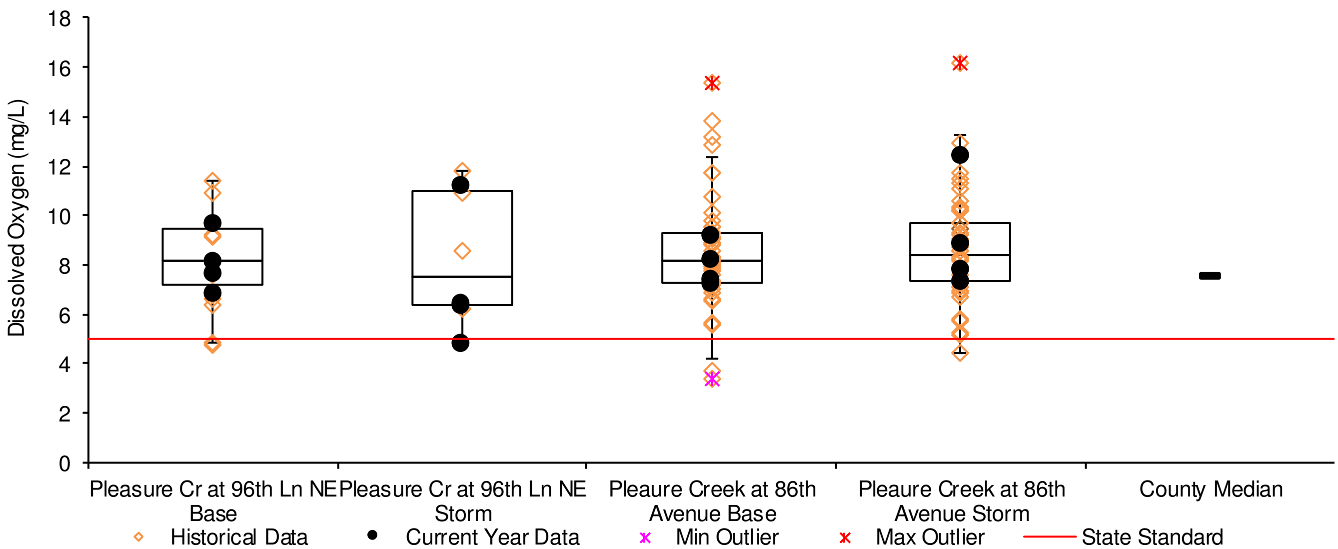
Dissolved Oxygen

Dissolved oxygen (DO) is essential for aquatic life. Fish, invertebrates, and other aquatic life suffers if DO falls below 5 mg/L. Low DO can be a result of organic pollution, the decomposition of which consumes oxygen. Dissolved oxygen in Pleasure Creek is generally high and within the acceptable range. No instances of DO <5mg/L have been measured at 86th Avenue since 2009. One storm event sample at the further upstream site (96th Lane) in 2018 did have just under 5 mg/L DO. Overall, there does not appear to be an issue with this parameter in Pleasure Creek.

Average and Median dissolved oxygen in Pleasure Creek. Data is from the 86th Avenue site and all years through 2018.

	Average Dissolved Oxygen (mg/L)	Median Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	8.54	8.19	5 mg/L daily minimum	47
Storms	8.66	8.44		50
All	8.62	8.31		97
Occasions <5 mg/L				4

Dissolved Oxygen at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



***E. coli* Bacteria**

E. coli is bacteria found in the feces of warm-blooded animals. *E. coli* is an easily measureable indicator of all pathogens that are associated with fecal contamination. The Minnesota Pollution Control Agency sets *E. coli* standards for contact recreation (swimming, etc.). A stream is designated as "impaired" if 10% of measurements in a calendar month are >1260 most probable number (MPN) of colony forming units per 100 milliliters of water, or if the geometric mean of five samples taken within 30 days is greater than 126 MPN.

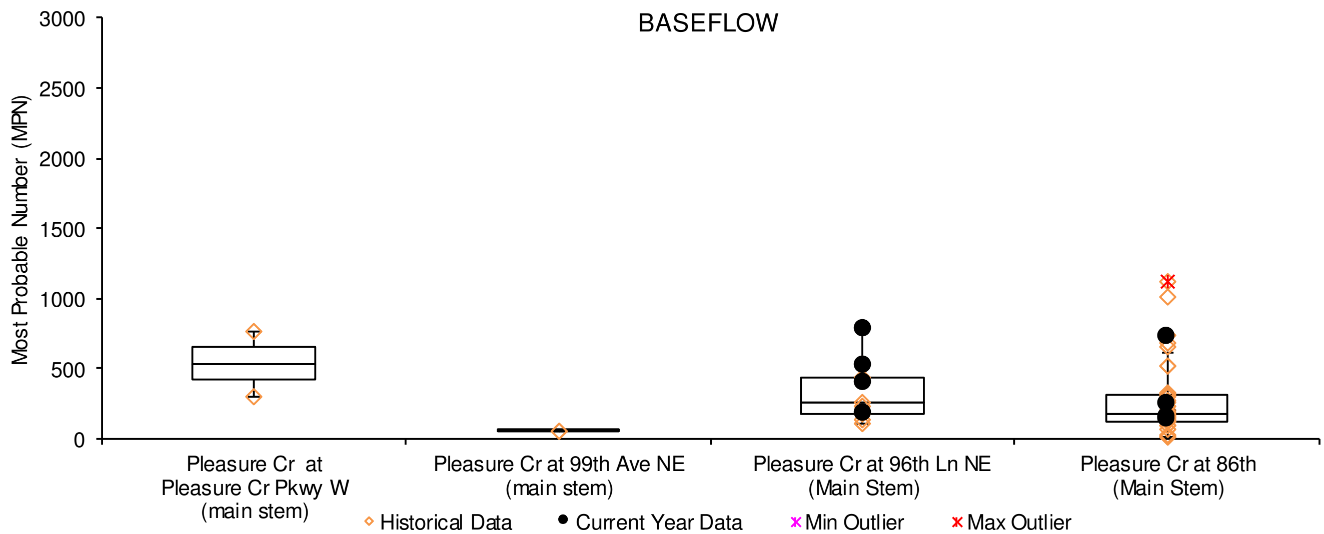
Pleasure Creek exceeded both criteria during extensive monitoring about a decade ago. The creek is listed as impaired for excessive *E. coli* by the State, and a TMDL has been approved. High *E. coli* persists today, so people should be wary about contact and inadvertent consumption of Pleasure Creek water. Studies around the year 2010 concluded likely bacteria sources include storm water ponds and storm water runoff from sources throughout the watershed.

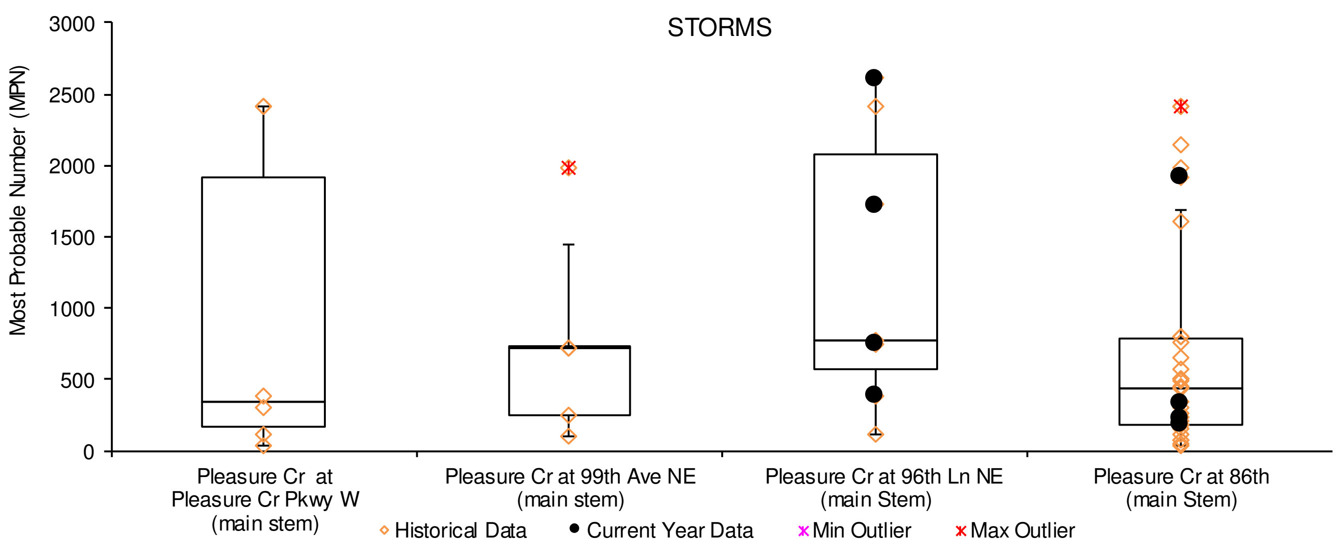
While current sampling frequency does not allow calculations based on state standards, *E. coli* measurements collected in 2018 are still informative. Every sample collected at both sites sampled, during both baseflow and post-storm even, exceeded the chronic standard of 126 MPN. It appears that Pleasure Creek usually harbors more *E. coli* than the chronic standard allows for. Storm samples at the further upstream site (96th Lane) had higher *E. coli* levels than storm samples collected downstream at 86th Ave. Baseflow results were similar for both sites.

Average and median *E. coli* in Pleasure Creek. Data is from the 86th Avenue site only, all data through 2018.

	Average *E. coli* (MPN)	Median *E. coli* (MPN)	State Standard	N
Baseflow	300	184	Monthly Geometric Mean >126	30
Storms	698	444		30
All	499	260	Monthly 10% average >1260	60
Occasions >126 MPN **Occasions >1260 MPN**				22 (73%) baseflow, 25 (83%) storm 0 baseflow, 6 (20%) storm

***E. coli* at Pleasure Creek.** Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





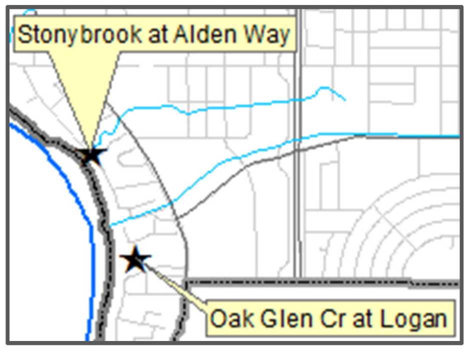
OAK GLEN CREEK AND STONYBROOK

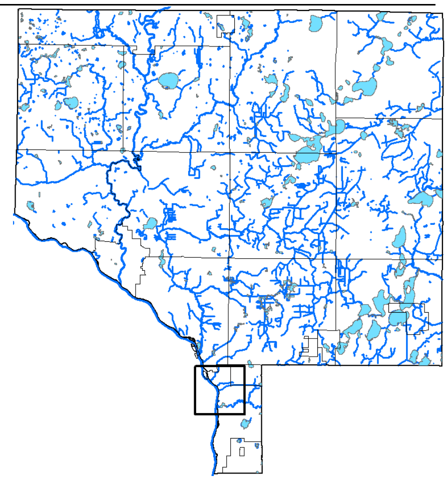
Oak Glen Creek at Logan Parkway

Stonybrook at Alden Way

Years Monitored

Oak Glen Creek at Logan Parkway 2017-**2018**
Stonybrook at Alden Way 2017-**2018**





Background

Stonybrook is a small waterway that drains a mostly urbanized and industrial watershed in northern Fridley and western Spring Lake Park. The stream's contributing area starts about one mile east of the Mississippi River as a storm sewer. The last 1/3 of the one-mile watershed is an open, deeply cut channel that descends 40 ft. to the Mississippi River. The sampling site is located about 250 ft. upstream of the confluence, just east of Alden Way. The creek is only about 10 ft. wide and 6 in. deep during baseflow conditions at the sampling site. Rain events frequently caused the stage to rise over 3 feet.

Oak Glen Creek is a small waterway that drains directly to the Mississippi River. The Oak Glen watershed is approximately 660 acres of mostly commercial development and dense residential land use. The watershed boundaries are Highway 65 to the east, Osborne Road to the north, and 71st Avenue to the south. The creek exists as an open channel for approximately 1,400 ft. between East River Road and the Mississippi River. The channel is deeply cut and narrow, descending about 40 ft. to the River. In 2017, a stormwater pond just east of East River road treating water from this watershed was expanded and had an iron enhanced sand filter added for additional water quality benefit.

Methods

Both streams were monitored during storm and baseflow conditions by grab samples. Eight water quality samples were collected each year; half during baseflow and half following storms. Storms were generally defined as one-in. or more of rainfall in 24 hours or a significant snowmelt event combined with rainfall. In some cases, especially during drought years, smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events. In addition, each of these sites was monitored for a number of "special timed" storm sample trips with the intention of collecting samples as the most polluted first flush comes down the ravines. Success has been mixed when comparing results to continuous YSI-read storm data (see pages x-x), but results are much more indicative of storm water quality in these creeks than samples collected the following day.

Eleven water quality parameters were tested. Parameters tested with portable meters included pH, specific conductance, turbidity, temperature, salinity, and dissolved oxygen. Parameters tested by water samples sent to a state-certified lab included total phosphorus and total suspended solids. During every sampling event, the water level (stage) was recorded using a staff gauge surveyed to sea level elevations. Stage was also continuously recorded using an electronic continuous data logging device.

Results and Discussion

2018 was the second consecutive year these streams were monitored, and some major water quality concerns are evident. Dissolved pollutants as measured by specific conductance do not have a state water quality standard, but both of these streams are higher than any other stream ever monitored in Anoka County. Additionally, phosphorus and *E. coli* levels are very high in Stonybrook in particular, and suspended solids and turbidity have large spikes in both streams during storms.

Following is a parameter-by-parameter summary and management discussion:

- Dissolved pollutants, as measured by specific conductance, at Stonybrook and Oak Glen Creek are the highest of any Anoka County stream. Chloride sampling in subsequent years is recommended to gain a sense of the extent to which road-deicing salts may be a contributor. Short flushes of dissolved pollutants cause spikes of specific conductance in Oak Glenn Creek unlike anything ever observed by ACD. We have now observed these spikes in both continuous data with a YSI sonde, and during our grab sample site visits. The source of these spikes may warrant further investigation.

  Management discussion: Dissolved pollutants enter the stream both directly through surface runoff and also by infiltrating into the shallow groundwater that feeds the stream during baseflow. A variety of sources are likely, including road deicing salts and road runoff. Preventing their release into the environment is important because they are not easily removed.

- Phosphorus concentrations are low in both streams during baseflow conditions with high, short-lived spikes during storm events that often exceed state water quality standards.

  Management discussion: Capturing the pollutants picked up and rushed through the system during storm events would likely be the best treatment in these small subwatersheds. Expanding water storage capacity and increasing retention practices that slow storm runoff down would help to settle the particulate debris out of the stormwater before it rushes to the Mississippi River.

- Suspended solids and turbidity are generally low in each creek during baseflow conditions and are higher as well as much more variable during storm flows. Continuous storm monitoring data indicates that we still aren't catching the worst water quality first flushes during specially timed storm samples, but even these conservative results reveal the poor condition of these streams during storms. Each creek commonly exceeds the 30 mg/L TSS standard during storms.

  Management discussion: Early indications show a large need to capture and treat stormwater in these small watersheds which potentially convey large quantities of material proportional to the size of the streams. Automated sampling gear should be considered to capture storm flows before they recede.

- pH and dissolved oxygen were within the range considered normal and healthy for streams in this area in both streams. Neither of these parameters should be of concern at this point.

- *E. coli* bacteria are a potential problem in Oak Glen Creek and are clearly a significant problem at Stonybrook. More intensive sampling and calculations based on the state water quality standards may be in order.

  Management discussion: With additional monitoring, it is likely that these two streams will be found to exceed State water quality standards for *E. coli*. Because *E. coli* is pervasive in the environment and neighborhoods there will be difficulty reducing *E. coli* levels below state water quality standards. Addressing *E. coli* should be part of an effort to improve overall water quality.

Specific conductance and Chlorides

Specific conductance and chlorides are measures of a broad range of dissolved pollutants. Dissolved pollutant sources include urban road runoff, industrial sources, agricultural chemicals, and others. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Specific conductance is the broadest measure of dissolved pollutants we use. It measures the electrical specific conductance of water; pure water with no dissolved constituents has zero specific conductance. Chlorides measures for 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; however, it is also noteworthy that both Oak Glen Creek and Stonybrook discharge into the Mississippi River just upstream from drinking water intakes for the Twin Cities.

Baseflow specific conductance measured in Oak Glen Creek and Stonybrook are the highest specific conductance levels measured in any Anoka County stream monitored by ACD. Oak Glen Creek has slightly higher readings on average than Stonybrook. The median level for each creek exceeded 1 mS/cm. While these median values are exceptionally high for the local area, some individual sampling events were substantially worse. The highest reading recorded in Oak Glen Creek in 2018 was 16.2 mS/cm. We observed similar spikes during continuous deployments of the YSI sondes, and finally captured a representative grab sample during such a sampling event in July. For perspective, the median specific conductance of all Anoka County streams is 0.363 mS/cm. The reading of 16.2 mS/cm is more than 44 times the countywide median. We now have evidence of short-term flushes of pollutants causing conductance spikes unlike anything ever observed in monitoring by ACD. These flushes may warrant further investigation.

Stonybrook had a maximum reading of 1.47 mS/cm in 2018. Both creeks have much lower conductance during storms than baseflow conditions. This indicates that large quantities of dissolved pollutants are entering these streams through the surficial groundwater, or other continuous inputs that feed baseflow. Storms then dilute the conductance for a short period. There is no state standard for specific conductance in streams, but these values are indicative of high levels of dissolved pollutants for which State standards may exist. Chlorides are one such constituent.

Both of these stream's watersheds are small and urbanized. The area has a long history of road de-icing chemical application, and these salts are an often-cited cause of water quality problems elsewhere in the metropolitan area. These pollutants readily dissolve into the water and infiltrate into the local water table where they feed baseflows in area streams. They do not break down over time.

