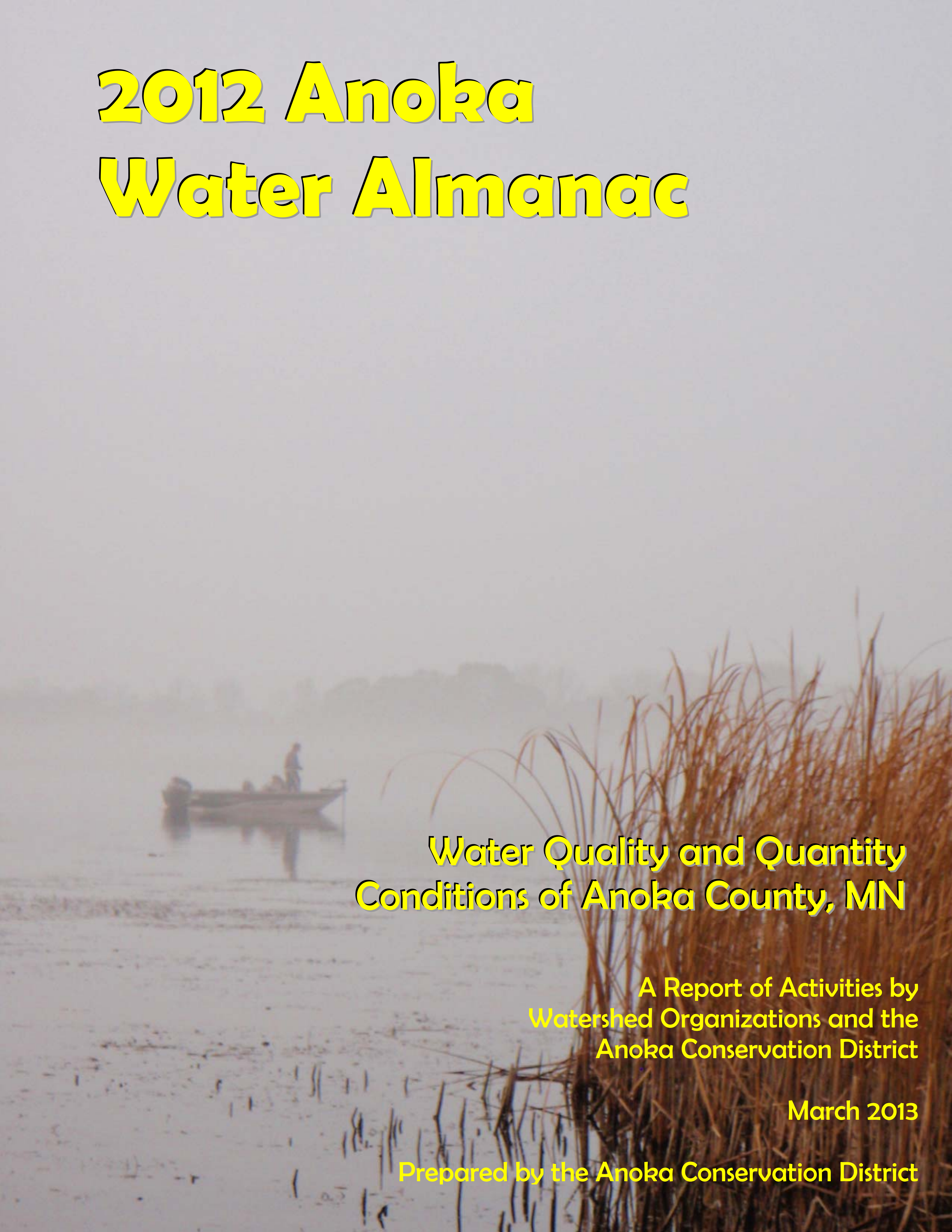
2012 Anoka Water Almanac



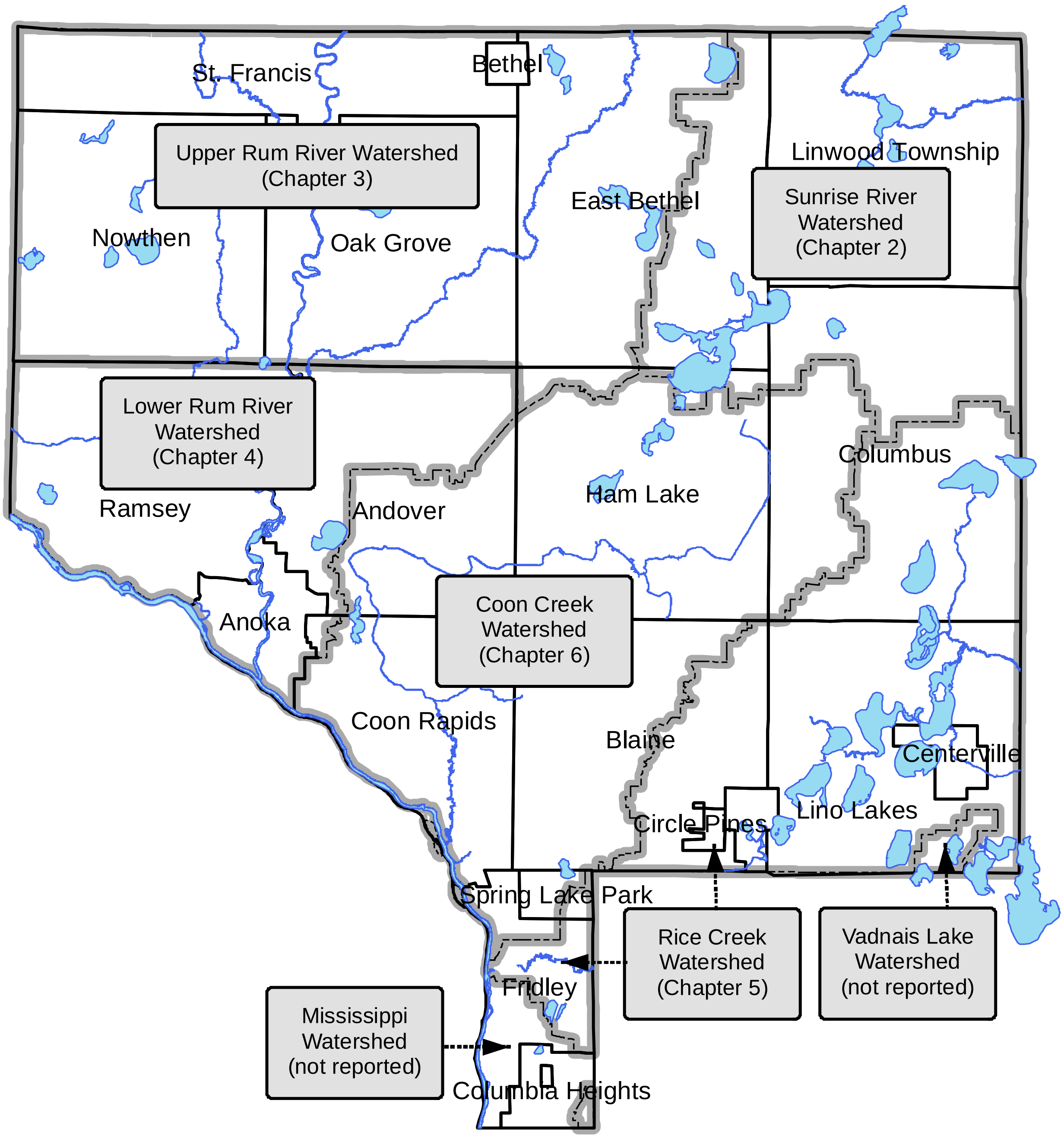
Water Quality and Quantity Conditions of Anoka County, MN

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

March 2013

Prepared by the Anoka Conservation District

Chapter 1 - Primer



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2012 ANOKA WATER ALMANAC

Water Quality & Quantity Conditions of Anoka County, Minnesota

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

March 2013

Prepared by
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ANOKA CONSERVATION DISTRICT

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

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 a watershed district or watershed management organization. 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 hints 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
    - deep groundwater 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,
    - precipitation storm analyses and long term antecedent moisture analyses, and
    - reference wetland vegetation inventories and 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 2012. 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 2012 is presented in this almanac (although trend and similar analysis also include previous years' data). For results of work completed in years past, readers should refer to previous Water Almanacs. All data collected in 2012 and in years past 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 and goundwater level database, and the State Climatology's online precipitation database.

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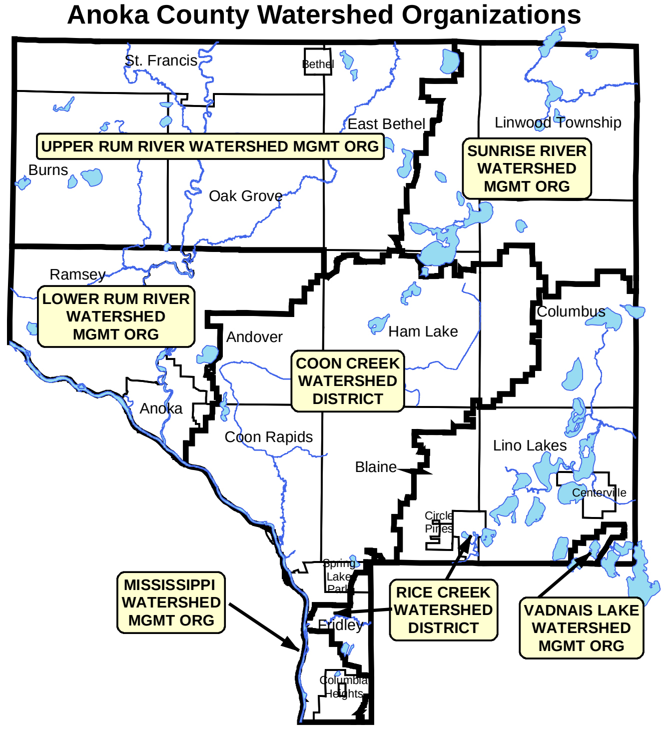
Anoka County Watershed Organizations

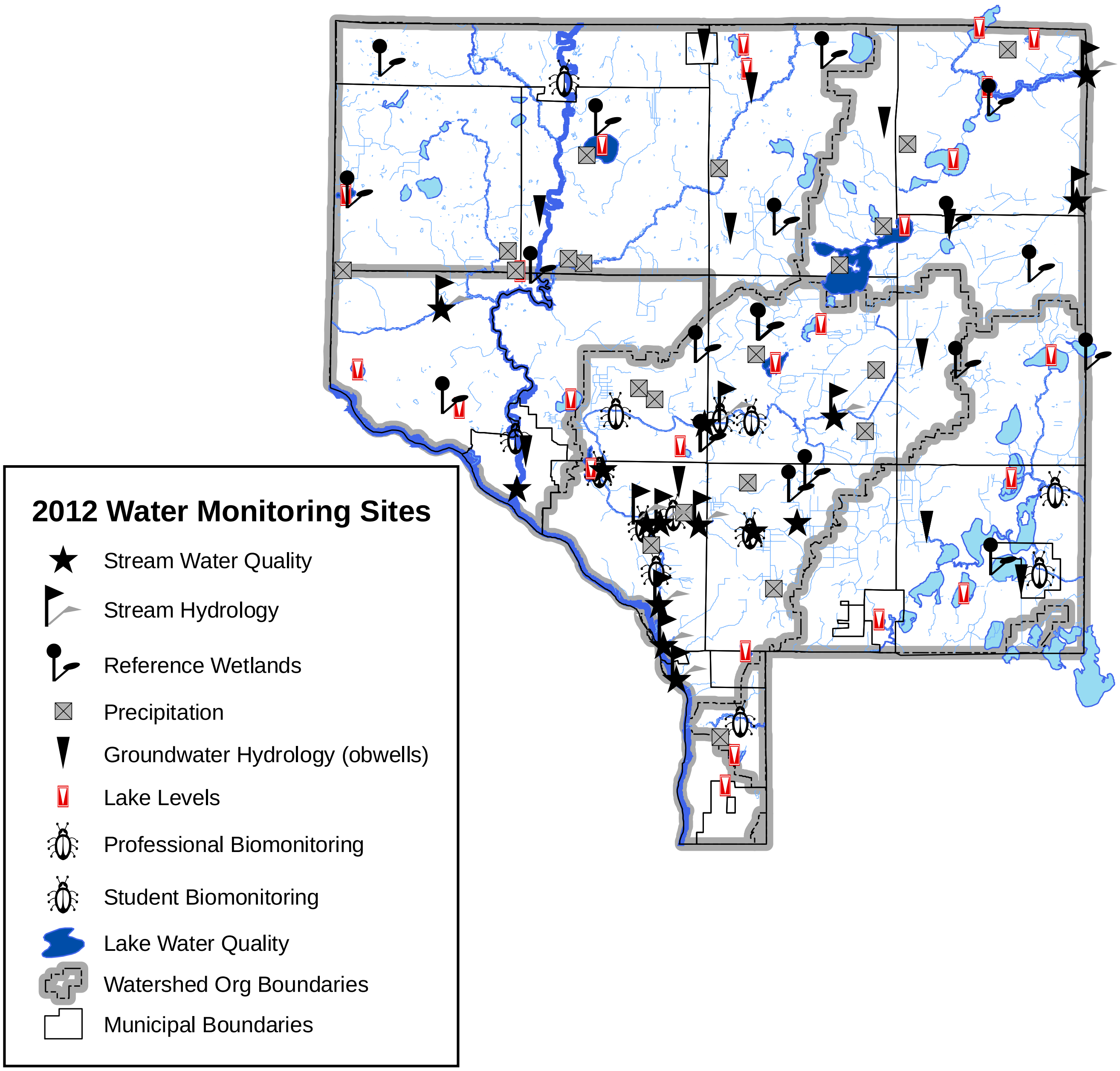


CHAPTER 1: WATER RESOURCE MONITORING PRIMER

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 layperson 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.

2012 Water Monitoring Sites



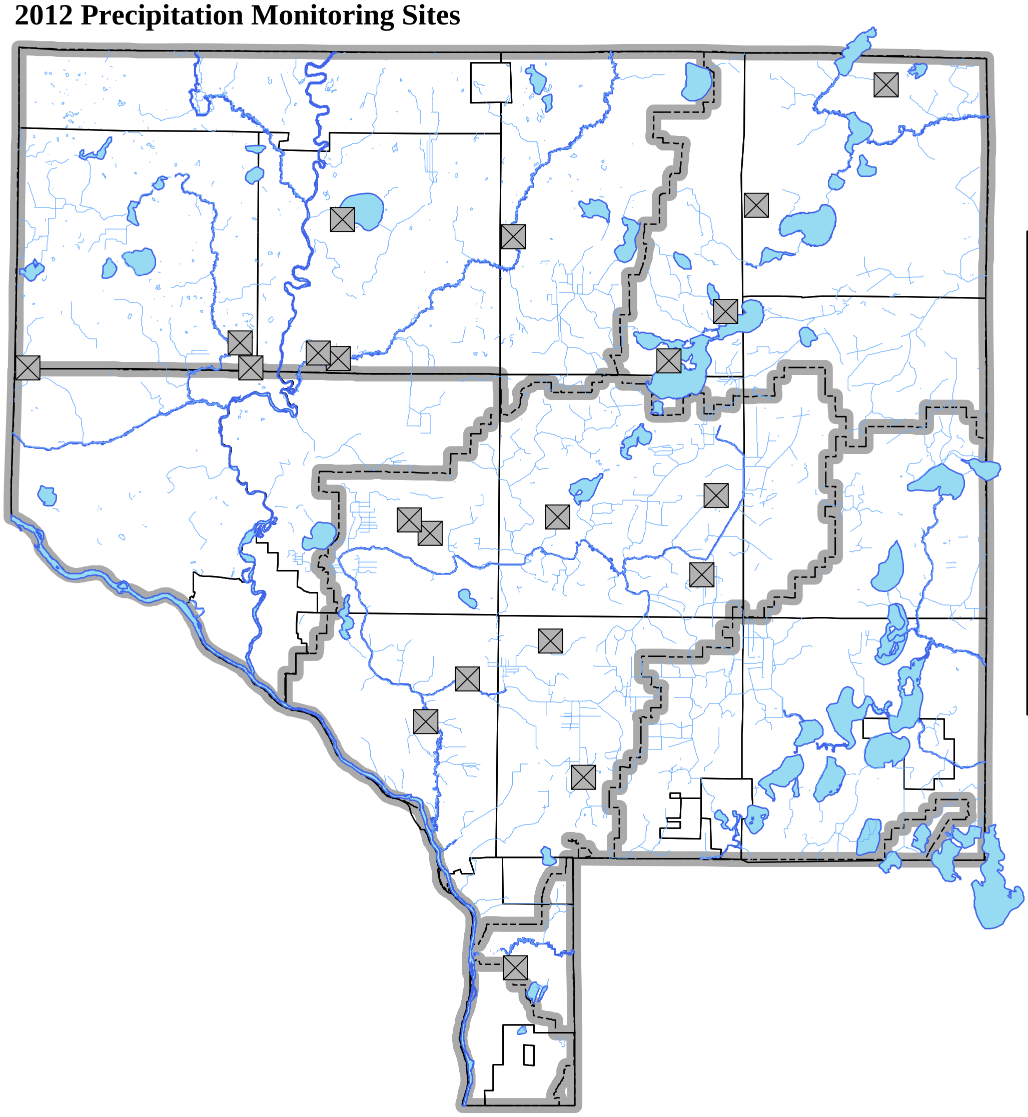
Precipitation

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.

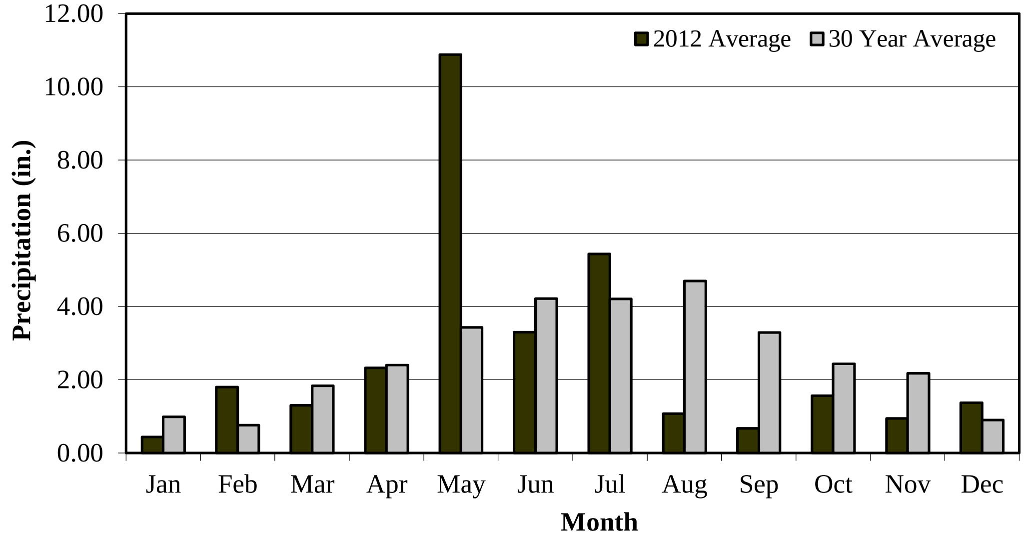
The ACD coordinates a network of 21 rain gauges countywide. Fifteen are monitored by volunteers and six are monitored using datalogging stations operated by the ACD for the Coon Creek Watershed District. The volunteer-operated stations are cylinder-style rain gauges located at the volunteer's home. Total rainfall is read daily. The datalogging rain gauges electronically record the time and date of each 0.01 inch of rain that falls. These gauges are downloaded approximately every four weeks. 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. Analyses of antecedent moisture for selected locations are provided in the Coon Creek Watershed chapter.

2012 Precipitation Monitoring Sites



2012 Anoka County Average Monthly Precipitation (average of all sites)



2012 Anoka County Monthly Precipitation at each Monitoring Site

Month

Location or Volunteer	City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total	Growing Season (May-Sept)
Tipping bucket, datalogging rain gauges (Time and date of each 0.01" is recorded)															
Andover City Hall	Andover			0.95	2.53	8.44	4.08	6.50		3.27	0.85				
Blaine Public Works	Blaine			0.84	2.28	9.37	3.41	4.87	0.95	0.58	1.17	1.05			19.18
Coon Rapids City Hall	Coon Rapids			1.28	2.48	11.20	3.52	6.17	1.28	0.61	1.39	0.98			22.78
Anoka Cons. District office	Ham Lake				2.66	10.65	3.00	6.36	0.76	0.29	1.38	1.03			21.06
Hoffman Sod Farm	Ham Lake				2.49	10.01	3.05			1.19	1.23	1.08			
Northern Nat. Gas substation	Ham Lake			0.86	2.34	10.16	2.40			0.47	1.28	0.70			
Cylinder rain gauges (read daily)															
N. Myhre	Andover	0.64	1.57	1.52	2.24	10.68	3.26	5.57	0.77	0.53	2.40	0.89	1.57	31.64	20.81
B. Guetzko	Nowthen				1.97	12.97									
J. Rufsvold	Burns				2.41	12.31	2.90		0.93	0.49	1.31				
J. Arzdorf	Blaine				2.60	10.24	2.94	5.63	1.06	0.58	1.44				20.45
S. Solie	Coon Rapids				2.78	10.43									
M. Gaynor	East Bethel				2.50	10.33									
P. Arzdorf	East Bethel				2.38	12.92	3.21	6.44	1.18	0.49	2.39				24.24
A. Mercil	East Bethel	0.38	1.80	1.29	2.49	10.87	2.84	4.54	1.58	0.40	1.85	0.91	0.76	29.71	20.23
K. Ackerman	Fridley	0.35	2.08	1.55	2.89	10.52	4.38	5.45	1.02	0.53	1.81	1.03	1.69	33.30	21.90
B. Myers	Linwood				2.13	9.46	2.73	4.04	1.10	0.28	1.55				17.61
D. Kramer	Linwood			1.21	2.48	11.59	3.10	5.09	1.23	0.49	2.11				21.50
A. Dalske	Oak Grove	0.39	1.74	1.04	2.39	12.45	2.80	5.22	1.02	0.37	2.46	0.95	1.48	32.31	21.86
P. Freeman	Oak Grove			2.50	0.43	9.95	4.03	5.55	1.07	0.57					21.17
D. Conger	Oak Grove					12.33	3.39	4.68	1.10	0.38	0.89				22.77
Y. Lyrenmann	Ramsey				2.00	11.57	4.38	5.42	1.08		1.03	0.88			22.45
2012 Average	County-wide	0.44	1.80	1.30	2.32	10.88	3.30	5.44	1.08	0.68	1.56	0.95	1.38	31.12	21.37
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.

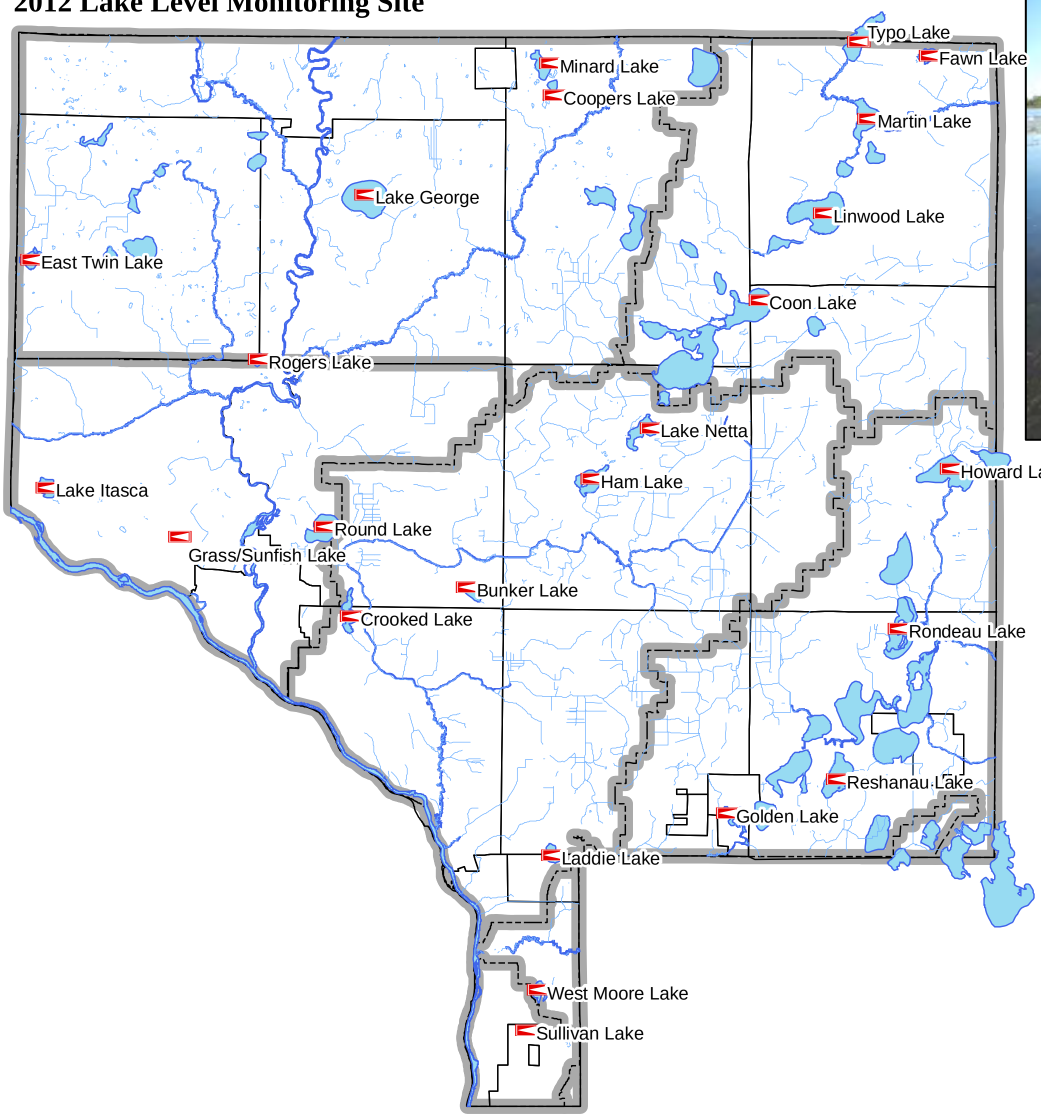
Lake Levels

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 24 lakes.

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.

2012 Lake Level Monitoring Site



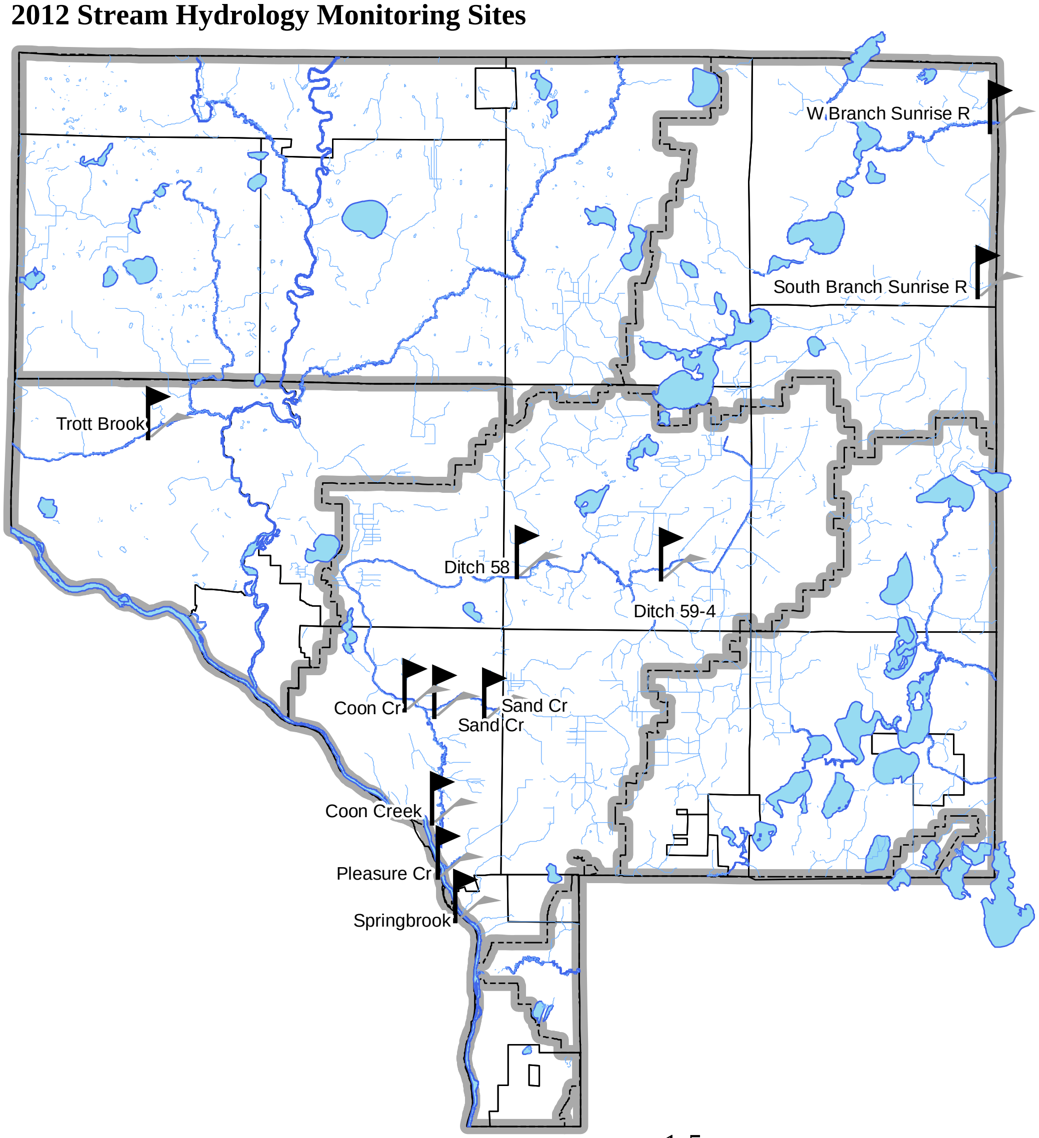
Stream Hydrology

Hydrology is the study of water quantity and movements. 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 is then used in computer models and water pollution regulatory determinations.

The ACD monitored hydrology at 11 stream sites in 2012. At each site is an electronic gauge that records water levels every two hours. 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. 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.

2012 Stream Hydrology Monitoring Sites



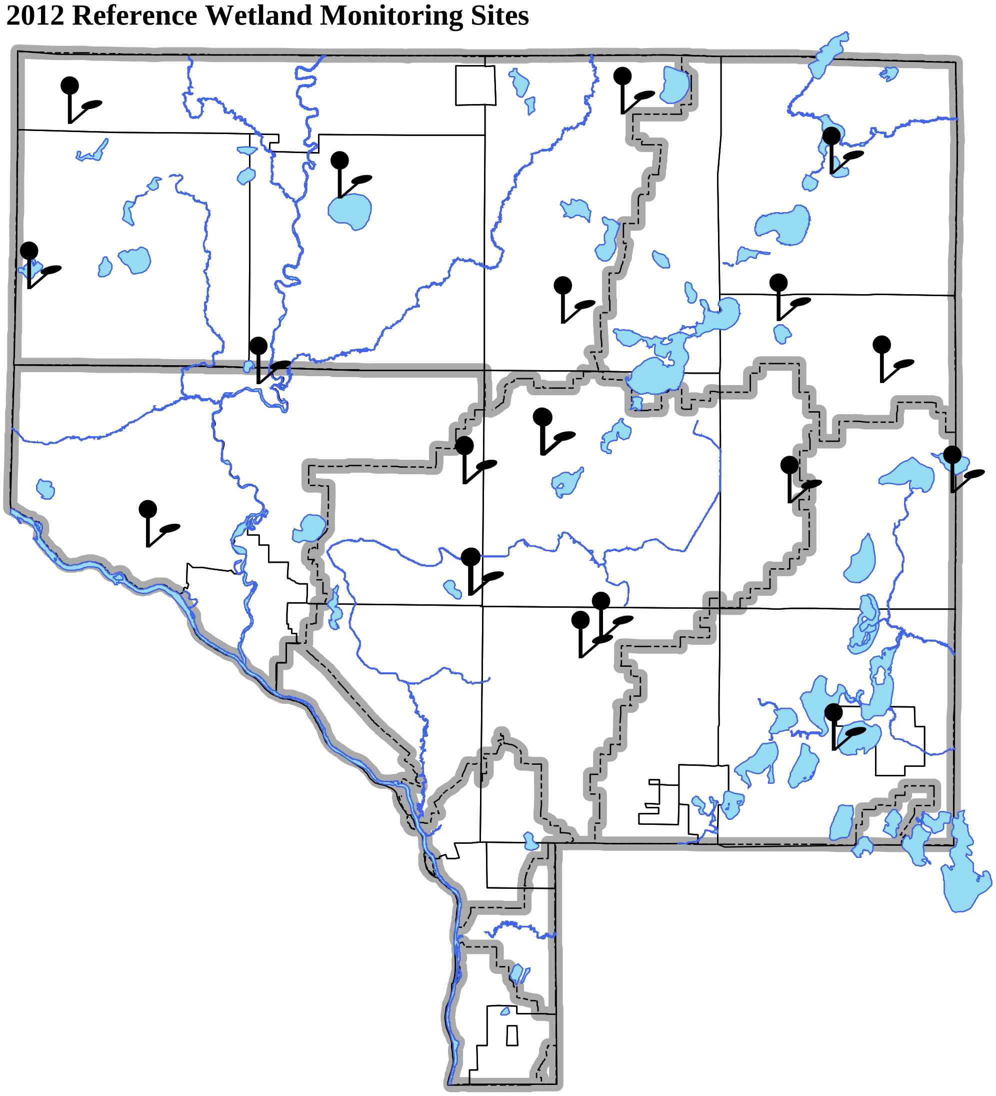
Wetland Hydrology

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. In order to facilitate fair, accurate wetland determinations the ACD monitors 18 wetlands throughout the county that serve as a reference of conditions county-wide. These are called reference wetlands. Electronic monitoring wells are used to measure subsurface water levels at the wetland edge every four hours down to a depth of 40 inches below grade. 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 some most been monitored for 10+ years.

Reference wetland data provides 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.

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.

2012 Reference Wetland Monitoring Sites

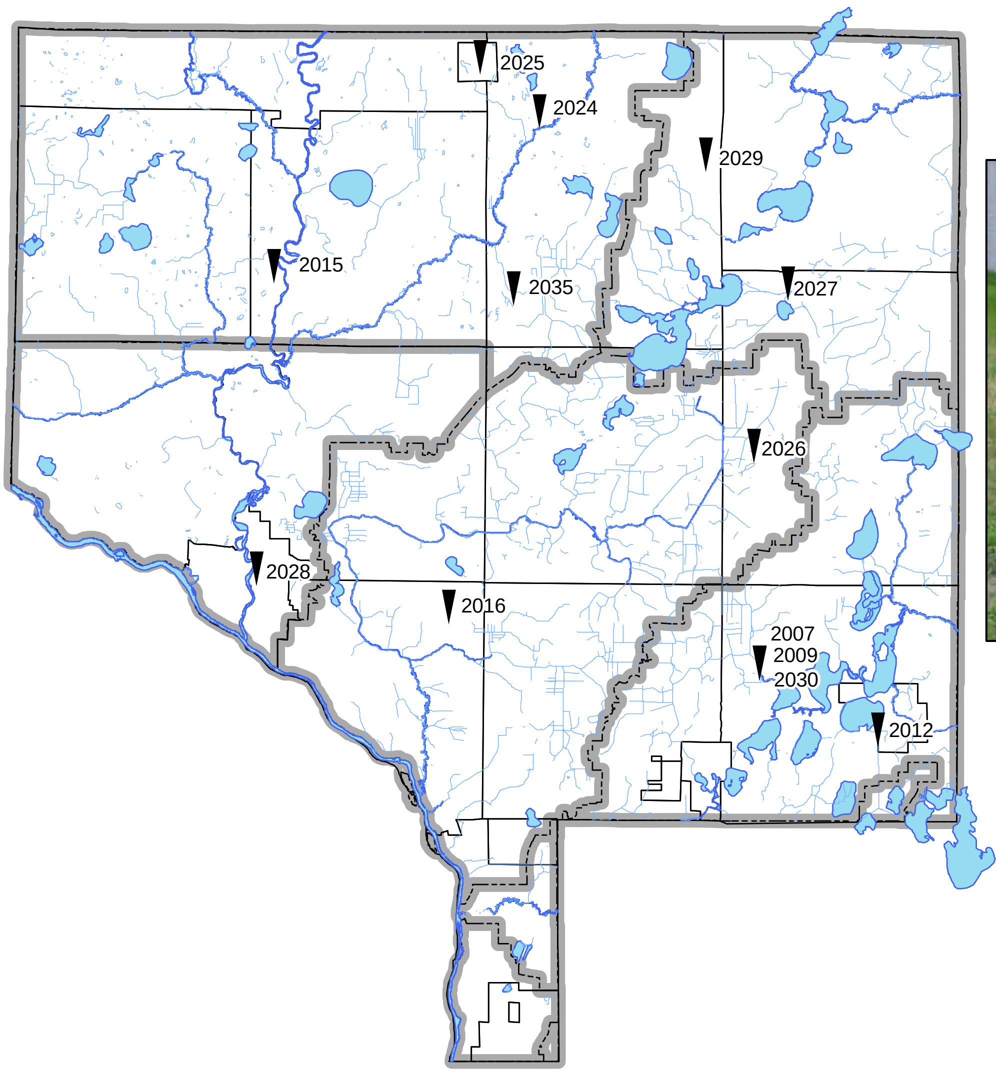


Groundwater Hydrology

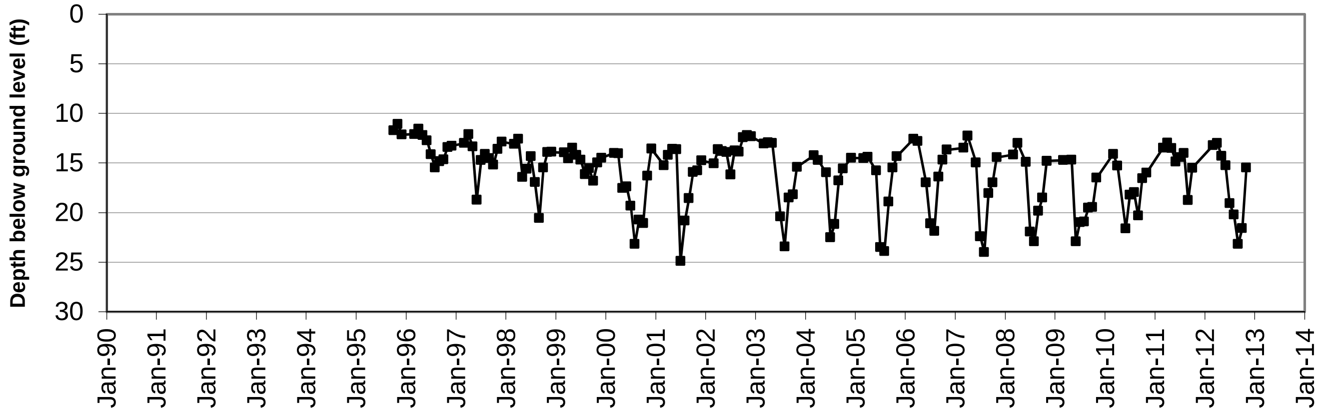
The Minnesota Department of Natural Resources (MN DNR) and ACD are interested in understanding Minnesota's groundwater quantity and flow. The MN DNR maintains a network of groundwater observation wells across the state. The ACD is contracted to take monthly water level readings in wells at 11 sites in Anoka County from March to December. At some sites, the MN DNR also has automated devices taking water level readings at more frequent intervals. The MN DNR incorporates these data into a statewide database that aids in groundwater mapping. The data are reported by the MN DNR and available to the public on their web site http://www.dnr.state.mn.us/waters/groundwater_section/obwell. 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 for 1990-2012. These results are not presented elsewhere in this report. Raw data can be downloaded from the MN DNR website.

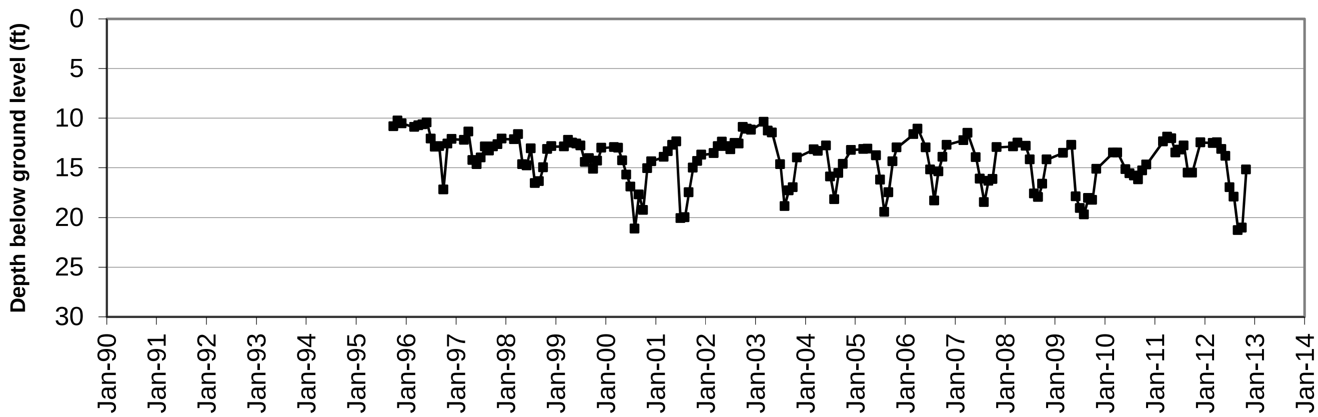
Groundwater Observation Well Sites and Well ID Numbers



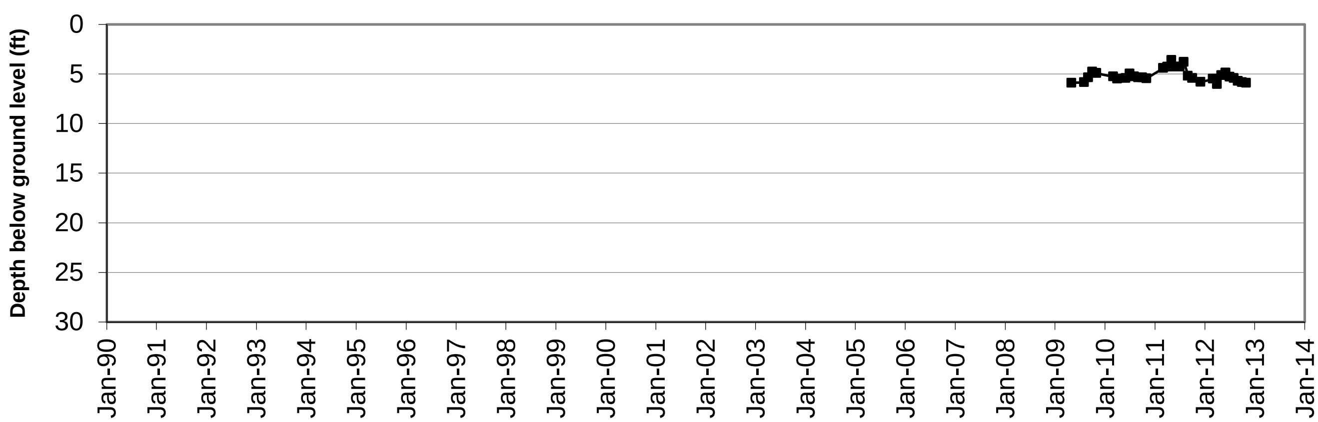
Observation Well #2007 (270 ft deep)—Lino Lakes



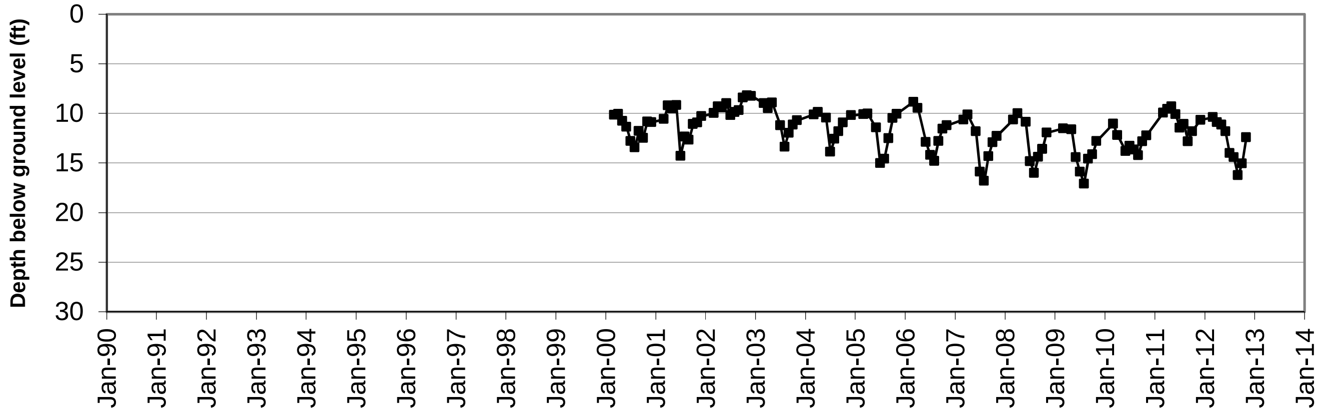
Observation Well #2009 (125 ft deep)—Lino lakes



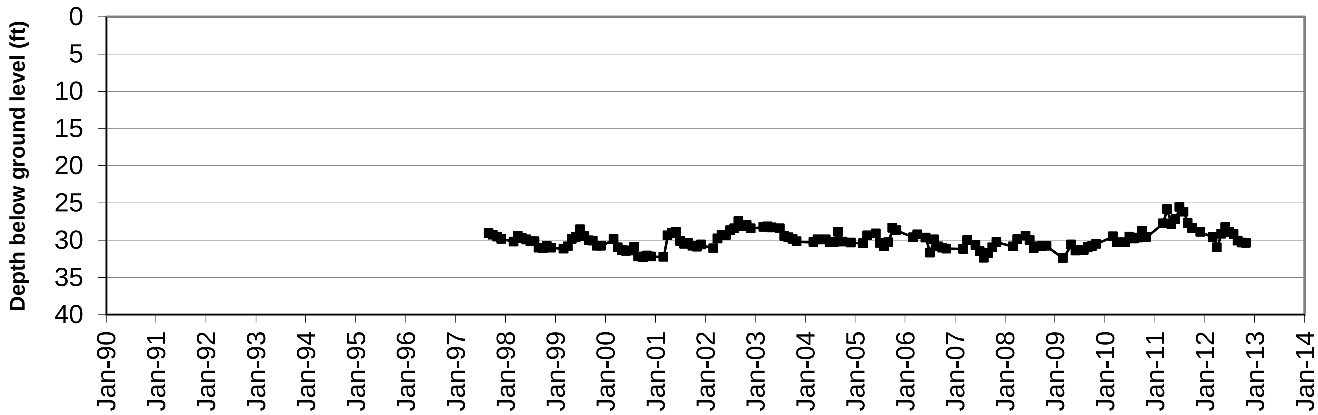
Observation Well #2030 (15 ft deep)—Lino Lakes



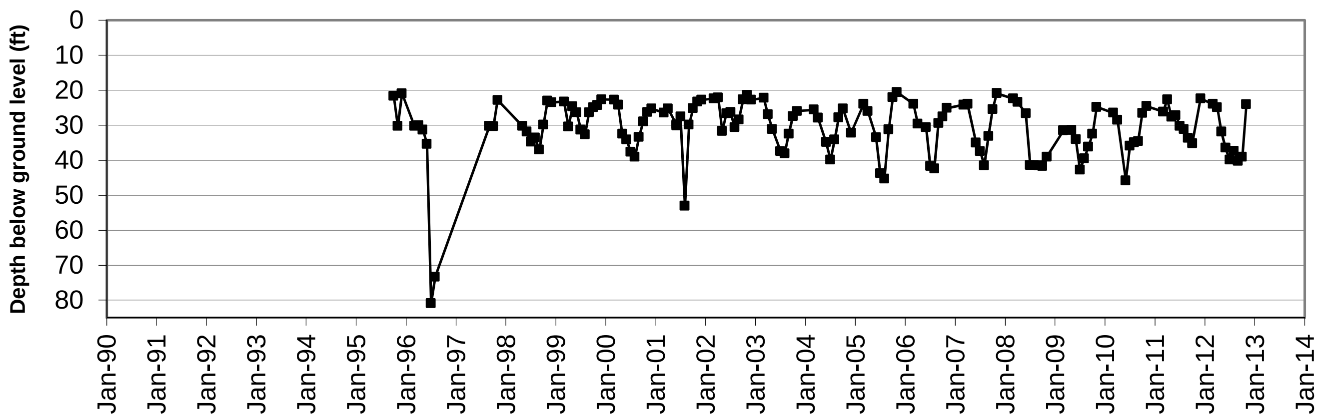
Observation Well #2012 (277 ft deep) – Centerville



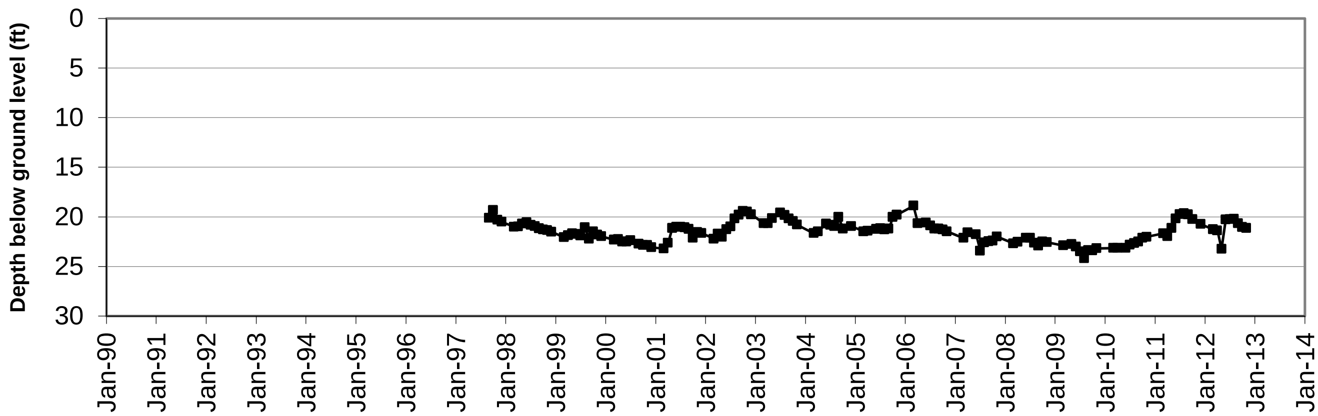
Observation Well #2015 (280 ft deep)—Ramsey



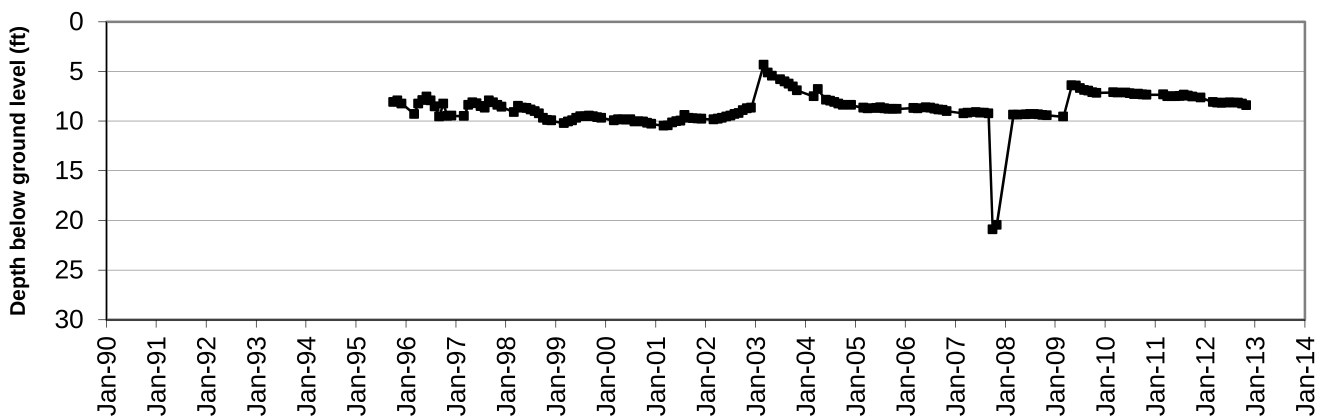
Observation Well #2016 (193 ft deep)—Coon Rapids



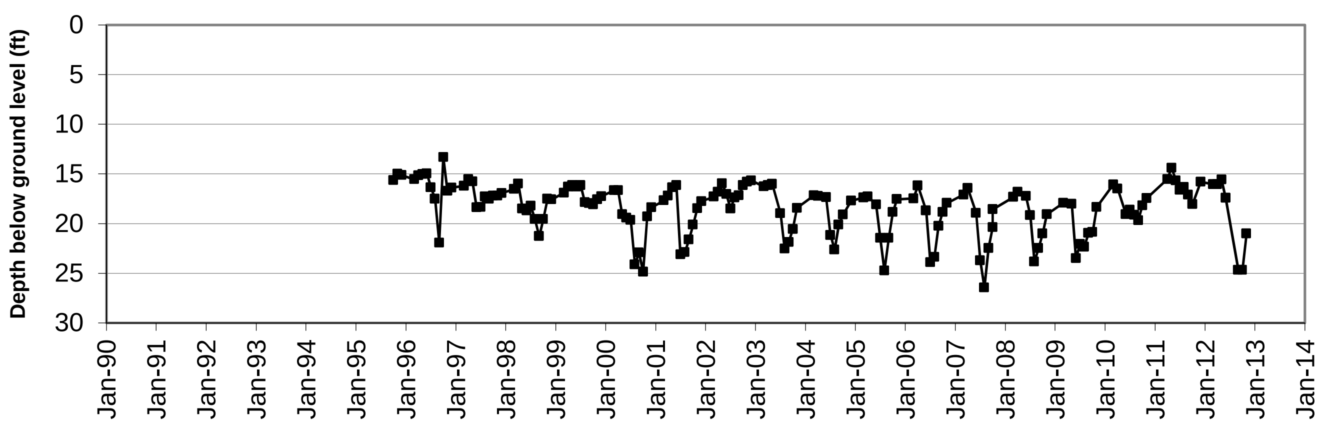
Observation Well #2024 (141 ft deep)—East Bethel



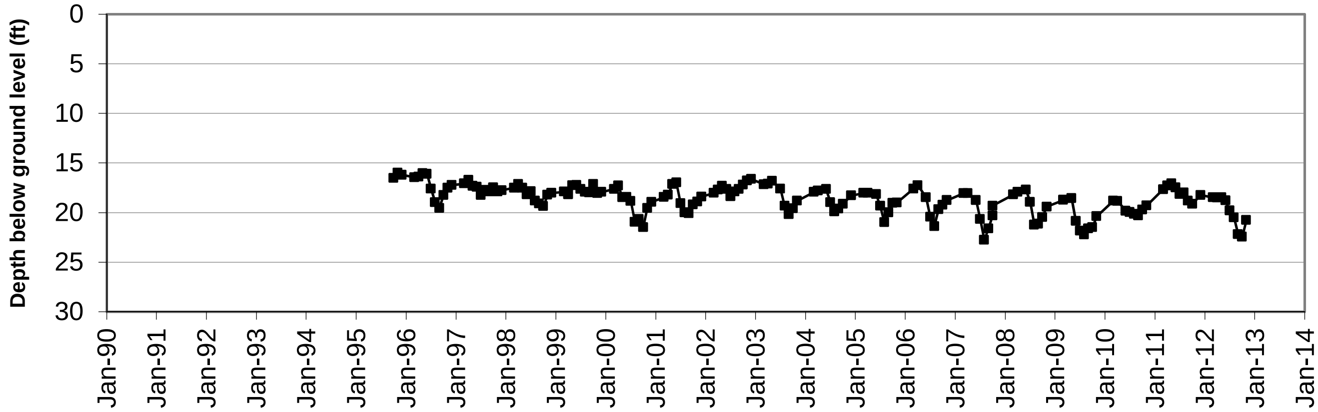
Observation Well #2025 (21 ft deep)—Bethel



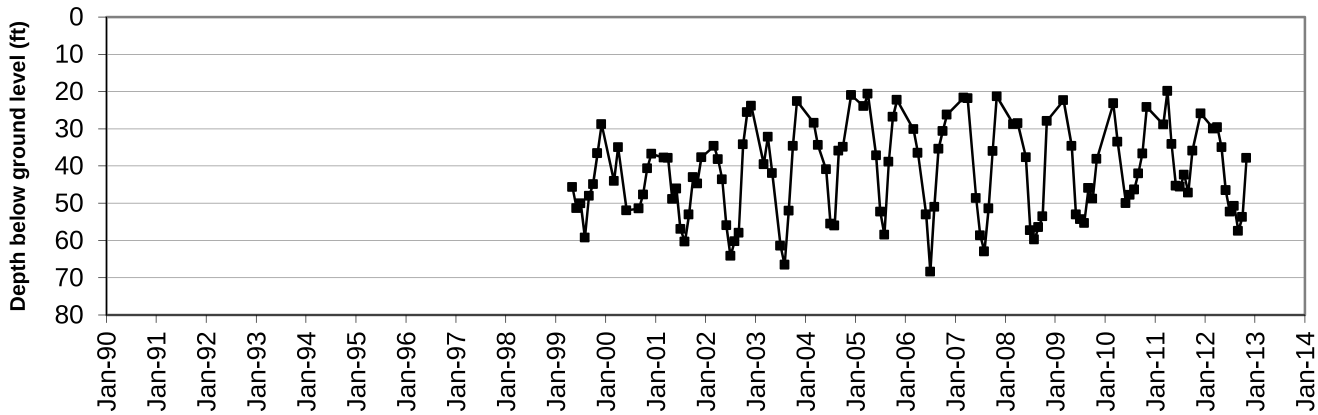
Observation Well #2026 (150 ft deep)— Carlos Avery #4



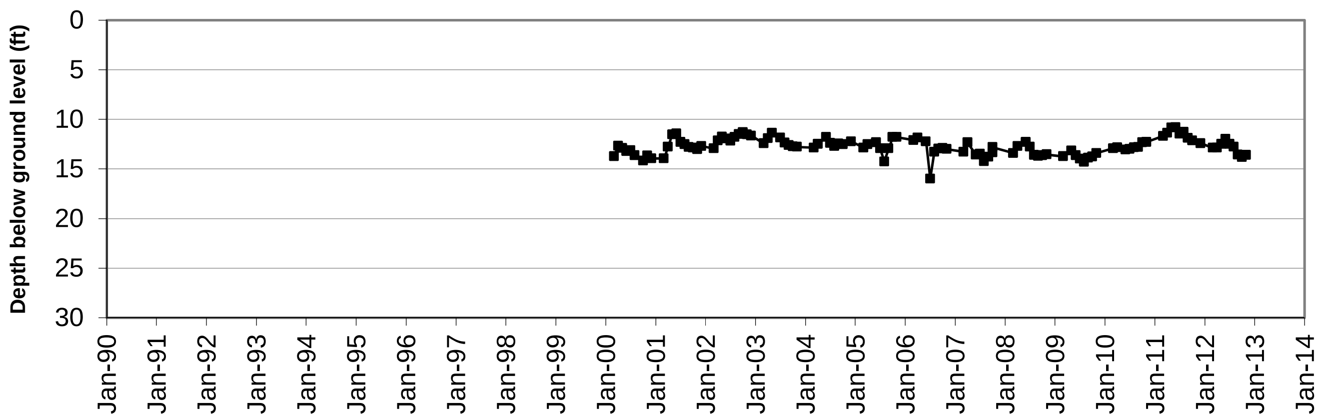
Observation Well #2027 (333 ft deep)— Columbus Twp.



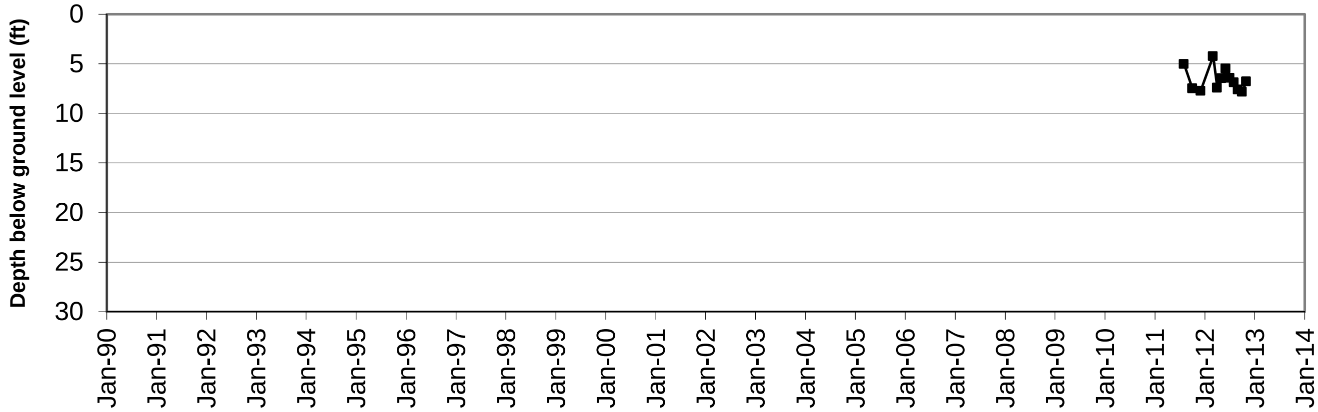
Observation Well #2028 (510 ft deep)—Anoka



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



Observation Well #2035 (20 ft deep)—East Bethel

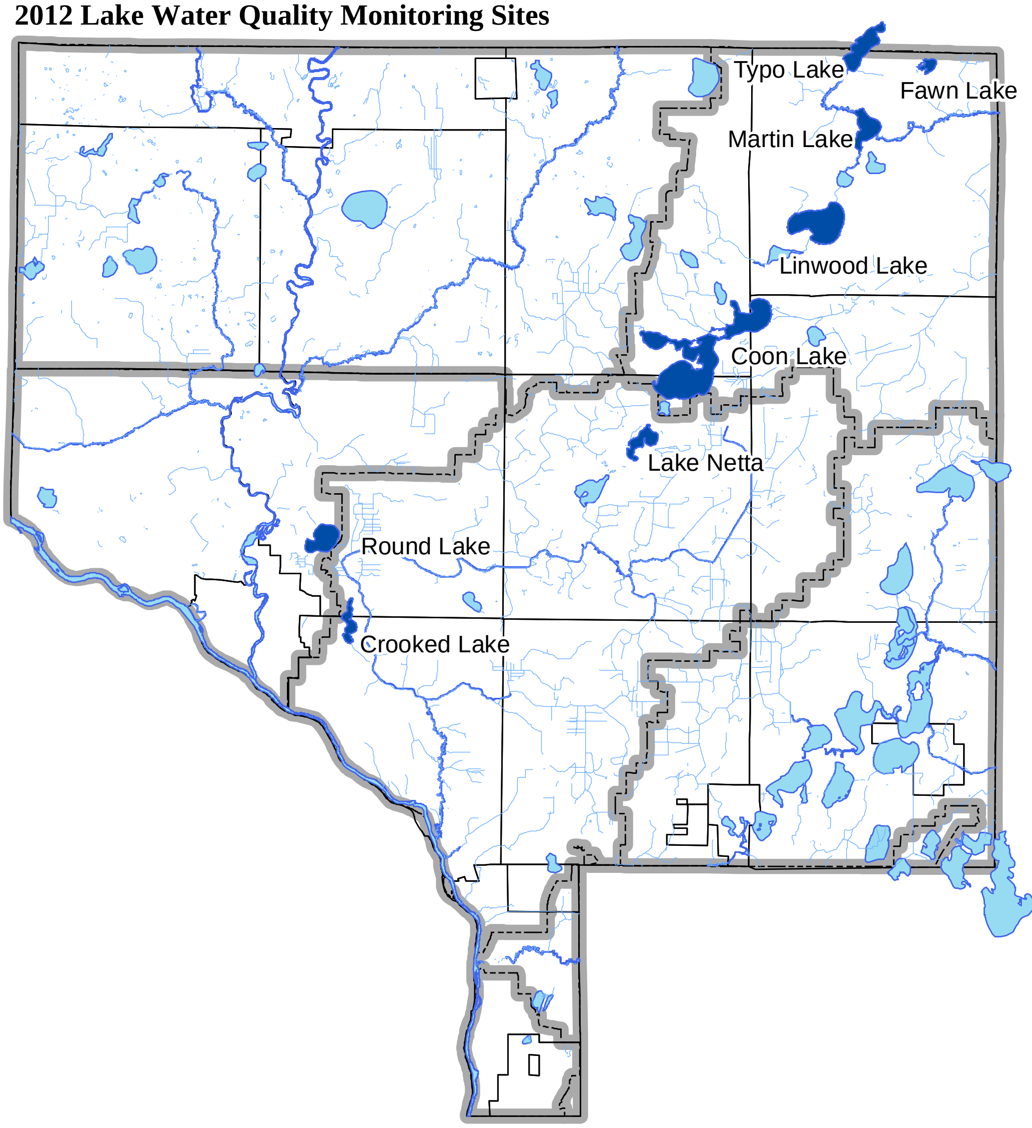


Lake Water Quality

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 prior to the current year, see the summary table on page 16. Detailed analyses for the lakes shown in that table are in that 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.

2012 Lake Water Quality Monitoring Sites



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. DO is measured in the field using a YSI® DO 200 dissolved oxygen and temperature probe. Conductivity, pH, turbidity, salinity and temperature are measured using the Horiba Water Checker® U-10 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 (MVTL Labs) for chlorophyll-a and total phosphorus. Sample bottles are provided by the laboratory. Total phosphorus sample bottles contain preservative sulfuric acid (H_2SO_4), while bottles for Chlorophyll-a analyses are wrapped in aluminum foil to exclude light. 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 Metropolitan Council's lake quality grading system and the Carlson's Trophic State Index 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 if 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 = >7). The pH of a lake will fluctuate daily and seasonally due to algal photosynthesis, runoff, and other factors.

Conductivity- This is a measure of the amount of 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 amount of 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 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 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 (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 wastes, and storm water 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	FNRU	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 do the lake physical condition and recreational suitability numbers mean?

A- The Minnesota Pollution Control Agency has established a subjective ranking system that ACD staff use during each lake visit (see table, this page). Ranks 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 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 depth. In the same way that a teacher would grade students on a "curve," the lake grading system compares each lake only to other lakes in the region. Thus, a lake that gets an "A" in the Twin Cities Metro might only get a "C" in northern Minnesota. The goal of this grading system is to provide a single, easily understandable description of lake water quality.

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 is the Carlson Trophic State Index?

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

There are four trophic state index values: one 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.

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.

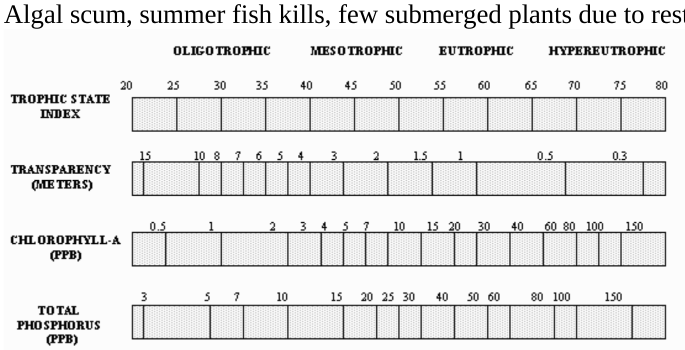
3. Eutrophic- In these lakes, the water is nutrient-rich. Productivity is high for both plants and fish. Abundant plant life, especially algae, results in poorer water clarity and can reduce the dissolved oxygen content when it decays. Algae blooms in the "dog days of summer" are commonplace. Bass and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

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- 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 set at < 40 µg/L (<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 at least 5 years of monitoring data are 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.

Historic Water Quality Grades for Anoka County Lakes (includes monitoring by ACD and Met Council's CAMP program, post-1980 only. Met Council grades for 2012 are preliminary.)

Year→	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
Cenaiko																	B	A	A	A	B	A	A	A	A	A	A	B	B	B	B	B
Centerville	C		C					D												C	C		C	C	A							
Coon				C					C					C			C	B	A	B	C	B		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
Coon (West Bay)																														A		A
Crooked			C		C				C					B	C	B	B	B		B		B	B		B	B		B	B		B	A
E. Twin	B		C						B						B		A	B	A	A		A			A			A		A	A	
Fawn								B									A	B	A	A	A	A		A		A		A		A		A
George	A	A		A					A					B			A	B	A	A		A			B			B			B	
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
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		B	A		B	B	
Highland																			D	C	D	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													B	B	B			C	B	B	B	B	B	B	B			B			B	
Linwood	C		C						C					C			C	C	C	C	C		C		C		C	C	C			C
Lochness																											A	B		B	C	C
Martin			D														D	D	C	D	D		D		D		D	D	D			D
E. Moore	C	C	C	C	B	C	C							C				C	B	B	C	C	C		C							
W. Moore	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
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	
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
Sandy													D	D	D		D	D	D	D	D	F	D	D	D							
Typo													F	F	F		F	F	F	F	F		F		F		F		F			F

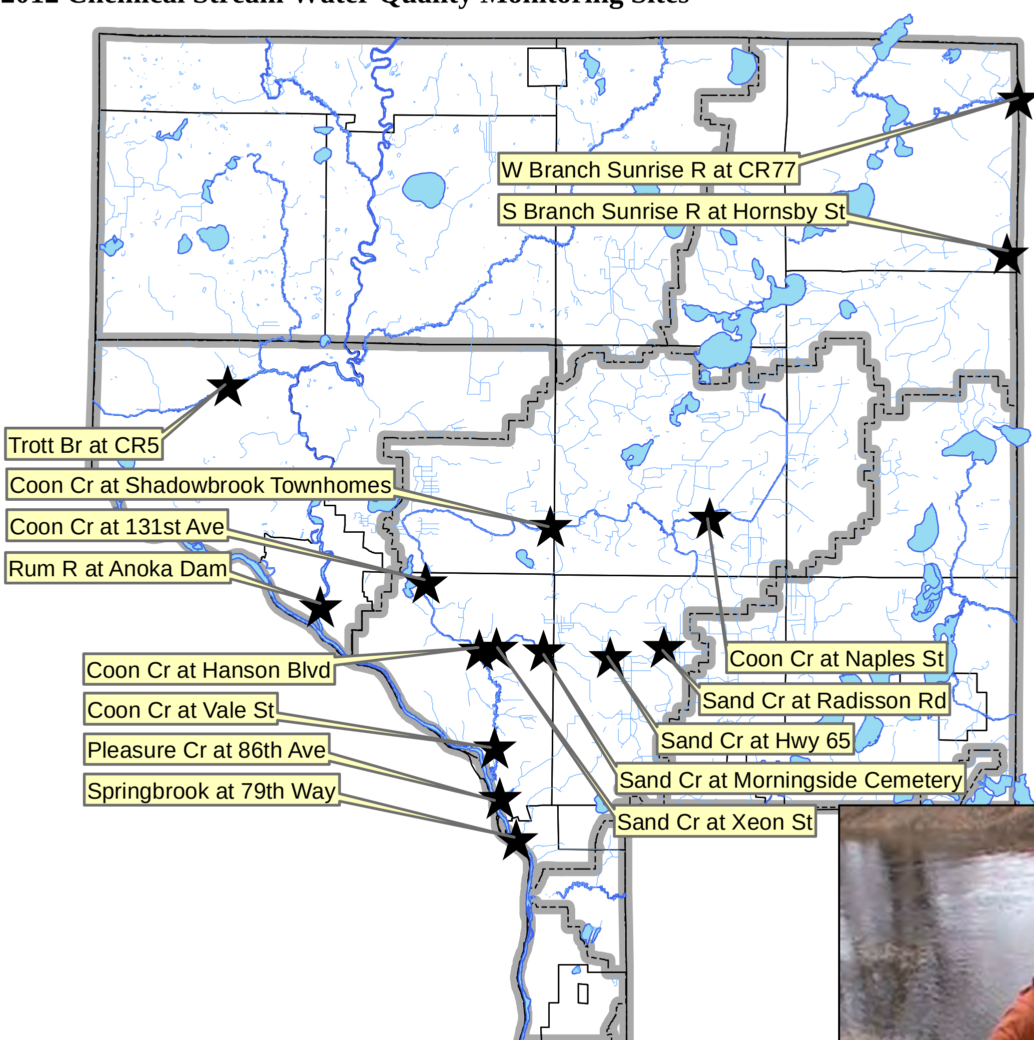
Stream Water Quality – Chemical Monitoring

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 2012 was conducted at Trott Brook, the South and West Branches of the Sunrise River, five Sand Creek sites, five Coon Creek sites, Pleasure Creek and Springbrook. 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.

2012 Chemical Stream Water Quality Monitoring Sites



Stream Water Quality Monitoring Methods

Stream water is monitored four times during base flow conditions and four 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. Grab samples are used for all stream water quality monitoring performed by the ACD. Each stream grab sample was tested for the following parameters:

- pH;
- Dissolved Oxygen (DO);
- Turbidity;
- Conductivity;
- Temperature;
- Salinity;
- Total Phosphorus (TP);
- Chlorides;
- Sulfate;
- Total hardness;
- Total Suspended Solids;
- others for some special investigations.

DO was measured in the field using a YSI® DO 200 dissolved oxygen and temperature probe. pH, turbidity, conductivity, temperature, and salinity were measured in the field using a Horiba Water Checker® U-10 multi-probe. Total phosphorus, chlorides, total suspended solids, sulfate, hardness, and any other parameters were analyzed by an independent laboratory (MVTL Labs). Sample bottles were provided by the laboratory, complete with necessary preservatives. Water samples were kept on ice and delivered to the laboratory within 24 hours of collection. Stream water level was noted when the sample was 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 amount of dissolved minerals in the stream. Although every stream 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 amount of solid material suspended in the water, due to "muddiness" or algae.

Dissolved Oxygen (DO) - Dissolved oxygen is essential to all aquatic organisms. The lower the DO concentration, the less likely a stream will support a wide range of organisms, including fish.
Sources of dissolved oxygen include the atmosphere, aeration from stream inflow, and submerged plants and algae in the lake creating oxygen through photosynthesis. Dissolved oxygen is consumed by the organisms in the stream and by decomposition within the stream. Large inputs of organic matter (manure, for example) are harmful, in part, because decomposition of these materials can reduce dissolved oxygen to harmfully low levels.

Salinity- Salinity is a measure of dissolved salts in the water. High salinity measurements may be the result of inputs from failing septic systems, spring runoff of road salts, farm field runoff, or others.

Temperature- Fish species and other aquatic life are sensitive to water temperature. Some can only survive in particular temperature ranges. 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.

Total Phosphorus (TP) - Phosphorus is an essential nutrient that stimulates algae growth. A single pound of phosphorus can result in 500 pounds of algal growth. Large amounts of algae reduce water clarity, deplete dissolved oxygen levels algal decomposition which impacts fish populations, and degrade aesthetics for recreation. Ideally, total phosphorus should be below 40 µg/L in lakes and 130 µg/L in streams. Sources of phosphorus include runoff from agricultural land, runoff from lakeshore properties carrying fertilizer and untreated human waste from failing septic systems, pet wastes, and storm water runoff.

Total Suspended Solids (TSS) - This is similar to turbidity, in that it measures the amount of solid material in the water. Turbidity is measured by sending a beam of light through a water sample and measuring how much of it is deflected. In this way it is particularly sensitive to large suspended particles, but not to small particles. Total suspended solids is measured by filtering a water sampling and weighing the filtered material.

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.

Sulfates and hardness – These parameters were tested because of research findings that chloride toxicity varies with sulfates and hardness. In some states, like Iowa, the chloride water quality standard is linked to hardness and sulfates. Minnesota is likely to change their water quality standards in this way in the near future.

Analytical Limits for Stream Water Quality Parameters

Parameter	Method Detection Limit	Reporting Limit	Analysis or Instrument Used
pH	0.01	0.01	Horiba U-10
Conductivity	0.001	0.001	Horiba U-10
Turbidity	1.0	1.0	Horiba U-10
Dissolved Oxygen	0.01	0.01	YSI DO 200
Temperature	0.1	0.1	Horiba U-10
Salinity	0.01	0.01	Horiba U-10
Total Phosphorus	0.3	1.0	EPA 365.4
Total Suspended Solids	5.0	5.0	EPA 160.2
Chloride	0.005	0.01	EPA 325.1
Sulfate		4.0	ASTM D516-02
Hardness		na	2340.B

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 34 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 was accomplished in the following ways:

Minnesota Valley Testing Laboratories (MVTL) conducted the laboratory analysis. MVTL has a comprehensive QA/QC program, which is available by contacting them directly. ACD followed field protocols supplied by MVTL including keeping samples on ice, avoiding sample contamination, delivering samples to the lab within 24 hours of sampling, and providing duplicates and blanks. Sample bottles were provided by MVTL and included the necessary preservatives.

The hand held Horiba U-10 multi-probe and the YSI dissolved oxygen meter used to conduct in-stream monitoring were 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	7.62
Conductivity	mS/cm	.389	.298	0.362
Turbidity	FNRU		7.1	9
Dissolved Oxygen	mg/L	-	-	6.97
Temperature	°F		71.6	
Salinity	%		0	0.01
Total Phosphorus	µg/L	220	130	135
Total Suspended Solids	mg/L		13.7	12
Chloride	mg/L		8	17
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.

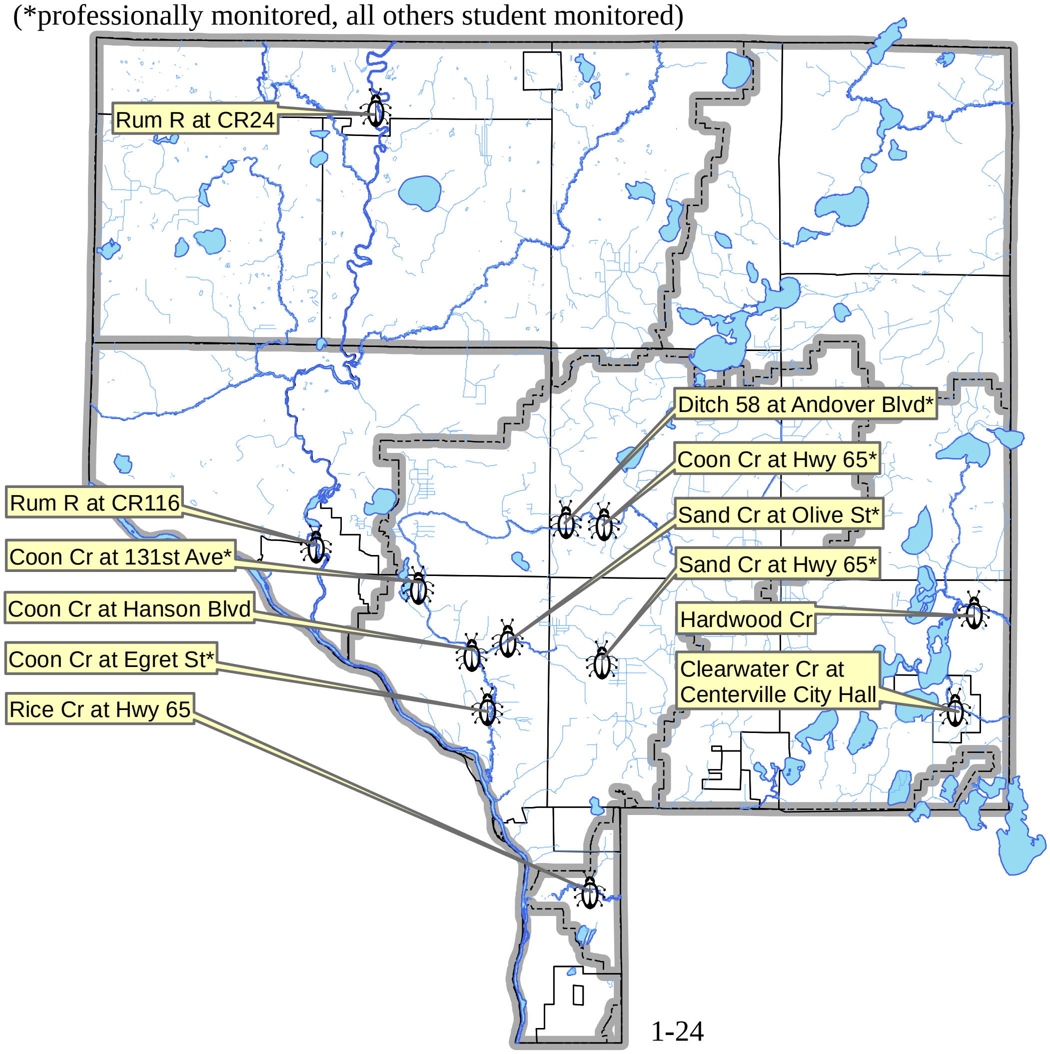
ACD adds an educational component to the program by involving students in the biomonitoring at many of the sites. High school science classes are the primary volunteers. In 2012 there were approximately 319 students from six high schools who monitored six sites. Since 2000 approximately 4,841 students have participated. The experience affords students an opportunity to learn scientific methodologies and become involved in local natural resource management.

In 2012 six sites were monitored by professionals without student involvement during both the summer and fall seasons. These sites were all within the Coon Creek drainage. The purpose was to examine sites listed by the MCPA as “impaired” for limited biota based on a single sample and to compare the biotic community in ditched and unditched stream reaches.

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

2012 Biological Stream Water Quality Monitoring Sites

(*professionally monitored, all others student monitored)



Biomonitoring Methods

ACD biomonitoring utilizes 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. 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: Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (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.

% Chironomidae: This measure compares the number of midges to the total number of organisms in the sample. A low percentage of midge larvae 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).

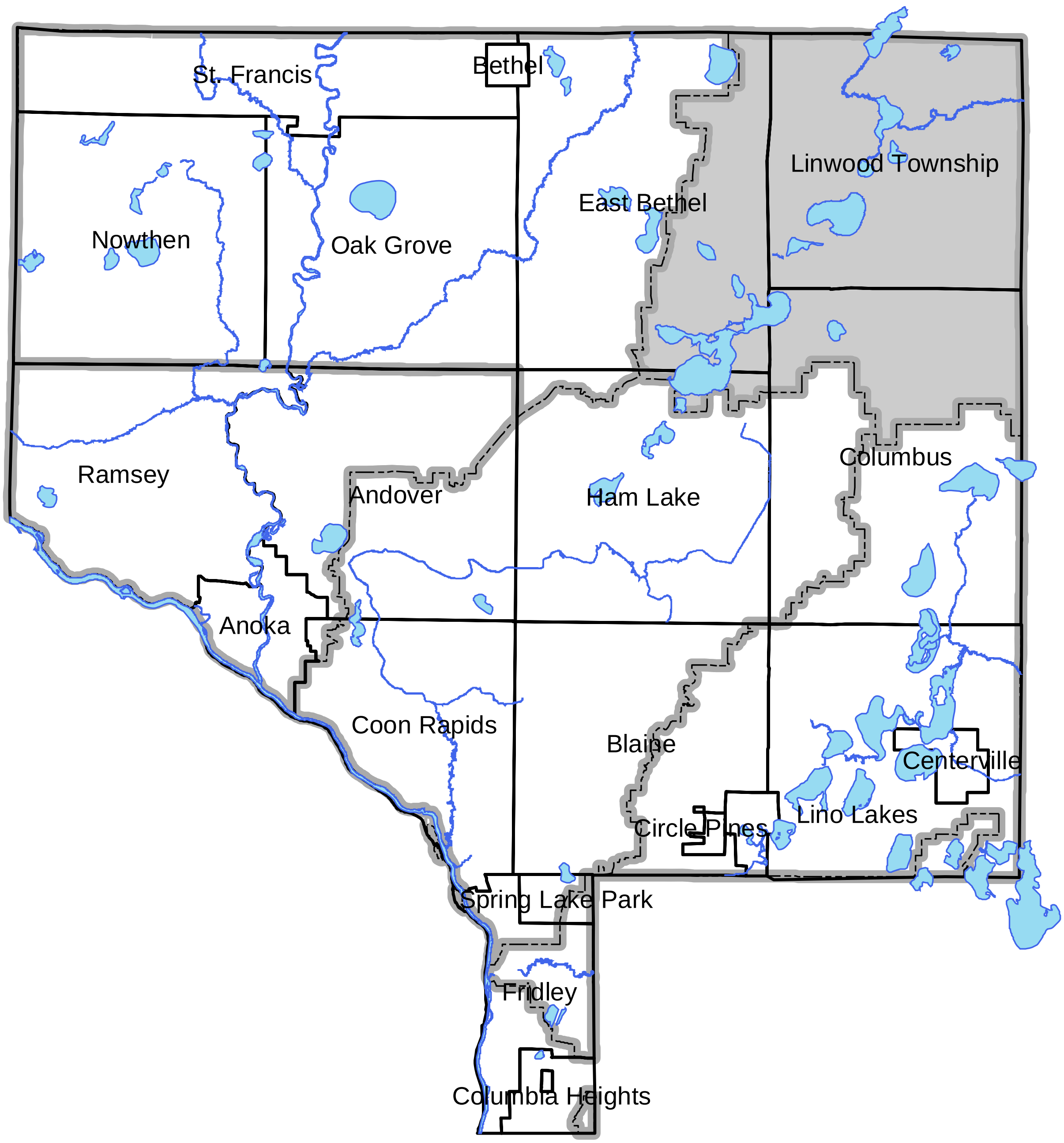
Sites

In 2012, twelve sites were monitored for benthic macroinvertebrates. High school classes, with ACD staff supervision, sampled six of these sites.

2012 Biomonitoring Sites and Corresponding Monitoring Groups

Monitoring Group	Stream
Anoka High School	Rum River (near Anoka)
Blaine High School	Coon Creek at Egret Blvd.
Centennial High School	Clearwater Creek
Forest Lake Area Learning Center	Hardwood Creek
St. Francis High School	Rum River (St. Francis)
Totino Grace High School	Rice Creek
Anoka Conservation District	Ditch 58 at Andover Blvd
Anoka Conservation District	Sand Cr at Olive St
Anoka Conservation District	Coon Creek at Hwy 65
Anoka Conservation District	Coon Creek at 131st Ave.
Anoka Conservation District	Coon Creek at Egret Blvd.
Anoka Conservation District	Ditch 41 at Hwy 65

Sunrise River Watershed



Contact Info: Sunrise River Watershed Management Organization
www.AnokaNaturalResources.com/SRWMO
763-434-9569

Anoka Conservation District
www.AnokaSWCD.org
763-434-2030

CHAPTER 2: SUNRISE RIVER WATERSHED

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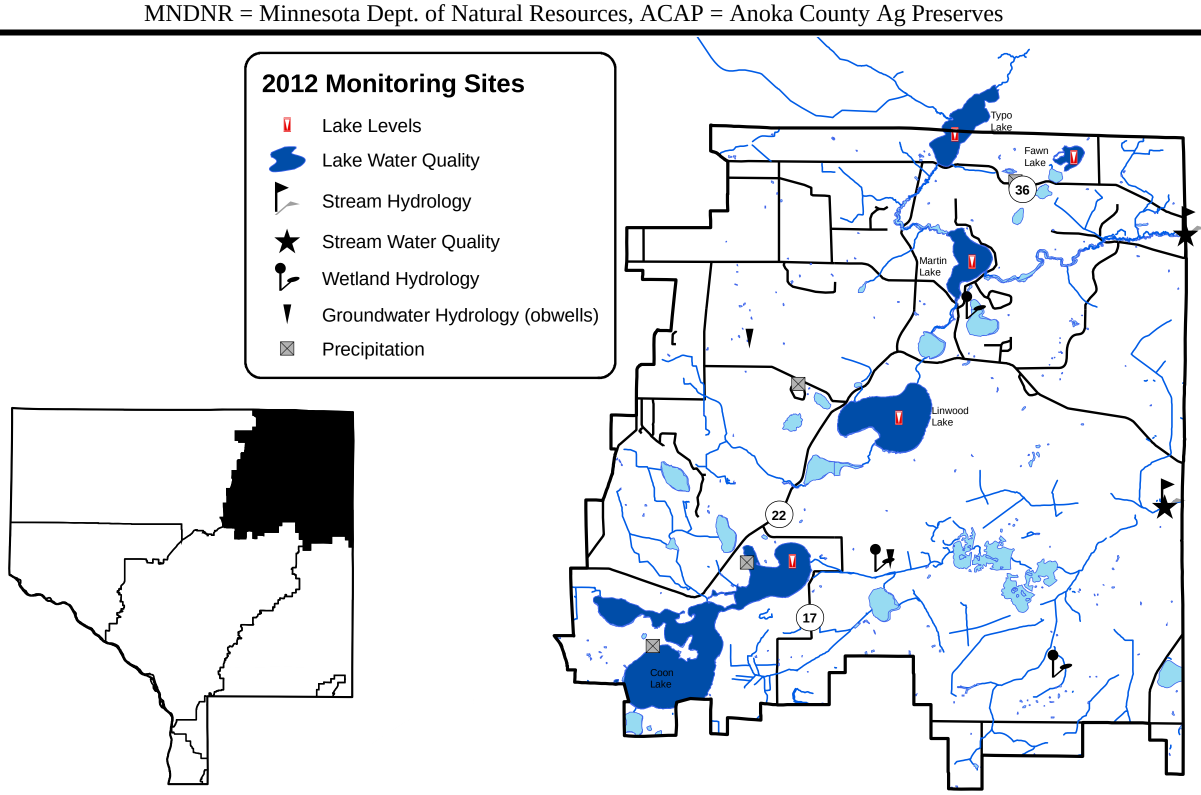
ACD = Anoka Conservation District, SRWMO = Sunrise River Watershed Management Organization, MNDNR = Minnesota Dept. of Natural Resources, ACAP = Anoka County Ag Preserves



Lake Levels

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

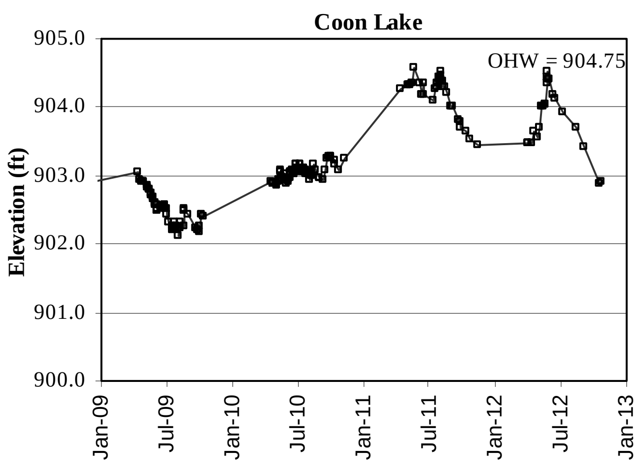
Purpose: To understand lake hydrology, including the impact of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

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

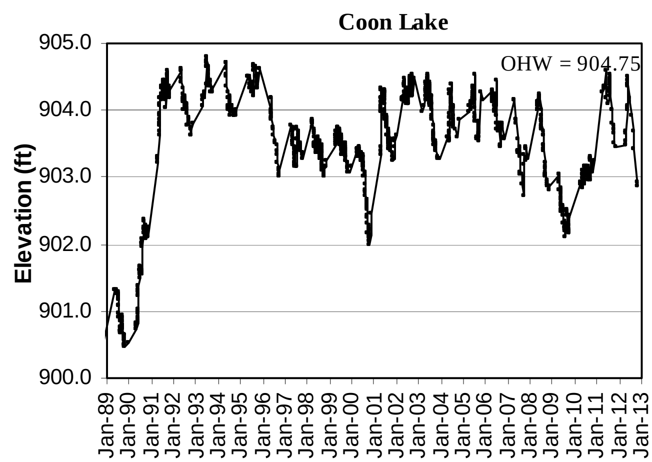
Results: Lake levels were measured by volunteers throughout the 2012 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. Lakes had sharply increasing water levels in spring and early summer 2012 when heavy rainfall totals occurred. Little rainfall fell later in the year and lake levels fell dramatically.

All lake level data can be downloaded from the MN DNR website's Lakefinder feature. Ordinary High Water Level (OHW), the elevation below which a DNR permit is needed to perform work, is listed for each lake on the corresponding graphs below.

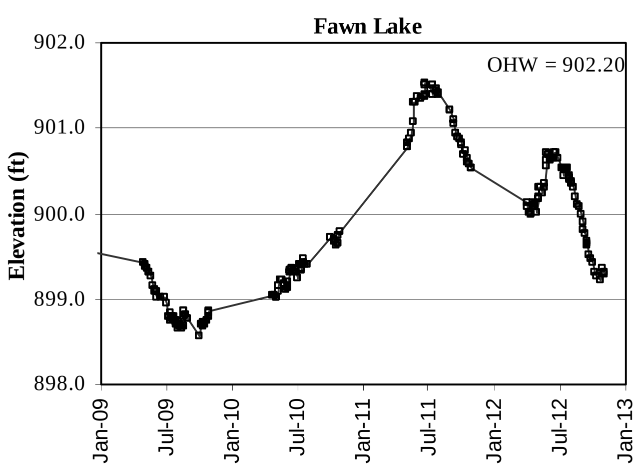
Coon Lake Levels – last 5 years



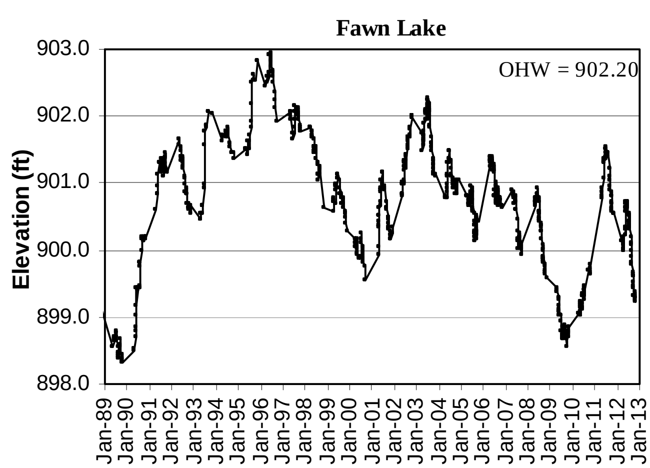
Coon Lake Levels – last 24 years



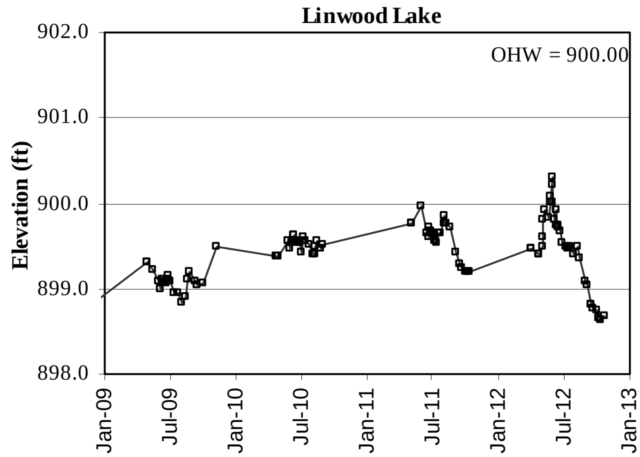
Fawn Lake Levels – last 5 years



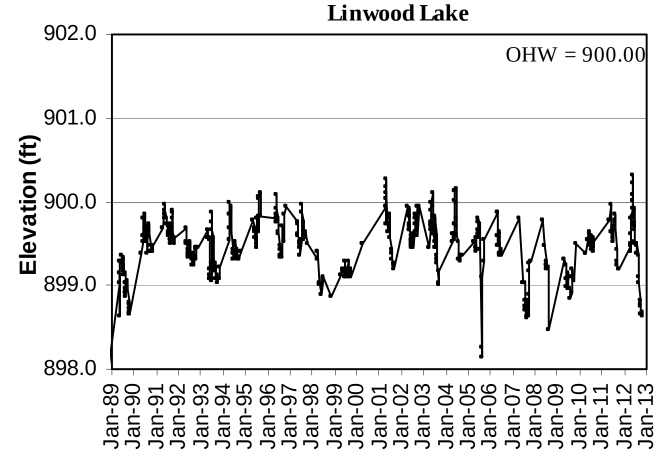
Fawn Lake Levels – last 24 years



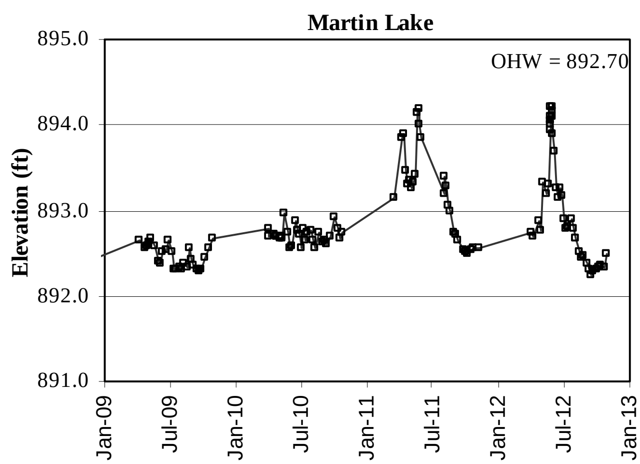
Linwood Lake Levels – last 5 years



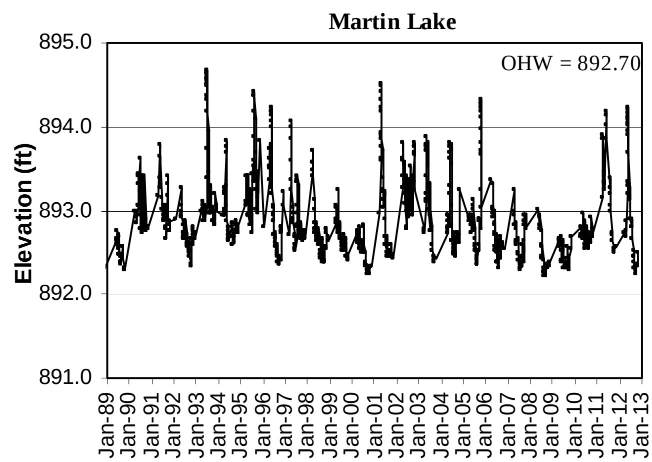
Linwood Lake Levels – last 24 years



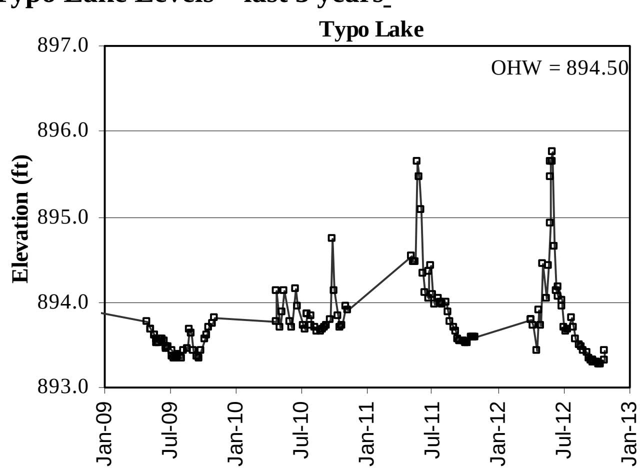
Martin Lake Levels – last 5 years



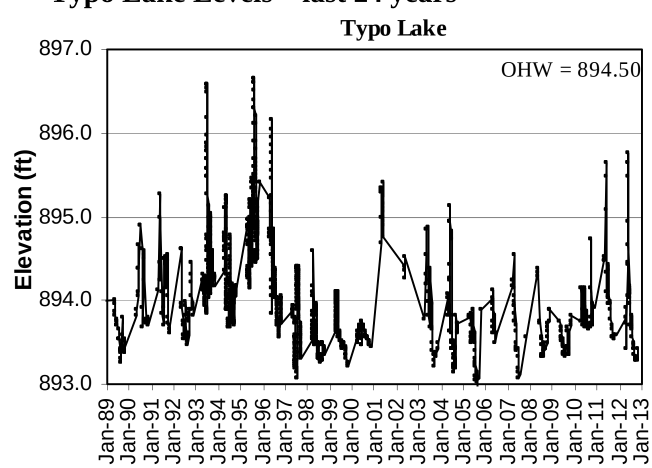
Martin Lake Levels – last 24 years



Typo Lake Levels – last 5 years



Typo Lake Levels – last 24 years



Lake Water Quality

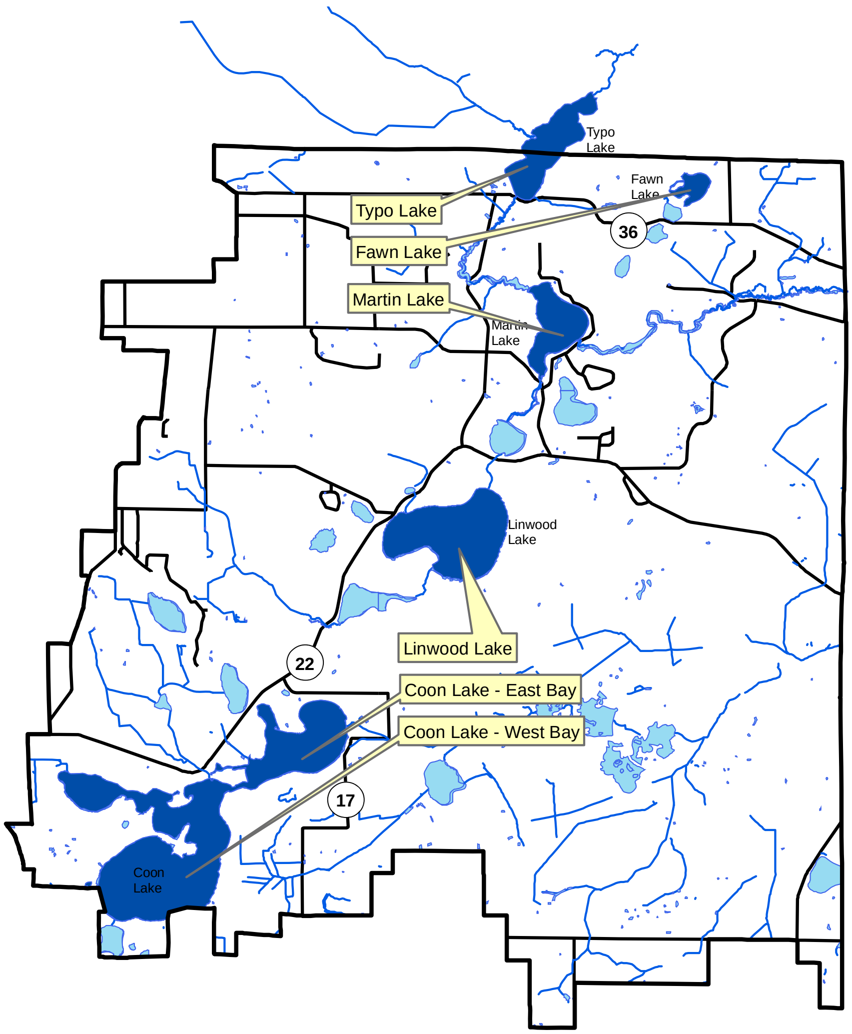
Description: May through September every-other-week monitoring of the following parameters: total phosphorus, chlorophyll-a, secchi transparency, dissolved oxygen, turbidity, temperature, conductivity, pH, and salinity.

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

Locations:
- Coon Lake East Bay
- Coon Lake West Bay
- Linwood Lake
- Typo Lake
- Fawn Lake
- Martin Lake

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

Sunrise Watershed Lake Water Quality Monitoring Sites



Coon Lake –East and West Bays
City of East Bethel, City of Ham Lake & City of Columbus, Lake ID # 02-0042

Background

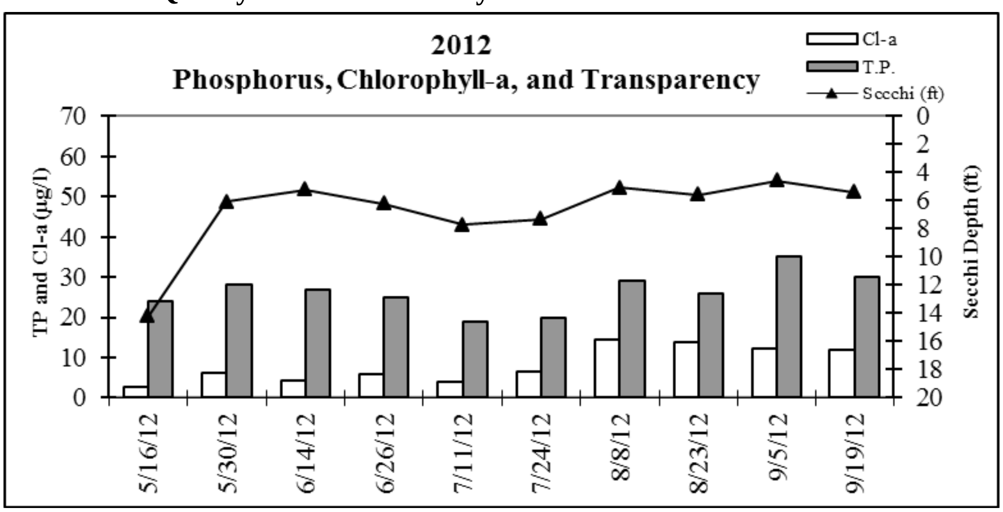
Coon Lake is located in east central Anoka County and is the county's largest lake. Coon Lake has a surface area of 1498 acres and a maximum depth of 27 feet (9 m). Public access is available at three locations with boat ramps, including one park with a swimming beach. The lake is used extensively by recreational boaters and fishers. Most of the lake is surrounded by private residences. The watershed of 6,616 acres is rural residential.

This report includes separate information for the East Bay (aka northeast or north bay) and West Bay (aka southwest or south bay) of Coon Lake. The 2010-12 data is from the Anoka Conservation District (ACD) monitoring at the MN Pollution Control Agency (MPCA) monitoring site #203 for the East Bay and #206 for the West Bay. Over the years, other sites have been monitored and are included in this report's trend analysis when appropriate. When making comparisons between the two bays, please consider that both bays were monitored simultaneously only in 2010 and 2012; data from other years do not lend themselves well to direct comparisons because monitoring regimes were likely different.

2012 Results – East Bay

In 2012 the East Bay had slightly better than average water quality for this region of the state (NCHF Ecoregion), receiving a B grade. Average values of important water quality parameters included 26 µg/L for total phosphorus, 8.2 µg/L chlorophyll-a, and Secchi transparency of 6.7 feet. Chlorophyll-a levels were the lowest of all monitored years. Phosphorus and transparency were similar to previous years. 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 until August and September, when there was a slight to moderate algae impairment.

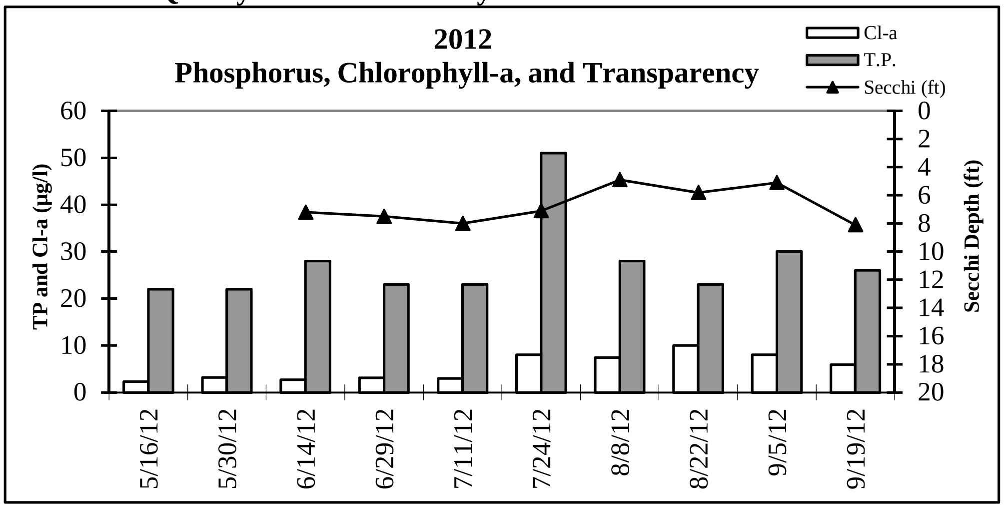
2012 Water Quality Results – East Bay



2012 Results – West Bay

In 2012 the West Bay had slightly better than average water quality for this region of the state (NCHF Ecoregion), receiving an A- letter grade. West Bay total phosphorus averaged 28.0 µg/L and chlorophyll-a averaged 5.4 µg/L. Secchi transparency could not be measured on two occasions because it exceeded basin's depth.

2012 Water Quality Results –West Bay



Comparison of the Bays

The East and West Bays of Coon Lake often have noticeably different water quality. In 2010, on every date water quality was better in the West Bay than East, with an average difference of 13 µg/L phosphorus and 5.4 µg/L chlorophyll-a (algae). In 2012, water quality in the two bays was more similar. Neither bay had consistently lower phosphorus and the average phosphorus reading differed by only 2 µg/L. Chlorophyll-a readings were more frequently lower in the West bay but the average reading only differed by 2.8 µg/L. A direct comparison of average Secchi transparency was not possible in 2010 or 2012 because transparency exceeded the lake depth on multiple occasions in the West Bay and a reading could not be obtained.

Trend Analysis

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

<u>East Bay Trend Analysis</u>

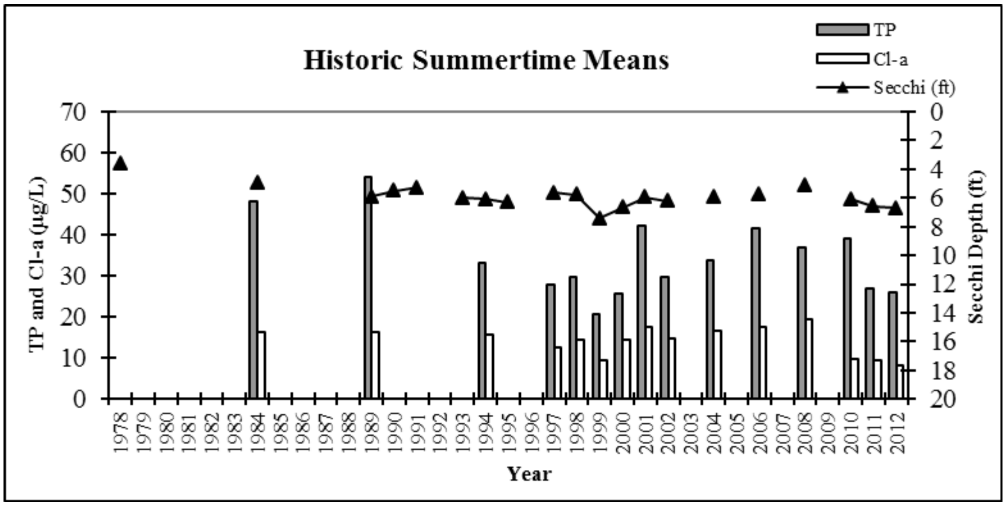
In the East Bay twenty years of water quality data have been collected since 1978. During the most recent 12 years that were monitored (since 1996), the data collected included total phosphorus, chlorophyll-a, and Secchi transparency. For most of the other eight years (all pre-1997) only Secchi transparency data is available. This provides an adequate dataset for a trend analysis, however given that most of the data is from the last 20 years, the analysis is not strong at detecting changes that occurred prior to 1990.

No water quality trend exists when we examined those years with total phosphorus, chlorophyll-a, and Secchi transparency, excluding the years with only Secchi transparency data. The analysis was a repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth ($F_{2,12}$=1.7, p=0.22). This is our preferred approach because it examines all three parameters simultaneously.

We also examined Secchi transparencies alone across all 18 years using a one-way ANOVA. Including all years, a significant trend of improving transparency is found ($F_{1,18}$=11.74, p=0.003). This result appears highly influenced by the low transparency in 1978. If we exclude 1978 and re-run the analysis we find the trend is still present, but just outside the bounds of statistical significance (p=0.06, p values of 0.05 or less indicate statistical significance at the 95% confidence level). In summary, it appears that mild improvements in transparency have been occuring.

It is noteworthy that a water quality improvement seems to have occurred between 1989 and 1994 (see graph below). The reason for such a change, if real, is unknown. Because there are only two years of phosphorus and chlorophyll-a data before 1994 it is difficult to determine if water quality was chronically poorer prior to 1994 or if the available monitoring data is not representative of typical conditions.

Historic Water Quality - East Bay

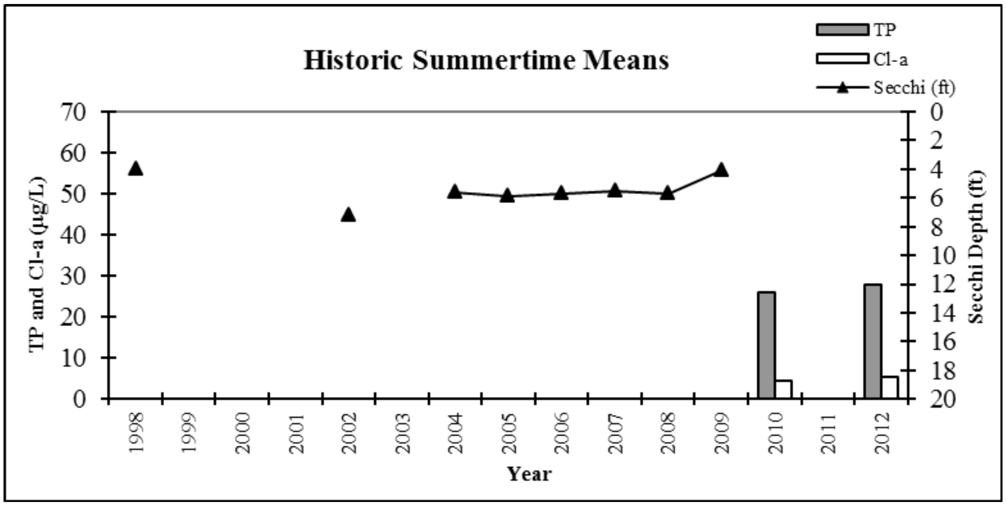


West Bay Trend Analysis

Ten years of data are available for the West Bay including only two years with phosphorus and chlorophyll-a data, so a powerful trend analysis is not possible. The dataset for Secchi transparency is longer, but data from 2010 and 2012 must be excluded because a full suite of Secchi measurements is not available due to clarity exceeding the lake depth occasionally. Therefore, a statistical analysis would not be highly meaningful. Instead, we'll use a non-analytical look at the data.

In 2012 the average secchi was 6.7 feet (excludes two measurements of >10feet). In 2010 the average secchi was 7.2 feet (excludes three measurements of >10feet). For eight monitored years in 1998-2009, seven of those years had average secchi of <6 feet. One year was 7.18 feet. It's notable that in the two most recent years the average secchi transparency was greater than in all but one of previous years. It suggests that if anything, transparency is mildly improving. We can speculate that the introduction of Eurasian watermilfoil to the lake may be resulting in increased clarity.

Historic Water Quality - West Bay



Discussion

While Coon Lake is not listed as "impaired" by the MN Pollution Control Agency, the East Bay is close to the state water quality standard of 40 µg/L of phosphorus or greater. In 2006 phosphorus averaged 42 µg/L, was 37 µg/L in 2008, and in 2010 was 39 µg/L. In 2012 phosphorus was lower (averaged 26 µg/L). Voluntary efforts to improve water quality are strongly encouraged to prevent the lake from becoming designated as "impaired." Such a designation would trigger an in-depth study under the Federal Clean Water Act.

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

A final challenge for Coon Lake is the aquatic invasive species Eurasian water milfoil (EWM) and Curly Leaf Pondweed (CLP). EWM was discovered in the lake in 2003 and has spread rapidly. In 2008 a Coon Lake Improvement District (CLID) was formed, with EWM management as a core of its function. EWM is actively monitored and treated with herbicide in accordance with DNR rules and a lake vegetation management plan, yet it continues to expand. CLP has been present longer. It can cause a spike in phosphorus levels in early summer. CLID started treatment of CLP in 2009. In 2010 the East Bay was accepted into a five year pilot program for treatment of CLP.

2012 Coon Lake East Bay Water Quality Data

Coon Lake East Bay

2012 Water Quality Data		Date	5/16/2012	5/30/2012	6/14/2012	6/26/2012	7/11/2012	7/24/2012	8/8/2012	8/23/2012	9/5/2012	9/19/2012			
		Time	9:50	9:40	11:20	10:15	9:35	10:05	10:20	9:45	9:50	9:40			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.62	7.95	8.04	8.34	8.34	8.52	8.59	8.75	8.62	8.12	8.39	7.95	8.75
Conductivity	mS/cm	0.01	0.198	0.185	0.179	0.179	0.158	0.139	0.186	0.183	0.168	0.150	0.173	0.139	0.198
Turbidity	FNRU	1.0	2	4	4	5	5	3	6	8	9	4	5	2	9
D.O.	mg/L	0.01	9.66	9.14					8.22	10.11	8.95	8.31	9.07	8.22	10.11
D.O.	%	1.0	100%	93%					101%	118%	108%	87%	101%	87%	118%
Temp.	°C	0.10	18.7	19.3	20.9	23.9	28.1	27.6	25.8	23.0	24.7	17.8	23.0	17.8	28.1
Temp.	°F	0.10	65.7	66.7	69.6	75.0	82.6	81.7	78.4	73.4	76.5	64.0	73.4	64.0	82.6
Salinity	%	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl-a	µg/L	1.0	2.7	6.2	4.4	5.9	4.0	6.6	14.4	13.9	12.1	12.0	8.2	2.7	14.4
T.P.	mg/L	0.005	0.024	0.028	0.027	0.025	0.019	0.020	0.029	0.026	0.035	0.030	0.026	0.019	0.035
T.P.	µg/L	5	24	28	27	25	19	20	29	26	35	30	26	19	35
Secchi	ft	0.1	14.2	6.1	5.2	6.2	7.7	7.3	5.1	5.6	4.6	5.4	6.7	4.6	14.2
Secchi	m	0.1	4.3	1.9	1.6	1.9	2.3	2.2	1.6	1.7	1.4	1.6	2.1	1.4	4.3
Physical			2	2.0	2.0	2.0	2.0	2.0	2.0	4.0	4.0	2.0	2.4	2.0	4.0
Recreational			2	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	2.0	2.2	2.0	3.0

*Reporting Limit

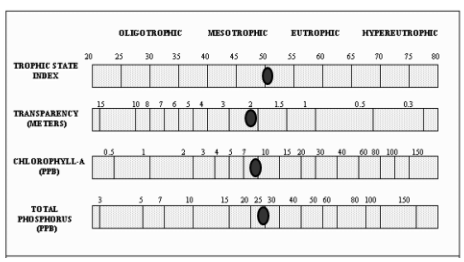
Coon Lake East Bay Historic Summertime Mean Values

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

Coon Lake Water Quality Report Card

Year	1978	1984	1989	1990	1991	1993	1994	1995	1997	1998	1999	2000	2001	2002	2004	2006	2008	2010	2011	2012
TP		C	C				C		B	B	A	B	C	B	C	C	C	C	B	B
Cl-a		B	B				B		B	B	A	B	B	B	B	B	B	A	A	A
Secchi	D	C	C	C	C	C	C	C	C	C	B	C	C	C	C	C	C	C	C	C+
Overall	**D**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**B**	**B**	**A**	**B**	**C**	**B**	**C**	**C**	**C**	**B-**	**B**	**B**

Carlson's Trophic State Index



2012 Coon Lake West Bay

Water Quality Data

Coon Lake West Bay
2012 Water Quality Data

	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
		Date	5/16/2012	5/30/2012	6/14/2012	6/29/2012	7/11/2012	7/24/2012	8/8/2012	8/22/2012	9/5/2012	9/19/2012			
		Time	9:30	9:20	10:45	9:35	10:00	10:30	10:40	10:05	10:15	9:20			
pH		0.1	8.72	7.87	8.12	8.29	8.16	8.25	8.41	8.68	8.23	7.94	8.27	7.87	8.72
Conductivity	mS/cm	0.01	0.157	0.152	0.145	0.148	0.126	0.117	0.159	0.156	0.145	0.129	0.14	0.117	0.159
Turbidity	FNRU	1.0	2	2	2	3	4	3	7	7	7	2	3.90	2	7
D.O.	mg/L	0.01	9.53	8.88					8.66	9.72	7.37	8.28	8.74	7.37	9.72
D.O.	%	1.0	98%	89%					105%	112%	88%	83%	0.96	83%	112%
Temp.	°C	0.10	18.9		20.1	24.0	27.9	27.9	25.3	22.4	24.5	16.2	23.02	16.2	27.9
Temp.	°F	0.10	66.0	32.0	68.2	75.2	82.2	82.2	77.5	72.3	76.1	61.2	69.30	61.2	82.2
Salinity	%	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl-a	µg/L	1.0	2.3	3.2	2.7	3.1	3.0	8.0	7.4	10.0	8.0	5.9	5.36	2.3	10.0
T.P.	mg/L	0.005	0.022	0.022	0.028	0.023	0.023	0.051	0.028	0.023	0.030	0.026	0.028	0.022	0.051
T.P.	µg/L	5	22	22	28	23	23	51	28	23	30	26	28	22	51
Secchi	ft	0.1	>10.6	>10.3	7.2	7.5	8.0	7.1	4.9	5.8	5.1	8.1	NA	4.9	>9.8
Secchi	m	0.1	>3.2	>3.1	2.2	2.3	2.4	2.2	1.5	1.8	1.6	2.5	NA	1.5	>3.0
Physical			2	2.0	2.0	2.0	3.0	2.0	2.0	4.0	4.0	2.0	2.5	2.0	4.0
Recreational			2	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	2.0	2.2	2.0	3.0

*Reporting Limit

Coon Lake West Bay Historic Summertime Mean Values

Agency	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	ACD	ACD
Year	1998	2002	2004	2005	2006	2007	2008	2009	2010	2012
TP									26.0	28.0
Cl-a									4.4	5.4
Secchi (m)	1.21	2.19	1.71	1.79	1.74	1.68	1.74	1.24		
Secchi (ft)	3.97	7.18	5.61	5.87	5.71	5.51	5.71	4.07		

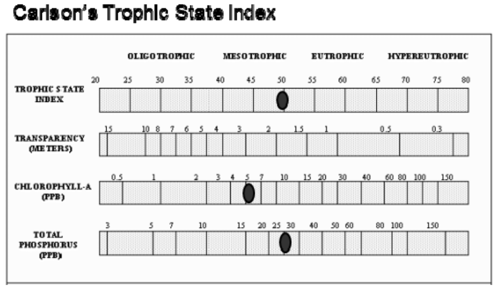
Carlsons trophic state indices

TSIP									51	52
TSIC									45	47
TSIS	57	49	52	52	52	53	52	57		
TSI									48	50

Coon Lake Water Quality Report Card

Year	98	2002	2004	2005	2006	2007	2008	2009	2010	2012
TP									B	B
Cl-a									A	A
Secchi	C	C	C	C	C	C	C	C		
Overall									**A-**	**A-**

Carlson's Trophic State Index



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 vacant with scattered residential.

Linwood Lake is on the Minnesota Pollution Control Agency's 303(d) list of impaired waters for excess nutrients.

2012 Results

In 2012 Linwood Lake had average or slightly below average water quality for this region of the state (NCHF Ecoregion), receiving an overall C grade. The lake is slightly eutrophic. In 2012 total phosphorus averaged 43 µg/L, chlorophyll-a averaged 18.2 µg/L, and Secchi transparency averaged 1.0 m. These measurements were average relative to the range observed in other years. ACD staff's subjective observations of the lake's physical characteristics were that there were large suspended algae in mid-May with a more significant algae bloom beginning in July and continuing through September. ACD staff subjectively ranked the lake as having some impairment of swimming in early May and again from mid-June through September.

Trend Analysis

Sixteen years of water quality data have been collected by the Metropolitan Council (1980, '81, '83, '89, '94, '97, 2008) and the ACD (1998-2001, 2003, '05, '07, '09, '12). Water quality has not significantly changed from 1980 to 2012 (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth; $F_{2,13}=0.78$, $p=0.20$).

Discussion

Linwood Lake is on the Minnesota Pollution Control Agency's (MPCA) list of impaired waters, but it is a borderline case. Linwood Lake was placed on the state impaired waters 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 deep spot. However it is very similar to other shallow lake systems and expectations for water quality should be more in line with shallow lake standards (total phosphorus <60 µg/L, chlorophyll-a <20 µg/L, and Secchi transparency >1m). In the last 10 years Linwood has been substantially lower than the shallow lake phosphorus standard, but it has occasionally exceeded the other two standards. Regardless, water quality improvement is needed.

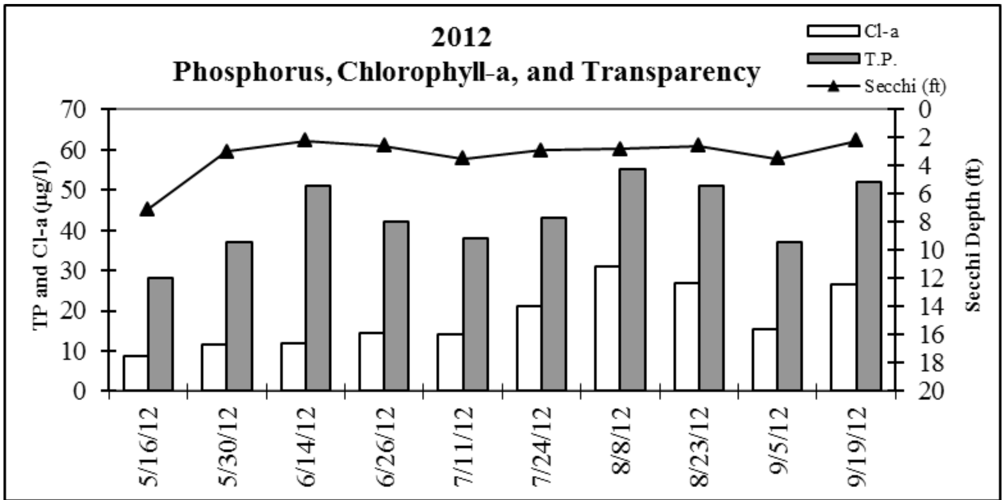
It is likely that major factors degrading water quality originate from the lake itself and/or its developed shoreline. The primary inlet to Linwood Lake comes from Boot Lake, a scientific and natural area, and it likely has good water quality (though has not been monitored). Threats to Linwood Lake likely include rough fish, failing shoreland septic systems, poor lakeshore lawn care practices, and natural sources such as nutrient-rich lake sediments. 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.

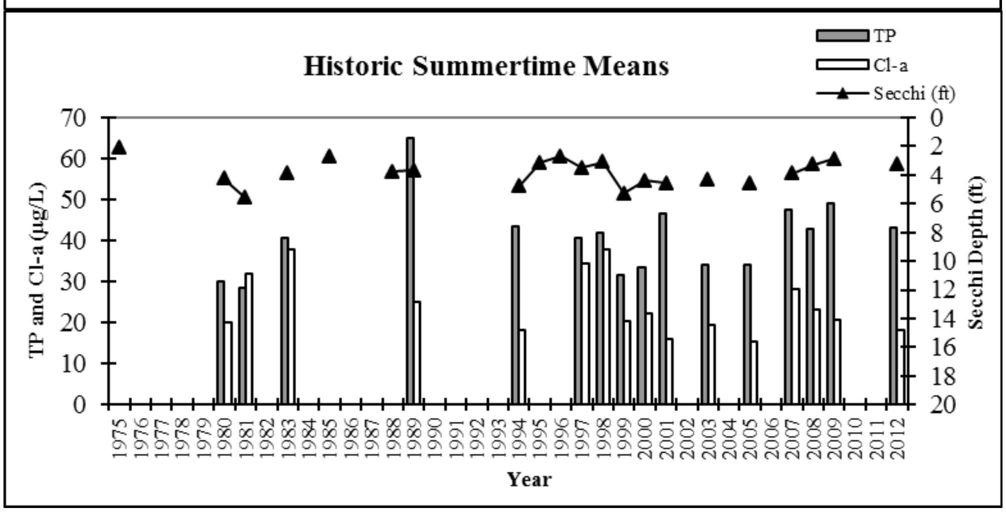
2012 Linwood Lake Water Quality Data

Linwood Lake 2012 Water Quality Data		Date Time	5/16/2012 10:35	5/30/2012 10:15	6/14/2012 11:45	6/26/2012 10:50	7/11/2012 10:45	7/24/2012 11:20	8/8/2012 11:40	8/23/2012 10:55	9/5/2012 10:50	9/19/2012 10:20			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.20	7.86	7.96	8.68	8.85	8.84	8.50	8.85	8.73	7.96	8.44	7.86	8.85
Conductivity	mS/cm	0.01	0.265	0.242	0.233	0.228	0.196	0.172	0.236	0.228	0.209	0.191	0.220	0.172	0.265
Turbidity	FNRU	1	4	12	16	15	12	17	17	17	11	11	13	4	17
D.O.	mg/L	0.01	9.84	8.49					8.64	11.01	8.46	7.31	8.96	7.31	11.01
D.O.	%	1	103%	86%					106%	127%	101%	76%	100%	76%	127%
Temp.	°C	0.1	18.3	18.8	20.2	24.2	28.1	27.3	25.6	22.5	24.4	17.5	22.7	17.5	28.1
Temp.	°F	0.1	64.9	65.8	68.4	75.6	82.6	81.1	78.1	72.5	75.9	63.5	72.8	63.5	82.6
Salinity	%	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Cl-a	µg/L	1	8.6	11.6	11.8	14.5	14.1	21.1	31.0	27.0	15.5	26.4	18.2	8.6	31.0
T.P.	mg/L	0.005	0.028	0.037	0.051	0.042	0.038	0.043	0.055	0.051	0.037	0.052	0.043	0.028	0.055
T.P.	µg/L	5	28	37	51	42	38	43	55	51	37	52	43	28	55
Secchi	ft	0.10	7.10	3.00	2.20	2.60	3.50	2.90	2.80	2.60	3.50	2.20	3.24	2.20	7.10
Secchi	m	0.1	2.2	0.9	0.7	0.8	1.1	0.9	0.9	0.8	1.1	0.7	1.0	0.7	2.2
Physical			4.0	2.0	3.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	3.4	2.0	4.0
Recreational			4.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.0	4.0

*reporting limit

Linwood Lake Water Quality Results





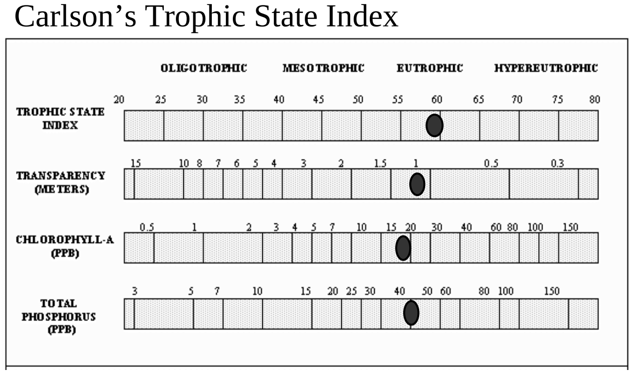
Linwood Lake Summertime Historic Mean

	CAMP	MC	MC	MC	CAMP	CAMP	MC	MC	CAMP	CAMP	MC	ACD	ACD	ACD	ACD	ACD	ACD	ACD	CAMP	ACD	ACD
	1975	1980	1981	1983	1985	1988	1989	1994	1995	1996	1997	1998	1999	2000	2001	2003	2005	2007	2008	2009	2012
TP (ug/L)		30.0	28.5	40.7			64.8	43.3			40.6	45.7	48.6	44.4	46.6	34.2	34.0	47.4	42.8	49.0	43.0
Cl-a (ug/L)		20.0	32.0	37.9			25.1	18.3			34.4	40.0	31.7	31.2	16.1	19.4	15.3	28.3	23.1	20.7	18.2
Secchi (m)	0.64	1.30	1.70	1.20	0.82	1.17	1.12	1.45	0.96	0.82	1.06	0.94	1.10	1.34	1.4	1.31	1.4	1.19	1.01	0.88	1
Secchi (ft)	2.1	4.3	5.6	3.9	2.7	3.8	3.7	4.8	3.2	2.7	3.5	3.1	3.6	4.4	4.6	4.3	4.6	3.9	3.3	2.9	3.2
Carlson's Tropic State Indices																					
TSIP		53	52	58			64	58			58	59	54	54	59	55	55	60	58	60	58
TSIC		60	65	66			62	59			65	67	60	61	57	60	57	63	62	60	59
TSIS	66	56	52	57	63	58	58	55	61	63	59	61	53	55	56	56	55	57	60	62	60
TSI		57	57	60			62	57			61	62	56	57	57	57	56	60	60	61	59

Linwood Lake Water Quality Report Card

Year	1975	1980	1981	1983	1985	1988	1989	1994	1995	1996	1997	1998	1999	2000	2001	2003	2005	2007	2008	2009	2012
TP		B	B	C			C	C			C	C	C	C	C	C	C	C	C	C	C
Cl-a		B	B	C			C	B			C	C	C	C	B	B	B	C	C	C+	B
Secchi	F	C	C	C	D	D	D	C	D	D	D	D	D	C	C	C	C	D	D	D	D
Overall		**B**	**B**	**C**			**C**	**C**			**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**

Carlson's Trophic State Index



Typo Lake

Linwood Township, Lake ID # 03-0009

Background

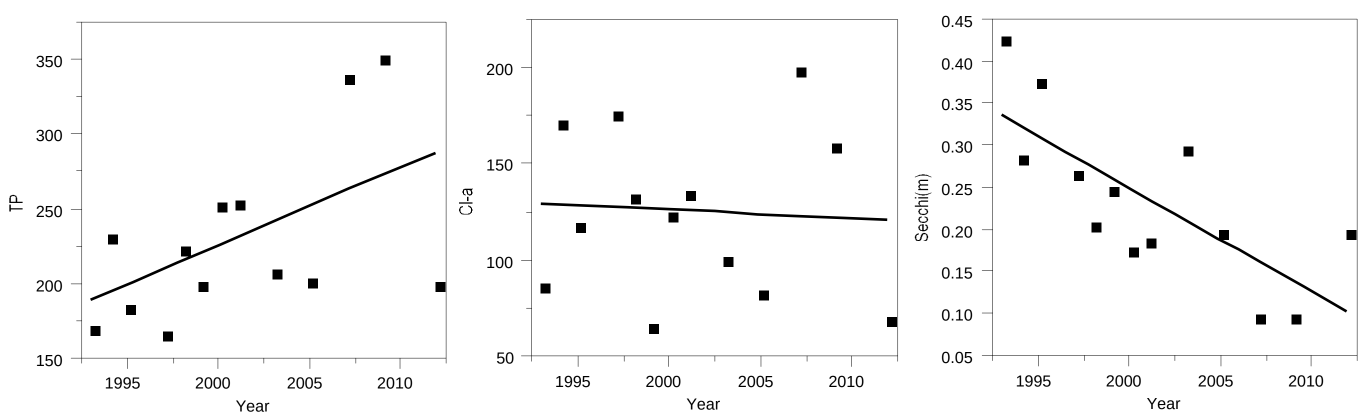
Typo Lake is located in the northeast portion of Anoka County and the southeast portion of Isanti County. It has a surface area of 290 acres and maximum depth of 6 feet (1.82 m), though most of the lake is about 3 feet deep. The lake has a mucky, loose, and unconsolidated bottom in some areas, while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

2012 Results

In 2012 Typo Lake had extremely poor water quality compared to other lakes in this region (NCHF Ecoregion), receiving an overall F letter grade. This is the same letter grade as the previous twelve years monitored, but 2007 and 2009 were the worst of all. In those two years total phosphorus averaged 340 and 353 µg/L, respectively. Total phosphorus in 2012 averaged 201 µg/L. Algae levels were also lower in 2012 (71 µg/L) than in 2009 (116 µg/L) or 2007 (201 µg/L). In both 2007 and 2009 a bright white Secchi disk could be seen only 5-6 inches below the surface, on average. There was a slight improvement in 2012 to 9-10 inches. The reason for the especially poor conditions in 2007 and 2009 seems to be drought-induced low water levels. This theory is supported by September 2012 monitoring results that occurred after several months without a significant rain event. Phoshorus increased substantially at that time. During drought it seems that internal loading (wind, rough fish, etc) builds nutrients and algae to very high levels because there is little flushing by storm water. Phosphorus and algae levels dropped substantially in the late summer of both 2007 and 2009 when ample rains fell.

Trend Analysis

Thirteen years of water quality monitoring have been conducted by the Minnesota Pollution Control Agency (1993, '94, and '95) and the Anoka Conservation District (1997-2001, '03, '05, '07, '09, '12). Water quality has significantly deteriorated from 1993 to 2012 (one-way ANOVAs on the individual response variables TP, Cl-a, and Secchi depth, $F_{2,10}=4.53$, $p=0.04$). Total phosphorus has significantly increased over time, chlorophyll-a has stayed relatively the same, while Secchi transparency has declined (see figures below). The trend toward poorer phosphorus and transparency continue to be strong despite the fact that in 2012 these parameters were slightly better than the previous two years monitored.



Discussion

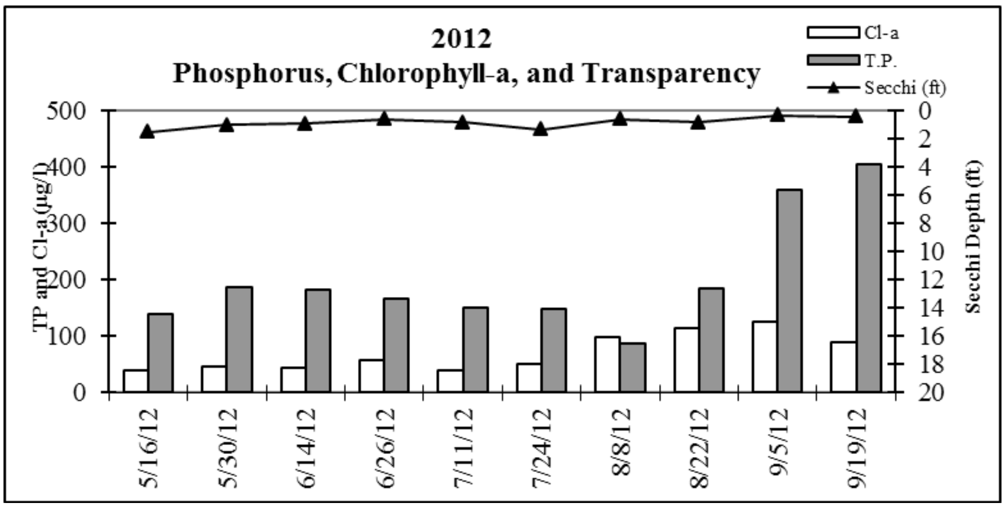
Typo Lake, along with Martin Lake downstream, were the subject of TMDL study by the Anoka Conservation District which was approved by the State and EPA in 2012. This study documented the source of nutrients to the lake, the degree to which each is impacting the lake, and put forward lake rehabilitation strategies. Some factors impacting water quality on Typo Lake include rough fish, high phosphorus inputs from a ditched wetland west of the lake, and lake sediments.

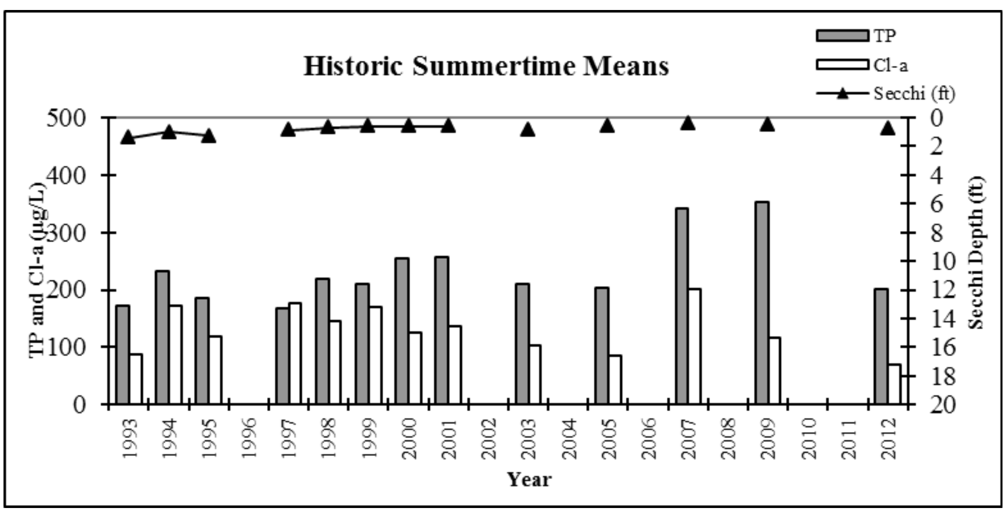
Typo Lake Water Quality Results

Typo Lake

2012 Water Quality Data		Date	16-May-12	30-May-12	14-Jun-12	6/26/2012	7/11/2012	7/24/2012	8/8/2012	8/22/2012	9/5/2012	9/19/2012			
		Time	11:40	11:20	12:45	12:00	11:45	12:25	12:50	12:10	11:45	11:30			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	9.17	8.12	8.90	9.35	9.14	9.29	9.40	9.60	9.17	9.24	9.14	8.12	9.60
Conductivity	mS/cm	0.01	0.231	0.178	0.203	0.212	0.186	0.167	0.202	0.195	0.204	0.191	0.197	0.167	0.231
Turbidity	FNRU	1	47.00	40.00	75.00	120.00	88	67	125.00	164.00	224.00	104.00	105	40	224
D.O.	mg/L	0.01	10.20	10.03					13.28	14.24	8.90	11.73	11.40	8.90	14.24
D.O.	%	1	106%	101%					168%	166%	107%	117%	128%	101%	168%
Temp.	°C	0.1	20.1	18.6	18.8	23.9	28.0	27.9	25.4	22.8	24.8	15.4	22.6	15.4	28.0
Temp.	°F	0.1	68.2	65.5	65.8	75.0	82.4	82.2	77.7	73.0	76.6	59.7	72.6	59.7	82.4
Salinity	%	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl-a	µg/L	1.0	39.3	46.0	44.9	58.1	40.4	51	99	115	125	89	70.7	39.3	125.0
T.P.	mg/L	0.005	0.140	0.187	0.182	0.167	0.151	0.149	0.087	0.185	0.360	0.406	0.201	0.087	0.406
T.P.	µg/L	5	140	187	182	167	151	149	87	185	360	406	201	87	406
Secchi	ft	0.1	1.5	1.0	0.9	0.6	0.8	1.3	0.6	0.8	0.3	0.4	0.8	0.3	1.5
Secchi	m	0.1	0.5	0.3	0.3	0.2	0.2	0.4	0.2	0.2	0.1	0.1	0.2	0.1	0.5
Physical			5.00	4.00	5.00	5.00	4.0	4.0	4.00	5.00	5.00	5.00	4.6	4.0	5.0
Recreational			5.00	3.00	4.00	4.00	4.0	4.0	5.00	4.00	4.00	4.00	4.1	3.0	5.0

*reporting limit





Lake Typo Summertime Historic Mean

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

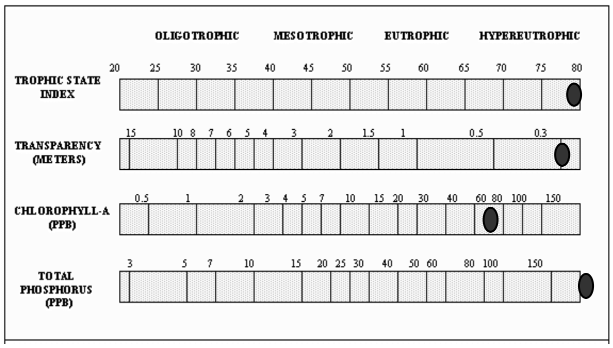
Carlson's Tropic State Indices

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

Lake Typo Water Quality Report Card

Year	74	75	93	94	95	97	98	99	2000	2001	2003	2005	2007	2009	2012
TP			F	F	F	F	F	F	F	F	F	F	F	F	F
Cl-a			F	F	F	F	F	D	F	F	F	F	F	F	D
Secchi	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Overall			**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**

Carlson's Trophic State Index



Fawn Lake

Linwood Township Lake ID # 02-0035

Background

Fawn Lake is located in extreme northeast Anoka County. Fawn Lake 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 less than 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 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 occur in high densities.

2012 Results

Fawn Lake is classified as mesotrophic and has some of the clearest water in Anoka County. In 2012, Fawn Lake continued its trend of excellent water quality for this region of the state (NCHF Ecoregion) by receiving an overall A grade. Water clarity was high while total phosphorus and chlorophyll *a* were low throughout the 2012 sampling season. Water clarity was 18.5 feet in spring, and averaged 12.6 feet from May through September. 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.

Trend Analysis

Twelve years of water quality data have been collected by the Minnesota Pollution Control Agency (1988) and the Anoka Conservation District (between 1997 and 2010). If we examine all years, there is a nearly statistically significant trend of improving water quality (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,9} = 0.55$, $p = 0.07$). However, this is driven nearly entirely by poor water quality in the earliest year monitored (1988). If 1988 is excluded, water quality has been consistent among years monitored.

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. One reason is that this lake's exceptionally high water quality is in part due to its healthy plant community. Moreover, curly-leaf pondweed, an invasive only recently noticed in the lake, readily colonizes disturbed areas and can affect both water quality and recreation.

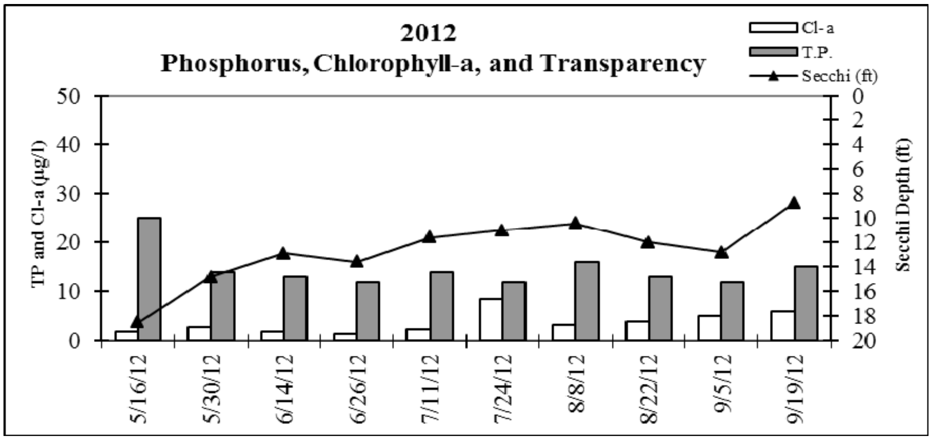
2012 Fawn Lake Water Quality Data

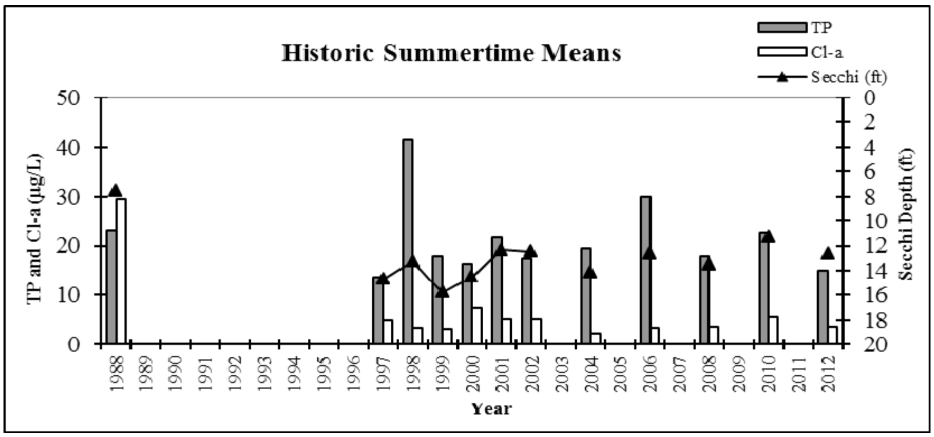
Fawn Lake
2012 Water Quality Data

		Date	5/16/2012	5/30/2012	6/14/2012	6/26/2012	7/11/2012	7/24/2012	8/8/2012	8/22/2012	9/5/2012	9/19/2012			
		Time	12:10	11:45	13:15	12:45	12:20	12:45	13:20	12:35	12:10	12:00			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.83	8.28	8.40	8.79	8.59	8.69	8.71	8.86	8.98	8.20	8.63	8.20	8.98
Conductivity	mS/cm	0.01	0.210	0.192	0.184	0.179	0.154	0.137	0.184	0.180	0.162	0.150	0.173	0.137	0.210
Turbidity	FNRU	1.0	2	1	1	2	2	1	1	2	1	1	1	1	2
D.O.	mg/L	0.01	10.22	9.19					8.88	10.40	9.54	6.84	9.18	6.84	10.40
D.O.	%	1.0	109	95					110	122	116%	73%	73	1	122
Temp.	°C	0.10	19.9	19.4	21.2	24.7	29.0	28.3	26.3	23.4	25.1	18.6	23.6	18.6	29.0
Temp.	°F	0.10	67.8	66.9	70.2	76.5	84.2	82.9	79.3	74.1	77.2	65.5	74.5	65.5	84.2
Salinity	%	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl-a	µg/L	1.0	1.8	2.8	1.8	1.4	2.3	8.4	3.2	3.9	5.0	6.0	3.7	1.4	8.4
T.P.	mg/L	0.005	0.025	0.014	0.013	0.012	0.014	0.012	0.016	0.013	0.012	0.015	0.015	0.012	0.025
T.P.	µg/L	5	25	14	13	12	14	12	16	13	12	15	15	12	25
Secchi	ft	0.1	18.5	14.8	12.9	13.6	11.6	11.0	10.4	12.0	12.8	8.7	12.6	8.7	18.5
Secchi	m	0.1	5.6	4.5	3.9	4.1	3.5	3.4	3.2	3.7	3.9	2.7	3.8	2.7	5.6
Physical			1.0	1.0	1.0	2.0	2.0	2.0	1.0	2.0	2.0	1.0	1.5	1.0	2.0
Recreational			1.0	1.0	2.0	2.0	2.0	1.0	1.0	2.0	2.0	1.0	1.5	1.0	2.0

*Reporting Limit

Fawn Lake Water Quality Results





Fawn Lake Historic Summertime Mean Values

Agency	MPCA	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD
Year	1988	1997	1998	1999	2000	2001	2002	2004	2006	2008	2010	2012
TP (µg/L)	23.0	13.6	41.6	18.0	16.3	21.7	17.4	19.4	30.0	18.0	22.6	15.0
Cl-a (µg/L)	29.4	5.0	3.4	3.1	7.5	5.2	5.1	2.4	3.5	3.7	5.6	3.7
Secchi (m)	2.3	4.5	4.1	4.8	4.4	3.8	3.8	4.3	3.8	4.1	3.5	3.8
Secchi (ft)	7.5	14.7	13.3	15.7	14.5	12.3	12.5	14.1	12.6	13.5	11.3	12.6

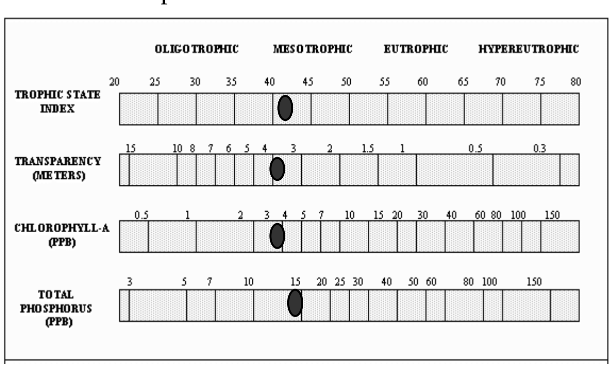
Carlson's Trophic State Indices

Year	1988	1997	1998	1999	2000	2001	2002	2004	2006	2008	2010	2012
TSIP	49	42	58	46	44	49	45	47	53	46	49	43
TSIC	64	46	43	42	50	47	47	39	43	44	47	43
TSIS	48	38	40	37	39	41	41	39	41	40	42	41
TSI	54	42	47	42	44	45	44	42	46	43	46	42

Fawn Lake Water Quality Report Card

Year	1988	1997	1998	1999	2000	2001	2002	2004	2006	2008	2010	2012
TP (µg/L)	B	A	C	A	A	A	A	A	B	A	A	A
Cl-a (µg/L)	C	A	A	A	A	A	A	A	A	A	A	A
Secchi (m)	A	A	A	A	A	A	A	A	A	A	A	A
Overall	**B**	**A**	**B**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**

Carlson's Trophic State Index



Martin Lake

Linwood Township, Lake ID # 02-0034

Background

Martin Lake is located in northeast Anoka County. It has a surface area of 223 acres and maximum depth of 20 ft. Public access is available on the southern end of the lake. The lake is used moderately by recreational boaters and fishers, and would likely be used more if water quality improved. Martin Lake is almost entirely surrounded by private residences. The 5402 acre watershed is 18% developed; the remainder is vacant, agricultural, or wetlands. The non-native, invasive plant curly-leaf pondweed occurs in Martin Lake, but not at nuisance levels. Martin is on the Minnesota Pollution Control Agency's (MPCA) list of impaired waters for excess nutrients.

2012 Results

In 2012 Martin Lake had poor water quality compared to other lakes in the North Central Hardwood Forest Ecoregion (NCHF), receiving a D letter grade. This eutrophic lake has chronically high total phosphorus and chlorophyll-a. In 2012 total phosphorus averaged 85.0 µg/L, slightly below the lake's historical average but still well above the impairement threshold of 60 µg/L. Chlorophyll-a was also slightly below the lake's long term average in 2012. Average Secchi transparency was only 2.0 feet in 2012 and poorer than the historical average. ACD staff's subjective perceptions of the lake were that "high" algae made the lake unsuitable for swimming during the entire monitored period from May through September.

Trend Analysis

Twelve years of water quality data have been collected by the Minnesota Pollution Control Agency (1983), Metropolitan Council (1998, 2008), and ACD (1997, 1999-2001, 2003, 2005, 2007, 2009, 2012). Citizens monitored Secchi transparency 17 other years. Anecdotal notes from DNR fisheries data indicate poor water quality back to at least 1954. A water quality change from 1983 to 2009 is detectable with statistical tests (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth; $F_{2,9}$=5.45, p=0.03). However, further examination of the data reveals that no water quality parameter alone has changed significantly, and the direction of their changes is mixed. If the oldest year of data (1983) is excluded, there is no longer a statistically significant trend. Because the statistical trend is dependent upon on year's data and the direction of change is mixed among the parameters, the statistical trend can be largely discounted. No true trend likely exists.

Discussion

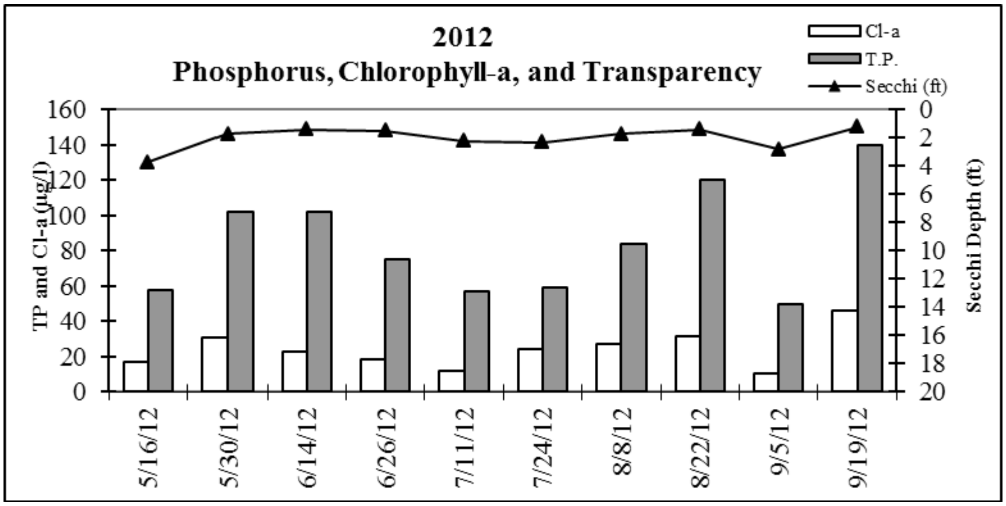
Martin Lake, along with Typo Lake upstream, were the subject of an TMDL study by the Anoka Conservation District that was approved by the State and EPA in 2012. This study documented the source of nutrients to the lake, the degree to which each is impacting the lake, and put forward lake rehabilitation 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.

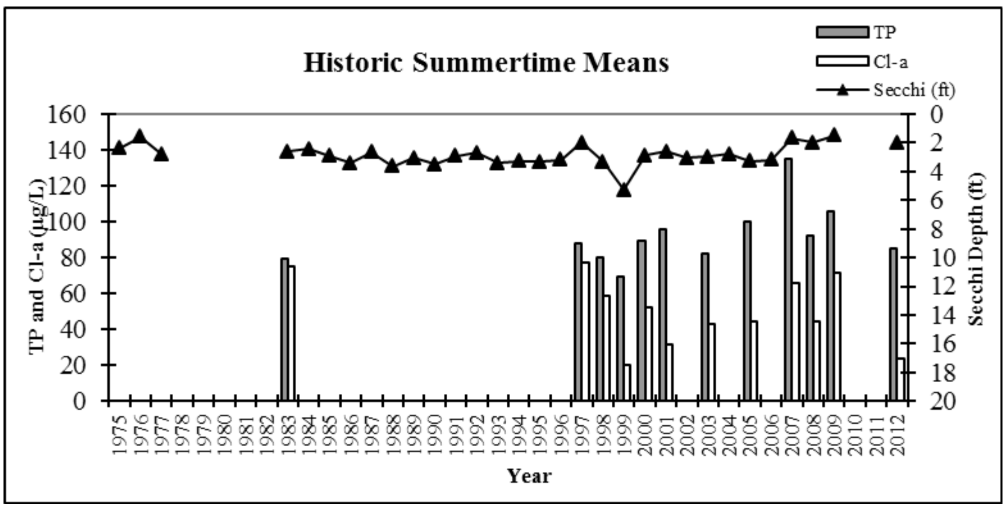
2012 Martin Lake Water Quality Data

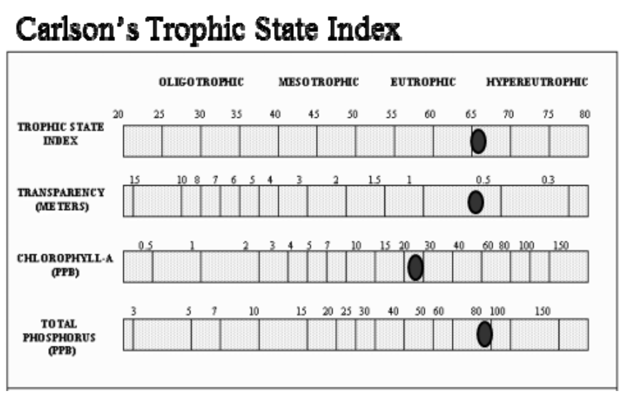
Martin Lake 2012 Water Quality Data		Date	5/16/2012	5/30/2012	6/14/2012	6/26/2012	7/11/2012	7/24/2012	8/8/2012	8/22/2012	9/5/2012	9/19/2012			
		Time	11:00	10:40	12:15	11:30	11:20	11:55	12:10	11:40	11:15	11:00			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.66	8.14	8.09	9.17	8.99	8.61	8.38	8.45	9.08	8.33	8.59	8.09	9.17
Conductivity	mS/cm	0.01	0.274	0.228	0.227	0.225	0.210	0.197	0.276	0.272	0.218	0.206	0.233	0.197	0.276
Turbidity	FNRU	1	12.00	21.00	28.00	32.00	18.00	18.00	23.00	44.00	19.00	24.00	24	12	44
D.O.	mg/L	0.01	11.77	9.70					8.87	12.01	9.66	9.44	10.24	8.87	12.01
D.O.	%	1	124%	99%					109%	137%	116%	100%	114%	99%	137%
Temp.	°C	0.1	18.5	18.9	20.4	23.9	27.8	27.3	25.8	22.1	24.6	17.6	22.7	17.6	27.8
Temp.	°F	0.1	65.3	66.0	68.7	75.0	82.0	81.1	78.4	71.8	76.3	63.7	72.8	63.7	82.0
Salinity	%	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.01
Cl-a	µg/L	1	17.2	30.6	23.0	18.6	11.7	24.6	27.1	31.8	10.3	46.1	24.1	10.3	46.1
T.P.	mg/L	0.005	0.058	0.102	0.102	0.075	0.057	0.059	0.084	0.120	0.050	0.140	0.085	0.050	0.140
T.P.	µg/L	5	58	102	102	75	57	59	84	120	50	140	85	50	140
Secchi	ft	0.1	3.7	1.7	1.4	1.5	2.2	2.3	1.7	1.4	2.8	1.2	2.0	1.2	3.7
Secchi	m	0.1	1.1	0.5	0.4	0.5	0.7	0.7	0.5	0.4	0.9	0.4	0.6	0.4	1.1
Physical			4.00	4.00	4.00	4.00	4.00	4.00	4.00	5.00	5.00	4.00	4.2	4.0	5.0
Recreational			4.00	3.00	4.00	3.00	3.00	3.00	4.00	4.00	4.00	4.00	3.6	3.0	4.0

*reporting limit

Martin Lake Water Quality Results







Martin Lake Summertime Historic Means

Agency	CLMP	CLMP	CLMP	MPCA	CLMP	CLMP	CLMP	CLMP	CLMP	CLMP	CLMP	CLMP	CLMP	CLMP	CLMP	CLMP
Year	1975	1976	1977	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
TP (ug/L)				79.6												
Cl-a (ug/L)				75.4												
Secchi (m)	0.73	0.49	0.85	0.78	0.75	0.90	1.05	0.81	1.11	0.93	1.07	0.89	0.82	1.05	1.00	1.02
Secchi (ft)	2.4	1.6	2.8	2.6	2.5	3.0	3.4	2.7	3.6	3.1	3.5	2.9	2.7	3.4	3.3	3.4

Carlson's Tropic State Indices

TSIP				67												
TSIC				73												
TSIS	65	70	62	64	64	62	59	63	58	61	59	62	63	59	60	60
TSI				68												

Martin Lake Water Quality Report Card

Year	1975	1976	1977	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
TP				D												
Cl-a				D												
Secchi	D	F	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Overall				**D**												

Martin Lake Summertime Historic Means

Agency	CLMP	ACD	MC	ACD	ACD	ACD	CLMP	ACD	CLMP	ACD	ACD	ACD	CAMP	CAMP	ACD
Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2012
TP (ug/L)		88.0	80.0	61.7	89.4	95.4		81.9		100		135.0	92.0	106.0	85.0
Cl-a (ug/L)		77.0	58.8	18.0	52.5	31.4		43.3		44.3		65.8	44.1	71.4	24.1
Secchi (m)	0.98	0.61	0.97	1.80	0.88	0.78	0.93	0.90	0.85	1.00	0.97	0.5	0.6	0.4	0.6
Secchi (ft)	3.22	2.0	3.3	5.3	2.9	2.6	3.1	3.0	2.8	3.3	3.2	1.7	2	1.5	2

Carlson's Tropic State Indices

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

Martin Lake Water Quality Report Card

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

Stream Water Quality

Description: Stream water quality is monitored with grab samples on eight occasions throughout the open water season including immediately following four storms and four times during baseflow. The selected are the farthest downstream limits of the Sunrise River Watershed Management Organization's jurisdictional area. Parameters monitored include water level, pH, conductivity, turbidity, transparency, dissolved oxygen, salinity, phosphorus, total suspended solids, chlorides, hardness, and sulfates. This data can be paired with stream hydrology monitoring to do pollutant loading calculations.

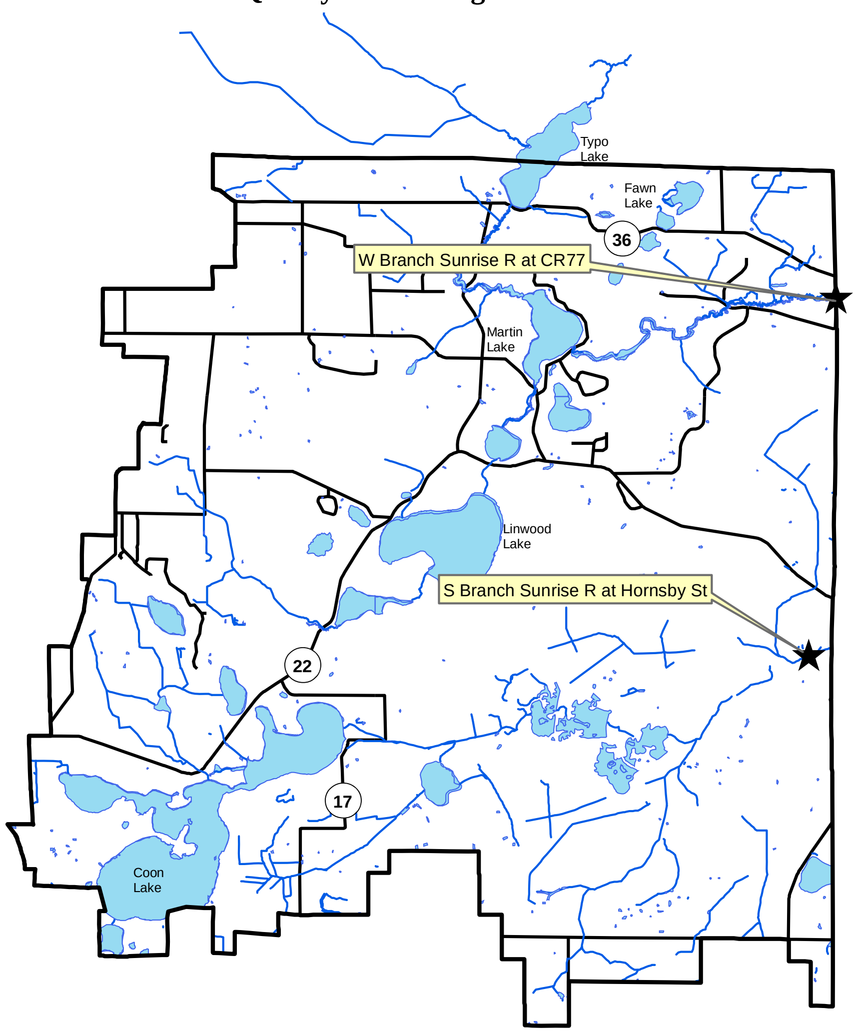
Purpose: To detect water quality trends and problems, and diagnose the source of problems.

Locations: West Branch of Sunrise River at CR 77

South Branch of Sunrise River at Hornsby St

Results: Results are presented on the following pages.

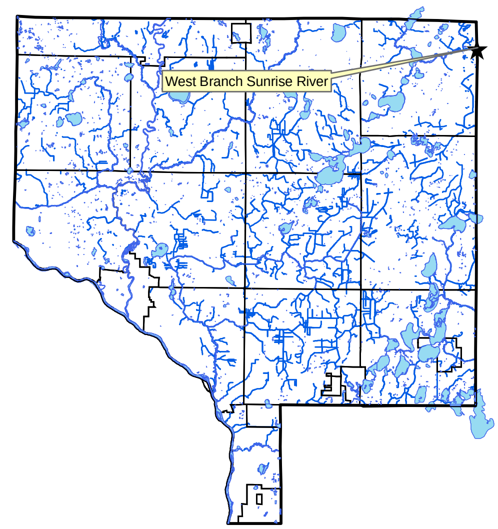
Sunrise Watershed Stream Water Quality Monitoring Sites



WEST BRANCH SUNRISE RIVER

at Co Road 77, Linwood Township

STORET SiteID = S001-424



Years Monitored

2001, 2003, 2006, 2012

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 at the bottom of their jurisdictional area. Flows in the West Branch of the Sunrise River are often around 70 cfs, but range from 15 cfs to near 200 cfs.

This segment of the river is listed by the MN Pollution Control Agency as impaired for turbidity and for poor fish and invertebrate communities. A TMDL study is underway and should be completed in 2013 or 2014.

Methods

In 2001, 2003, 2006, and 2012 the West Branch of the Sunrise River ws monitored at County Road 77 (Lyons St). This location is the boundary between Anoka and Chisago Counties. It is also the farthest downstream point within the Sunirse River Watershed Management Organization's jurisdiction.

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, conductivity, turbidity, temperature, salinity, and dissolved oxygen. Parameters tested by water samples sent to a state-certified lab included total phosphorus, total suspended solids, and chlorides. In 2012 lab tests for hardness and sulfates were added. Water level is monitored continuously in the open water season and a rating curve has been developed to calculate flows from those water level records.

Results and Discussion

Summary

Summarized water quality monitoring findings and management implications include:

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

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

- Phosphorus was on the high end of acceptable levels. When state water quality standards are developed for phosphorus in streams, the West Branch of the Sunrise River may exceed it.

  Management discussion: Management in upstream lakes will help reduce phosphorus in the river.

- Suspended solids and turbidity were high, and in exceedance of state water quality standards. The largest source is likely algae from upstream lakes.

  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.

- Dissolved oxygen (DO) was typically within the range considered normal and healthy, but other data collected by MPCA shows problems. We found two occassions of low dissolved oxygen, but these measurements were taken in the afternoon when oxygen would be expected to be highest. The MPCA has taken around-the-clock DO measurements for eight days in 2012 and found it dipped below 5 mg/L every morning.

  Management discussion: Low dissolved oxygen is likely impacting aquatic life. The Sunrise River TMDL project should provide insights into the cause and corrective actions.

This reach of the West Branch of the Sunrise River has an impaired invertebrate and fish community according to the MPCA. There was one invert sample taken for this determination. The invertebrate monitoring crew sampled overhanging vegetation and macrophytes and did not sample the stream bed. The stream bed is difficult to sample because sediments are deep and unconsolidated. There were two fish samples taken at County Road 77, and another right upstream. The fish visits were scored against a low gradient Index of Biotic Integrity (IBI), which is appropriate for this river.