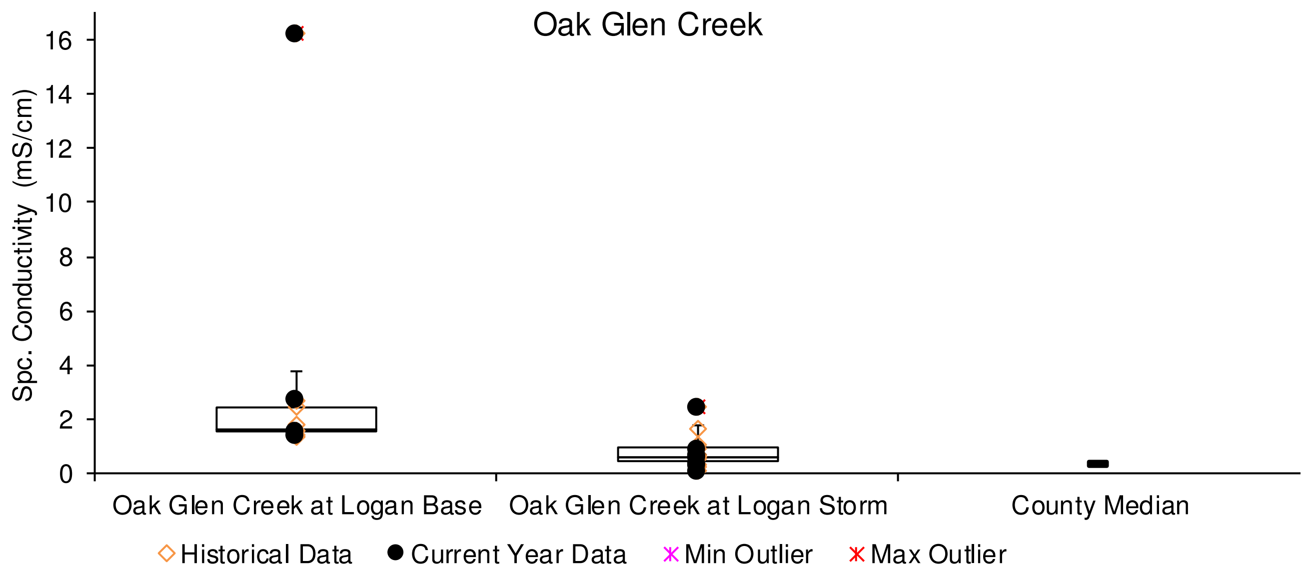
Dissolved pollutants are especially difficult to manage once in the environment. They are not removed by stormwater settling ponds. Infiltration practices can provide some treatment through biological processes in the soil, but also risk contaminating groundwater. The first approach to dissolved pollutant management must be to minimize their release into the environment.

Average and median specific conductance in Oak Glen Creek. All data collected 2017-2018.

	Average specific conductance (mS/cm)	Median specific conductance (mS/cm)	State Standard	N
Baseflow	3.382*	1.600	n/a	9
Storms	0.821	0.602		11
All	1.974	1.370		20
Occasions > state standard				

* Skewed from high outlier sample of 16.2 mS/cm in July 2018

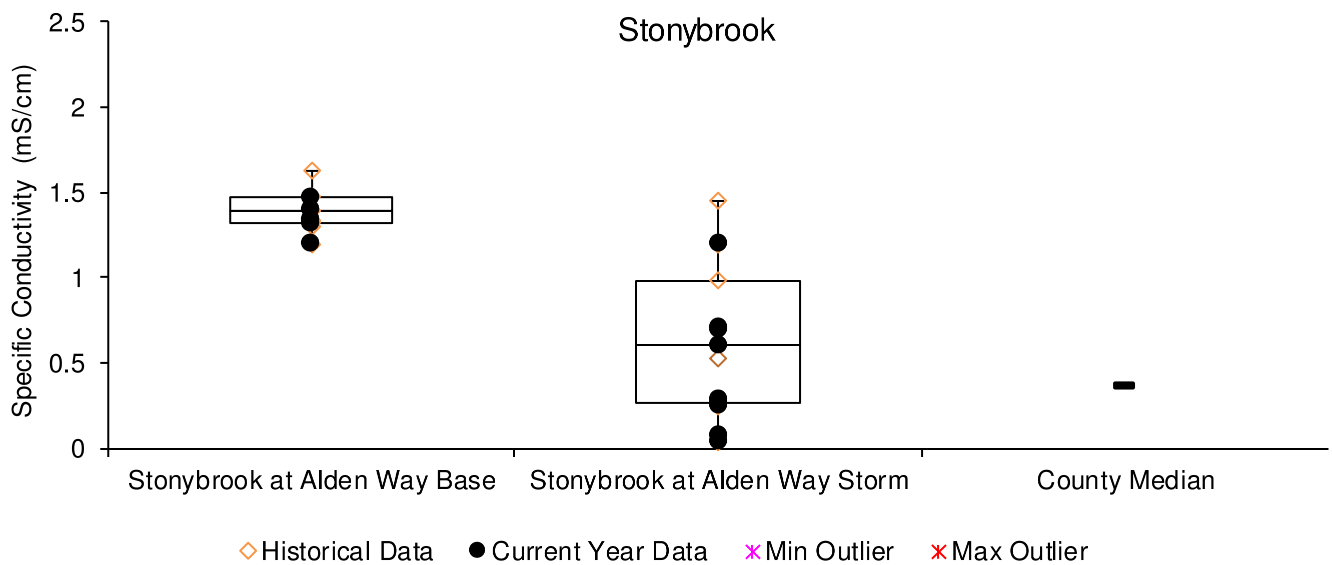
Specific conductance at Oak Glen Creek. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Average and median specific conductance in Stonybrook. All data collected 2017-2018.

	Average specific conductance (mS/cm)	Median specific conductance (mS/cm)	State Standard	N
Baseflow	1.39	1.39	n/a	9
Storms	0.63	0.60		13
All	0.94	1.19		22
Occasions > state standard				

Specific conductance at Stonybrook. Orange diamonds are historical data from previous years and black circles are 2018 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

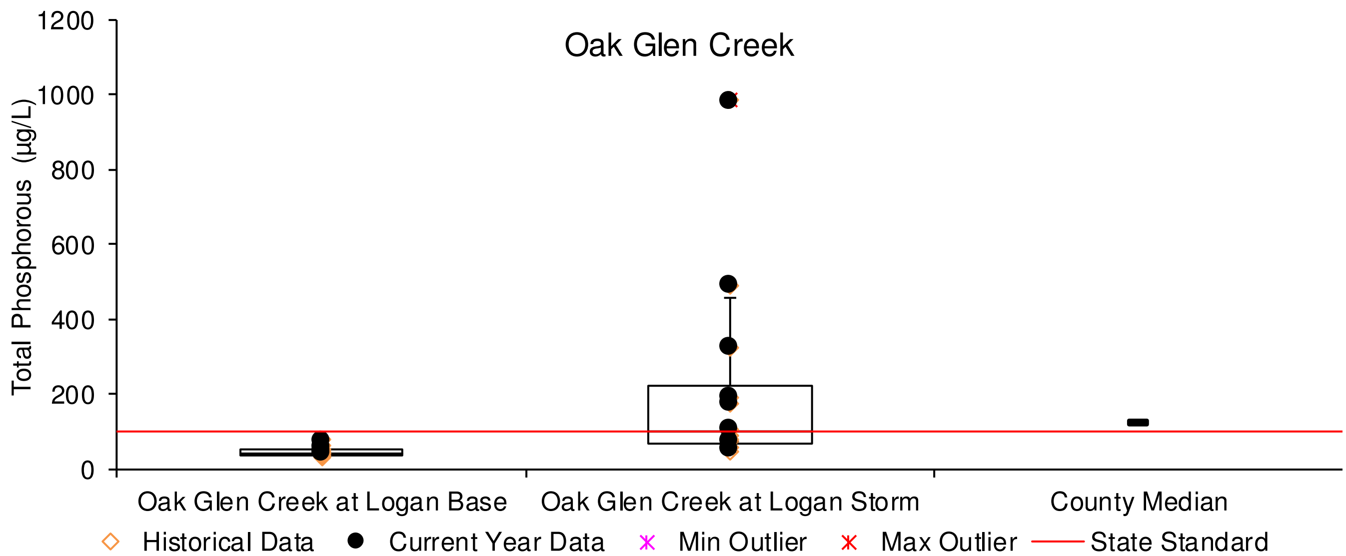
Total phosphorus (TP) is a common nutrient pollutant and is the limiting factor for most algae growth. The state standard for total phosphorus concentrations in streams in this area is 100 µg/L.

While median values are relatively low compared to state standards in Oak Glen Creek, storm event samples exceeded 100 µg/L in six of seven samples in 2018. No such exceedances were recorded in 2017; however, this stream was subject to special timed storm sampling that occurred during the storm event. These special monitoring trips were timed much better in 2018 than during the previous year. It is clear that large amounts of phosphorus are quickly flushed through this system during storm events. The Oak Glen Creek average concentration for storm event total phosphorus in 2018 was 337 µg/L, more than triple the state standard.

Average and median total phosphorus in Oak Glen Creek. All data collected 2017-2018.

	Average Total Phosphorus (µg/L)	Median Total Phosphorus (µg/L)	State Standard	N
Baseflow	50.0	47.0	100	9
Storms	239.3	108.0		11
All	154	67.5		20
Occasions > state standard				0 baseflow 6 (55%) storms

Total phosphorus at Oak Glen Creek. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

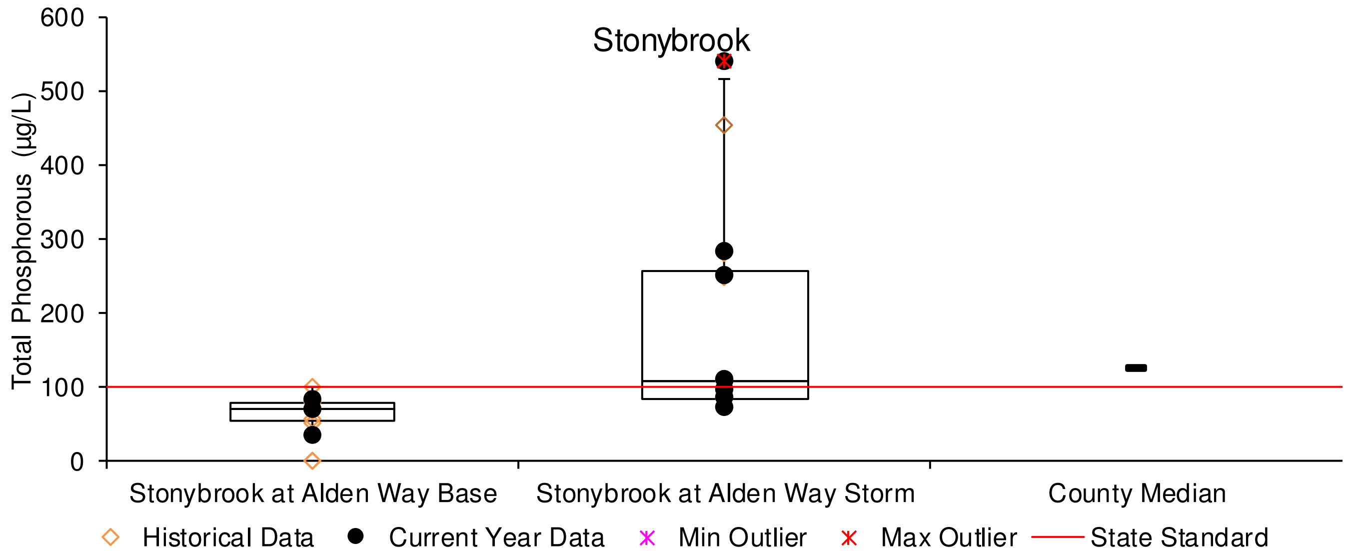


Stonybrook also has high phosphorus concentrations during storm events. Similar to Oak Glen Creek, specially timed storm sample trips to capture the initial storm pulse found total phosphorus in exceedance of the state standard in five of eight samples in 2018. Baseflow phosphorus concentrations in Stonybrook, however, were low with median and average values well below the standard. This stream is also very flashy and storm events cause very quick and intense spikes to the pollutant load. In both of these streams, capturing the sediment and nutrients on the landscape before they rush through the system and to the Mississippi during storm flows should be a focus of management.

Average and median total phosphorus in Stonybrook. All data collected 2017-2018.

	Average Total Phosphorus (µg/L)	Median Total Phosphorus (µg/L)	State Standard	N
Baseflow	68.1	71.0	100	8
Storms	187.9	108.5		12
All	140.0	83.5		20
Occasions > state standard				0 baseflow 7 (58%) storms

Total phosphorus at Stonybrook. Orange diamonds are historical data from previous years and black circles are 2018 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 and Turbidity

Total suspended solids (TSS) and turbidity both measure solid particles in the water. TSS is measured by weighing materials filtered out of the water. Turbidity is measured by the diffraction of a beam of light sent though the water sample and is most sensitive to large particles. Suspended solids are important because they carry other pollutants, affect water appearance and clarity, and can harm stream biota.

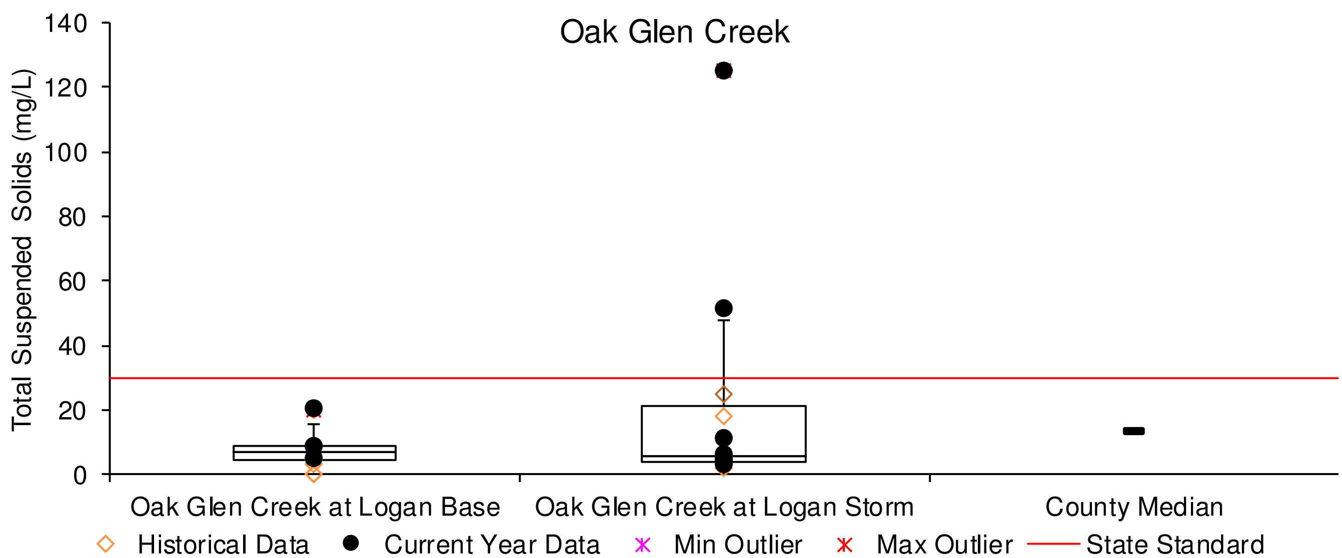
Oak Glen Creek has relatively low TSS and turbidity during baseflow conditions, never exceeding the TSS standard of 30 mg/L. During two storm events in 2018, however, Oak Glen Creek had concentrations exceeding 30 mg/L, with one event in July having more than four times that concentration at 125 mg/L. Turbidity levels are elevated during storm samples as well. During special storm sampling, one turbidity reading of 71.5 NTU was recorded. We have seen levels up to 10 times this number during YSI continuous storm deployments. It seems that while we did a better job in 2018 at collecting samples during storms, the method could still be refined to get the true storm flush.

Similarly, Stonybrook has low TSS and turbidity at baseflow, both of which sharply increase during storms. Stonybrook exceeded the 30 mg/L state standard for TSS in four of eight storm samples collected in 2018. Three turbidity readings exceeded 70 NTU during 2018 storms, but again YSI continuous data indicates that turbidity does get much higher at this site. Storm surges flush through these systems so fast that it is difficult to collect samples at the perfect moment. ACD staff have witnessed Stonybrook water appearing as an opaque black color after small rain events.

Average and median total suspended solids in Oak Glen Creek. All data collected 2017-2018.

	Average Total Suspended Solids (mg/L)	Median Total Suspended Solids (mg/L)	State Standard	N
Baseflow	6.2	4.3	30 mg/L	9
Storms	23.1	5.8		11
All	15.5	4.8		20
Occasions > state TSS standard				0 baseflow 2 (18%) storms

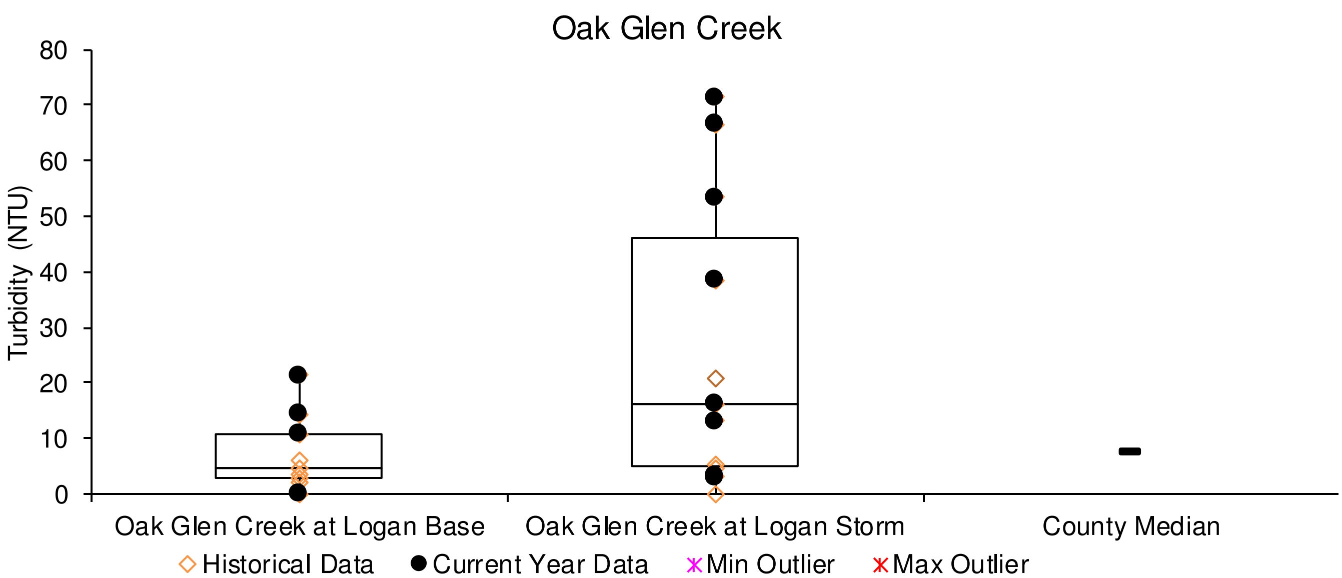
Total suspended solids at Oak Glen Creek. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Average and median turbidity in Oak Glen Creek. All data collected 2017-2018.