A Total Maximum Daily Load (TMDL) study for this river reach is being completed in 2013. It is part of a larger Sunrise River Watershed Restoration and Protection Project (WRAPP) led by the Chisago Soil and Water Conservation District and MN Pollution Control Agency. Local entities should become involved in this project as it will determine causes of the turbidity and biotic impairments and set forth measures needed to correct them.

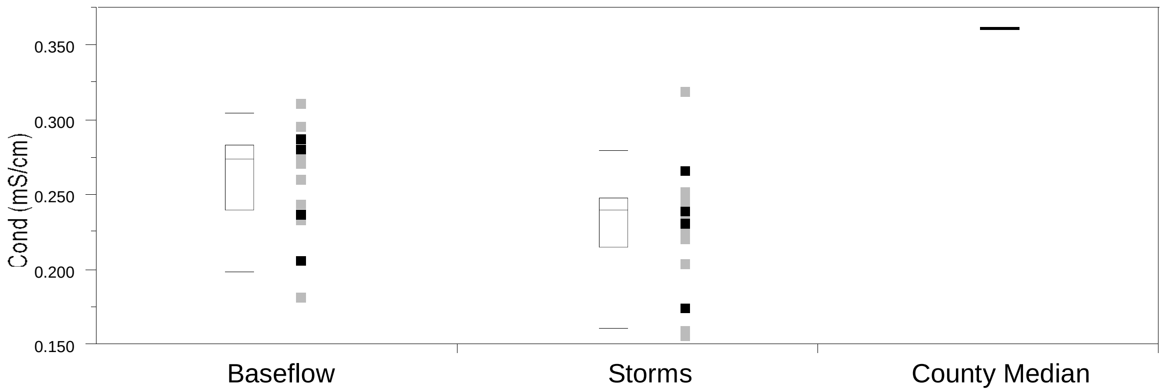
Conductivity and chlorides

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. Conductivity is the broadest measure of dissolved pollutants we used. It measures electrical conductivity of the water; pure water with no dissolved constituents has zero conductivity. Chlorides 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.

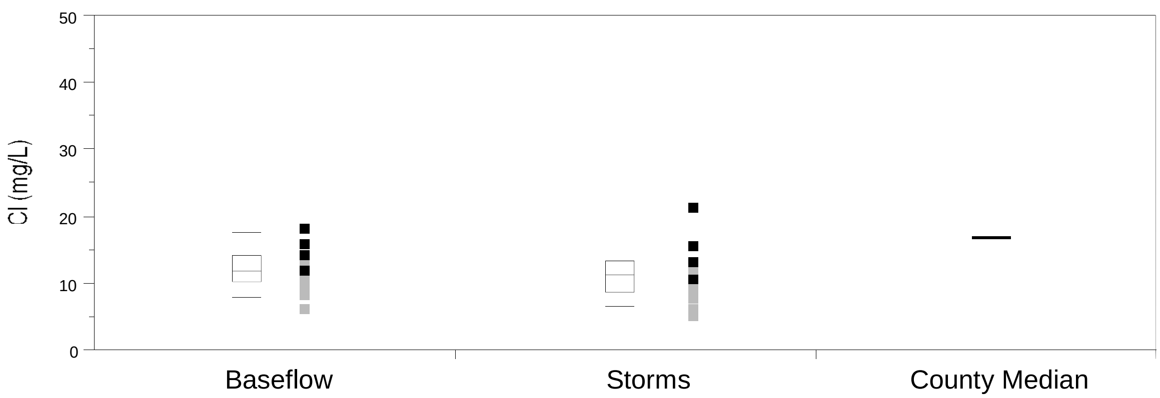
Conductivity was acceptably low in the West Branch of the Sunrise River. Median conductivity across all years was 0.247 mS/cm. This is notably lower than the median for 34 Anoka County streams of 0.362 mS/cm. Conductivity was lowest during storms, suggesting that stormwater runoff contains fewer dissolved pollutants than the surficial water table that feeds the river during baseflow. High baseflow conductivity has been observed in many other area streams too, studied extensively, and the largest cause is road salts that have infiltrated into the shallow aquifer.

Chloride results parallel those found for conductivity. Median chloride levels in the West Branch of the Sunrise River across all years are the same as the median for Anoka County streams of 12 mg/L. The levels observed are much lower than the Minnesota Pollution Control Agency's (MPCA) chronic standard for aquatic life of 230 mg/L. The primary reason for low chloride levels in this river is low road densities in the watershed, and therefore less use or road deicing salts.

Conductivity during baseflow and storm conditions Black squares are 2012 readings. Grey squares are individual readings from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Chloride during baseflow and storm conditions Black squares are 2012 readings. Grey squares are individual readings from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

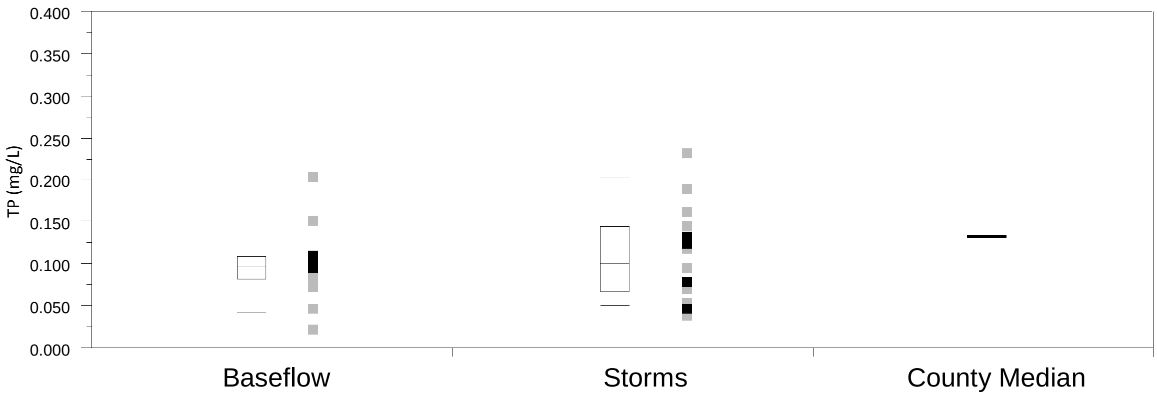


Total Phosphorus

Total phosphorus (TP), a nutrient, is one of the most common pollutants in our region, and can be associated with urban runoff, agricultural runoff, wastewater, and many other sources. Total phosphorus in the West Branch of the Sunrise River is on the high end of the acceptable range. The median TP for Anoka County streams is 128 ug/L and future state water quality standard is likely to be similar. The median phosphorus concentration in the West Branch of the Sunrise River across all years was 101.5 ug/L, and in 2012 alone was 112.5 ug/L. Six of 32 samples (19%) from all years had TP higher than 150 ug/L and two samples were higher than 200 ug/L.

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 100 ug/L during the last 10 years. Water quality improvements to Martin Lake will benefit the river downstream.

Total phosphorus during baseflow and storm conditions Black squares are 2012 readings. Grey squares are individual readings from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Turbidity and Total Suspended Solids (TSS)

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

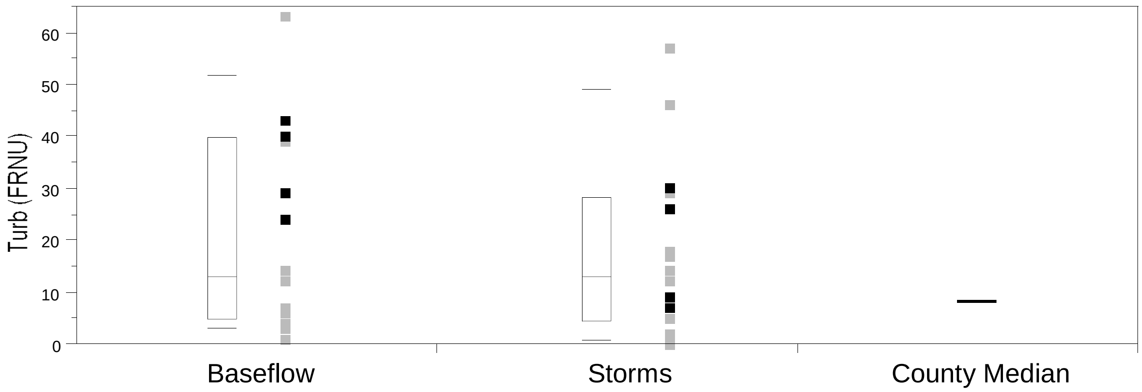
It is important to note the suspended solids can come from sources in and out of the river. Sources on land include soil erosion, road sanding, and others. Riverbank erosion and movement of the river bottom also contributes to suspended solids. A moderate amount of this “bed load” is natural and expected.

The West Branch of the Sunrise River has been declared as “impaired” for excess turbidity by the MN Pollution Control Agency. Their threshold is 25 NTU turbidity. If a river exceeds this value on three occassions and at least 10% of all sampling events, then it is declared impaired for turbidity. Based on all years of data, the West Branch of the Sunrise River has exceeded 25 NTU turidity on 11 of 32 sampling occassions (34%). In 2012 alone, six of eight samples had turbidity of 25 NTU or higher, and the maximum was 44 NTU.

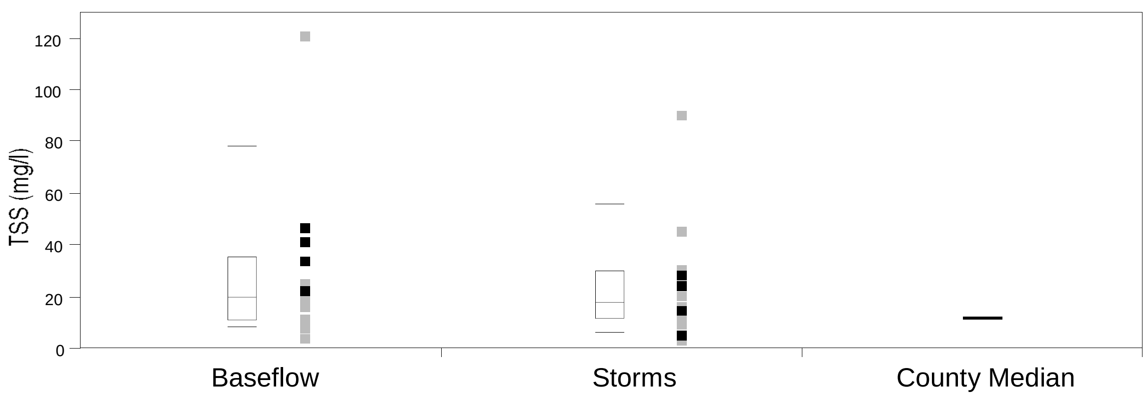
When inadequate turbidity data exists, total suspended solids can be used as a surrogate. The threshold value is 100 mg/L. Only one of 32 samples exceeded that threshold, and none in 2012. Regardless of this, the turbidity standard is clearly exceeded.

The most obvious source of turbidity is algae from upstream lakes. Three of the four immediately upstream lakes are impaired for excessive nutrients and high algae. They include Linwood, Martin, and Typo Lakes. The river sampling site is just 3 miles downstream from Martin Lake. The intervening area between the lake and sampling site is a wide floodplain fringe and forests with little human impacts that would be expected to add 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 move around and contribute to turbidity.

Turbidity during baseflow and storm conditions Black squares are 2012 readings. Grey squares are individual readings from previous years. 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 Black squares are 2012 readings. Grey squares are individual readings from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



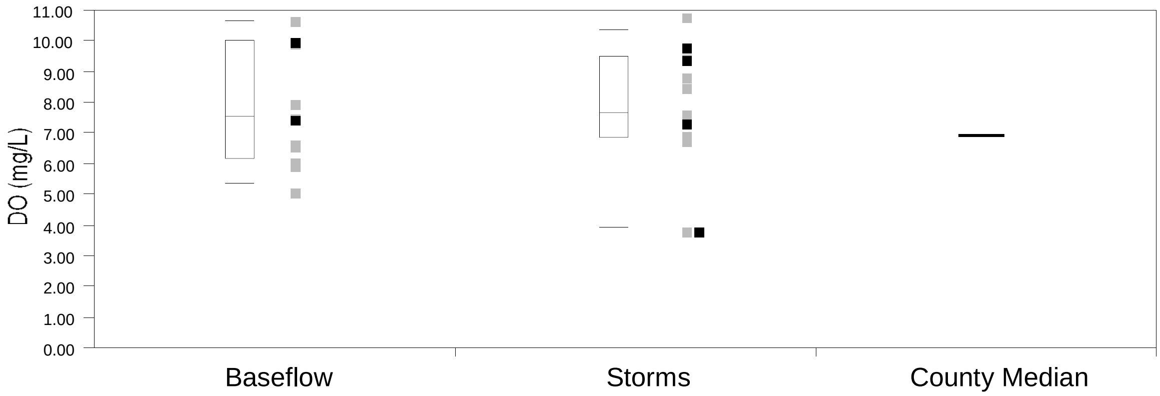
Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution consumes oxygen when it decomposes. If oxygen levels fall below 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.

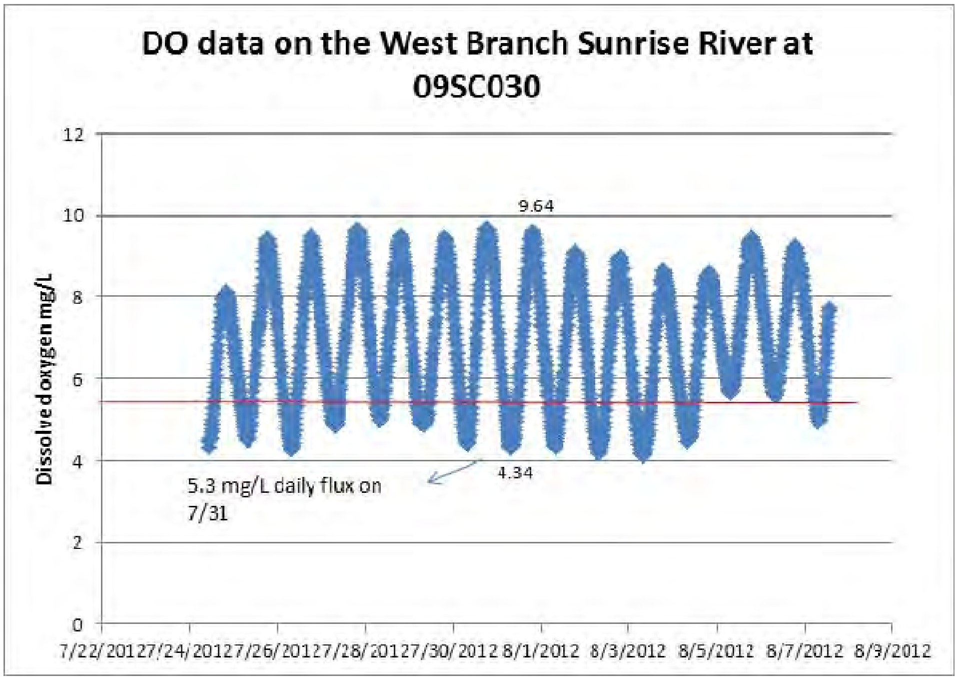
For the West Branch of the Sunrise River there are two datasets to consider. First, spot measurements were taken with the other water quality monitoring described in this report. Dissolved oxygen has twice been found at 4 mg/L. Both were during storm events, one in 2003 and one in 2012. All of these measurements were taken in afternoon when DO is typically highest. 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 have been designated as impaired for poor fish and invertebrate communities. Low dissovled oxygen could definitely contribute to or cause this impairment. The Sunrise River TMDL study should provide further diagnosis of the low DO and corrective measures.

Dissolved oxygen results during baseflow and storm conditions Black squares are 2012 readings. Grey squares are individual readings from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Dissolved oxygen results during 2012 around-the-clock dissolved oxygen monitoring by the MPCA and Chisago SWCD.

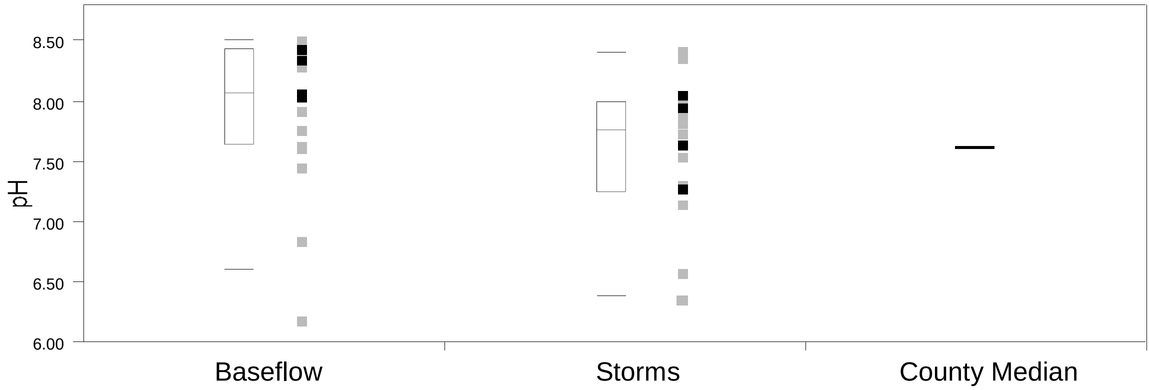


pH

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. 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 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, it's affect on this aquatic system is small.

pH results during baseflow and storm conditions Black squares are 2012 readings. Grey squares are individual readings from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



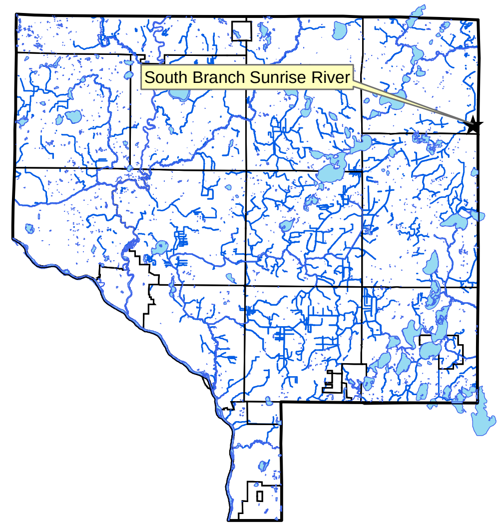
Recommendations

A Total Maximum Daily Load (TMDL) study is underway to determine address impairments of this river. The study will identify sources of problems, reductions needed to reach goals, and suggested actions. At this time, it appears that many of the issues in the river are best addressed by water quality improvement projects targeted at upstream lakes, however low dissolved oxygen may be an in-river problem.

SOUTH BRANCH SUNRISE RIVER

at Hornsby Street, Linwood Township

STORET SiteID = S005-640



Years Monitored
2012 only

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.

2012 was the first year of water quality monitoring at this site. Other monitoring downstrem has occurred. Hydrology (stage) monitoring has been done since 2009. No rating curve has been established.

The MN Pollution Control Agency has designated this site as "impaired" due to low dissolved oxygen. A TMDL study is underway and should be completed in 2013 or 2014.

Methods

Water Quality was monitored during 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, conductivity, turbidity, temperature, salinity, and dissolved oxygen. Parameters tested by water samples sent to a state-certified lab included total phosphorus, total suspended solids, and chlorides, hardness and sulfates. Water level is monitored continuously in the open water season. A rating curve has not been developed to calculate flows from those water level records.

Dry River Sampling on October 23, 2012

An anomoly occurred during the final 2012 sampling event. On October 23, 2012, immediately following a storm, staff visited the site. The river was dry, except for intermittent pools in the channel. This is highly unusual and staff speculated that management operations in Carlos Avery WMA pools may have caused the river drawdown.

Staff believed that sampling the water in the intermittent pool channels could be valuable for understanding the river's water quality. There has been speculation that poor water quality in this river may be due to upstream wetlands and native soils. On October 23, 2012 the water was strongly red and extremely turbid, even more so than when the river is flowing. Because there was no flow, and hence no watershed runoff, testing the pools of water seemed a good opporutnity to test the impact of native soils on water quality. The data from those tests are discussed here, but not included in the graphs or discussions elsewhere in this report because they are not representative of water quality when the river is flowing.

October 23, 2012 water quality results for intermittent pools within the otherwise dry river channel

pH	Conductivity (mS/cm)	Turbidity (FNRU)	DO (mg/L)	Temp (C)	Sal (%)	TP (mg/L)	Cl (mg/L)	TSS (mg/L)
7.35	0.186	504	4.28	12.5	0.00	1.64	<30	113

The South Branch of the Sunrise River at this site has had a reddish color on previous occasions, particularly when flows and dissolved oxygen are low. It has been speculated that iron-rich soils are the source of this color. When oxygen is low, bacteria change iron to its reduced form. This reduced form is more mobile and less able to hold phosphorus.

On October 23, 2012, when the stream channel held only intermittent pools of water, the water was even more intensely red, turbid, and had extremely high phosphorus. This result is consistent with the theory that iron-rich native soils are an important source of turbidity and phosphorus. It does not appear that watershed practices are to blame.

Results and Discussion

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 baseflow and low oxygen.

The issues of low oxygen, turbidity, and phoshorus appear to be related. Addressing them in concert may be helpful. The water has a notable reddish color during baseflow, when dissolved oxygen would be expected to be lowest. This color may be due to reduction of iron in soils. Iron in its reduced form is more mobile (hence the reddish water color) and less able to hold phoshorus. High turbidity and phoshorus coincide with low oxygen and baseflow. Low oxygen is likely due to decomposition in upstream wetlands, which might be described as "natural."

Summarized water quality results include:

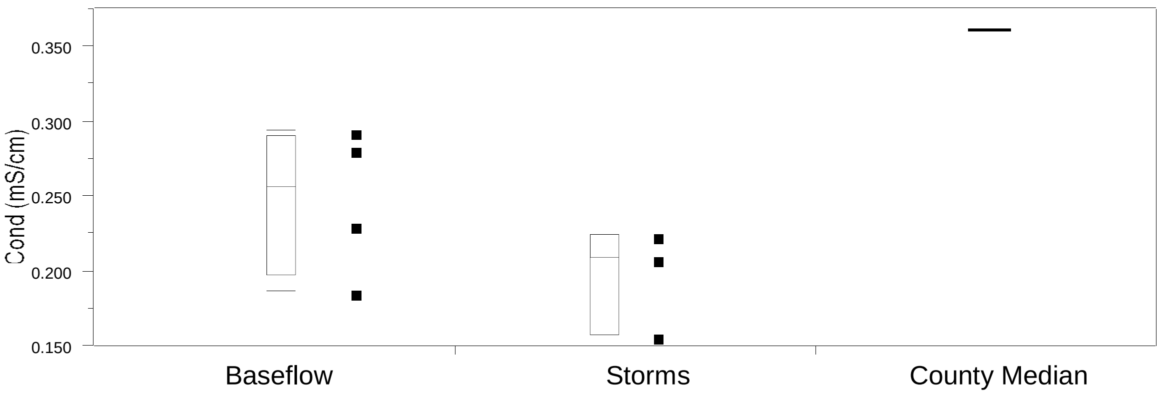
- Dissolved pollutants, as measured by conductivity and chlorides, are low.
- Phosphorus was high during baseflow. The source may be wetland soils in a low oxygen environment. When state water quality standards are developed for phosphorus in streams, the South Branch of the Sunrise River may exceed it.
- Suspended solids and turbidity were high during baseflow. Twenty measurements, which we do not yet have, are required determine if it fails to meet state water quality standards. However the data to date suggest the site may fail to meet state standards.
- pH was within the range considered normal and healthy for streams in this area. Interestingly, pH was lower during baseflow than storms. This is the opposite of most streams.
- Dissolved oxygen was occassionally low. This river reach is already listed by the State as "impaired" for low dissolved oxygen.

Conductivity and chlorides

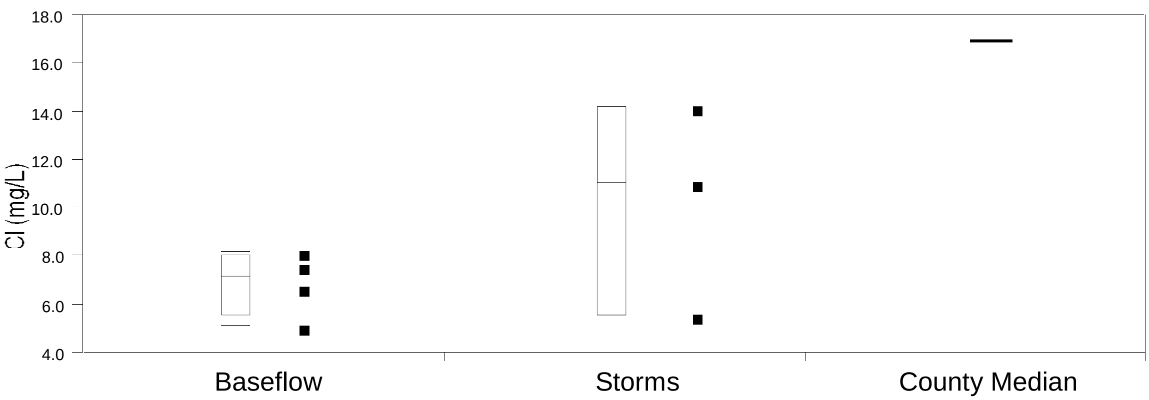
Conductivity and chlorides are measures of dissolved pollutants. Dissolved pollutant sources include urban road runoff, industrial chemicals, and others. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Conductivity is the broadest measure of dissolved pollutants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

Conductivity is low in the South branch of the Sunrise River. Conductivity was lowest during storms, suggesting that stormwater runoff contains fewer dissolved pollutants than the surficial water table that feeds the river during baseflow. Higher conductivity during baseflow suggests an impact from road deicing salts that have infiltrated to the shallow groundwater and feed the stream during baseflow.

Conductivity during baseflow and storm conditions Black squares are 2012 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Chloride during baseflow and storm conditions Black squares are 2012 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Chlorides are low in the South Branch of the Sunrise River. The levels observed are much lower than the Minnesota Pollution Control Agency's (MPCA) chronic standard for aquatic life of 230 mg/L. This is likely because of low road densities (and therefore deicing salt use) in the watershed. Because of large expanses of public natural areas in the watershed, future increases in chlorides should be minimal.

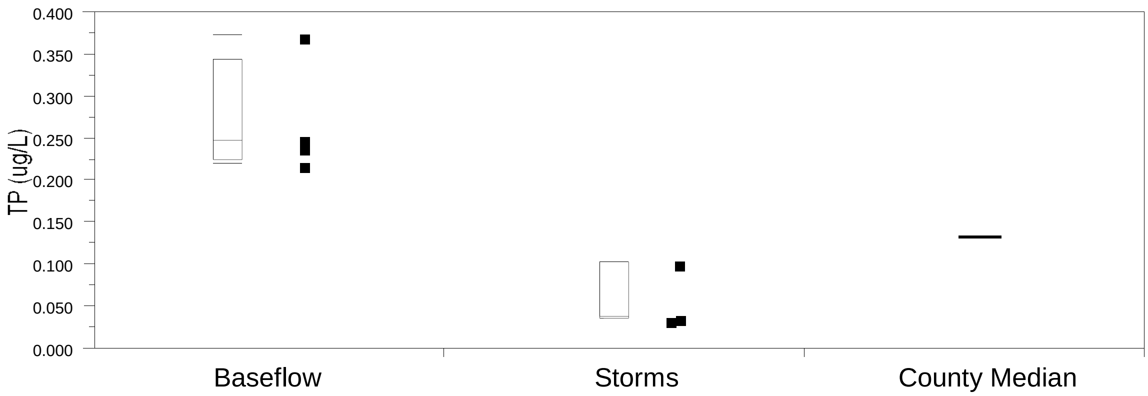
Total Phosphorus

Total phoshporus (TP) was high during baseflow (average 274 ug/L) but low during storms (average 61 ug/L). This is the opposite of most streams, where watershed runoff contributes phosphorus. As described earlier, we've hypothesized that an important source of phosphorus and turbidity in this river is native soils and low oxygen. During baseflow conditions the water is often red, dissolved oxygen is low, and phosphorus is high. When oxygen is low, the iron in soils would become reduced. Reduced iron is more mobile (hence the red color) and less able to hold phosphorus.

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 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.

Total phosphorus during baseflow and storm conditions Black squares are 2012 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.

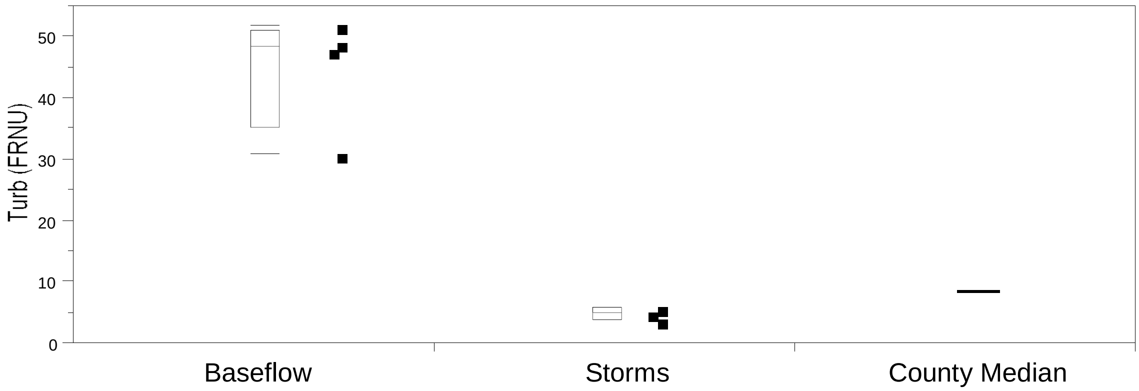
Turbidity and TSS were high during baseflow, but low during storms. This is the opposite of most streams, where watershed runoff contributes phosphorus. During baseflow, average turbidity was 45 FNRU, while it was only 5 FNRU during storms. Average TSS during baseflow was 15 mg/L, but only 5 mg/L during storms.

The South Branch of the Sunrise River would likely be designated as “impaired” for turbidity if more data existed. The state water quality standard is based on turbidity; TSS can be used as a surrogate if turbidity is not available. The threshold for impairment is at turbidity of 25. If 10% and at least 3 of all measurements exceed this value, the river is impaired. At least 20 measurements are required, but only seven have been taken at this site.

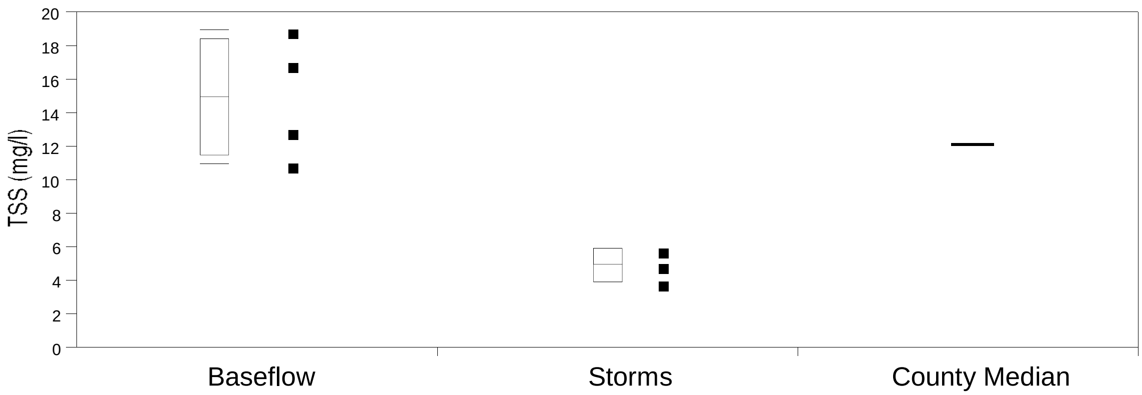
The cause of high turbidity, like high phoshorus, is likely iron-rich native soils in low oxygen conditions. Reduced iron is more mobile. The river frequently a reddish color during baseflow and low oxygen conditions.

Another cause of turbidity may be the nature of the peat soils through which the river flows. Especially when dried these soils can be susceptible to crumbling easily. Their snow-flake like particles stay suspended in the water column.

Turbidity during baseflow and storm conditions Black squares are 2012 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 Black squares are 2012 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

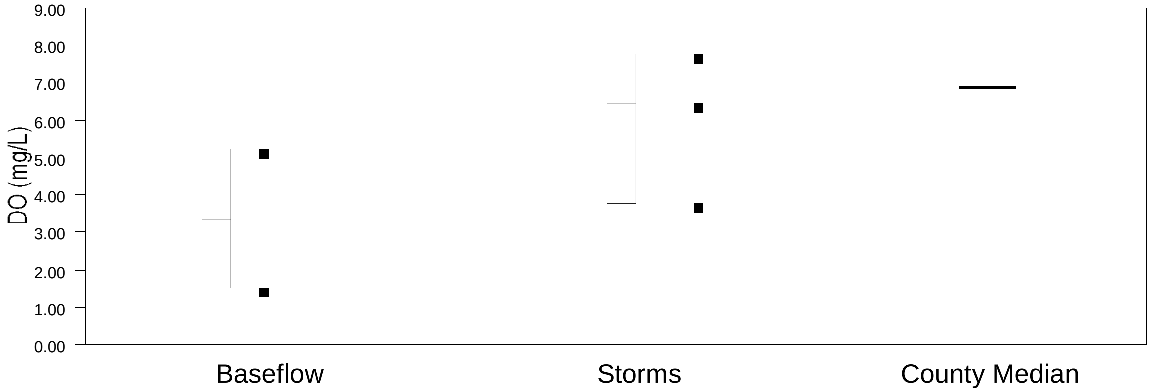


Dissolved Oxygen (DO)

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 2012 only five DO measurements were taken; equipment failures occurred on two other occassions. Of these, low measurements of 1.55 and 3.86 mg/L were found. Another measurement of 5.30 mg/L is concerningly low, especially considering all measurements were taken in the afternoon when DO is typically highest. We speculate that decomposition in the vast wetlands and pools of the Carlos Avery Wildlife Management Area upstream consume oxygen is likely the cause of low oxygen.

Dissolved oxygen results during baseflow and storm conditions Black squares are 2012 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

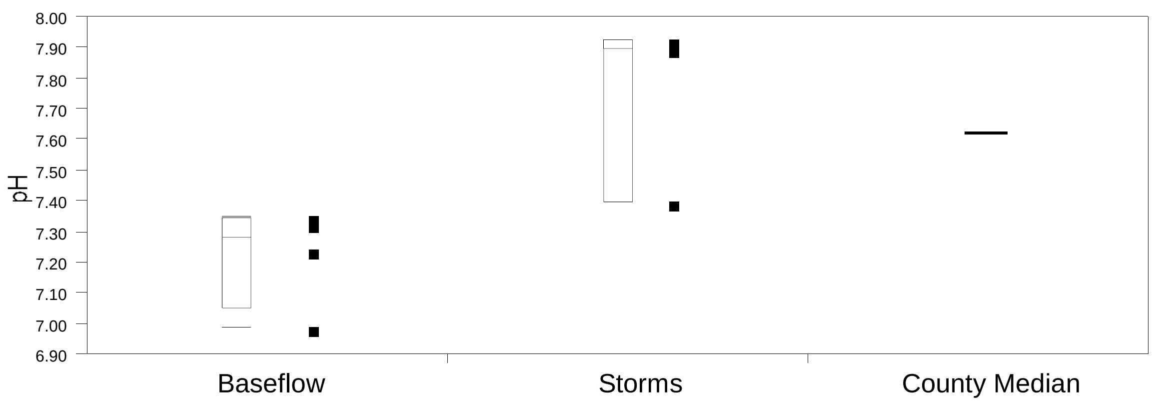


pH

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.

pH in the South Branch of the Sunrise River is within the acceptable range, however it's changes 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. The reason is not known.

pH results during baseflow and storm conditions Black squares are 2012 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 is underway to determine address impairments of this river. The study will identify sources of problems, reductions needed to reach goals, and suggested actions. While presently this river's impairment is dissolved oxygen, we suggest that the TMDL should also look at turbidity and total phosphorus. These are high as well, and may be linked to to the low oxygen problem.

Stream Hydrology

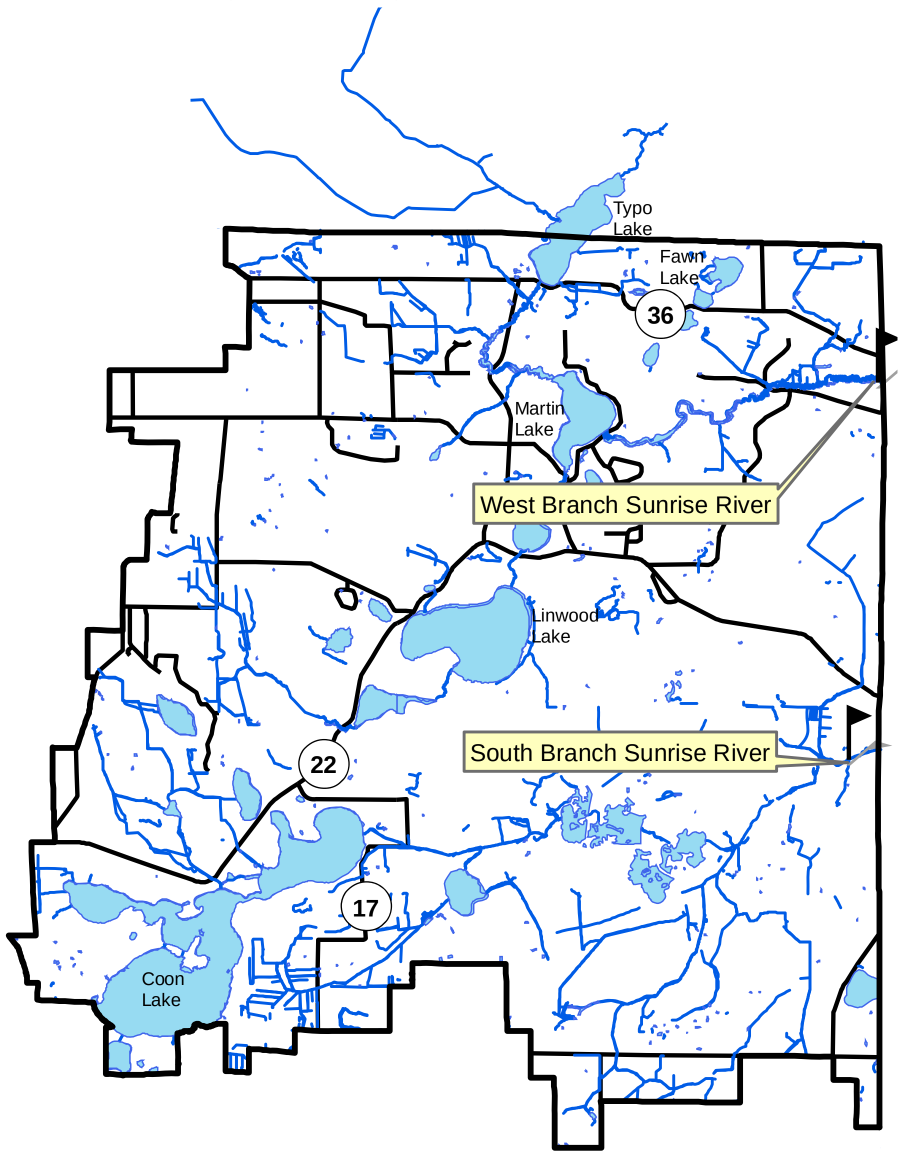
Description: Continuous water level monitoring in streams.

Purpose: To provide understanding of stream hydrology, including the impact of climate, land use or discharge changes. These data are also needed for calculation of pollutant loads and use of computer models for developing management strategies. In the Sunrise River Watershed, the monitoring sites are the outlets of the Sunrise River Watershed Management Organization's jurisdictional area, thereby allowing estimation of flows and pollutant loads leaving the jurisdiction.

Locations: South Branch Sunrise River at Hornsby St NE

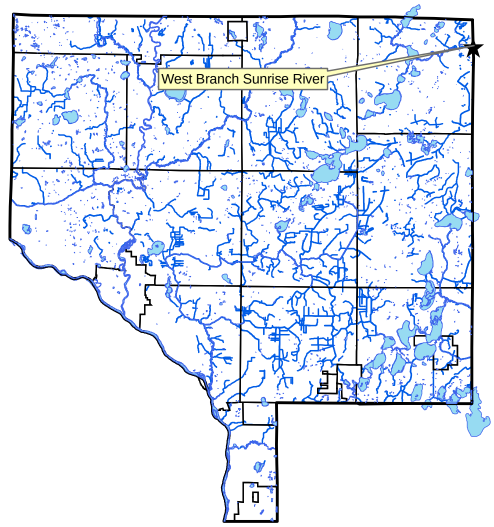
West Branch Sunrise River at Co Rd 77

Sunrise Watershed Stream Hydrology Monitoring Sites



West Branch of Sunrise River

At Co Rd 77, Linwood Township



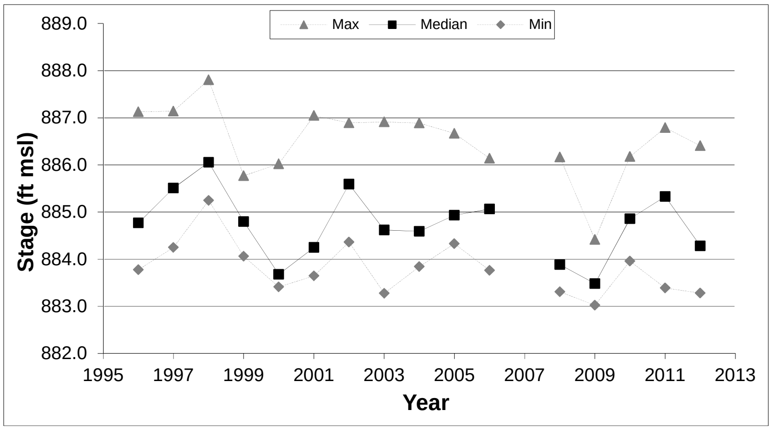
Notes

This monitoring site is the bottom of this watershed in Anoka County, at the Chisago County border. Upstream, this river drains through Linwood, Island, Martin, and Typo Lakes. The Sunrise River Watershed Management Organization monitors this site because it is at the bottom of their jurisdictional area. They have done water quality monitoring at this site and created a rating curve to estimate flow volumes from the 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.

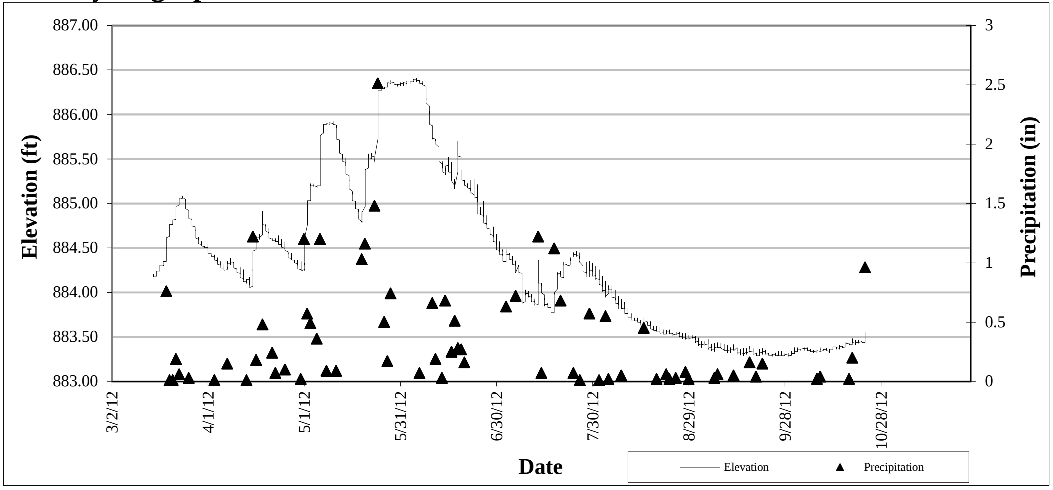
The rating curve to calculate flows (cfs) from stage data is:
Discharge (cfs) = $5.2509(\text{stage}-882.5)^2 + 10.88(\text{stage}-883.5) + 2.699$
$R^2=0.87$

This rating curve was first prepared in 2002. Five additional flow-stage measurements were taken in 2008-09 to keep the equation updated.

Summary of All Monitored Years



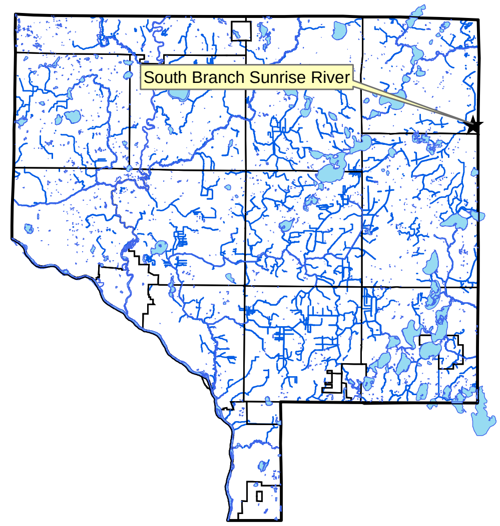
2012 Hydrograph



SOUTH BRANCH OF SUNRISE RIVER

At Hornsby St, Linwood Township

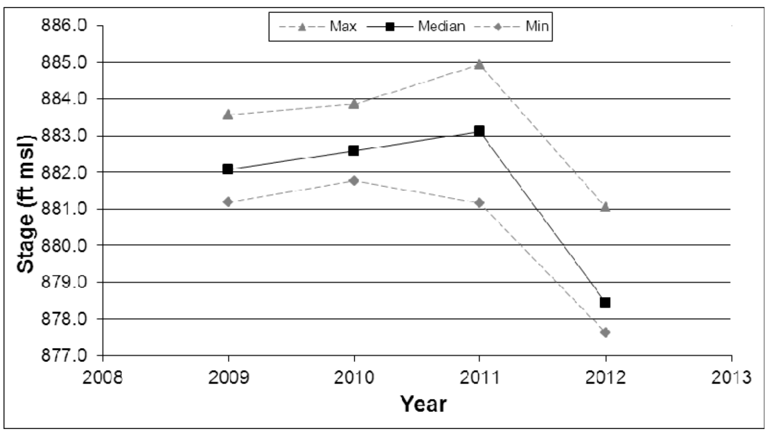
Notes



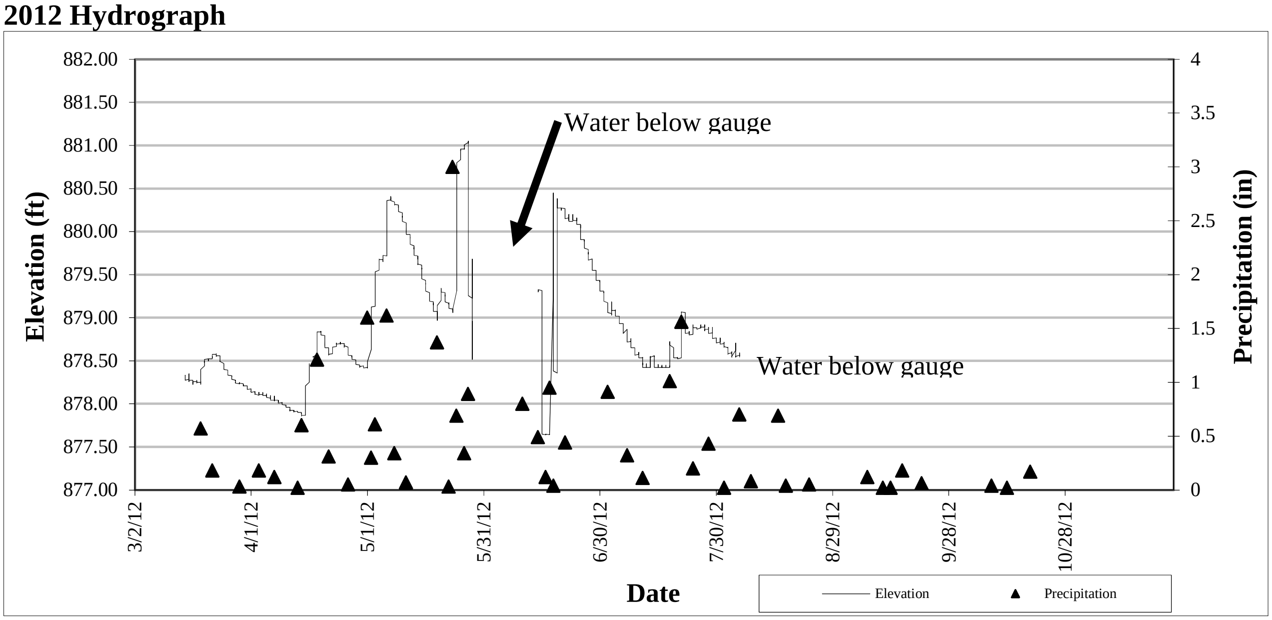
This monitoring site is the bottom of this watershed in Anoka County, at the closest accessible point to the Anoka-Chisago County boundary. Upstream, this river drains from Coon Lake and through the Carlos Avery Wildlife Management Area. The Sunrise River Watershed Management Organization monitors this site because it is at the bottom of their jurisdictional area. 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 not yet occurred at this site, nor has a rating curve been created to estimate flow volumes from the water level measurements.

No rating curve exists for this site.

Summary of All Monitored Years



2012 Hydrograph



Stream Rating Curves

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

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

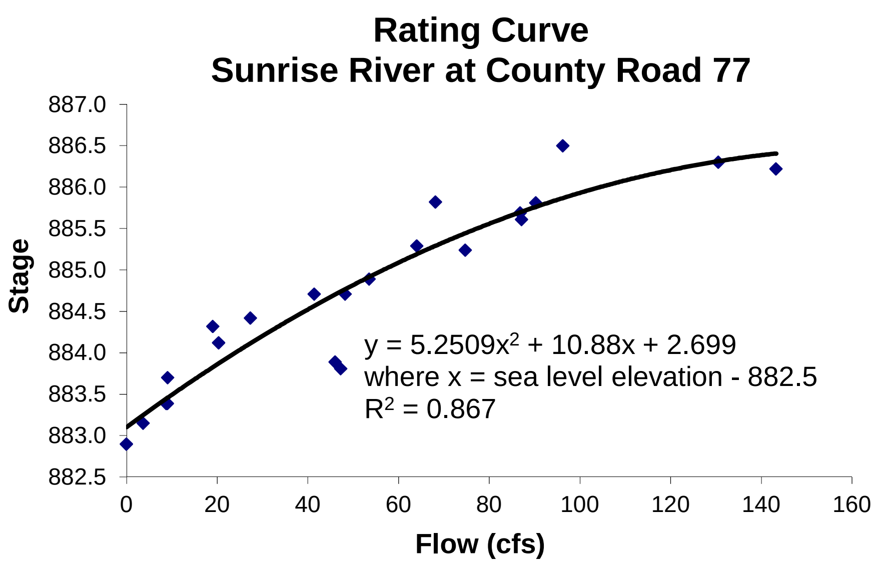
Locations: West Branch Sunrise River at County Road 77

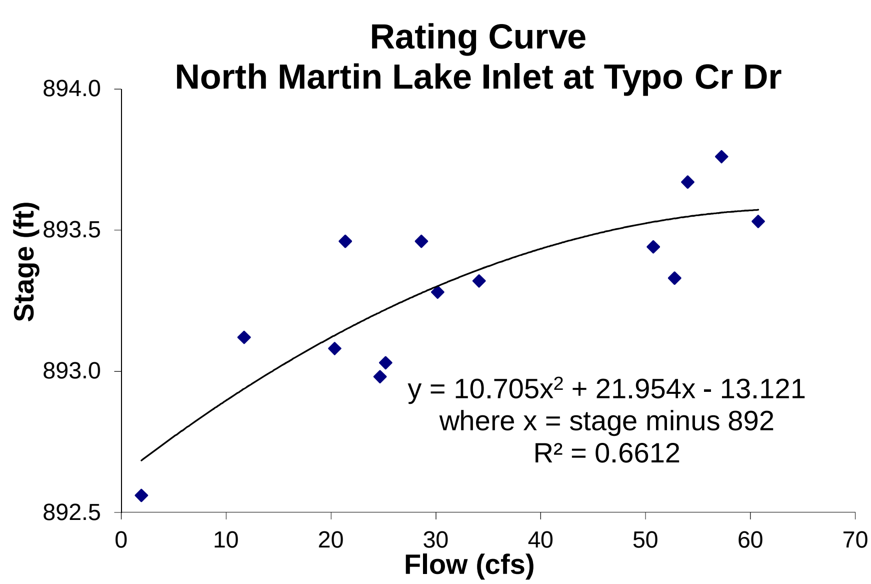
North Inlet of Martin Lake (Typo Cr) at Typo Creek Drive

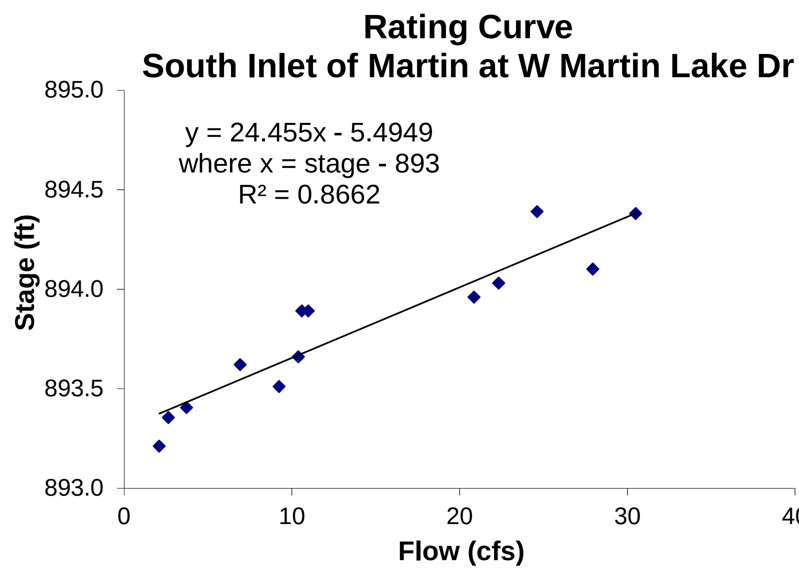
South Inlet of Martin Lake at West Martin Lake Drive

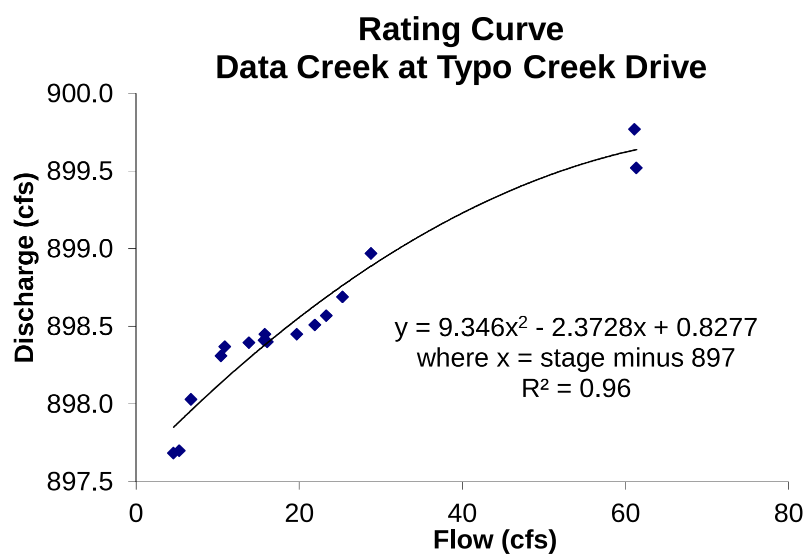
Data Creek at Typo Creek Drive

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






Rating Curve
South Inlet of Martin at W Martin Lake Dr
y = 24.455x - 5.4949
where x = stage - 893
R² = 0.8662
Stage (ft)
895.0
894.5
894.0
893.5
893.0
0
10
20
30
40
Flow (cfs)


Rating Curve
Data Creek at Typo Creek Drive
y = 9.346x² - 2.3728x + 0.8277
where x = stage minus 897
R² = 0.96
Discharge (cfs)
900.0
899.5
899.0
898.5
898.0
897.5
0
20
40
60
80
Flow (cfs)

Wetland Hydrology

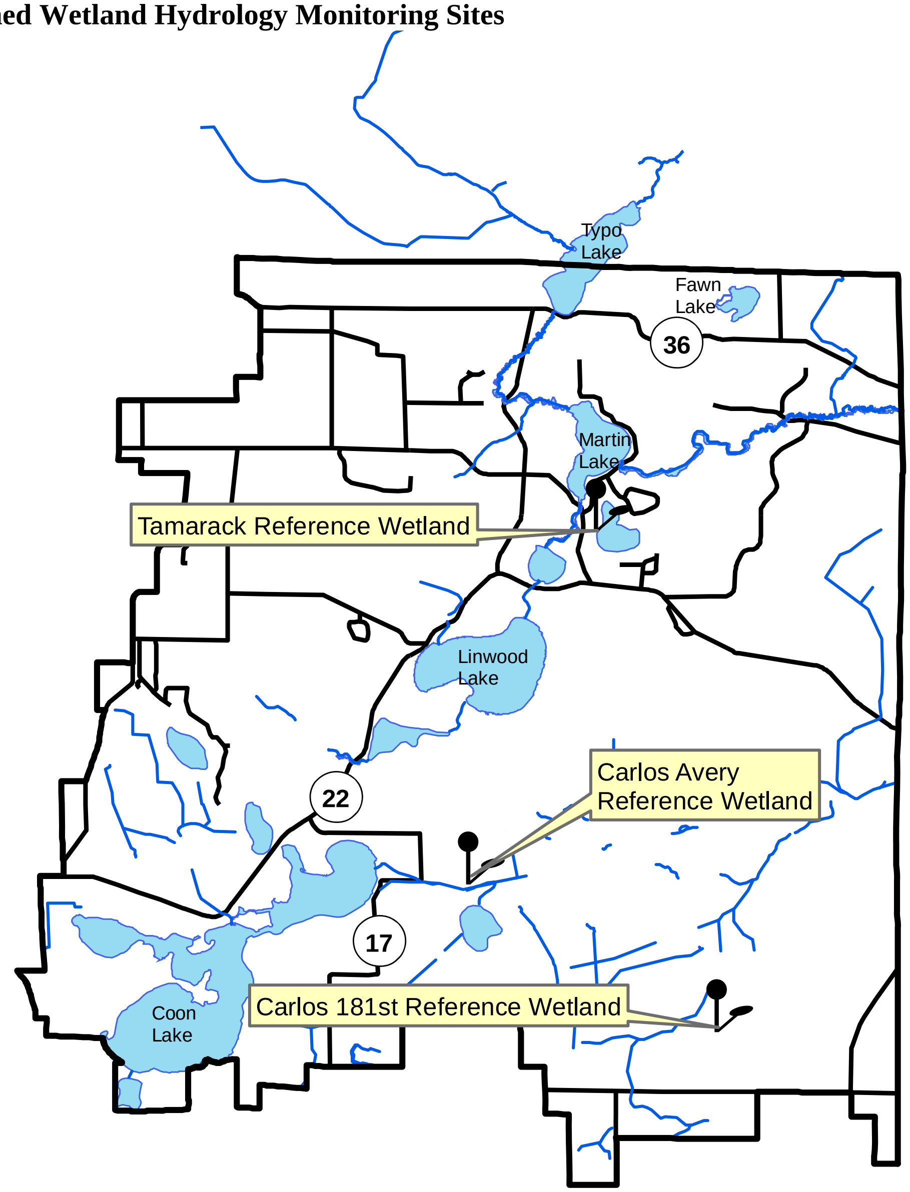
Description: Continuous groundwater level monitoring at a wetland boundary, to a depth of 40 inches. County-wide, the ACD maintains a network of 18 wetland hydrology monitoring stations.

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

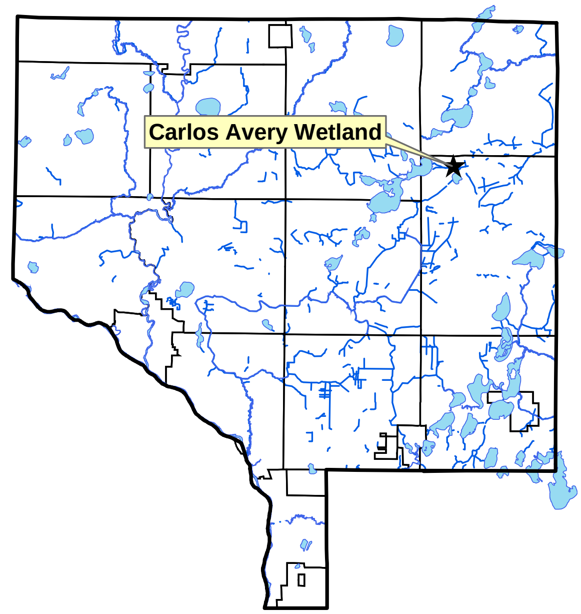
Sunrise Watershed Wetland Hydrology Monitoring Sites



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

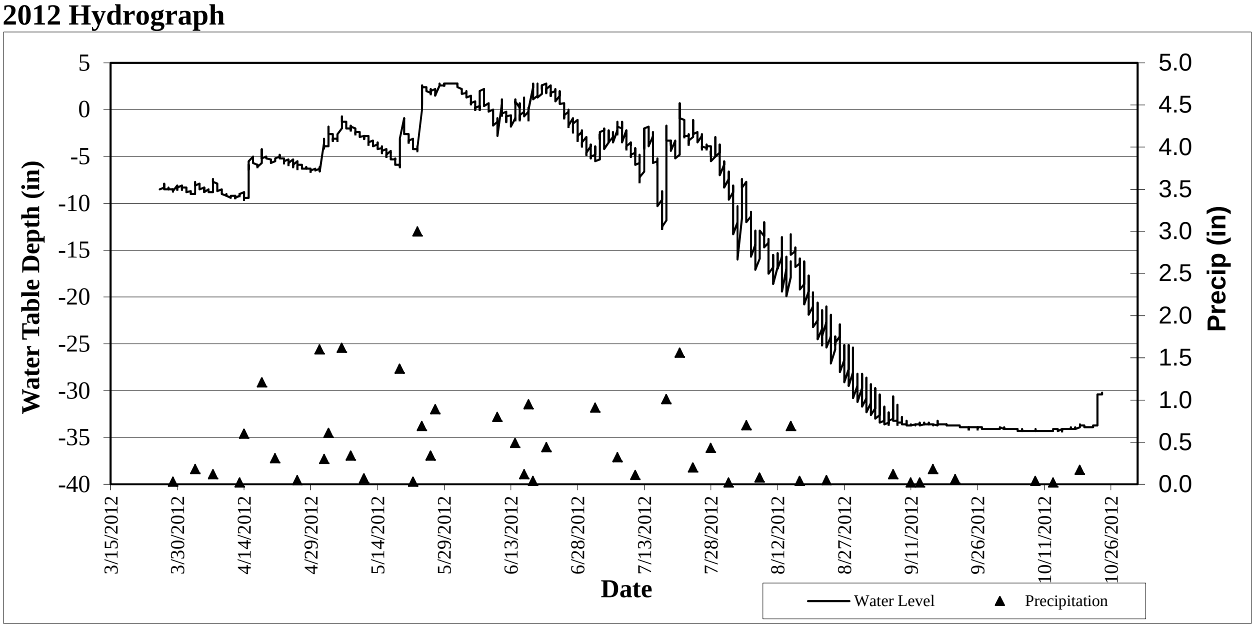
Surrounding Soils: Lino loamy fine sand

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.

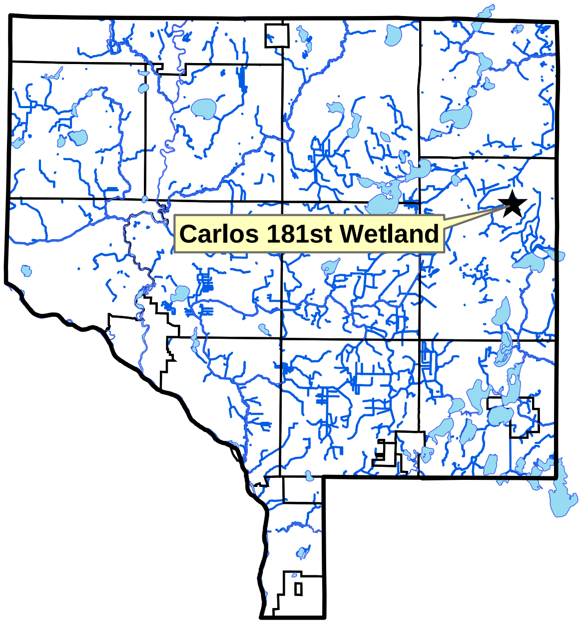
2012 Hydrograph



Well depths were 40 inches, so a reading of –40 indicates water levels were at an unknown depth greater than or equal to 40 inches.

CARLOS 181ST REFERENCE WETLAND

Carlos Avery Wildlife Management Area, City of Columbus



Site Information

Monitored Since: 2006

Wetland Type: 2-3

Wetland Size: 3.9 acres (approx)

Isolated Basin? Yes

Connected to a Ditch? Roadside swale only

Soils at Well Location:

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

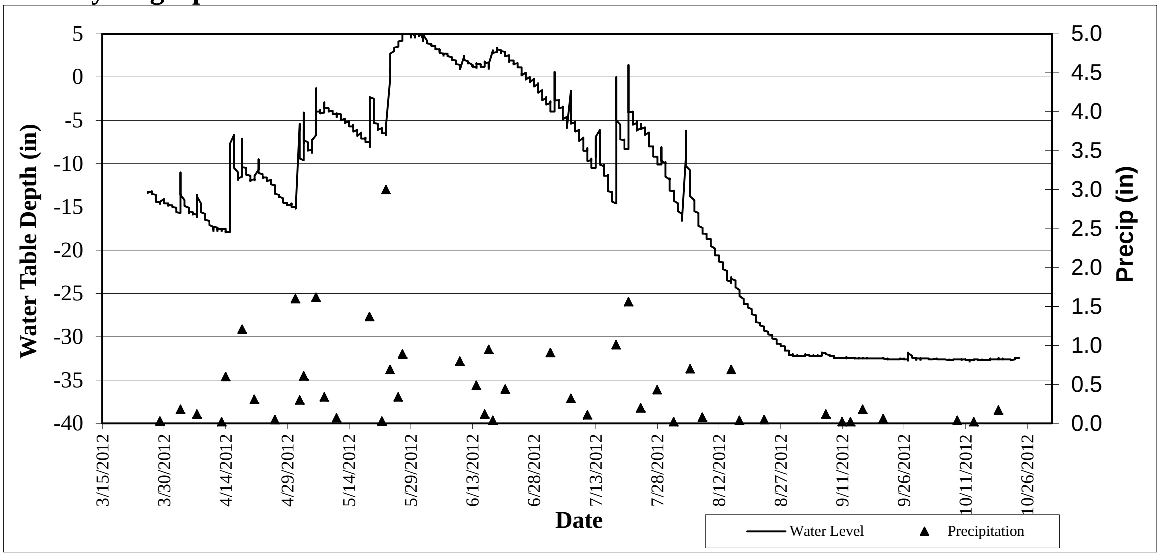
Surrounding Soils: Soderville fine sand

Vegetation at Well Location:

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

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

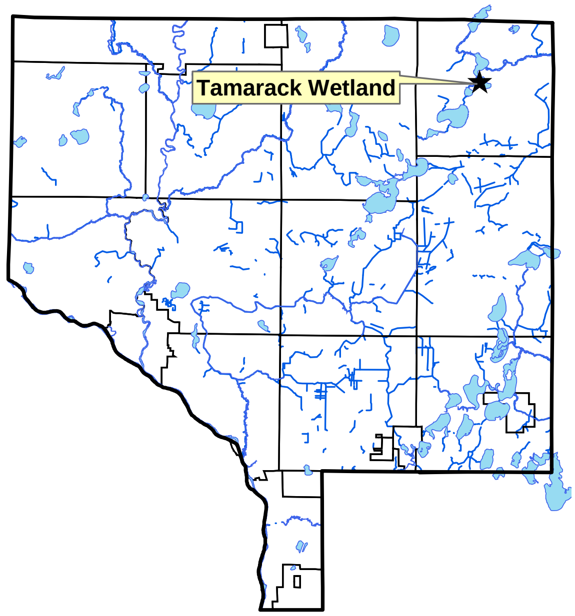
2012 Hydrograph



Well depths were 40 inches, so a reading of –40 indicates water levels were at an unknown depth greater than or equal to 40 inches.

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	-

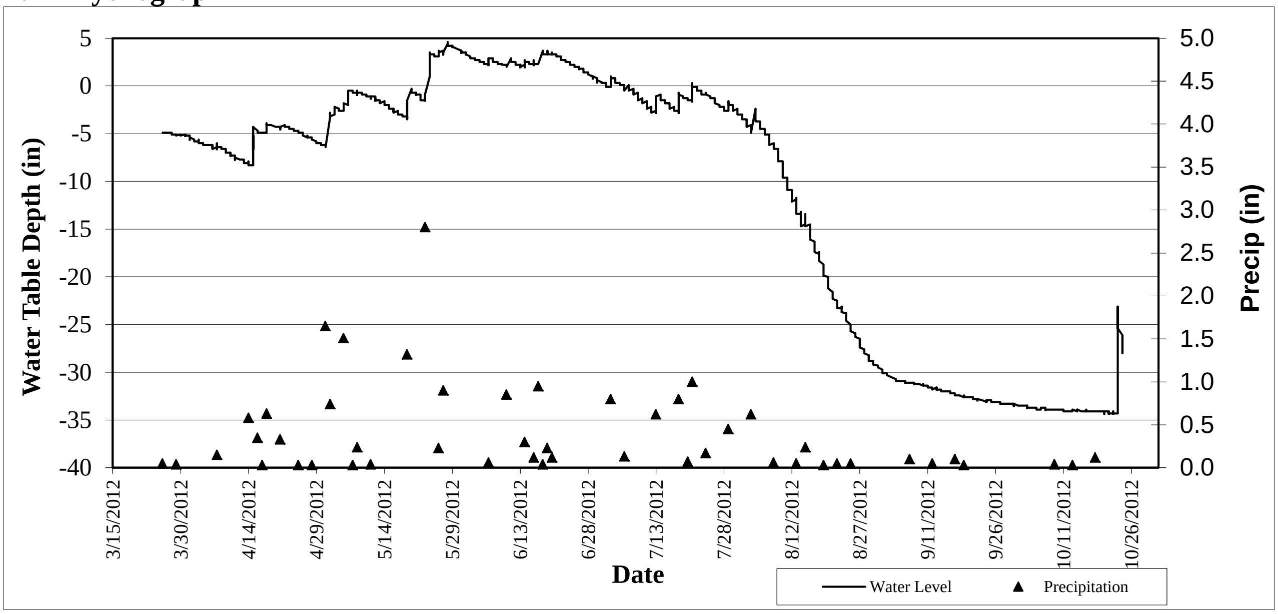
Surrounding Soils: Sartell fine sand

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.

2012 Hydrograph



Well depth was 35 inches, so a reading of –35 indicates water levels were at an unknown depth greater than or equal to 35 inches.

Water Quality Grant Fund

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

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

Locations: Throughout the watershed.

Results: In 2012 one lakeshore restoration project at Linwood Lake was awarded a grant from this fund. Additionally, $4,300 was transferred out of this fund at the discretion of the SRWMO Board and directed to the Martin and Typo Lakes Carp Barriers project.

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
Fund Balance		**$5,848.74**

Water Quality Improvement Projects

Description: Projects on either public or private property that will improve water quality, such as repairing streambank erosion, restoring native shoreline vegetation, or rain gardens. These projects are partnerships between the landowner, the Anoka Conservation District, state agencies, lake associations, or others.

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 in-progress or installed in 2012 in the SRWMO include:

- **Linwood Lake – Gustafson Lakeshore Restoration.**
  Description: Replaced turf grass with native plants. Also installed native aquatic plants at the water's edge. The project is located in place where topography leads to concentrated runoff into the lake. The project size was 98 square feet.
  An important purpose of this project was to serve as a demonstration for other lakeshore homeowners. The Linwood Lake Association's annual meeting was held at the project site. The Anoka Conservation District gave a short presentation about the project and Native Plant Nursery, Inc. also gave a presentation.

  Funding:

SRWMO Cost Share Grant	$37.35
Landowner	$37.35

  Plants donated by Native Plant Nursery, Inc (approx value $72)

- **Carp barriers at Martin and Typo Lakes**. In 2012 and 2013 carp barriers will be installed at four sites around Martin and Typo Lakes. Additionally, commercial carp harvests will be conducted with the aid of radio tracking the schooling fish in wintertime. This project aims to improve water quality in these lakes by reducing the carp population.

  Carp are a high percentage of the fish biomass in these waterbodies. They strongly degrade habitat and water quality throughout their feeding and spawning behaviors. Carp control will improve water clarity, increase plants, improve the game fishery, and enhance wildlife opportunities. Barriers are an effective strategy for carp control because Typo and Martin Lake each provide something important for carp, and moving between the lakes is important to their success. Martin Lake is deeper, and good for overwintering. Typo Lake is shallow and good for spawning. Stopping migrations between the lakes will reduce overwintering survival and spawning success. The barriers alone will achieve this over time, but we will accelerate results with carp harvests.

  This project encounted challenges in 2012. Original cost estimates from the project engineer proved to be far too low. In response, the SRWMO committed an additional $14,300 to the project which matched an additional $92,392 in DNR Conservation Partners Legacy Grant funds. This new, larger budget was based upon on-site feedback from construction contractors. Unfortunately, when the project was bid in December 2012 the lowest contractor bid was nearly double the project budget. Options for proceeding are being evaluated.

This project is a collaboration between the SRWMO, Anoka Conservation District, Martin Lakers Association, MN DNR, and Linwood Township. Major funding is provided by the SRWMO, Martin Lakers Association, and the Outdoor Heritage Fund (from the Clean Water, Land, and Legacy Amendment).

- **Coon Lake Stormwater Retrofits -** In 2012 the City of East Bethel installed additional stormwater treatment while rehabilitating road surfaces in the Coon Lake Beach Neighborhood. Stormwater that would otherwise reach Coon Lake will be diverted into roadside swales for infiltration. This project was guided with input from the Anoka Conservation District who accelerated a stormwater assessment study to find these opportunities for improved stormwater treatment. Funding for installation was from the City of East Bethel.

Coon Lake Area Stormwater Retrofit Analysis

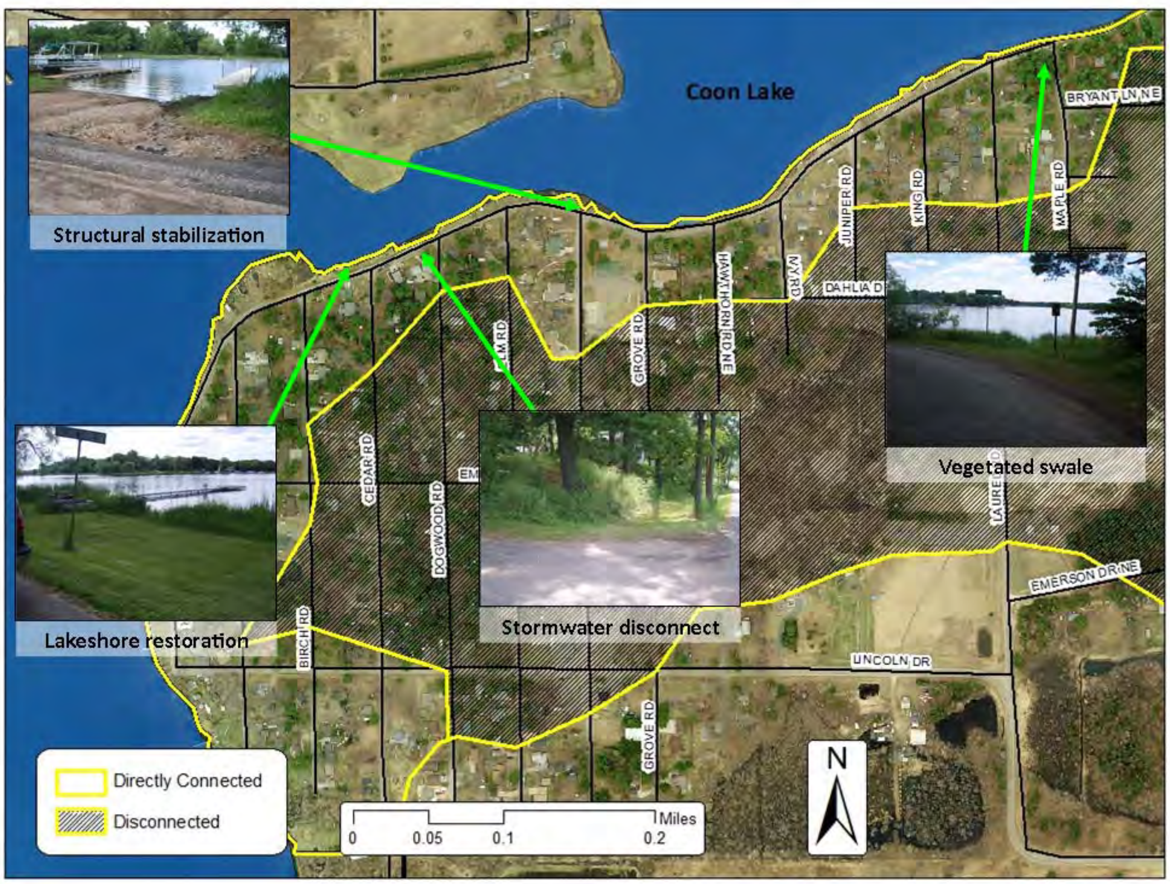
Description: A Stormwater Retrofit Analysis is a systematic approach of identifying opportunities for improved stormwater treatment within a subwatershed of a high priority waterbody. Once stormwater retrofit options are identified, they are modeled to determine pollutant removal benefits. Costs for each potential project are estimated. Finally, the cost effectiveness of each project is calculated and projects are ranked accordingly. The final report serves as a guide for installing water quality projects in a cost effective manner.

Purpose: To improve Coon Lake water quality.

Results: The Anoka Conservation District was contracted to complete a Stormwater Retrofit Analysis of the Coon Lake subwatershed beginning in 2012 with the majority of work and delivery of final report to occur in 2013. Recent water quality data shows total phosphorus concentrations in Coon Lake are close to the state standard of 40 µg/L. Therefore, even relatively small reductions in phosphorus are helpful to remain below the standard. The retrofit analyisis will identify and prioritize projects that improve the quality and reduce the volume of stormwater runoff.

In 2012 the City of East Bethel implemented a street reconstruction project in the Coon Lake Beach neighborhood. The Coon Lake Beach neighborhood, or "catchment," is estimated to deliver 37 pounds of phosphorus and 11,000 pounds of sediment to the lake via stormwater runoff annually. To take advantage of the planned construction, ACD accelerated the retrofit analysis for the area. Several retrofit opportunities were identified including stormwater disconnects, vegetated swales, lakeshore restorations, and rain gardens. Several stormwater disconnects (redirecting stormwater into roadside ditches) were installed during street reconstruction by the City. Analysis of the remaining lake subwatershed will be completed in 2013.

Stormwater retrofit opportunities identified in the Coon Lake Beach neighborhood in 2012.



Lakeshore Landscaping Education

Description: One goal of the Sunrise River WMO is to encourage and facilitate lakeshore restorations with native plants. These projects, usually accomplished by homeowners with assistance from agencies like the SRWMO, are beneficial to overall lake health. By planting native plants at the shoreline runoff into the lake is filtered, and fish and wildlife habitat is substantially improved. To move toward its goal, the SRWMO does regular education and marketing of lakeshore restorations to homeowners.

Purpose: To improve lake water quality and lake health.

Results: In 2012 the SRWMO contracted the Anoka Conservation District (ACD) to accomplish the tasks listed below to further lakeshore landscaping education:

Linwood Lake Association Presentation – A presentation about lakeshore landscaping to the Linwood Lake Association was completed on behalf of the SRWMO. The presentation was given at the lake association's annual meeting.

Rather than give a traditional presentation with displays and photos, the ACD worked with the landowner to install a lakeshore restoration at the meeting site (see Gustafson Lakeshore restoration on previous pages). Staff then described to the group of how the project came together, labor involved, costs, and how it will look in coming years. To futher bolster the presentation, Native Plant Nursery, Inc. also talked about plants they offer and why homeowners should choose native plants.

SRWMO Display Banner – The SRWMO has regularly borrowed displays from the Anoka Conservation District for community events, however it has lacked a banner with the organization's name. The ACD created four banner designs for SRWMO Board consideration. The design selected was printed onto solid plastic fits existing display boards.

Web Video Promotion – In 2011 the SRWMO and ACD created a web video about lakeshore landscaping. That video resides on the SRWMO webpage. In 2012 the ACD promoted that video by emailing it to all SRWMO cities and lake associations, asking that they forward it to others would would be interested.

Blue Thumb membership – Blue Thumb is a consortium of Minnesota agencies, plant nurseries, landscapers, and others who share resources in their efforts to promote the use of native plants to improve water quality through shoreline stabilizations, rain gardens, and native plant gardens. Resources that are shared amongst Blue Thumb members include pre-fab marketing materials, displays, how-to manuals, and others. The ACD enrolled the SRWMO in Blue Thumb and performed all necessary administration to maintain the membership and renew it in 2012.

The ACD manages the SRWMO's Blue Thumb membership by submitting annual membership applications and tracking SRWMO contributions. Maintaining a Blue Thumb membership requires an annual contribution of either $1,500 cash or 30 hours of efforts. The SRWMO chooses to meet this requirement by incorporating Blue Thumb into a variety of tasks that are already planned and benefit from Blue Thumb (including those listed above). In 2012 the SRWMO exceeded the 30 hour commitment with the following work:

- Web video about shoreline stabilization.
- Presentation at Linwood Lake Association annual meeting
- Demonstration project at Linwood Lake, Gustafson property.
- Grant applications for potential projects.
- Martin Lake rain garden maintenance.

Annual Education Publication

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

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

Results: In 2012 the SRWMO contracted with the ACD to write the annual newsletter and provide it to member communities for distribution in their newsletters. Topics for annual newsletter were discussed by the SRWMO Board, and septic system maintenance was chosen. The article was also to include the SRWMO website address and general organizational information.

Limited space in city newsletters was recognized as an issue. To keep the article size minimal, yet deliver a memorable message, ACD staff wrote a poem. This form kept the article snappy and somewhat humorous. It was provided to member cities for their city newsletters in May.

SRWMO 2012 newsletter article, which was published in member city newsletters

Ode to the Septic System

A magical thing happens right under my lawn
I flush the toilet, it goes there, then gone!
That wonderful septic takes all that we do
Every drop is digested, even numbers one & two

Sounds like my job, perhaps you might say
Then you understand TLC can brighten the day
Attention and maintenance is not merely a perk
So let's take a look at how that septic system works

Because of the baffles, the tank keeps the poo
Which needs to be pumped every 3rd year or two
The liquids pass on to the drainfield with ease
Its pipes have holes, just like Swiss cheese

Speaking of doo, here's what you should
Using less water is wonderfully good
Don't do the laundry many loads in a row
Overloading could cause the system to blow

The 'don't' list is longer and cannot be rushed
A whole lot of things just shouldn't be flushed
Kleenex, solvents, paints, and antifreeze
Foods like fat, oil, coffee grounds, and veggies

Poison, cigarettes, and anti-bacterials too
Old meds and even feminine products are taboo

Don't drive on the drainfield or it will get crushed
Light a match near the tank and explode in a rush
Inside the tank is icky, and no place to play
If you smell yuck in your home call for help right away

When will I know there's a problem you think?
How about when your basement is flooded with stink
If your drains won't dry even after you plunge
The yard becomes soggy like a big poopy sponge

So for the sake of our lakes, streams, and your piggy bank
Please have someone regularly pump your septic tank

Brought to you by the Sunrise River Watershed Management Organization (SRWMO). We are considering establishing a low interest loan program to help homeowners with septic system upgrade or replacement, particularly in shoreland areas. If interested, please contact Jamie Schurbon at 763-434-2030 ext. 12 or jamie.schurbon@anokaswcd.org.

For more information about the SRWMO, please visit www.AnokaNaturalResources.com\srwmo

SRWMO Website

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

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.AnokaNaturalResources.com/SRWMO

Results: The SRWMO website contains information about both the SRWMO and about natural resources in the area.

Information about the SRWMO includes:

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

Other tools on the website include:

- an interactive mapping tool that shows natural features and aerial photos
- an interactive data download tool that allows users to access all water monitoring data that has been collected
- narrative discussions of what the monitoring data mean

SRMWO Website Homepage

Grant Searches and Applications

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

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

Results: At the direction of the SRWMO Board, in 2012 ACD staff prepared two grant requests in cooperation with the SRWMO:

1. **Martin and Coon Lake Stormwater Retrofits, BWSR Clean Water Fund Request**

   We proposed to install stormwater retrofits identified in the Martin Lake (complete) and Coon Lake (2013) stormwater retrofit assessments. Those studies identify opportunties to improve stormwater treatment to the lake. We proposed to install a network of a network of up to seven strategically-placed rain gardens, retrofit up to two catch basins with SAFL Baffles (a screen that reduces turbulence inside the structure and improves its ability to retain sediment), and add check dams to an existing roadside swale. In total, these projects would reduce discharge of phosphorus to these lakes by 4.22 lbs/yr and suspended solids by 3,862 lbs/yr. Our grant request was for $82,046. The SRWMO committed the minimum allowable match of $20,512 (25% of grant). This grant application was not successful.

   Grant awarded: No

2. **Typo and Martin Lake Carp Barriers, DNR Conservation Partners Legacy Request**

   This project was awarde a DNR Conservation Partners Legacy grant in 2011 for $128,938. Later, we discovered this budget would be inadequate for project installation; the engineer's original cost estimate was too low. We requested an additional $92,392 and the SRWMO provided additional match required. This grant request was successful.

   Grant awarded: Yes. $92,392

SRWMO 2011 Annual Report to BWSR

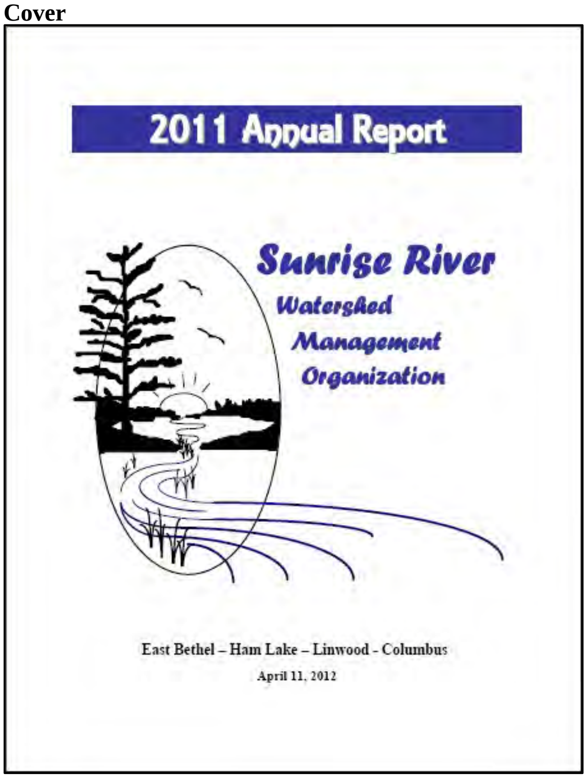
Description: The Sunrise River Watershed Management Organization (SRWMO) is required by law to submit an annual report to the Minnesota Board of Water and Soil Resources (BWSR), the state agency with oversight authorities. This report consists of an up-to-date listing of SRWMO Board members, activities 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).

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 a 2011 Sunrise River WMO Annual Report. ACD drafted the report and a cover letter. The draft was provided to the SRWMO Board on March 29, 2012. After SRWMO Board review, on April 13, 2012, 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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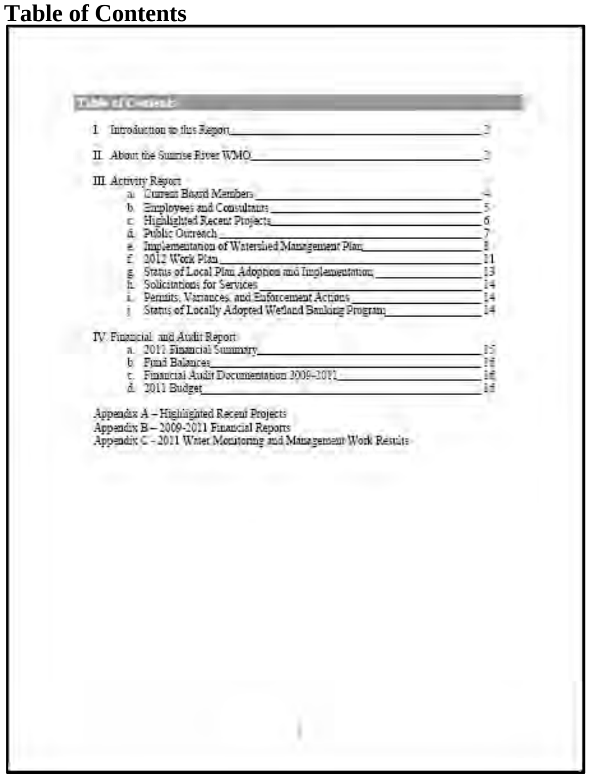
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Review Local Water Plans

Description: SRWMO member municipalities must update their Local Water Management Plans and ordinances within 2 years of the adoption of the new SRWMO Plan (MN Rules 8410.0130 and 84100160). All must be consistent with the SRWMO Plan. The SRWMO has approval authority over the Local Water Management Plans. Once a community submits their updated Local Water Management Plan to the WMO for review, the WMO has 60 days to provide comments. The Metropolitan Council has a simultaneous 45-day review period, and the WMO's review of the Plan must include a review of Metropolitan Council's comments. ACD assists the SRWMO by providing a technical review of Local Water Management Plans, as they are completed, and Metropolitan Council's comments on each.

ACD's assistance includes:

- Reviewing each of the four member municipalities' draft local water management plan, and any relevant ordinances, for consistency with the SRWMO Plan.
- Writing comments in the form of a letter to the municipality and presenting it to the SRWMO Board.
- Sending the comments to the municipality when authorized by the SRWMO Board.
- Do all of the above within the 60 day comment period allowed by law.

Purpose: To ensure consistency between municipal local water plans and the SRWMO Watershed Management Plan.

Results: All local water plans, except Ham Lake, have been approved. The following is the status of each city or township's local water plan, as of December 17, 2012:

Linwood Township – Linwood Township has adopted the SRWMO Watershed Management Plan by reference.

Ham Lake – The Ham Lake Local Water Plan was reviewed in January 2012. The staff recommendation is for approval, contingent upon inclusion of the SRWMO wetland standards. In 2012 the City has expressed concerns about inconsistencies between the URRWMO and SRWMO standards, both of which affect the City. The situation is not yet rectified.

East Bethel – The SRWMO received a draft local water plan in June 2010. Changes were requested. In May 2011 a final draft was received and approved.

Columbus – Approved at the February 2011 SRWMO meeting.

Deadline for all – June 3, 2012 is the deadline for all SRWMO cities and townships to revise local water plans and ordinances to be consistent with the SRWMO 3rd Generation Watershed Management Plan.

On-call Administrative Services

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

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

Results: In 2012 a total of 26.2 hours of administrative assistance were performed. This exceeded the alloted hours and budgeted amout of 20.5 hours. Acutal hours also exceeded the budget in 2011. It is recommended that the SRWMO increase its budget for administrative services in the future.

The following tasks were accomplished:

- Facilitated the Watershed Plan amendment process including writing amendments, sending them for agency review, posting public notices, writing the record of public hearing, and providing final drafts to all member communities and agencies.
- Annual financial reporting to the State Auditor, which is separtate from annual reporting to BWSR.
- Posted notice of one special meeting.
- Reminders to member cities to submit annual reports to the SRWMO.
- Responded to board member emails.
- Correspondenced with member cities including budget information and a request for copies of the JPA.
- Reviewed Linwood Township's comprehensive plan.
- Tabulated the SRWMO's Blue Thumb in-kind contributions and reported them on the Blue Thumb website.
- Administrative reporting of the SRWMO's cost share grant fund.
- Corresponded with Ham Lake regarding their concerns about SRWMO wetland standards.
- Attended SRWMO meetings to discuss the above issues.
- Meeting preparations including distributing materials to Board members and the agenda.
- Prepared 2014 SRWMO draft budget.

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.

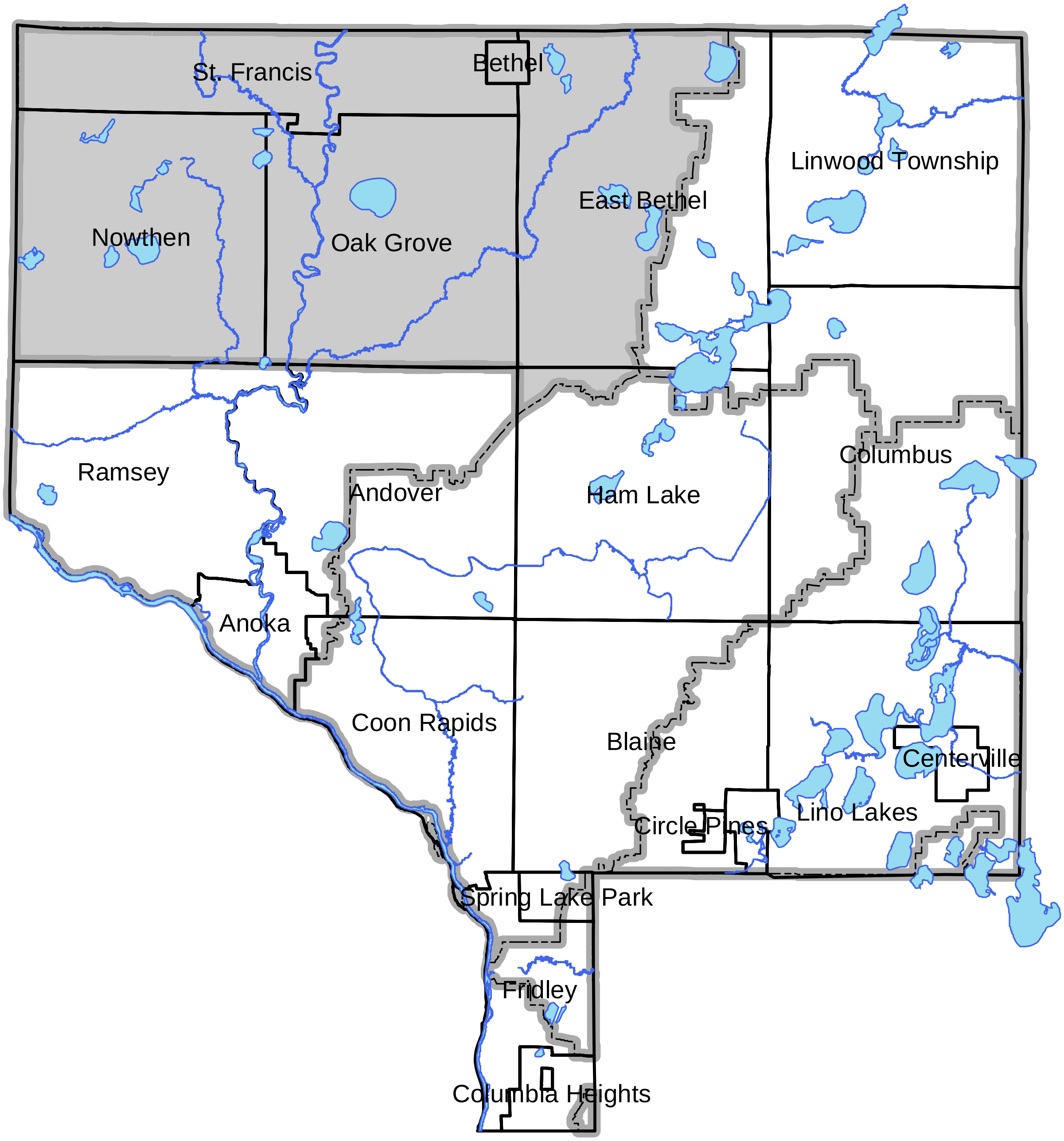
Sunrise River Watershed Financial Summary

Sunrise River Watershed	Ref Wet	Lake Lvl	Stream Level	Lake WQ	Stream WQ	Martin/Typo Carp Bariers	SRWMO Admin	Cost Share/ Lakescape/ Rain Garden	SRWMO Outreach/Promo	SRWMO Retrofit Promo	SRWMO Retrofit Install	Coon Lake Assmt	On-call SRWMO admin (hourly)	SRWMO Grant Search	Total
Revenues															
SRWMO	1650	850	1100	6570	2660	11651	1195	29	1490	0	0	0	1500	1000	29696
State	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anoka Conservation District	0	0	0	0	0	18827	0	0	961	0	278	2745	413	421	23645
County Ag Preserves	0	0	0	1946	0	0	0	0	0	2431	0	0	0	0	4378
Regional/Local	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Service Fees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Local Water Planning	0	105	0	1295	346	0	0	0	0	0	0	0	0	0	1746
TOTAL	1650	955	1100	9811	3006	30478	1195	29	2451	2431	278	2745	1913	1421	59464
Expenses-															
Capital Outlay/Equip	12	9	6	83	19	190	3	0	16	0	0	24	23	29	412
Personnel Salaries/Benefits	1106	819	852	6176	1594	16172	675	0	2088	0	245	2364	1648	1184	34923
Overhead	88	65	69	537	130	1357	59	0	167	0	15	201	127	143	2958
Employee Training	2	2	3	8	5	36	4	0	6	0	0	3	6	0	76
Vehicle/Mileage	24	17	18	134	32	339	12	0	48	0	8	58	28	18	736
Rent	49	38	44	257	76	733	45	0	99	0	10	97	81	48	1575
Program Participants	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Program Supplies	8	4	27	2617	1150	11651	135	0	27	2431	0	0	0	0	18052
McKay Expenses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1290	955	1020	9811	3006	30478	932	0	2451	2431	278	2745	1913	1421	58732
NET	360	0	80	0	0	0	263	29	0	0	0	0	0	0	732

Recommendations

- **Participate the Sunrise River Watershed Restoration and Protection Project (WRAPP)** which is led by Chisago SWCD and MPCA. It will result in TMDLs for the Sunrise River and Linwood Lake.
- **Install stormwater retrofits around Coon and Martin Lakes.** A stormwater assessment is complete for Martin Lake and will be complete in 2013 for Coon Lake. They identify and rank stormwater retrofit projects that will benefit lake water quality.
- **Continue efforts to secure grants.** A number of water quality improvement projects are being identified. Outside funding will be necessary for installation of most of these. These projects should be highly competitive for those grants.
- **Bolster lakeshore landscaping education efforts.** The SRWMO Watershed Management Plan sets a goal of 3 lakeshore restorations per year. Few are occurring. New efforts or incentives are planned for 2013, and new approaches should be welcomed.
- **Increase the use of web videos as an effective education and reporting tool.**
- **Continue the SRWMO cost share grant program** to encourage water quality projects.
- **Encourage communities to report water quality projects to the SRWMO.** An overarching goal in the SRWMO Plan is to reduce phosphorus by 20% (986 lbs). State oversight agencies will evaluate efforts toward this goal. Both WMO and municipal project benefits should be counted.

Upper Rum River Watershed



Contact Info: Upper Rum River Watershed Management Organization
www.AnokaNaturalResources.com/URRWMO
763-753-1920

Anoka Conservation District
www.AnokaSWCD.org
763-434-2030

CHAPTER 3: UPPER RUM RIVER WATERSHED

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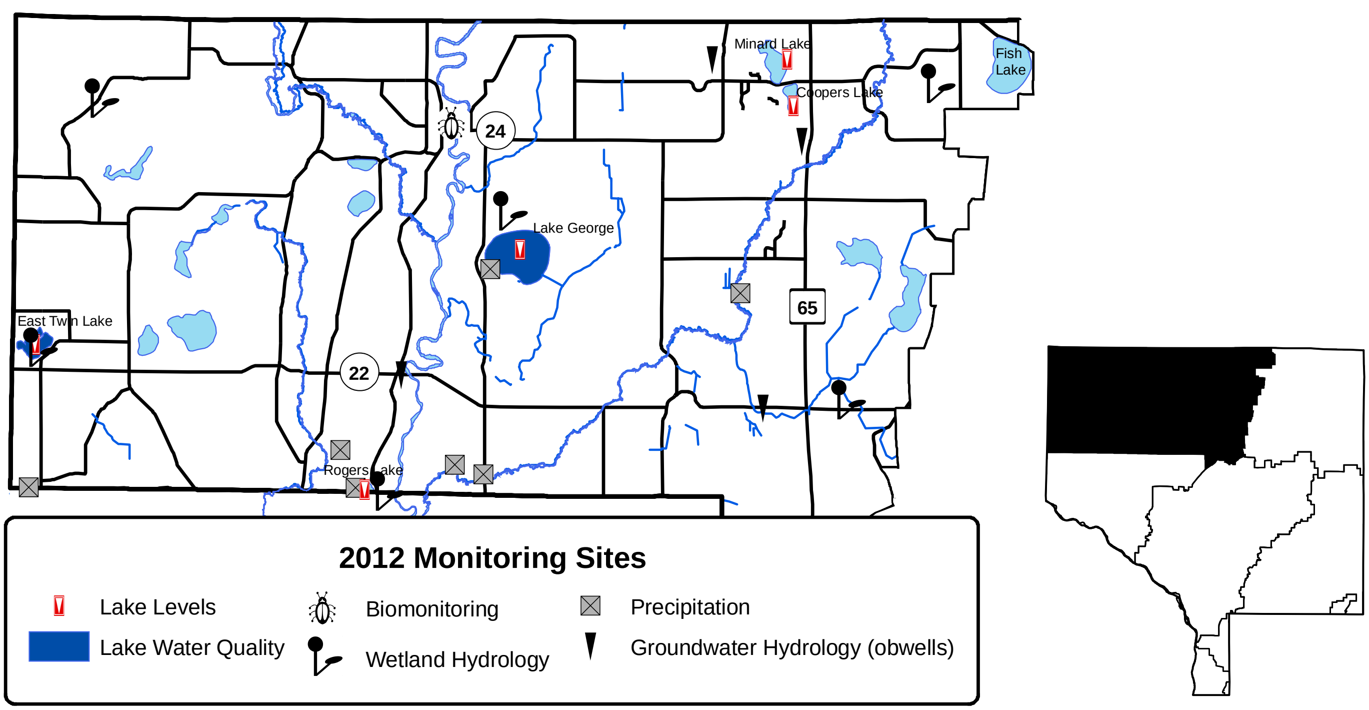
ACAP = Anoka County Ag Preserves, ACD = Anoka Conservation District,
LRRWMO = Lower Rum River Watershed Mgmt Org, MC = Metropolitan Council
MNDNR = Minnesota Dept. of Natural Resources, URRWMO = Upper Rum River Watershed Mgmt Org



Lake Levels

Description: Weekly water level monitoring in lakes. The past five years are shown below, and all historic 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: East Twin Lake, Lake George, Rogers Lake, Minard Lake, Coopers Lake

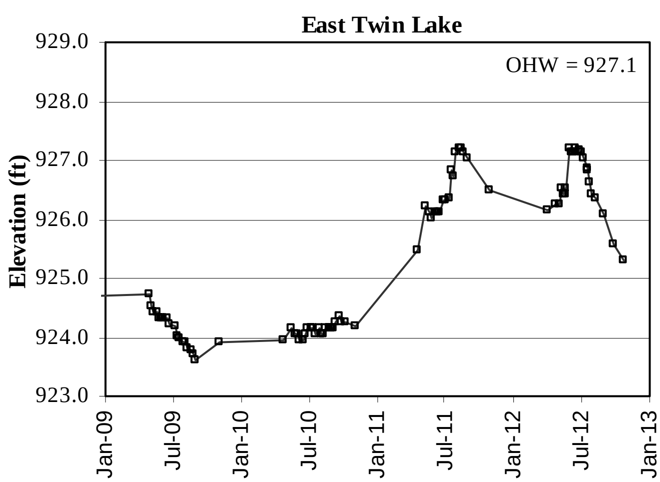
Results: Lake levels were measured by volunteers throughout the 2012 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. Lakes had sharply increasing water levels in spring and early summer 2012 when heavy rainfall totals occurred. Little rainfall fell later in the year and lake levels fell dramatically.

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.

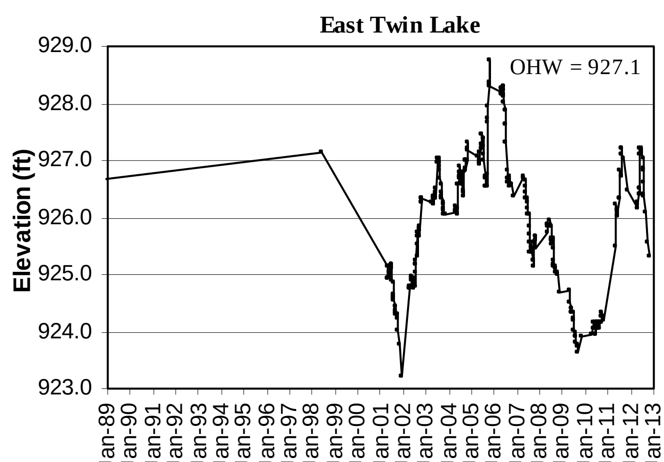
2011 and 2012 were the first years for monitoring Coopers and Minard Lakes. In recent years, there had been complaints about disproportionately low water in Coopers Lake and questions about why Minard Lake did not seem to have this problem. Indeed, both lakes have had similar maximum water levels in spring (Minard slightly higher because it is upstream). But Coopers Lake level drop rapidly by several feet in dry conditions, while Minard Lake is maintained higher.

The reasons for differences between Minard and Coopers Lake are likely due to both the elevation of the culvert between the lakes, as well as differences in geology and groundwater interaction. Minard Lake can flow into Coopers Lake through a road culvert when the water is high enough. More often, Minard Lake does not outflow. It therefore maintains higher water even during drought. Coopers Lake can have surface water outflows at lower elevations; it drains to wetlands south of the lake. At very low water levels surface water runout from Coopers Lake also ceases but lake levels continue to drop. This suggests geology and groundwater connections also are important.

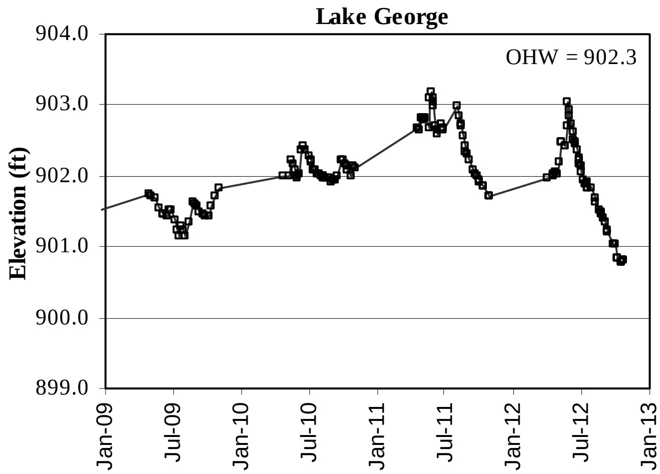
East Twin Lake Levels – last 5 years



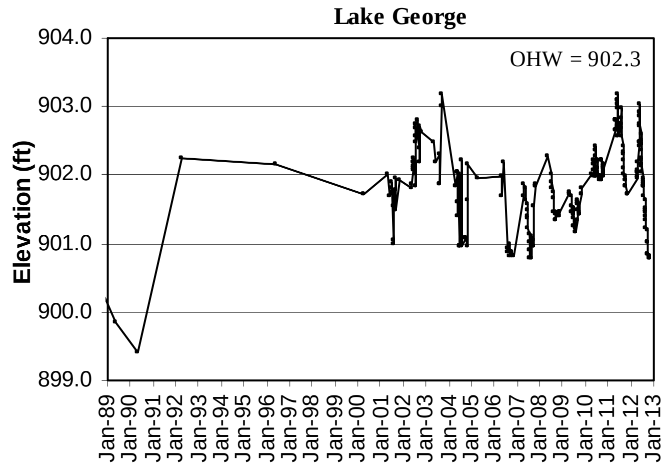
East Twin Lake Levels – last 24 years



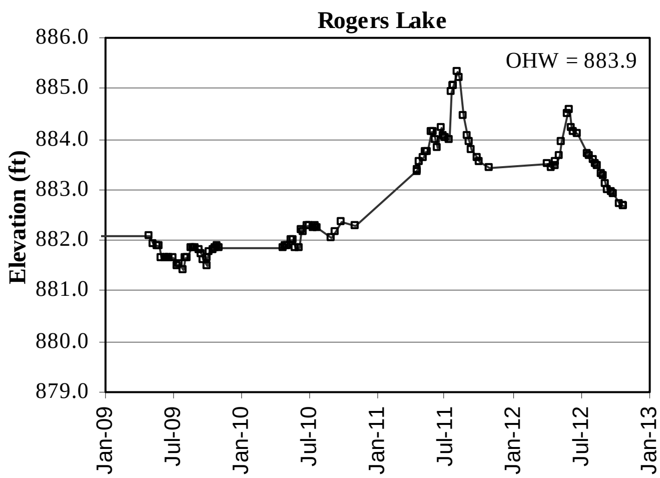
Lake George Levels – last 5 years



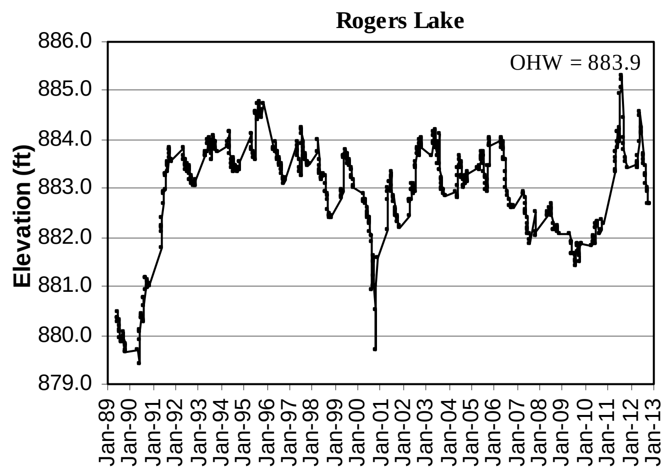
Lake George Levels – last 24 years



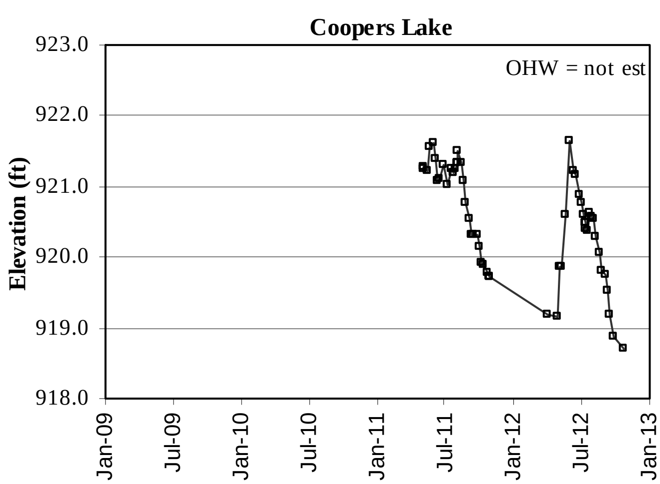
Rogers Lake Levels – last 5 years



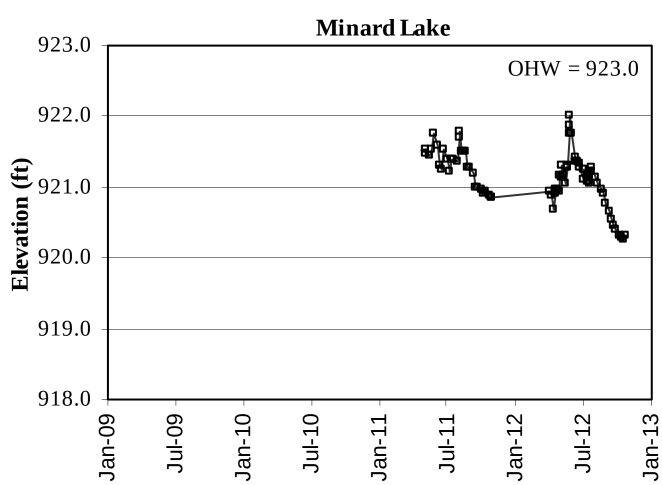
Rogers Lake Levels – last 24 years



Coopers Lake Levels – last 5 years



Minard Lake Levels – last 5 years



Stream Water Quality – Biological Monitoring

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 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.

Locations: Rum River at Hwy 24, Rum River North County Park, St. Francis

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, as 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.

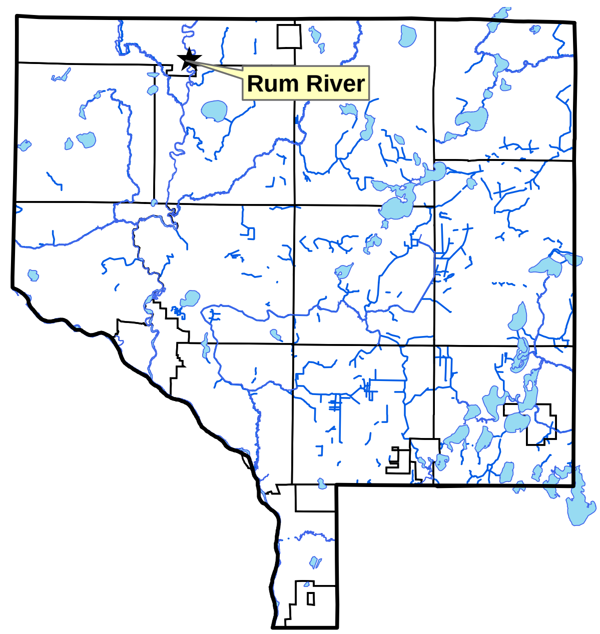
Family Biotic Index (FBI) — An index that utilizes known pollution tolerances for each family. Lower numbers indicate better stream quality.

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

% Dominant Family — High numbers indicates an uneven community, and likely poorer stream health.

RUM RIVER

at Hwy 24, Rum River North County Park, St. Francis



Last Monitored

By St. Francis High School in 2012

Monitored Since

2000

Student Involvement

104 students in 2012, approximately 1,224 since 2000

Background

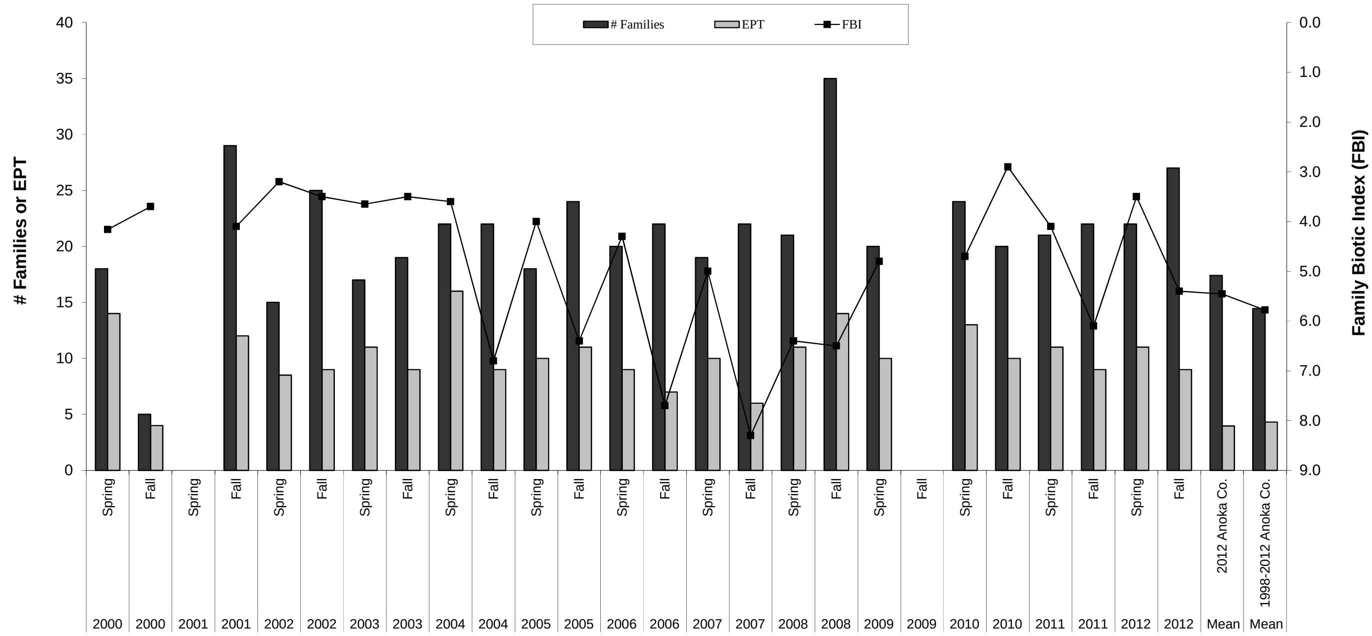
The Rum River originates from Lake Mille Lacs, and flows south through western Anoka County where it joins the Mississippi River in the City of Anoka. Other than the Mississippi, this is the largest river in the county. In Anoka County the river has both rocky riffles as well as pools and runs with sandy bottoms. The river's condition is generally regarded as excellent. Portions of the Rum in Anoka County have a state "scenic and recreational river" designation.

The sampling site is in Rum River North County Park. This site is typical of the Rum in northern Anoka County, having a rocky bottom with numerous pool and riffle areas.

Results

St. Francis High School classes monitored the Rum River in spring and fall 2012, with Anoka Conservation District (ACD) oversight. Biological data for 2012, and historically, indicate the Rum River in northern Anoka County has the best conditions of all streams and rivers monitored throughout Anoka County. In fall 2012, 27 families were found which is the most of any site in Anoka County. The number of families and number of EPT families were substantially above the county averages.

Summarized Biomonitoring Results for Rum River at Hwy 24, St. Francis (samplings by St. Francis High School and Crossroads Schools in 2002-2003 are averaged)



Biomonitoring Data for Rum River at Rum River North County Park, St. Francis

Data presented from the most recent five years. Contact the ACD to request archived data.

Year	2008	2008	2009	2009	2010	2010	2011	2011	2012	2012	Mean	Mean
Season	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	2012 Anoka Co.	1998-2012 Anoka Co.
FBI	6.40	6.50	4.80	Unusable	4.7	2.9	4.1	6.1	3.5	5.4	5.5	5.8
# Families	21	35	20	Sample	24	20	21	22	22	27	17.4	14.5
EPT	11	14	10		13	10	11	9	11	9	4.0	4.3
Date	27-May	30-Sep	29-Apr	13-Oct	27-Apr	29-Oct	10-Jun	28-Sep	22-May	27-Sep		
Sampled By	SFHS	SFHS	SFHS	SFHS	SFHS	ACD	ACD	SFHS	SFHS	SFHS		
Sampling Method	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH		
Mean # Individuals/Rep.	348	156	267		142	274	418	443	144	333		
# Replicates	2	4	2		3	1	1	2	2	1		
Dominant Family	Corixidae	Corixidae	Corixidae		Nemouridae	Leptophlebiidae	baetidae	hydrophilidae	hydropsyc	veliidae		
% Dominant Family	57.5	61.4	24.3		28.1	39.4	66.3	21.4	36.6	13.8		
% Ephemeroptera	11.9	17.9	18.7		23.9	51.1	81.3	3.6	43.2	34.2		
% Trichoptera	5.9	6.9	20.2		10.8	6.2	6.0	4.3	41.1	4.2		
% Plecoptera	17.1	2.1	27.7		32.8	26.6	3.8	9.7	5.2	11.1		

Supplemental Stream Chemistry Readings

Data presented from the most recent five years. Contact the ACD to request archived data.

Parameter	5/27/2008	9/30/2008	4/29/2009	10/13/2009	4/27/2010	10/29/2010	4/27/2010	9/28/2011	5/22/2012	9/27/2012
pH	7.73	7.7	7.62	7.87	na	7.51	na	8.35	8.14	7.87
Conductivity (mS/cm)	0.284	0.341	0.266	0.291	0.324	0.249	0.324	0.228	0.275	0.239
Turbidity (NTU)	7	4	6	na	2	na	2	na	18	2
Dissolved Oxygen (mg/L)	10.18	7.83	10.53	12.22	9.14	na	9.14	8.7	8.24	8.17
Salinity (%)	0.01	0.01	0.01	0.01	0.01	0	0.01	0	0.01	0
Temperature (°C)	15.3	13.4	12.2	5.2	12	7.2	12	13.8	17.5	10.3

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.

Water resource management should be focused upon protecting the Rum's quality. Some steps to protect the Rum River could include:

- Enforce the building and clear cutting setbacks from the river required by state scenic river laws.
- Retrofit stormwater conveyance systems to provide better water quality treatment in cities including St. Francis and Anoka. Older areas of some communities lack or have little stormwater treatment.
- Use the best available technologies to reduce pollutants delivered to the river and its tributaries through the storm sewer system. This should include all of the watershed, not just those adjacent to the river.
- Education programs to encourage actions by residents that will benefit the river's health.
- Continue water quality monitoring programs.

Wetland Hydrology

Description: Continuous groundwater level monitoring at a wetland boundary, to a depth of 40 inches. County-wide, the ACD maintains a network of 18 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: Alliant Tech Reference Wetland, Alliant Tech Systems property, St. Francis

Cedar Creek, Cedar Creek Natural History Area, East Bethel

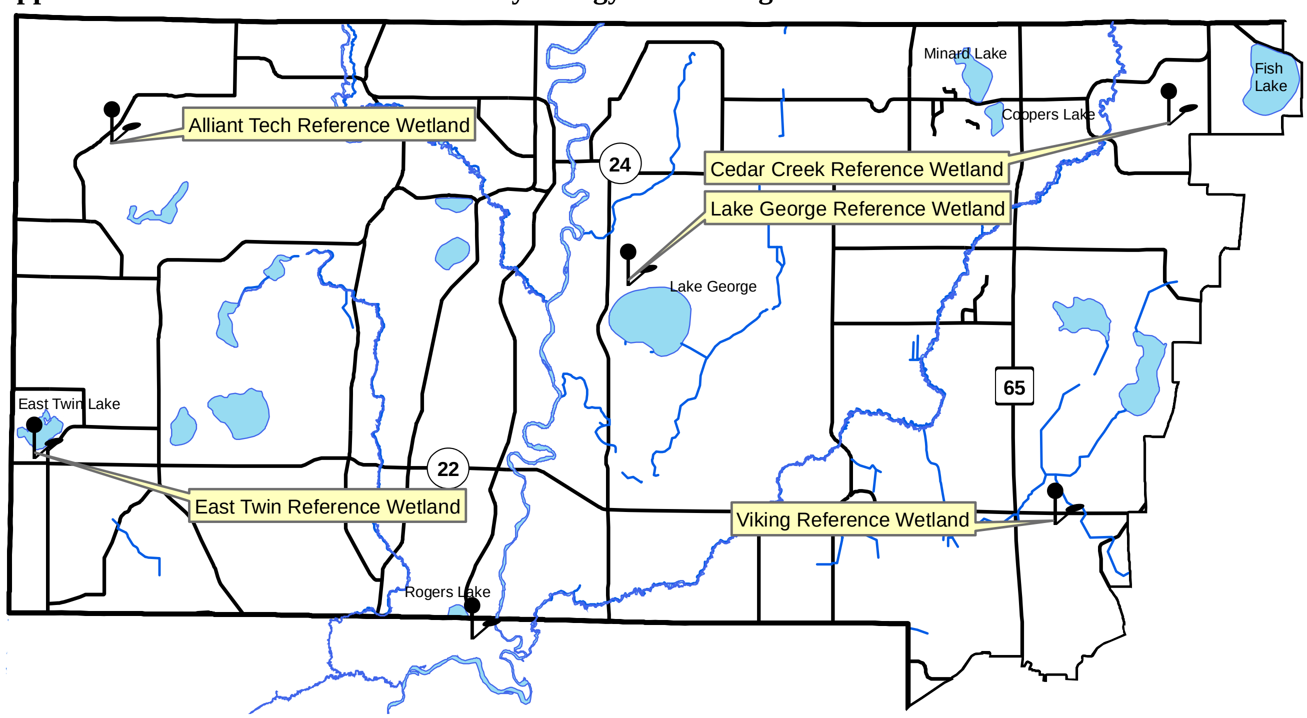
East Twin Reference Wetland, East Twin Township Park, Nowthen

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.

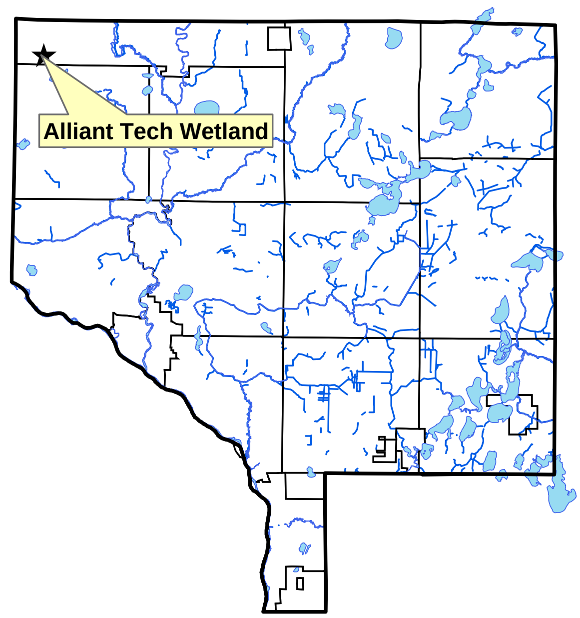
Upper Rum River Watershed Wetland Hydrology Monitoring Sites



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	-

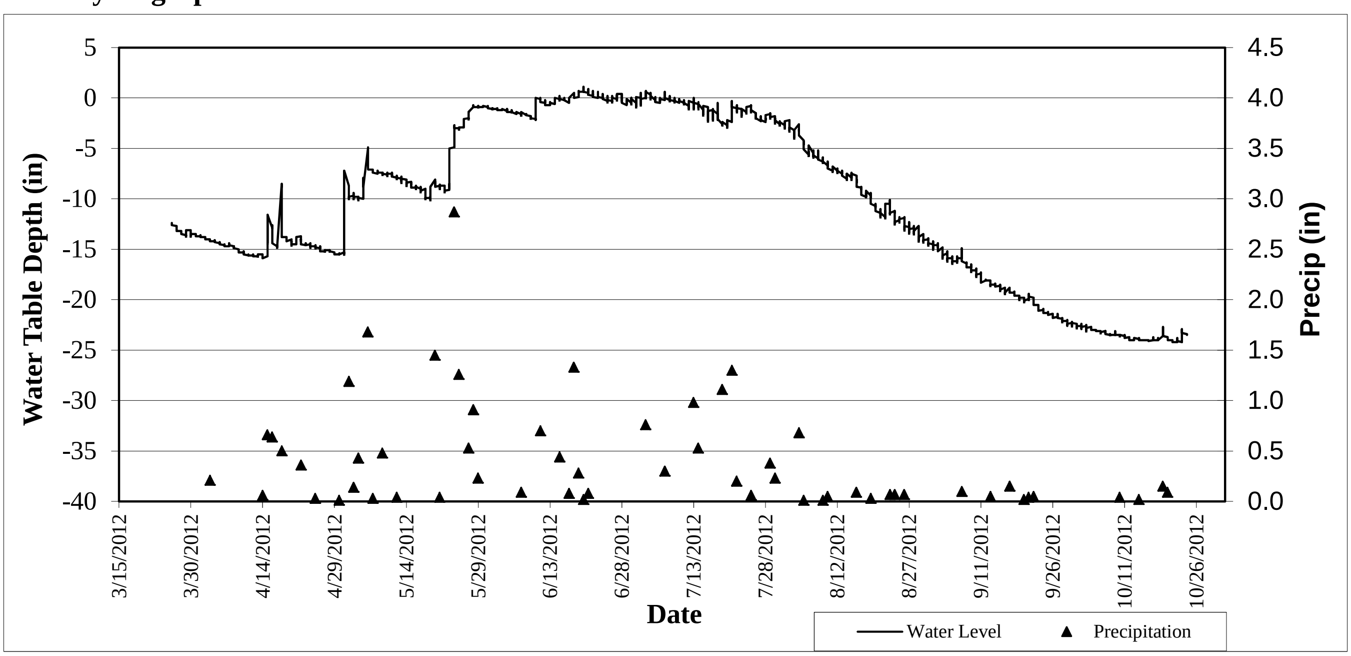
Surrounding Soils: Emmert

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.

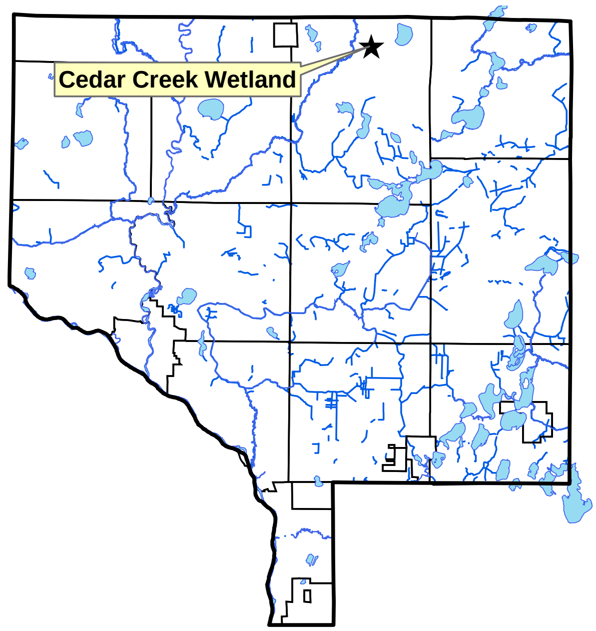
2012 Hydrograph



Well depth was 40 inches, so a reading of –40 indicates water levels were at an unknown depth greater than or equal to 40 inches.

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

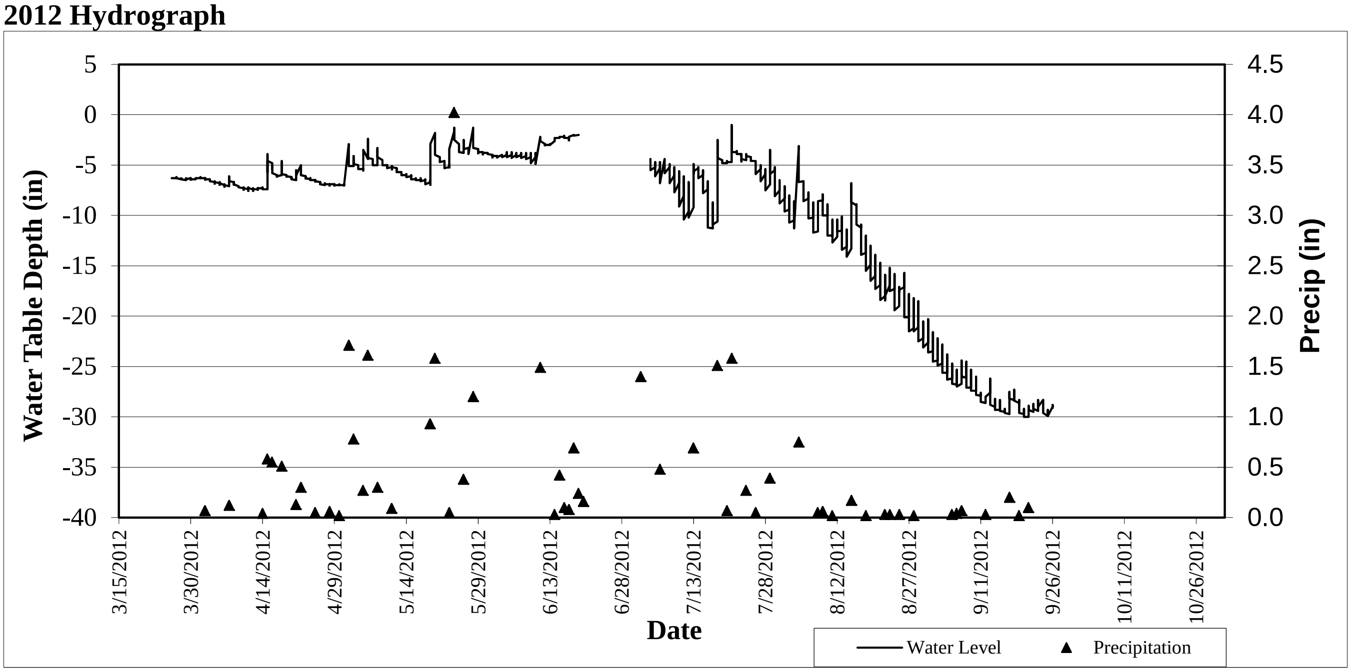
Soils at Well Location: not yet available

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.

2012 Hydrograph

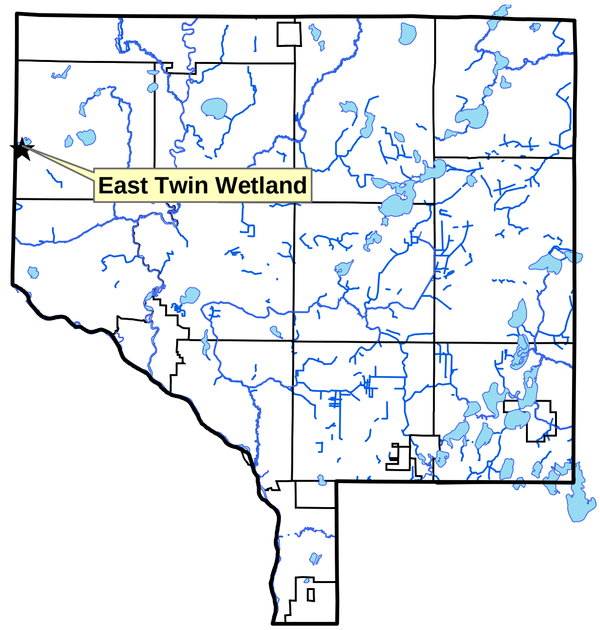


Well depth was 37 inches, so a reading of –37 indicates water levels were at an unknown depth greater than or equal to 37 inches.

Wetland Hydrology Monitoring

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	-

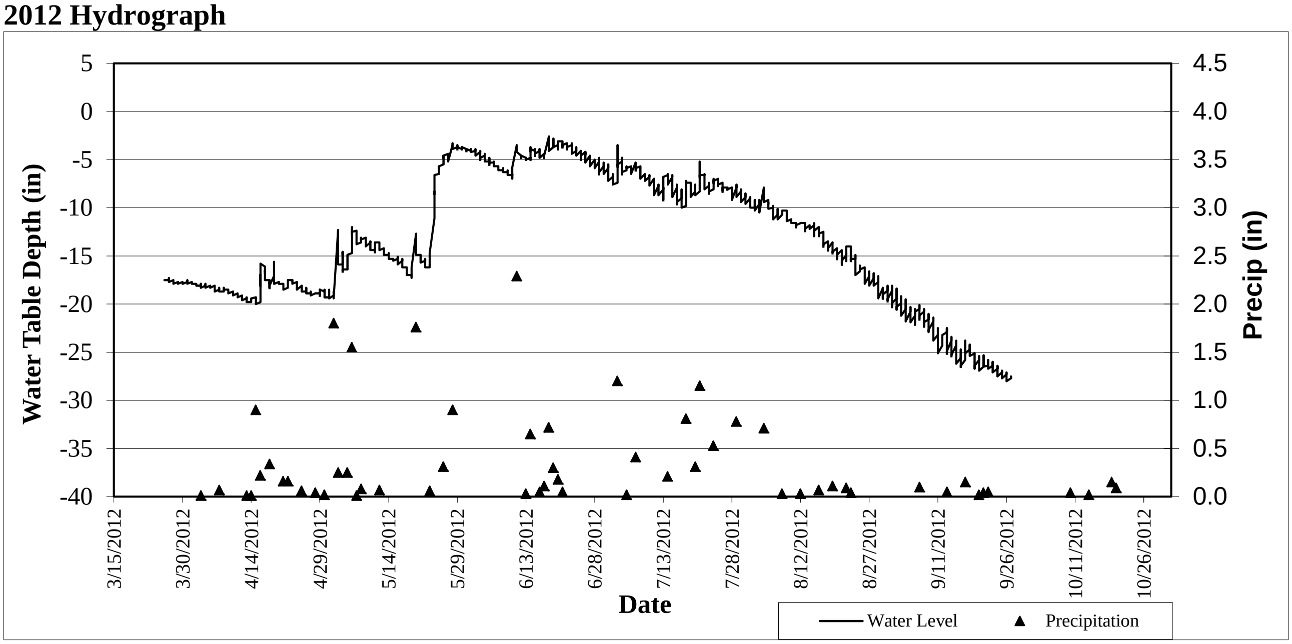
Surrounding Soils: Lake Beach, Growton and Heyder fine sandy loams

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.

2012 Hydrograph

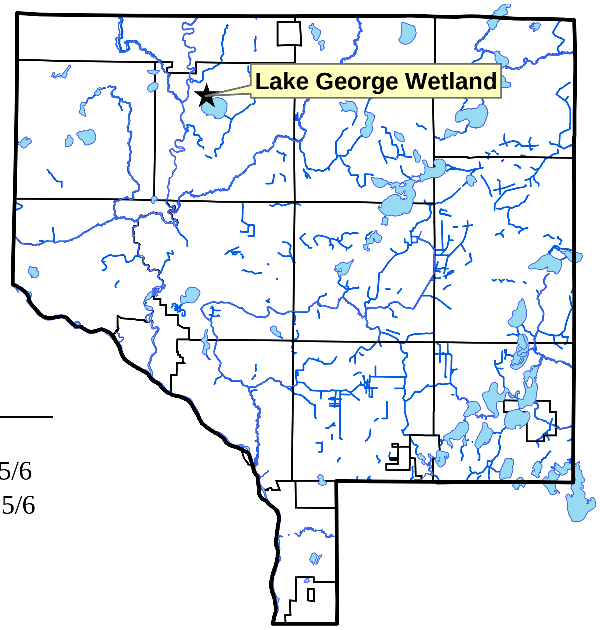


Well depth was 40 inches, so a reading of –40 indicates water levels were at an unknown depth greater than or equal to 40 inches.

Wetland Hydrology Monitoring

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

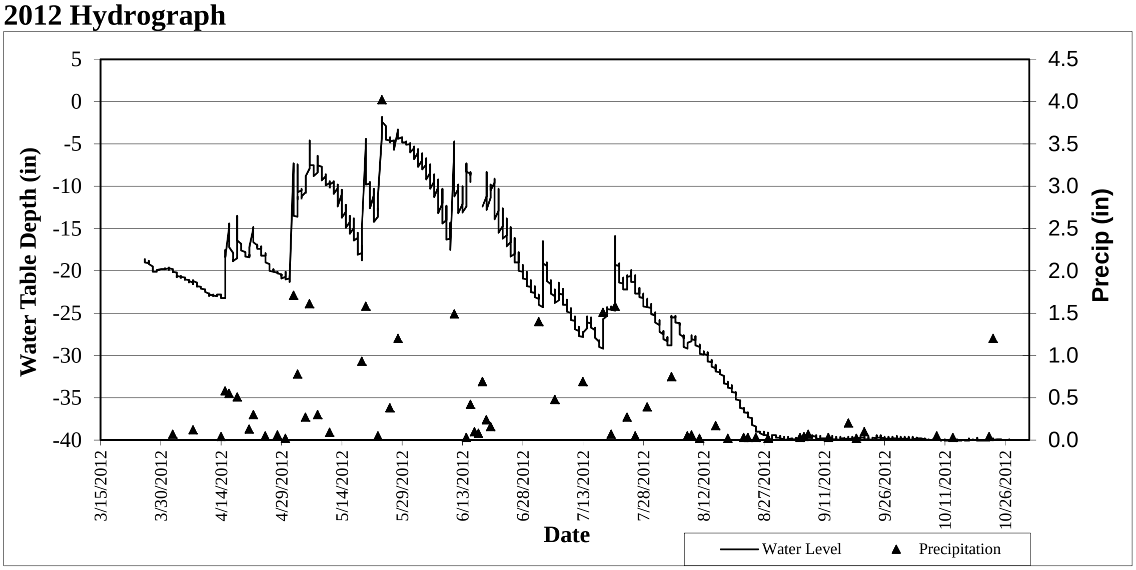
Surrounding Soils: Lino loamy fine sand and Zimmerman fine sand

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.

2012 Hydrograph

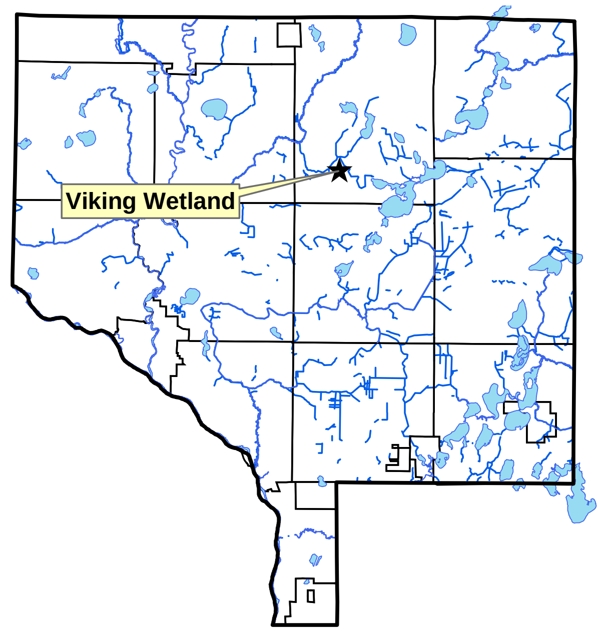


Well depth was 40 inches, so a reading of –40 indicates water levels were at an unknown depth greater than or equal to 40 inches.

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

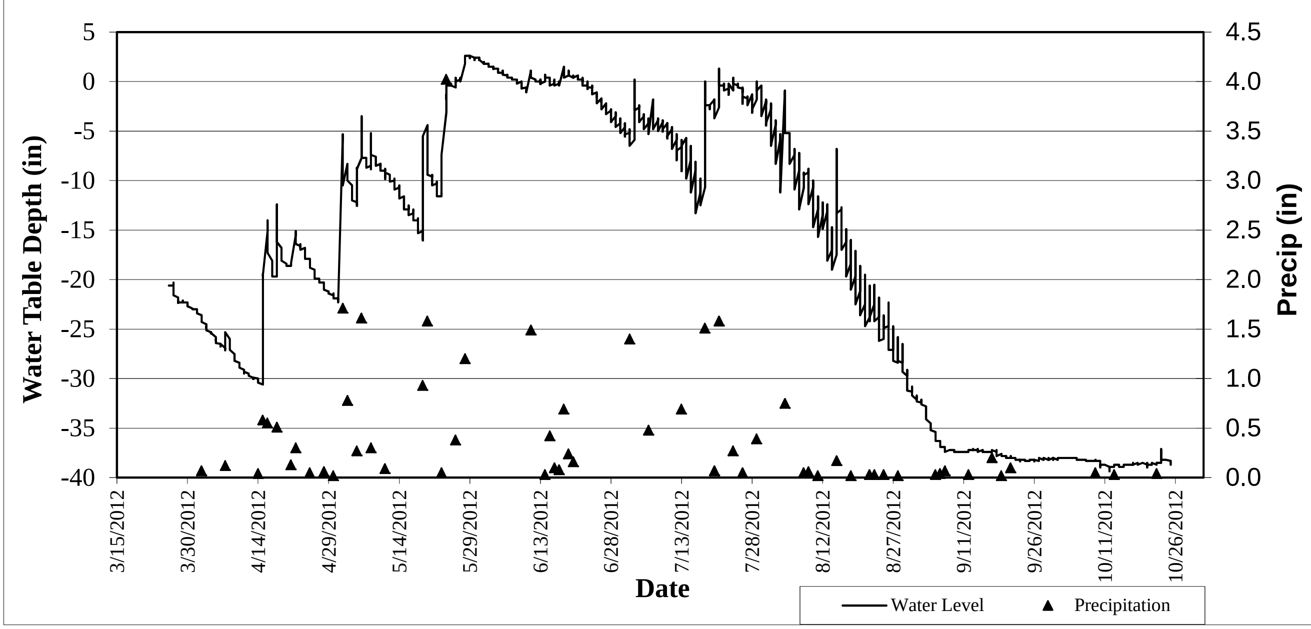
Surrounding Soils: Zimmerman fine sand

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).

2011 Hydrograph



Well depth was 40 inches, so a reading of –40 indicates water levels were at an unknown depth greater than or equal to 40 inches.

Water Quality Grant Fund

Description: The Upper River Watershed Management Organization (URRWMO) partners with the Anoka Conservation District's (ACD) Water Quality Cost Share Program. The URRWMO contributes funds to be used as cost share grants for projects that improve water quality in lakes, streams, or rivers within the URRWMO area. The ACD provides administration of the grants. Grant awards follow ACD policies and generally cover 50% or 70% of materials (see ACD website for full policies). The ACD Board of Supervisors approves any dispersements.

Grant administration is through the Anoka Conservation District for efficiency and simplicity. The ACD administers a variety of other similar grants, thus providing a one-stop-shop for residents. Additionally, the ACD's technical staff provide project consultation and design services at low or no cost, which is highly beneficial for grant applicants. ACD staff also have expertise to process and scrutinize grant requests. Lastly, the ACD Board meets monthly, and can therefore respond to grant requests rapidly, while URRWMO meetings are much less frequent.

The Anoka Conservation District (ACD) and Upper Rum River WMO have both undertaken efforts to promote these types of projects and the availability of grants. For example, in 2007 the URRWMO did a customized mailing to 20 homeowners on East Twin and George Lakes who had been identified with erosion problems or likely to develop problems. The ACD mentions the grants during presentations to lake associations and other community groups, in newsletters, and in website postings. In order to promote these types of projects the ACD also assists landowners throughout projects, including design, materials acquisition, installation, and maintenance.

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

Locations: Throughout the watershed.

Results: Projects are reported in the year they are installed. In 2012 a Lake George shoreline restoration was installed at the Erickson property. Followup work on that project is planned for spring 2013, so some dollars remain encumbered.

URRWMO Cost Share Fund Summary

2006 URRWMO Contribution	+	$ 990.00
2006 Expenditures		$ 0.00
2007 URRWMO Contribution	+	$ 1,000.00
2007 Expenditures		$ 0.00
2008 Expenditures		$ 0.00
2009 Expenditures		$ 0.00
2010 URRWMO Contribution	+	$ 500.00
2011 URRWMO Contribution	+	$ 567.00
2010-11 Expenditure Petro streambank stabilization	-	$1,027.52
2011 Expenditure Erickson lakeshore restoration	-	$ 233.15
2012 Expenditure Erickson lakeshore restoration (encumbered)	-	$ 137.98
2012 URRWMO Contribution	+	$1,000.00
Fund Balance		**$ 2,658.35**

Erickson Lakeshore Restoration Summary

Brief Description:

This project will restore 54 feet of Lake George shoreline with native plants and correct minor erosion. Site is at the bottom of a moderately steep slope on a residential property. This shoreline restoration will provide native plants that filter stormwater runoff to the lake and provide habitat benefits. Habitat benefits will be for all shoreline animals including fish, insects, birds, and others. Because the project includes aquatic plantings the benefits to fish and in-lake ecology are greater.

The landowner is active member of the Lake George Improvement District and plans to promote lakeshore restorations with others who live around the lake.

Funding sources:

URRWMO water quality cost share grant	$ 371.60
Landowner	$ 371.60
TOTAL	$ 743.20

In-kind contributions:
Landowner provides installation labor
Project design was provided by the Anoka Conservation District and landowner

URRWMO Website

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. The website has been in operation since 2003.

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.AnokaNaturalResources.com/URRWMO

Results: The URRWMO website contains information about both the URRWMO and about natural resources in the area.

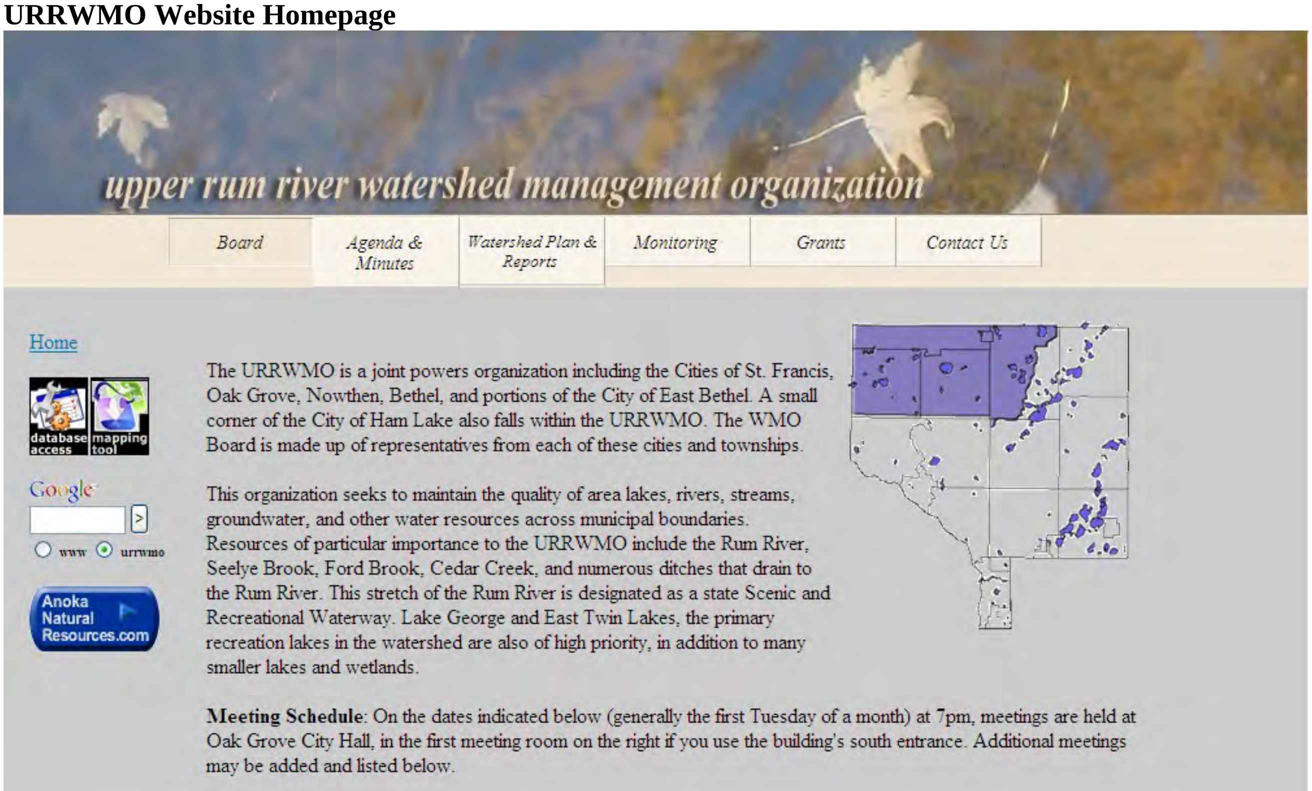
Information about the URRWMO includes:

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

Other tools on the website include:

- an interactive mapping tool that shows natural features and aerial photos
- an interactive data download tool that allows users to access all water monitoring data that has been collected
- narrative discussions of what the monitoring data mean

URRWMO Website Homepage



more on next page

URRWMO Annual Newsletter

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

Purpose: To increase public awareness of the URRWMO and its programs.

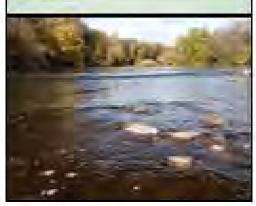
Locations: Watershed-wide.

Results: The Anoka Conservation District (ACD) assisted the URRWMO by drafting the annual newsletter article. At their March 6, 2012 the URRWMO discussed topics to be covered in the article. It was decided that the newsletter article should highlight the St. Francis High School Rum River monitoring program, which the URRWMO helps finance.

ACD staff drafted the newsletter article and sent it to the URRWMO Board for review. The URRWMO Board reviewed and edited the draft article. The finalized article was sent to each member community in July 2012, as well as to the Independent School District 15 publication, "The Courier." It was printed in The Courier.

2012 URRWMO Newsletter Article

Rum River benefits from 1,200+ St. Francis High School student volunteers



Science teacher DC Randle declares, "this, they really remember," refering to his students. Why? It's outdoors, catching critters most have never seen, and the work products get used beyond the classroom. When St. Francis science classes assist with long-term Rum River monitoring near the school, they get memorable lessons in biology and math, while working alongside professionals. Watershed managers are happy too; the school's curriculum produces data they use.

Each spring and fall, students use nets to collect macroinvertebrates – mostly aquatic insects. These small critters serve as a gauge of the river's health. Some types are only found where water quality and habitat is good. Others tolerate poorer conditions. The Minnesota Pollution Control Agency has developed mathematical ways to translate invertebrate samplings into rankings of river health, and made it an official part of state water quality standards.

Over the last 12 years, 1,200+ students have donned waders and captured thousands of invertebrates. They are accompanied by biologists from the Anoka Conservation District who provide instructions on methodology. Their captures are identified and students calculate indices of river health. Then, everything goes to the Anoka Conservation District for quality checks and reporting.

Students have found a rich invertebrate community and many sensitive kinds like stoneflies and mayflies. The Rum River is in great shape. It's invertebrates reflect a river system that has good water quality, has a plentiful fishery, and is used by an assortment of wildlife.

One agency paying special attention to water quality is the Upper Rum River Watershed Management Organization (URRWMO). They provide funding for the equipment, professional guidance, and final analyses. The URRWMO is a special purpose unit of government covering St. Francis, Nowthen, Oak Grove, Bethel, andparts of East Bethel and Ham Lake.

To see a video about St. Francis High School and Rum River monitoring, and learn more about the URRWMO visit their website – www.AnokaNaturalResources.com/URRWMO.

Invertebrate photo source: Hennepin Conservation District

Web Video about Student Biomonitoring

Description: A website video was produced about the URRWMO's St. Francis High School Student Biomonitoring program to improve public visibility of URRWMO projects and bolster the WMO's website.

Purpose: To increase public awareness of the URRWMO and its programs.

Locations: Watershed-wide.

Results: In spring 2012 the Anoka Conservation District (ACD) shot video footage of students capturing invertebrates at the Rum River in spring 2012. The teacher secured written permission from parents to use images of their children. After the fieldwork, ACD assembled a three minute video. After a review by the URRWMO Board, that video was posted to the URRWMO website. A companion newspaper article was written by the ACD and printed in The Courier newspaper, which serves the St. Francis area. Later, the video was noticed by the Friends of the Rum River group, who emailed it broadly to their entire distribution list. Finally, a link to the video was sent to all URRWMO member community staff with a request that it also be forwarded to city council members.

The video can be watched at www.AnokaNaturalResources.com/URRWMO

URRWMO 2011 Annual Report to BWSR

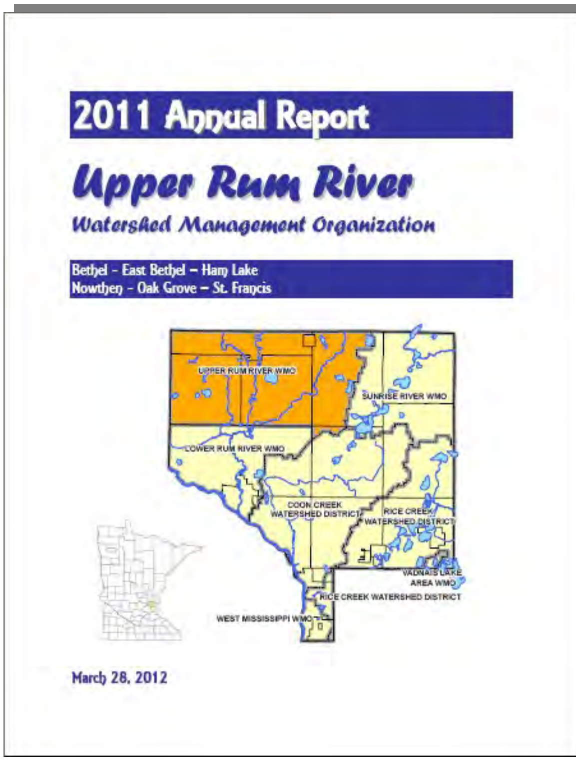
Description: The Upper Rum River Watershed Management Organization (URRWMO) is required by law to submit an annual report to the Minnesota Board of Water and Soil Resources (BWSR), the state agency with oversight authorities. This report consists of an up-to-date listing of URRWMO Board members, activities 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).

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 2011 Upper Rum River WMO Annual Report. ACD provided copies of this report and a cover letter to the entire URRWMO Board on March 29, 2012 for review. On April 13, 2011 the final draft was sent to the URRWMO Chair, Todd Miller. The Chair submitted the report to BWSR. The full report can be viewed at the URRWMO website.

Cover



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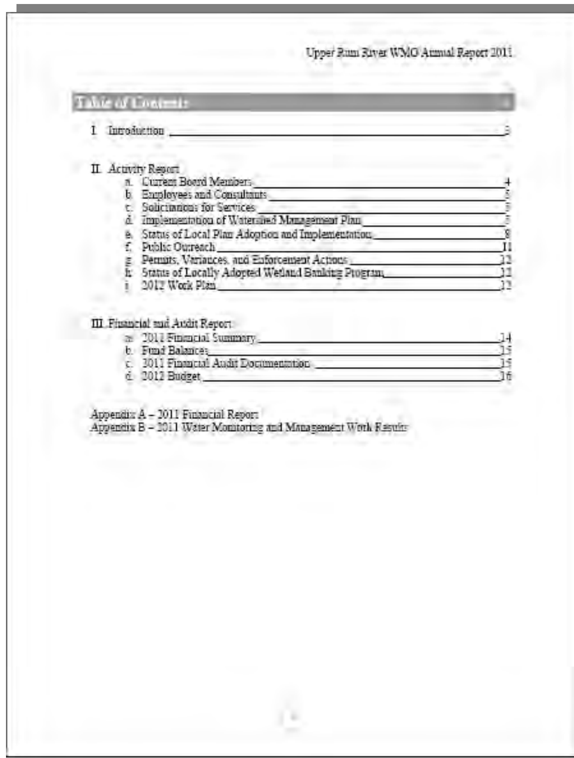
Upper Rum River WMO Annual Report 2011

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2013-2017 URRWMO Water Monitoring Plan

Description: The URRWMO's Watershed Management Plan included a schedule for monitoring lakes, rivers, and other waterbodies through 2012. In 2012 the URRWMO was to update this monitoring plan.

Purpose: To ensure adequate water resource management and financial planning.

Locations: Watershed-wide

Results: The Anoka Conservation District drafted an update of the URRWMO water monitoring plan to cover 2013-2017, and presented it to the URRWMO for consideration or revision in November 2012. The 2013-2017 monitoring plan is consistent with the approaches and schedules that had been used the previous five years. Because of this, the MN Board of Water and Soil Resources informed the WMO that it was not necessary to go through the formality of the watershed plan amendment process. The URRWMO is, however, ensuring that member cities and other agencies receive a copy of the update.

The updated monitoring plan can be found on the URRWMO website.

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.

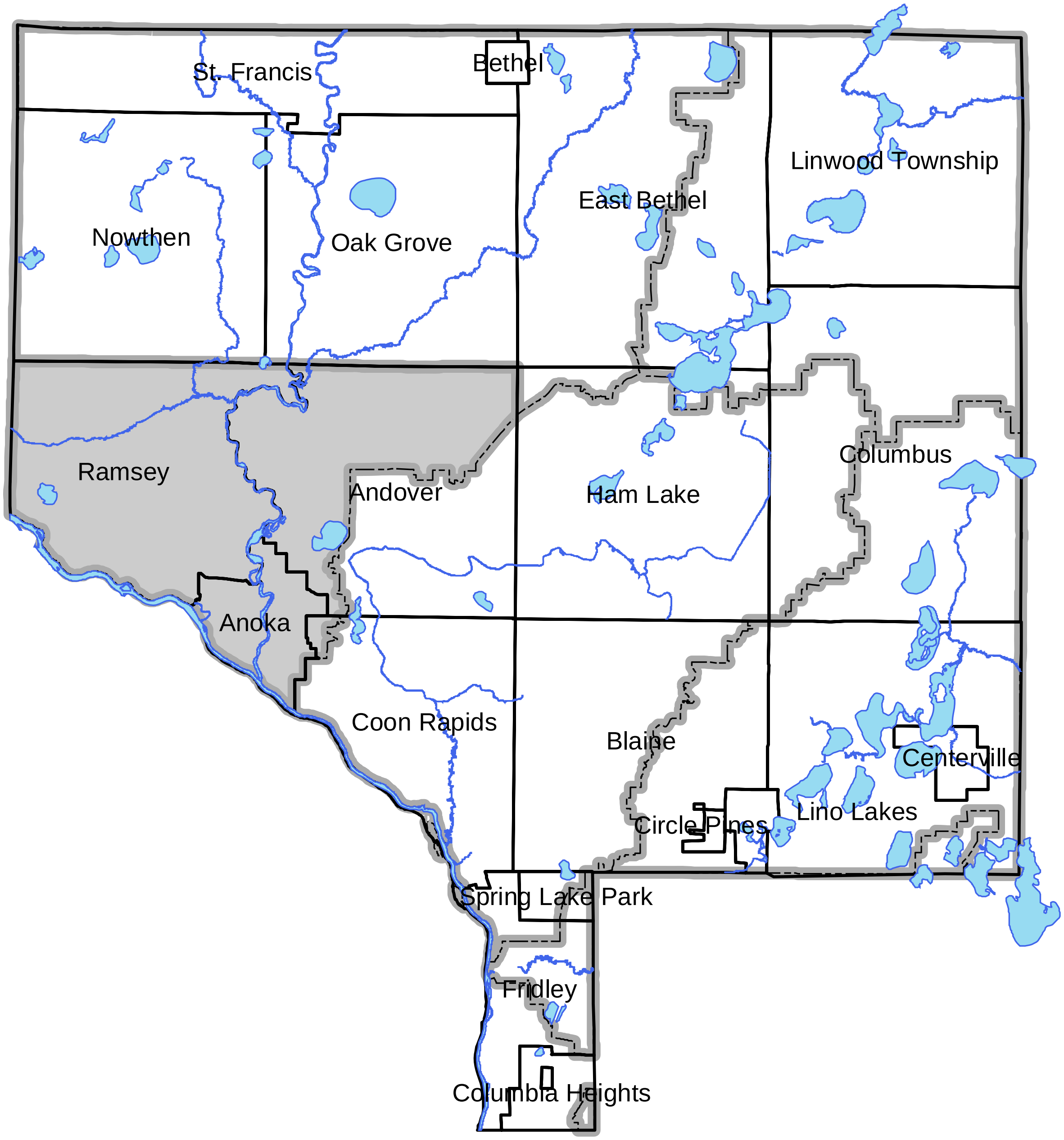
Upper Rum River Watershed Financial Summary

Upper Rum River Watershed	Ref Wet	Lake Lvl	Student Biomon	Cost Share/ Lakescape/ Rain Garden	URRWMO Admin	URRWMO Outreach/Promo	Total
Revenues							
URRWMO	1100	680	795	233	1085	1690	5583
State	175	0	0	0	0	0	175
Anoka Conservation District	175	0	0	0	696	0	871
County Ag Preserves	175	0	145	1508	0	0	1828
Regional/Local	175	0	0	0	0	0	175
Other Service Fees	175	0	0	0	0	0	175
Local Water Planning	175	84	0	0	0	0	259
TOTAL	2149	764	940	1742	1781	1690	9066
Expenses-							
Capital Outlay/Equip	20	7	11	0	25	9	72
Personnel Salaries/Benefits	1843	655	745	0	1515	1160	5919
Overhead	146	52	60	0	140	95	493
Employee Training	4	2	1	0	4	3	14
Vehicle/Mileage	40	14	16	0	25	27	122
Rent	81	30	30	0	73	55	270
Program Participants	0	0	0	1742	0	0	1742
Program Supplies	14	4	77	0	0	0	94
McKay Expenses	0	0	0	0	0	0	0
TOTAL	2149	764	940	1742	1781	1348	8725
NET	0	0	0	0	0	342	342

Recommendations

- **Actively participate in the MPCA Rum River WRAPP (Watershed Restoration and Protection Plan) which is beginning in 2013.** This WRAPP is an assessment of the entire Rum River watershed. This is an opportunity for the URRWMO to prioritize and coordinate efforts with upstream entities and state agencies.
- **Consider a St. Francis stormwater assessment** that is aimed at identifying and installing cost effective stormwater treatment opportunities before water is discharged into the Rum River. The assessment should be focused on those portions of the city that are generally lacking sufficient stormwater treatment.
- **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.
- **Correct water quality issues discovered during the 2010 Rum River survey**. Several locations of riverbank erosion were documented. Landowners were contacted, and some responded, however none have committed to corrective work. Part of the reason is that these projects are expensive and the landowner would bear some of the cost.
- **Encourage public works departments to implement measures to minimize road deicing salt applications**. These salts are the most noticeable form of Rum River deterioration in the URRWMO. MN DOT, University of Minnesota Extension, and others offer training on this topic.
- **Investigate the condition of Ditch 19, the only inlet to Lake George**. Residents have complained that condition of the ditch and water control structures are contributing to low lake water levels in recent years. Anoka County is the legal ditch authority.
- **Facilitate resident efforts to control aquatic plant growth on Rogers Lake** as a means to improving low dissolved oxygen problems. In 2010 a neighborhood meeting was held, and while there was enthusiasm from residents, the needed follow-up by residents did not occur.
- **Promote water quality improvement projects** for lakes, streams, and rivers. Cost share grants are available through the URRWMO and ACD to encourage landowners to do projects that will have public benefits to water quality. Technical assistance for landowners is available through the Anoka Conservation District.

Lower Rum River Watershed



Contact Info: Lower Rum River Watershed Management Organization
www.AnokaNaturalResources.com/LRRWMO
763-421-8999

Anoka Conservation District
www.AnokaSWCD.org
763-434-2030

CHAPTER 4: LOWER RUM RIVER WATERSHED

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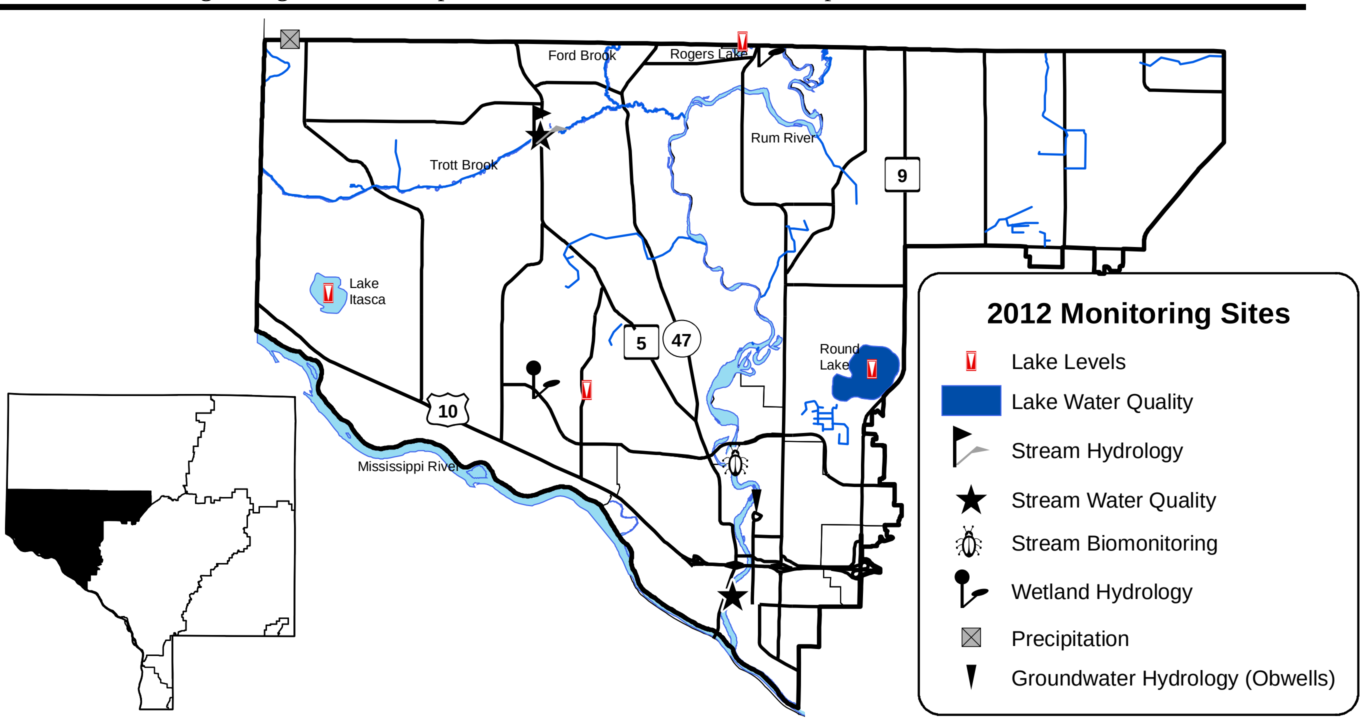
ACAP = Anoka County Ag Preserves, ACD = Anoka Conservation District, LRRWMO = Lower Rum River Watershed Mgmt Org, MC = Metropolitan Council, MNDNR = MN Dept. of Natural Resources



Lake Level Monitoring

Description: Weekly water level monitoring in lakes. The past five years are shown below, and all historic 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.