	Average Turbidity (NTU)	Median Turbidity (NTU)	State Standard	N
Baseflow	7.3	4.7	n/a	9
Storms	26.7	16.3		11
All	18.0	8.5		20

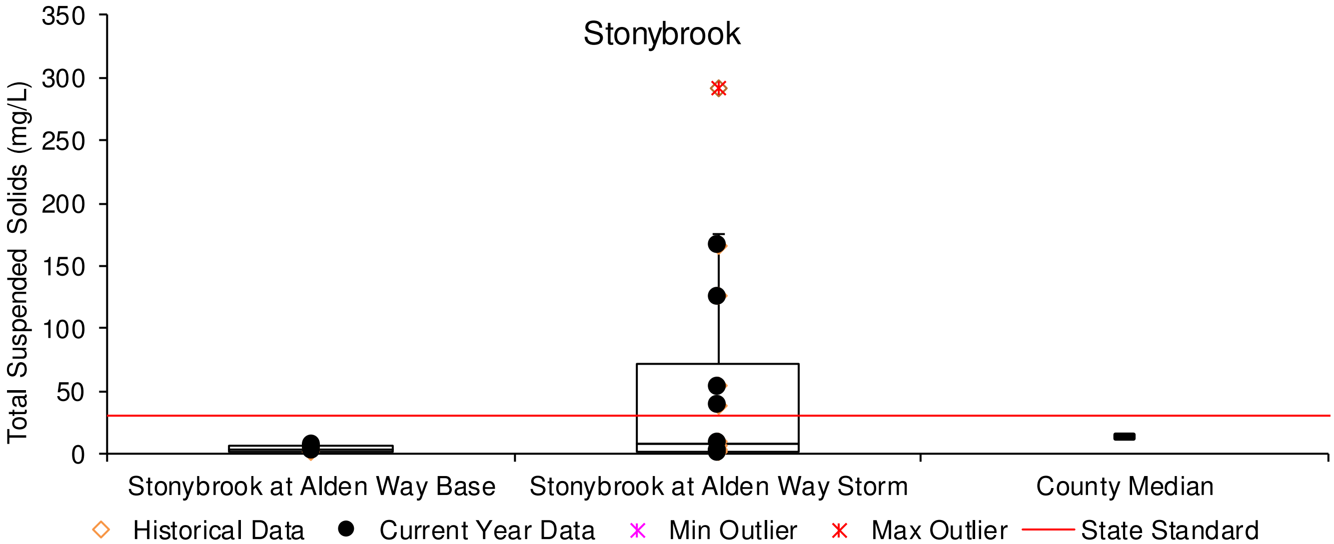
Turbidity at Oak Glen Creek. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Average and median total suspended solids in Stonybrook. All data collected 2017-2018.

	Average Total Suspended Solids (mg/L)	Median Total Suspended Solids (mg/L)	State Standard	N
Baseflow	4.3	4.1	30 mg/L TSS	8
Storms	58.6	8.3		12
All	36.9	5.3		20
Occasions > state TSS standard				0 baseflow 5 (41%) storms

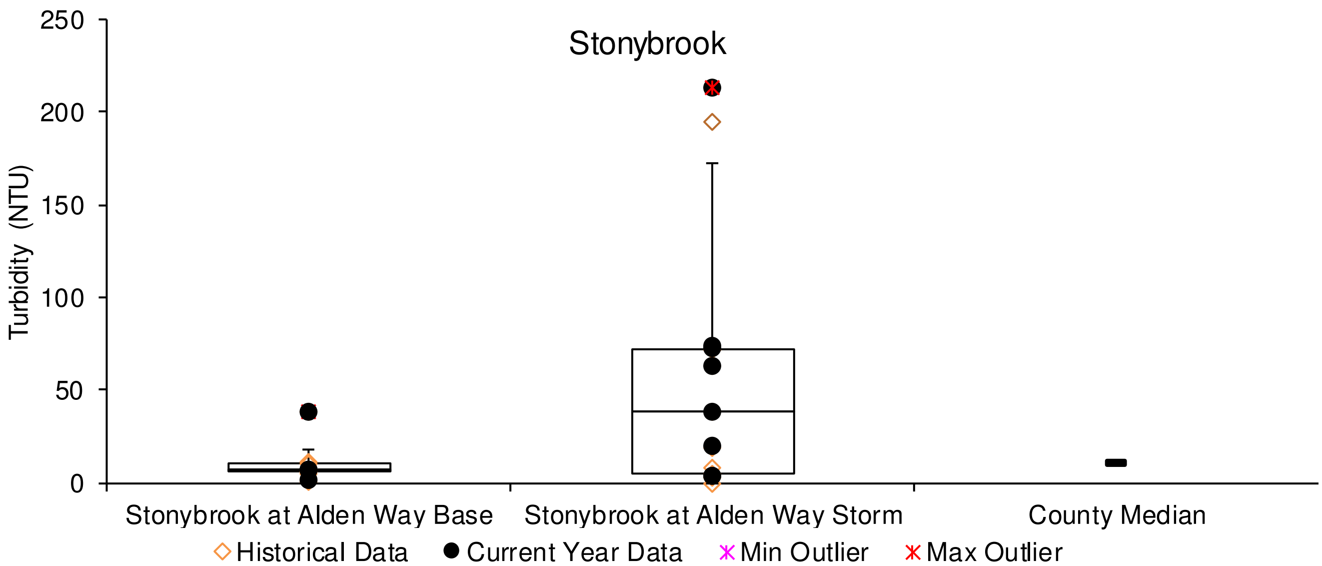
Total suspended solids at Stonybrook. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Average and median turbidity in Stonybrook. All data collected 2017-2018.

	Average Turbidity (NTU)	Median Turbidity (NTU)	State Standard	N
Baseflow	10.3	6.4	n/a	9
Storms	58.9	38.0		13
All	39.0	9.4		21

Turbidity at Stonybrook. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



pH

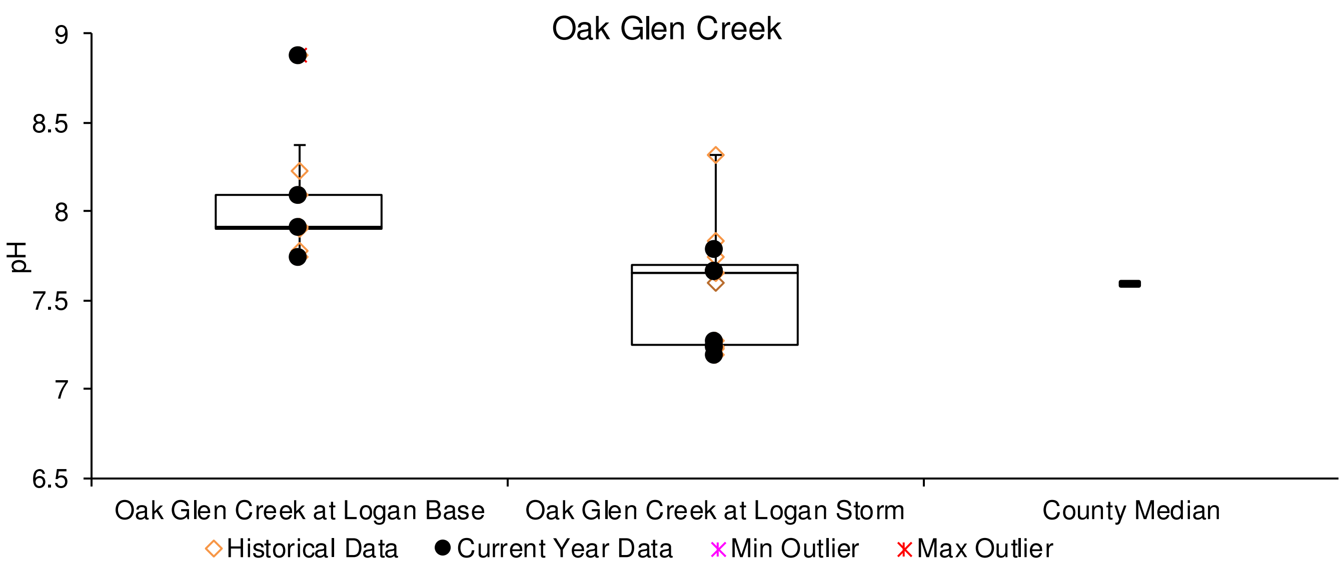
pH levels are generally stable and within the healthy range for both Oak Glen Creek and Stonybrook. These sites both showed a similar slight decline in pH during storm flows due to the slight acidity of rainfall compared to ambient water. The Minnesota Pollution Control Agency water quality standards set the range for pH to remain between 6.5 and 8.5. Oak Glen Creek exceeded the standard once during a baseflow sample in May 2018 with a value of 8.88.

These sites were each additionally monitored continuously during four storm events with YSI EXO data sondes; pH values were within the desired range during all monitored events.

Average and median pH in Oak Glen Creek. All data collected 2017-2018.

	Average pH	Median pH	State Standard	N (each site)
Baseflow	8.04	7.91	6.5-8.5	9
Storms	7.58	7.66		11
All	7.79	7.76		20
Occasions outside state standard				1 (11%) baseflow 0 storms

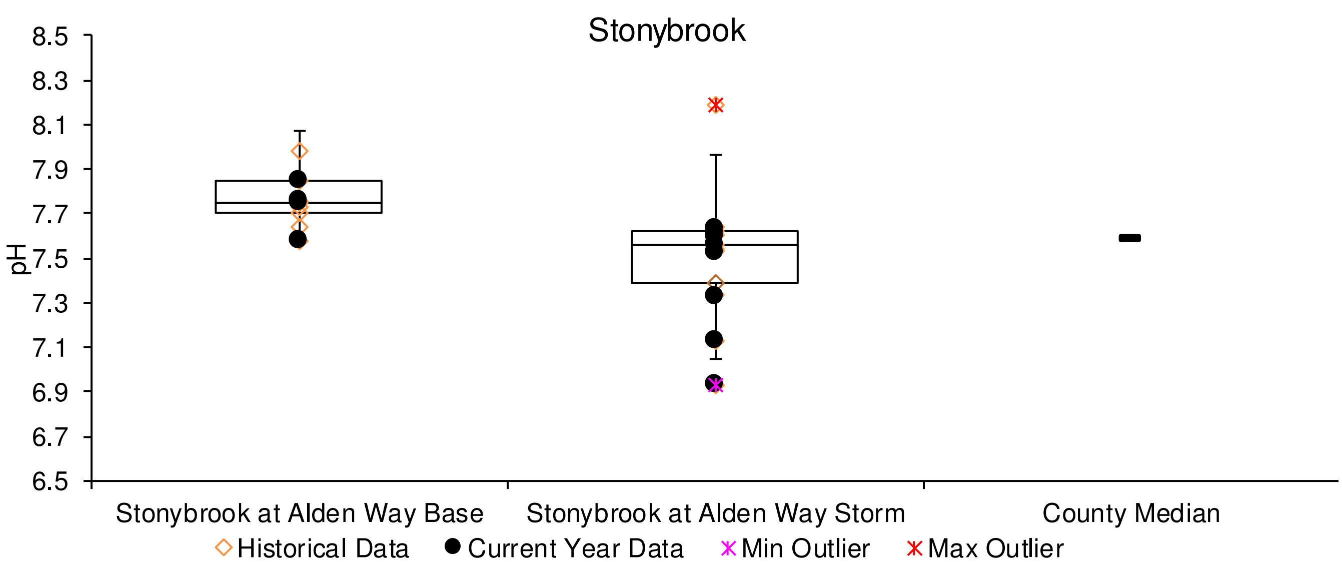
pH at Oak Glen Creek. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Average and median pH in Stonybrook. All data collected 2017-2018.

	Average pH	Median pH	State Standard	N (each site)
Baseflow	7.86	7.75	6.5-8.5	9
Storms	7.52	7.56		13
All	7.66	7.63		21
Occasions outside state standard				0

pH at Stonybrook. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



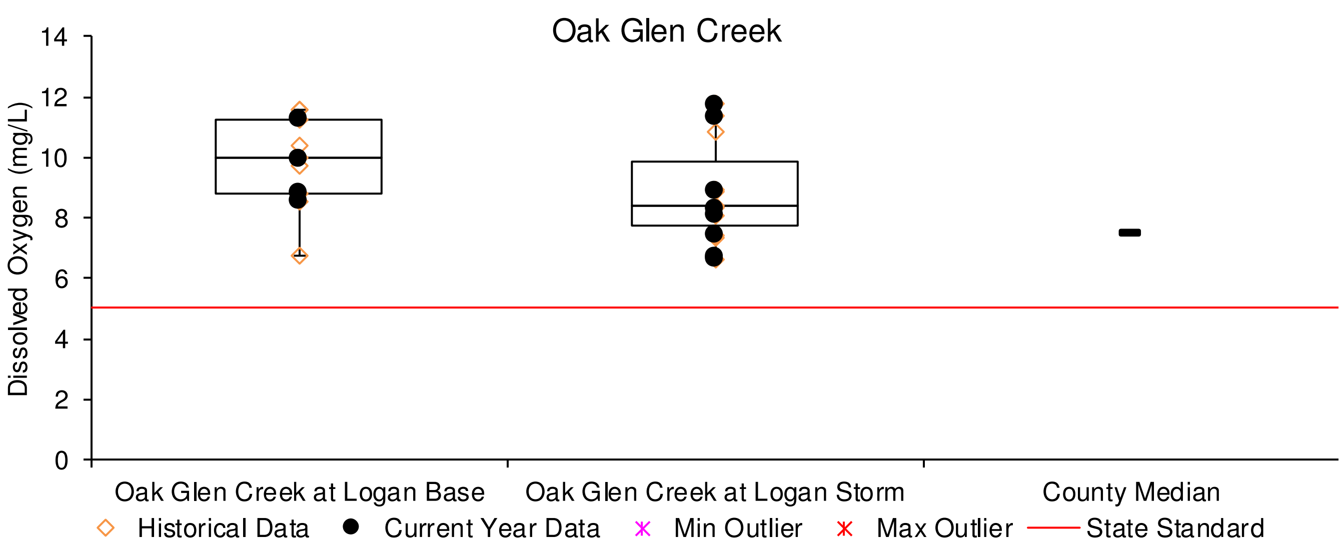
Dissolved Oxygen

Sampling in 2018 showed dissolved oxygen (DO) concentrations to be healthy and stable in both streams. During sample collection, neither stream approached the state standard level of a 5 mg/L daily minimum, and both had median values about double that concentration. Pairing this data with the continuous storm monitoring of DO using a YSI EXO data sonde during four storm events shows high concentrations rarely dropping below 7 mg/L in both streams. These streams have quite turbulent flow as they traverse down steep gullies to the monitoring site, remaining well aerated.

Average and median dissolved oxygen in Oak Glen Creek. All data collected 2017-2018.

	Average Dissolved Oxygen (mg/L)	Median Dissolved Oxygen (mg/L)	State Standard	N (each site)
Baseflow	9.85	9.97	5 mg/L daily minimum	9
Storms	8.91	8.43		11
All	9.33	8.90		20
Occasions <5 mg/L				0

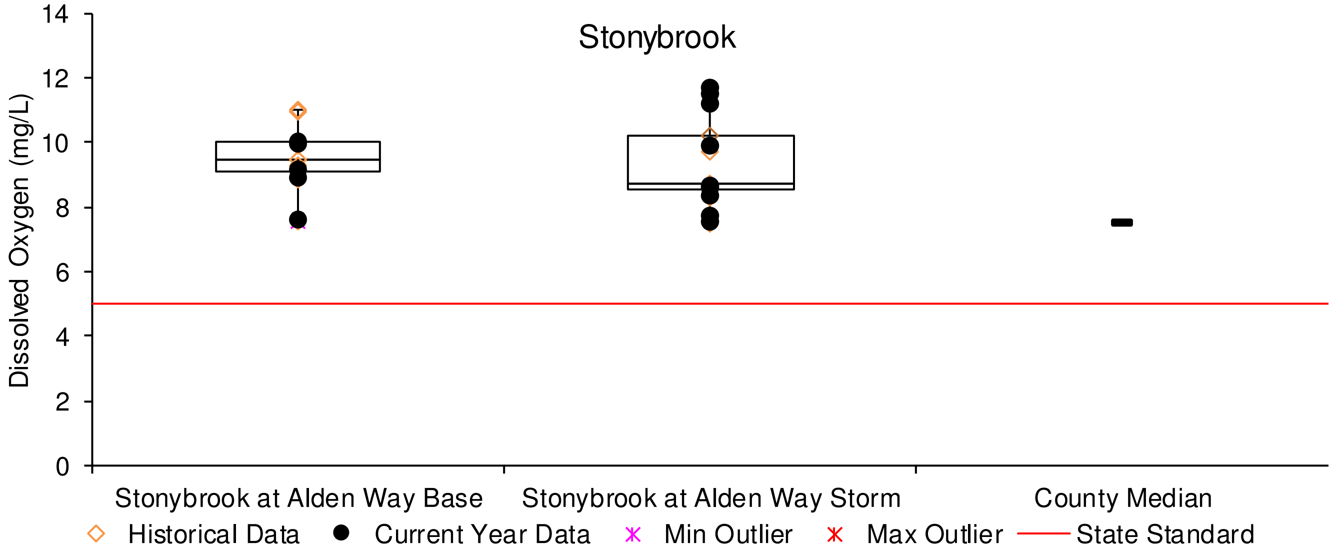
Dissolved Oxygen at Oak Glen Creek. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Average and median dissolved oxygen in Stonybrook. All data collected 2017-2018.

	Average Dissolved Oxygen (mg/L)	Median Dissolved Oxygen (mg/L)	State Standard	N (each site)
Baseflow	11.0	10.22	5 mg/L daily minimum	9
Storms	8.67	9.22		13
All	10.01	9.60		21
Occasions <5 mg/L				0

Dissolved Oxygen at Stonybrook. Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



E. coli

E. coli is bacteria found in the feces of warm-blooded animals. *E. coli* is an easily measureable indicator of all pathogens that are associated with fecal contamination. The Minnesota Pollution Control Agency sets *E. coli* standards for contact recreation (swimming, etc.). A stream is designated as "impaired" if 10% of measurements in a calendar month are >1,260 most probable number (MPN) of colony forming units per 100 milliliters of water, or if the geometric mean of five samples taken within 30 days is greater than 126 MPN.