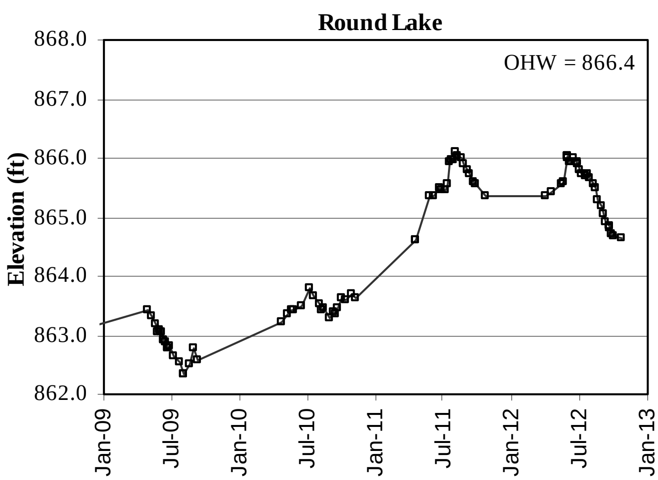
Locations: Itasca, Round, Rogers, and Sunfish/Grass Lakes

Results: Lake levels were measured by volunteers throughout the 2012 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. Lakes had sharply increasing water levels in spring and early summer 2012 when heavy rainfall totals occurred. Little rainfall fell later in the year and lake levels fell dramatically.

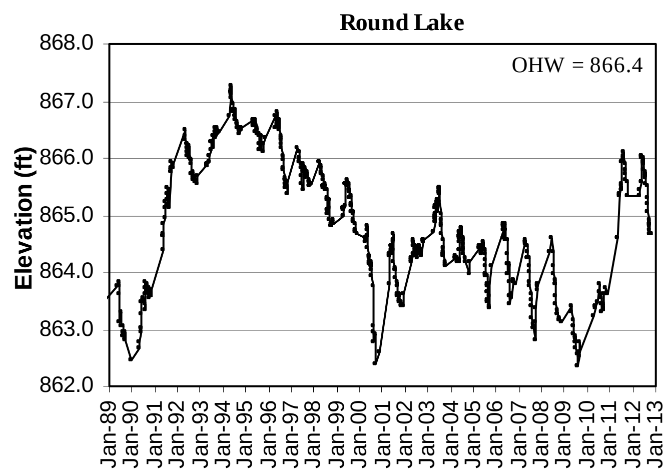
All lake level data can be downloaded from the MN DNR website’s Lakefinder feature. Ordinary High Water Level (OHW), the elevation below which a DNR permit is needed to perform work, is listed for each lake on the corresponding graphs below.

In 2012 Sunfish/Grass Lake water levels were measured infrequently. The volunteer for this lake has been asked to take more readings in the future or provide notice that they cannot so another volunteer can be found.

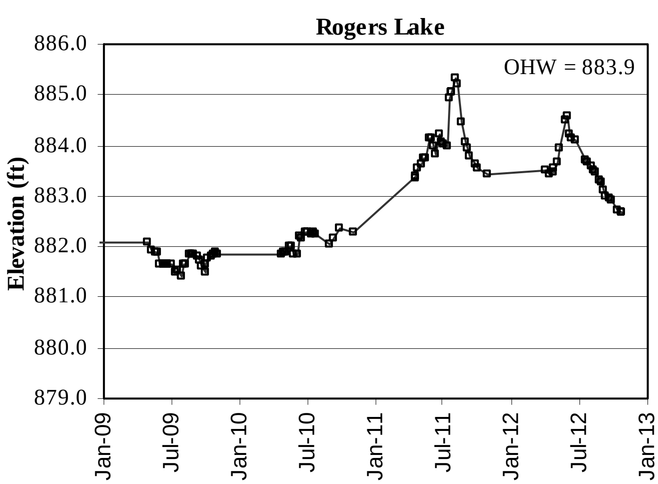
Round Lake Levels – last 5 years



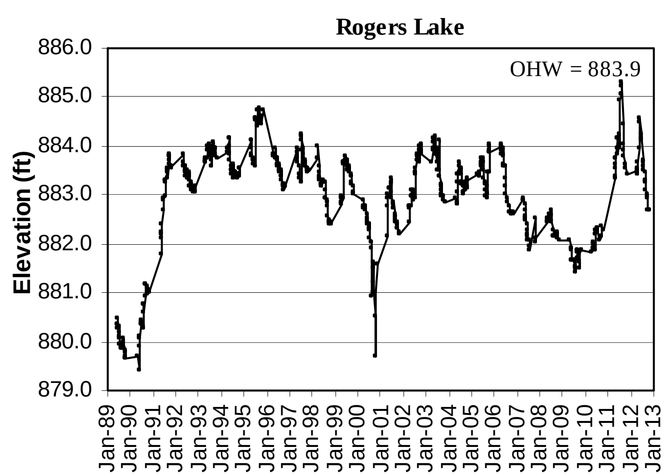
Round Lake Levels – last 24 years



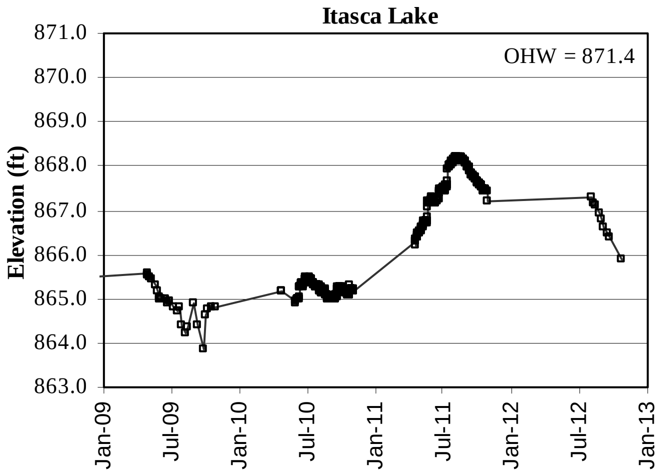
Rogers Lake Levels – last 5 years



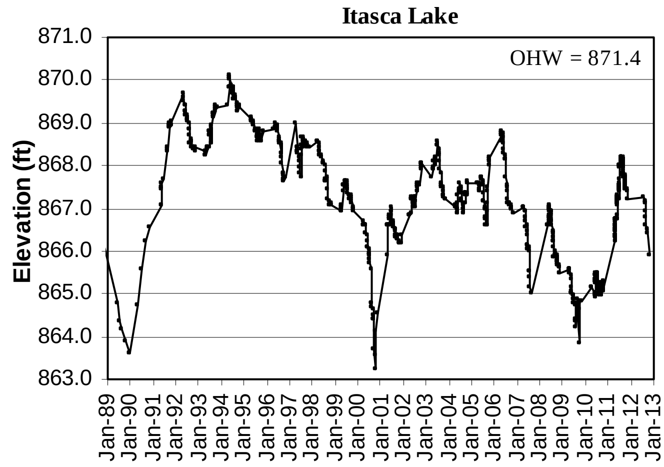
Rogers Lake Levels – last 24 years



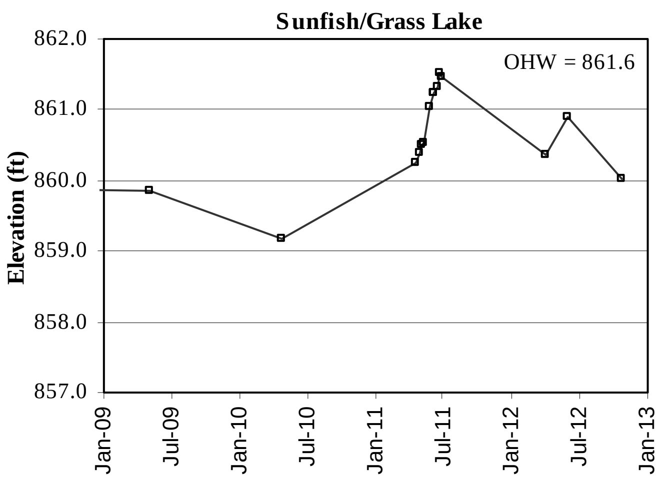
Itasca Lake Levels – last 5 years



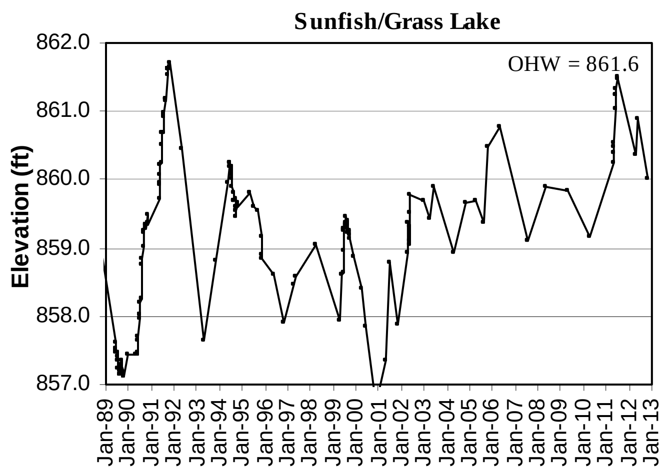
Itasca Lake Levels – last 24 years



Sunfish/Grass Lake Levels – last 5 years



Sunfish/Grass Lake Levels – last 24 years



Lake Water Quality

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

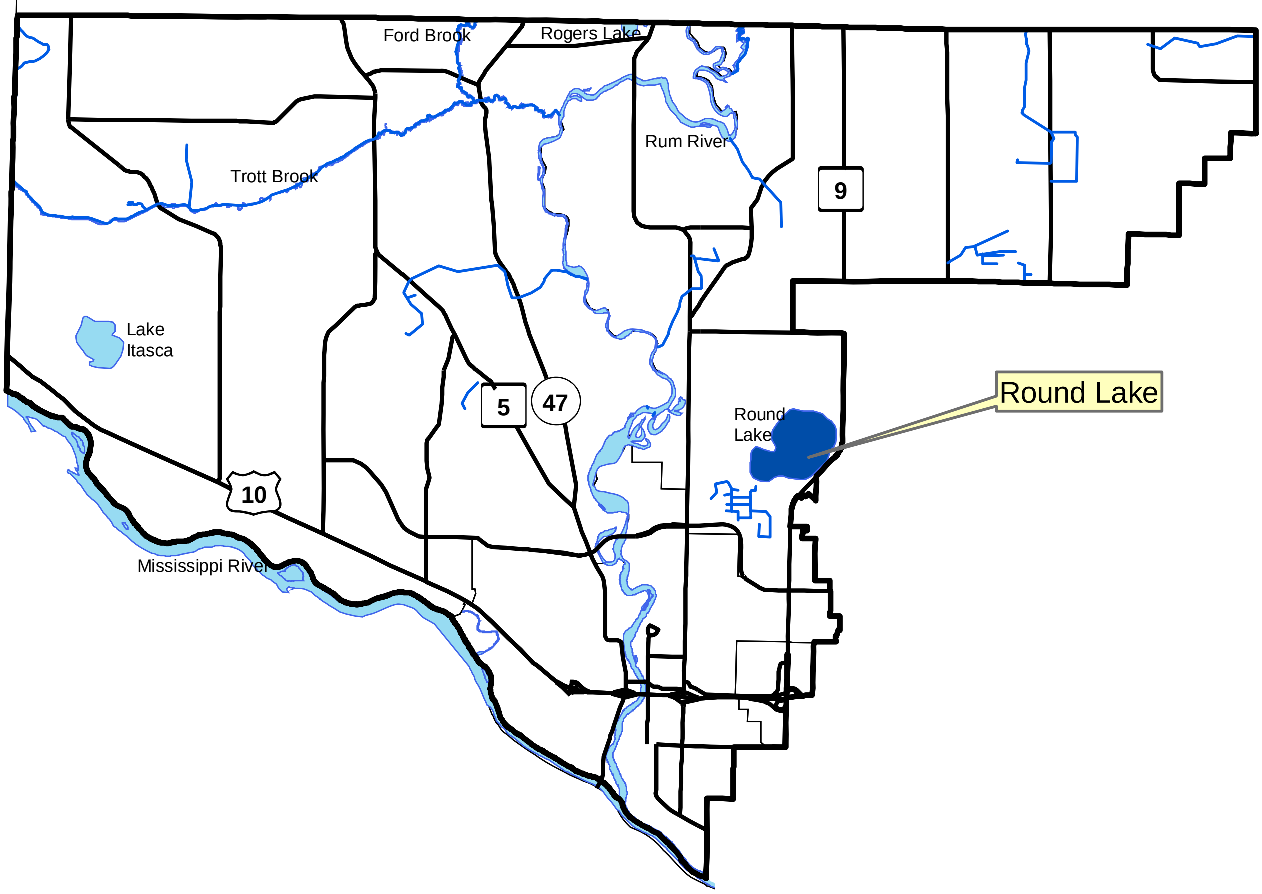
Purpose: To detect water quality trends and diagnose the cause of changes.

Locations: Round 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 interpreting the data and on lake dynamics.

Originally, Sunfish/Grass Lake was also to be monitored in 2012. After discovery that the local community college was monitoring it was dropped.

Lower Rum River Watershed Lake Water Quality Monitoring Sites



Round Lake

City of Andover, Lake ID # 03-0089

Background

Round Lake is located in southwest Anoka County. It has a surface area of 220 acres and maximum depth of 19 feet, though the majority of the lake is less than 4 feet deep. The lake is surrounded by cattails and has submerged vegetation interspersed throughout the basin. This lake has a small watershed, with a watershed to surface area ratio of less than 10:1. Public access is from a dirt ramp on the lake's southeast side. Almost no boating and mostly wintertime fishing occurs. Wildlife, especially waterfowl, usage of the lake is relatively high.

2012 Results

In 2012 Round Lake's water quality was very good compared with other lakes in this region (NCHF Ecoregion) receiving an overall A letter grade. Average total phosphorus was the lowest on record (19.0 ug/L) and chlorophyll *a* was only slightly higher than the lowest recorded value from 2003. Secchi transparency was 11.4 feet, which is the best ever observed at this lake.

Phosphorus and algae was highest in early spring. The first water sample taken in mid-May had much higher levels of TP and chlorophyll *a* than subsequent samples. This could be the result of a very mild winter with little snow cover (more light penetration) and early ice out.

Trend Analysis

Nine years of water quality monitoring have been conducted by the Anoka Conservation District (1998-2000, 2003, 2005, 2007, and 2009-2010, 20012), which is a marginal number of years for a powerful statistical test of trend analysis. In 2010, the results of the analysis indicated a significant trend of declining water quality across the years studied (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,5}$ = 9.6065, p = 0.0194). When the analysis is run to include the exceptional water quality observed in 2012 no significant water quality changes are apparent ($F_{2,6}$ = 0.66, p = 0.29).

Discussion

2012 was a welcome return to good water quality for Round Lake. There was growing concern about a trend toward poorer water quality. Phosphorus and chlorophyll-a had increased substantially in each of four monitored years from 2005-2009, and 2010 was similar to 2009. These were years of low lake levels. There was speculation that in-lake sources of nutrients, driven by sediment mixing, were a source of phosphorus. During low water there is more wind mixing because of shallow water depths, and in these years there was also a conspicuous reduction of chara (a plant-like algae) carpeting the bottom. In 2012 water levels recovered substantially in spring, chara was once again blanketing the lake bottom, and water quality was dramatically improved. It does seem that low water levels in Round Lake lead to poorer water quality. Additional monitoring in the future can help verify.

Since at least the 1980's there have been complaints about low water in Round Lake. The lake has few surface water in-flows, so groundwater is important to lake hydrology. There have been concerns that local surficial groundwater levels, and hence the lake, are negatively impacted by a variety of causes including irrigation, residential groundwater use, stormwater management, road embankments, and others. Each has been studied by groups including the MN DNR, Anoka Conservation District, Watershed Organizations, and City. None have been found to cause lower-than-expected lake levels. But there is evidence that Round Lake levels do behave differently from other nearby lakes. Moreover, studies by the Metropolitan Council and others have found regional surficial water tables are being drawn down by groundwater pumping thorughout the metro. Several lakes, including Round and Bunker Lakes are believed to be victims of this groundwater overuse.

Conservation of groundwater must become a regional and local priority, least there will be negative impacts on lakes. In fact many negative impacts are already being documented. At Round Lake, where water quality appears linked to water levels, this issue is very important.

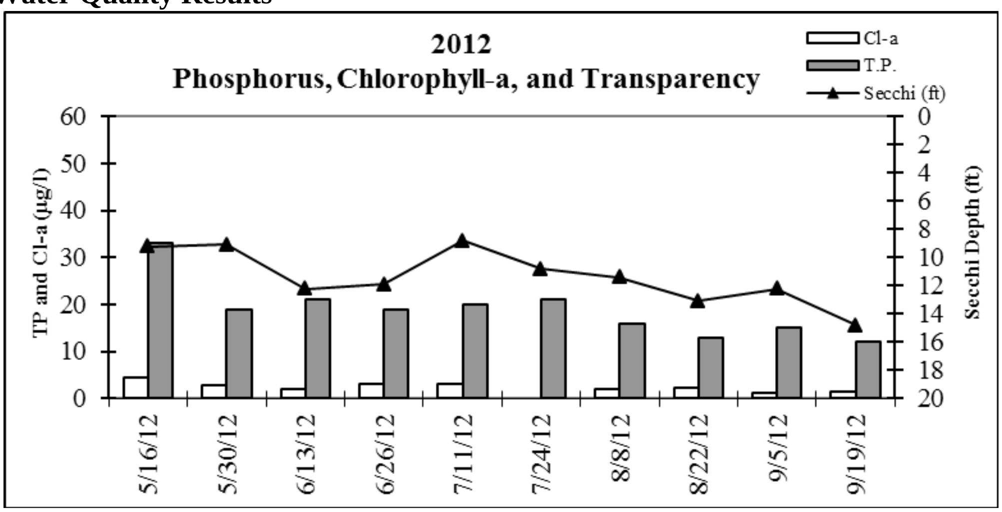
2012 Round Lake Water Quality Data

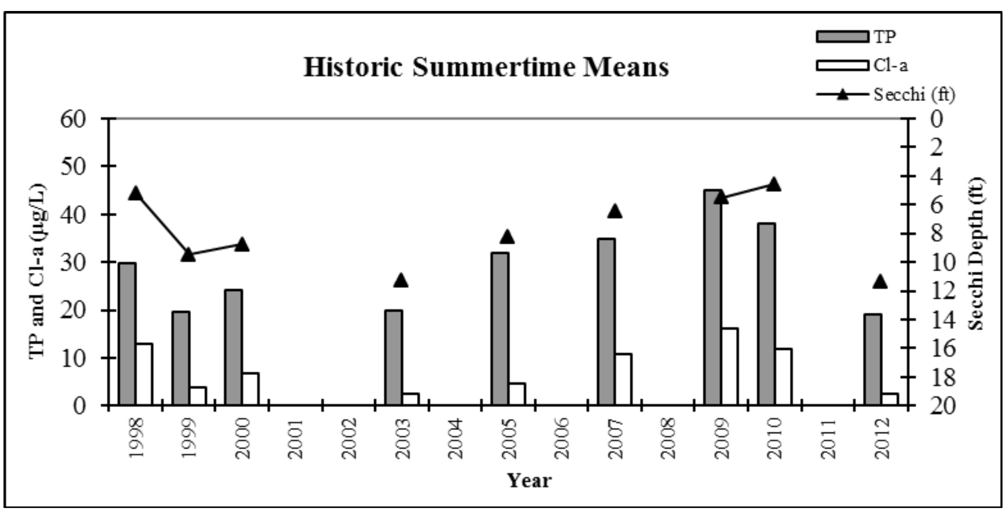
Round Lake
2012 Water Quality Data

	Units	Date / Time / R.L.*	5/16/2012 13:50 Results	5/30/2012 13:20 Results	6/13/2012 14:00 Results	6/26/2012 14:25 Results	7/11/2012 15:00 Results	7/24/2012 14:00 Results	8/8/2012 14:35 Results	8/22/2012 13:45 Results	9/5/2012 13:10 Results	9/19/2012 13:00 Results	Average	Min	Max
pH		0.1	8.32	8.14	8.30	8.51	8.34	8.12	8.25	8.41	8.38	8.21	8.30	8.12	8.51
Conductivity	mS/cm	0.01	0.354	0.308	0.286	0.267	0.230	0.214	0.291	0.280	0.266	0.242	0.274	0.214	0.354
Turbidity	FNRU	1.0	3	2	1	4	4	1	1	2	2	1	2	1	4
D.O.	mg/L	0.01	9.60	8.88	10.48				9.06	10.96	8.80	8.69	9.50	8.69	10.96
D.O.	%	1.0	106	90	105				111	128	107	88	105	88	128
Temp.	°C	0.10	21.1	18.7	21.7	24.8	29.4	27.9	25.7	22.7	25.0	16.3	23.3	16.3	29.4
Temp.	°F	0.10	70.0	65.7	71.1	76.6	84.9	82.2	78.3	72.9	77.0	61.3	74.0	61.3	84.9
Salinity	%	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.00	0.01
Cl-a	µg/L	1.0	4.6	2.8	1.9	3.1	3.1	<1	2.1	2.2	1.1	1.5	2.5	1.1	4.6
T.P.	mg/L	0.005	0.033	0.019	0.021	0.019	0.020	0.021	0.016	0.013	0.015	0.012	0.019	0.012	0.033
T.P.	µg/L	5	33	19	21	19	20	21	16	13	15	12	19	12	33
Secchi	ft	0.1	9.2	9.1	12.2	11.9	8.8	10.8	11.4	13.1	12.2	14.8	11.4	8.8	14.8
Secchi	m	0.1	2.8	2.8	3.7	3.6	2.7	3.3	3.5	4.0	3.7	4.5	3.5	2.7	4.5
Physical			1	1.0	1.0	1.0	2.0	2.0	1.0	2.0	2.0	1.0	1.4	1.0	2.0
Recreational			1	1.0	1.0	1.0	2.0	1.0	1.0	1.0	2.0	1.0	1.2	1.0	2.0

*Reporting Limit

Round Lake Water Quality Results





Round Lake Summertime Historic Mean

Agency	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD
Year	1998	1999	2000	2003	2005	2007	2009	2010	2012
TP (µg/L)	29.8	19.6	24.1	20.0	32.0	34.7	45.0	38.0	19.0
Cl-a (µg/L)	12.8	3.7	6.9	2.4	4.6	10.9	16.2	11.8	2.5
Secchi (m)	1.6	2.9	2.7	3.4	2.5	2.0	1.7	1.4	3.5
Secchi (ft)	5.2	9.5	8.8	11.3	8.3	6.5	5.5	4.6	11.4

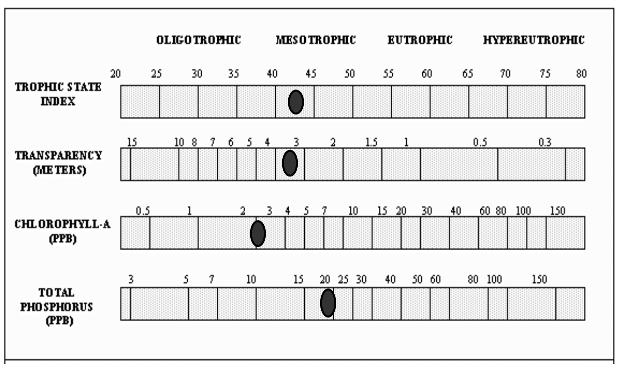
Carlson's Tropic State Indices

Year	1998	1999	2000	2003	2005	2007	2009	2010	2012
TSIP	53	47	50	47	54	55	59	57	47
TSIC	56	44	48	39	46	54	58	55	40
TSIS	55	45	46	42	47	50	52	55	42
TSI	55	45	48	43	49	53	56	56	43

Round Lake Water Quality Report Card

Year	1998	1999	2000	2003	2005	2007	2009	2010	2012
TP (µg/L)	B	A	B	A	B	C	C	C	A
Cl-a (µg/L)	B	A	A	A	A	B+	B	B	A
Secchi (m)	C	B	B	A	B	C	C	C	A-
Overall	**B**	**A**	**B**	**A**	**B**	**C**	**C**	**C**	**A**

Carlson's Trophic State Index



Stream Water Quality - Chemical Monitoring

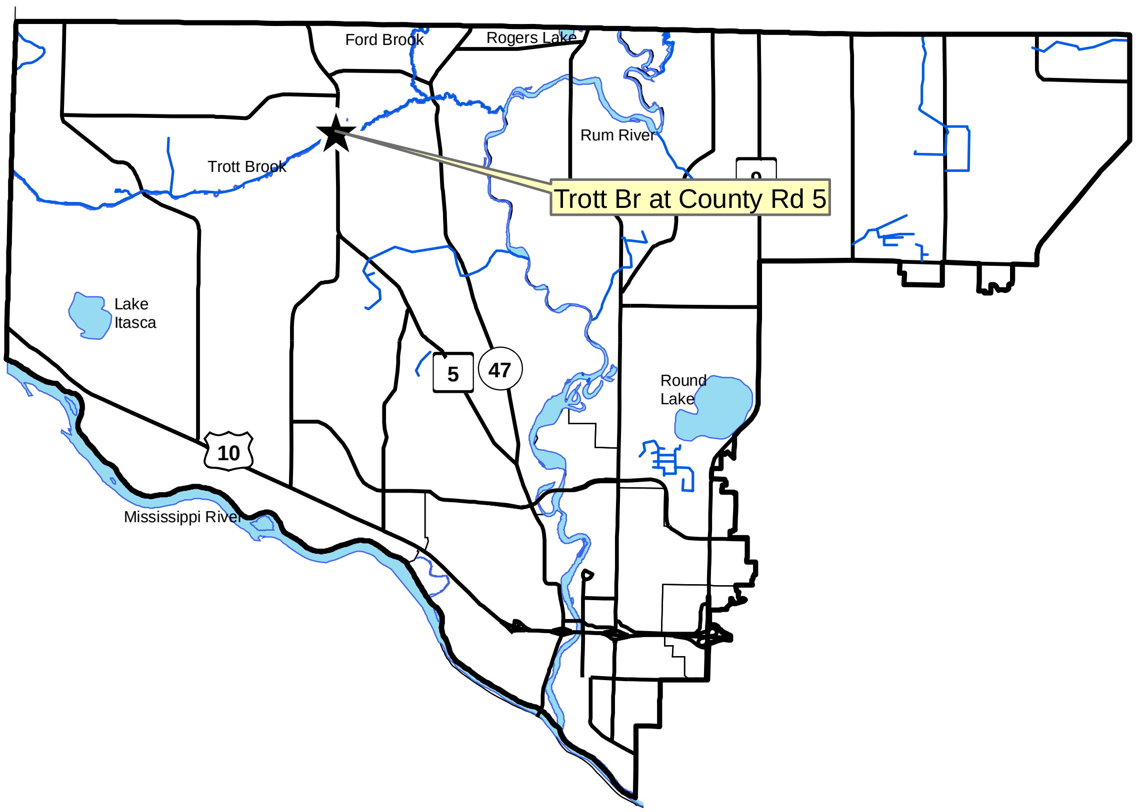
Description: The Rum River has been monitored simultaneously at three strategic locations in 2004, 2009, 2010, and 2011. The locations include the approximate top and bottom of the Upper and Lower Rum River Watershed Management Organizations. The two organizations share the middle location. The Metropolitan Council collects additional data at the farthest downstream location. Collectively, the data collected allow for an upstream to downstream water quality comparison within Anoka County, as well as within each watershed organization. While other Rum River monitoring has occurred, it is excluded from this report in order to include only data that were collected simultaneously for the greatest comparative value.

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

Locations: Trott Brook at County Road 5

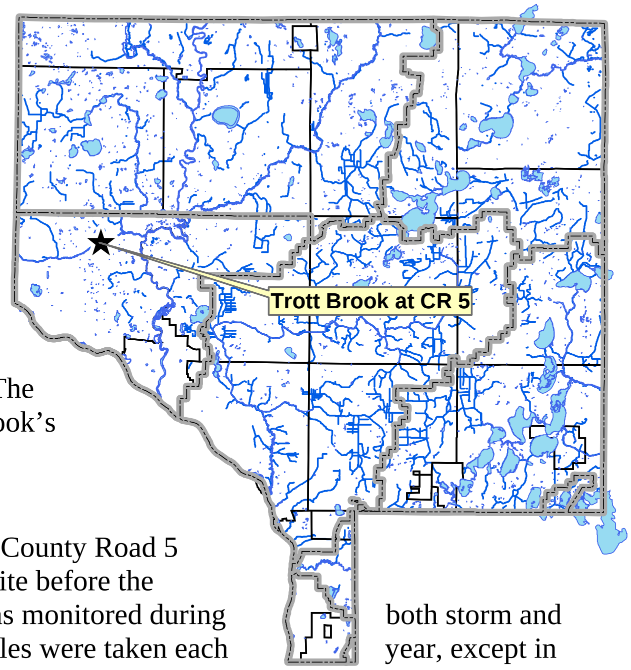
Results: Results are presented on the following pages.
Results from the Metropolitan Council's monitoring station on the Rum River at the Anoka Dam can be obtained from the Metropolitan Council (see http://www.metrocouncil.org/Environment/RiversLakes/).

2012 Rum River Monitoring Sites



TROTT BROOK

Trott Brook at Co. Rd. 5, Ramsey   STORET SiteID = S003-176



Years Monitored

Trott at Co. Rd. 5   1998, 2003, 2006, 2012

Background

Trott Brook is a medium-sized creek that flows south through Sherburne County, paralleling the Anoka-Sherburne County boundary before turning east through the City of Ramsey where outlets to the Rum River. Overall, the watershed is rural or suburban residential, and areas within the watershed are undergoing rapid development. The creek is about 25 feet wide and 2.5 feet deep at the monitoring site during baseflow. The monitoring site is approximately one mile upstream of Trott Brook's confluence with Ford Brook.

Methods

In 1998, 2003, 2006 and 2012 monitoring was conducted at the County Road 5 crossing. This is the farthest-downstream, publicly-accessible site before the confluence with Ford Brook or the Rum River. The stream was monitored during both storm and baseflow conditions by grab samples. Eight water quality samples were taken each year, except in 1998 when only four samples were taken. Half of samples were 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, particularly the drought year of 2009, smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events.

Parameters tested with portable meters included pH, conductivity, turbidity, temperature, salinity, and dissolved oxygen. Parameters tested by water samples sent to a state-certified lab included total phosphorus, total suspended solids, and chlorides. Lab analyses of sulfates and hardness were added in 2012 because these parameters can affect chloride toxicity. During every sampling the water level (stage) was recorded. Continuous water levels were also recorded throughout the 2012 open water season. In 2012 a rating curve was developed for the site, allowing flow to be calculated from the water levels.

All data from monitoring is held in the MN Pollution Control Agency's EQuIS database, which is available through their website. That raw data includes more information that is presented in this report, including the field crew's notes. The raw data is also available from the Anoka Conservation District.

Results and Discussion

Trott Brook water quality is generally good except for low dissovled oxygen. Summarized water quality results include:

- Dissolved pollutants, as measured by conductivity and chlorides, are within the typical range for streams in the area and well below the state chloride standard.
- Phosphorus was low during baseflow and higher during storms. Fourteen of 28 (50%) of samples exceeded 100 ug/L. All but one of these were during storms. Presently there is no state water quality standard for phosphorus in streams, however a standard around 100 ug/L is likely to be adopted soon. Trott Brook might exceed that new standard when it is adopted.
- Suspended solids and turbidity were low during all condtions.

- pH was within the range considered normal and healthy for streams in this area.
- Dissolved oxygen (DO) dips below the state water quality standard routinely. Over all conditions in the last 10 years, eight of 22 measurements (36%) were below the state water quality threshold of 5 mg/L. Based on this information, Trott Brook does not meet state water quality standards for dissolved oxygen, however the state has not yet listed it as such. Additional monitoring with deployable equipment that records around-the-clock DO levels would be the next step to verify this condition.

In 2013-14 the MPCA and local partners will be doing additional monitoring as part of the Rum River Watershed Restoration and Protection Plan project. That monitoring will include the parameters discussed in this report, several other chemcial parameters, and fish and/or invertebrates. If Trott Brook if found to be impaired for any parameter at that time a Total Maximum Daily Load (TMDL) study will be completed. That study will determine pollutant reductions needed to meet water quality standards and likely means to meet those reductions. An implementation plan will be prepared to identify projects to address the water quality problems. It will largely fall to local entities, such as the Anoka Conservation District and Lower Rum River WMO, to install these projects.

Conductivity and chlorides

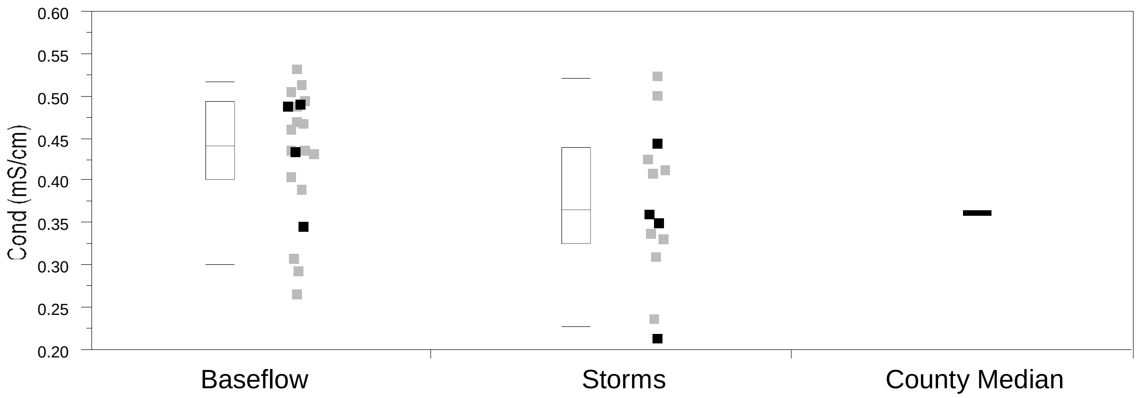
Conductivity and chlorides are measures of dissolved pollutants. Dissolved pollutant sources include urban road runoff, industrial chemicals, and others. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Conductivity is the broadest measure of dissolved pollutants we used. It measures electrical conductivity of the water; pure water with no dissolved constituents has zero conductivity. Chlorides is a test for chloride salts, the most common of which are road de-icing chemicals. Chlorides can also be present in other pollutant sources, such as wastewater. Dissolved 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 Trott Brook is upstream from the Twin Cities drinking water intakes on the Mississippi River.

Conductivity and chlorides in Trott Brook are within the acceptable range, and similar to other nearby streams. The median for both parameters is nearly identical for the median of all monitored streams in Anoka County. The median conductivity for Trott Brook was 0.440 mS/cm; for all streams in Anoka County it is 0.362 mS/cm. The median chlorides for Trott Brook was 19 mg/L; for all streams in Anoka County it is 17 mg/L. The highest observed chloride concentration was 30 mg/L, though higher levels may have occurred during snowmelts which were not monitored. The levels observed are much lower than the Minnesota Pollution Control Agency's (MPCA) chronic standard for aquatic life of 230 mg/L.

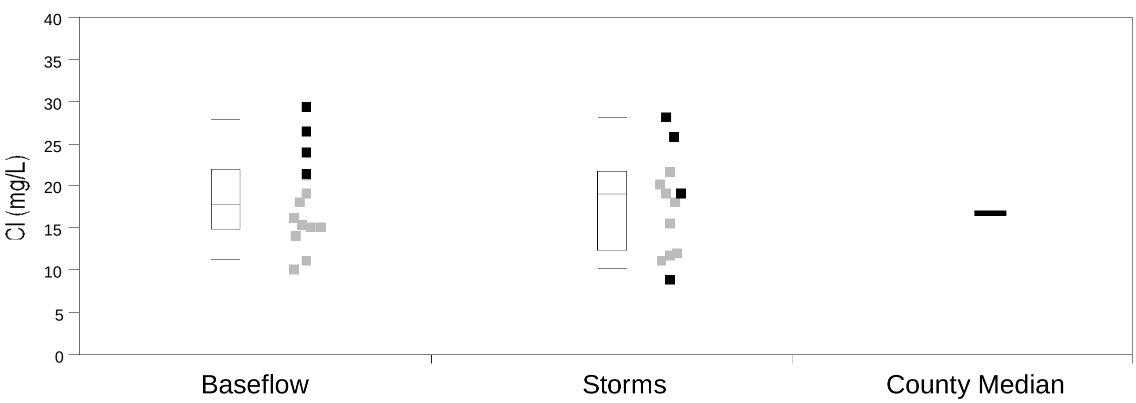
Conductivity and chlorides were similar during storms and baseflow. If runoff were the only source, we would expect these parameters to be highest during storms. An well-documented reason dissolved pollutants are elevated during baseflow too is because of road deicing salt infiltration into the shallow groundwater.

Hardness and sulfate in the water affect the toxicity of chlorides so these parameters were measured in 2012. The State of Iowa has developed equations to adjust the maximum allowable chlorides based upon sulfates and hardness. Minnesota is considering the same approach. Because Trott Brook chlorides are far lower than state standards, the effect of sulfates and hardness is of minimal interst and not investigated.

Conductivity during baseflow and storm conditions Black squares are individual readings from 2012. Grey squares are individual readings from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Chloride during baseflow and storm conditions Black squares are individual readings from 2012. Grey squares are individual readings from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

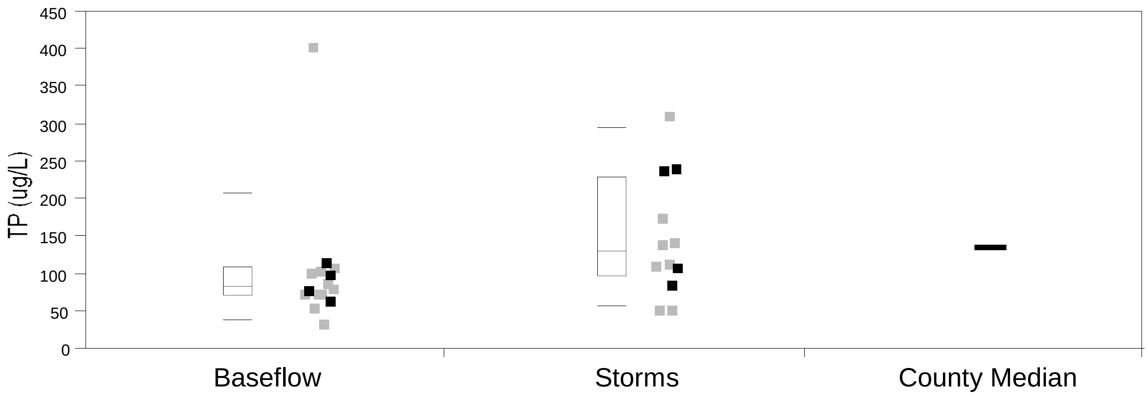


Total Phosphorus

Total phosphorus , a nutrient, is one of the most common pollutants in our region, and can be associated with urban runoff, agricultural runoff, wastewater, and many other sources.

Total phosphorus concentrations in Trott Brook were acceptable during baseflow but more variable and sometimes high during storms. The median phosphorus for Anoka County streams is 135 *u*g/L. There is no state water quality standard for this parameter in streams, however one is likely to be adpoted soon at around 130 *u*g/L. In Trott Brook the median phosphorus during baseflow was 84 *ug/L*, which is desirable. The median phoshorus during storms was 131 *u*g/L but ranged from 56 *u*g/L to 316 *u*g/L. Across all samples, seven of 28 (25%) of measurements were greater than 130 *u*g/L; all but one were during storms. In all, phosphorus in Trott Brook is flirting with unacceptably high levels and should be an area of pollution control effort as the watershed urbanizes.

Total phosphorus during baseflow and storm conditions Black squares are individual readings from 2012. Grey squares are individual readings from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



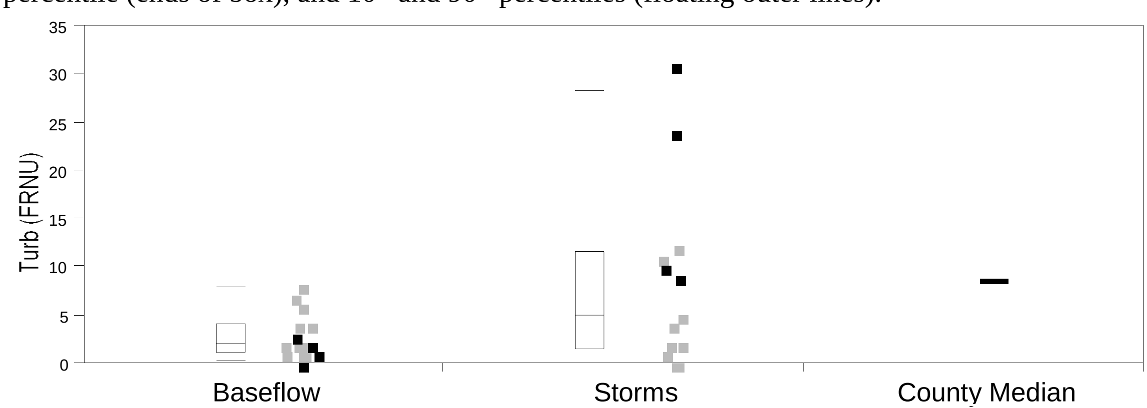
Turbidity and Total Suspended Solids (TSS)

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.

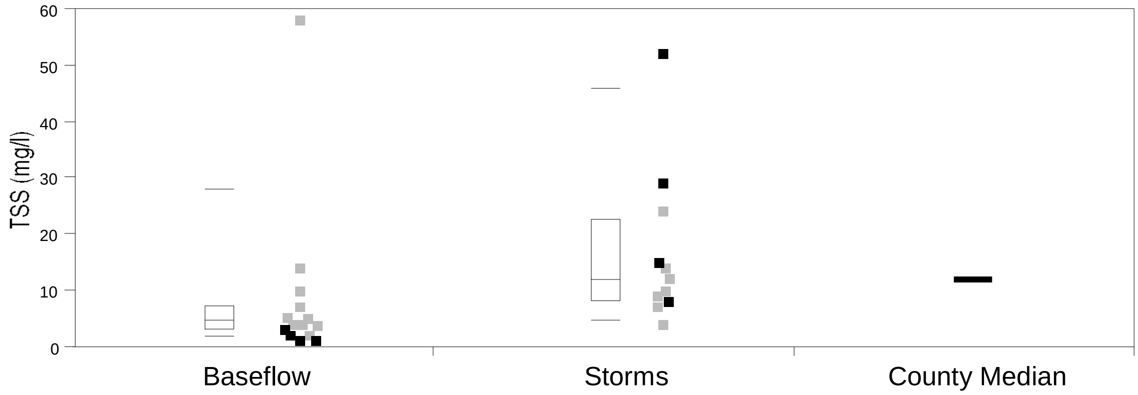
Turbidity in Trott Brook is acceptably low. The current state water quality threshold for turbidity is 25 NTU. If a stream exceeds this value on three occassions and at least 10% of all sampling events, then it is declared impaired for turbidity (20 sample minimum). Trott Brook turibity exceeded 25 NTU only once of 33 measurements. Tubidity was higher during storms (median 5 NTU, range 0-31) than during baseflow (median 2 NTU, range 0-8).

Total suspended solids (TSS) are also acceptably low in Trott Brook. Presently TSS is only used in state water quality standards as a surrogate for turbidity when little turbidity data exists. The threshold is 100 mg/L. In the future the MPCA plans to switch to using TSS for the water quality standard. In Trott Brook the median of all TSS measurements was only 7 mg/L. During baseflow (median 5 mg/L) TSS was lower than during storms (median 12 mg/L). The maximum observed during any conditions was 59 mg/L.

Turbidity during baseflow and storm conditions Black squares are individual readings from 2012. Grey squares are individual readings from previous years. 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 Black squares are individual readings from 2012. Grey squares are individual readings from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



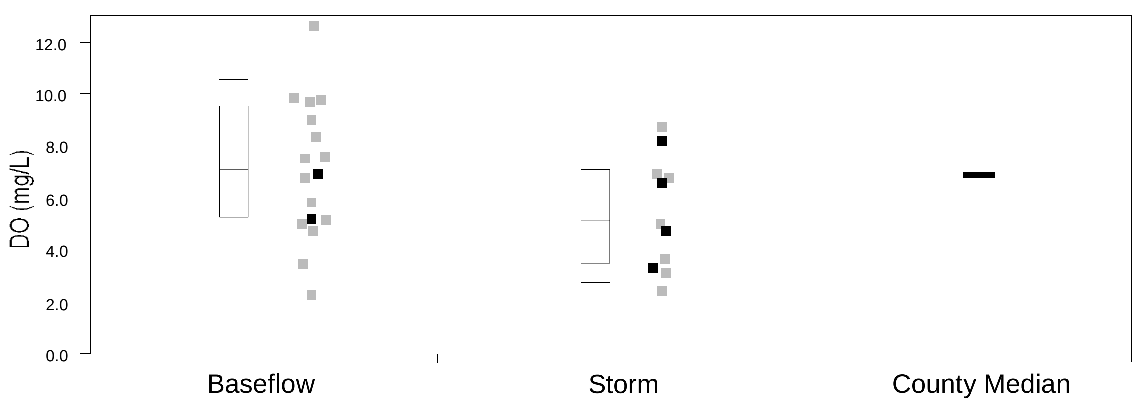
Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution consumes oxygen when it decomposes. If oxygen levels fall below 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.

In Trott Brook dissolved oxygen (DO) dips below the state water quality standard routinely. The median DO during baseflow was 7.16 mg/L but during storms was just 5.19 mg/L. Readings below 5 mg/L were observed in all of the four monitored years except 1998. In 1998 the lowest observed DO was 5.36 mg/L. Over all conditions in the last 10 years, eight of 22 measurements (36%) were below 5 mg/L. Based on this information, Trott Brook does not meet state water quality standards for dissolved oxygen although it has not yet been declared “impaired.” Additional monitoring with deployable equipment that record aroun-the-clock DO levels would be the next step to verify this condition.

The most common reason for low oxygen is high levels of organic material. Decomposition of these materials consumes oxygen. Trott Brook and its ditch tributaries flow through expanses of wetland where organic soils dominate. Decomposition in those wetlands could contribute to the low stream DO. The relatively low suspended solids and phosphorus in the stream suggest that direct discharges of organic materials into the stream are not a significant cause of low DO.

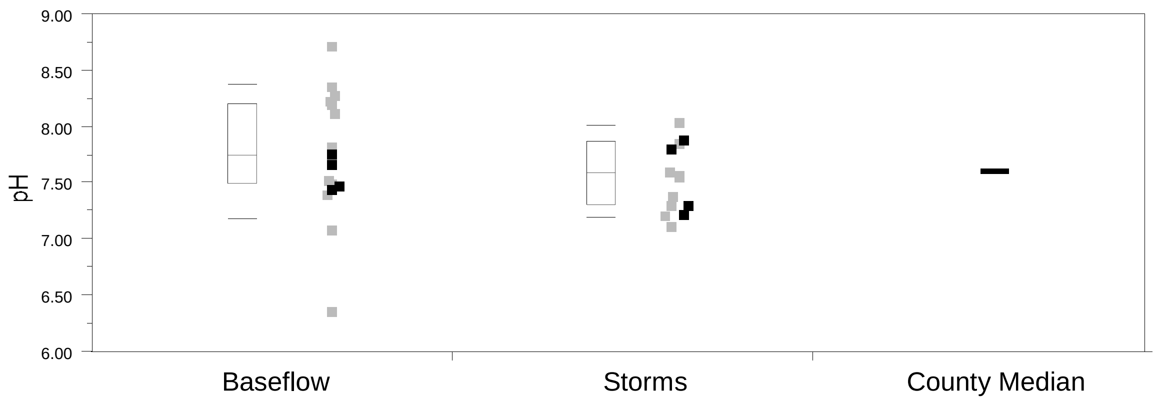
Dissolved oxygen during baseflow and storm conditions Black squares are individual readings from 2012. Grey squares are individual readings from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



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. All pH measurements at Trott Brook have been within this range. No concerns have been noted.

pH during baseflow and storm conditions Black squares are individual readings from 2012. Grey squares are individual readings from previous years. 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 – Biological Monitoring

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 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.

Locations: 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.

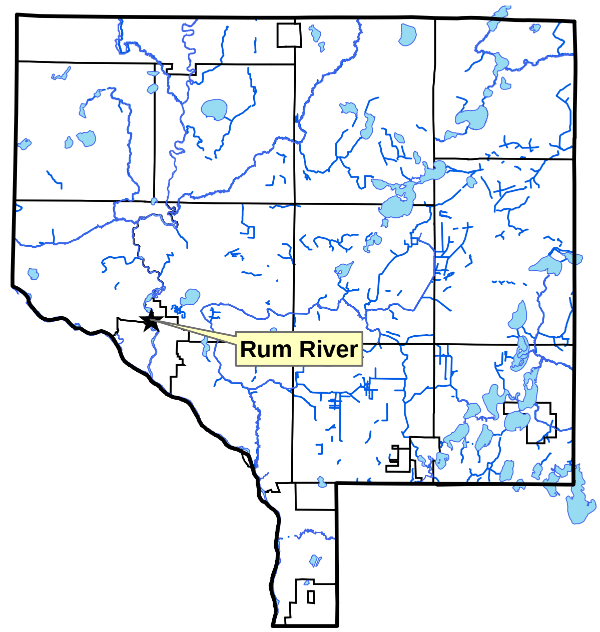
Family Biotic Index (FBI) — An index that utilizes known pollution tolerances for each family. Lower numbers indicate better stream quality.

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

% Dominant Family — High numbers indicates an uneven community, and likely poorer stream health.

RUM RIVER

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



Last Monitored

By Anoka High School in 2012

Monitored Since

2001

Student Involvement

70 students in 2012, approximately 480 since 2001

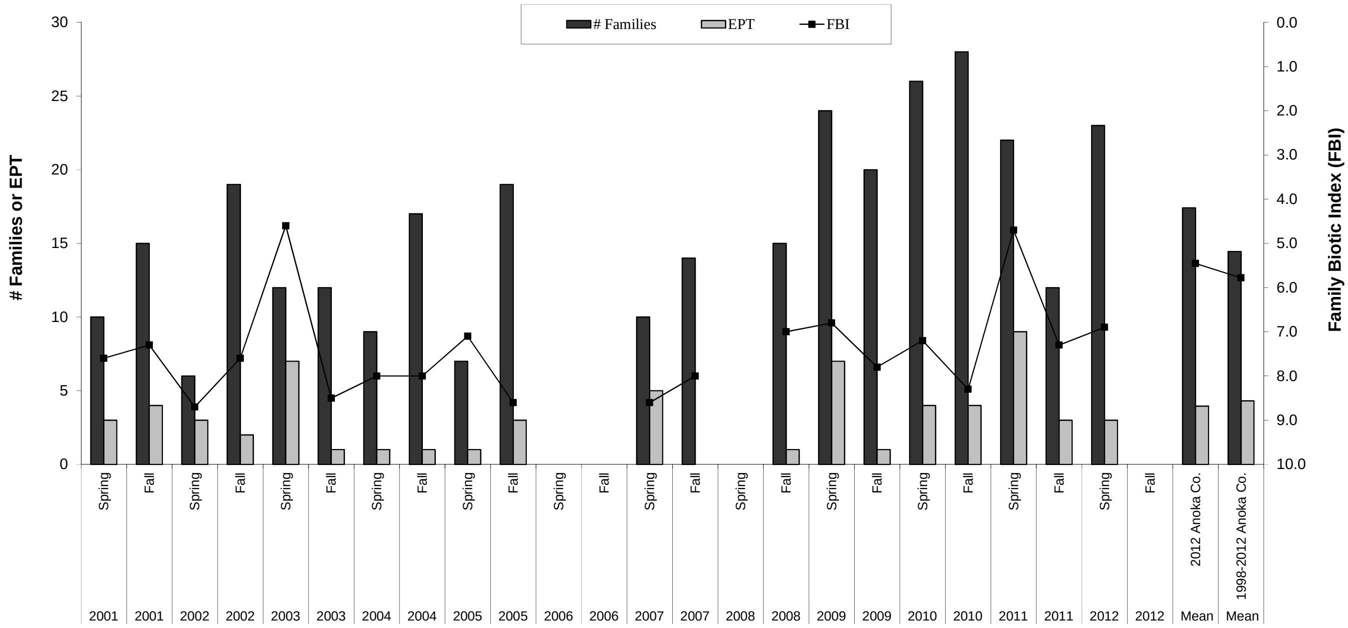
Background

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 is not conducted in a backwater rather than the main channel.

Results

The results for spring 2012 were within the range experienced in previous years. More families were found than the average in Anoka County streams. This should be expected as most other sites are small streams and this is a river. The number of sensitive EPT families and the FBI score were poorer than the county average. Taken together, the invertebrate data indicates poorer river health than is desirable. A complicating factor is that sampling was in backwaters rather than the main channel, and a poorer invertebrate community would be expected there.

Summarized Biomonitoring Results for Rum River behind Anoka High School



Biomonitoring Data for the Rum River behind Anoka High School

Data presented from the most recent five years. Contact the ACD to request archived data.

Year	2008	2009	2009	2010	2010	2011	2011	2012	Mean	Mean
Season	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	2012 Anoka Co.	1998-2012 Anoka Co.
FBI	7.00	6.80	7.80	7.20	8.30	4.70	7.30	6.90	5.5	5.8
# Families	15	24	20	26	28	22	12	23	17.4	14.5
EPT	1	7	1	4	4	9	3	3	4.0	4.3
Date	13-Oct	8-May	28-Sep	18-May	7-Oct	10-Jun	5-Oct	8-May		
Sampled By	AHS	AHS	AHS	AHS	AHS	ACD	ACD	AHS		
Sampling Method	MH	MH	MH	MH	MH	MH	MH	MH		
Mean # Individuals/Rep.	626	880	585	443	816	604	188	502		
# Replicates	1	1	2	1	1	1	1	2		
Dominant Family	Baetidae	Siphlonuridae	Hyalellidae	Gastropoda	Hyalellidae	baetidae	hyalellidae	silphonuridae		
% Dominant Family	26.5	40.7	39.1	31.8	34.1	57.5	63.3	37.8		
% Ephemeroptera	26.5	48.2	0.9	8.1	0.9	59.3	11.2	44.9		
% Trichoptera	0	0.1	0	0	0.2	1	0	1.2		
% Plecoptera	0	2.6	0	0.5	0	3.8	0.5	0		

Supplemental Stream Chemistry Readings

Data presented from the most recent five years. Contact the ACD to request archived data.

Parameter	5/7/2007	10/22/2007	10/10/2008	5/8/2009	9/28/2009	5/18/2010	10/7/2010	6/10/2011	10/5/2011	5/8/2012
pH	8.5	7.42	7.75	7.91	7.82	7.24	7.22	7.84	7.98	8.10
Conductivity (mS/cm)	0.283	0.243	0.348	0.276	0.421	0.207	0.399	0.296	0.296	0.205
Turbidity (NTU)	17	13	3	6	5	7	7	18	10	7
Dissolved Oxygen (mg/L)	11.41	9.72	8.99	10.82	8.76	6.93	na	6.85	7.91	7.87
Salinity (%)	0.01	0	0.01	0.01	0.01	0	0.01	0.01	0.01	0.00
Temperature (°C)	15.3	10.6	12.3	17.2	15.5	14.8	12.2	20.7	15.3	15.7

Discussion

Biomonitoring results for this site are much different from the upstream in St. Francis. In St. Francis the Rum River harbors the most diverse and pollution-sensitive macroinvertebrate community of all sites monitored in Anoka County. At the City of Anoka diversity has been moderately high, but the biotic indices were poorer than average because most families were generalists.

The largest reason difference between St. Francis and Anoka invertebrate communities is likely habitat differences. The river near St. Francis has a steeper gradient, and has a variety of pools, riffles, and runs. Downstream, near Anoka, the river is much slower moving, lacking pools, riffles and runs. The bottom is silt-laden. The area is more developed, so there are more direct and indirect human impacts to the river.

Water quality is good throughout the Rum River, though slightly poorer in Anoka than St. Francis. Chemical monitoring in 2004, 2009, 2010, and 2011 revealed that total suspended solids, conductivity, and chlorides were all slightly higher near Anoka than upstream. This is probably due to more urbanized land uses and the accompanying storm water inputs. Given that water quality is still very good even in these downstream areas, it is unlikely that water quality is the primary factor limiting macroinvertebrates at the City of Anoka.

One additional factor to consider when comparing the up and downstream monitoring results is the type of sampling location. Sampling near Anoka was conducted mostly in a backwater area that has a mucky bottom and does not receive good flow. This area is unlikely to be occupied by families which are pollution intolerant.

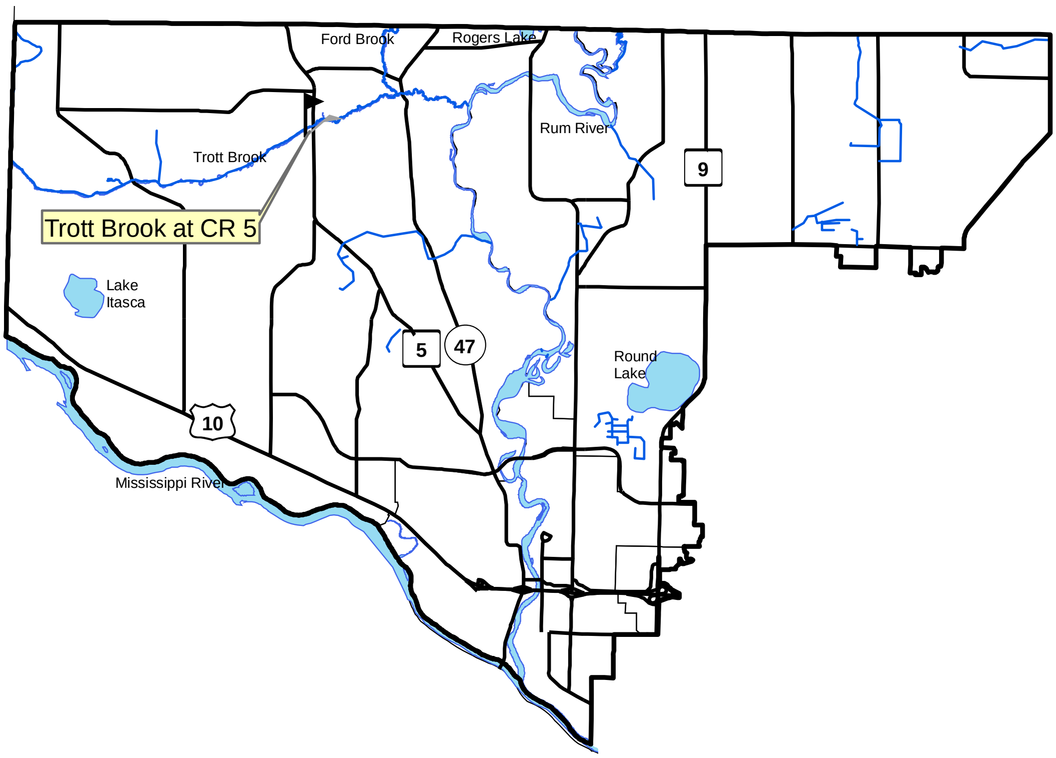
Stream Hydrology

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 are also needed for calculation of pollutant loads and use of computer models for developing management strategies. In the Sunrise River Watershed, the monitoring sites are the outlets of the Sunrise River Watershed Management Organization's jurisdictional area, thereby allowing estimation of flows and pollutant loads leaving the jurisdiction.

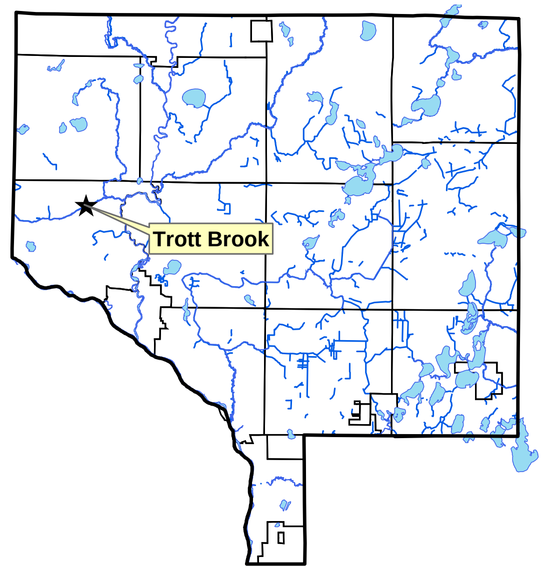
Locations: Trott Brook at County Road 5

Lower Rum River Watershed Stream Hydrology Monitoring Sites



TROTT BROOK

at County Road 5 (Nowthen Blvd NW), Ramsey
STORET SiteID = S003-176



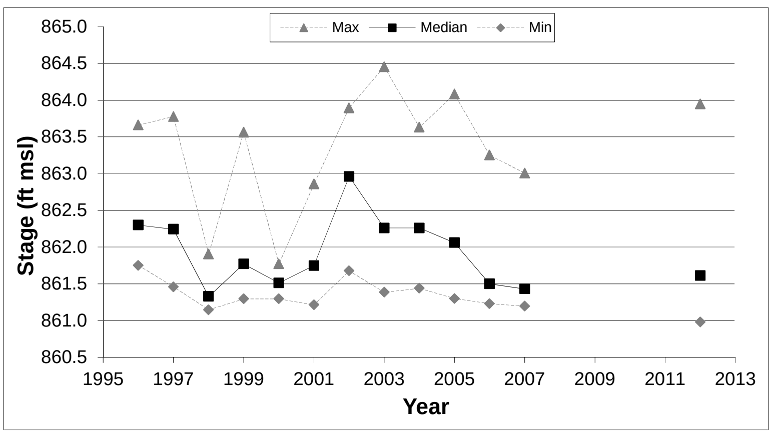
Notes

Trott Brook is a medium-sized creek that flows south through Sherburne County, paralleling the Anoka-Sherburne County boundary before turning east through the City of Ramsey where outlets to the Rum River. Overall, the watershed is rural or suburban residential, and areas within the watershed are undergoing rapid development. The creek is about 25 feet wide and 2.5 feet deep at the monitoring site during baseflow.

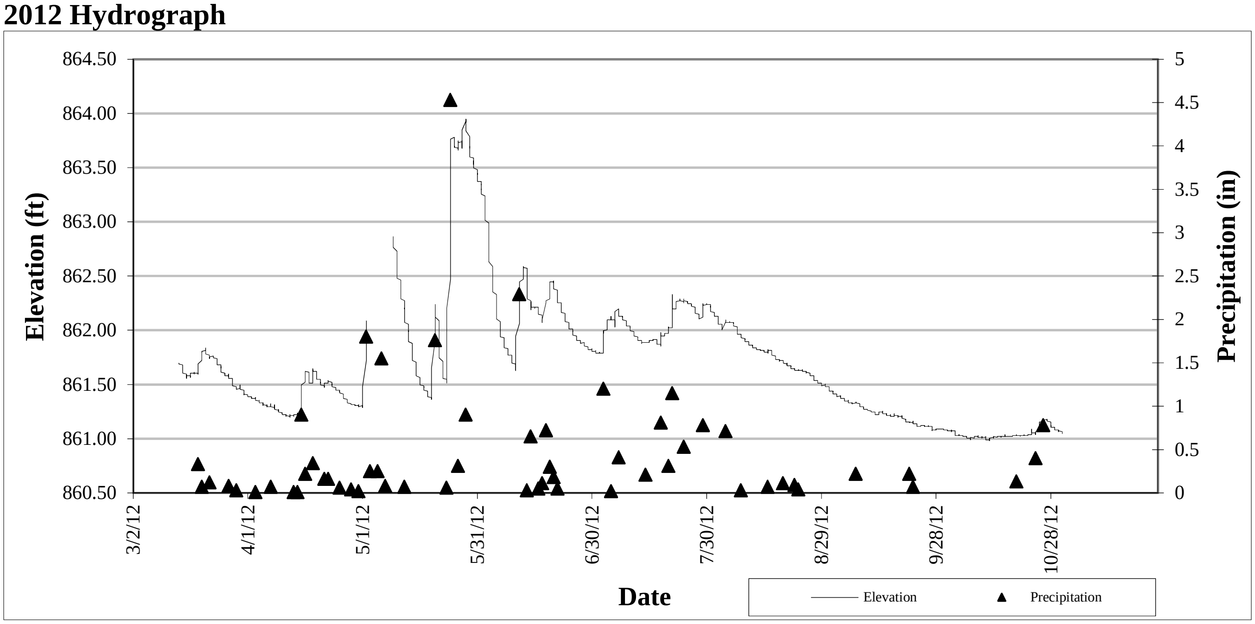
A rating curve for this site was developed in 2012:

$$\text{Flow (cfs)} = 9.1917(\text{stage}-859)^2 - 37.669(\text{stage}-859) + 41.931$$

Summary of All Monitored Years



2012 Hydrograph



Stream Rating Curves

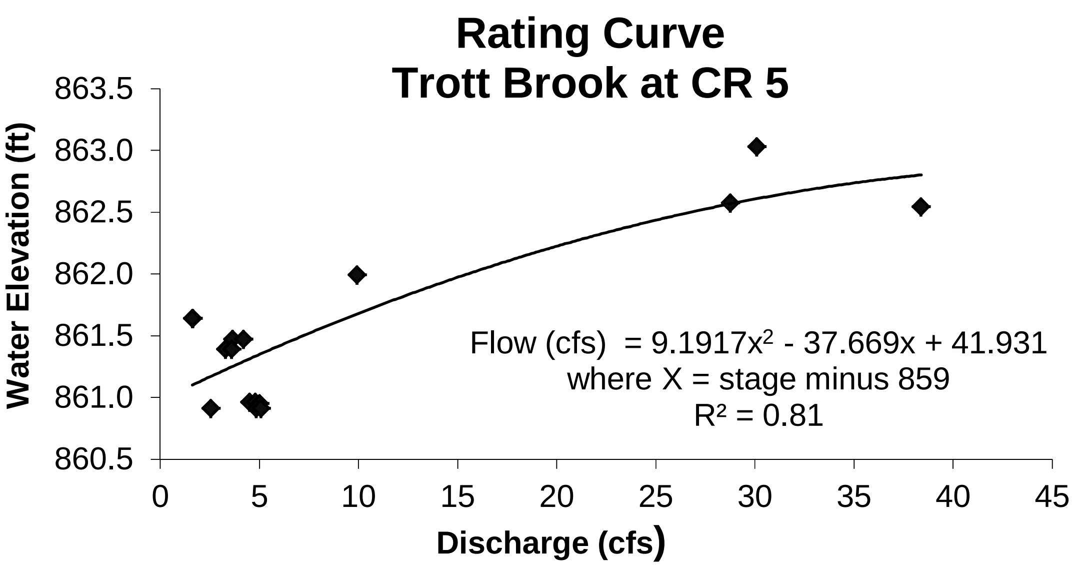
Description: Rating curves are the mathematical relationship between water level and flow volume. They are developed by manually measuring flow at a variety of water levels. These water level-flow measurements are plotted and the equation of a line best fitting these points is calculated. That equation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

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

Locations: Trott Brook at County Road 5

Results: In 2012 ACD staff manually measured flow in Trott Brook under a variety of water level conditions. 16 such measurements were used to develop the rating curve presented below. The equation was used to calculate flow from continuous stream water level monitoring measurements.

Trott Brook at County Road 5 Rating Curve



Wetland Hydrology

Description: Continuous groundwater level monitoring at a wetland boundary to a depth of 40 inches. County-wide, the ACD maintains a network of 21 wetland hydrology monitoring stations.

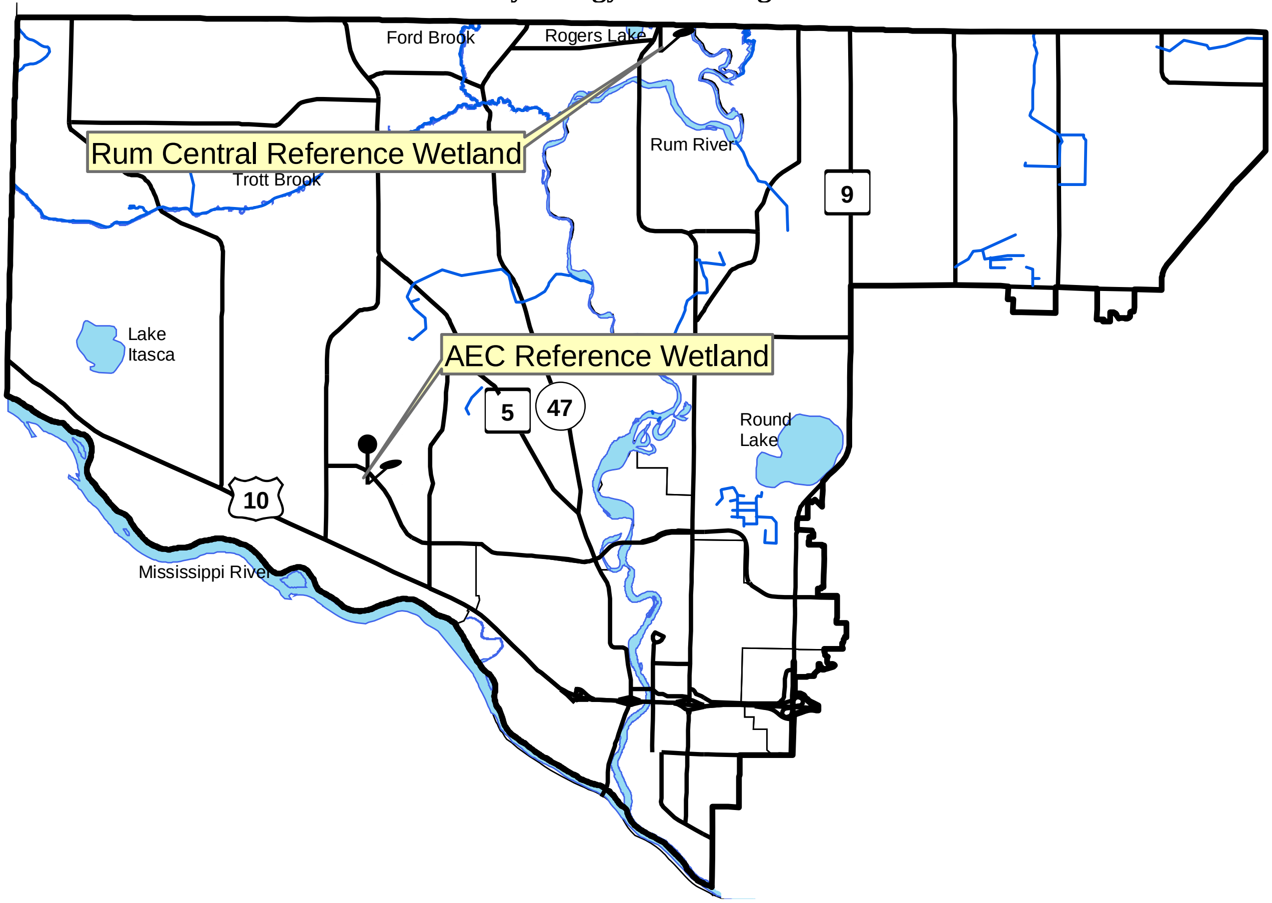
Purpose: To provide understanding of wetland hydrology, including the impact of climate and land use. These data aid in delineation of nearby wetlands by documenting hydrologic trends including the timing, frequency, and duration of saturation.

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

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

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

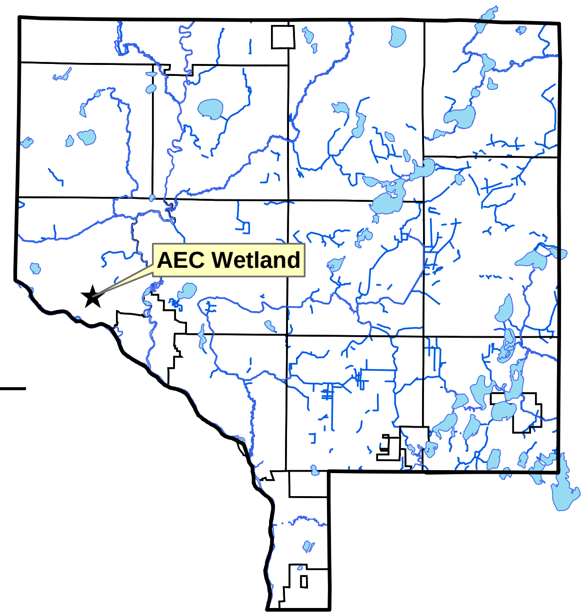
Lower Rum River Watershed Wetland Hydrology Monitoring Sites



Wetland Hydrology Monitoring

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	-

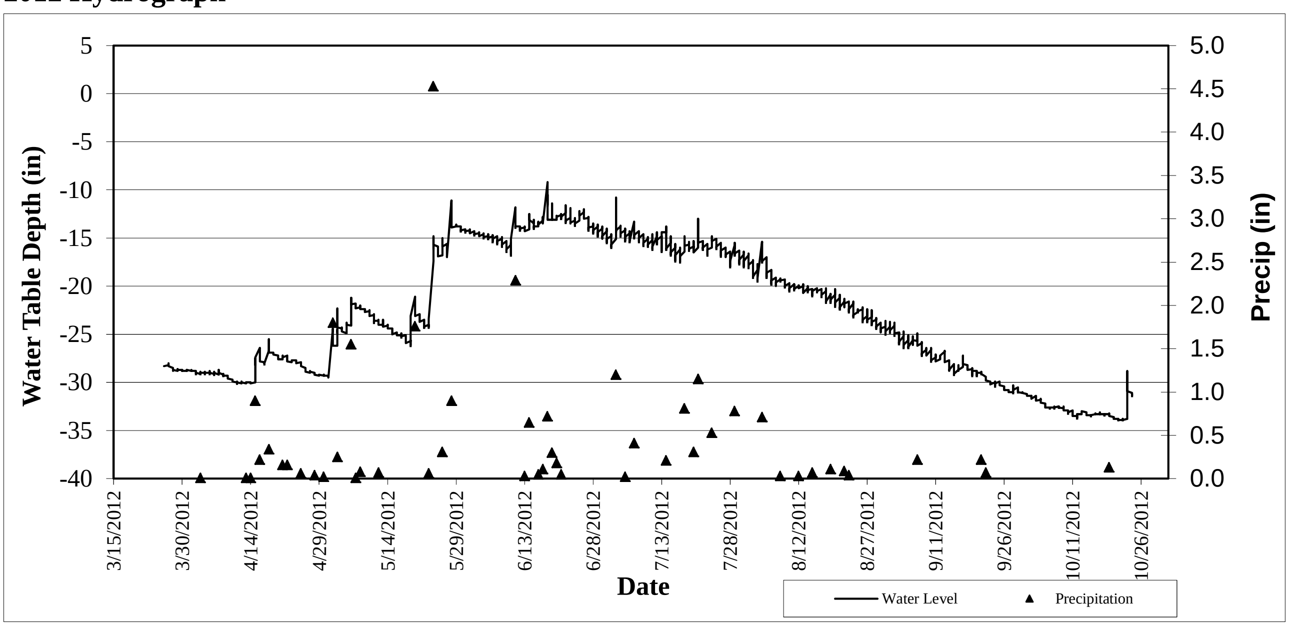
Surrounding Soils: Hubbard coarse sand

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.

2012 Hydrograph

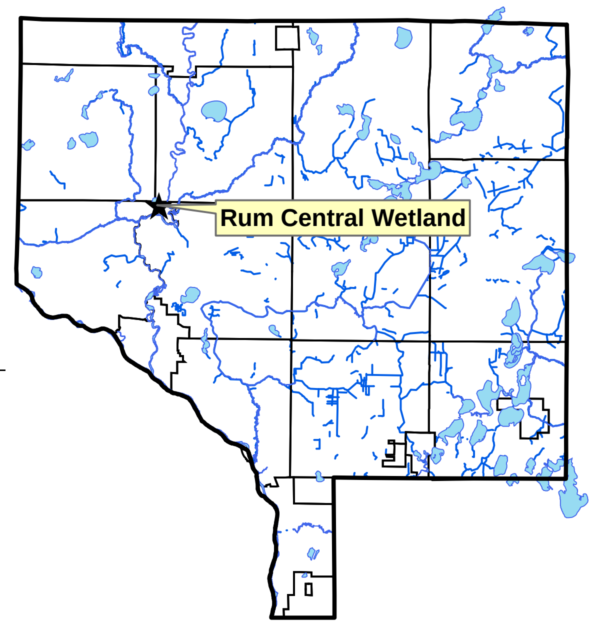


Well depth was 42 inches, so a reading of –42 indicates water levels were at an unknown depth greater than or equal to 42 inches.

Wetland Hydrology Monitoring

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	-

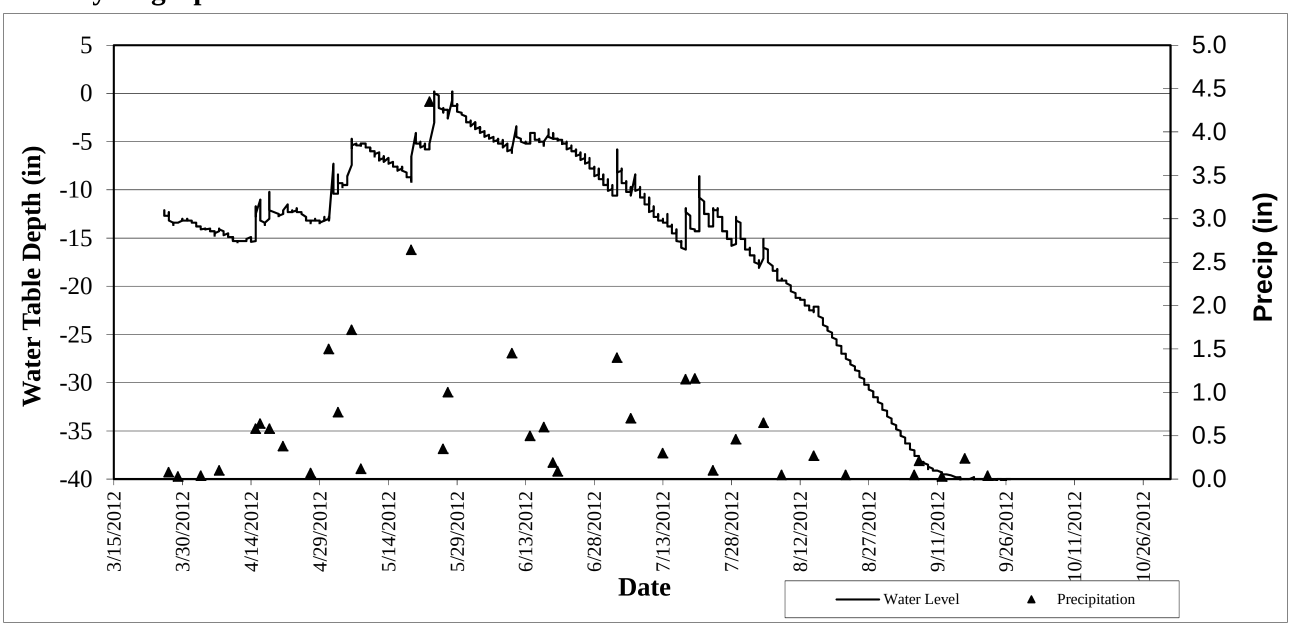
Surrounding Soils: Zimmerman fine sand

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.

2012 Hydrograph



Well depth was 40 inches, so a reading of –40 indicates water levels were at an unknown depth greater than or equal to 40 inches.

Water Quality Grant Fund

Description: The LRRWMO provided cost share 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 was administered by the Anoka Conservation District, which works with landowners on conservation projects. Projects affecting the Rum River were given the highest 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 receiving grant funds are reported in the year they are installed. In 2012 the Smith Rum Riverbank Stabilization used $1,596.92 of LRRWMO cost share dollars.

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
Fund Balance		**$ 431.20**

Smith Rum River Stabilization

Anoka Conservation District (ACD) staff installed a cedar tree revetment on a residential property that borders the Rum River in Ramsey during the fall of 2012. Cedar tree revetments are a cost-effective bioengineering practice that can be used to stabilize mild or moderately eroding streambanks. The Smith property had moderate bank undercutting. Installation of the 70 foot cedar tree revetment will slow or stop the erosion and reduce the likelihood of a much larger and more expensive corrective project in the future. Because this project was on a steep slow below a home, it was a high priority for the landowner. It benefits river water quality by reducing sediment delivered to the river, and improves habitat.

Cedar tree revetments are created by anchoring cut cedar trees to the bank. In this case, the trees were harvested at no cost from an Anoka County park where they were undesirable. Each tree was anchored to the toe of the slope using cable, horseshoe clamps, and a duckbill anchor driven 3-4 feet into the bank. The tree's many branches deflect the water's energy from the bank. This low cost treatment is highly effective on mild to moderate problem areas.

Project Funding

LRRWMO Water Quality Cost Share	$1,596.92
Ag PreservesWater Quality Cost Share	$563.88
Landowner	$2,160.80
TOTAL	$4,321.60

Public Education – Web Video

Description: The Lower Rum River Watershed Management Organization (LRRWMO) contracted the Anoka Conservation District (ACD) to create a short web video about state scenic river rules that apply to the Rum River. The video is to be posted on the LRRWMO website.

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

Location: www.AnokaNaturalResources.com/LRRWMO

Results: As of January 27, 2013 the video production is in process. Appropriate video clips have been compiled. Many of these video clips were collected by ACD staff during the LRRWMO's boat tour of the river in September 2011. The video compilation will be completed and presented to the LRRWMO Board before March 31, 2012.

Review Member Communities' Local Water Plans

Description: Member cities must have local water plans and ordinances consistent with the LRRWMO 3rd Generation Watershed Management Plan (MN Rules 8410.0130 and 84100160). Cities might start this process in 2012, and the deadline for completion is December 14, 2013. The LRRWMO has approval authority over the Local Water Management Plans. Once a community submits their updated Local Water Management Plan to the WMO for review, the WMO has 60 days to provide comments. The Metropolitan Council has a simultaneous 45 day review period, and the WMO's review of the Plan must include a review of Metropolitan Council's comments.

The LRRWMO has requested that the ACD assist with their review of local water plans as they are completed. It is anticipated that communities will submit plans for review in both 2012 and 2013.

Purpose: To ensure the policies and actions in the LRRWMO 3rd Generation Watershed Management Plan are implemented consistently across the watershed.

Location: Watershed-wide

Results: As of January 7, 2012 no cities have submitted local water plan updates to the LRRWMO for review. Cities should be reminded of the December 14, 2013 deadline.

LRRWMO Website

Description: The Lower Rum River Watershed Management Organization (LRRWMO) contracted 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. The LRRWMO pays the ACD annual fees for maintenance and update of the website.

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. The website serves as the LRRWMO's alternative to a state-mandated newsletter.

Location: www.AnokaNaturalResources.com/LRRWMO

Results: The LRRWMO website contains information about both the LRRWMO and about natural resources in the area.

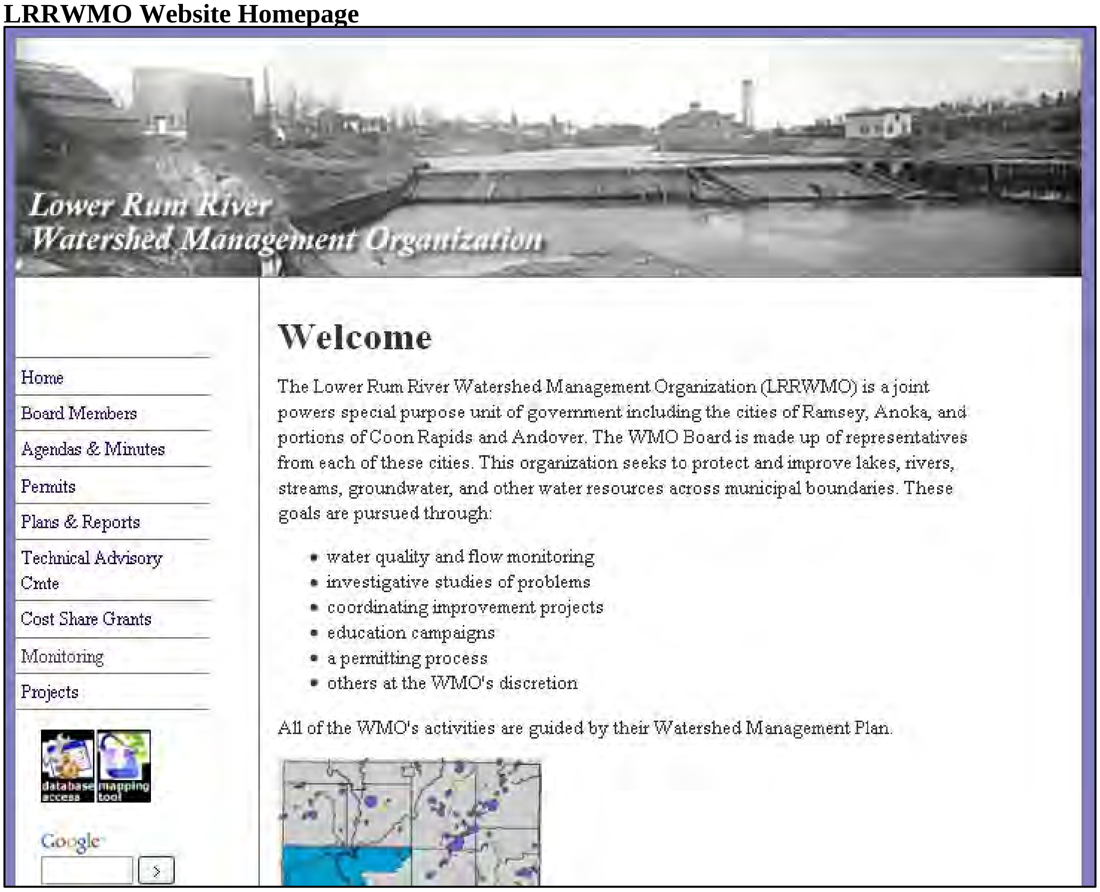
Information about the LRRWMO includes:

- a directory of board members,
- meeting minutes and agendas,
- descriptions of work that the organization is directing,
- highlighted projects,
- permit applications,
- the watershed management plan,
- annual reports, and others.

Other tools on the website include:

- an interactive mapping tool that shows natural features and aerial photos
- an interactive data download tool that allows users to access all water monitoring data that has been collected
- narrative discussions of what the monitoring data mean

LRRWMO Website Homepage



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.

Lower Rum River Watershed Financial Summary

Lower Rum River Watershed	Ref Wet	Lake Lvl	Stream Level	Rating curve	Lake WQ	Stream WQ	Student Biomon	LRRWMO Admin	Cost Share/ Lakescape/ Rain Garden	LRRWMO Outreach/Promo	Total
Revenues											
LRRWMO	1100	680	550	1800	1370	1330	795	5967	1597	1420	16609
State	0	0	0	0	0	0	0	0	0	0	0
Anoka Conservation District	0	0	0	0	0	0	0	0	0	0	0
County Ag Preserves	0	0	0	0	405	0	145	0	564	0	1114
Regional/Local	0	0	0	0	0	0	0	0	0	0	0
Other Service Fees	0	0	0	0	0	0	0	0	0	0	0
Local Water Planning	0	84	0	0	269	173	0	0	0	0	526
TOTAL	1100	764	550	1800	2044	1503	940	5967	2161	1420	18248
Expenses-											
Capital Outlay/Equip	8	7	3	23	17	9	11	3	0	3	84
Personnel Salaries/Benefits	737	655	426	1333	1287	797	745	303	0	538	6822
Overhead	59	52	35	102	112	65	60	29	0	52	565
Employee Training	2	2	2	1	2	2	1	2	0	4	16
Vehicle/Mileage	16	14	9	27	28	16	16	4	0	9	138
Rent	33	30	22	50	53	38	30	20	0	36	312
Program Participants	0	0	0	0	0	0	0	0	2161	0	2161
Program Supplies	5	4	14	0	545	575	77	0	0	0	1220
McKay Expenses	0	0	0	0	0	0	0	0	0	0	0
TOTAL	860	764	510	1535	2044	1503	940	360	0	641	9157
NET	240	0	40	265	0	0	0	5607	2161	779	9091

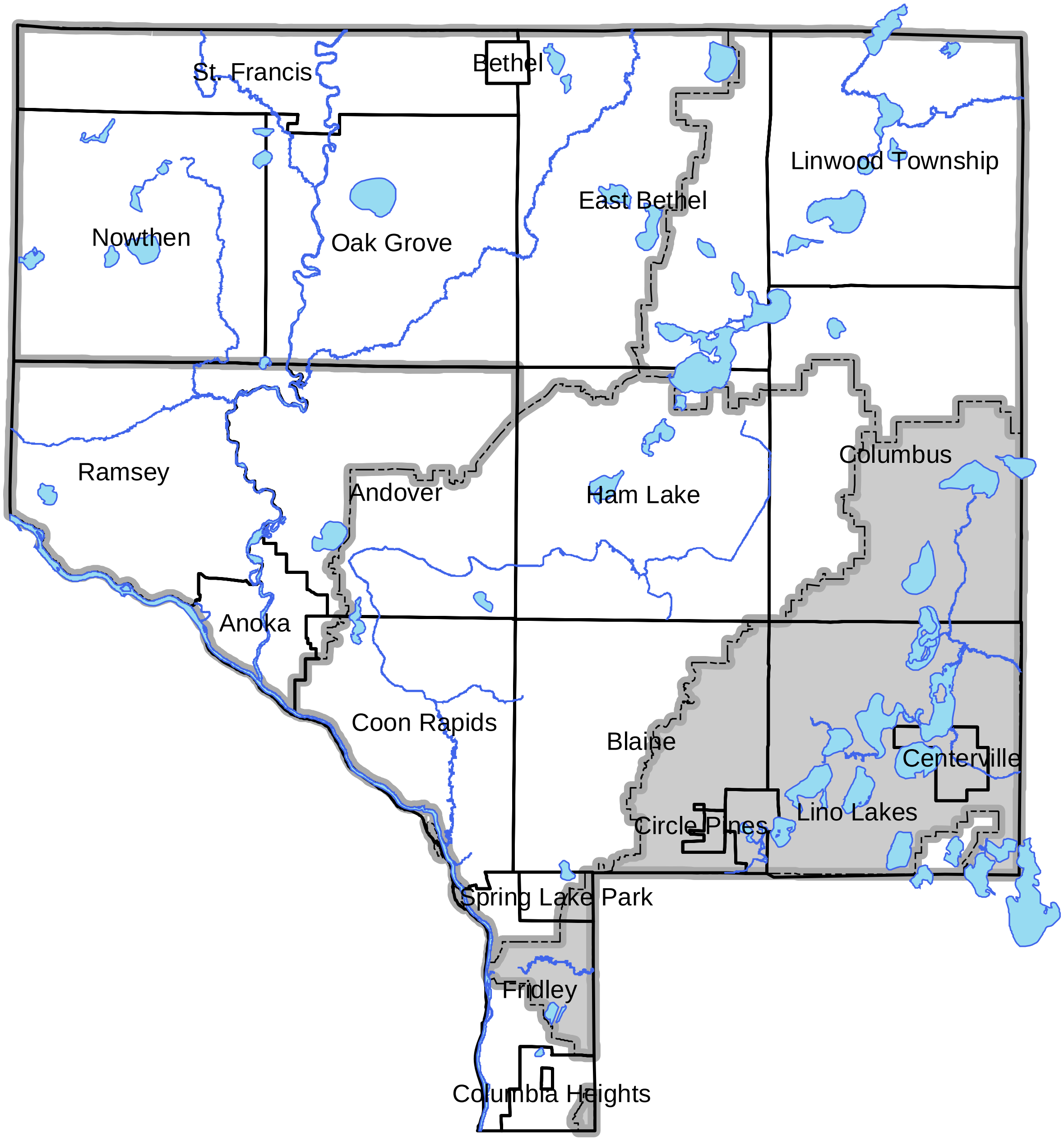
Recommendations

- **Actively participate in the MPCA Rum River WRAPP (Watershed Restoration and Protection Plan) which is beginning in 2013.** This WRAPP is an assessment of the entire Rum River watershed. This is an opportunity for the LRRWMO to prioritize and coordinate efforts with upstream entities and state agencies. TMDL studies with regulatory implications will likely arise out of this project.
- **Diagnose low dissolved oxygen in Trott Brook.** Water quality and hydrology monitoring is planned during 2012 for the Rum River WRAPP project. A TMDL study and implementation plan are desirable outcomes.
- **Remind LRRWMO Cities that local water plans must be updated**, reviewed, and approved by the LRRWMO by December 14, 2013. The review process takes several months.
- **Implement water conservation measures** throughout the watershed and promote it metro-wide. Depletion of surficial water tables are having observable, sometimes dramatic, impacts

on some lake levels and wetlands. Metropolitan Council models predict 3+ft drawdown of surface waters in certain areas by 2030, and 5+ft by 2050.

- **Repeat periodic tours of the Rum River by the LRRWMO Board.** These boat tours are useful for identifying problems and the overall condition of the resource.
- **Continue lake level monitoring, especially on Round Lake** where residents have expressed concerns with levels. Other nearby lakes should be monitored for comparison and problems.
- **Facilitate resident efforts to control aquatic plant growth on Rogers Lake** as a means to improving low dissolved oxygen problems. In early 2010 a meeting for residents was held, interest expressed, but coordination and work needed by residents did not materialize. Treatments should occur in early spring, occur on no more than 15% of the lake, be coordinated, and proceed under DNR permits.
- **Emphasize protection of Rum River water quality.** The river's water quality declines slightly in the LRRWMO and anticipated future development could cause further deterioration.
- **Complete a stormwater retrofitting assessment for the City of Anoka.** The project will identify and rank projects that improve stormwater runoff before it is discharged to the Rum River.
- **Continue the existing cost share grant program for water quality improvement projects** on private properties.
- **Encourage public works departments to implement measures to minimize road deicing salt applications**. Monitoring and special investigations in the LRRWMO and elsewhere nearby have shown that road salts are a serious and widespread sources of stream degradation.

Rice Creek Watershed



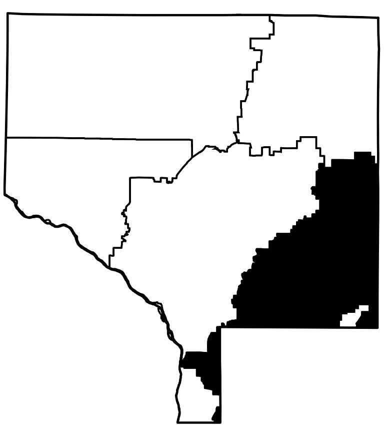
Contact Info: Rice Creek Watershed District
www.ricecreekwd.com
763-398-3070

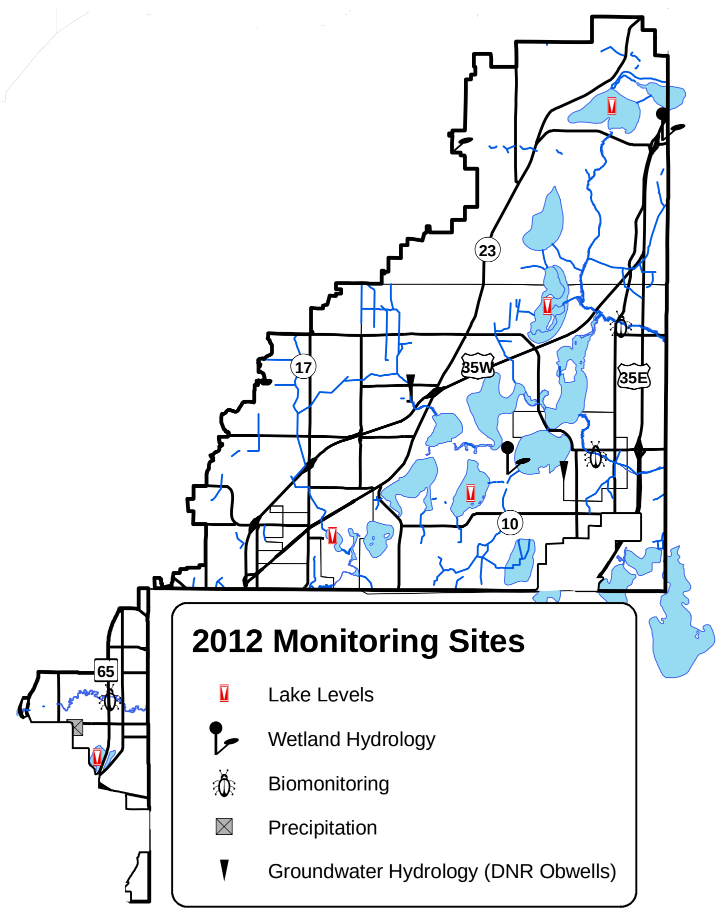
Anoka Conservation District
www.AnokaSWCD.org
763-434-2030

CHAPTER 5: RICE CREEK WATERSHED

Task	Partners	Page
Lake Levels	RCWD, ACD	5-134
Wetland Hydrology	RCWD, ACD	5-136
Stream Water Quality – Biological	RCWD, ACD, ACAP, Centennial HS, Forest Lake Area Learning Center, Totino Grace HS	5-139
Water Quality Grant Administration	RCWD, ACD	5-146
Financial Summary		5-147
Recommendations		5-147
Precipitation	ACD, volunteers	see Chapter 1
Ground Water Hydrology (obwells)	ACD, MNDNR	see Chapter 1
Additional work not reported here	RCWD	contact RCWD

ACD = Anoka Conservation District, RCWD = Rice Creek Watershed District, MNDNR = Minnesota Dept. of Natural Resources, ACAP = Anoka County Ag Preserves





Lake Levels

Description: Weekly water level monitoring in lakes. Graphs for the past five years as well as historical data since 1990 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.

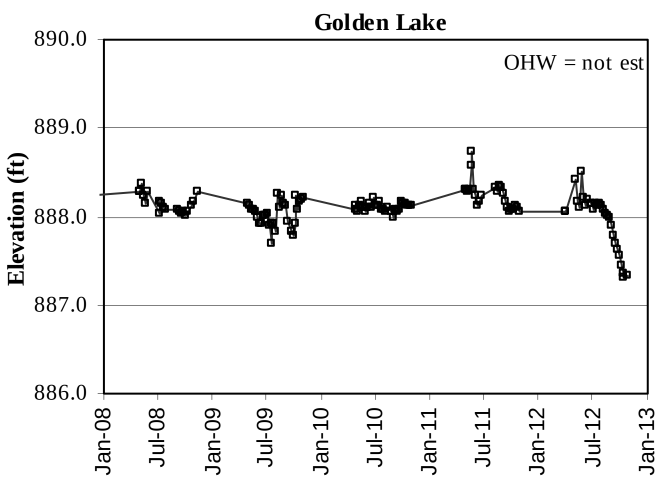
Locations: Golden Lake, Howard Lake, Moore Lake, Reshanau Lake, and Rondeau Lake

Results: Lake levels were measured by volunteers throughout the 2012 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. Lakes had sharply increasing water levels in spring and early summer 2012 when heavy rainfall totals occurred. Little rainfall fell later in the year and lake levels fell dramatically.

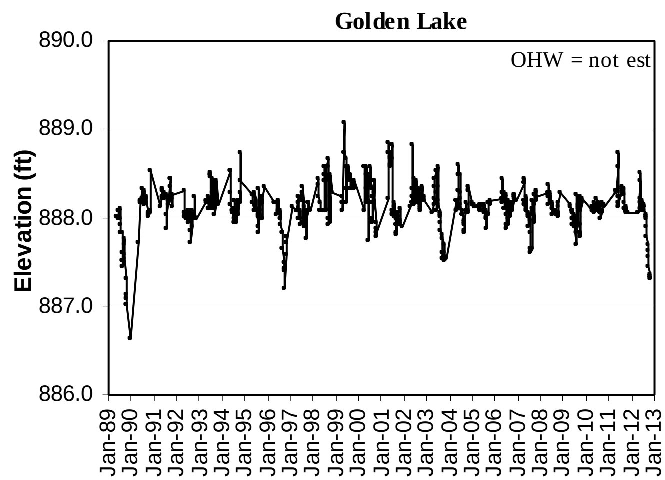
All lakes in the Rice Creek Watershed within Anoka County displayed near record low levels at the end of 2012. Most notably, Rondeau Lake set a new record low water level (884.68) on both October 8th and 15th of 2012. This is following the previous record low water level (884.89) set on November 28th of 2011.

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.

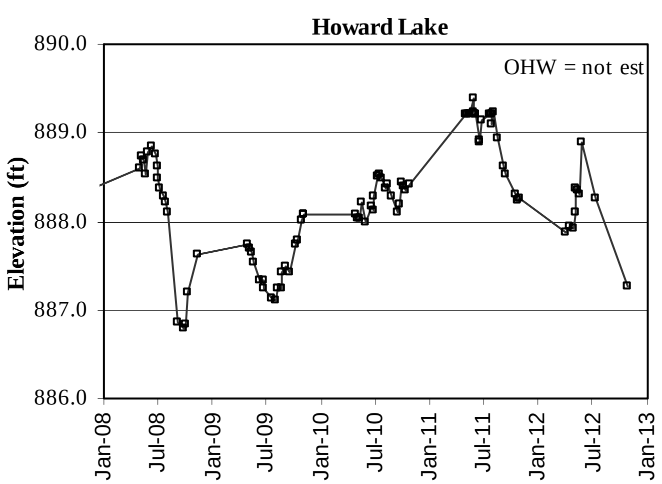
Golden Lake Levels 2008-2012



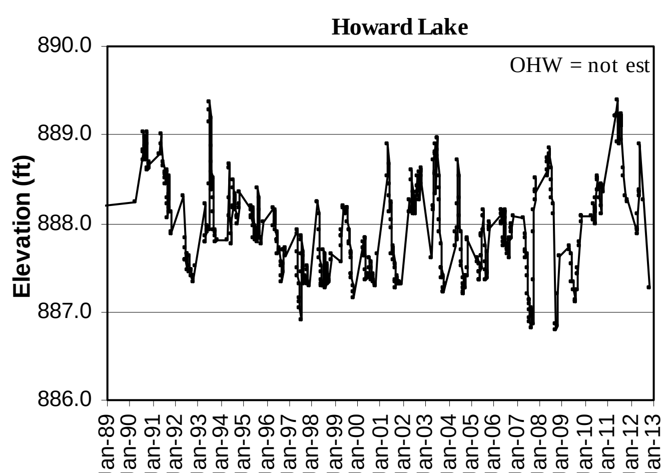
Golden Lake Levels 1990-2012



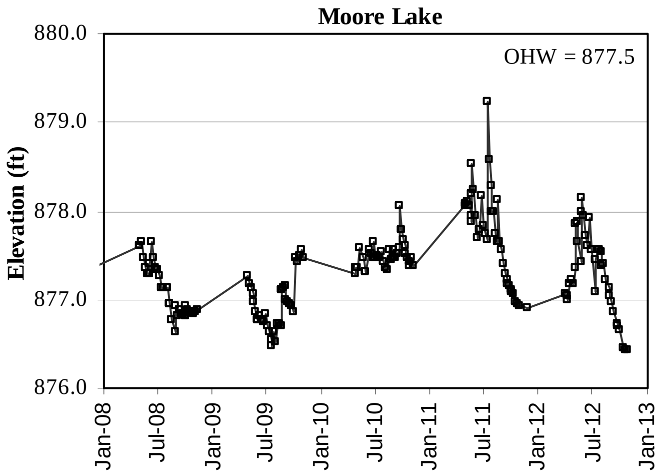
Howard Lake Levels 2008-2012



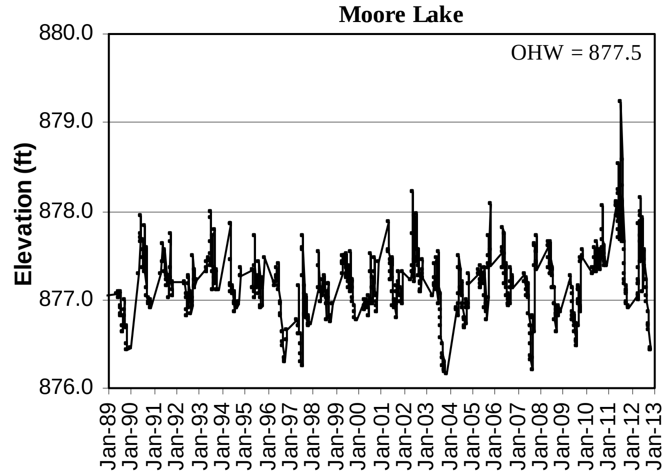
Howard Lake Levels 1990-2012



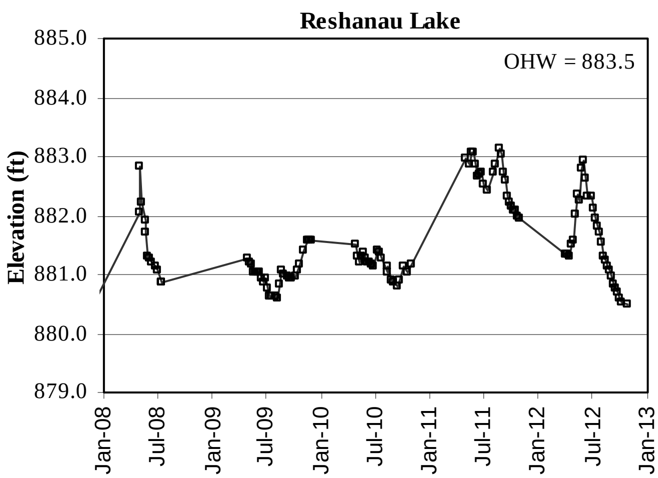
Moore Lake Levels 2008-2012



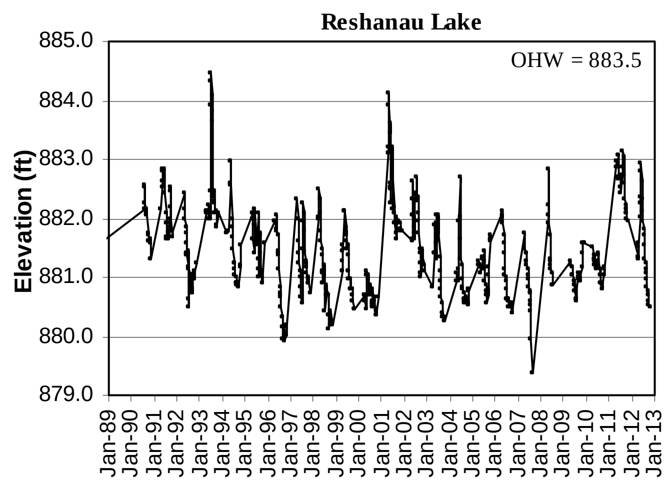
Moore Lake Levels 1990-2012



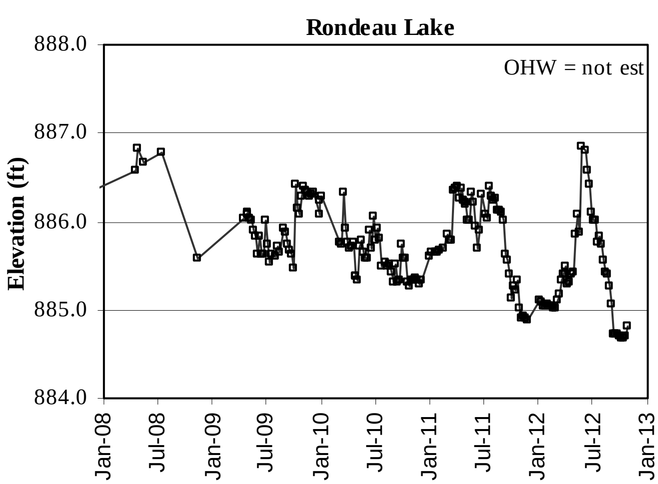
Reshanau Lake Levels 2008-2012



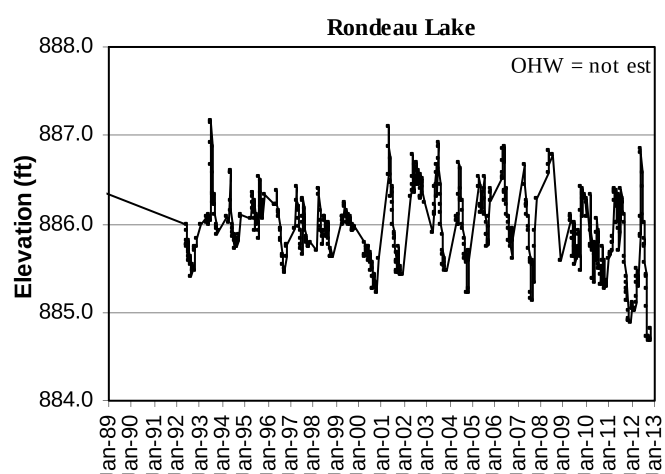
Reshanau Lake Levels 1990-2012



Rondeau Lake Levels 2008-2012



Rondeau Lake Levels 1990-2012



Wetland Hydrology

Description: Continuous groundwater level monitoring at a wetland boundary, to a depth of 40 inches. County-wide, the ACD maintains a network of 18 wetland hydrology monitoring stations.

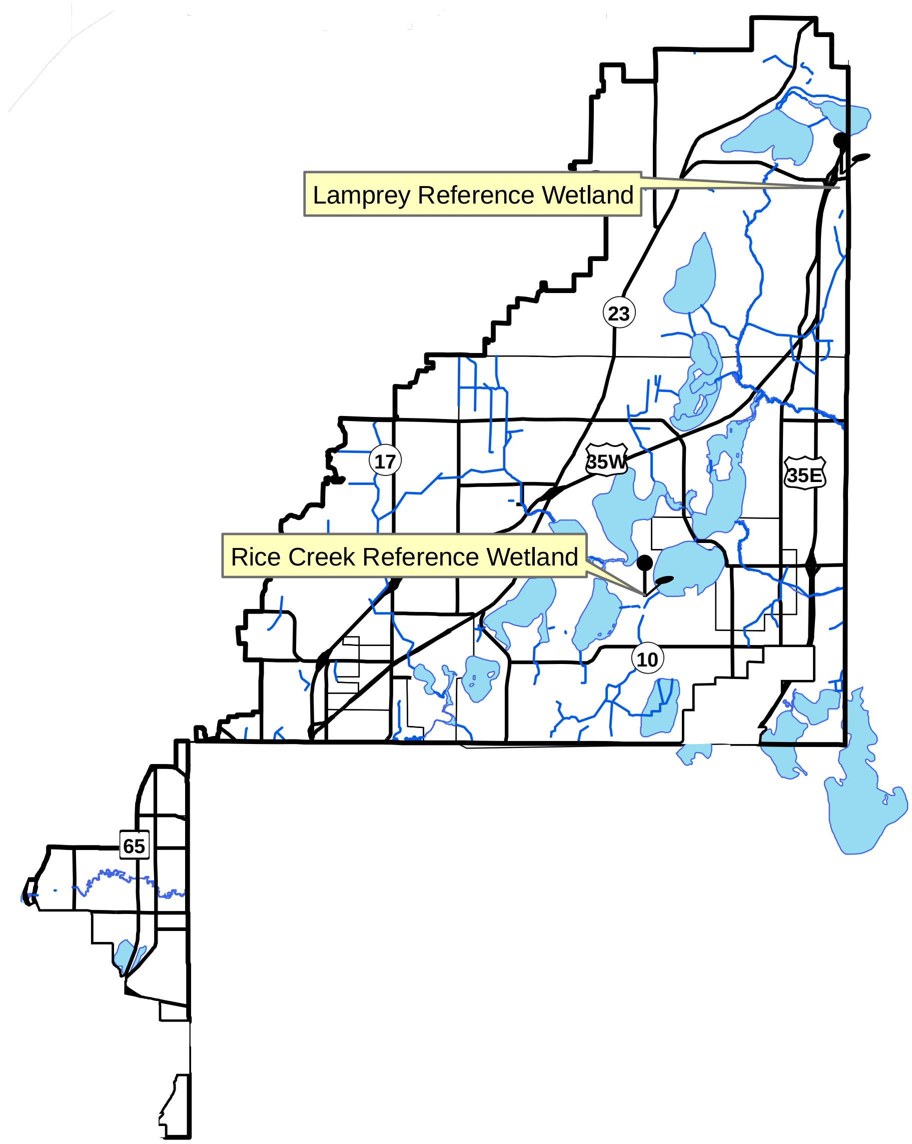
Purpose: To provide an understanding of wetland hydrology, including the impact of climate and land use. These data aid in delineation of nearby wetlands by documenting hydrologic trends including the timing, frequency, and duration of saturation.

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

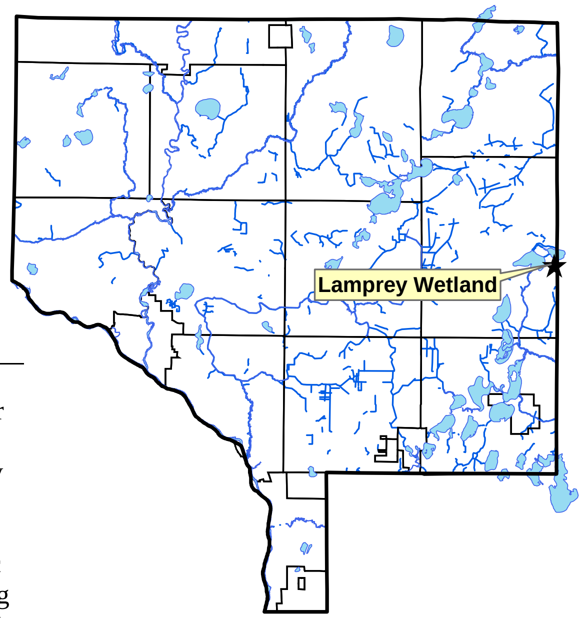


Wetland Hydrology Monitoring

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

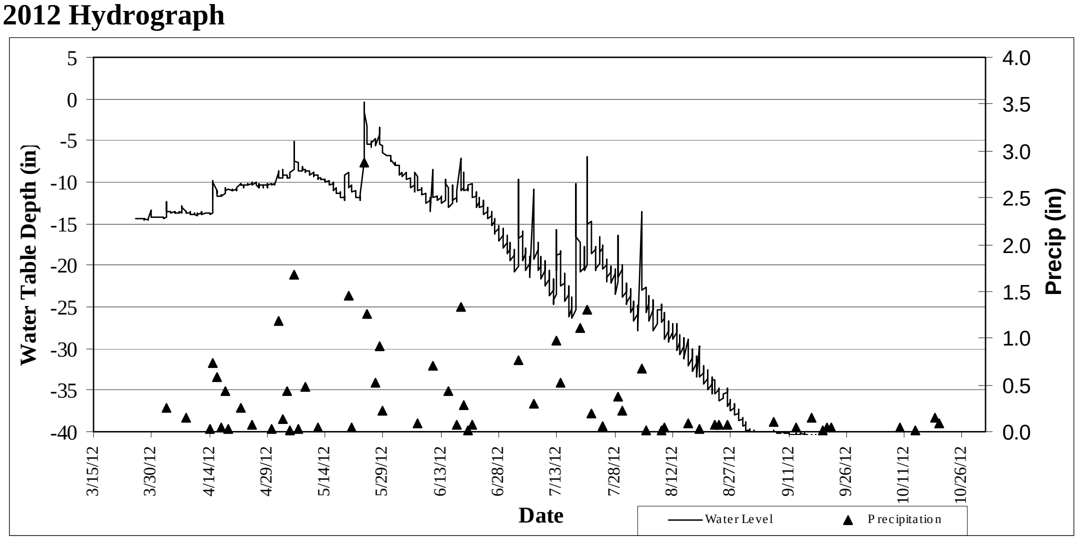
Surrounding Soils: Braham loamy fine sand

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.

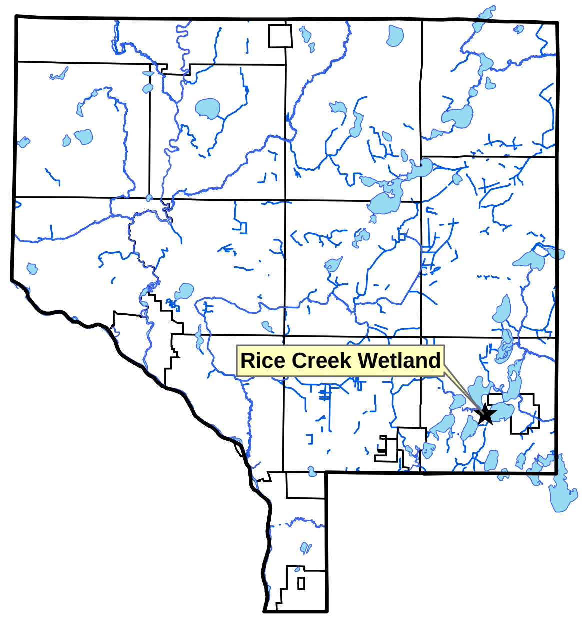
2012 Hydrograph



Well depth was 40 inches, so a reading of –40 indicates water levels were at an unknown depth greater than or equal to 40 inches.

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

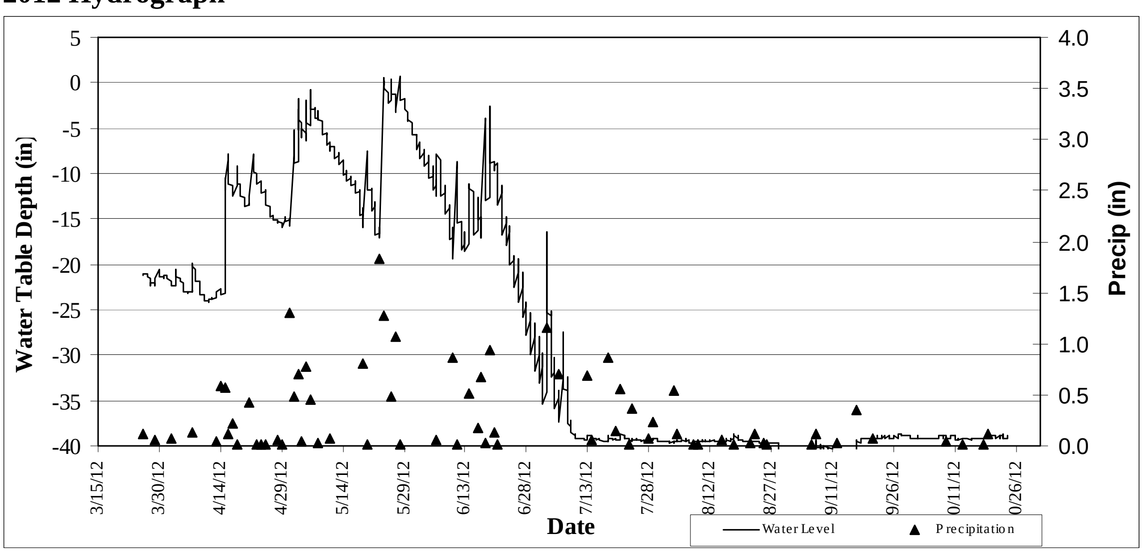
Surrounding Soils: Nessel fine sandy loam and Blomford loamy fine sand

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.

2012 Hydrograph



Well depth was 40 inches, so a reading of –40 indicates water levels were at an unknown depth greater than or equal to 40 inches.

Stream Water Quality – Biological Monitoring

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 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.

Locations: Clearwater Creek at Centerville City Hall, Centerville

Hardwood Creek at several locations, Lino Lakes

Rice Creek at Hwy 65, Fridley

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, as 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.

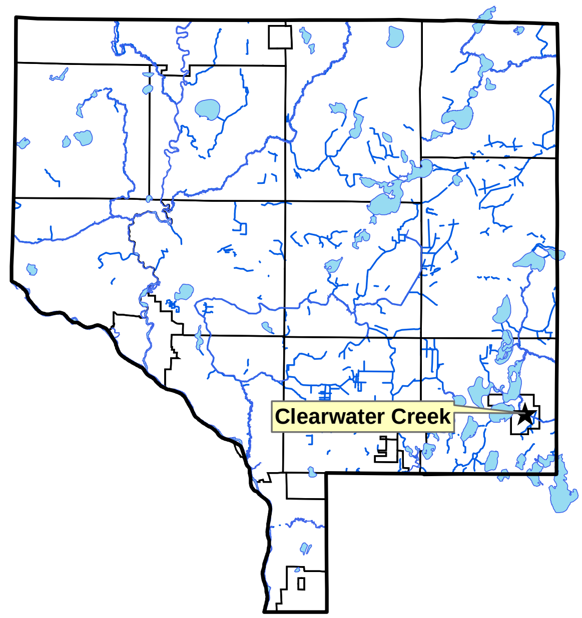
Family Biotic Index (FBI) — An index that utilizes known pollution tolerances for each family. Lower numbers indicate better stream quality.

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

% Dominant Family — High numbers indicate an uneven community, and likely poorer stream health.

CLEARWATER CREEK

at Centerville City Hall, Centerville



Last Monitored

By Centennial High School in the spring of 2012

Monitored Since

1999

Student Involvement

25 students in 2012, approximately 599 since 2001

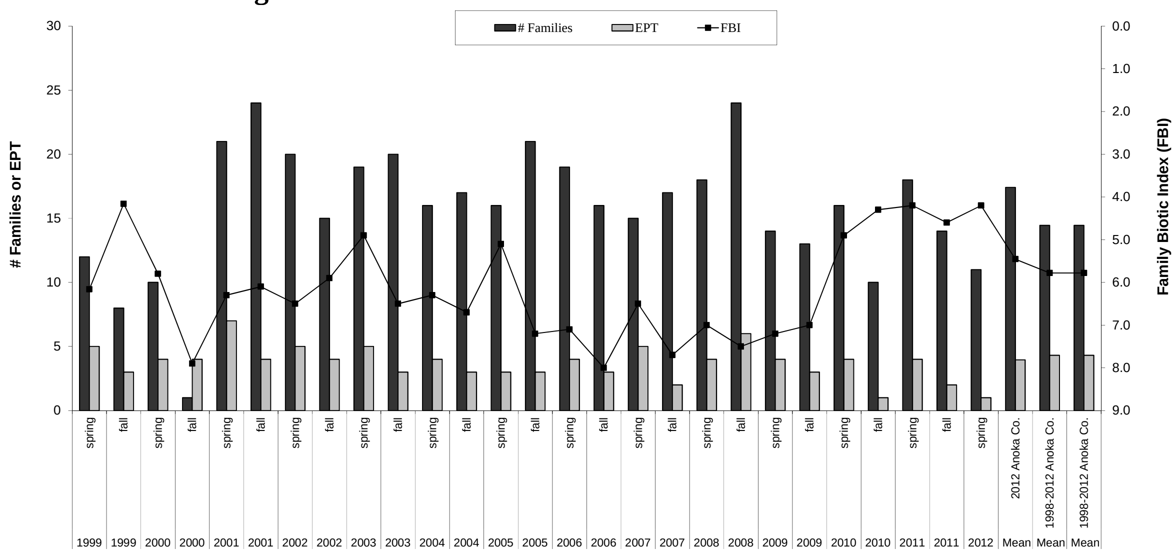
Background

Clearwater Creek originates from Bald Eagle Lake in northwest Ramsey County and flows northwest into Peltier Lake. Land use is an approximately equal mix of residential and vacant/agricultural with some small commercial sites. The land use immediately surrounding the sampling site is entirely residential and developed, however in late summer 2007 a major city reconstruction project began near the stream monitoring site in Centerville, and large areas were graded or disturbed. The stream banks are steep with erosion in spots. The streambed is composed of sand and silt with a few areas of gravel. The stream is 6-12 inches deep at baseflow and approximately 10-15 feet wide.

Results

Centennial High School classes monitored Clearwater Creek in the spring of 2012, with oversight by the Anoka Conservation District (ACD). Overall, this stream has average or slightly below average conditions based upon the invertebrate data, though fluctuations occur. Data from 2010-12 represented an interesting deviation from previous years. A dramatic decrease in the family biotic index (FBI) occurred. The lower FBI value suggests an increase in pollution intolerant species. However, this change was likely driven by the dominance of the invertebrate community by Gammaridae, which has a moderate tolerance value of four. Gammaridae comprised 78%, 90%, 94%, 80%, and 88% of the invertebrate community in the spring of 2010 through the spring of 2012 samplings, respectively. Comparison of total number of families and EPT from 2012 with previous years suggests a slight decrease in overall stream health.

Summarized Biomonitoring Results for Clearwater Creek in Centerville



Biomonitoring Data for Clearwater Creek in Centerville

Data presented from the most recent five years. Contact the ACD to request archived data.

Year	2008	2008	2009	2009	2010	2010	2011	2011	2012	Mean	Mean
Season	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	spring	2011 Anoka Co.	1998-2011 Anoka Co.
FBI	7.00	7.50	7.20	7.00	4.9	4.3	4.2	4.6	4.2	5.5	5.8
# Families	18	24	14	13	16	10	18	14	11	17.4	14.5
EPT	4	6	4	3	4	1	4	2	1	4.0	4.3
Date	8-May	1-Oct	20-May	9-Oct	14-May	6-Oct	31-May, 6-Jun	12-Oct	17-May		
Sampled By	CHS	CHS	CHS	CHS	CHS	CHS	CHS & ACD	CHS	CHS		
Sampling Method	MH	MH	MH	MH	MH	MH	MH	MH	MH		
Mean # Individuals/Rep.	180	450	238	386	664	532	2003	146	273		
# Replicates	1	1	1	1	1	1	2	1	1		
Dominant Family	Simuliidae	Corixidae	Hyalellidae	Corixidae	Gammaridae	Gammaridae	Gammaridae	Gammaridae	Gammaridae		
% Dominant Family	27.8	42.3	26.1	53.9	77.7	89.7	93.5	80.1	87.9		
% Ephemeroptera	10.6	4.7	28.2	8.5	1.8	0.6	0.6	0.7	2.2		
% Trichoptera	2.2	0.7	0.8	2.8	0.6	0.0	0.1	0.7	0.0		
% Plecoptera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Supplemental Stream Chemistry Readings

Data presented from the most recent five years. Contact the ACD to request archived data.

Parameter	5/5/2008	10/1/2008	5/20/2009	10/9/2009	5/14/2010	10/6/2010	5/31/2011	6/6/2011	10/6/2011	5/17/2012
pH	8	7.65	7.56	7.27	7.23	7.29	7.66	7.88	7.74	7.78
Conductivity (mS/cm)	0.452	0.607	0.699	0.558	0.788	0.701	0.551	0.560	0.551	0.491
Turbidity (NTU)	10	13	4	8	10	21	0	6	16	8
Dissolved Oxygen (mg/L)	11.84	8.74	4.85	9.25	10.31	na	6.32	7.98	1.42	7.58
Salinity (%)	0.01	0.02	0.02	0.02	0.03	0.04		0.02	0.02	0.02
Temperature (°C)	14.3	9.5	16.9	7.6	10.0	12.2	18.6	22.9	17.3	16.7

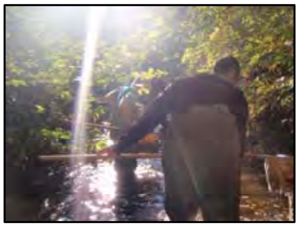
Discussion

This creek's biological community is probably limited by a combination of habitat, hydrology, and water chemistry factors. The portion of the creek that is monitored has been ditched, and is straight with steep banks, no pools or riffles, and homogeneous bottom composition. There is a strip of forested land approximately 20-50 feet wide on each side of the stream, but other areas upstream and downstream have less adjacent natural habitat. Flows are generally slow and water levels are low during much of the year, such that the stream sides are seldom submerged to provide habitat. When higher water does occur, it is usually during large storms, and the urbanized subwatershed results in a flashy hydrograph.

Supplemental water chemistry measurements have highlighted occasions when one or more water quality parameters are substandard, but not necessarily during storms when runoff to the creek would be greatest. For example, a highly turbid condition was noted in October 2004 during a baseflow period when the water was barely moving. Likewise, high conductivity values in 2006-2011 were during low water levels. On October 6, 2011 we found dissolved oxygen of just 1.42 mg/L, much lower than required by most aquatic life. The water chemistry data collected in 2012 did not display any outliers relative to previous years.

Overall, this creek seems to provide adequate habitat and water quality for pollution-tolerant invertebrates, but more sensitive varieties are unable to survive. Particularly in the last three years, species evenness has been low. Captures were dominated by gammaridae, a moderately pollutation-tolerant scud. They accounted for 78%, 90%, 94%, 80%, and 88% of the invertebrate community in the spring 2010 through the fall of 2012 samplings, respectively. While 9-17 other families were also found, there were in low abundance, even those that are generalists. Collectively, these data indicate a very limited invertebrate community is able to thrive in Clearwater Creek.

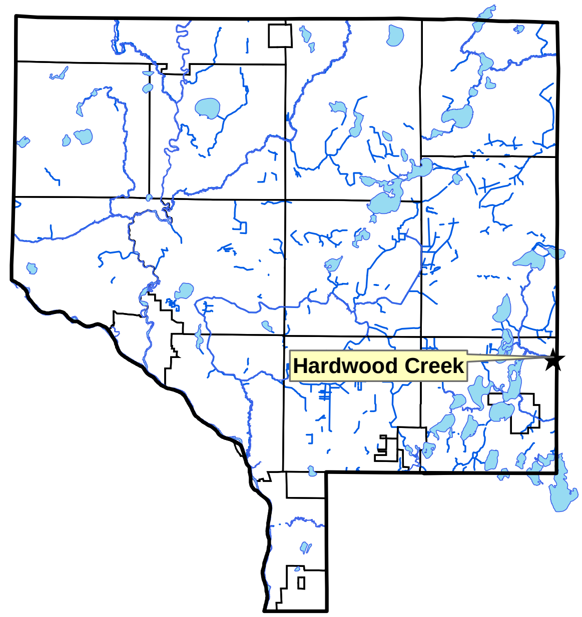
Centennial High School students at Clearwater Creek.



Biomonitoring

HARDWOOD CREEK

see list of monitoring locations below



Last Monitored

By Forest Lake Area Learning Center in fall of 2012

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
2009-12 at Cecelia LaRoux property 600 m W of I-35

Student Involvement

20 students in 2012, approximately 228 since 2001

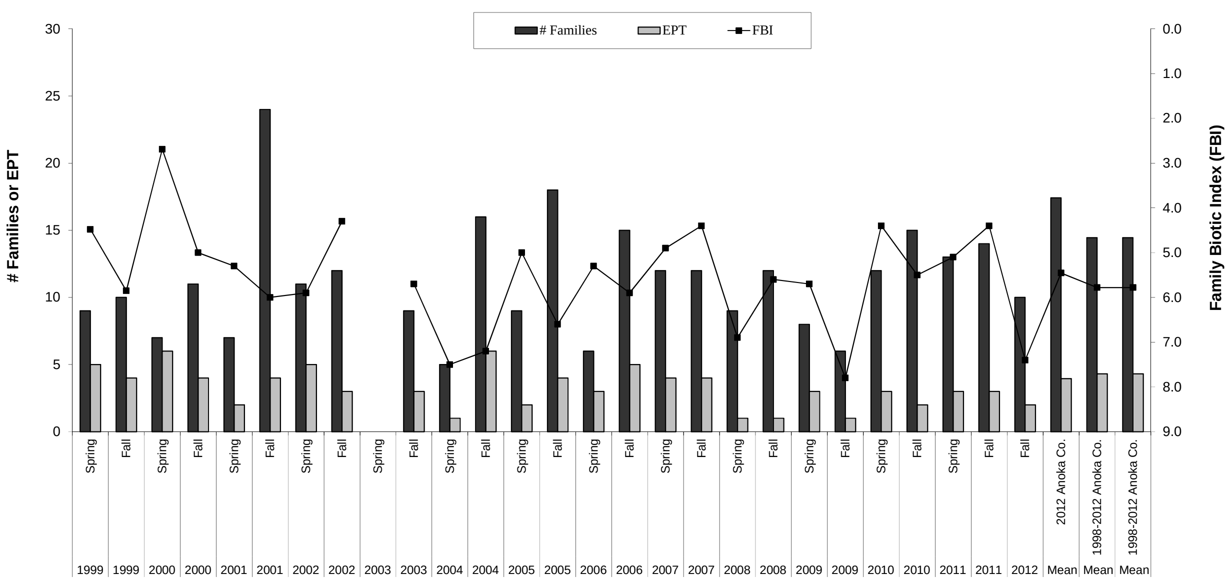
Background

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 2009-12 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 2012, 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. The previous improvement in stream health documented in 2010-11 showed a subtle decrease in number of families and EPT in 2012. A more dramatic decrease in the FBI was observed in 2012. The decreases likely reflect normal variation, but future monitoring will provide additional data to support this hypothesis. Examining biological data from all years and sites indicates poorer than average stream health before 2010, and near average after 2010.

Summarized Biomonitoring Results for Hardwood Creek in Lino Lakes



Biomonitoring Data for Hardwood Creek in Lino Lakes

Data presented from the most recent five years. Contact the ACD to request archived data.

Year	2008	2008	2009	2009	2010	2010	2011	2011	2012	Mean	Mean
Season	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Fall	2012 Anoka Co.	1998-2012 Anoka Co.
FBI	6.90	5.60	5.70	7.80	4.40	5.50	5.1	4.4	7.4	5.5	5.8
# Families	9	12	8	6	12	15	13	14	10	17.4	14.5
EPT	1	1	3	1	3	2	3	3	2	4.0	4.3
Date	15-May	8-Oct	19-May	8-Oct	5-May	14-Oct	11-May	5-Oct	11-Oct		
Sampled By	FLALC	FLALC	FLALC	FLALC	FLALC	FLALC	FLALC	FLALC	FLALC		
Sampling Method	MH	MH	MH	MH	MH	MH	MH	MH	MH		
Mean # Individuals/Rep.	440	159	400	391	290	110	237	190	83		
# Replicates	1	1	1	1	1	1	1	1	1		
Dominant Family	Simuliidae	Dystidae	Simuliidae	Corixidae	Baetidae	Gammaridae	Gammaridae	Gammaridae	Hyalellidae		
% Dominant Family	49.1	57.2	67.3	74.7	68.6	51.8	50.2	62.6	73		
% Ephemeroptera	0	0.6	19.5	0.3	69	9.1	2.5	16.3	12		
% Trichoptera	0.2	0	0.8	0	1.4	0	0.4	1.1	0		
% Plecoptera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Supplemental Stream Chemistry Readings

Data presented from the most recent five years. Contact the ACD to request archived data.

	Fenway Ave Site		C. LaRoux Property						
Parameter	5/15/2008	10/8/2008	5/19/2009	10/8/2009	5/5/2010	10/14/2010	5/11/2011	10/5/2011	10/11/2012
pH	7.13	7.46	8.1	7.43	na	7.57	7.76	7.97	8.04
Conductivity (mS/cm)	0.361	0.431	0.426	0.37	0.457	0.509	0.411	0.314	0.405
Turbidity (NTU)	13	11	6	22	7	6	13	4	na
Dissolved Oxygen (mg/L)	10.88	7.14	12.3	11.5	11.6	na	9.67	7.01	5.27
Salinity (%)	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01
Temperature (°C)	12.4	12.4	16.5	9.7	10.4	9.8	17.3	14.5	7.6

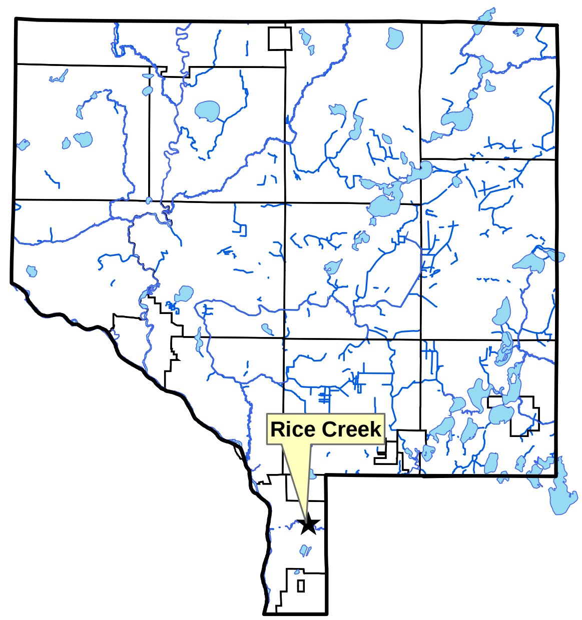
Discussion

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 or near 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. Invertebrate indices seemed to decline when monitoring was moved from the north side of Highway 140, where habitat was moderate to good, to Fenway Avenue where little in-stream habitat exists. Monitoring data from the C. La Roux property displayed a substantial increase in stream health during 2010 and 2011, while an overall decrease was observed in 2012. Continued monitoring efforts will elucidate whether natural variation or a trend toward decreased stream health is the cause of the change.

Forest Lake Area Learning Center students at Hardwood Creek in 2012

RICE CREEK

at Hwy 65, Locke Park, Fridley



Last Monitored

By Totino Grace High School in fall 2012

Monitored Since

1999

Student Involvement

80 students in 2012, approximately 840 since 2001

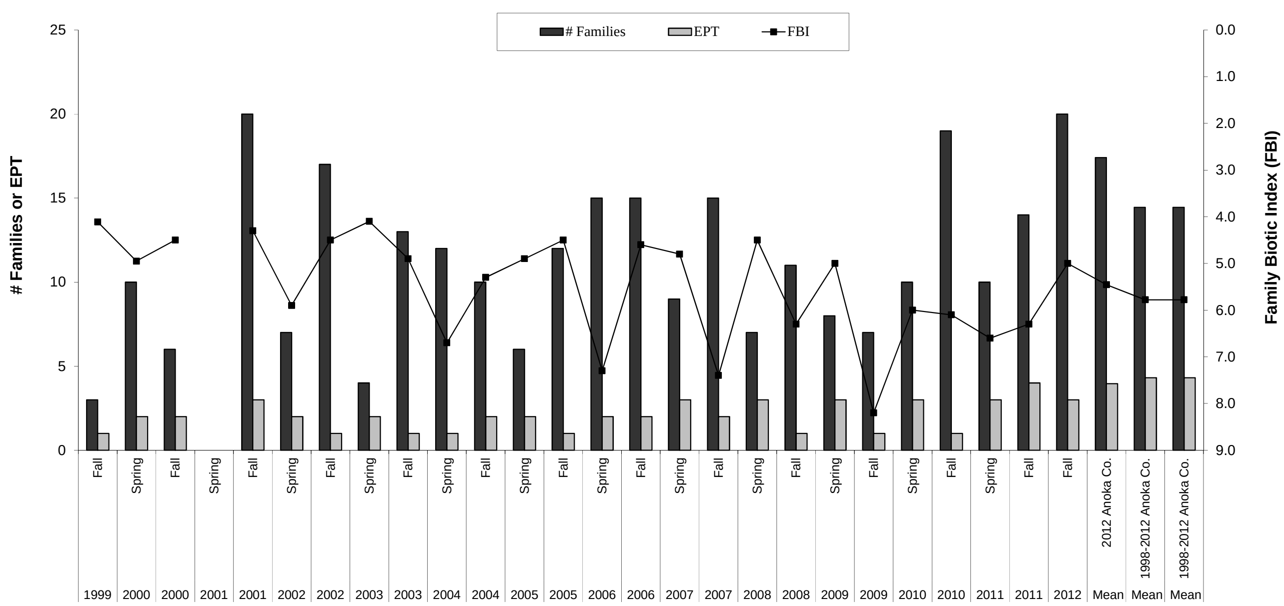
Background

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 wooded. Outside of this buffer, though, the watershed is highly 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 2012, facilitated by the Anoka Conservation District (ACD). At this site, Rice Creek has an impaired macroinvertebrate community. While the number of families present has been similar to the average for Anoka County streams on several occasions (fall 2010, 2011, and 2012 most recently), most of these are generalist species that can tolerate polluted conditions. The number of EPT families present has been below the county average in all years. EPT are generally pollution-sensitive, but the EPT family most often found in Rice Creek, the caddisfly hydropsychidae, is an exception to that rule. Hydropsychidae has been the most abundant family in 12 of 25 creek samplings, often >50% of catches. The Family Biotic Index (FBI) for this site is usually below the mean of Anoka County streams, but it showed an increase in 2012 to near the county average.

Summarized Biomonitoring Results for Rice Creek at Hwy 65, Fridley



Biomonitoring Data for Rice Creek at Hwy 65, Fridley

Data presented from the most recent five years. Contact the ACD to request archived data.

Year	2008	2008	2009	2009	2010	2010	2011	2011	2012	Mean	Mean
Season	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Fall	2012 Anoka Co.	1998-2012 Anoka Co.
FBI	4.5	6.3	5.0	8.2	6	6.1	6.6	6.3	5	5.5	5.8
# Families	7	11	8	7	10	19	10	14	20	17.4	14.5
EPT	3	1	3	1	3	1	3	4	3	4.0	4.3
Date	23-May	10-Oct	11-May	8-Oct	14-May	13-Oct	31-May	7-Oct	5-Oct		
Sampled By	ACD	TGHS	ACD	TGHS	ACD	TGHS	ACD	TGHS	TGHS		
Sampling Method	MH	MH	MH	MH	MH	MH	MH	MH	MH		
# Individuals	180	104	148	111	154	132	126	215	248		
# Replicates	1	1	1	1	1	1	1	1	2		
Dominant Family	Baetidae	Hydropsychidae	Baetidae	Corixidae	Chironomidae	Hydropsychidae	Chronomidae	Simulidae	Philopotamidae		
% Dominant Family	70.0	40.0	50.0	74.8	29.2	31.1	39.7	23.3	38.0		
% Ephemeroptera	74.4	0.0	50.7	0.0	23.4	0.0	15.9	12.1	10.9		
% Trichoptera	7.2	42.3	6.8	9.0	3.2	31.1	0.8	14.0	43.1		
% Plecoptera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Supplemental Stream Chemistry Readings

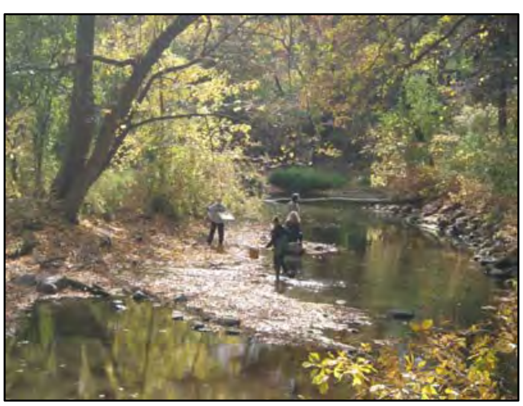
Data presented from the most recent five years. Contact the ACD to request archived data.

Parameter	5/23/2008	10/10/2008	5/11/2009	10/8/2009	5/14/2010	10/13/2010	5/31/2011	10/7/2011	10/5/2012
pH	8.12	7.73	8.23	4.76	7.85	7.92	7.62	8.02	8.17
Conductivity (mS/cm)	0.461	0.639	0.624	0.638	0.545	0.535	0.504	0.364	0.460
Turbidity (NTU)	15	13	16	18	13	15	0	6	na
Dissolved Oxygen (mg/L)	9.56	9.01	12.29	10.74	12.64	na	7.94	7.34	7.82
Salinity (%)	0.01	0.02	0.02	0.02	0.02	0.02	na	0.01	0.01
Temperature (°C)	19	12.9	14.5	11.2	12.8	16.5	19.6	17.1	9.6

Discussion

The poor macroinvertebrate community in this creek is likely due to poor water quality, 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.

Totino Grace High School students at Rice Creek in 2012.



Water Quality Grant Administration

Description: ACD worked with RCWD to develop and coordinate the implementation of a cost-share grant program for private landowners. Tasks included landowner outreach and education, site reviews, project evaluations, BMP design, contractor assistance, construction oversight, long-term project monitoring and other services as needed to ensure a smooth-running program.

Purpose: To assist property owners with the implementation of BMPs that improve water quality within the District.

Results: In 2012 ACD provided technical/design assistance valued at $17,097 and was reimbursed $11,000 through the Rice Creek Watershed District. Nineteen landowners were contacted through the program, and efforts resulted in seven completed designs and installation of four projects. Additional projects are likely to be installed in 2013.

Project Management Details. The entries in this table provide details on ACD's efforts toward the RCWD BMP cost share program summarized in the project management column of the financial summary table at the end of this chapter.

Description	Hours	Rate	Value
Services			
Admin Hours (Specialist)	39	$73	$2,847
TA Hours (Specialist)	102	$73	$7,446
TA Hours (Technician)	24	$65	$1,560
Design Hours (Specialist)	38	$73	$2,774
Design Hours (Technician)	38	$65	$2,470
Total Value of Services			**$17,097**
Revenue			
Rice Creek BMP Cost Share Service Agreement			($10,000)
Rice Lake RG Repair Service Agreement			($1,000)
Total Value of Unpaid Services			**$6,097**

Example project – The photo on the left shows a lakeshore restoration on Reshanau Lake in Lino Lakes. ACD provided technical/design assistance and construction oversight. The project received cost share funds through the RCWD cost share program. More details on projects installed in RCWD are included in a separate report produced by the Anoka Conservation District.

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.

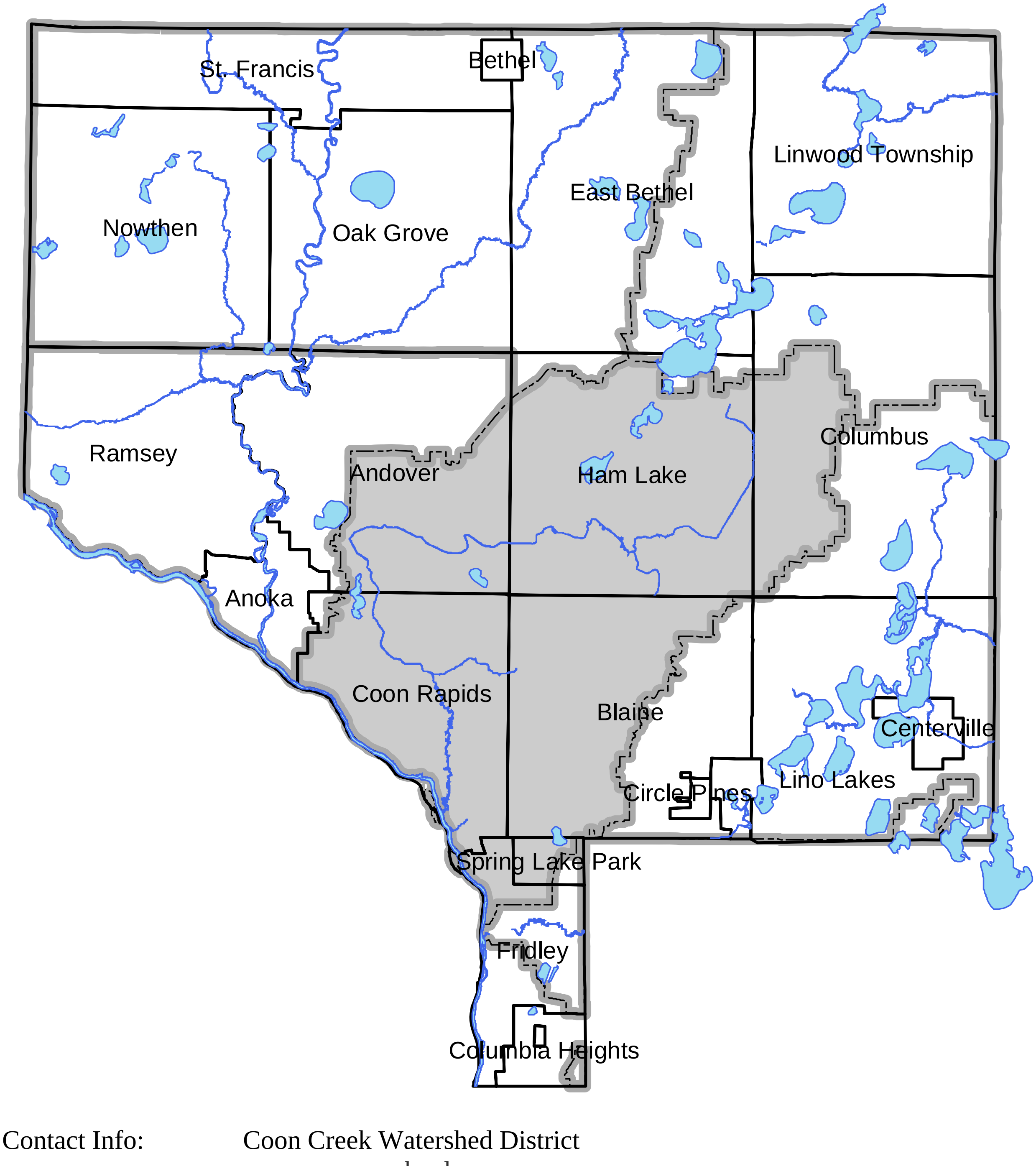
Rice Creek Watershed Financial Summary

Rice Creek Watershed	Ref Wet	Lake Lvl	Student Biomon	Golden Lk Retro Assess	Rice Lake Retrofit Install	RCWD Cost Share Admin	Moore Lake SRA	Total
Revenues								
RCWD	1100	850	2385	0	0	11000	0	15335
State	0	0	0	0	0	0	0	0
Anoka Conservation District	0	0	0	1225	1767	6097	2065	11154
County Ag Preserves	0	0	435	0	0	0	0	435
Regional/Local	0	0	0	0	0	0	0	0
Other Service Fees	0	0	0	0	0	0	0	0
Local Water Planning	0	105	0	0	0	0	0	105
TOTAL	1100	955	2820	1225	1767	17097	2065	27029
Expenses-								
Capital Outlay/Equip	8	9	33	5	25		39	118
Personnel Salaries/Benefits	737	819	2236	1010	1494	17097	1775	25169
Overhead	59	65	180	111	156		154	725
Employee Training	2	2	3	8	1		1	17
Vehicle/Mileage	16	17	47	12	30		30	153
Rent	33	38	90	78	61		66	366
Program Participants	0	0	0	0	0		0	0
Program Supplies	5	4	231	0	0		0	241
McKay Expenses	0	0	0	0	0		0	0
TOTAL	860	955	2820	1225	1767	17097	2065	26789
NET	240	0	0	0	0	0	0	240

Recommendations

- **Install and maintain water quality improvement projects identified through the Moore, Rice, and Golden Lake Subwatershed Retrofit Analyses.**
- **Pursue projects that address water quality problems identified in the TMDLs for Peltier and Centerville Lakes, and Lino Lakes Chain.**
- **Continue 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 IBI's. Hardwood Creek is impaired based on invertebrate data and low dissolved oxygen. In Anoka County Rice Creek does not have this designation, but reaches just upstream are impaired based on invertebrate and fish IBIs. The Anoka County invertebrate data for Rice Creek indicate a depleted invertebrate community.
- **Expand the network of reference wetlands** to include altered and ditched sites. These will aid in accurate wetland regulatory determinations.
- **Reduce road salt use.** Elevated chlorides are pervasive throughout shallow aquifers and the streams that feed them.

Coon Creek Watershed



Contact Info: Coon Creek Watershed District
www.cooncreekwd.org
763-755-0975

Anoka Conservation District
www.AnokaSWCD.org
763-434-2030

CHAPTER 6:
COON CREEK WATERSHED

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Stream Hydrology and Rating Curves	CCWD, ACD	6-163
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Stormwater Retrofit Analysis - Lower Coon Creek	CCWD, ACD	6-300
Stormwater Retrofit Analysis – Oak Glen Creek	CCWD, ACD	6-301
Sand Creek Rain Garden Promotion and Design	CCWD, ACD	6-302
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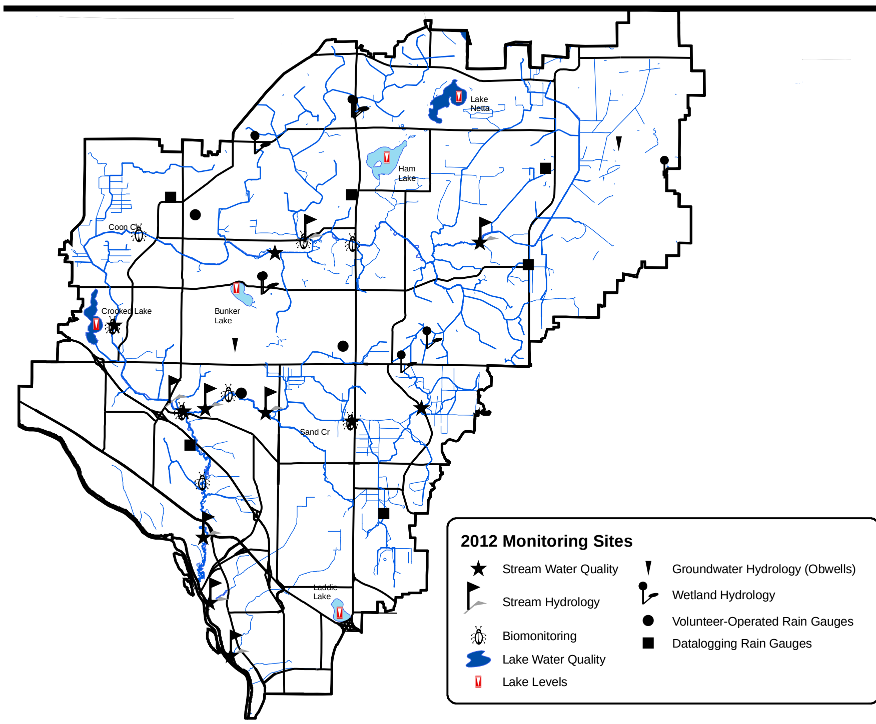
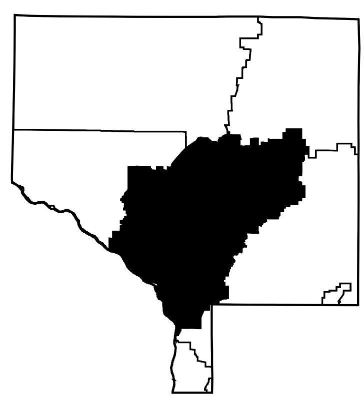
Groundwater Hydrology (obwells)	ACD, MNDNR	see Chapter 1

ACAP = Anoka County Ag Preserves, ACD = Anoka Conservation District,
CCWD = Coon Creek Watershed District, MNDNR = MN Dept. of Natural Resources





Precipitation

Description: Continuous monitoring of precipitation with both data-logging rain gauges and non-logging rain gauges that are read daily by volunteers. 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.

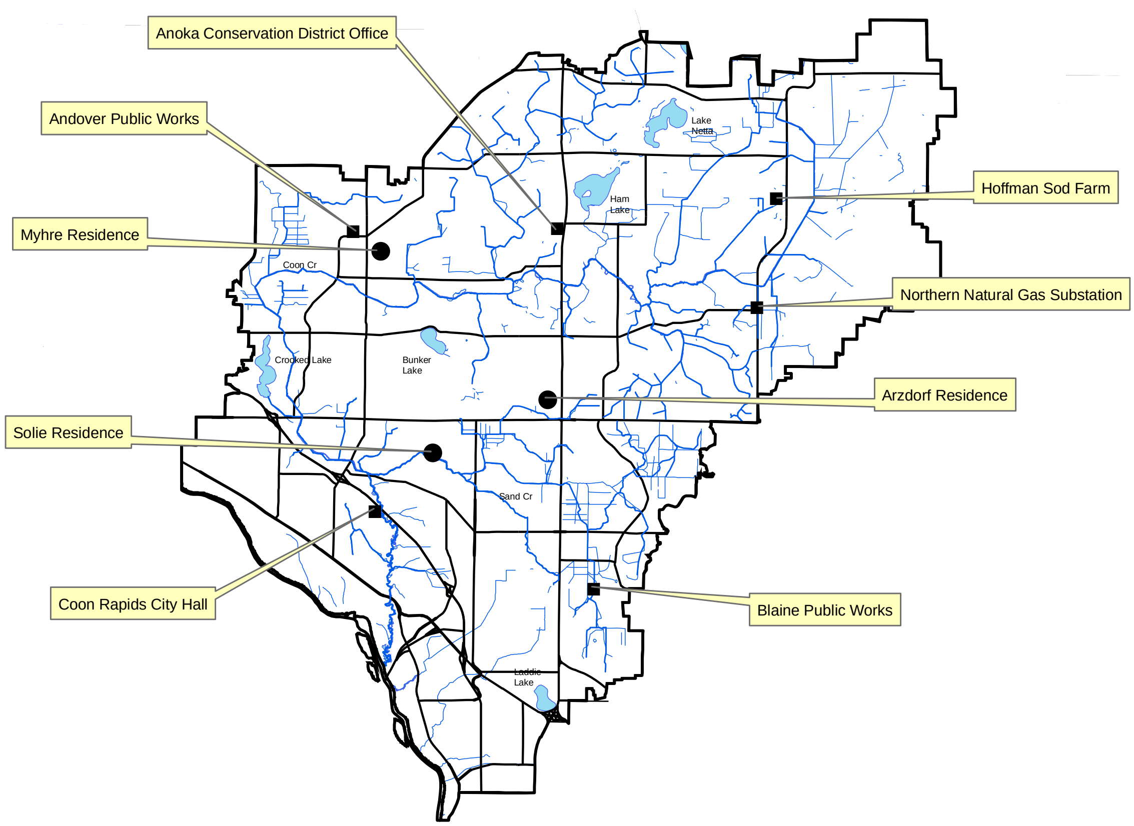
Locations:

Type	Site	City
Data Logging	Andover City Hall	Andover
Data Logging	Anoka Conservation District Office	Ham Lake
Data Logging	Blaine Public Works	Blaine
Data Logging	Coon Rapids City Hall	Coon Rapids
Data Logging	Hoffman Sod Farm	Ham Lake
Data Logging	Northern Natural Gas Substation	Ham Lake
Cylinder - Volunteer	Arzdorf residence	Blaine
Cylinder – Volunteer	Myhre residence	Andover
Cylinder – Volunteer	Solie residence	Coon Rapids

Note: Additional county-wide precipitation summaries can be found in Chapter 1.

Results: Precipitation data were reported to the Coon Creek Watershed in digital format. A summary table and graph are presented on the following page.

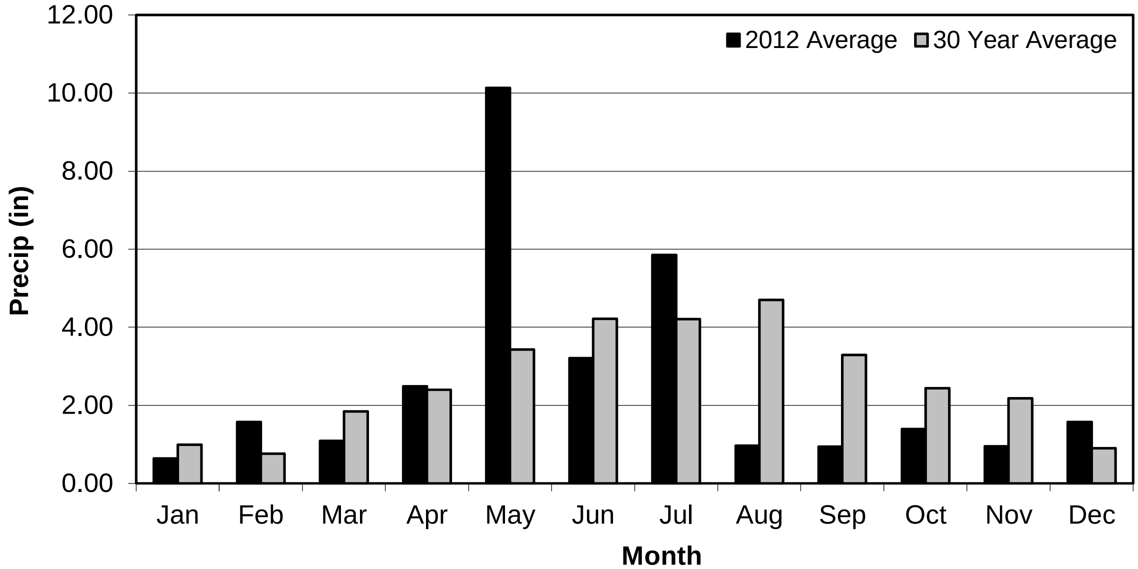
Coon Creek Watershed 2012 Precipitation Monitoring Sites



Coon Creek Watershed 2012 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)
						Month									
Tipping bucket, datalogging rain gauges (Time and date of each 0.01" is recorded)															
Andover City Hall	Andover			0.95	2.53	8.44	4.08	6.50		3.27	0.85				22.29
Blaine Public Works	Blaine			0.84	2.28	9.37	3.41	4.87	0.95	0.58	1.17	1.05			19.18
Coon Rapids City Hall	Coon Rapids			1.28	2.48	11.20	3.52	6.17	1.28	0.61	1.39	0.98			22.78
Anoka Cons. District office	Ham Lake				2.66	10.65	3.00	6.36	0.76	0.29	1.38	1.03			21.06
Hoffman Sod Farm	Ham Lake				2.49	10.01	3.05			1.19	1.23	1.08			14.25
Northern Nat. Gas substation	Ham Lake			0.86	2.34	10.16	2.40			0.47	1.28	0.70			13.03
Cylinder rain gauges (read daily)															
N. Myhre	Andover	0.64	1.57	1.52	2.24	10.68	3.26	5.57	0.77	0.53	2.40	0.89	1.57	31.64	20.81
J. Arzdorf	Blaine				2.60	10.24	2.94	5.63	1.06	0.58	1.44				20.45
S. Solie	Coon Rapids				2.78	10.43									10.43
2012 Average	County-wide	0.64	1.57	1.09	2.49	10.13	3.21	5.85	0.96	0.94	1.39	0.96	1.57	30.80	21.09
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



Precipitation Analyses

Description: Two different precipitation analyses were done – 1) 2012 storm analyses and 2) long term precipitation trend analysis.

1.) **2012 Storm Analyses:** Precipitation events at each of the six Coon Creek Watershed District data-logging rain gauges were analyzed. Total precipitation, storm duration, intensity, and recurrence interval were determined for all precipitation events of >0.03 inches. Storms with a recurrence that was two months or longer were analyzed further. The storm's intensity was tracked throughout the storm and graphed (similar to storm typing, but a type was not assigned). The rate of effective precipitation was determined from the rainfall intensity and surrounding soil type. Effective precipitation was defined as precipitation occurring at an intensity that is lower than the soil infiltration rate (i.e. rain that soaks in and doesn't run off).

   The results of this analysis were delivered to the Coon Creek Watershed District in digital form and are not reported here due to complexity and lengthiness.

2.) **Long Term Precipitation Trends Analysis:** Monthly rainfall deviations from normal were graphed for 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.

Locations:

Site	City
Andover City Hall	Andover
Anoka Conservation District Office	Ham Lake
Blaine Public Works	Blaine
Coon Rapids City Hall	Coon Rapids
Hoffman Sod Farm	Ham Lake
Northern Natural Gas Substation	Ham Lake

Results:

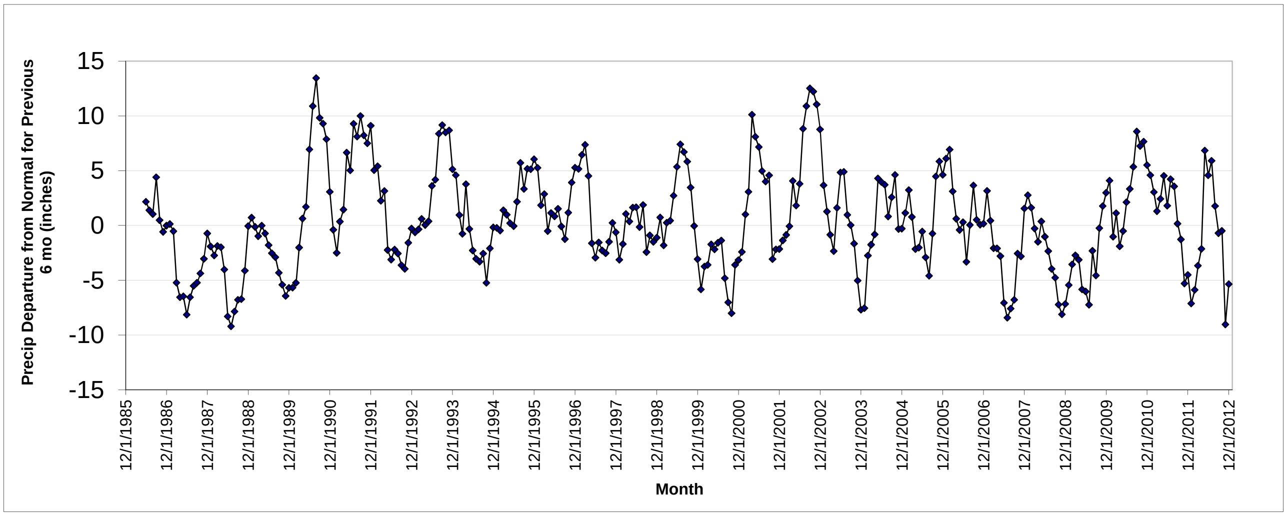
1.) **2012 Storm Analyses:** The results of these analyses were delivered to the Coon Creek Watershed District in digital form and are not reported here due to complexity and lengthiness.

2.) **Long Term Precipitation Trends Analysis:** Results are presented on the following page.

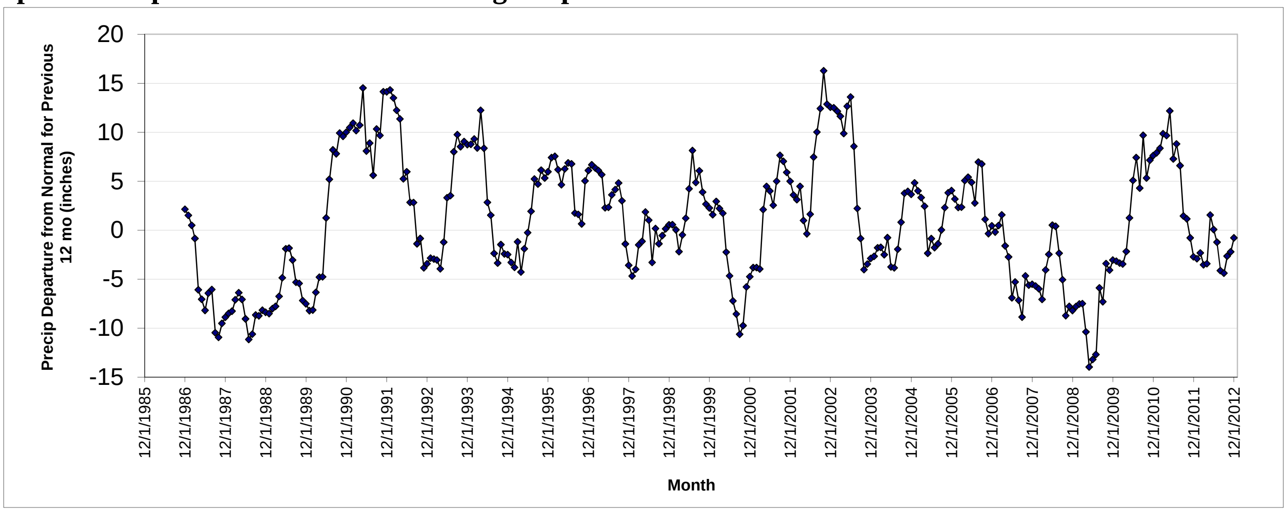
Long Term Precipitation Trends

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.

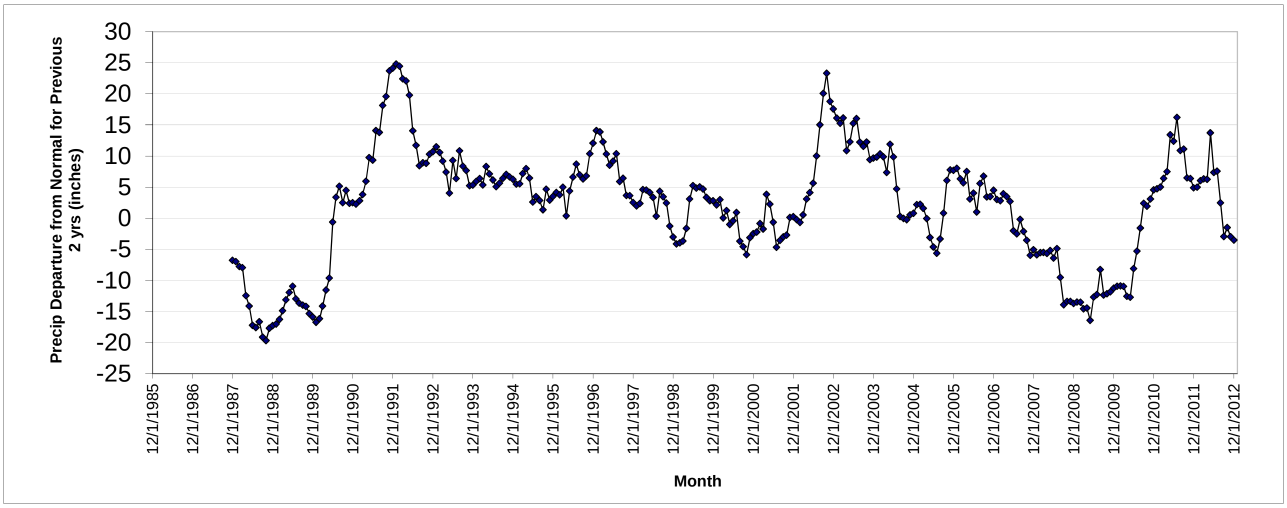
Precipitation departure from normal during the previous 6 months



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 historic 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

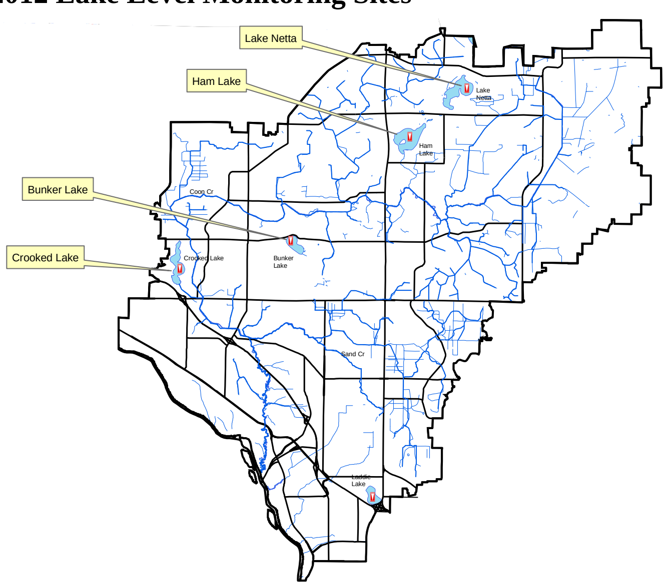
Results: Lake levels were measured by volunteers 35 times at Crooked Lake, 67 times at Ham Lake, and 30 times at Lake Netta. The level in Bunker Lake was monitored using an electronic gauge, which resulted in 173 days of measurements generated by averaging six readings from each day.