Our data are not sufficient to determine if the MPCA standards are met. We took samples throughout summer, often with only 1-2 samples in each month, too little for calculation of a monthly geometric mean or to reasonably say that 10% of samples in a month were in exceedance. We can perform other examinations of the data, however that lend some insight into potential issues with *E. coli* in the monitored creeks.

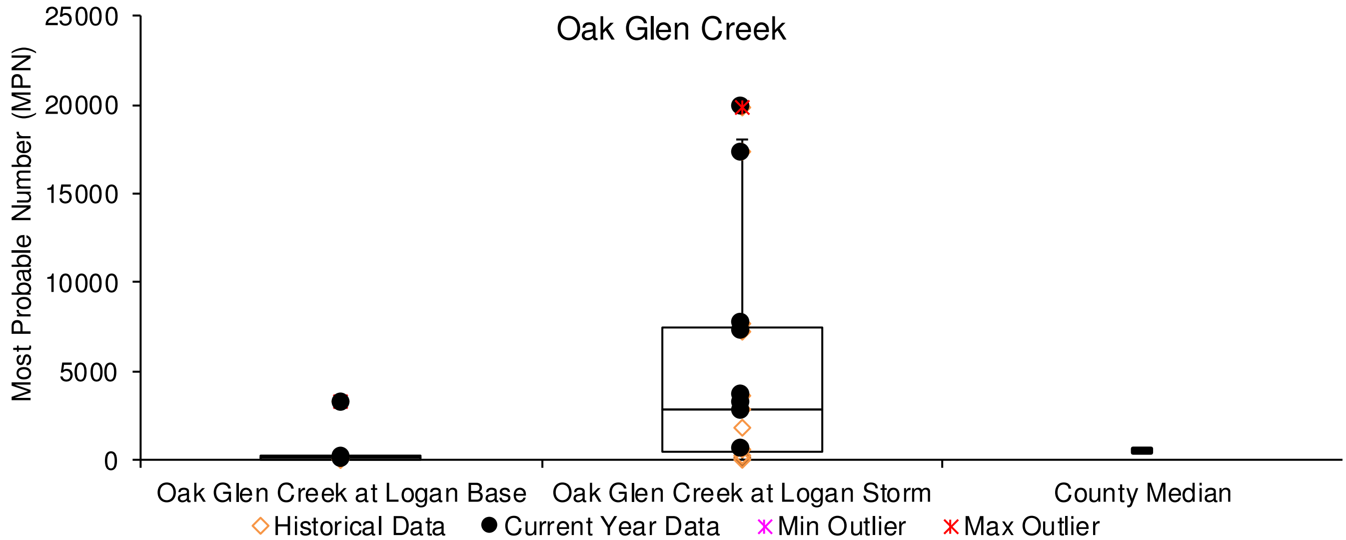
Initial sampling of these streams in 2017 and 2018 indicates that *E. coli* may be an issue in Oak Glen Creek. Oak Glen Creek exceeded the chronic standard of 126 MPN in 11 of 12 samples collected in 2018. Additionally, two of five baseflow samples, and six of seven storm flow samples, exceeded 1,260 MPN, the acute standard. Two storm event samples had over 17,000 MPN. Based on these results, it is very likely that Oak Glen Creek would be impaired for *E. coli* if sampled frequently enough to compare to water quality standards.

Stonybrook *E. coli* levels are equally concerning. Two of four baseflow samples, and all eight storm flow samples, exceeded the chronic 126 MPN standard. All stormflow samples also exceeded 1,260 MPN, with some samples many times that value. Two storm samples contained greater than 17,000 MPN. Median and average baseflow conditions exceed the chronic water quality standard, and storm event median and average conditions exceed the acute water quality standard. It is likely that Stonybrook would also be impaired for *E. coli* if sampled frequently enough for evaluation against state standards.

Average and median *E. coli* in Oak Glen Creek. All data collected 2017-2018.

	Average *E. coli* (MPN)	**Median *E. coli* (MPN)**	**State Standard (MPN)**	**N**
Baseflow	804	142	Monthly Geometric Mean >126	9
Storms	5,612	2,851		11
All	3,449	470		20
Occasions >126 MPN			Monthly 10% average >1260	5 (56%) baseflow 10 (91%) storms
Occasions >1260 MPN				2 (22%) baseflow 7 (64%) storms

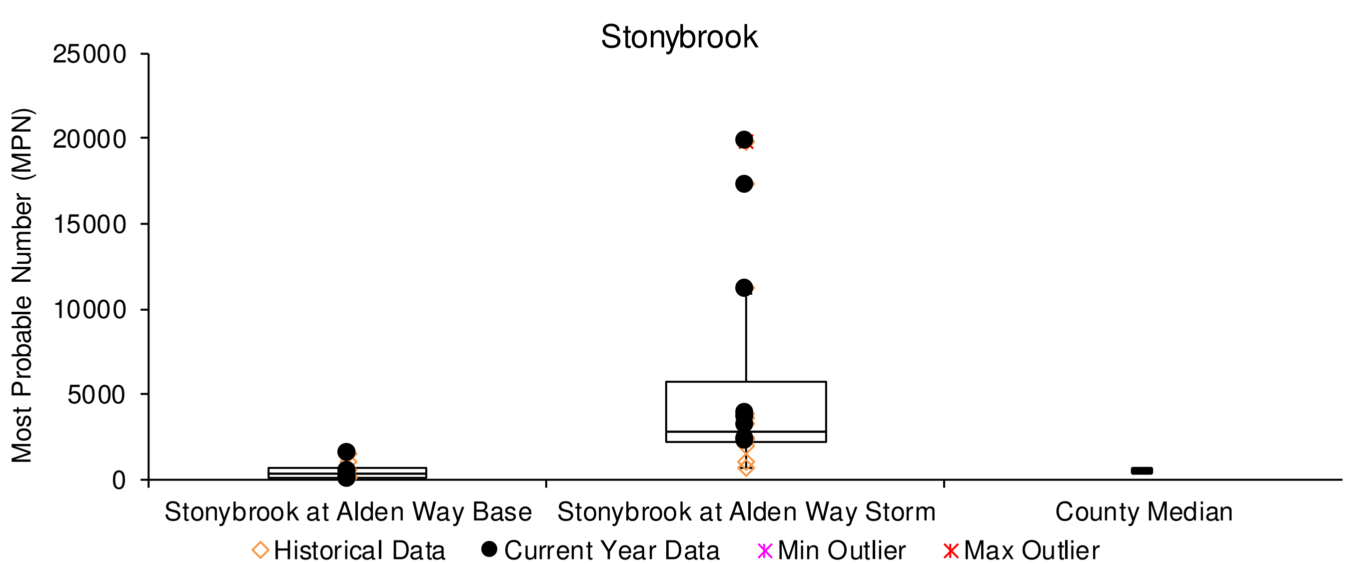
***E. coli* at Oak Glen Creek.** Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Average and median *E. coli* in Stonybrook. All data collected 2017-2018.

	Average *E. coli* (MPN)	Median *E. coli* (MPN)	State Standard (MPN)	N
Baseflow	530	363	Monthly Geometric Mean >126	8
Storms	5,834	2,837		12
All	3,712	1,783	Monthly 10% average >1260	20
Occasions >126 MPN				6 (75%) baseflow 12 (100%) storms
Occasions >1260 MPN				1 (12%) baseflow 10 (83%) storms

***E. coli* at Stonybrook.** Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



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 impact 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: Bannochie Wetland, SW of Main St and Radisson Rd, Blaine

Bunker Wetland, Bunker Hills Regional Park, Andover
(middle and edge of Bunker Wetland are monitored)

Camp Three Wetland, Carlos Avery WMA on Camp Three Road, Columbus Township

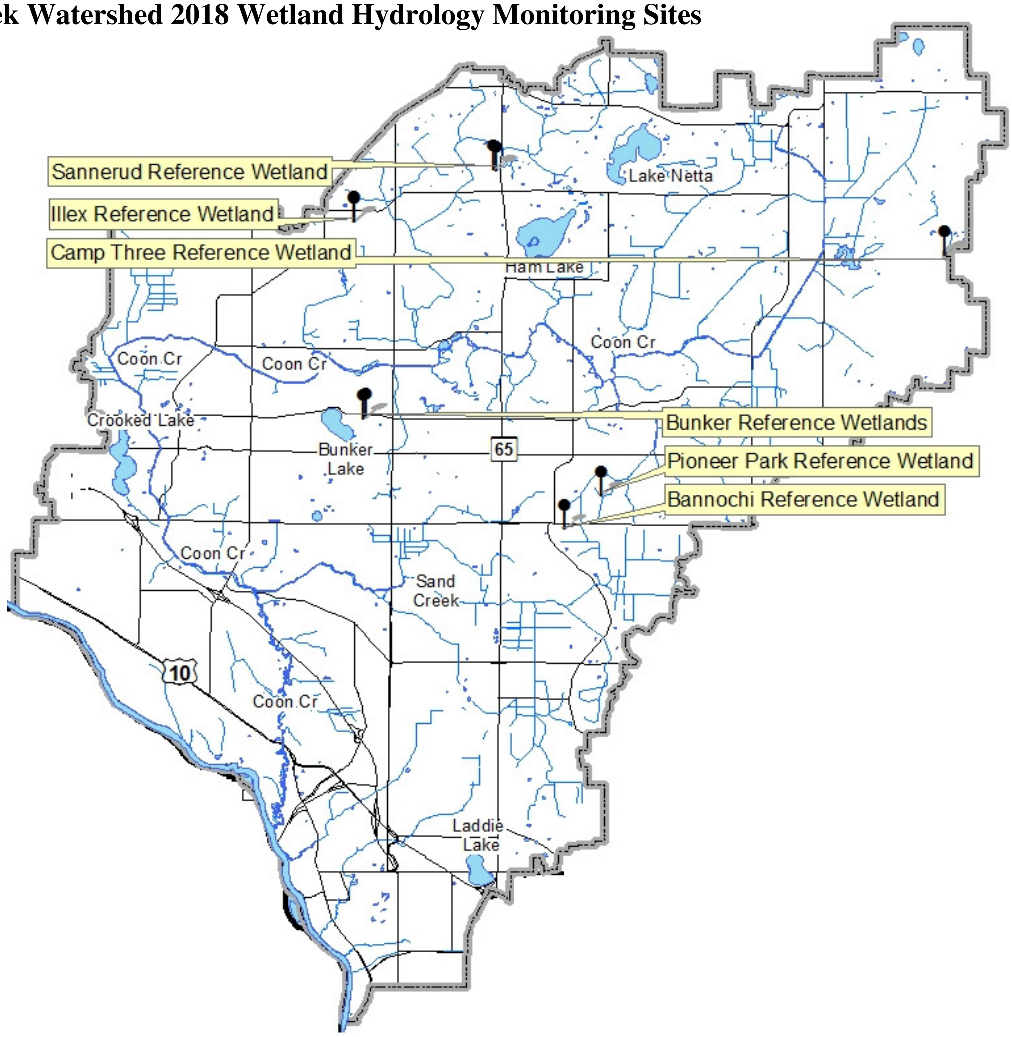
Ilex Wetland, City Park at Ilex St and 159th Ave, Andover
(middle and edge of Ilex Wetland are monitored)

Pioneer Park Wetland, Pioneer Park off Main St., Blaine

Sannerud Wetland, W side of Hwy 65 at 165th Ave, Ham Lake
(middle and edge of Sannerud Wetland are monitored)

Results: See the following pages.

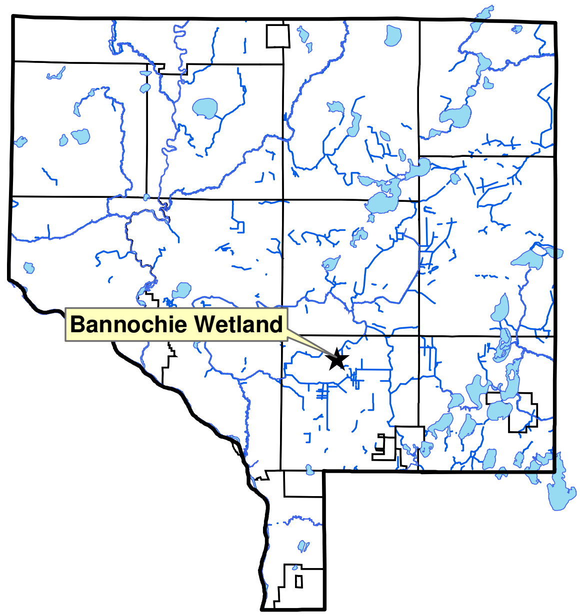
Coon Creek Watershed 2018 Wetland Hydrology Monitoring Sites



BANNOCHIE REFERENCE WETLAND

SE quadrant of Radisson Rd and Hwy 14, Blaine

Site Information



Monitored Since: 1997

Wetland Type: 2

Wetland Size: ~21.5 acres

Isolated Basin? No

Connected to a Ditch? Yes, on edges, but not the interior of wetland

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
Oe1	0-6	10yr 2/1	Organic	-
Oe2	6-40	10yr 2/1-7.5yr2.5/1	Organic	-

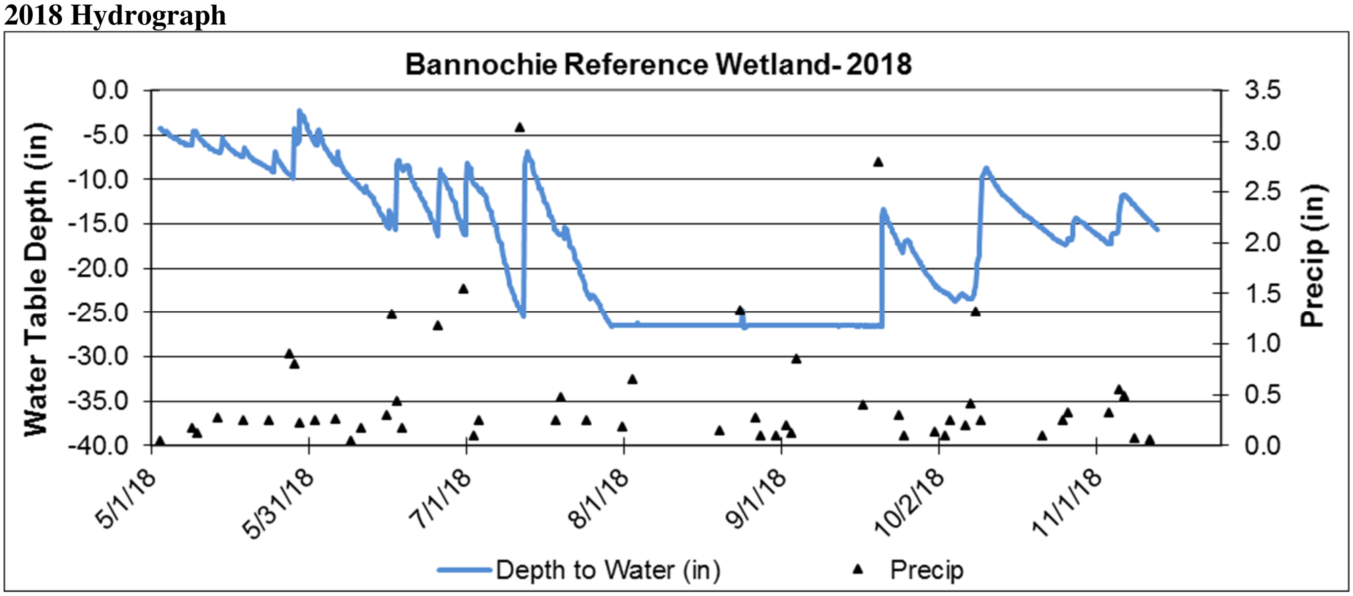
Surrounding Soils: Rifle and some Zimmerman fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Phragmites australis	Giant Reed	80
Rubus spp.	Dewberry	100
Onoclea sensibilis	Sensitive Fern	10

Other Notes: This well is not at the wetland boundary, but rather is within the basin. Intense residential construction has occurred nearby in recent years, including construction dewatering.

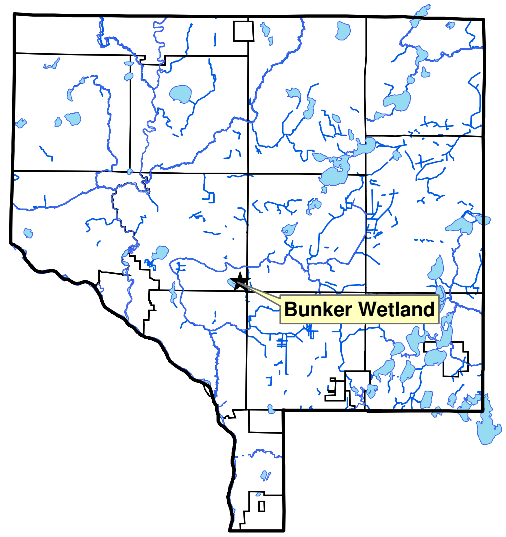
2018 Hydrograph



Wetland Hydrology Monitoring

BUNKER REFERENCE WETLAND - EDGE

Bunker Hills Regional Park, Andover



Site Information

Monitored Since: 1996-2005 at wetland edge. In 2006 re-delineated wetland moved well to new wetland edge (down-gradient).