Coon Creek Watershed lake levels during 2012 generally exhibited a trend similar to that observed in 2011. Following early spring increases due to sufficient precipitation, lake levels then dropped steadily throughout the remainder of the year. As in 2011, Bunker, Crooked, Ham, and Netta Lakes all ended 2012 with water levels lower than the beginning of 2012.

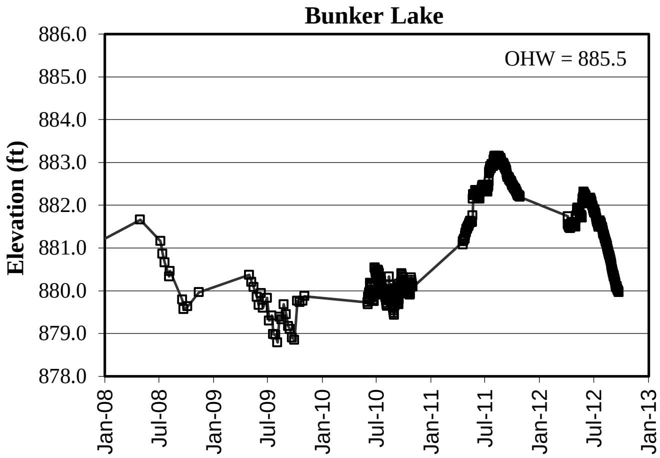
Exceptionally high rainfall in late May 2012 caused lake levels to spike, but below average rainfall in five of the seven remaining months resulted in a steady water level decline. Following the late May precipitation, most lake levels rebounded to early 2011 levels. However, the subsequent less than average rainfall resulted in levels falling to near 2010 values.

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.

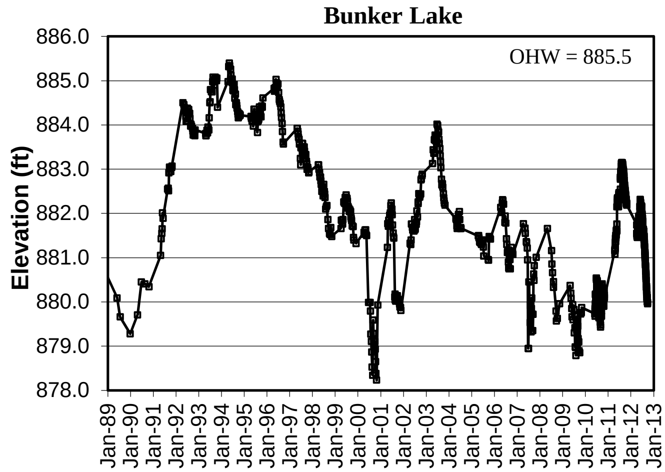
Coon Creek Watershed 2012 Lake Level Monitoring Sites



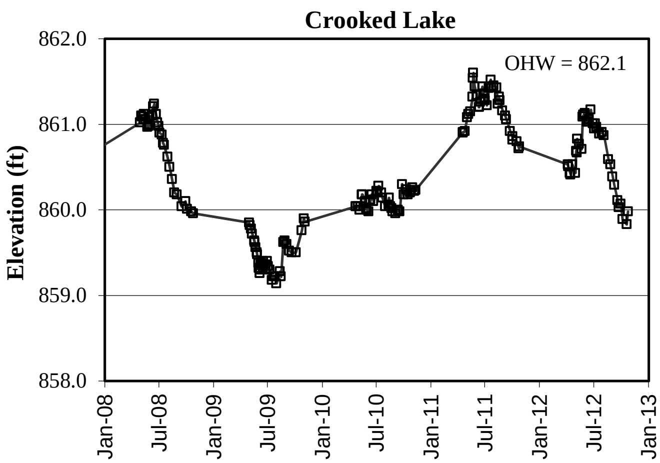
Bunker Lake Levels 2008-2012



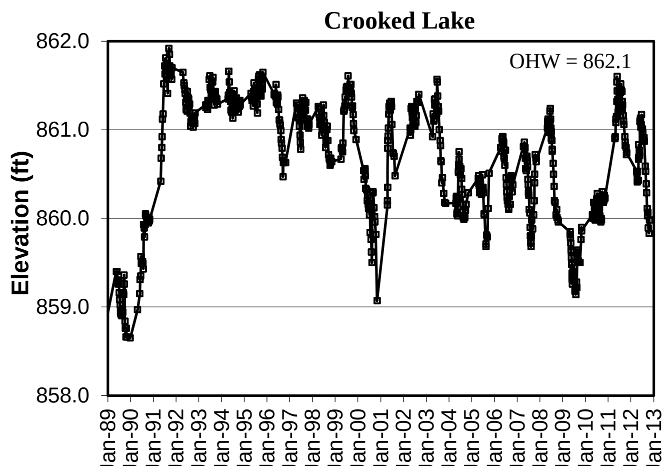
Bunker Lake Levels 1990-2012



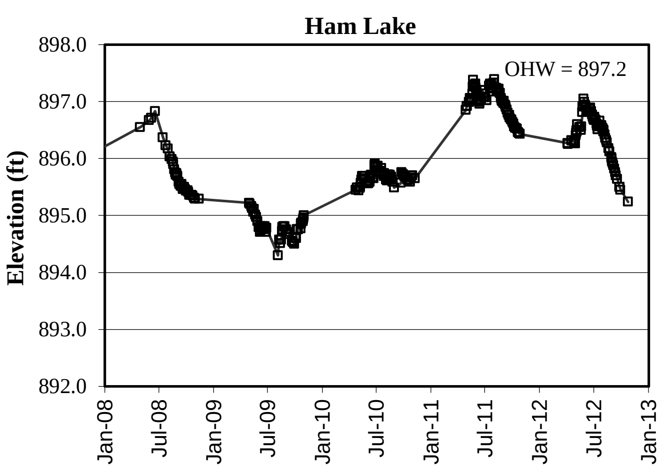
Crooked Lake Levels 2008-2012



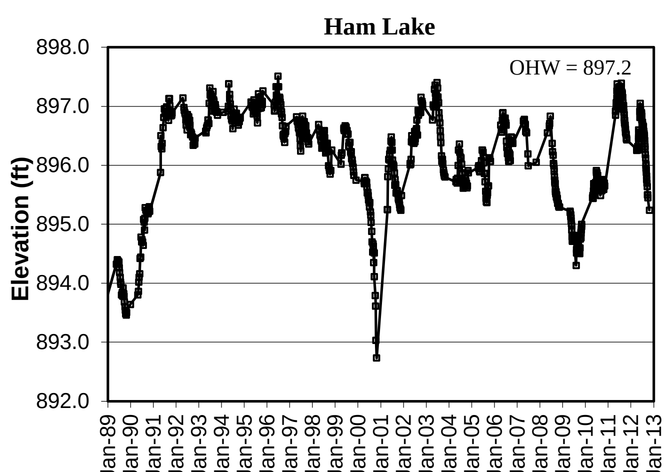
Crooked Lake Levels 1990-2012



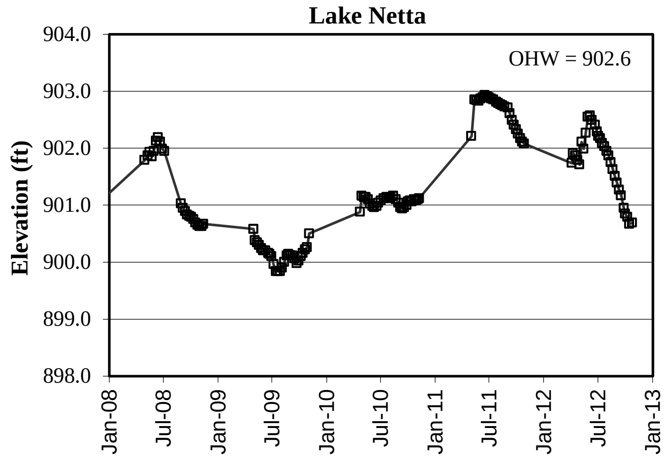
Ham Lake Levels 2008-2012



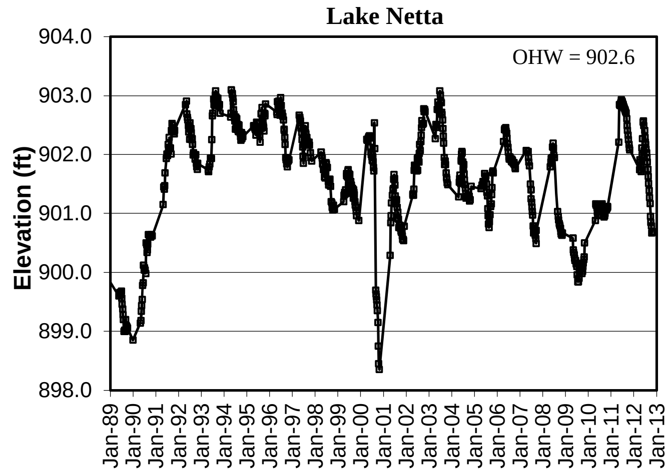
Ham Lake Levels 1990-2012



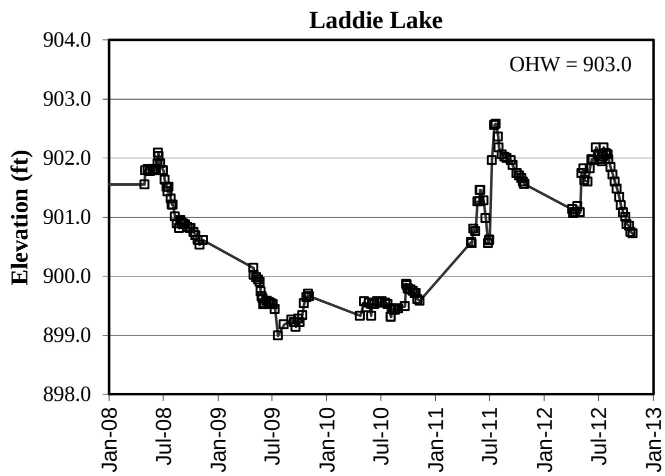
Lake Netta Levels 2008-2012



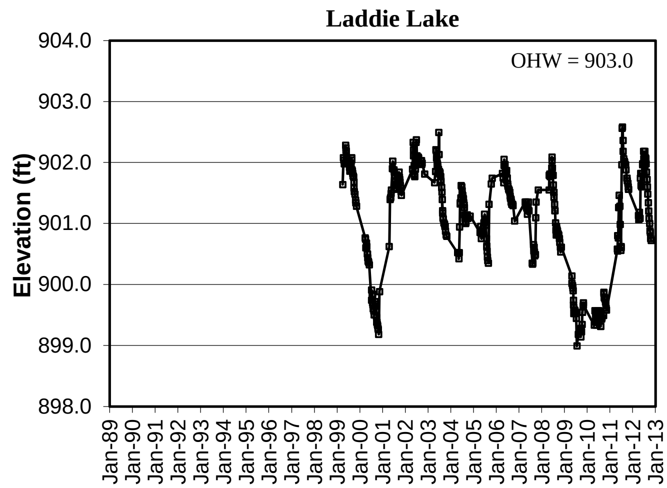
Lake Netta Levels 1990-2012



Laddie Levels 2008-2012



Laddie Levels 1990-2012



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

Lake	Year	Average	Min	Max
Bunker	2008	880.41	879.57	881.66
	2009	879.52	878.79	880.37
	2010	880.01	879.43	880.54
	2011	882.40	881.08	883.15
	2012	881.45	879.96	882.32
Crooked	2008	860.75	859.96	861.24
	2009	859.47	859.14	859.90
	2010	860.12	859.96	860.30
	2011	861.19	860.72	861.60
	2012	860.64	859.83	861.17
Ham	2008	895.75	895.29	896.83
	2009	894.80	894.30	895.22
	2010	895.66	895.44	895.91
	2011	897.00	896.43	897.39
	2012	896.40	895.24	897.05

Lake	Year	Average	Min	Max
Netta	2008	901.32	900.63	902.19
	2009	900.15	899.84	900.58
	2010	901.06	900.88	901.16
	2011	902.64	902.08	902.93
	2012	901.76	900.67	902.57
Laddie	2008	901.28	900.53	902.09
	2009	899.55	898.99	900.14
	2010	899.56	899.31	899.87
	2011	901.51	900.55	902.58
	2012	901.58	900.72	902.18

Lake Water Quality

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

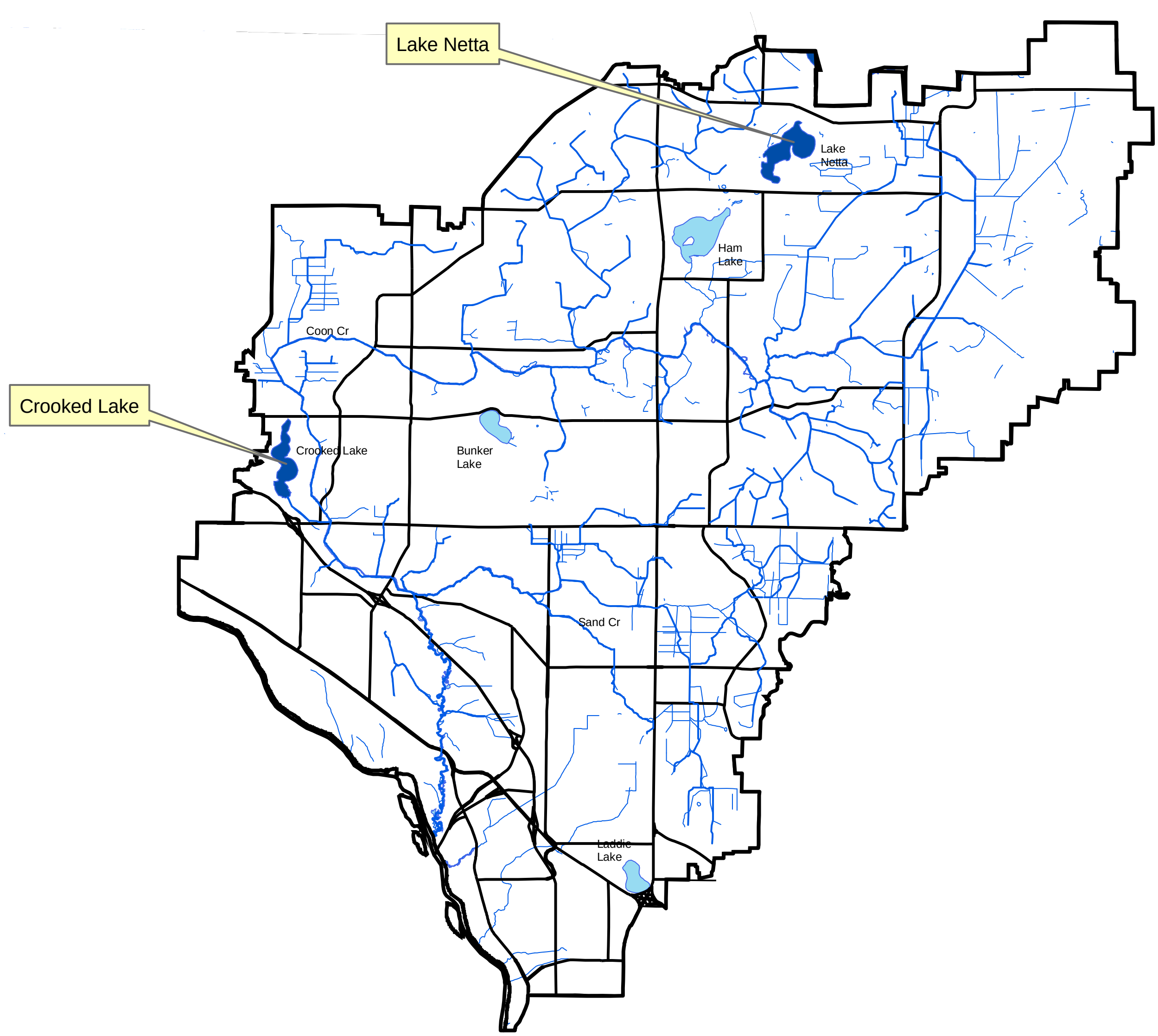
Purpose: To detect water quality trends and diagnose the cause of changes.

Locations:

Site	City
Crooked Lake	Andover/Coon Rapids
Lake Netta	Ham 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 interpreting the data and on lake dynamics.

Coon Creek Watershed 2012 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 feet (7.9 m). Public access is from two locations, at a boat launch off Bunker Lake Boulevard and at a City of Coon Rapids park on the east side of the lake where a fishing pier is located. 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. In 1992 a whole-lake treatment with fluridone was conducted that eradicated nearly all aquatic vegetation. EWM was discovered again in 1996. In 2002 the DNR implemented a low dose of fluridone, which reduced the EWM while having a lesser impact on other vegetation. Spot treatments using triclopyr or 2, 4-D have been conducted since 2010, with 11.5 acres being treated in 2012. EWM is still at nuisance levels in some areas, and may be expanding or becoming denser. In other areas the similar-looking, native, northern milfoil is present. The exotic, invasive plant curly leaf pondweed is also present, but rarely to nuisance levels.

2012 Results

In 2012 Crooked Lake had above-average water quality for this region of the state (NCHF Ecoregion). Water quality in Crooked Lake received an overall A- grade in 2012, which is a substantial improvement over the B grade received in 11 of the previous 14 years. This improvement was driven by a decrease in TP to the lake's lowest summertime average observed (22 µg/L). In addition, chlorophyll–a concentrations averaged 4.9 µg/L, which is lower than the previous record set in 2011. Although average Secchi transparency decreased by 0.5 feet relative to 2011, it was still good with an average of 9.0 feet. This is in contrast to water clarity that rarely averaged near 4 feet before 1995.

Trend Analysis

Seventeen years of water quality data have been collected between 1983 and 2012, with eight additional years of transparency measurements by citizens. Water quality has significantly improved from 1983 to 2012 (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,14} = 34$, $p < 0.001$). 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 analysis, $F_{2,10} = 8.96$, $p = 0.005$). Examining the trend during this period for each parameter (one-way ANOVA graphs on following page) we find no change in phosphorus, but a trend toward lower chlorophyll-a and greater transparency.

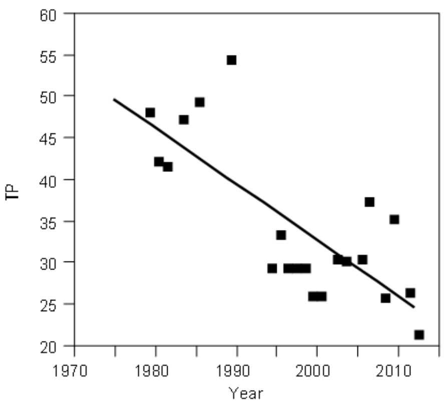
Discussion

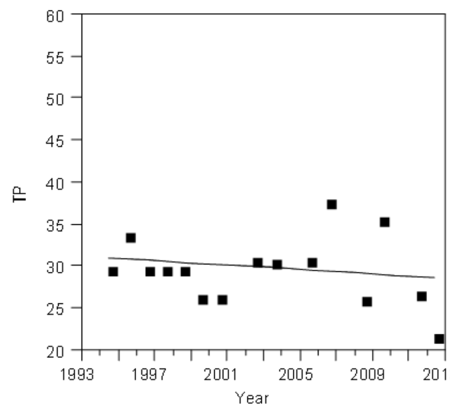
Water quality in Crooked Lake is remarkably good considering its urbanized watershed and intensely manicured shorelines. Noticeable improvements in water quality occurred in both 2011 and 2012. The cause of this trend is unknown, but it may be linked to the submerged plant community sequestering nutrients and out-competing algae. Continued efforts to improve stormwater draining to the lake and implement shoreline restorations are encouraged. Invasive aquatic plants continue to be a challenge in Crooked Lake, and EWM seems to be persisting as the primary nuisance, despite continued herbicide treatments. Native plants like the native northern milfoil and coontail 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 2009 lake management plan provides direction for protecting water quality and managing plants.

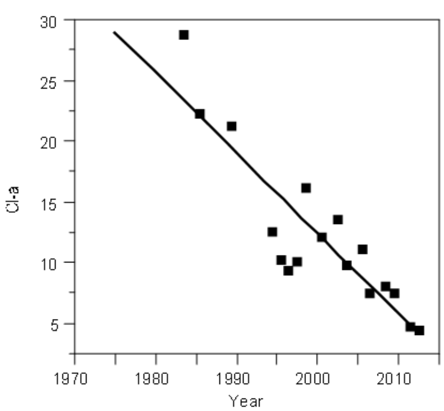
2012 Crooked Lake Water Quality Data

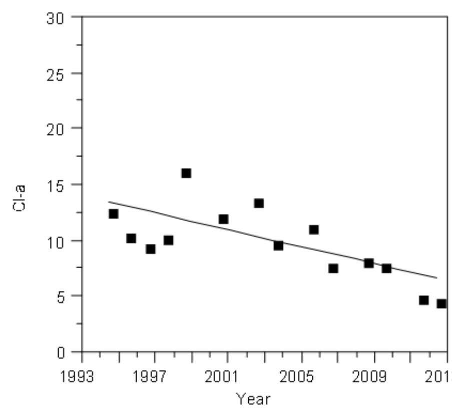
Crooked Lake **2012 Water Quality Data**	Units	Date Time R.L.*	5/16/2012 13:20 Results	5/30/2012 12:45:00 PM Results	6/13/2012 14:40 Results	6/26/2012 14:55 Results	7/11/2012 15:20 Results	7/24/2012 14:30 Results	8/8/2012 15:05 Results	8/22/2012 14:05 Results	9/5/2012 13:40 Results	9/19/2012 13:30 Results	Average	Min	Max
pH		0.1	8.62	8.40	8.79	8.87	8.60	8.44	8.48		8.58	8.08	8.54	8.08	8.87
Conductivity	mS/cm	0.01	0.450	0.419	0.397	0.397	0.360	0.333	0.460	0.454	0.418	0.375	0.406	0.333	0.460
Turbidity	FNRU	1	2	2	3	6	6	5	3	3	3	2	4	2	6
D.O.	mg/L	0.01	11.04	9.36					8.23	9.59	8.79	6.91	8.99	6.91	11.04
D.O.	%	1	118%	97%					102%	113%	107%	74%	102%	74%	118%
Temp.	°C	0.10	19.7	19.6	22.4	24.9	29.6	28.1	26.3	23.8	25.1	18.60	23.8	18.6	29.6
Temp.	°F	0.10	67.5	67.0	72.3	76.8	85.3	82.6	79.3	74.8	77.2	65.5	74.9	65.5	85.3
Salinity	%	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Cl-a	µg/L	1	4.2	4.6	5.2	4.3	5.9	6.6	5.6	4.8	3.3	4.8	4.9	3.3	6.6
T.P.	mg/L	0.005	0.030	0.021	0.020	0.024	0.015	0.018	0.024	0.024	0.018	0.027	0.022	0.015	0.030
T.P.	µg/L	5	30	21	20	24	15	18	24	24	18	27	22	15	30
Secchi	ft	0.1	15.8	12.3	7.9	7.9	7.4	6.5	7.1	8.4	9.4	7.6	9.0	6.5	15.8
Secchi	m	0.1	4.8	3.7	2.4	2.4	2.3	2.0	2.2	2.6	2.9	2.3	2.8	2.0	4.8
Field Observations															
Physical			1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.9	1.0	2.0
Recreational			1.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0	2.0	2.0	1.8	1.0	2.0

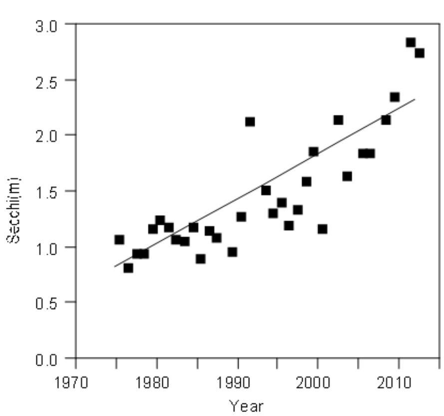
Crooked Lake Water Quality Changes for Each Parameter, All Years (left column) and 1994 – 2012 (right column).

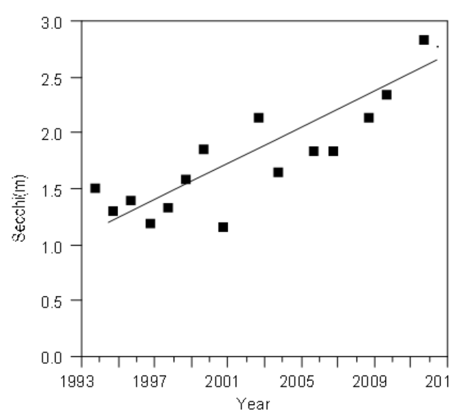




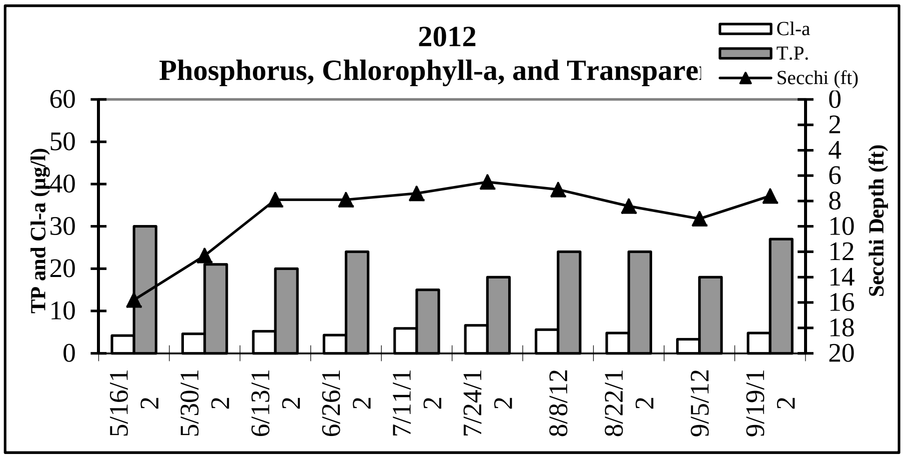


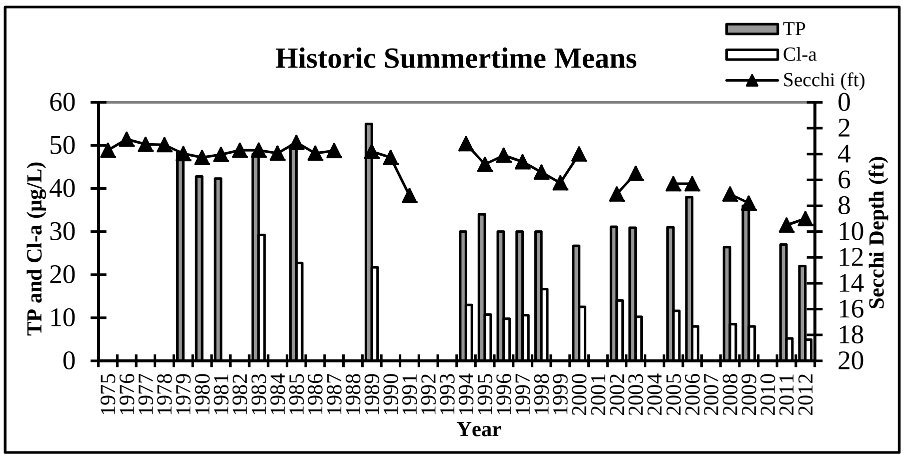






Crooked Lake Water Quality Results





Crooked Lake Historical Summertime Mean Values

Agency	CAMP	CAMP	CAMP	CAMP	CAMP	CAMP	CAMP	CAMP	MC	CAMP	MC	CAMP	CAMP	MC	CAMP	CAMP
Year	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1989	1990	1991
TP					48.5	42.8	42.3		48.0		50.0			55.0		
Cl-a									29.2		22.7			21.7		
Secchi (m)	1.1	0.9	1.0	1.0	1.2	1.3	1.2	1.1	1.1	1.2	1.0	1.2	1.1	1.0	1.3	2.2
Secchi (ft)	3.7	2.9	3.2	3.3	4.0	4.3	4.0	3.7	3.7	3.9	3.1	3.9	3.7	3.8	4.3	7.2

Carlson's Tropic State Indices

TSIP					60	58	58		60		61			62		
TSIC									64		61			61		
TSIS	58	62	60	60	57	56	57	58	58	57	61	57	58	60	56	49
TSI									61		61			61		

Crooked Lake Water Quality Report Card

Year	75	76	77	78	79	80	81	82	83	84	85	86	87	89	90	91
TP									C		C			C		
Cl-a									C		C			C		
Secchi	C	D	D	D	C	C	C	D	D		D	C	D	D	C	C
Overall									**C**		**C**			**C**		

Crooked Lake Historical Summertime Mean Values

Agency	MC	MC	MC	MC	MC	CAMP	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD
Year	1994	1995	1996	1997	1998	1999	2000	2002	2003	2005	2006	2008	2009	2011	2012
TP	30.0	34.0	30.0	30.0	30.0		26.7	31.1	30.9	31.0	38.0	26.4	36.0	27.0	22.0
Cl-a	13.0	10.7	9.8	10.6	16.7		12.5	14.0	10.2	11.6	8.0	8.5	8.0	5.2	4.9
Secchi (m)	1.4	1.5	1.3	1.4	1.6	1.9	1.2	2.2	1.7	1.9	1.9	2.2	2.4	2.9	2.8
Secchi (ft)	3.2	4.8	4.1	4.6	5.4	6.2	4.0	7.1	5.5	6.3	6.3	7.1	7.8	9.5	9.0

Carlson's Tropic State Indices

TSIP	53	55	53	53	53		52	54	54	54	57	51	56	52	49
TSIC	56	54	53	54	58		56	57	53	55	51	52	51	47	46
TSIS	56	55	57	55	53	51	57	49	52	51	51	49	47	45	45
TSI	55	55	54	54	55		55	53	53	53	53	51	51	48	47

Crooked Lake Water Quality Report Card

Year	94	95	96	97	98	99	2000	2002	2003	2005	2006	2008	2009	2011	2012
TP	B	C	B	B	B		B	B	B	B	C	B	C	B	A-
Cl-a	B	B	A	B	B		B	B	B	B	A	A	A	A	A
Secchi	C	C	C	C	C	C	C	C	C	C	C	B-	B	B	B
Overall	**B**	**C**	**B**	**B**	**B**		**B**	**B**	**B**	**B**	**B-**	**B**	**B**	**B**	**A-**

Lake Netta

CITY OF HAM LAKE, LAKE ID # 02-0053

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 feet (5.8 m). There is a small, rugged public access on the west side of the lake in a neighborhood park. This access can accommodate canoes only. The lake receives little recreational use due to the difficulty of public access. The lakeshore is only lightly developed, with a few small lakeside neighborhoods and scattered housing elsewhere. The watershed is a mixture of residential, commercial and vacant land, but is under development pressure. No exotic plant species have been documented in Lake Netta.

2012 Results

Lake Netta again had above-average water quality for this region of the state (NCHF Ecoregion) in 2012. The overall B+ grade was driven by low concentrations of total phosphorus and chlorophyll *a*. However, the Secchi transparency depth observed in 2012 (7.3 feet) was the lowest average value observed since 1997, when ACD began regularly monitoring water quality. Nevertheless, the other measured water quality parameters were similar to previous years and indicate the stability of the clear water and healthy submerged vegetation community with this system.

Trend Analysis

Eleven years of water quality data have been collected by the Anoka Conservation District (1997-1999, 2001, 2003-2004, 2006-2007, 2009-2010, and 2012), along with Secchi depth measurements by citizens five other years. Lake water quality has fluctuated between "A" and "B" grades, but there is no significant long-term trend of changing lake water quality (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,8} = 0.52$, $p = 0.61$).

Discussion

High water quality in Lake Netta has persisted since 1997, when ACD began regularly monitoring water quality. Primary production in the lake is dominated by the submerged macrophyte (large plant) community, as opposed to being dominated 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, which consume algae. Other reasons for good water quality in this lake include that it has a small watershed and receives little direct runoff. No streams of any consequence enter this lake. Maintaining good water quality in this lake will be, in large part, dependent upon protecting the in-lake aquatic vegetation, as well as maintenance of vegetated buffers near the water's edge by property owners.

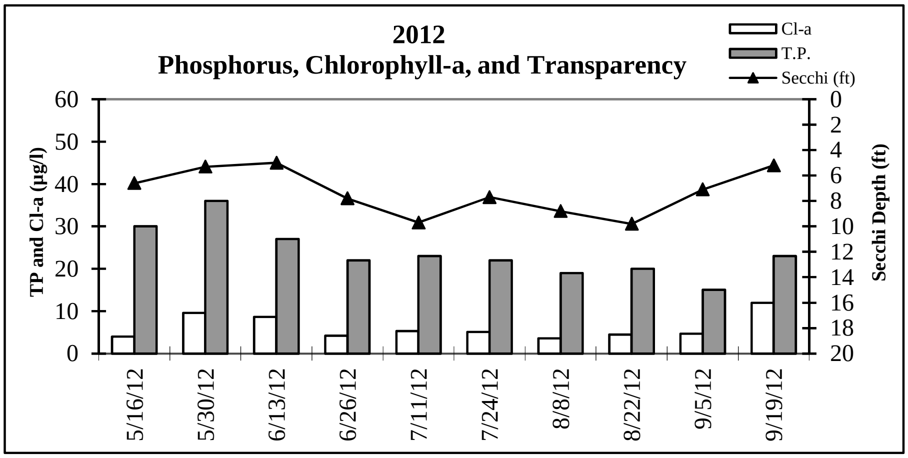
2012 Lake Netta Water Quality Data

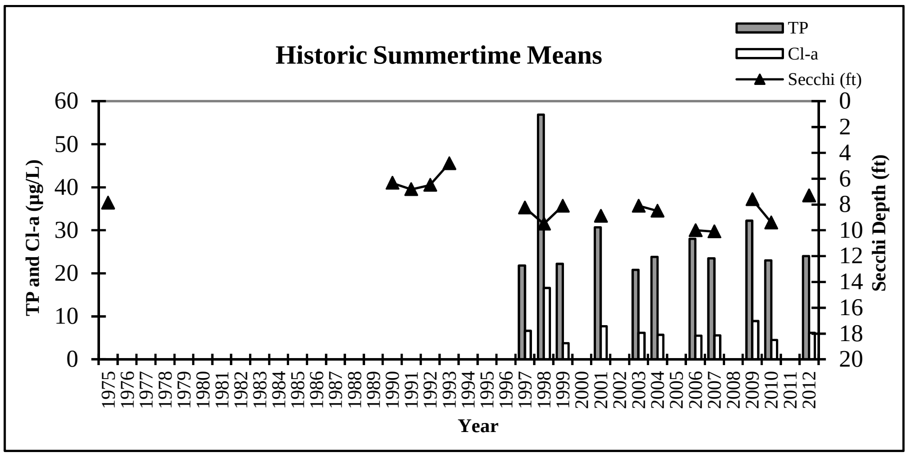
Lake Netta

2012 Water Quality Data		Date	5/16/2012	5/30/2012	6/13/2012	6/26/2012	7/11/2012	7/24/2012	8/8/2012	8/22/2012	9/5/2012	9/19/2012			
		Time	8:45	8:45	15:40	8:50	9:00	9:20	9:30	9:10	9:05	8:40			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.36	8.09	8.21	7.98	7.57	7.80	7.89	8.79	7.98	7.79	8.05	7.57	8.79
Conductivity	mS/cm	0.01	0.215	0.193	0.187	0.190	0.170	0.151	0.202	0.197	0.179	0.159	0.184	0.151	0.215
Turbidity	FNRU	1.0	5	4	4	3	2	1	1	2	2	2	3	1	5
D.O.	mg/L	0.01	9.58	8.57					7.16	8.80	8.20	7.11	8.24	7.11	9.58
D.O.	%	1.0	103	88					87	100	97	74	91	74	103
Temp.	°C	0.10	20.0	19.3	22.3	24.1	27.3	27.1	25.3	21.8	23.9	17.5	22.9	17.5	27.3
Temp.	°F	0.10	68.0	66.7	72.1	75.4	81.1	80.8	77.5	71.2	75.0	63.5	73.1	63.5	81.1
Salinity	%	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl-a	µg/L	1.0	4.0	9.6	8.6	4.2	5.3	5.1	3.6	4.5	4.7	12.0	6.2	3.6	12.0
T.P.	mg/L	0.005	0.030	0.036	0.027	0.022	0.023	0.022	0.019	0.020	0.015	0.023	0.024	0.015	0.036
T.P.	µg/L	5	30	36	27	22	23	22	19	20	15	23	24	15	36
Secchi	ft	0.1	6.6	5.3	5.0	7.8	9.7	7.7	8.8	9.8	7.1	5.2	7.3	5.0	9.8
Secchi	m	0.1	2.0	1.6	1.5	2.4	3.0	2.3	2.7	3.0	2.2	1.6	2.2	1.5	3.0
Physical			1.0	1.0	2.0	2.0	1.0	2.0	1.0	2.0	2.0	2.0	1.6	1.0	2.0
Recreational			1.0	2.0	2.0	2.0	1.0	1.0	2.0	2.0	1.0	2.0	1.6	1.0	2.0

*Reporting Limit

Lake Netta Water Quality Results





Lake Netta Historical Summertime Mean Values

Agency	CLMP	CLMP	CLMP	CLMP	CLMP	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD
Year	1975	1990	1991	1992	1993	1997	1998	1999	2001	2003	2004	2006	2007	2009	2010	2012
TP (µg/L)						21.8	56.9	22.2	30.7	20.8	23.8	28.0	23.5	32.2	23.0	24.0
Cl-a (µg/L)						6.7	16.6	3.8	7.7	6.2	5.7	5.5	5.6	8.9	4.5	6.2
Secchi (m)	2.4	1.93	2.08	1.98	1.47	2.53	2.90	2.47	2.70	2.47	2.58	3.00	3.10	2.30	2.90	2.20
Secchi (ft)	7.9	6.3	6.8	6.5	4.8	8.3	9.5	8.1	8.9	8.1	8.5	10.0	10.1	7.6	9.4	7.3

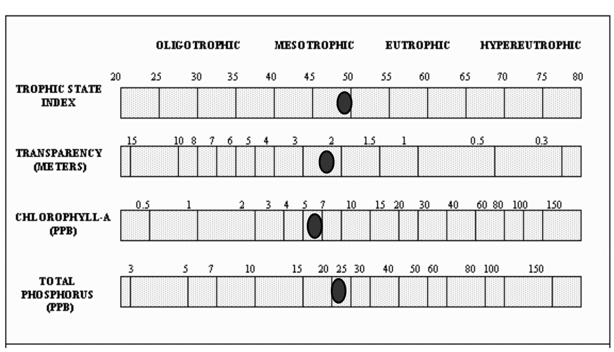
Carlson's Trophic State Index

Year	1975	1990	1991	1992	1993	1997	1998	1999	2001	2003	2004	2006	2007	2009	2010	2012
TSIP						49	62	49	54	48	50	52	50	54	49	50
TSIC						49	58	44	51	48	48	47	48	52	45	48
TSIS	47	51	49	50	54	47	45	47	46	47	46	44	44	48	45	49
TSI						48	55	47	50	48	48	48	47	51	46	49

Lake Netta Water Quality Report Card

Year	1975	1990	1991	1992	1993	1997	1998	1999	2001	2003	2004	2006	2007	2009	2010	2012
TP (µg/L)						A	C	A	B	A	B+	B	B	C	A-	B+
Cl-a (µg/L)						A	B	A	A	A	A	A	A	A	A	A
Secchi (m)	B	C	C	C	C	B	B	B	B	B	B	B+	A	B	B+	B
Overall						**B**	**B**	**A**	**B**	**A**	**A**	**B+**	**B+**	**B**	**A-**	**B+**

Carlson's Trophic State Index



Stream Hydrology and Rating Curves

Description: Continuous water level monitoring in streams.

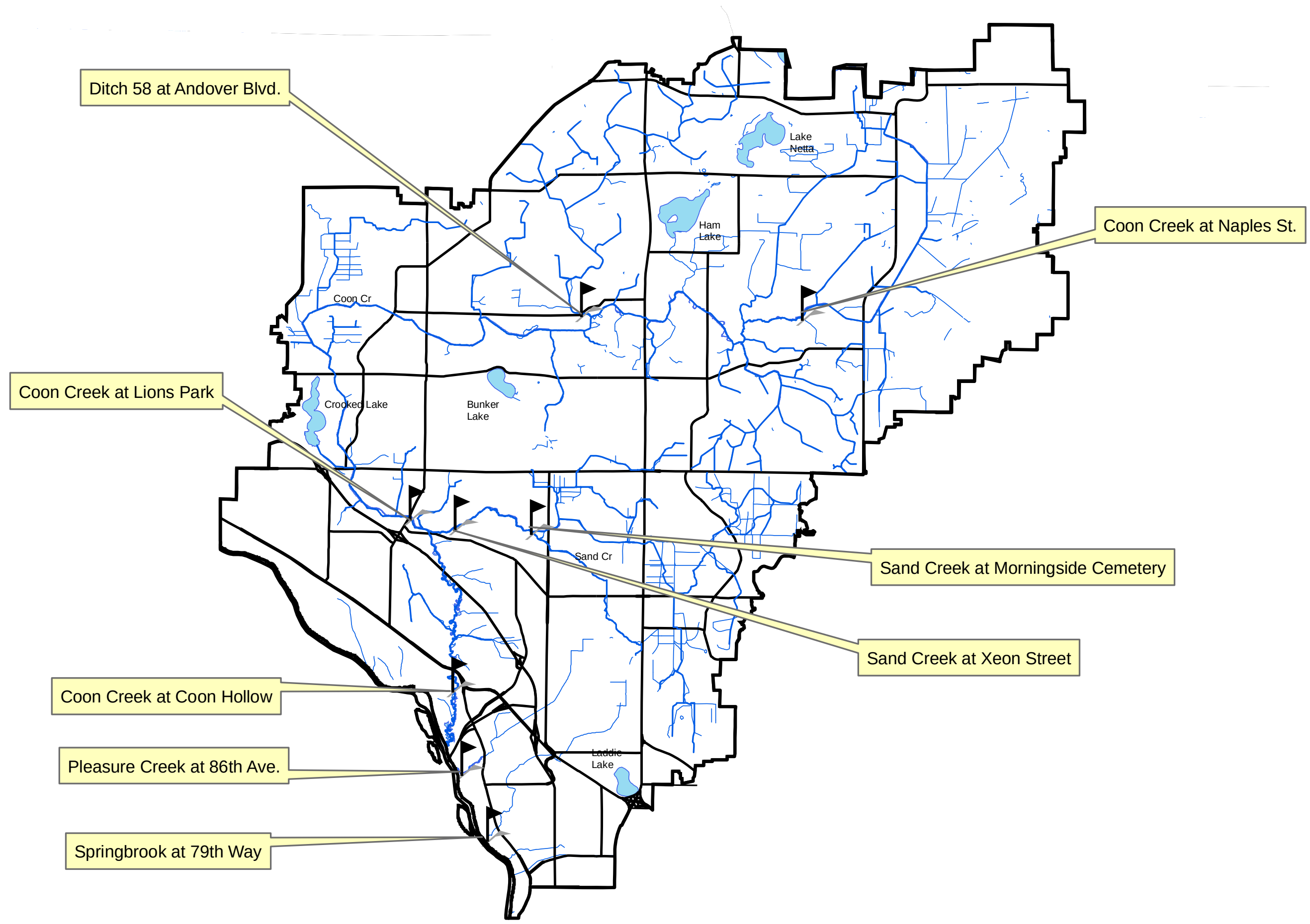
Purpose: To provide understanding of stream hydrology, including the impact of climate, land use or discharge changes. These data also facilitate calculation of pollutant loads, use of computer models for developing management strategies, and water appropriations permit decisions.

Locations:

Stream	Location	City
Coon Creek	Coon Hollow	Coon Rapids
Coon Creek	Lions Park	Coon Rapids
Coon Creek	Naples St. NE	Ham Lake
Ditch 58	Andover Blvd.	Ham Lake
Sand Creek	Xeon St.	Coon Rapids
Sand Creek	Morningside Cemetery	Coon Rapids
Springbrook	79th Way NE	Fridley
Pleasure Creek	86th Ave. NW	Coon Rapids

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

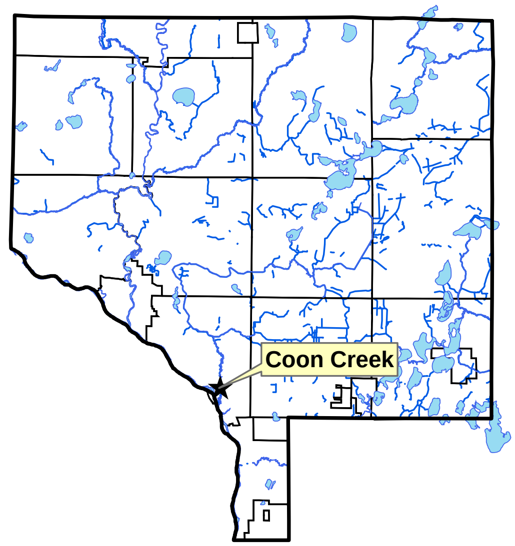
Coon Creek Watershed 2012 Stream Hydrology Monitoring Sites



COON CREEK

at Coon Creek Hollow, Vale Street, Coon Rapids

Notes



Coon Creek is a major drainage through central Anoka County. This monitoring location is the closest to the outlet to the Mississippi River that is accessible and does not have backwater effects from the Mississippi during high water. Land use in the upstream watershed ranges from rural residential upstream to highly urbanized downstream. The creek is about 30 feet wide and 1.5 to-2 feet deep at the monitoring site during baseflow. Both creek water levels and flow are available for this site.

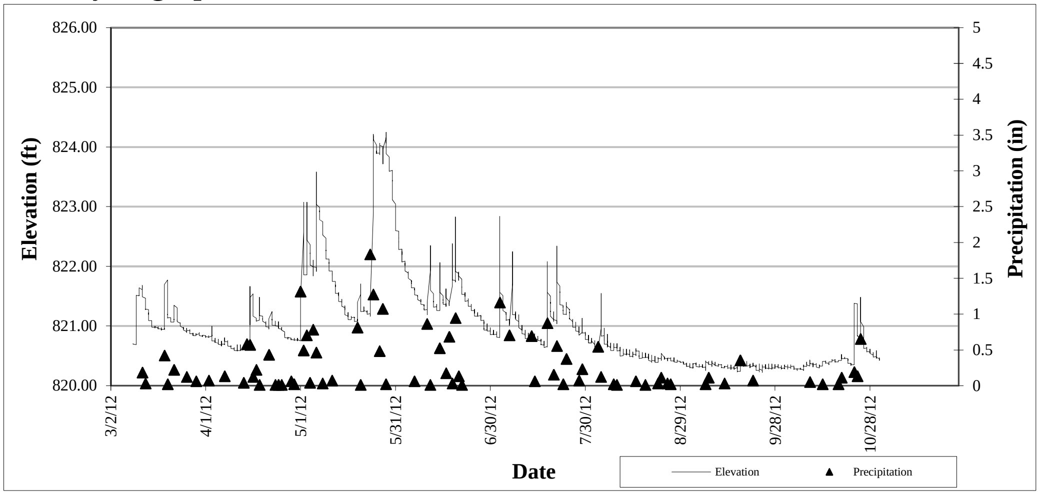
In 2012 Coon Creek water levels spanned a range of 4.03 feet (see hydrograph on next page). This is the third largest range since 2005 (4.14 feet in 2007 and 4.08 in 2009). Over a span of five days in late May, 4.65 inches of rain resulted in the maximum observed stream level (824.25 feet), while below average rainfall from August to October resulted in little water level fluctuation and the lowest stream level of the year (820.22).

Coon Creek has flashy responses to storms, as displayed in the hydrograph on the next page. Water levels rise quickly in response to precipitation, but return to baseflow conditions more slowly. The quick, intense response to rainfall is runoff from the urbanized downstream watershed near the monitoring station. 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 2006-2012 serve to illustrate this phenomenon. In the few hours following larger storms, water levels can rise nearly 4 feet. During 2006's largest storm, a 2.23-inch storm on June 16, water levels rose 3.4 feet in the first 16 hours, including one two-hour period when the creek rose 2.23 feet. It took about 15 days for the water level to return to pre-storm levels, despite only three rain events of less than 0.15 inches during that time. During 2008's largest storm, 1.54-inches on August 27, creek levels rose 2.42 feet during a two hour period, rising a total of 3.46 feet in response to the storm. A 2.11-inch rainfall on August 19th, 2009 caused the creek to rise 3.62 feet within 16 hours. The largest storm of 2010, 1.62 inches on June 25th, resulted in an increase in stream elevation of 2.83 feet over approximately 10 hours. During a particularly intense rainstorm in 2011, 2.10-inches fell on August 18, creek levels rose 1.99 feet during a two hour period, rising a total of 2.42 feet in response to the storm. A 1.83-inch rain event in May of 2012 caused the stream level to rise by 2.58 feet during a six hour period.

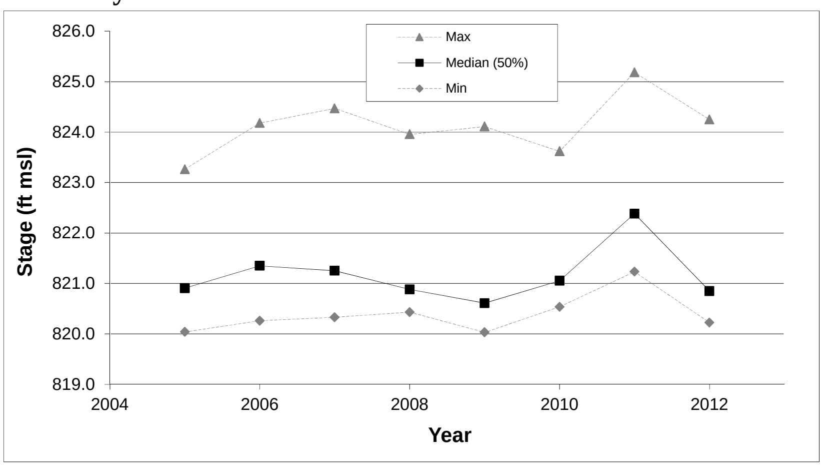
Increases in Coon Creek's water level are also substantial when analyzed using a per-inch of rainfall perspective. Examining 32 relatively isolated storms ranging in size from 0.72 to 2.49 inches in 2006-12, the creek level increased an average of 1.76 feet per inch of rainfall. The creek increase per inch of rain ranged from 0.76 to 2.64 feet. This discussion, as well as the one in the preceding paragraph, is obviously simplified because it neglects to consider the phenology of each of the storms. It only serves to emphasize that this creek responds quickly and dramatically to storms but water levels fall much more slowly.

The rating curve previously developed for this site and updated in 2010 (most recently reported in the 2011 Water Almanac) has been revised and is presented on the next page. ACD staff discovered an error in the equation that has since been corrected. All past hydrology records that used the equations were also corrected.

2012 Hydrograph

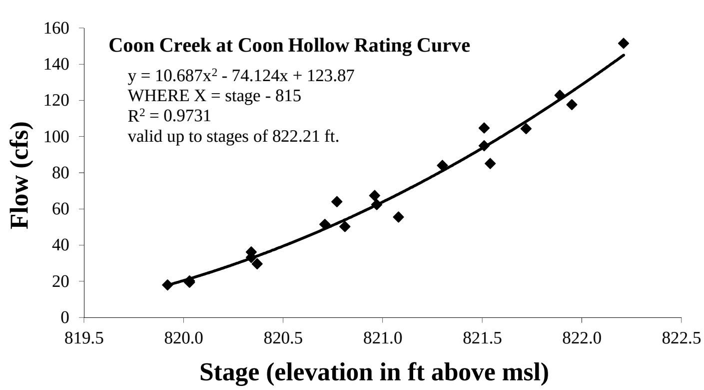


Summary of All Monitored Years



Percentiles	2005	2006	2007	2008	2009	2010	2011	2012
Min	820.04	820.26	820.33	820.43	820.03	820.54	821.23	820.22
2.5%	820.06	820.42	820.40	820.52	820.12	820.64	821.27	820.28
10.0%	820.19	820.53	820.53	820.57	820.20	820.73	821.31	820.33
25.0%	820.57	820.78	820.73	820.63	820.35	820.85	821.83	820.45
Median (50%)	820.91	821.35	821.25	820.88	820.61	821.05	822.38	820.85
75.0%	821.26	821.78	821.88	821.78	820.93	821.32	822.99	821.28
90.0%	821.77	822.27	822.63	822.26	821.31	821.68	823.70	821.89
97.5%	822.92	822.76	823.21	822.79	822.05	822.33	824.56	823.60
Max	823.26	824.18	824.47	823.96	824.11	823.62	825.18	824.25

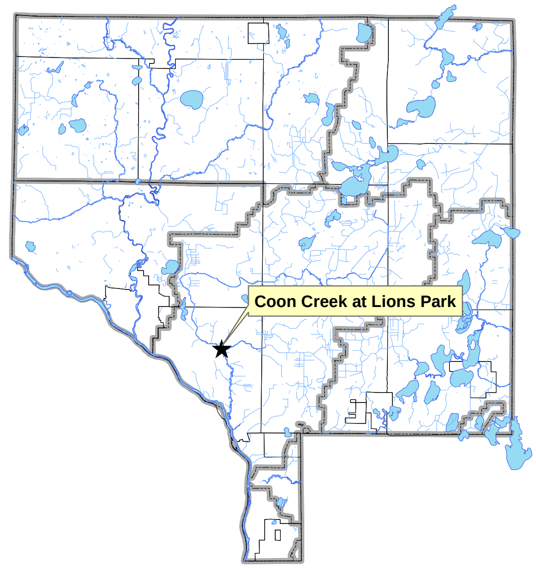
Rating Curve (2010 - updated)



COON CREEK

at Lions Park, Hanson Blvd., Coon Rapids

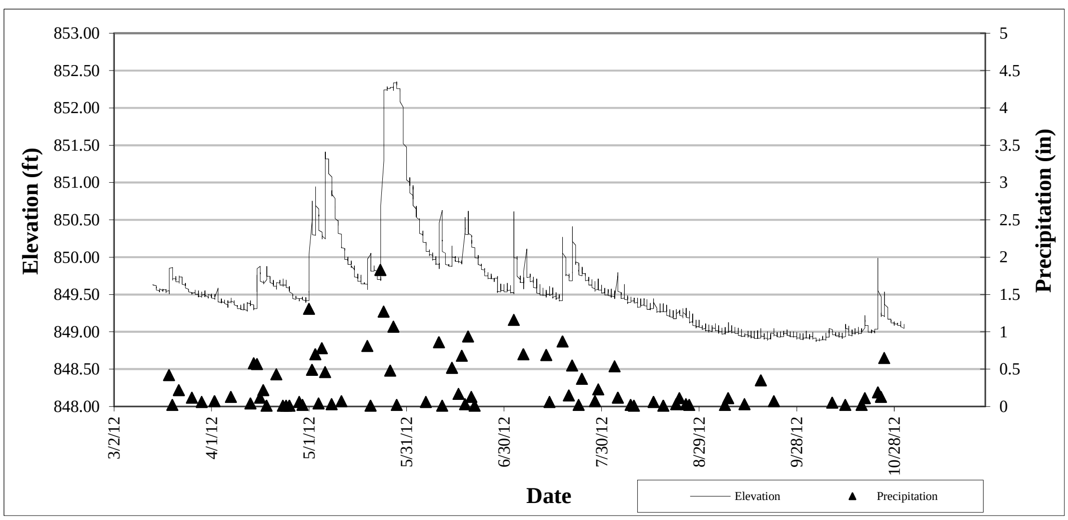
Notes



Coon Creek is a major drainage through central Anoka County. This monitoring location is within Lions Park in Coon Rapids, just downstream of the intersection of Coon Creek with Hanson Blvd. Land use in the upstream watershed ranges from rural residential to highly urbanized. The creek is approximately 35 feet wide and 2 to 2.5 feet deep at the monitoring site during baseflow. Both creek water levels and flow are available for this site.

Stream level and flow were monitored for the first time at this site in 2012. This site has a flashy hydrograph due to the urbanized watershed, similar to the Coon Creek at Coon Hollow site. Following 4.67 inches of rain in the preceding 6 days, the stream swelled to a width of 41.5 feet on May 29th. During this time, the peak flow and stream level were observed. Additional measurements may be conducted in 2013 to refine the rating curve.

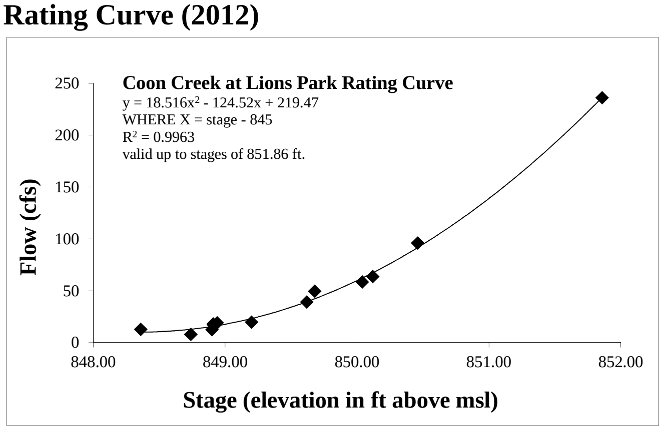
2012 Hydrograph



Summary of All Monitored Years

Percentiles	2012
Min	848.87
2.5%	848.91
10.0%	848.96
25.0%	849.11
Median (50%)	849.51
75.0%	849.78
90.0%	850.31
97.5%	851.94
Max	852.35

Rating Curve (2012)



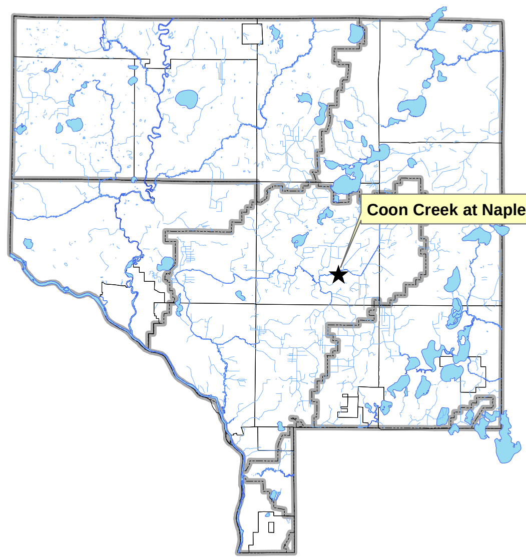
COON CREEK

at Naples St. NE, Ham Lake

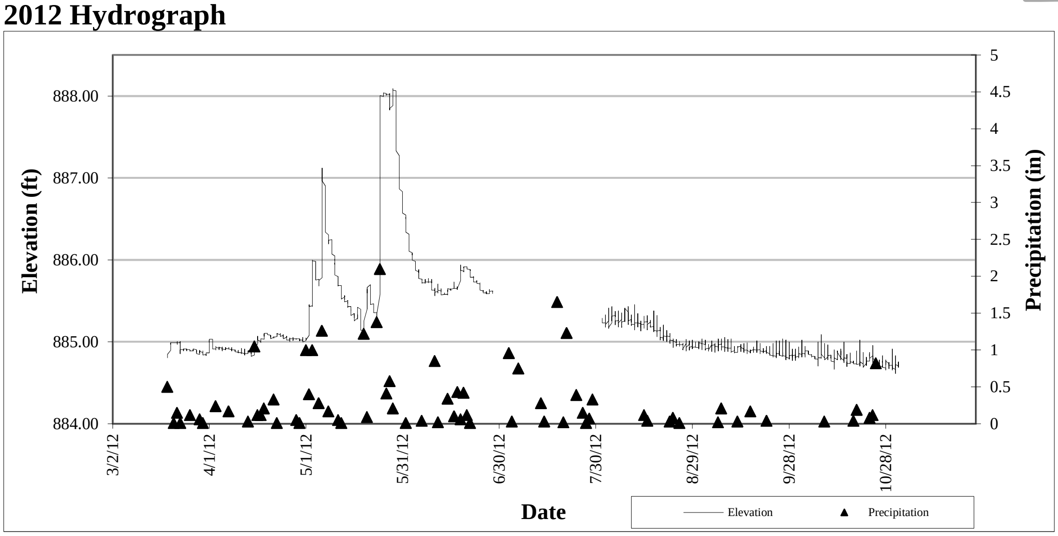
Notes

Coon Creek is a major drainage through central Anoka County. This monitoring location is just upstream of the intersection of Coon Creek with Naples St. NE and is the most upstream sampling site of the entire Coon Creek system. Land use in the upstream watershed is comprised of rural residential and sod fields. The creek is approximately 15 feet wide and 1 foot deep at the monitoring site during baseflow.

Stream level was monitored for the first time at this site in 2012. Stream levels fluctuated 3.48 feet between minimum (884.61 ft.) and maximum (888.09 ft.) levels, which represents a significant change in stream level for any site, and particularly this upstream site. Fluctuations in stream level were insignificant from August through the end of the monitoring season due to below average rainfall.



2012 Hydrograph



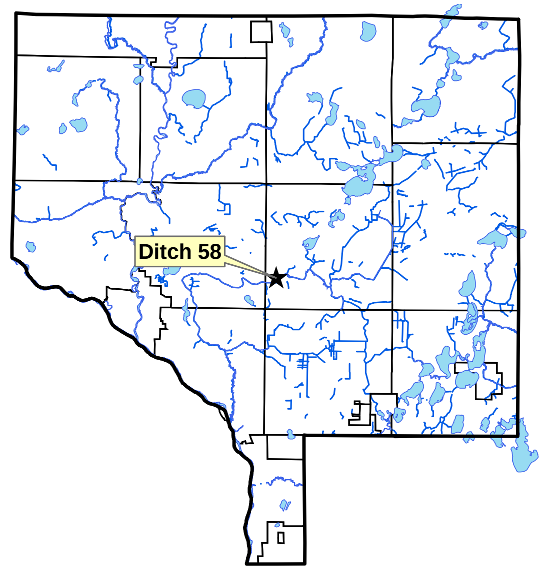
Summary of All Monitored Years

Percentiles	2012
Min	884.61
2.5%	884.71
10.0%	884.81
25.0%	884.89
Median (50%)	885.01
75.0%	885.49
90.0%	885.89
97.5%	887.78
Max	888.09

Rating Curve – Under development in 2013.

DITCH 58

at Andover Boulevard, Ham Lake

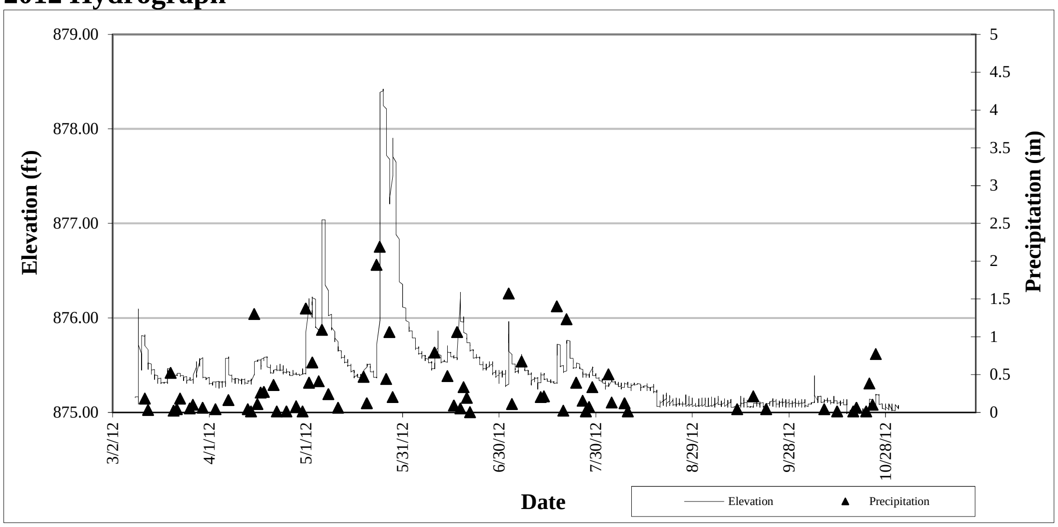


Notes

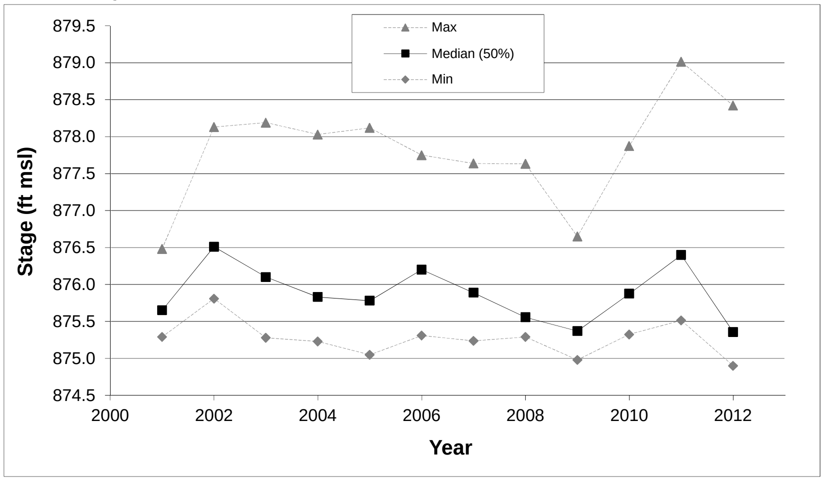
Ditch 58 is a tributary to Coon Creek. Upstream of the monitoring site are 20 miles of ditch, including many small tributaries. Its light bulb-shaped watershed is roughly delimited by Lake Netta to the northeast, Crosstown Boulevard to the northwest and southwest, and highway 65 to the southeast. Watershed land uses are primarily suburban residential and sod fields. The ditch is about 10 feet wide and 2 feet deep at the monitoring site during baseflow.

Ditch 58 water levels fluctuated more during 2011 and 2012 than in previous years because of the increased frequency of larger rainfall events. Water levels spanned a range of 3.5 feet in response to rainfall, nearly one foot more than seen in previous years. Of particular note was a 2.51 foot increase in water level over 22 hours following a 3.05 inch rain event on May 21, 2011. At one point following that storm, water levels rose 0.88 feet in two hours.

2012 Hydrograph



Summary of All Monitored Years



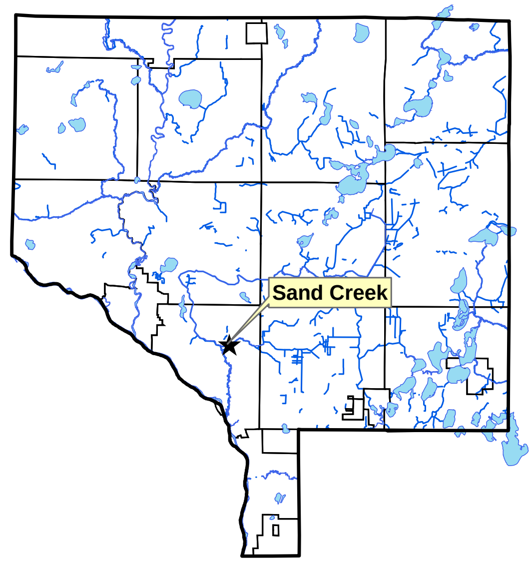
Percentiles	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	All Years Thru 2012
Min	875.29	875.81	875.28	875.23	875.05	875.31	875.24	875.29	874.98	875.33	875.52	874.90	874.98
2.5%	875.35	876.18	875.57	875.63	875.54	875.91	875.29	875.33	875.01	875.39	875.62	875.02	875.27
10.0%	875.48	876.33	875.64	875.51	875.37	875.66	875.37	875.36	875.16	875.48	875.65	875.06	875.37
25.0%	875.58	876.41	875.74	875.63	875.54	875.91	875.49	875.39	875.29	875.58	875.79	875.12	875.54
Median (50%)	875.65	876.51	876.10	875.83	875.78	876.20	875.89	875.56	875.37	875.88	876.40	875.36	875.88
75.0%	875.77	876.73	876.59	876.05	876.04	876.35	876.16	876.06	875.46	876.25	876.92	875.51	875.88
90.0%	876.23	877.42	877.01	876.45	876.22	876.47	876.40	876.28	875.54	876.49	877.67	875.79	876.72
97.5%	876.30	878.13	878.16	877.04	876.98	876.89	876.90	876.61	875.79	877.13	878.55	877.02	877.70
Max	876.48	878.13	878.19	878.03	878.12	877.75	877.64	877.63	876.65	877.88	879.02	878.42	879.02

"All Years" is not an average of each year's summary statistic. Rather, it is calculated from the continuous, multi-year record.
calculated based on every reading, not daily summaries, as they would "iron out" big jumps associated with intense storms.

SAND CREEK

at Xeon Street, Coon Rapids

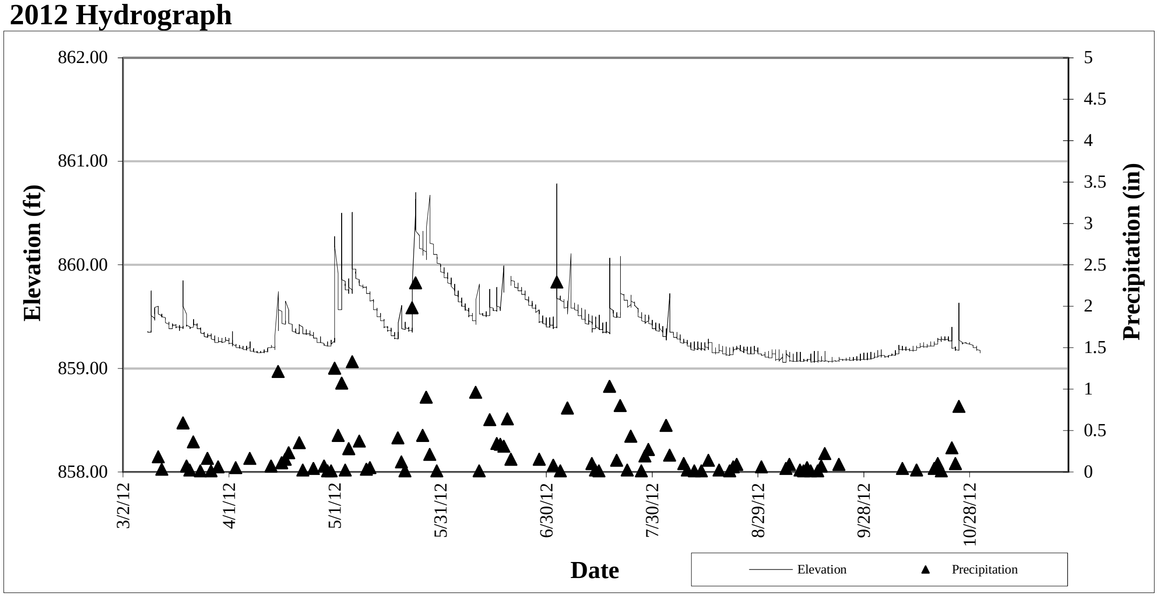
Notes



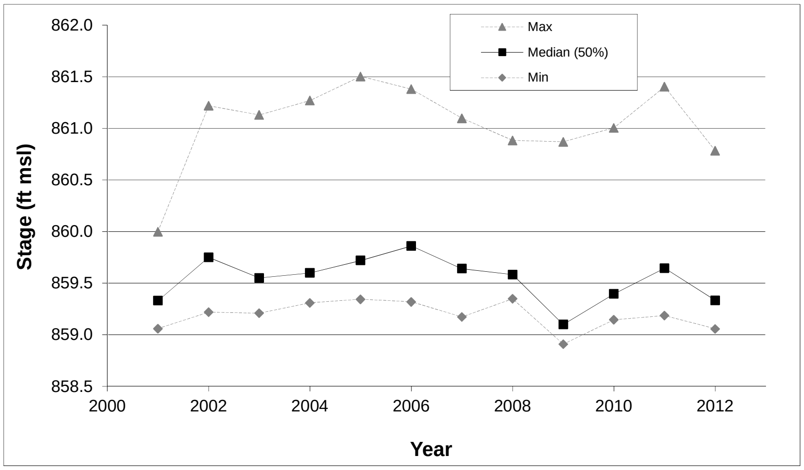
Sand Creek is the largest tributary to Coon Creek. It drains suburban residential, commercial and retail areas throughout northeastern Coon Rapids and western Blaine. The stream is about 15 feet wide and 3 feet deep at the monitoring site during baseflow.

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 short-lived. Still, the creek can have more dramatic hydrologic changes in the first hours immediately following larger storms. For example, in 2007 Sand Creek rose 1.93 feet in 4 hours in response to a 2.25-inch storm on August 1. In 2011 storms of 1.42 (July 30) and 2.10 (Aug 16) inches caused stream levels to rise 1.49 and 1.17 feet, respectively, within two hours and then recede.

2012 Hydrograph



Summary of All Monitored Years



Percentiles	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	All Years Thru 2012
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	858.91
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	859.04
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	859.21
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	859.37
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	859.54
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	859.54
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	859.99
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	860.22
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	861.50

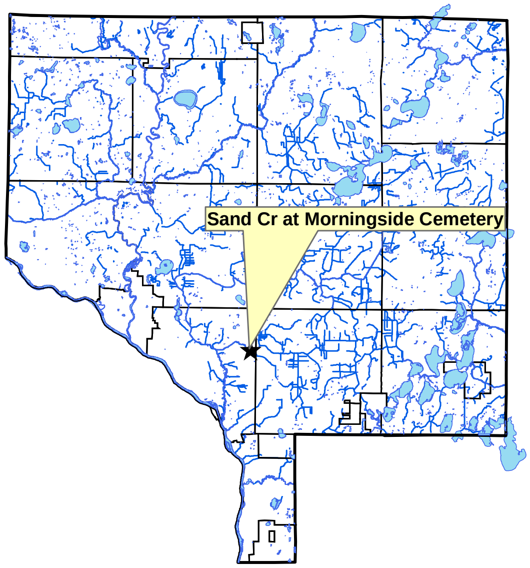
calculated based on every reading, not daily summaries, as they would "iron out" big jumps associated with intense storms.

"All Years" is not an average of each year's summary statistic. Rather, it is calculated from the continuous, multi-year record.

SAND CREEK

at Morningside Cemetery, Coon Rapids

Notes

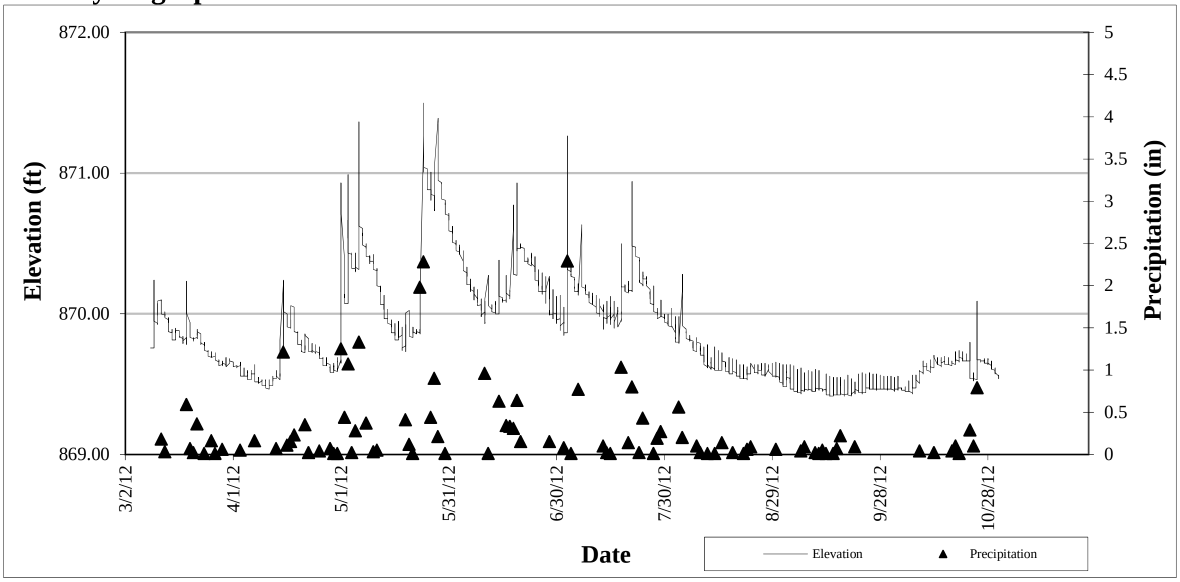


Sand Creek is the largest tributary to Coon Creek. It drains suburban residential, commercial and retail areas throughout northeastern Coon Rapids and western Blaine. The stream is approximately 8 feet wide and 3 feet deep at the monitoring site during baseflow.

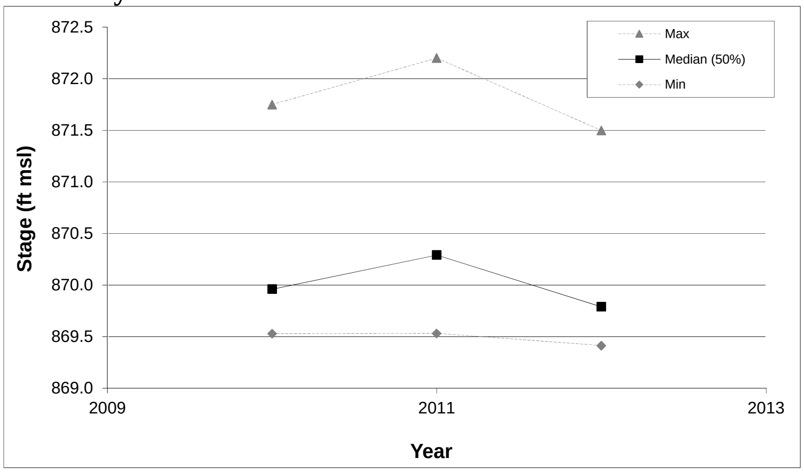
Sand Creek at Morningside Cemetery was monitored for the first time in 2010. The site was added because of its position between the cities of Blaine and Coon Rapids, which provides an estimate of the stormflow contributions from Blaine. In addition, the site is located immediately downstream of the confluence of Ditch 39 with Sand Creek. Water levels in the creek fluctuated 2.67 feet between baseflow and peak flow conditions during 2011.

Interestingly, creek levels often rise at this site more than downstream at Xeon Street following rainstorms. It is likely that flow volumes are similar or less at the cemetery, but because the channel is narrow the vertical rise in water levels is greater.

2011 Hydrograph



Summary of All Monitored Years



Percentiles	2010	2011	2012	All Years Thru 2012
Min	869.53	869.53	869.42	869.53
2.5%	869.61	869.59	869.44	869.59
10.0%	869.70	869.67	869.47	869.70
25.0%	869.79	870.03	869.59	869.85
Median (50%)	869.96	870.29	869.79	870.08
75.0%	869.96	870.53	870.09	870.08
90.0%	870.29	870.86	870.38	870.66
97.5%	870.60	871.17	870.82	871.03
Max	871.75	872.20	871.50	872.20

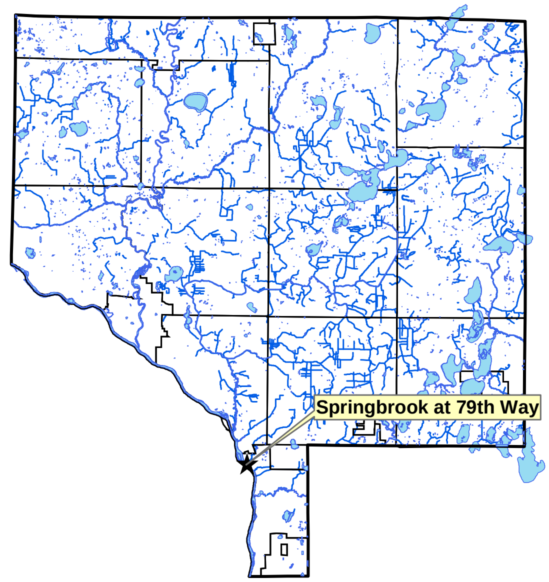
calculated based on every reading, not daily summaries, as they would "iron out" big jumps associated with intense storms.
"All Years" is not an average of each year's summary statistic. Rather, it is calculated from the continuous, multi-year record.

Stream Hydrology Monitoring

SPRINGBROOK

at 79th Way, Fridley

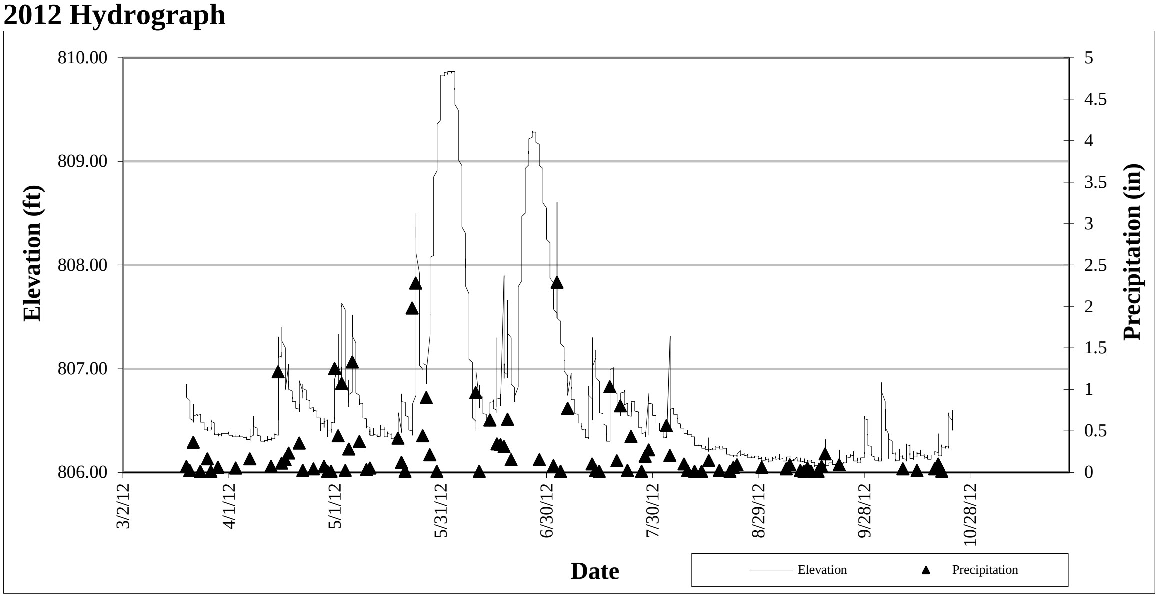
Notes



Springbrook 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, 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 feet wide and 1 foot deep at baseflow.

The stream is flashy, with water levels that increase dramatically following rainfall and quickly recede thereafter. This occurs despite the possible dampening effect of the stream flowing through the Springbrook Nature Center impoundment just upstream. In 2012, the only year monitored so far, the stream ranged 3.81 feet. During an isolated 1.21 inch rainstorm on April 15, 2012 the stream rose 1.07 feet. When 4.26 inches fell from May 23-24, 2012 the stream rose 2.13 feet, including 0.4 feet in a two hour period.

2012 Hydrograph



Summary of All Monitored Years

Percentiles	2012
Min	806.06
2.5%	806.09
10.0%	806.13
25.0%	806.20
Median (50%)	806.41
75.0%	806.73
90.0%	807.68
97.5%	809.31
Max	809.87

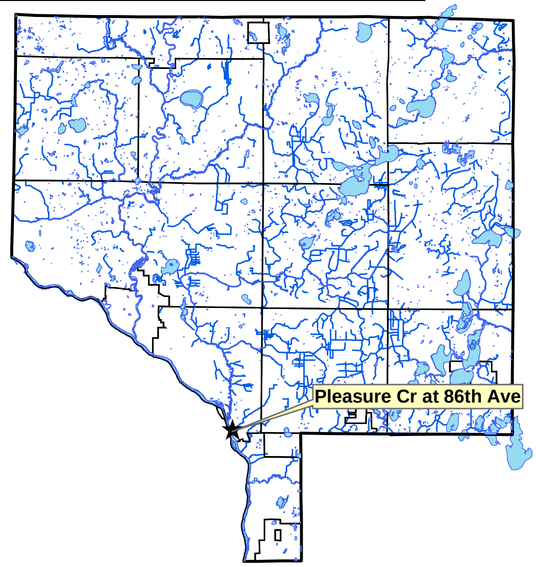
PLEASURE CREEK

at 86th Ave, Fridley

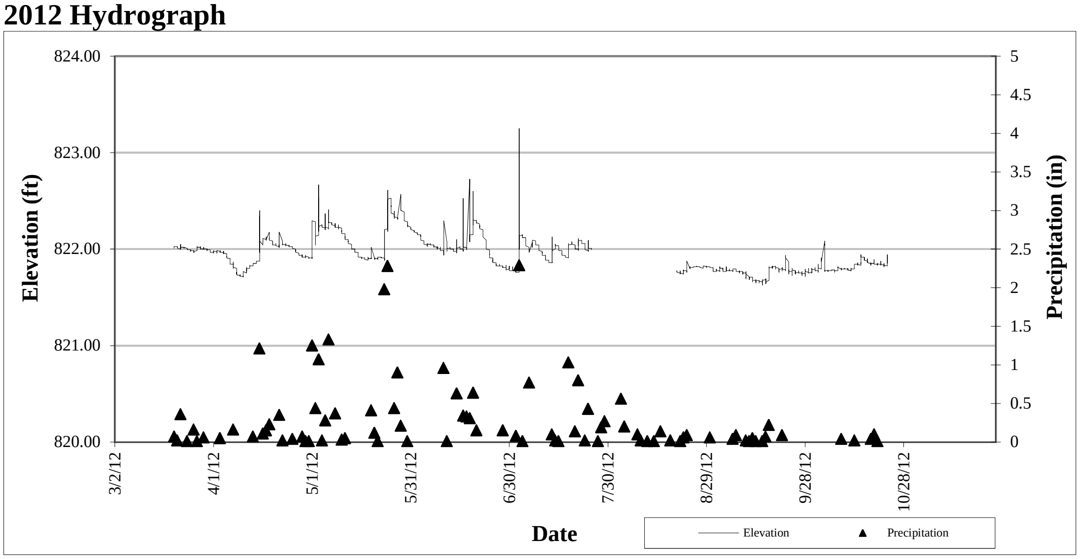
Notes

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 foot deep during baseflow. It flows through an interconnected network of stormwater ponds in the upper part of the watershed.