Wetland Type: 2

Wetland Size: ~1.0 acre

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
AC1	0-3	7.5yr3/1	Sandy Loam	50% 7.5yr 4/6
AC2	3-20	10yr2/1-5/1	Sandy Loam	-
2Ab1	20-31	N2/0	Mucky Sandy Loam	-
2Oa	31-39	N2/0	Organic	-
2Oe	39-44	7.5yr 3/3	Organic	-

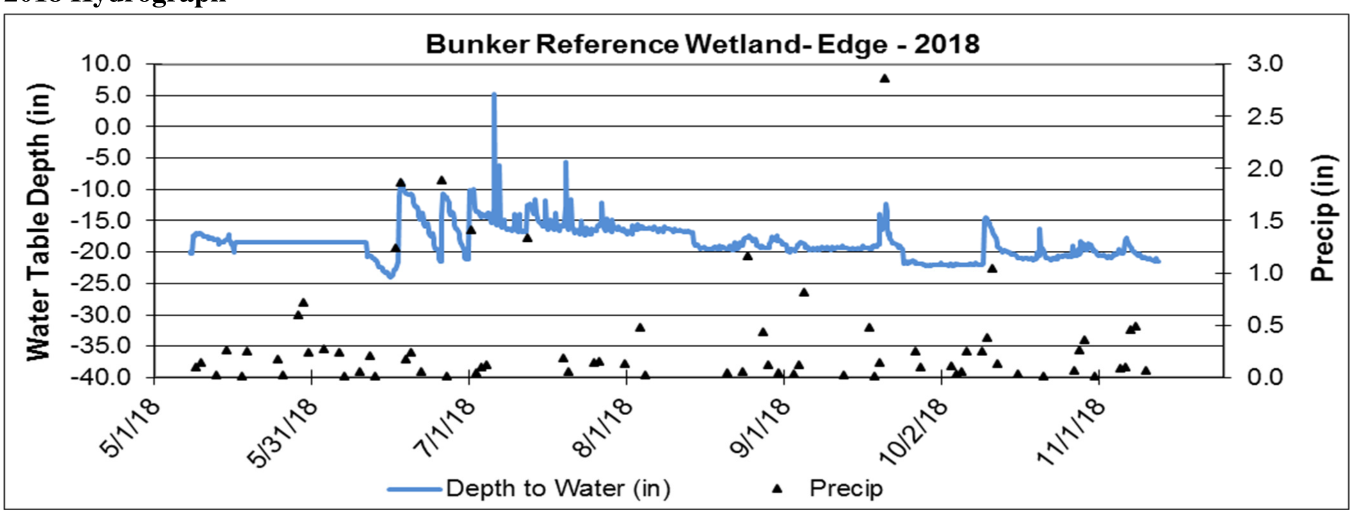
Surrounding Soils: Zimmerman fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	100
Populus tremuloides(T)	Quaking Aspen	30

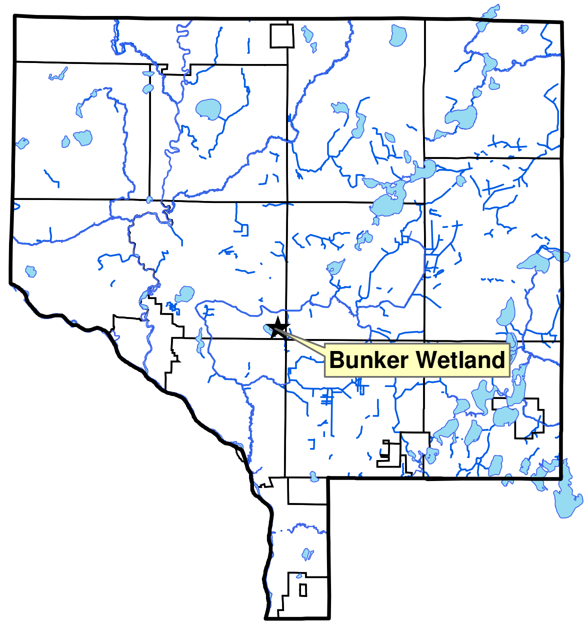
Other Notes: This well is located at the wetland boundary. In 2000-2005 the water table was >40 in. below the surface throughout most or all of the growing season. This prompted us to re-delineate the wetland and move the well down-gradient to the new wetland edge at the end of 2005. As a result, water levels post-2005 are not directly comparable to previous years.

2018 Hydrograph



BUNKER REFERENCE WETLAND - MIDDLE

Bunker Hills Regional Park, Andover



Site Information

Monitored Since: Wetland edge monitored since 1996, but this well in middle of wetland began in 2006.

Wetland Type: 2

Wetland Size: ~1.0 acre

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
Oa	0-22	N2/0	Organic	-
Oe1	22-41	10yr2/1	Organic	-
Oe2	41-48	7.5yr3/4	Organic	-

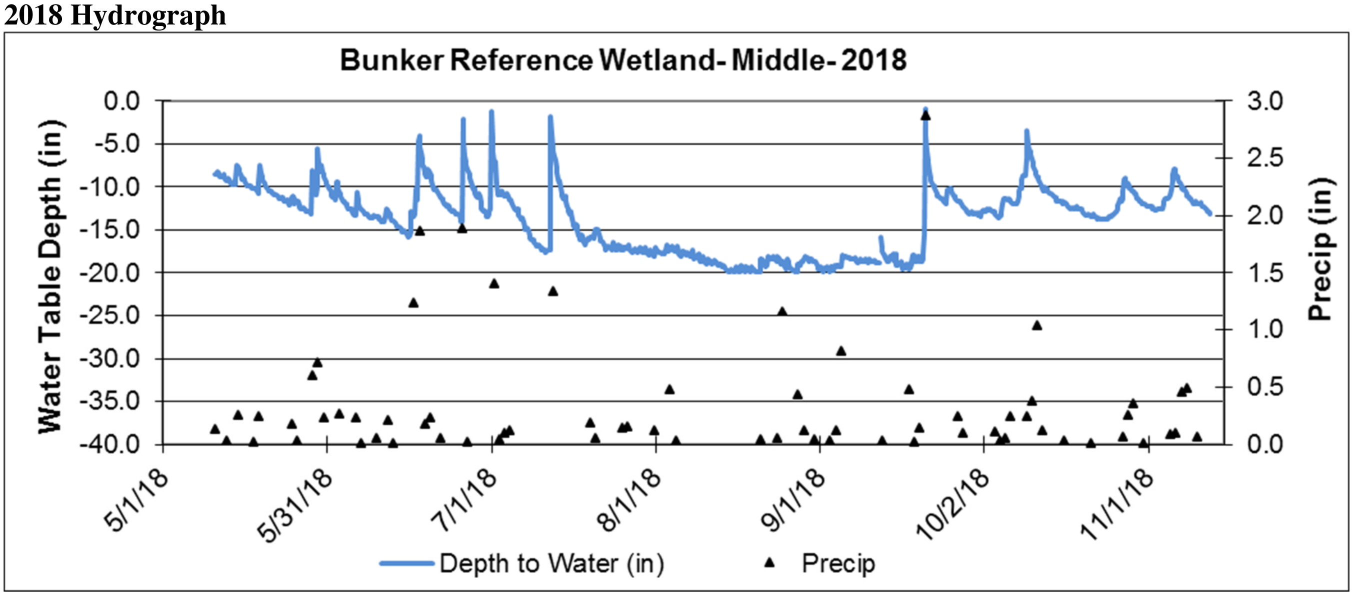
Surrounding Soils: Zimmerman fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Poa palustris	Fowl Bluegrass	90
Polygonum sagitatum	Arrow-leaf Tearthumb	20
Aster spp.	Aster undiff.	10

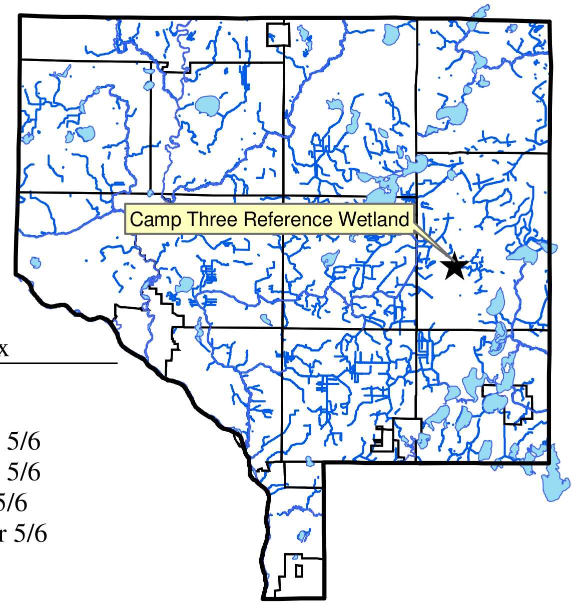
Other Notes: This well at the middle of the wetland and was installed at the end of 2005 and first monitored in 2006.

2018 Hydrograph



CAMP THREE REFERENCE WETLAND

Carlos Avery Wildlife Management Area, Columbus Township



Site Information

Monitored Since: 2008

Wetland Type: 3

Wetland Size: Part of complex > 200 acres

Isolated Basin? No

Connected to a Ditch? Yes

Soils at Well Location: Markey Muck

Horizon	Depth	Color	Texture	Redox
A	0-4	N2/0	Mucky Fine Sandy Loam	-
A2	4-13	10yr 3/1	Fine Sandy Loam	20% 5yr 5/6
Bg1	13-21	10yr 5/1	Fine Sandy Loam	2% 10yr 5/6
Bg2	21-39	10yr 5/1	Fine Sandy Loam	5% yr 5/6
Bg3	39-55	10yr 5/1	Very Fine Sandy Loam	10% 10yr 5/6

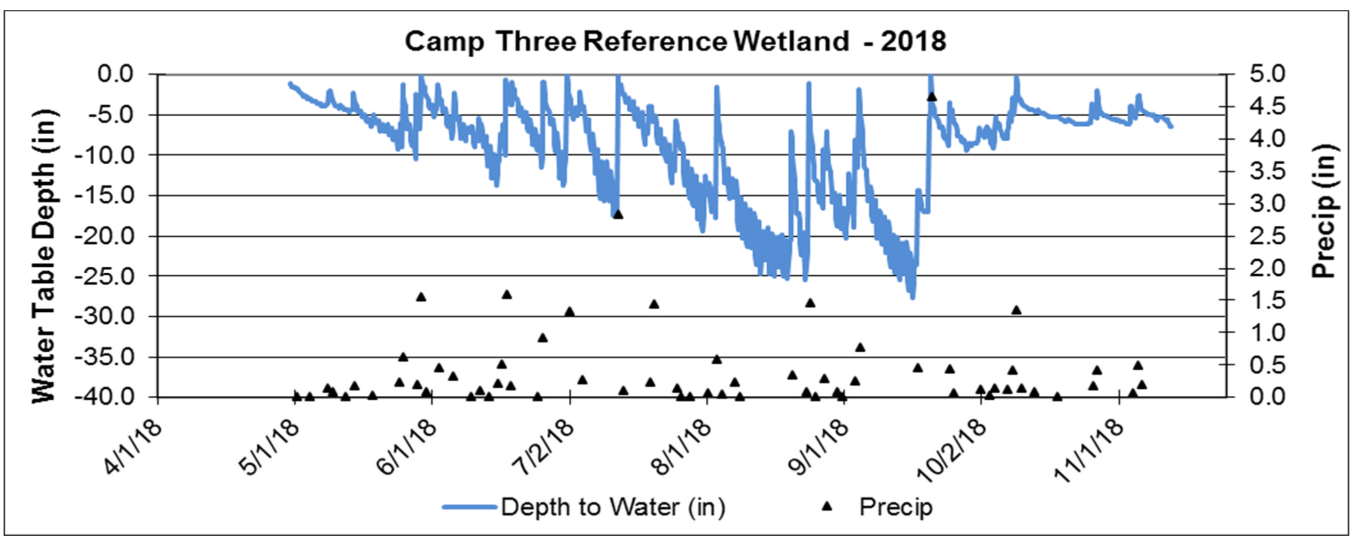
Surrounding Soils: Zimmerman Fine Sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	100
Populus tremuloides (T)	Quaking Aspen	30
Acer negundo (S)	Boxelder	30
Acer rubrum (T)	Red Maple	10

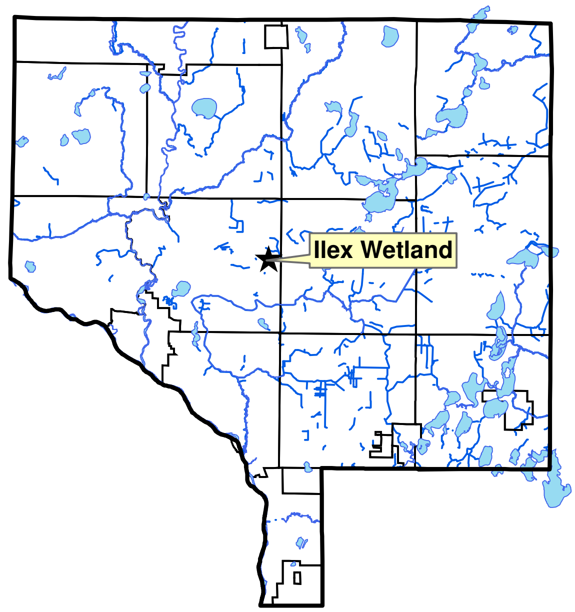
Other Notes: This well is located at the wetland boundary. It maintained a consistent water level of -26 in. throughout summer 2008. This may have been due to water control structures elsewhere in the Carlos Avery Wildlife Management Area.

2018 Hydrograph



ILEX REFERENCE WETLAND - EDGE

City Park at Ilex St and 159th Ave, Andover



Site Information

Monitored Since: 1996

Wetland Type: 2

Wetland Size: ~9.6 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A	0-10	10yr2/1	Fine Sandy Loam	-
Bg	10-14	10yr4/2	Fine Sandy Loam	-
2Ab	14-21	N2/0	Sandy Loam	-
2Bg1	21-30	10yr4/2	Fine Sandy Loam	-
2Bg2	30-45	10yr5/2	Fine Sand	-

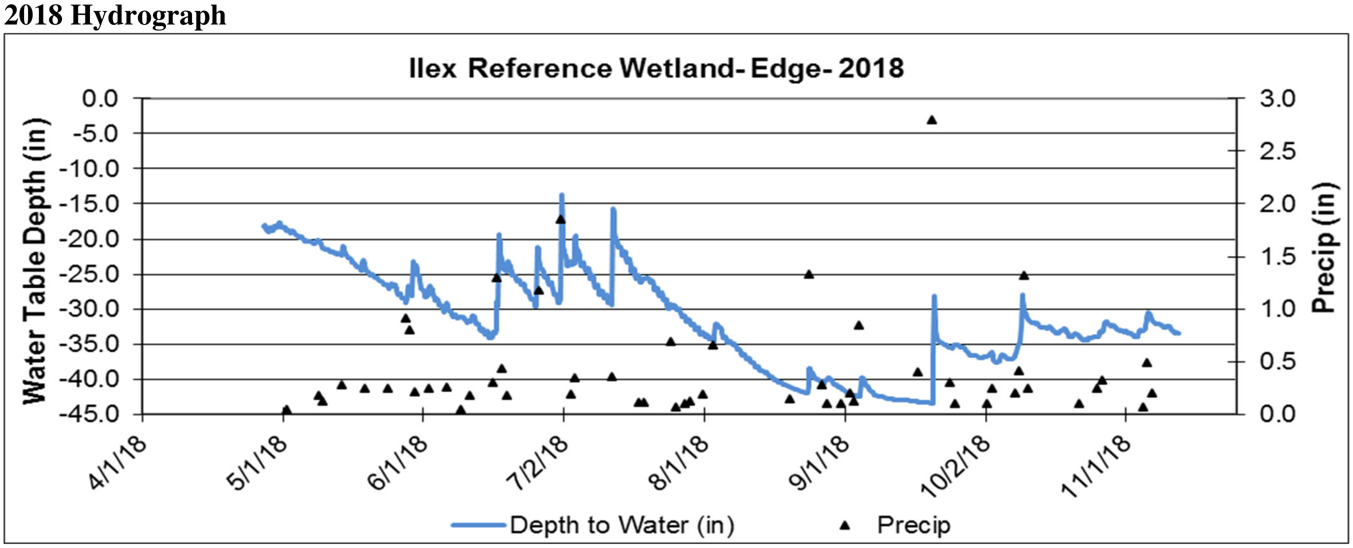
Surrounding Soils: Loamy wet sand and Zimmerman fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	100
Solidago gigantia	Giant Goldenrod	20
Populus tremuloides (T)	Quaking Aspen	20
Rubus strigosus	Raspberry	10

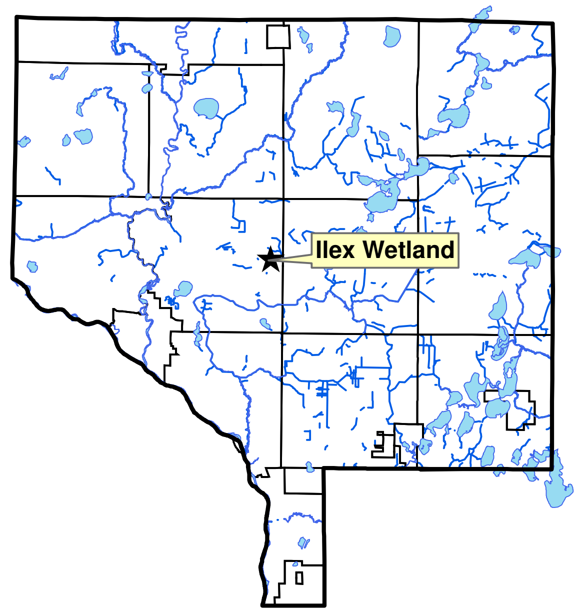
Other Notes: This well is located at the wetland boundary. In 2000-2005 the water table was only once within 15 in.es of the surface and seldom within 40 in.es. This prompted us to re-delineate the wetland and move the well down-gradient to the new wetland edge at the beginning of 2006. As a result, water levels post-2005 are not directly comparable to previous years.

2018 Hydrograph



ILEX REFERENCE WETLAND - MIDDLE

City Park at Ilex St and 159th Ave, Andover



Site Information

Monitored Since: 2006

Wetland Type: 2

Wetland Size: ~9.6 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
Oa	0-9	N2/0	Organic	-
Bg1	9-19	10yr4/2	Fine Sandy Loam	-
Bg2	19-45	10yr5/2	Fine Sand	-

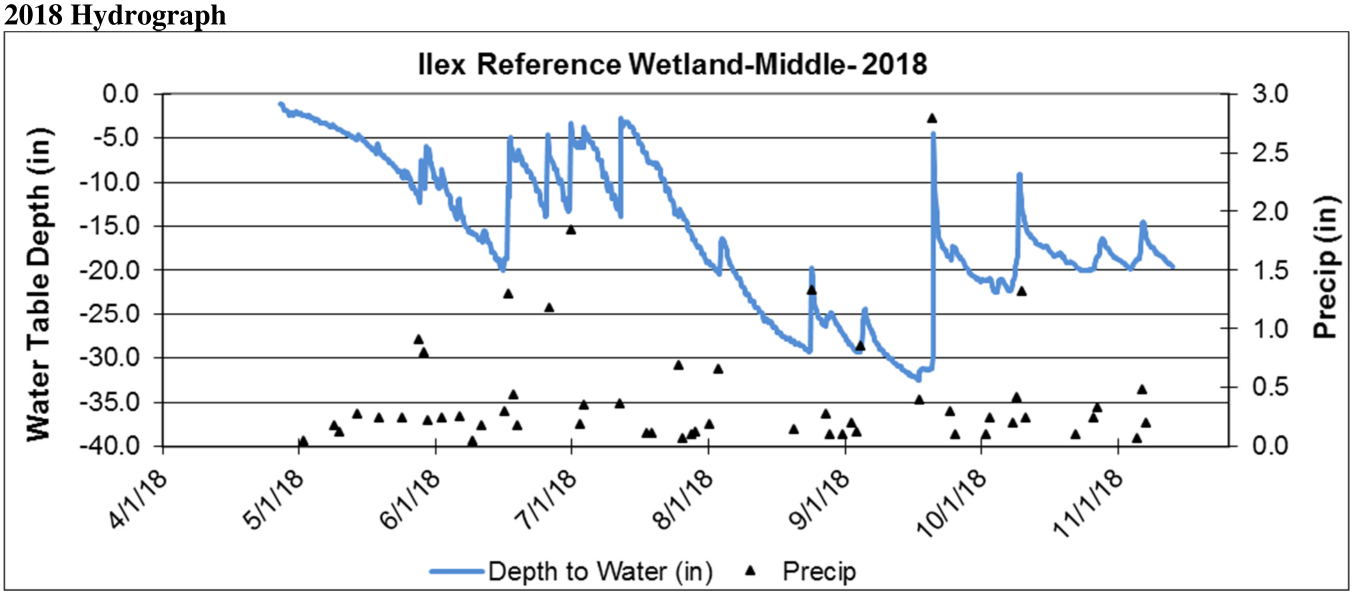
Surrounding Soils: Loamy wet sand and Zimmerman fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	80
Typha angustifolia	Narrow-leaf Cattail	40

Other Notes: This well is located near the middle of the wetland basin.

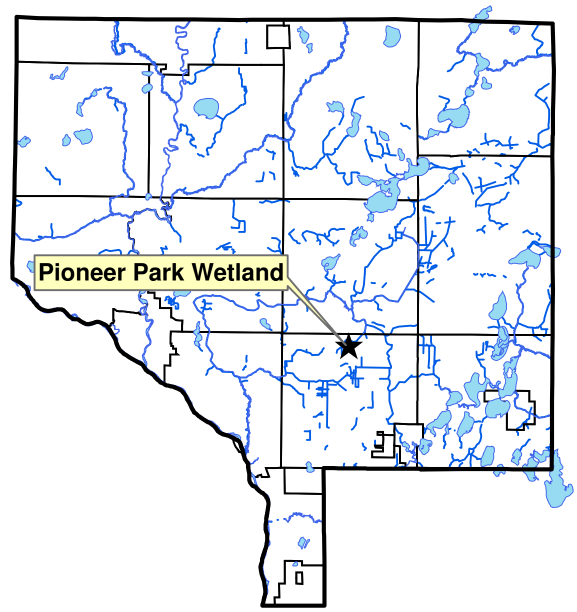
2018 Hydrograph



Wetland Hydrology Monitoring

PIONEER PARK REFERENCE WETLAND

Pioneer Park N Side of Main St. E of Radisson Road, Blaine



Site Information

Monitored Since: 2005

Wetland Type: 2

Wetland Size: Undetermined. Part of a large wetland complex.

Isolated Basin? No

Connected to a Ditch? Not directly.Wetland complex has small drainage ways, culverts, & nearby ditches.

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
Oa1	0-4	10yr 2/1	Sapric	-
Oa2	4-8	N 2/0	Sapric	-
AB	8-12	10yr 3/1	Mucky Sandy Loam	-
Bw	12-27	2.5y 5/3	Loamy Sand	-
Bg	27-40	2.5y 5/2	Loamy Sand	-

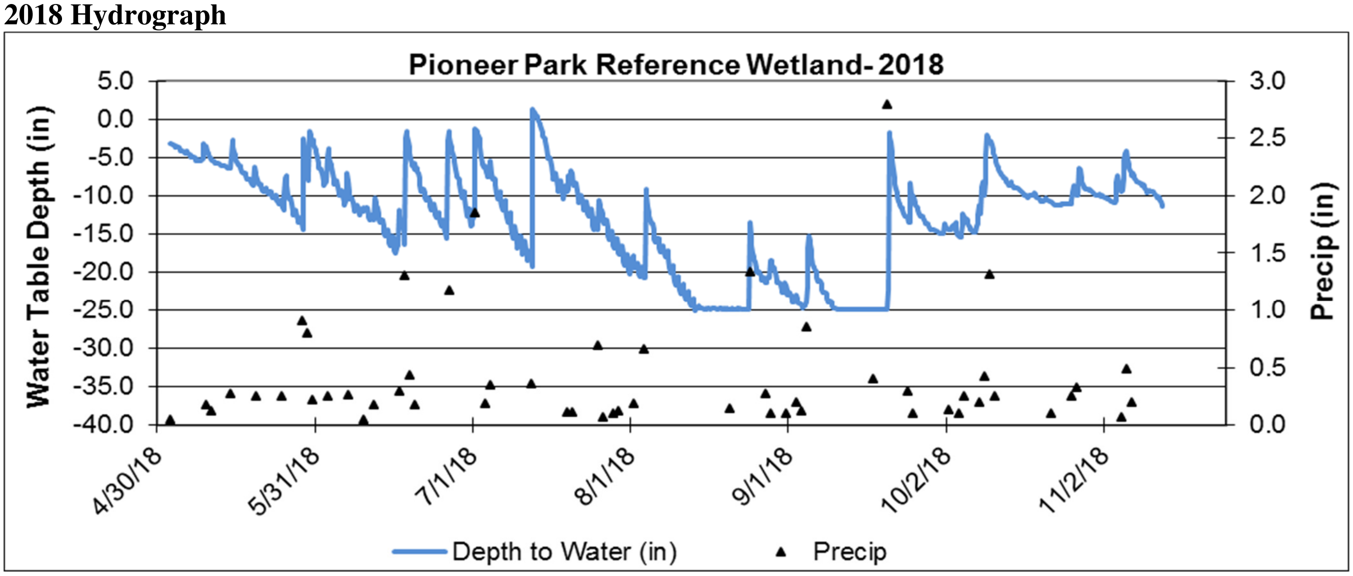
Surrounding Soils: Rifle and loamy wet sand.

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	100
Carex lacustris	Lake Sedge	20
Fraxinus pennsylvanica (T)	Green Ash	30
Rhamnus frangula (S)	Glossy Buckthorn	20
Ulmus americana (T)	American Elm	20
Populus tremuloides (S)	Quaking Aspen	20
Urtica dioica	Stinging Nettle	10

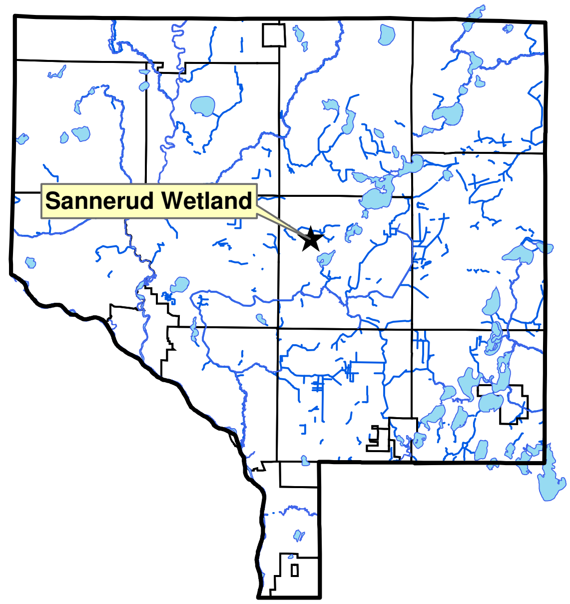
Other Notes: This well is located within the wetland, not at the edge. City of Blaine surveyed calibration line 6-2013. Elevation = 897.366 (NGVD 29)

2018 Hydrograph



SANNERUD REFERENCE WETLAND - EDGE

W side of Hwy 65 at 165th Ave, Ham Lake



Site Information

Monitored Since: 2005
Wetland Type: 2
Wetland Size: ~18.6 acres
Isolated Basin? Yes
Connected to a Ditch? Is adjacent to Hwy 65 and its drainage systems. Small remnant of a ditch visible in wetland.

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
Oa	0-8	N2/0	Sapric	-
Bg1	8-21	10yr 4/1	Sandy Loam	-
Bg2	21-40	10yr 4/2	Sandy Loam	-

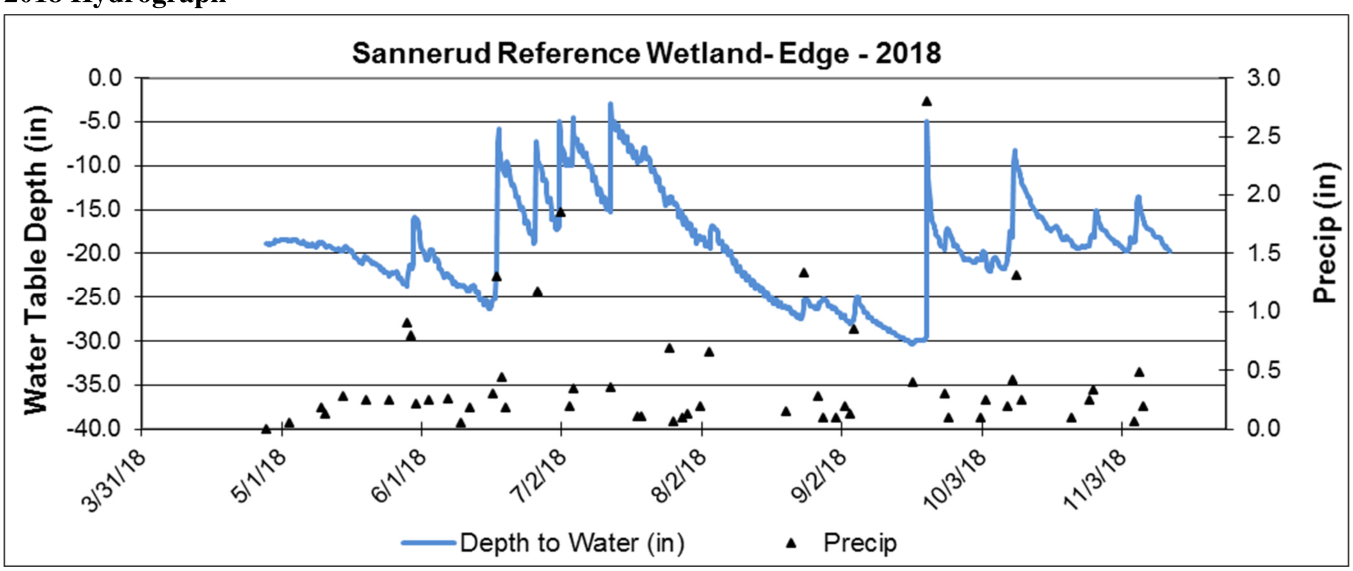
Surrounding Soils: Zimmerman and Lino.

Vegetation at Well Location:

Scientific	Common	% Coverage
Rubus spp.	Undiff Rasberry	70
Phalaris arundinacea	Reed Canary Grass	40
Acer rubrum (T)	Red Maple	30
Populus tremuloides (S)	Quaking Aspen	30
Betula papyrifera (T)	Paper Birch	10
Rhamnus frangula (S)	Glossy Buckthorn	10

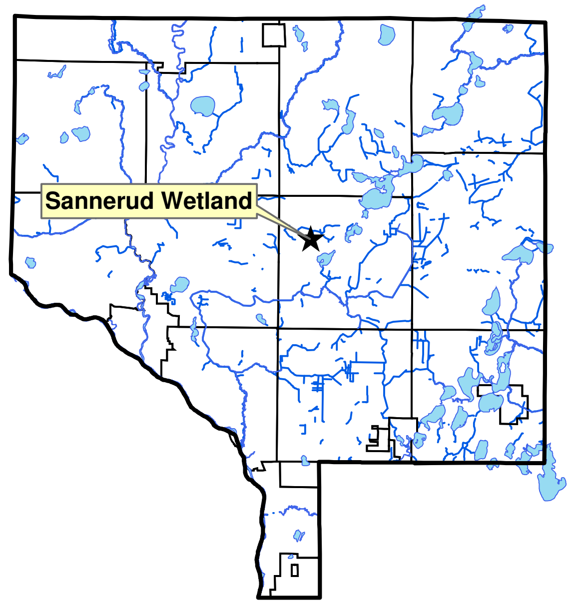
Other Notes: This is one of two monitoring wells on this wetland. This one is at the wetland's edge, while the other is near the middle. The wetland edge well is slightly deeper than most reference wetland wells, at 43.5 in.es deep.

2018 Hydrograph



SANNERUD REFERENCE WETLAND - MIDDLE

W side of Hwy 65 at 165th Ave, Ham Lake



Site Information

Monitored Since: 2005

Wetland Type: 2

Wetland Size: ~18.6 acres

Isolated Basin? Yes

Connected to a Ditch? Is adjacent to Hwy 65 and its drainage systems. Small remnant of a ditch visible in wetland.

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
Oe	0-3	7.5yr 3/1	Organic	-
Oe2	18-Mar	10yr 2/1	Organic	-
Oa	18-48	10yr 2/1	Organic	-

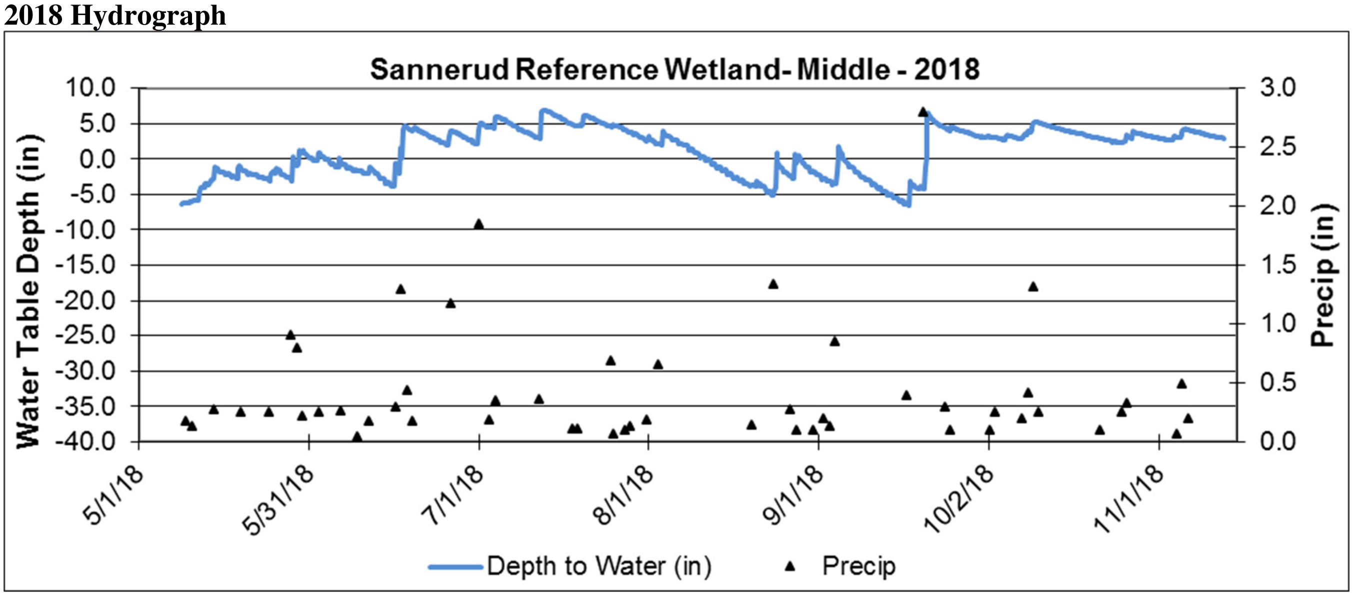
Surrounding Soils: Zimmerman and Lino.

Vegetation at Well Location:

Scientific	Common	% Coverage
Carex lasiocarpa	Wooly-Fruit Sedge	90
Calamagrostis canadensis	Blue-Joint Reedgrass	40
Typha angustifolia	Narrow-Leaf Cattail	5
Scirpus validus	Soft-Stem Bulrush	5

Other Notes: This is one of two monitoring wells on this wetland. This one is near the center of the wetland, while the other is at the wetland's edge.

2018 Hydrograph



Reference Wetland Analyses

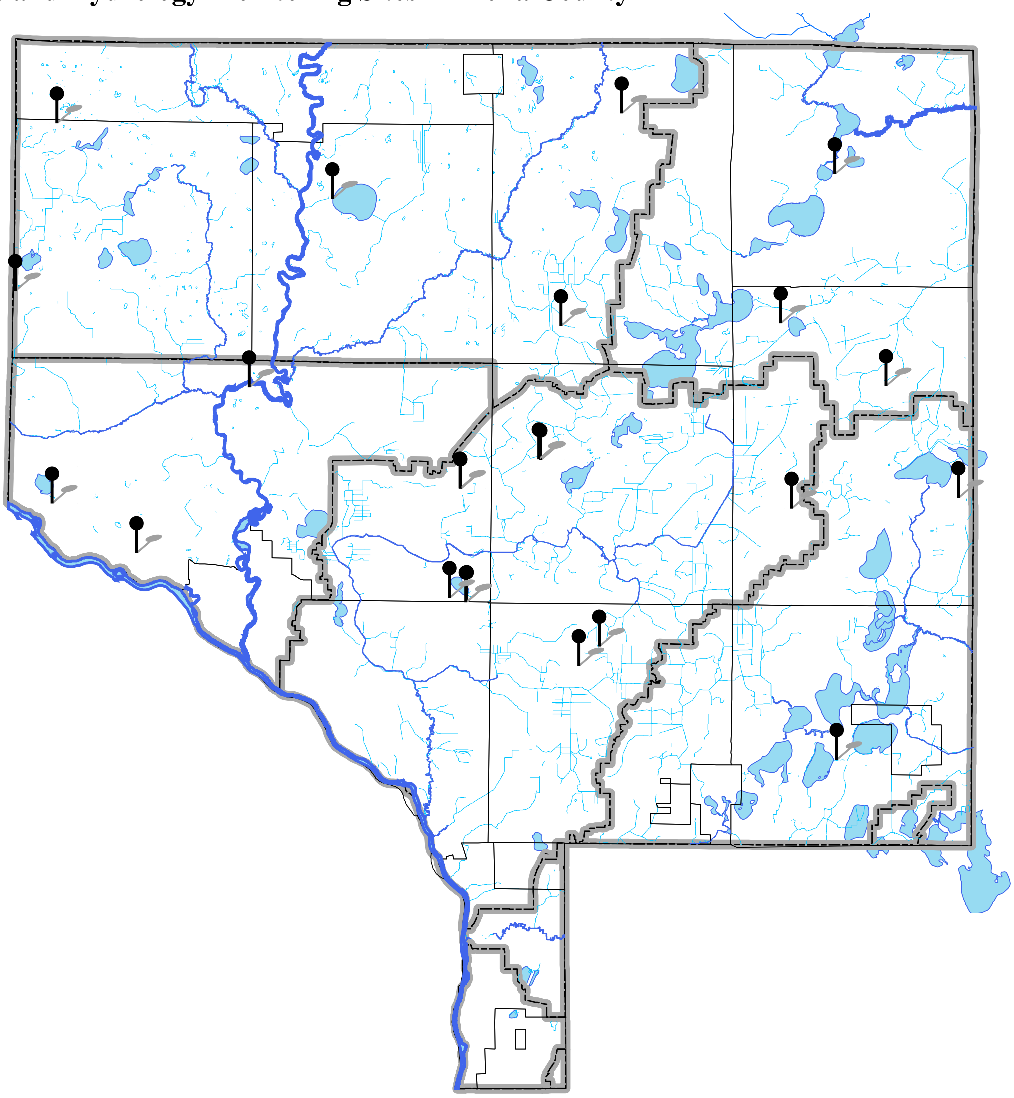
Description: This section includes analyses of wetland hydrology data of 23 reference wetland sites collected at 19 locations. Shallow groundwater levels at the edge of these wetlands are recorded every four hours. Many have been monitored since 1996. These analyses summarize this enormous multi-year, multi-wetland dataset. In the process of doing this analysis, a database summarizing all of the data was created. This database will allow many other, more specific, analyses to be done to answer questions as they arise, particularly through the wetland regulatory process.

Purpose: To provide a summary of the known hydrological conditions in wetlands across Anoka County that can be used to assist with wetland regulatory decisions. In particular, these data assist with deciding if an area is or is not a wetland by comparing the hydrology of an area in question to known wetlands in the area. The database created to produce the summaries below can be used to answer other, more specific, questions as they arise.

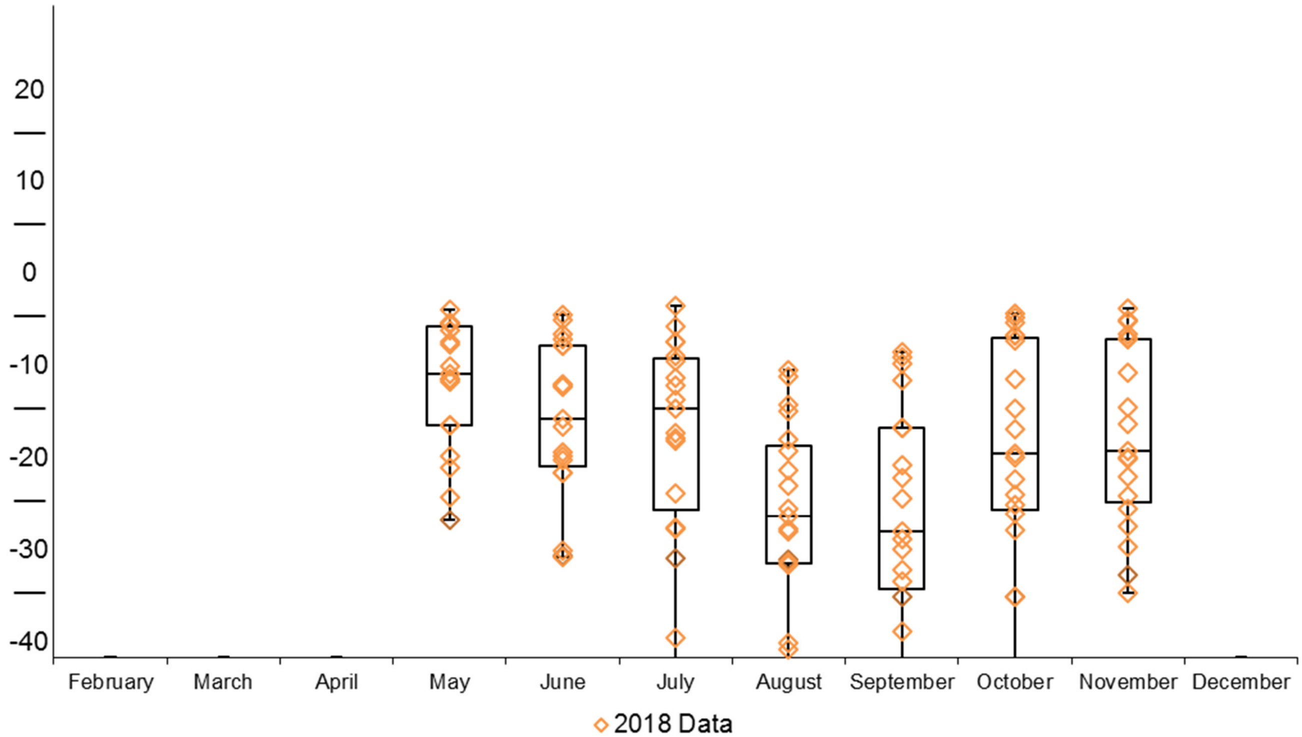
Locations: All 23 reference wetland hydrology monitoring sites in Anoka County.

Results: On the following pages. Data has been summarized for the most recent year alone, as well as across all years with available data.

Reference Wetland Hydrology Monitoring Sites – Anoka County



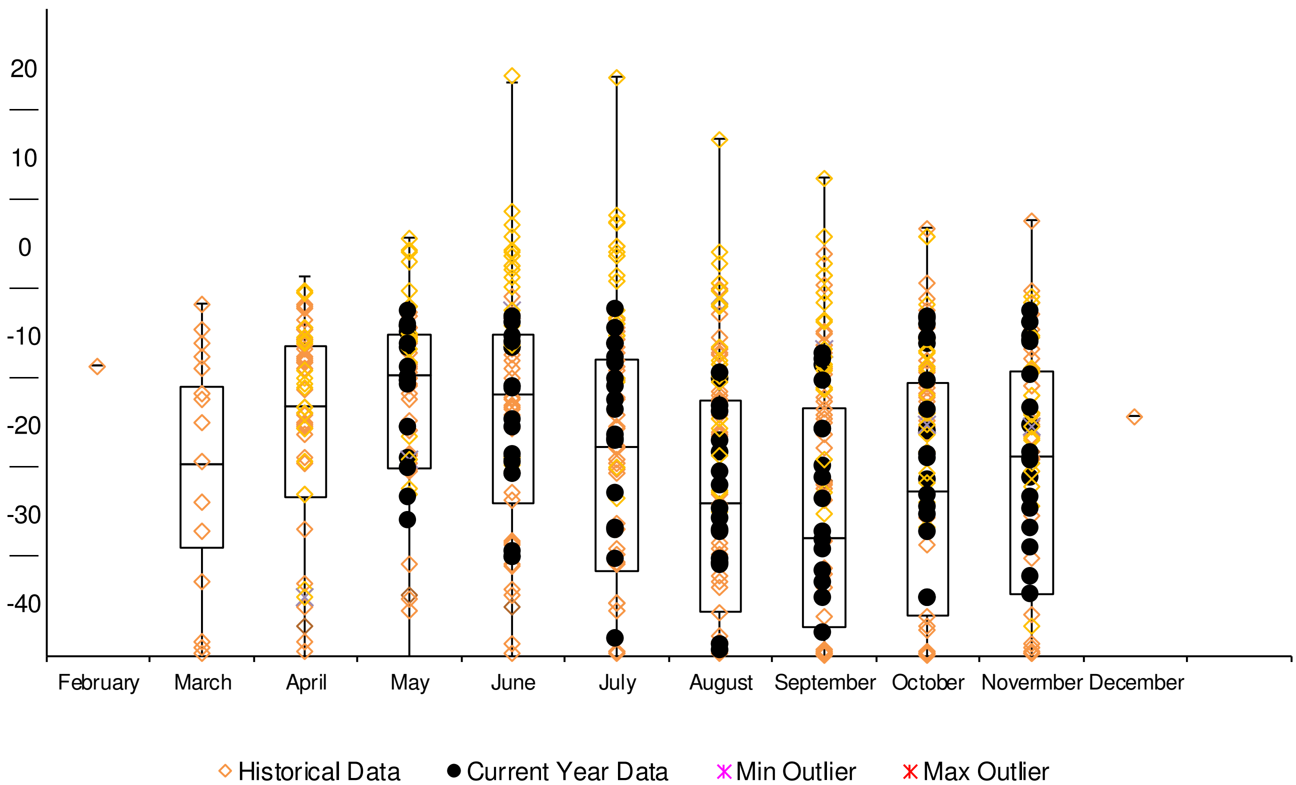
2018 Reference Wetland Water Levels Summary: Each marker represents the median depth to the water table at the edge of one reference wetland for a given month in 2018. The quantile boxes show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentile (floating horizontal lines). Maximum well depths were 40 to 45 in, so a reading < -40 in. likely indicates water was below the well at an unknown depth.



Quantiles

Month	Min	10%	25%	Median	75%	90%	Max
5	-25.2	-20.2	-15.1	-9.6	-4.6	-4.2	-2.7
6	-29.3	-28.7	-19.5	-14.4	-6.5	-5.0	-3.3
7	-40.2	-31.1	-24.2	-13.4	-8.0	-5.8	-2.3
8	-41.5	-39.4	-29.9	-24.9	-17.2	-12.3	-9.2
9	-42.1	-40.4	-32.7	-26.5	-15.4	-8.3	-7.3
10	-41.6	-33.5	-24.1	-18.1	-5.8	-4.0	-3.1
11	-33.1	-28.8	-23.3	-17.8	-5.8	-3.9	-2.5

1996-2018 Reference Wetland Water Levels Summary: Each dot represents the mean depth to the water table at the edge of one reference wetland for a month between 1996 and 2018. The quantile boxes show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentile (floating horizontal lines). Maximum well depths were 40 to 45 in., so a reading < -40 in. likely indicates water was below the well at an unknown depth.



Quantiles

Month	Min	10%	25%	Median	75%	90%	Max
2	-8.6	-8.6	-8.6	-8.6	-8.6	-8.6	-8.6
3	-41.6	-39.1	-28.3	-19.3	-10.8	-6.4	-1.9
4	-41.6	-33.5	-22.7	-13.0	-6.5	-2.7	1.2
5	-41.6	-31.3	-19.7	-9.6	-5.1	-2.1	5.3
6	-50.5	-35.5	-23.4	-11.7	-5.2	-0.1	22.9
7	-67.9	-39.6	-30.7	-17.3	-8.0	-2.7	22.6
8	-50.3	-40.0	-35.1	-23.5	-12.3	-5.4	15.9
9	-48.8	-40.4	-36.9	-27.2	-13.1	-6.2	11.8
10	-45.0	-40.0	-35.5	-22.2	-10.4	-5.3	6.4
11	-46.9	-39.8	-33.4	-18.4	-9.2	-4.5	7.2
12	-14.0	-14.0	-14.0	-14.0	-14.0	-14.0	-14.0

Discussion:

The purpose of reference wetland data is to help ensure that wetlands are accurately identified by regulatory personnel, as well as to aid understanding of shallow groundwater hydrology. State and federal laws place restrictions on filling, excavating, and other activities in wetlands. Commonly, citizens wish to do work in an area that is sometimes, or perhaps only rarely, wet. Whether this area is a wetland under regulatory definitions is often in dispute. Complicating the issue is that conditions in wetlands are constantly changing—an area that is very wet and clearly wetland at one time may be completely dry only a few weeks later (dramatically displayed in the graphs above). As a result, regulatory personnel look at a variety of factors, including soils, vegetation, and current moisture conditions. Reference wetland data provide a benchmark for comparing moisture conditions in dispute, thereby helping assure accurate regulatory decisions. Likewise, it allows us to compare current shallow water levels to the range of observed levels in the past; this is useful for purposes ranging from flood prediction to drought severity indexing. The analysis of reference wetland data is a quantitative, non-subjective tool.

The simplest use of the reference wetland data in a regulatory setting is to compare water levels in the reference wetlands to water levels in a disputed area. The graphics and tables above are based upon percentiles of the water levels experienced at known wetland boundaries. The quantile boxes in the figures delineate the 10^{th}, 25^{th}, 50^{th}, 75^{th}, and 90^{th} percentiles. Water table depths outside of the box have a low likelihood of occurring, or may only occur under extreme circumstances such as extreme climate conditions or in the presence of anthropogenic hydrologic alterations. If sub-surface water levels in a disputed area are similar to those in reference wetlands, there is a high likelihood that the disputed area is a wetland.

This approach can be refined by examining data from only the year of interest and only certain wetland types. This removes much of the variation that is due to climatic variation among years and due to wetland type. Substantial variation in water levels will no doubt remain among wetlands even after these factors are accounted for, but this exercise should provide a reasonable framework for understanding what hydrologic conditions were present in known wetlands during a given time period.

Water table levels are recorded every 4 hours at all 23 reference wetlands (except during winter), and the raw water level data are available through the Anoka Conservation District.

Aquatic Invasive Species Early Detection Surveys

Description: AIS early detection surveys are conducted twice annually on up to five lakes within Coon Creek Watershed District (CCWD). ACD conducts a meandering boat survey on each lake in early and late summer. During the surveys, ACD staff weave between the shoreline and maximum rooting depth around the entire lake. In lakes shallow enough for plants to root throughout, meanders are made from shoreline to shoreline. Invasive aquatic vegetation is searched for from the boat and using a weed rake. At least 20 rake tosses are performed on each lake each time surveyed. Any new infestations to each lake are noted and CCWD and MN DNR staff are notified.

Starting in 2018, CCWD lakes were surveyed as Tier 1 or Tier 2 lakes (see table below). Tier 1 lakes surveyed included a 30 minute visual search at the public access and 10 minute visual searches at each of three separate target sites in addition to the meandering boat search and weed rake tosses. Tier 2 lakes included a 10 minute visual search at each public access in addition to the meandering boat search and weed rake tosses. Visual searches were performed by wading and slowly paddling the boat to not cloud up the water.

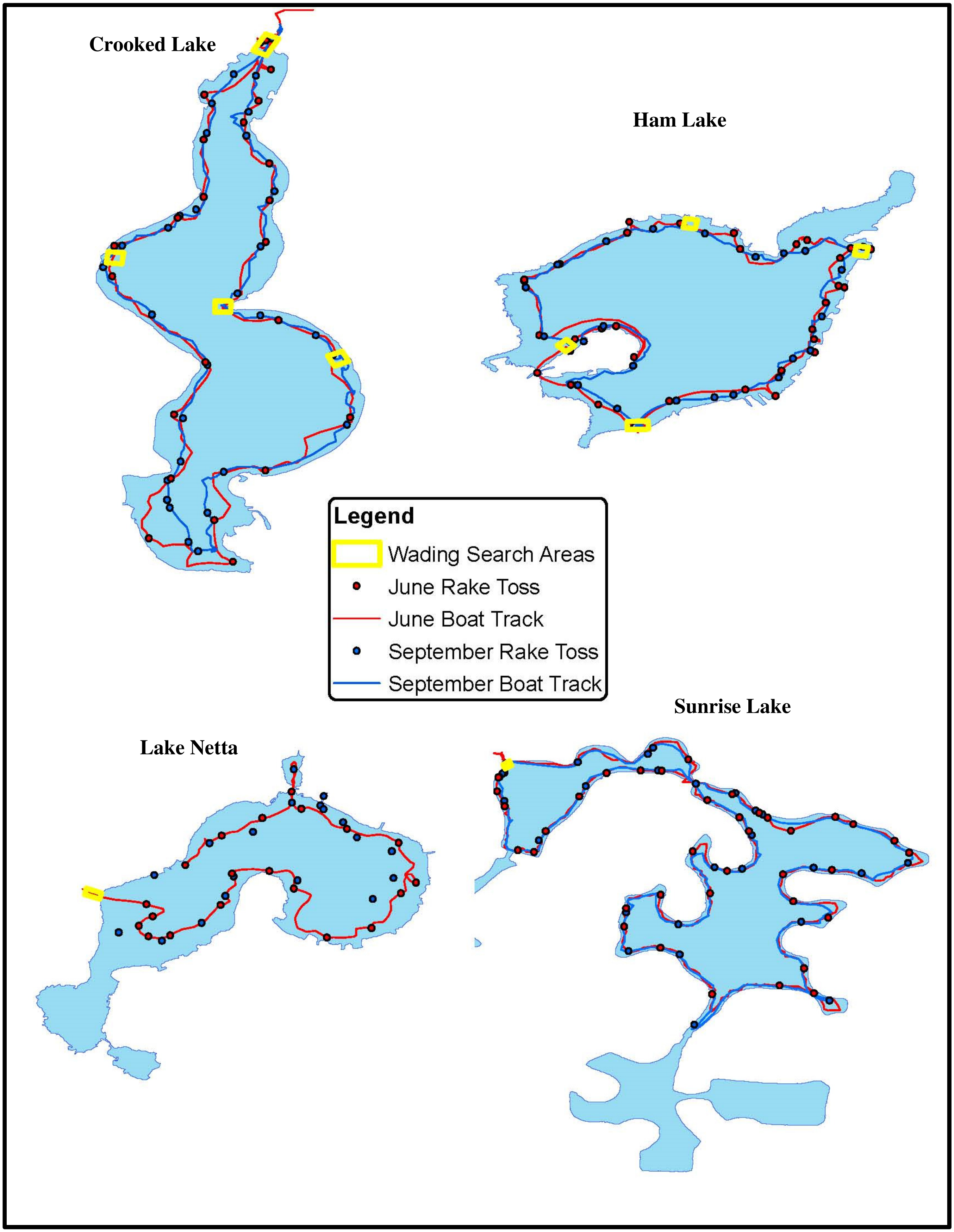
Purpose: To detect new invasive aquatic species in CCWD lakes

Locations:

Site	City	Dates Surveyed
Crooked Lake	Andover/Coon Rapids	6/27/2018 & 9/14/2018
Ham Lake	Ham Lake	6/28/2018 & 9/10/2018
Lake Netta	Ham Lake	6/28/2018 & 9/10/2018
Sunrise Lake	Blaine	6/27/2018 & 9/14/2018

Results: Surveys were conducted in June and September of 2018. Invasive phragmites was discovered on Ham and Sunrise Lakes. Purple loosestrife was discovered on Lake Netta. A stand of milfoil was detected on Sunrise Lake, but further analysis is required to determine if it is a native or invasive species.

Meandering boat tracks and weed rake toss locations are shown in the maps below. The Lake Netta September boat track was lost from the GPS unit used by ACD staff, but the 20 rake toss locations remained.



Crooked Lake
Ham Lake
Legend
Wading Search Areas
June Rake Toss
June Boat Track
September Rake Toss
September Boat Track
Sunrise Lake
Lake Netta

Financial Summary

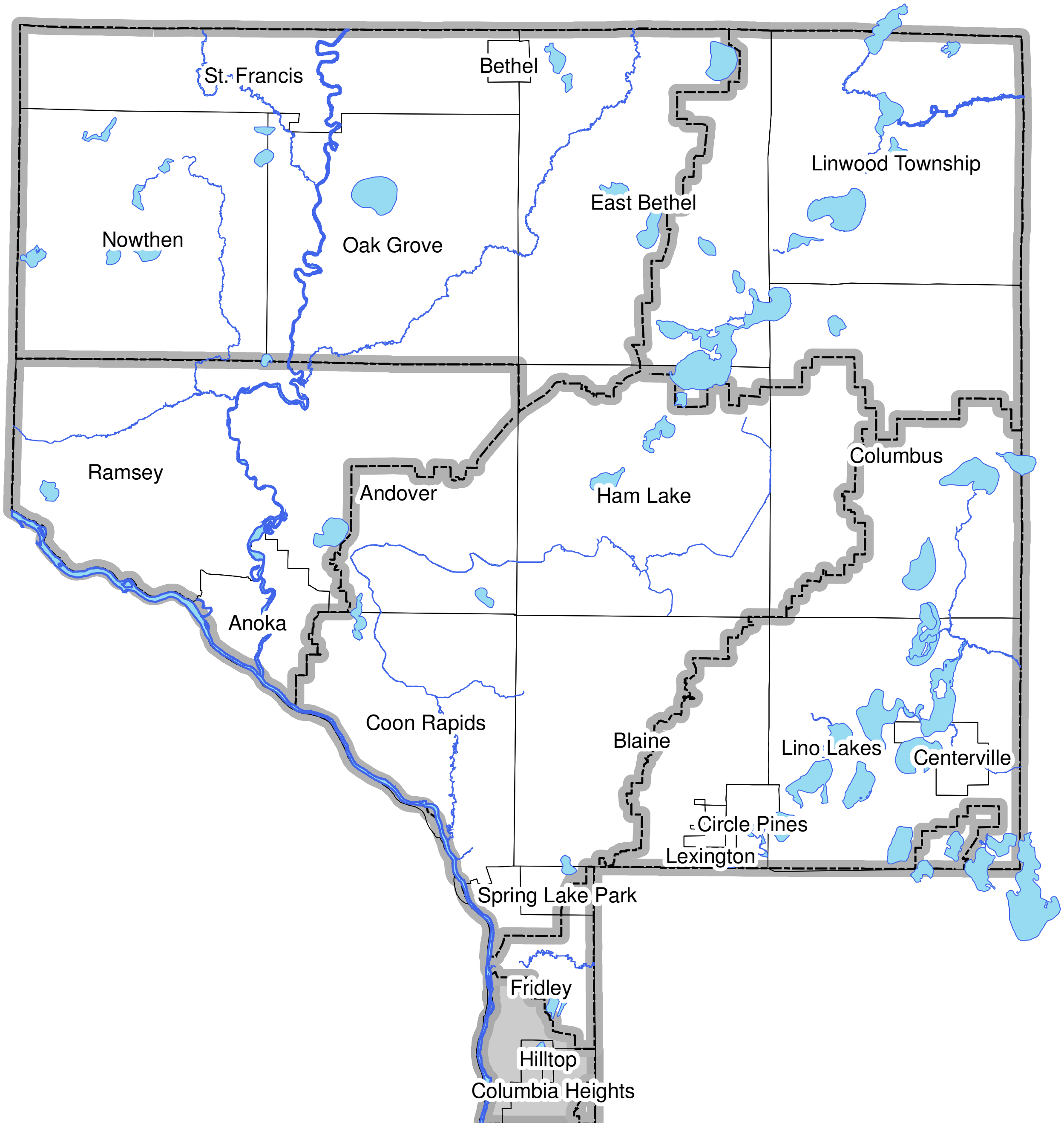
ACD accounting is organized by program and not by customer. This allows us to track all of the labor, materials and overhead expenses for a program, such as our lake water quality monitoring program. We do not, however, know specifically which expenses are attributed to monitoring which lakes. To enable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

Coon Creek Watershed District 2018 Financial Summary

		Monitoring										Analysis		Planning		Administrative Assistance											Outreach				
Coon Creek Watershed	Total	Volunteer Precip	DNR Groundwater Wells	Wetland Levels	Lake Levels	Stream Levels	Rating Curves	Lake Water Quality	Stream Water Quality	CCWD Continuous Storm Monitoring	CCWD AIS Early Detection	Inventory - Mississippi River Below Dam	Water Resources Almanac	Anoka Sandplain Partnership	Wetland Resto Opportunities	Land Prot/Resto Strategies	Land Protection Outreach	Landowner Tech. Asst.	Project Profiles	BMP Maintenance & Inspection	WCA Enforcement	Wetland Consultation	Wetland Restoration and Banking	Cooperative Weed Management	WCA Implementation	Watershed Based Funding Coordination	Video Development	Brochures & Displays	Web Blog	Web Story Map	Anoka County Outreach Program
Revenues																															
CCWD	68322			4872	1800	6850	7500	7800	34600	2800	2100																				
State - Other	26762		490																					4408	21864						
MPCA																															
DNR OHF																															
DNR CPL																															
BWSR - Service Grant	18685											657		2507	2541	897		2282	716	1556						5233	743	1413	140		
BWSR - Project Grant	5395																														5395
Metro ETA & NPEAP	200																	200													
Regional/Local	369							369																							
Anoka Conservationi District	31376										2560		8358	364		62	266	2347		119	805	6994	596	22	8049	14		143	34	437	207
County Ag Preserves/Projects	1077							1077																							
Service Fees	1441																865							524	52						
TOTAL	153627		490	4872	1800	6850	7500	9246	34600	2800	4660	657	8358	2870	2541	959	1131	4830	716	1675	805	6994	596	4954	29965	5247	743	1556	173	437	5601
Expenses-																															
Personnel Salaries/Benefits	111327	367	1062	2695	974	10888	2485	6641	11912	5136	3766	666	11492	2410	2149	829	956	4218	643	1343	711	5834	520	3666	19708	4441	175	1210	131	398	3897
Overhead	13530	47	138	311	111	1262	302	798	1401	617	455	56	1536	338	322	98	141	498	84	167	93	808	74	409	2200	660	27	176	12	45	343
Vehicle/Mileage	2028	7	17	68	24	253	75	157	242	118	87	12	89	20	12	10	6	89	5	26	14	80	4	78	388	53	1	17	2	5	71
Project Direct - Supplies	18369	4		47	3	163		1506	6201	234	163						21			119		119		836	8093	14	536	143	27		140
Project Direct - Capital	1084							311	773																						
Project Direct - Installation																															
TOTAL	146338	425	1217	3122	1112	12566	2861	9413	20529	6105	4471	735	13117	2768	2482	938	1124	4805	733	1655	818	6841	598	4989	30389	5168	739	1547	173	448	4450

2018 Anoka Water Almanac

Chapter 7: Mississippi Watershed



Prepared by the Anoka Conservation District

Mississippi Watershed Management Organization

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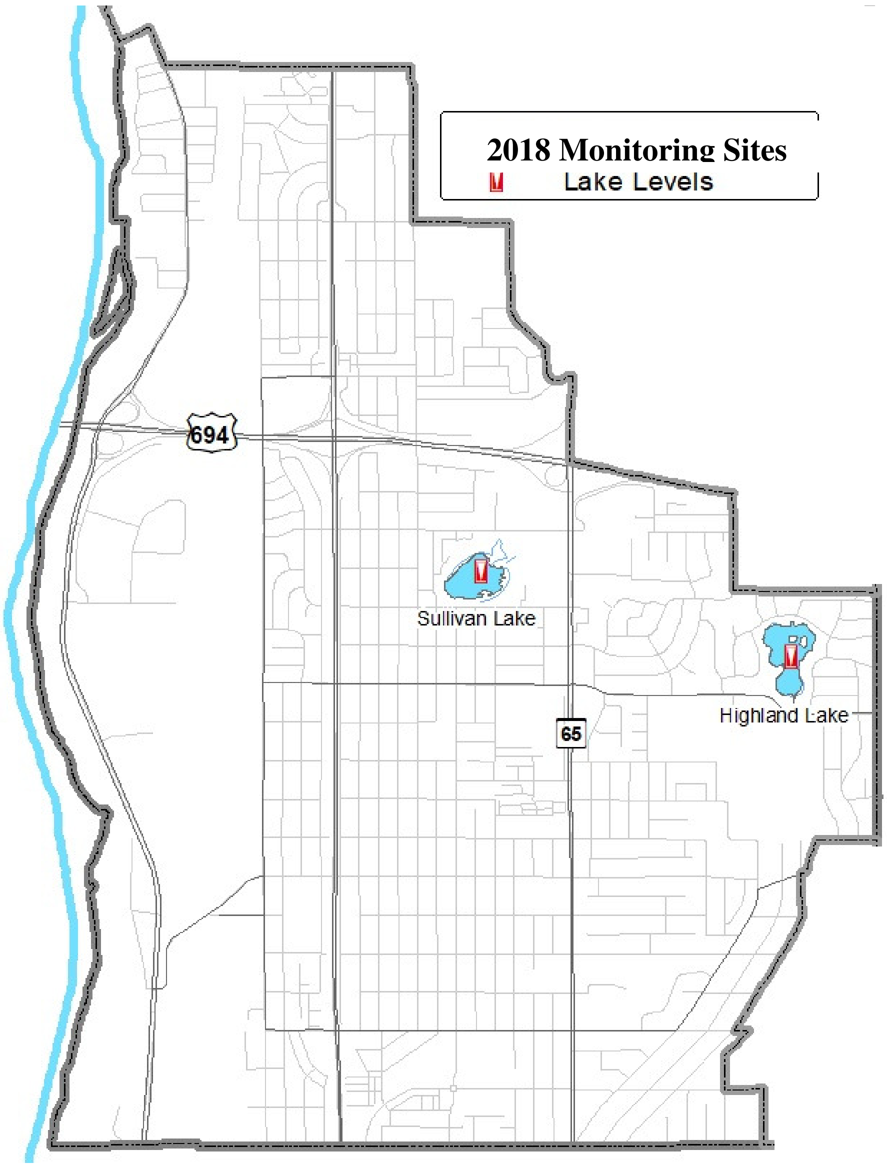
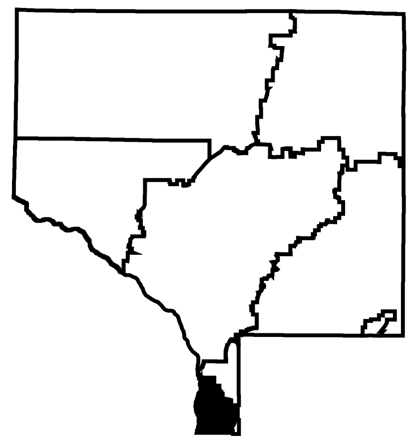




Lake Levels

Partners: MWMO, ACD, MN DNR, volunteers

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

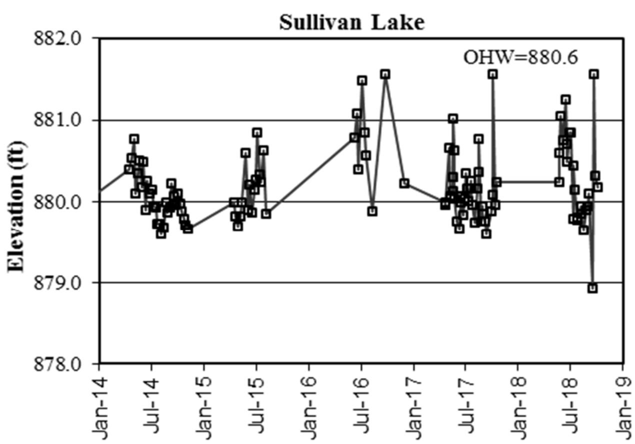
Purpose: To provide understanding of lake hydrology, including the impact of climate and water budget changes. These data are useful for regulatory, building/development, and lake hydrology manipulation decisions.

Locations: Sullivan/Sandy Lake
Highland Lake

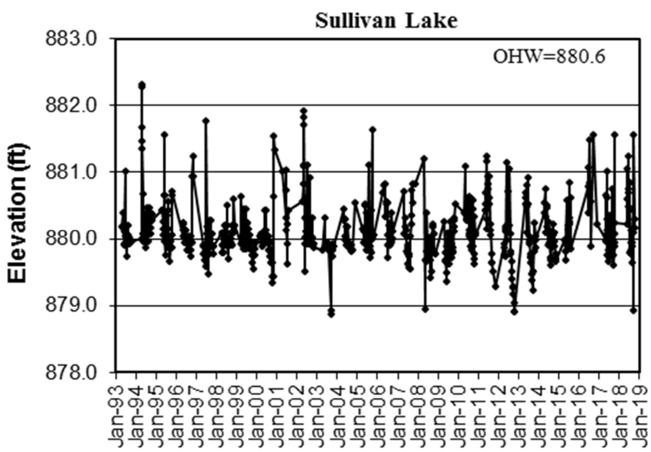
Results: Lake levels were measured 24 times at each lake May through October of 2018. Sullivan Lake water levels fluctuate widely, routinely bouncing by half a foot in response to rainfall and fluctuating 2.64 ft in 2018. Sullivan Lake experiences these fluctuations because it receives a large amount of storm water relative to its size, and its outlet releases water in all but the lowest water conditions. Highland Lake fluctuated very little only ranging 0.50 ft. throughout the season.

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

Sullivan/Sandy Lake Levels last 5 years



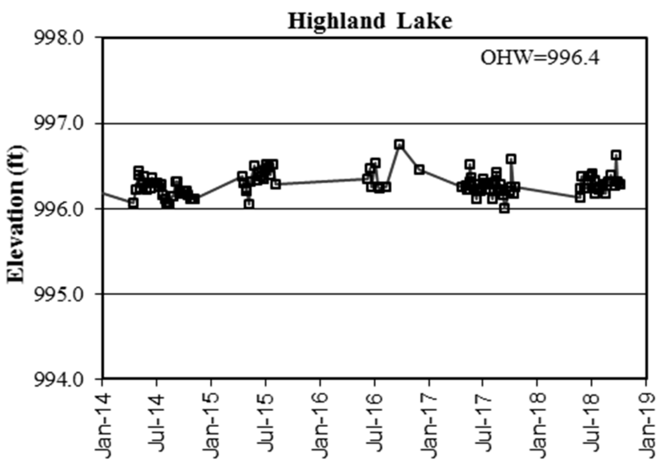
Sullivan/Sandy Lake Levels last 25 years



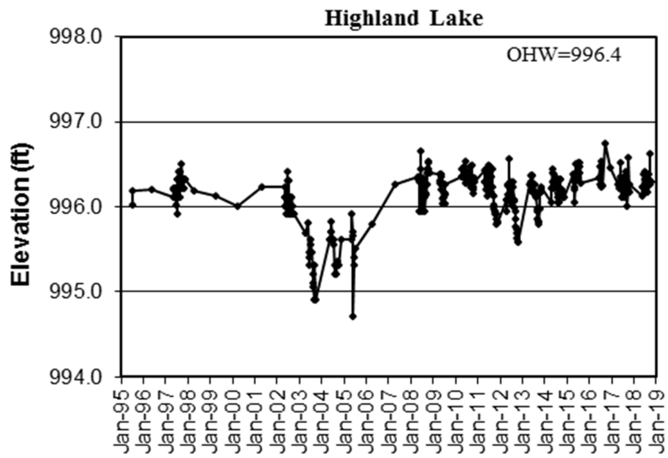
Sullivan/Sandy Lake level 5 year summary

Year	Average	Min	Max
2014	880.05	879.60	880.76
2015	880.14	879.69	880.85
2016	880.76	879.88	881.56
2017	880.13	879.60	881.56
2018	880.29	878.93	881.57
5-year	880.27	878.93	881.57

Highland Lake Levels last 5 years



Highland Lake Levels 1995-2018



Highland Lake level 5-year summary

Year	Average	Min	Max
2014	996.22	996.05	996.44
2015	996.36	996.05	996.52
2016	996.40	996.24	996.75
2017	996.27	996.01	996.58
2018	996.30	996.13	996.63
5-year	996.29	996.01	996.75

Financial Summary

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MWMO 2018 Financial Summary

		Monitoring & Inventory			Analysis & Planning				Technical & Administrative Assistance										Outreach				
Mississippi WMO	Total	Lake Levels	Inventory - Mississippi River Below Dam	Water Resources Almanac	Highland/Sullivan Subwatershed Analysis	Anoka Sandplain Partnership	Wetland Resto Opportunities	Land Prot/Resto Strategies	Land Protection Outreach	Landowner Tech. Asst.	Project Profiles	BMP Maintenance & Inspection	WCA Enforcement	Wetland Consultation	Wetland Restoration and Banking	Cooperative Weed Management	WCA Implementation	Watershed Based Funding Coordination	Video Development	Brochures & Displays	Web Blog	Web Story Map	Anoka County Outreach Program
Revenues																							
MWMO	600	600																					
State - Other	2985															501	2485						
MPCA																							
DNR OHF																							
DNR CPL																							
BWSR - Service Grant	2706		657			285	289	102		259	81	177						595	84	161	16		
BWSR - Project Grant	613																						613
Metro ETA & NPEAP	1682				1659					23													
Regional/Local																							
Anoka Conservationi District	2669			149	195	41		7	30	267		14	91	795	68	3	915	2		16	4	50	23
County Ag Preserves/Projects																							
Service Fees	164								98							60	6						
TOTAL	11419	600	657	149	1854	326	289	109	128	549	81	190	91	795	68	563	3405	596	84	177	20	50	637
Expenses-																							
Personnel Salaries/Benefits	9166	390	666	205	1855	274	244	94	109	479	73	153	81	663	59	417	2240	505	20	138	15	45	443
Overhead	1029	44	56	27	163	38	37	11	16	57	10	19	11	92	8	47	250	75	3	20	1	5	39
Vehicle/Mileage	161	10	12	2	37	2	1	1	1	10	1	3	2	9	0	9	44	6	0	2	0	1	8
Project Direct - Supplies	1143	1							2			14		14		95	920	2	61	16	3		16
Project Direct - Capital																							
Project Direct - Installation																							
TOTAL	11500	445	735	234	2056	315	282	107	128	546	83	188	93	777	68	567	3453	587	84	176	20	51	506

Recommendations

- Continue to monitor levels on Highland and Sullivan Lakes.
- Periodically monitor water quality on Highland and Sullivan Lakes.
- A Stormwater Retrofit Analysis (SRA) of the Highland and Sullivan Lake contributing drainage areas is planned for 2019. This study will result in a project list ranked by cost-effectiveness at reducing pollutant loading to the lake. Implementing the recommendations from this analysis should result in the most cost effective water quality improvement possible for these two lakes.