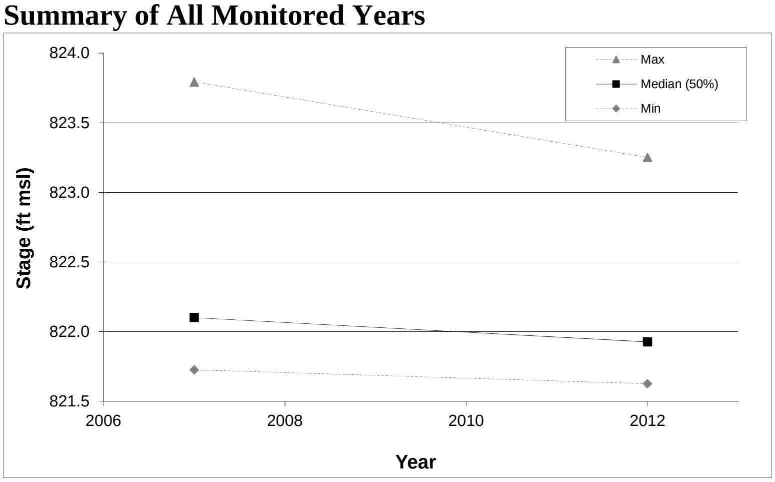
Variations in the water level at Pleasure Creek are seldom more than one foot. As an example, during a 1.21 inch storm on April 15, 2012 Pleasure Creek rose 0.52 feet in two hours, and then retreated 0.40 feet in the following two hours. Even for storms over two inches the stream response was less than one foot.



2012 Hydrograph



Summary of All Monitored Years



Percentiles	2007	2012
Min	821.73	821.63
2.5%	821.77	821.69
10.0%	821.84	821.77
25.0%	821.95	821.80
Median (50%)	822.10	821.93
75.0%	822.32	822.04
90.0%	822.49	822.19
97.5%	822.63	822.33
Max	823.79	823.25

Stream Water Quality – Chemical Monitoring

Description: Each stream was monitored eight times during the open water season; four times during baseflow and four times during storm flow. Storm flow events were defined as an approximately one-inch rainfall in 24 hours, though totals vary from location to location. Each stream was tested for pH, conductivity, turbidity, dissolved oxygen, temperature, salinity, total suspended solids, chlorides, sulfates, hardness, and total phosphorus.

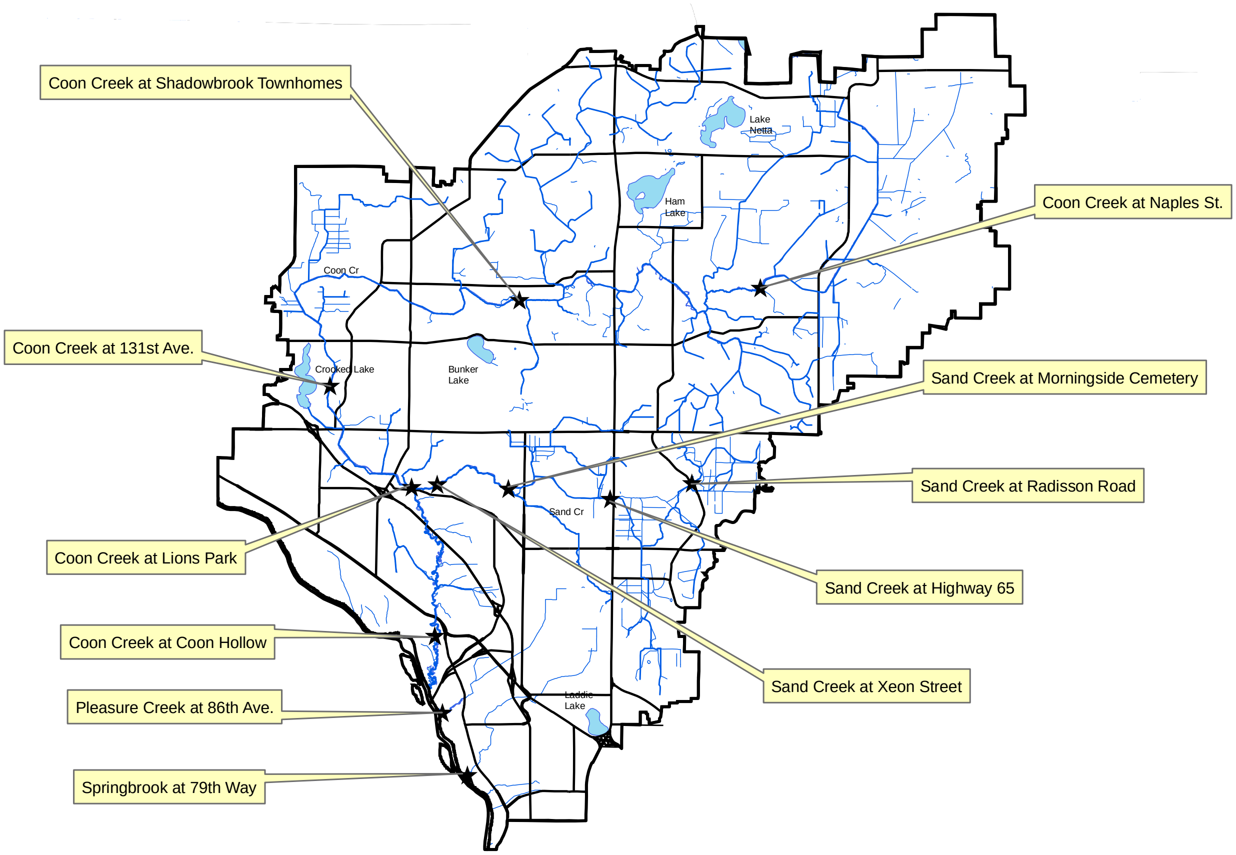
Purpose: To detect water quality trends and problems, and diagnose the source of problems.

Locations:

Stream	Location	City
Coon Creek	131st Ave.	Coon Rapids
Coon Creek	Coon Hollow	Coon Rapids
Coon Creek	Lions Park	Coon Rapids
Coon Creek	Naples St. NE	Ham Lake
Coon Creek	Shadowbrook Townhomes	Andover
Pleasure Creek	86th Ave. NW	Coon Rapids
Sand Creek	Highway 65	Blaine
Sand Creek	Morningside Cemetery	Coon Rapids
Sand Creek	Radisson Road	Blaine
Sand Creek	Xeon St.	Coon Rapids
Springbrook	79th Way NE	Fridley

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

Coon Creek Watershed 2012 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 happened at each stream. Also, in some cases the extremes measurements are important than the median values presented. Please see detailed results from each stream for more insight.

For Coon Creek, Sand Creek, and Pleasure Creek the numbers shown are medians of all readings from all sites. Springbrook has only one monitoring site. All data through 2012 are included.

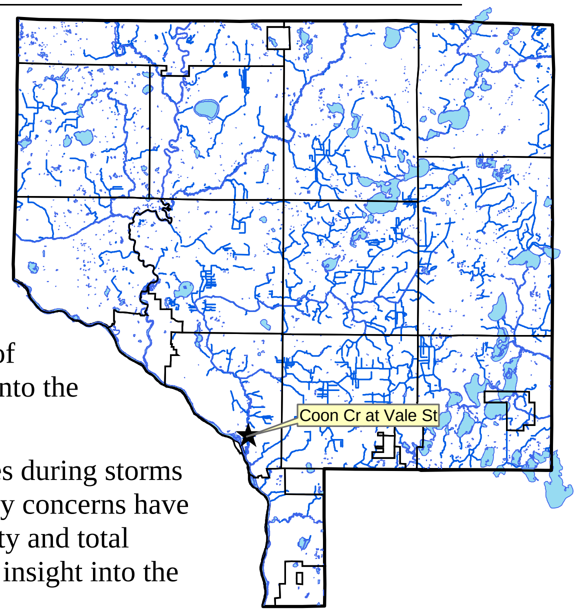
	Springbrook Cr	**Pleasure Cr**	**Sand Cr**	**Coon Cr**	**Median for Anoka Co Streams**	**State Water Quality Standard**
Conductivity (mS/cm)	0.753	0.756	0.723	0.485	0.362	none
Chlorides (mg/L)	159	125	67	40	17	860 - acute 230 - chronic
Turbidity (FNRU)	5	10	8.5	17	8.5	None*
Total Suspended Solids (mg/L)	5	6.5	6	14	12	30*
Total Phosphorus (ug/L)	74	106.5	65.5	128	135	100*
Dissolve Oxygen (mg/L)	8.19	8.46	8.12	8.60	6.97	5
pH	7.97	7.89	7.73	7.76	7.62	6.5-8.5

*Proposed new state water quality standards.

Hydrolab Continuous Stream Water Quality Monitoring

COON CREEK

Coon Creek at Vale St., Coon Rapids STORET SiteID = S003-993



Years Monitored

Coon Cr at Vale Street 2011, 2012

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 ditch serves as an important stormwater conveyance for the Cities of Ham Lake, Andover, Blaine, and Coon Rapids. The creek outlets into the Mississippi River.

Coon Creek and its tributaries have been monitored by grab samples during storms and baseflow over the course of several years. Several water quality concerns have been noted, including dissolved pollutants, phosphorus, and turbidity and total suspended solids. Continuous monitoring is needed to gain further insight into the nature and possible corrective actions for problems.

The purpose of hydrolab continuous water quality monitoring is to document water quality changes throughout a storm. This should help 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

Coon Creek at Vale Street was chosen for monitoring because it is the farthest downstream, easily accessible site on Coon Creek. Access might be achieved farther downstream, but backwater influences from the Mississippi River would be likely during high flow. This site has been used for past monitoring efforts.

Coon Creek at Vale Street was monitored immediately before, during, and after storms with a Hydrolab MS5 water quality sonde. The sonde was suspended inside a PVC pipe by a chain from 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 if flow was low. The sonde was programmed to take readings every 30 minutes. Readings included pH, salinity, specific conductance, temperature, dissolved oxyen, and turbidity. The sonde was calibrated before each deployment.

Staff deploying the Hydrolab MS5. In the background are the Hydrolab casing (shorter) and a Measura continuous water level monitoring device.

The Hydrolab was deployed into the stream when a storm predicted to drop at least 0.5 inches of rain, and preferably greater, was approaching. Past grab sample monitoring had found that the greatest water quality problems occurred after storms exceeding one inch. In some instances, water level was already high before the storm and remained high after the storm. At other times, predicted rain did not fall and we were monitoring baseflow conditions. In all instances, the Hydrolab was left in the field for several days.

Water levels were continuously monitored before, during, and after all Hydrolab monitoring. A Measura WM-80 water level monitoring device recorded water levels every two hours. This stream stage is presented with the water quality data. It would be preferable to present flow, and a rating curve does exist, however during some sampling events water was exceptionally high and exceeded the capacity of the rating curve so that flow could not be accurately calculated. To make graphs from all storms comparable, stage is shown for all.

Precipitation data are provided with the water quality results. These data were taken from the datalogging rain gauge at Coon Rapids City Hall, which is approximately 2 miles north of the stream monitoring site. In our analysis we also looked at precipitation totals in other portions of the watershed and noted any large differences.

Results and Discussion

A variety of storm sizes were analyzed. Rainfall during the monitored time periods ranged from 0.16 to 5.82 inches. The wide distribution is helpful in discerning the creek's response to different events.

The discussion below incorporates results from all years of Hydrolab monitoring, but only 2012 individual storm results are presented in this report. The individual storm results for previous years are in that year's Anoka Water Alamanc, or are available upon request from the Anoka Conservation District. Each year the finding of Hydrolab analysis are reviewed and re-evaluated.

On the following pages results from each storm monitored are shown. The graphs show precipitation and the stream hydrograph approximately one day before and after water quality monitoring began. Separate graphs show each water quality parameter. The text below discusses summarizes findings across all storms for each parameter.

<u>Turbidity</u>

- For most storms there is a brief, large turbidity spike during or immediately following rainfall. This is due to the first flush of urban stormwater from the lower portions of the watershed. Turbidity retreats to much lower levels within hours, or for the largest storms, a few days.
- Turbidity remained slightly higher than observed baseflow in the days following a storm. This turbidity could be runoff from upper portions of the watershed or bed load associated with higher flows, or both. In either case, it is minor compared to the very high turbidity seen immediately following rainfall.
- Because turbidity does not closely follow stream stage, bed load is not the primary driver of high turbidity.
- Brief but intense storms of 0.3 inches or more cause dramatic increases in turbidity from single digits to 25+ NTU.
- There is substantial variability among storms. Storms with similar rainfall totals may produce dramatically different turbidity in the creek. Intervening factors include storm intensity, whether snowmelt is occurring synchronously, and the amount of time since the last wash off event.

<u>Specific Conductance</u>

- Specific conductance, a measure of dissolved pollutants, is inversely related to water level. When creek water rises, conductance drops. During brief, intense rainfall the stream conductance drops sharply. The shallow groundwater that feeds the stream during baseflow has higher conductance than stormwater runoff, and storm runoff dilutes it. Infiltration of road deicing salts are a likely source of high conductance in stream baseflow year round.

Dissolved Oxygen

- The observed dissolved concentrations in Coon Creek stayed well within the healthy, desirable range.
- Dissolved oxygen stayed above 5 mg/L, the state water quality standard, in all but one event monitored. Below this level some fish species begin to suffer. During a 2011storm of 4.11 inches dissolved oxygen dropped with rising water levels and was maintained between four and five mg/L for an extended period.
- When stream levels rise, a dissolved oxygen often drops, but not to critically low levels.

Temperature

- Water temperature is generally not considered a concern in Coon Creek because there is no trout or other temperature sensitive resource.
- Cycles of day warming and night cooling are apparent in the data.

pH

- pH is inversely related to water level in Coon Creek. When water level rises, pH declines. This is because rainwater has a lower pH than that of local shallow groundwater.
- pH was always within the desired range of 6.5 to 8.5 that is specified in state water quality standards.

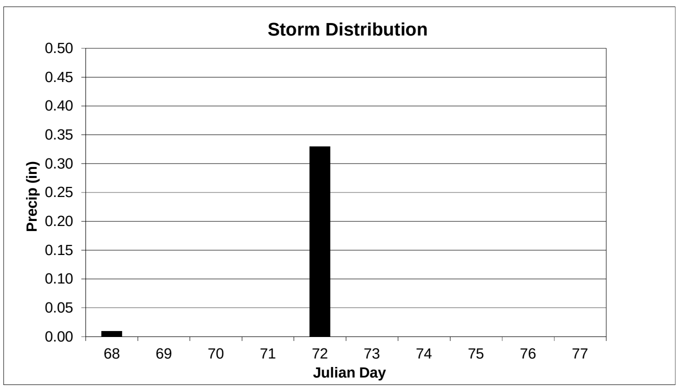
Hydrolab Continuous Monitoring
Storm 1 - 2012

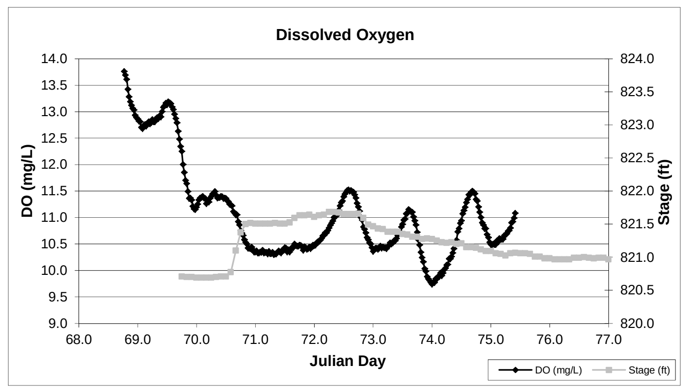
<u>Storm Summary:</u>

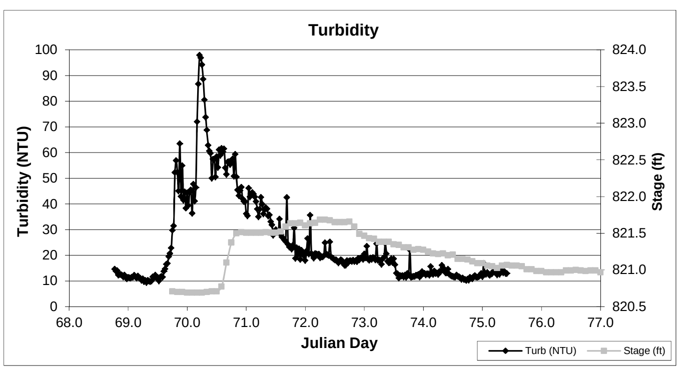
Dates: 9 March 2012 (day 69) to 16 March 2012 (day 76)

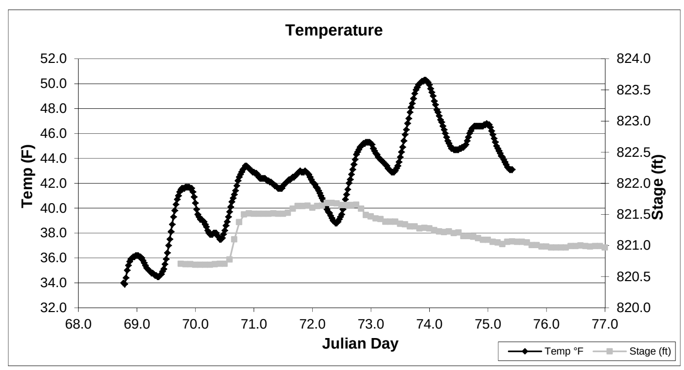
Precipitation: 0.34 inches plus snowmelt ongoing

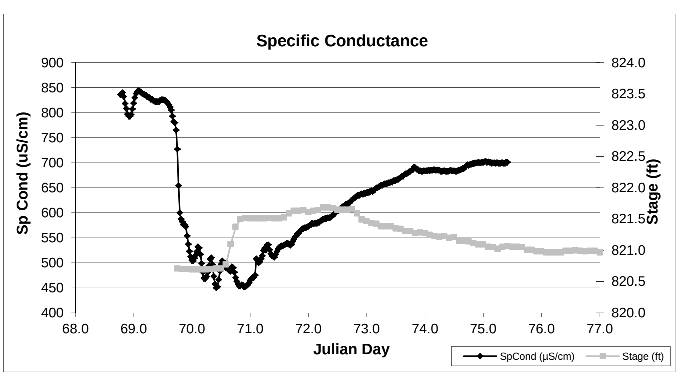
Notes: This was a period of rapid warming and a substantial <u>snowmelt event</u>. The 4-8 inches of snowpack on the ground at the start of this period was mostly gone by the end due to daytime temperatures in the 50's F and nighttime temperatures above freezing.

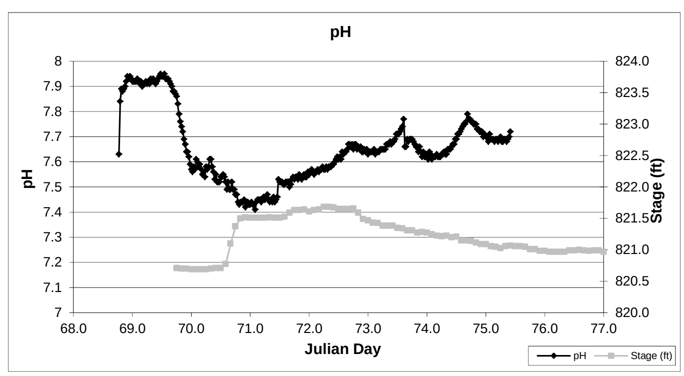












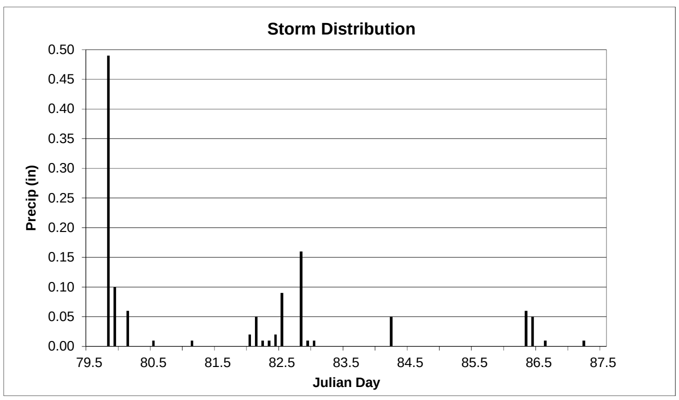
Hydrolab Continuous Monitoring
Storm 2 - 2012

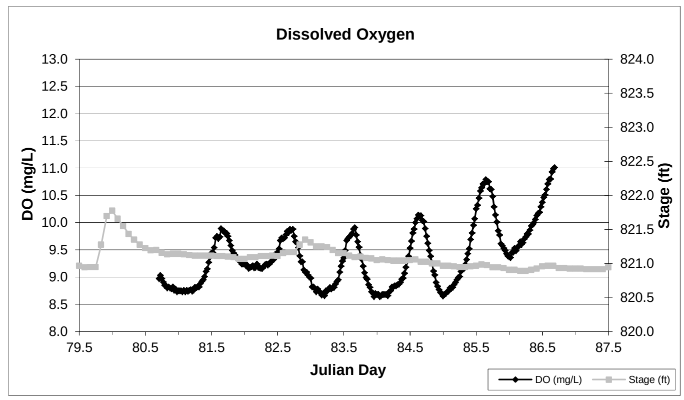
Storm Summary:

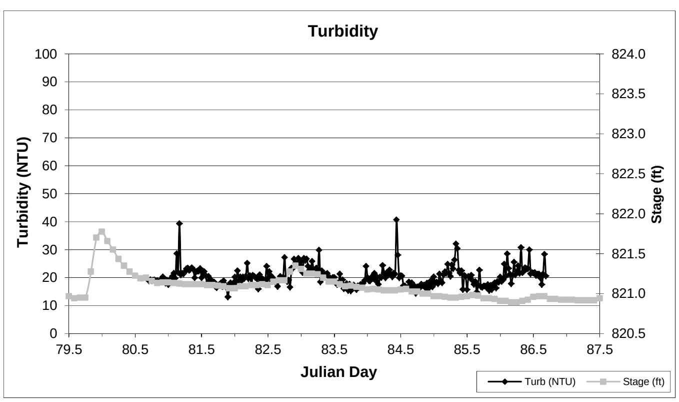
Dates: 20 March 2012 (day 80) to 26 March 2012 (day 86)

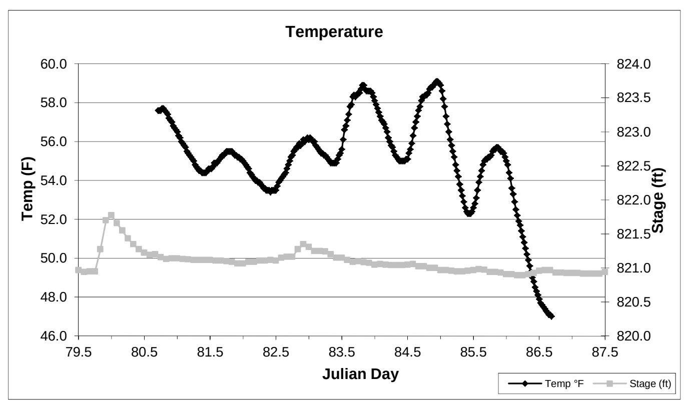
Precipitation: 1.22 inches

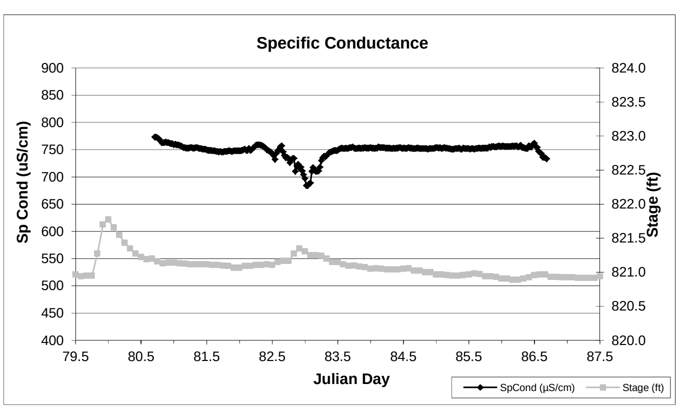
Notes: Most of the rainfall was before the Hydrolab was deployed. 0.59 inches of rain fell on March 19 and the Hydrolab was deployed on March 20th at 5pm.

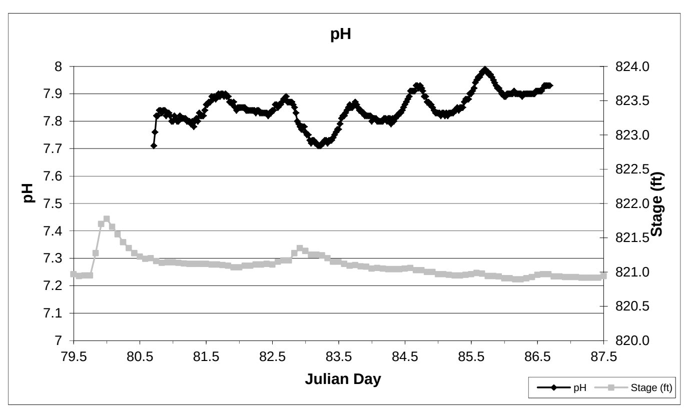








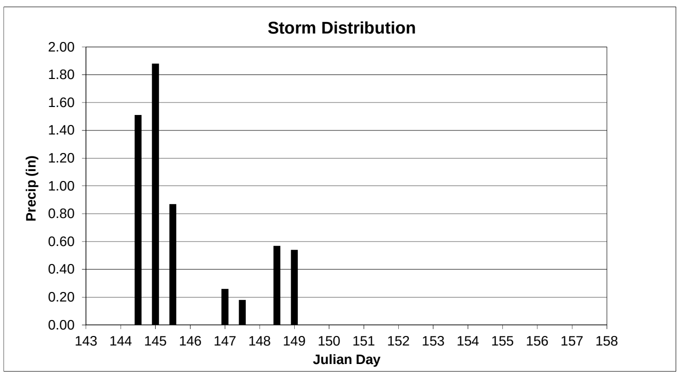


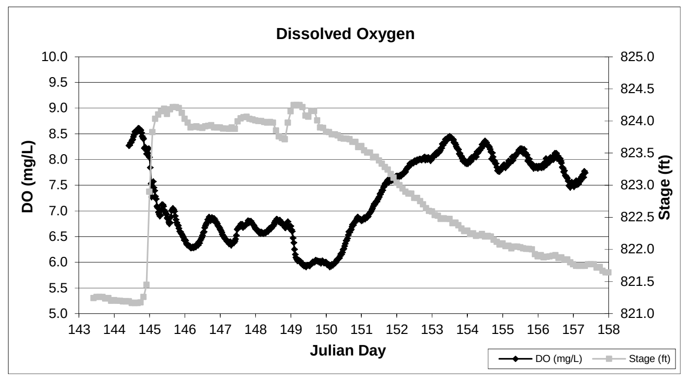


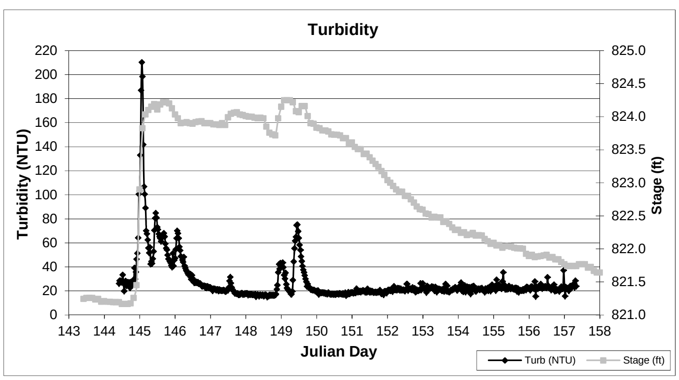
Hydrolab Continuous Monitoring
Storm 3 - 2012

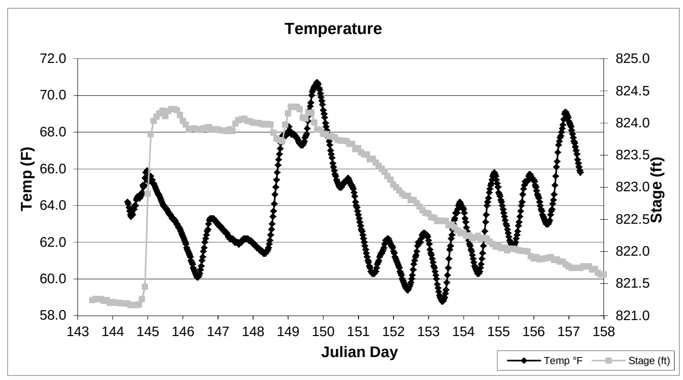
Storm Summary:

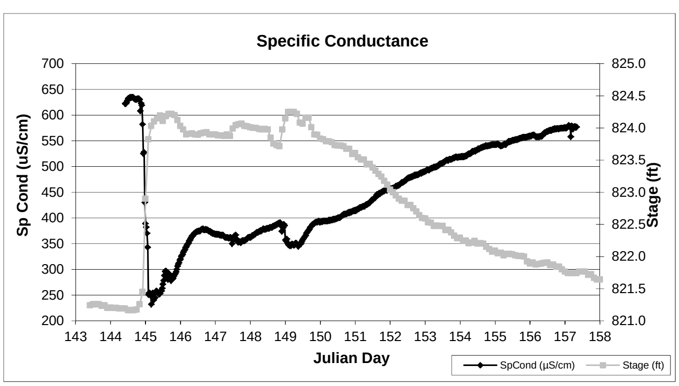
Dates:	23 May 2012 (day 144) to 5 June 2012 (day 157)
Precipitation:	5.82 inches
Notes:	Large rainfall event with widespread totals of 3-6 inches. Stream levels were very high. Notice that turbidity is >200 NTU during the initial burst of rainfall, but then falls to <80 NTU in the following storm bursts within 24 hours. This reflects initial wash off of impervious surfaces like roads by the first rainfall. The relatively lower turbidity after the storm, despite high stream levels, suggests that stormwater runoff is much more problematic for Coon Creek than turbidity from the upper watershed or bed load transport.

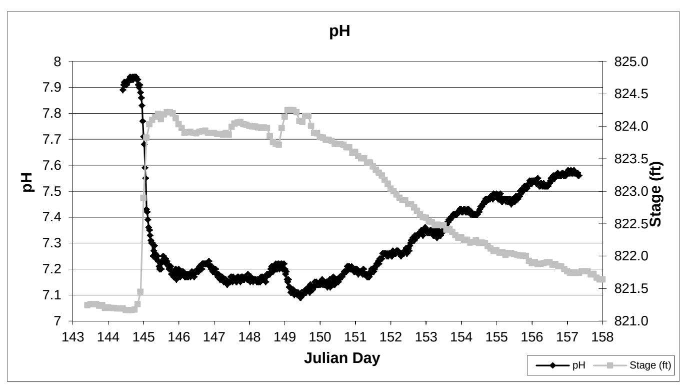








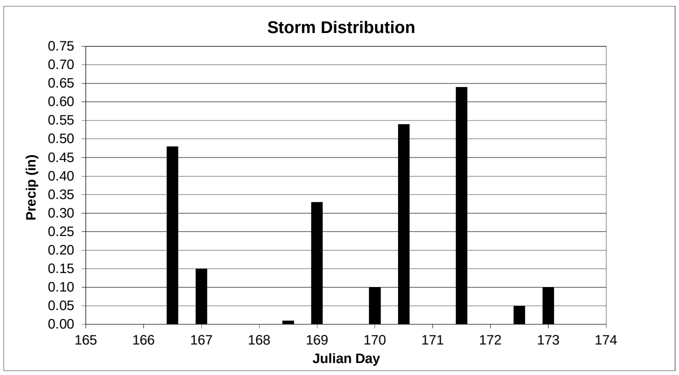


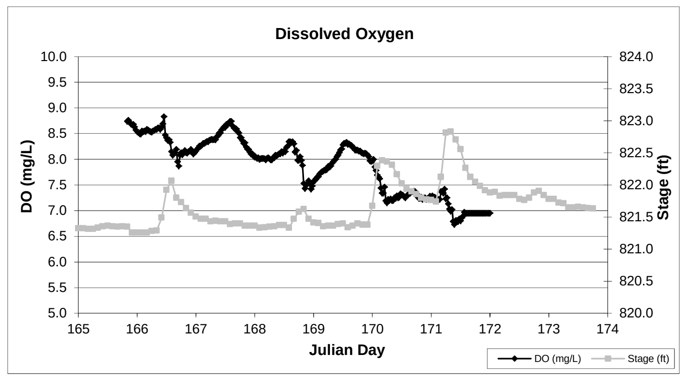


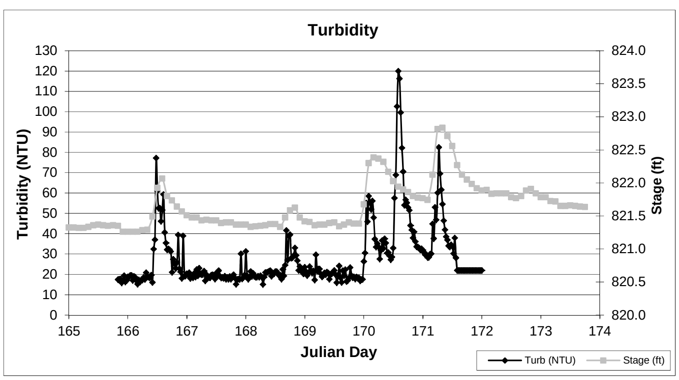
Hydrolab Continuous Monitoring
Storm 4 - 2012

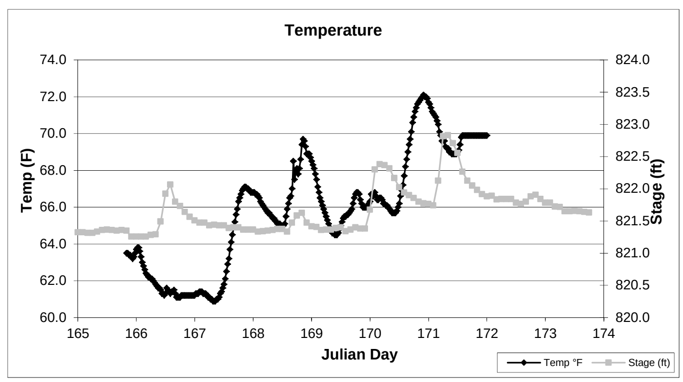
Storm Summary:

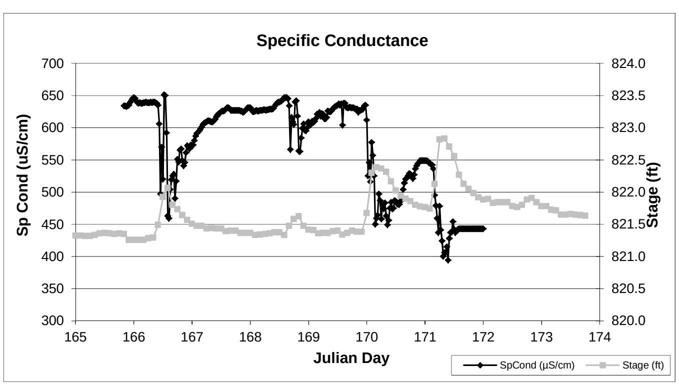
Dates: 13 June 2012 (day165) to 20 June 2012 (day173)
Precipitation: 2.40 inches
Notes: This time period included several consecutive days of moderate rainfall. Dates and amounts of rainfall included: June 14 – 0.63", June 16 – 0.34", June 17 – 0.33", June 18 – 0.31", June 19 – 0.64", June 20 – 0.15"

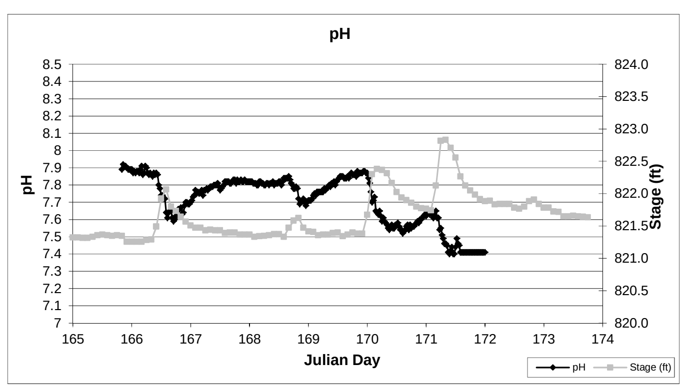












Hydrolab Continuous Monitoring
Storm 5 - 2012

Storm Summary:

Dates: 24 July 2012 (day 206) to 27 July 2012 (day 210)

Precipitation: 0.65 inches

Notes: 1.39 inches of rain fell three days prior to Hydrolab deployment. 0.43 inches fell on the day of deployment before the equipment was installed in the field.

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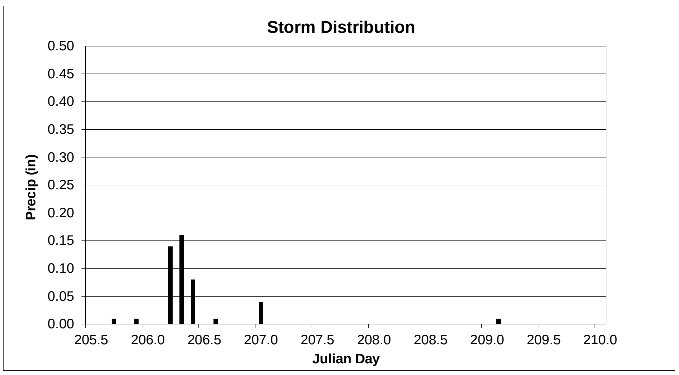
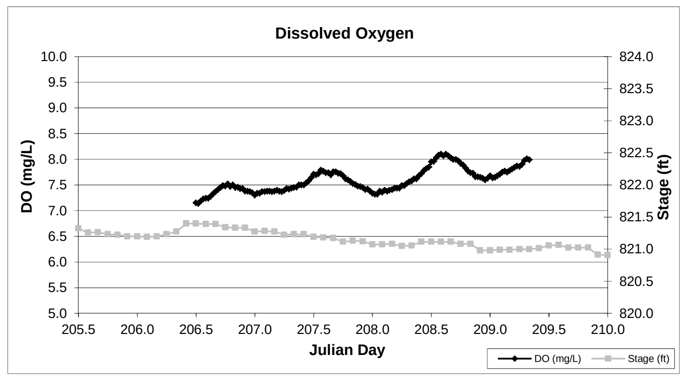
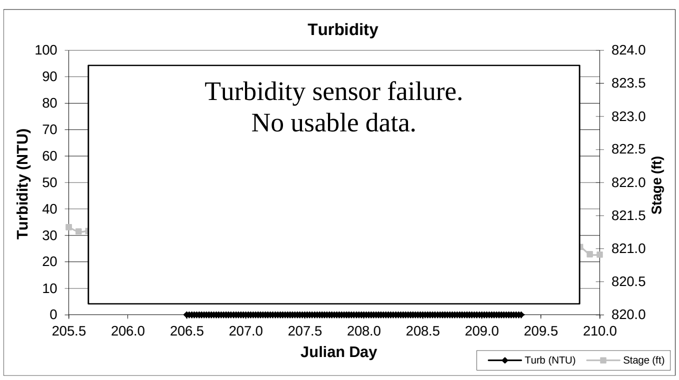
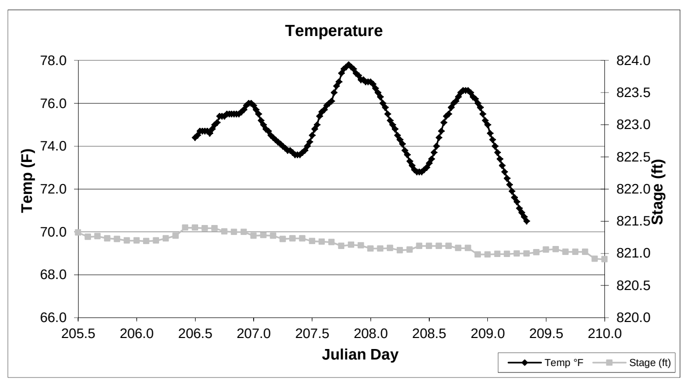
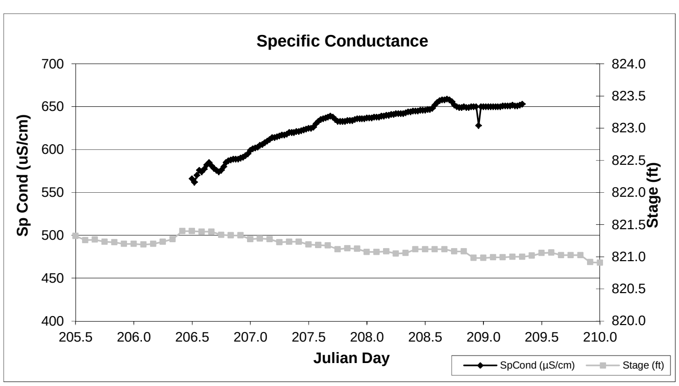
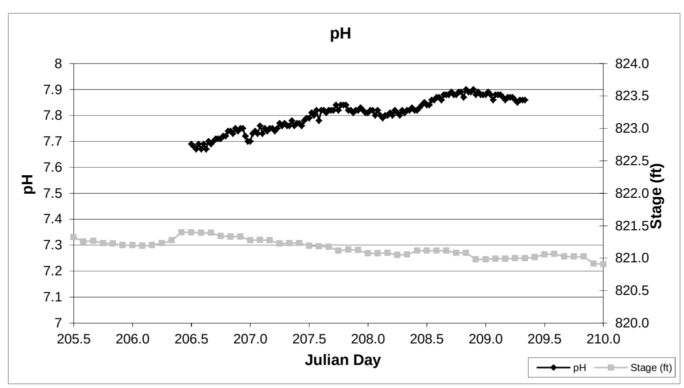












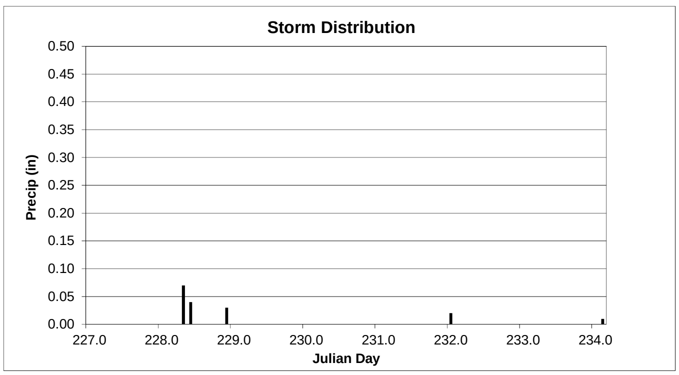
Hydrolab Continuous Monitoring
Storm 6 - 2011

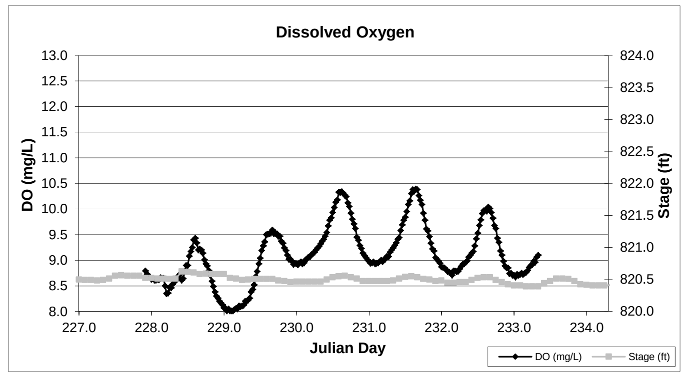
Storm Summary:

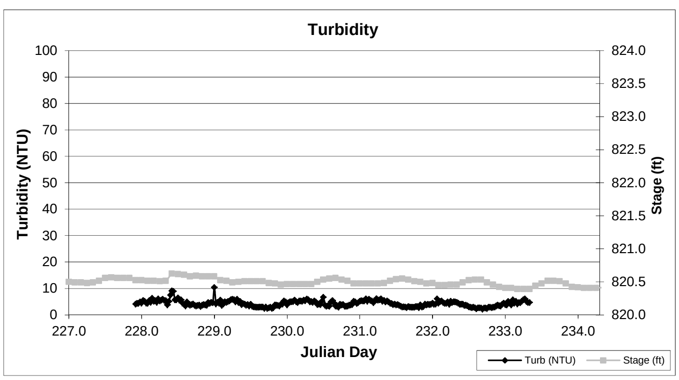
Dates: 14 August 2012 (day 235) to 20 August 2012 (day 241)

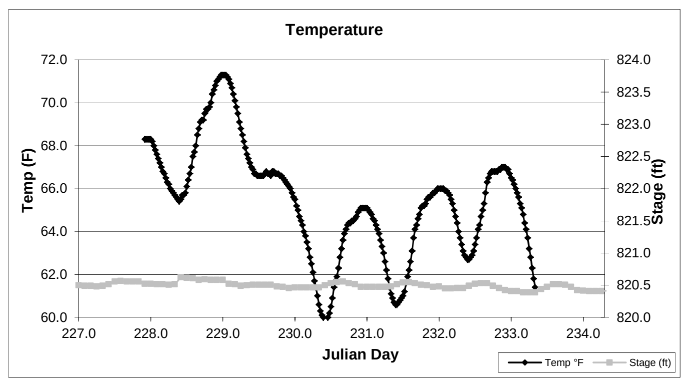
Precipitation: 0.16 inches

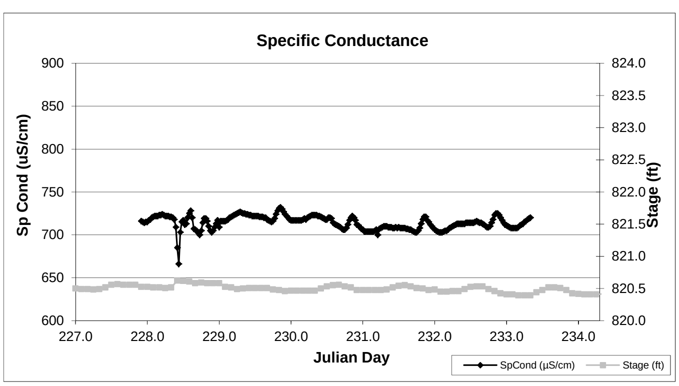
Notes: Minor rain shower which had little or no effect on water quality. This time period is more representative of baseflow conditions.

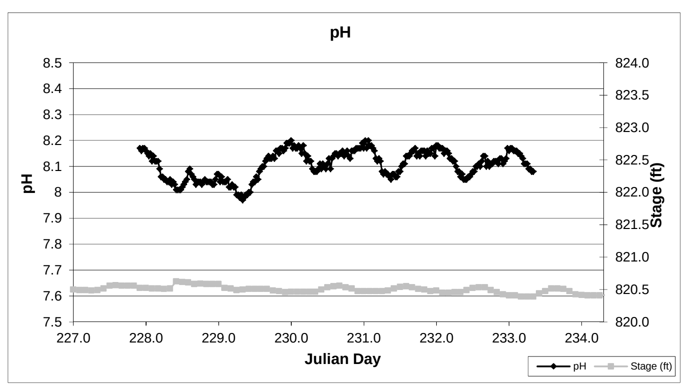




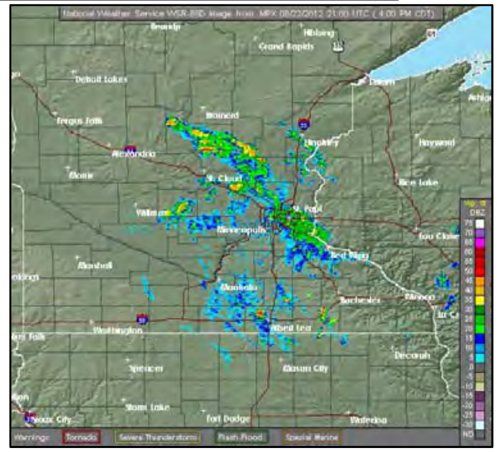






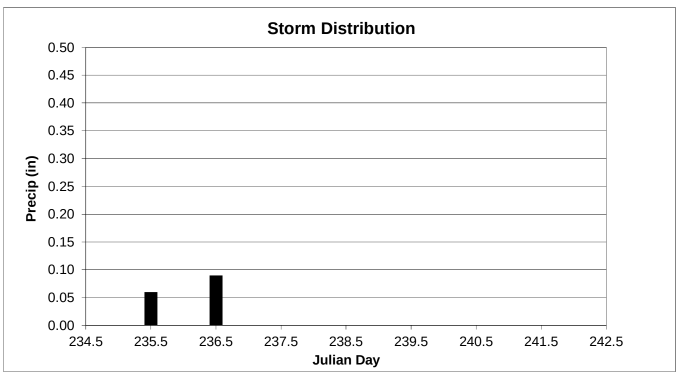


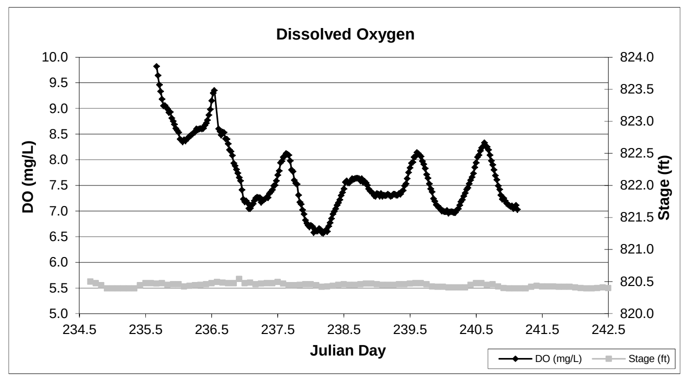
Hydrolab Continuous Monitoring
Storm 7 - 2012

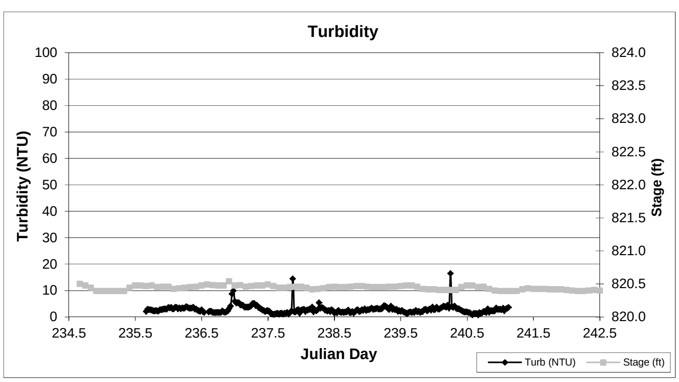


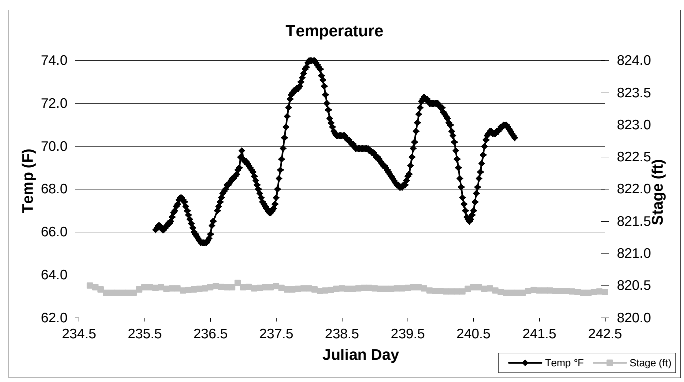
<u>Storm Summary:</u>

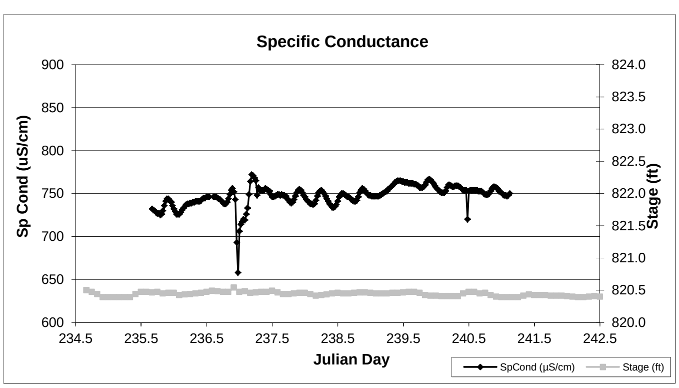
Dates:	22 August 2012 (day 235) to 28 August 2012 (day 241)
Precipitation:	0.16 inches
Notes:	Isolated thunderstorm. Radar image provided.

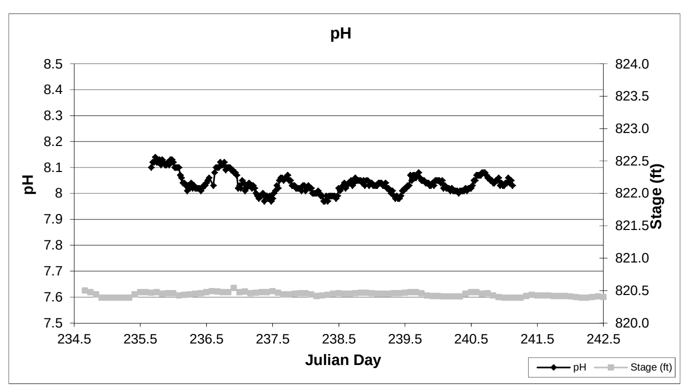








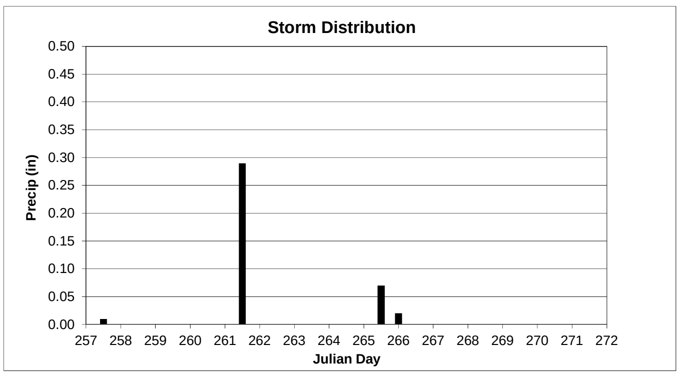


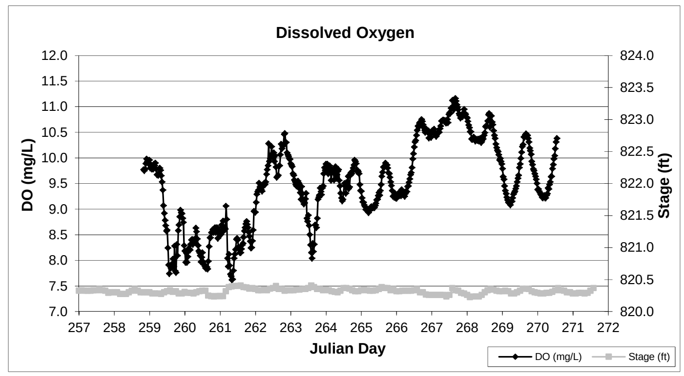


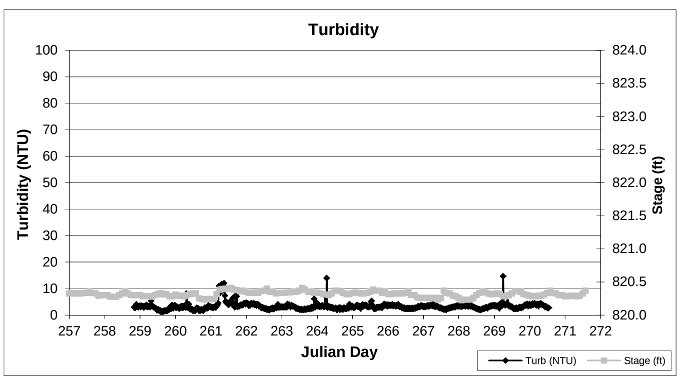
Hydrolab Continuous Monitoring
Storm 8 - 2012

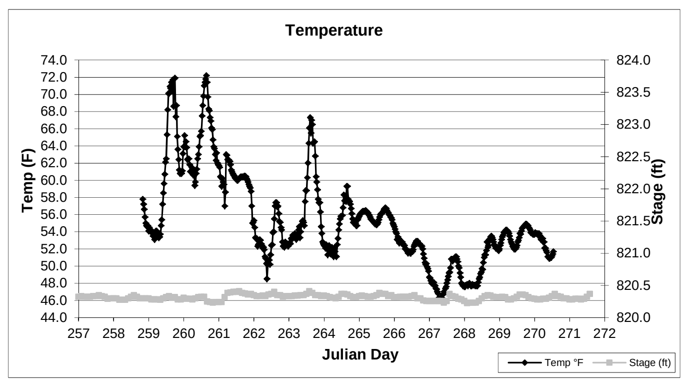
<u>Storm Summary:</u>

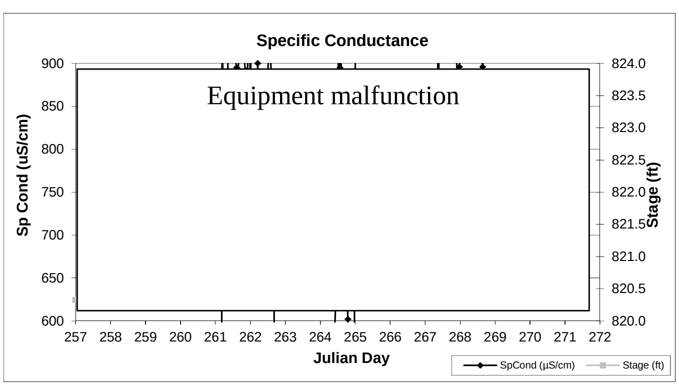
Dates: 13 September 2012 (day 257) to 26 September 2012 (day 270)
Precipitation: 0.44 inches
Notes:

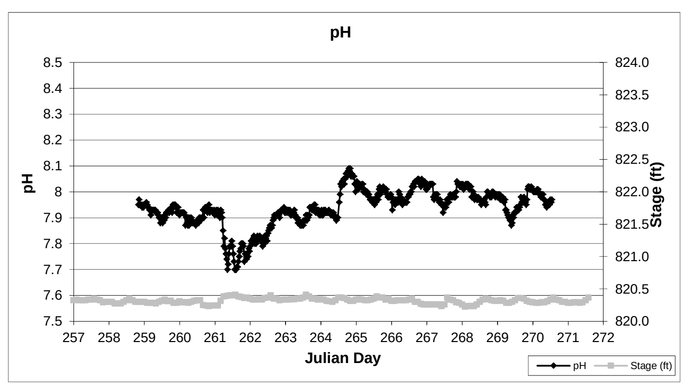








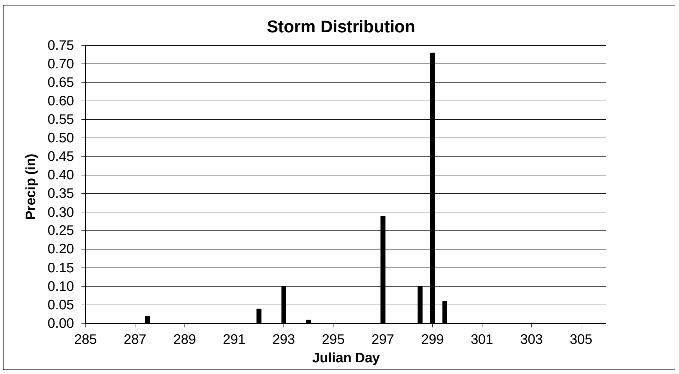


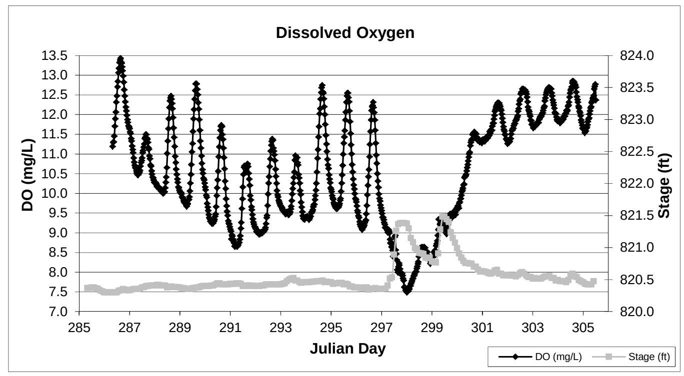


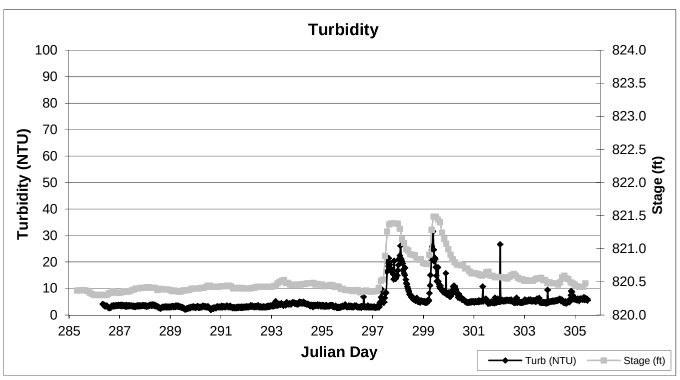
Hydrolab Continuous Monitoring
Storm 9 - 2012

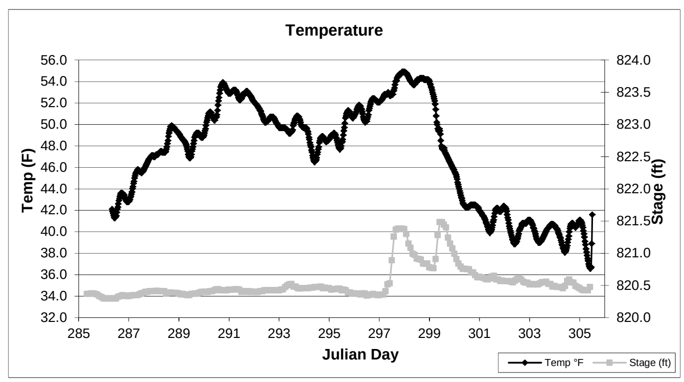
Storm Summary:

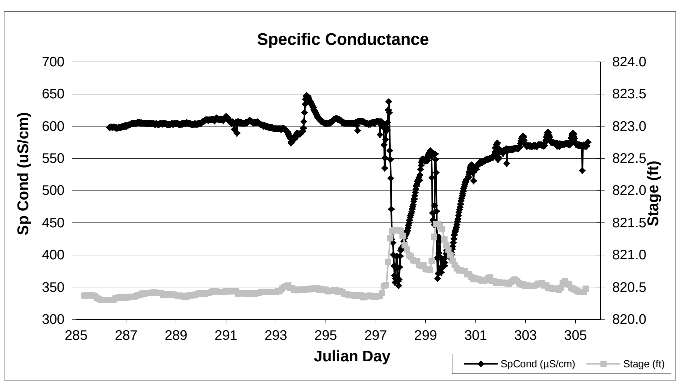
Dates: 12 October 2012 (day 286) to 31October 2012 (day 305)
Precipitation: 1.35 inches
Notes: Periods of light rain, plus 0.29 inches on October 23 and 0.79 inches on October 25.

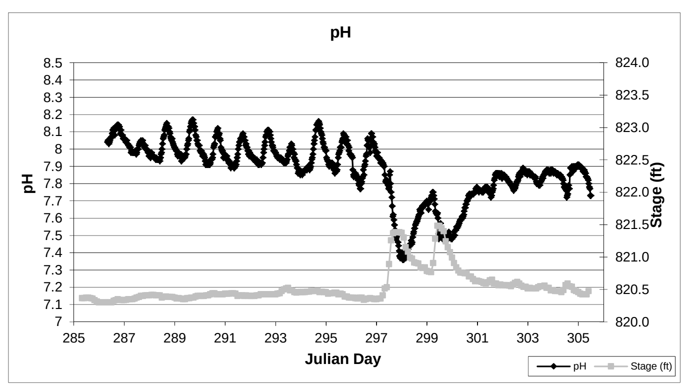












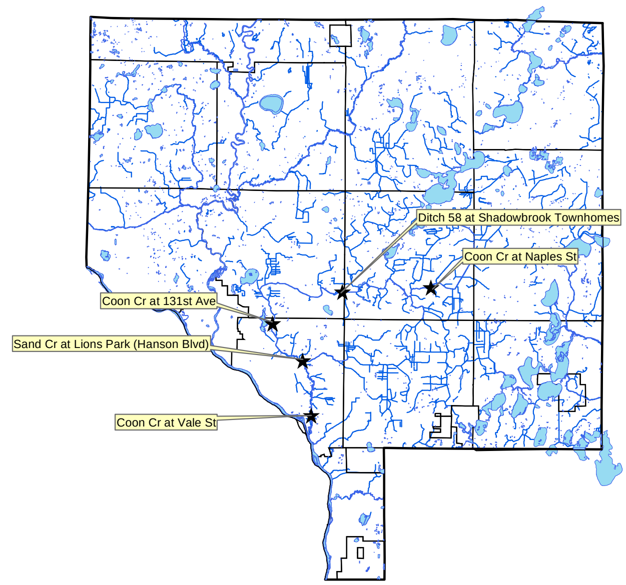
COON CREEK

Coon Creek at Naples Street, Ham Lake	STORET SiteID = S007-057
Coon Creek at Shadowbrook Townhomes, Andover	STORET SiteID = S004-620
Coon Creek at 131st Avenue, Coon Rapids	STORET SiteID = S005-257
Coon Creek at Lions Park, Coon Rapids	STORET SiteID = S004-171
Coon Creek at Vale St., Coon Rapids	STORET SiteID = S003-993

Years Monitored

Coon Cr at Naples St	2012
Coon Cr at Vale St	2005-2012
Coon Cr at 131st Ave	2010-2012
Coon Cr at Shadowbrook Townhomes	2007-2012
Coon Cr at Lions Park (Hanson Blvd)	2007-2012

Additional, intermittent data available at some other sites



Note that continuous water quality monitoring has been conducted at Vale Street in 2011-2012 using a Hach Hydrolab. That data is reported elsewhere.

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 Ham Lake, Andover, Blaine, and Coon Rapids. It outlets into the Mississippi River.

Methods

Coon Creek was monitored during both storm and baseflow conditions 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. In some years, particularly the drought year of 2009, 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, conductivity, turbidity, temperature, salinity, and dissolved oxygen. Beginning in 2009 transparency tube measurements were added, as well as photo-documentation of water appearance. Parameters tested by water samples sent to a state-certified lab included total phosphorus, total suspended solids, chlorides, hardness, and sulfate.

During every sampling the water level (stage) was recorded using a staff gauge surveyed to sea level elevations. Stage was also continuously recorded using a datalogging electronic gauge at the Xeon Street stream crossing (farthest downstream).

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. We focus upon an upstream-to-downstream comparison of water quality, a comparison of baseflow and storm conditions, and an overall assessment. There are water quality concerns throughout Coon Creek. Following is a summary, including a management discussion:

- Dissolved pollutants, as measured by conductivity and chlorides, in Coon Creek were approximately double the median for other streams in Anoka County. They are highest in downstream reaches and during baseflow. Coon Creek is well below the state water quality standard for chlorides.

  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 was at acceptably low levels during baseflow, but was much more variable and generally higher during storms. During baseflow phosphorus was lower than the median for streams in Anoka County and often lower than the MPCA's not-yet-adopted water quality standard of 100 ug/L. However phosphorus doubles during storms, likely exceeding state standards that will soon be adopted. Phosphorus is higher in downstream reaches than upstream.

  Management discussion: Phosphorus needs to be reduced in both the upper and lower watershed, though the sources are likely different.

- Suspended solids and turbidity were low upstream and during baseflow, but increase dramatically during storms. During baseflow suspended sediment was below state standards, but increased 1.7 to 4.5-fold during storms, frequently exceeding state standards. Suspended solids were high at all sites during storms, though the source likely differs in different parts of the watershed. While bedload is a concern, Hydrolab monitoring has shown that suspended solids concentration does not follow stream flows, suggesting is it not the primary source.

  Management discussion: There are at least two sources of suspended solids and turbidity that seem to be important in 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 fully-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 probably near and in-stream sediment sources like bedload and streambank erosion. High flows are a common aggravator of this type sediment source. We would anticipate near and in-stream significant sources to be important in Coon Creek because much of it is ditched, and ditches generally have unstable sides, and because native soils are highly erodable. Yet continuous monitoring of turbidity with a Hydrolab 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 found it was common for turbidity to increase for several days after a storm, even when flows were dropping. We would expect bedload and streambank erosion to increase with flow.

- pH and dissolved oxygen were with the range considered normal and healthy for streams in this area.

Conductivity and Chlorides

Conductivity, chlorides, and salinity are all measures of a broad range of dissolved pollutants. Dissolved pollutant sources include urban road runoff, industrial sources, and others. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Conductivity is the broadest measure of dissolved pollutants we used. It measures electrical conductivity of the water; pure water with no dissolved constituents has zero conductivity. Chlorides 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, however it is noteworthy that Coon Creek is upstream from the drinking water intakes on the Mississippi River for the Twin Cities.

Both measures of dissolved pollutants in Coon Creek were notably higher than the median for other Anoka County streams (see table and figures below). Median conductivity in Coon Creek (all sites, all conditions) was 0.505 mS/cm compared to the countywide median of 0.362 mS/cm. Median chlorides in Coon Creek (all sites, all conditions) was 39 mg/L compared to the countywide median of 17mg/L.

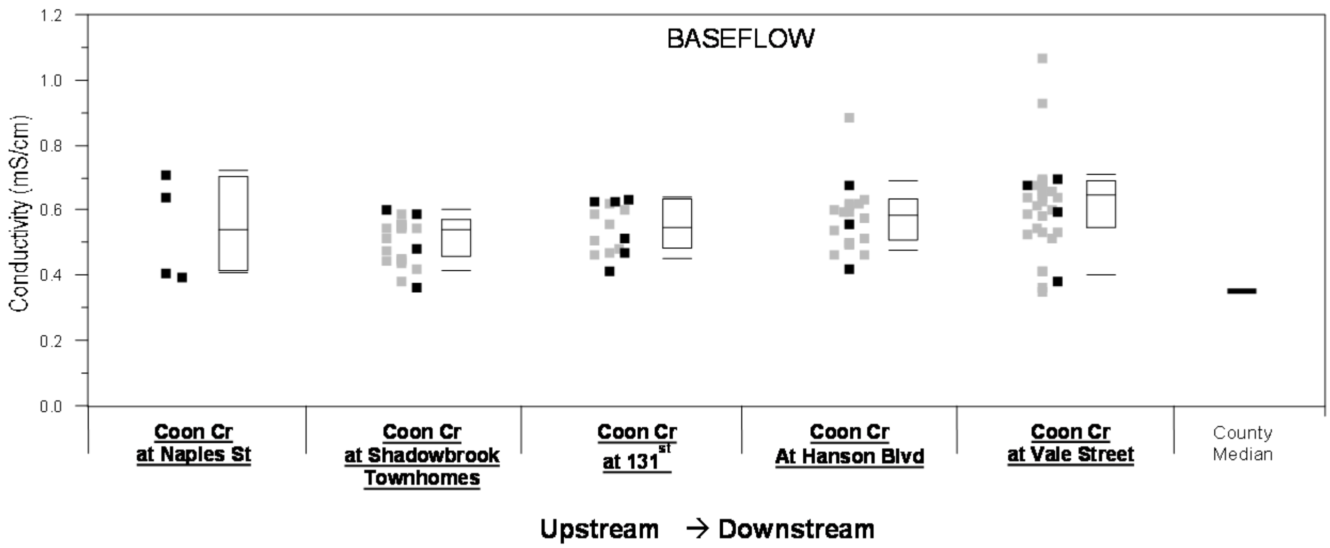
Dissolved pollutants were higher in downstream reaches of Coon Creek, where there is more impervious area (see figures below). Median conductivity increased modestly from upstream to downstream (0.425, 0.462, 0.507, 0.515, and 0.505 mS/cm, respectively), as did chlorides (23, 33, 39, 51, and 52 mg/L, respectively). Chlorides increased more in from upstream to downstream than conductivity, suggesting road deicing salt is the pollutant that increases most in the lower part of the watershed.

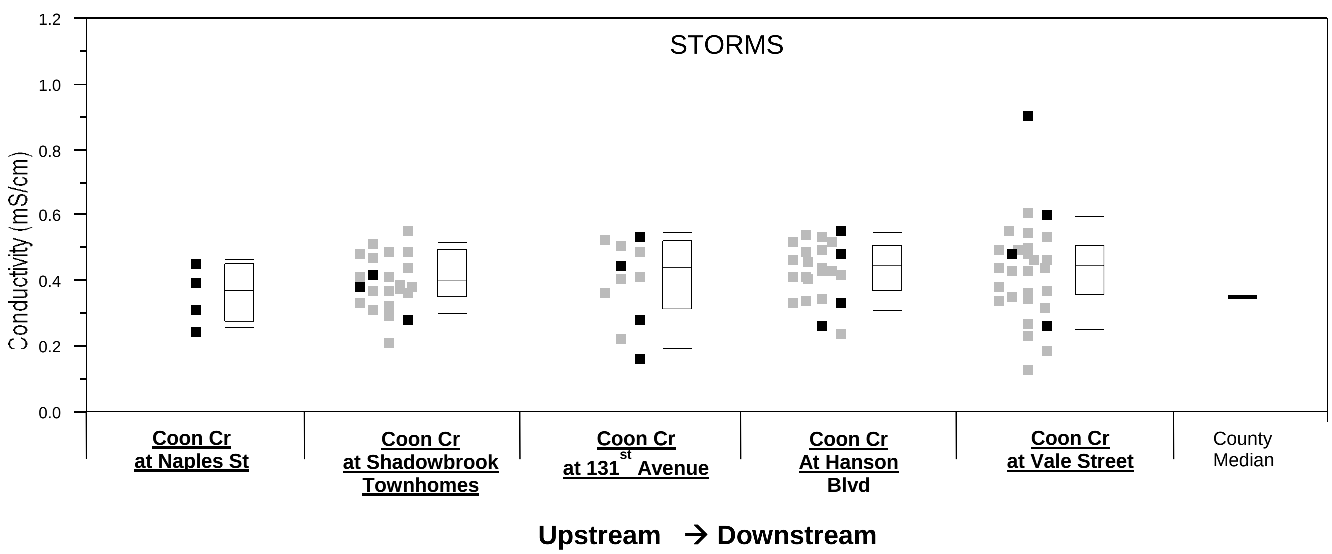
Dissolved pollutants were lower during storms. For example, median chlorides during baseflow were 62 mg/L during baseflow and 40 mg/L during storms at Vale street. Similarly, median conductivity during baseflow was 0.618 mS/cm, but 0.385 mS/cm during storms at Vale Street. This lends some insight into the pollutant sources. If dissolved pollutants were only elevated during storms, stormwater runoff would be suspected as the primary contributor. 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 Coon Creek 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 being slightly worse. While storms dilute some of the baseflow pollutants, they also carry additional pollutants which somewhat offset the dilution. From a management standpoint, 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.

Median conductivity and chlorides in Coon Creek. Data is from Vale St for all years through 2012.

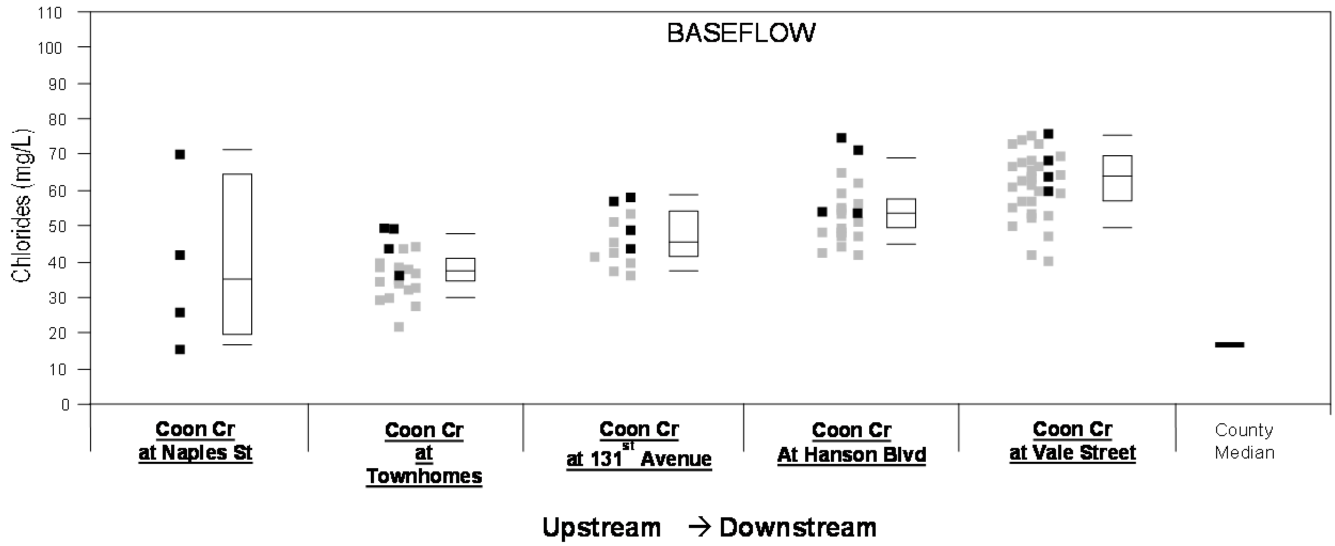
	Conductivity (mS/cm)	Chlorides (mg/L)	State Standard	N
Baseflow	0.618	62	Conductivity – none Chlorides 860 mg/L acute, 230 mg/L chronic	32
Storms	0.382	40		32
All	0.495	52		64
Occasions > state standard				0

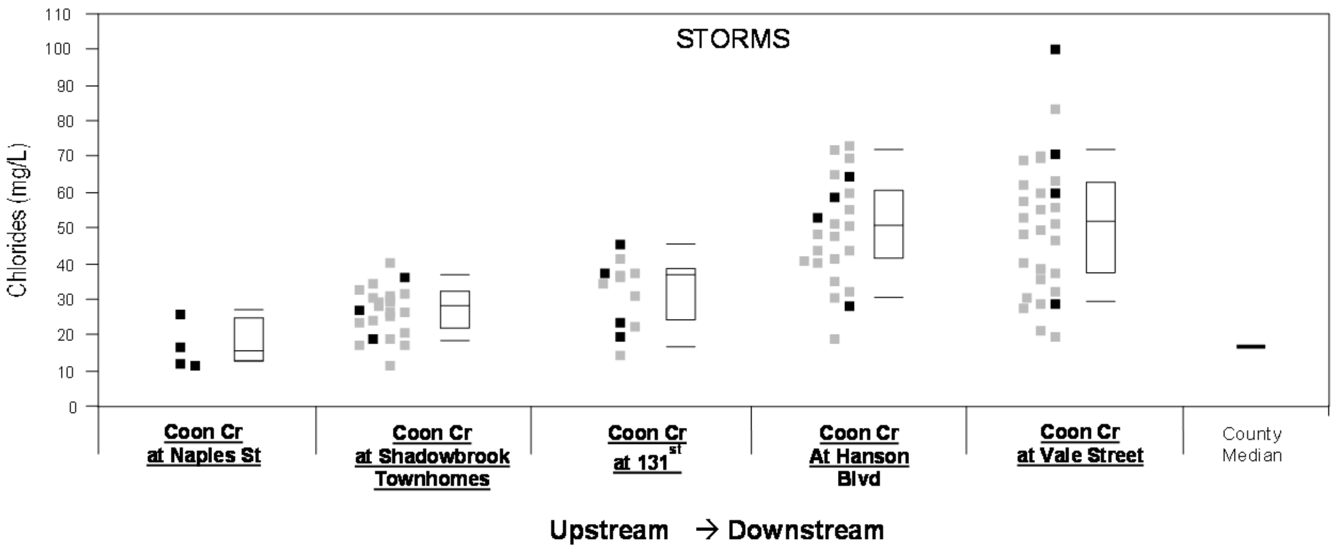
Conductivity Coon Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Chlorides Coon Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Recent research has shown that chloride toxicity is heavily dependent upon water hardness, and to a lesser degree, sulfate levels in the water. Therefore, these parameters were measured in 2011 and 2012. This data is summarized in the table below.

Sulfate and hardness at Coon Creek. The median of eight measurements taken in 2011 from Coon Creek at Xeon Street is shown. No other years of data are available. Data from other sites are available.

	Coon Creek at Vale Street
Sulfate (mg/L)	52.8
Hardness (mg/L CaCO3)	233

Iowa has revised its water quality standards to reflect the impact of sulftates and hardness on chloride toxicity, and Minnesota is in the process of doing so. Iowa has developed the following equations to calculate acute and chronic chloride standards for each waterbody:

Acute chloride standard = $287.8(\text{Hardness})^{0.205797}(\text{Sulfate})^{-0.07452}$

Chronic chloride standard = $177.87(\text{Hardness})^{0.205797}(\text{Sulfate})^{-0.07452}$

These equations are applied to Coon Creek data in the table below.

Coon Creek chloride standards using Iowa equations that account for sulfate and hardness. Data used are eight hardness and sulfate measurements in Coon Creek at Vale Street through 2012. Coon Creek observations listed are only from Vale Street because that is the site with highest observed chlorides and therefore the most likely to exceed state standards.

	Stream-specific chloride standard as calculated with Iowa equations	**Current Minnesota Standard**	**Coon Creek Observations**
Acute (one hour average)	**658 mg/L**	**860 mg/L**	**85.2 mg/L** = Maximum observed
Chronic (four day average)	**406 mg/L**	**230 mg/L**	**43 mg/L** = Average of all observations

The effect of these site-specific standards for Coon Creek, once adopted in Minnesota, would be to make the acute standard more strict, and the chronic standard less strict. Presently, Coon Creek is far below both standards. It will become even less likely that the stream will violate the chronic standard once it is relaxed. However, there is a greater likelihood that Coon Creek might exceed the acute standard, particularly during winter or snowmelt when chlorides are likely to be highest. The only winter monitoring that has occurred has been late in the snowmelt process.

Total Phosphorus

Total phosphorus (TP) is a common nutrient pollutant. It is limiting for most algae growth. Total phosphorus in Coon Creek was consistently low during baseflow conditions, but approximately doubled during storms (see figure below). The Minnesota Pollution Control Agency is developing a TP water quality standard for streams, and Coon Creek will likely be designated as impaired for exceeding it during storms in the lower part of the watershed. Best management practices for this stream are needed to address stormwater phosphorus along the entire monitored stream length.

Baseflow TP was low, but high during storms. During baseflow the five monitoring sites had median TP of 66, 75, 121, 88, and 82 ug/L, respectively, from upstream to downstream. This is lower than the countywide median for streams of 135 ug/L. It is also generally lower than the not-yet-finalized state water quality standard of 100 ug/L, although 12 of 32 measurements were above 100 mg/L. There was little variability among baseflow samples.

During storms TP was higher, and sometimes much higher. Median TP during storms was 2.0 (131st Ave site) to 2.4 (Shadowbrook Townhomes site) greater than the median for baseflow. Storms also had much greater variability. The standard deviation for storm readings were, from upstream to downstream, 74, 109, 141, 105, and 136 ug/L. By contrast, the standard deviations during baseflow were 6, 49, 46, 45, and 36 ug/L, respectively, from upstream to downstream. Variation in the timing, magnitude, and intensity of the storm is likely responsible for the greater variability in TP during storms compared to baseflow.

TP was higher at downstream sites than upstream during storms. Median storm TP upstream to downstream were 137, 182, 245, 194, and 187 ug/L, respectively.

TP at the all sites downstream monitoring site regularly exceed the likely and not-yet-finalized state standard of 100 ug/L. At Vale Street only one of 32 TP measurements during storms was lower than 100 ug/L. The maximum observed was 672 ug/L.

The dominant phosphorus source is likely different in upstream and downstream stream reaches. Upstream is less developed and development occurred more recently with more stringent stormwater treatment requirements. Here, mobilization of in-stream sediments and agricultural runoff may be an important phosphorus source, and stormwater runoff to a lesser degree. Drained, organic wetland soils may be another source; many ditch tributaries exist. Downstream parts of the watershed are fully developed and some were 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 quite important.

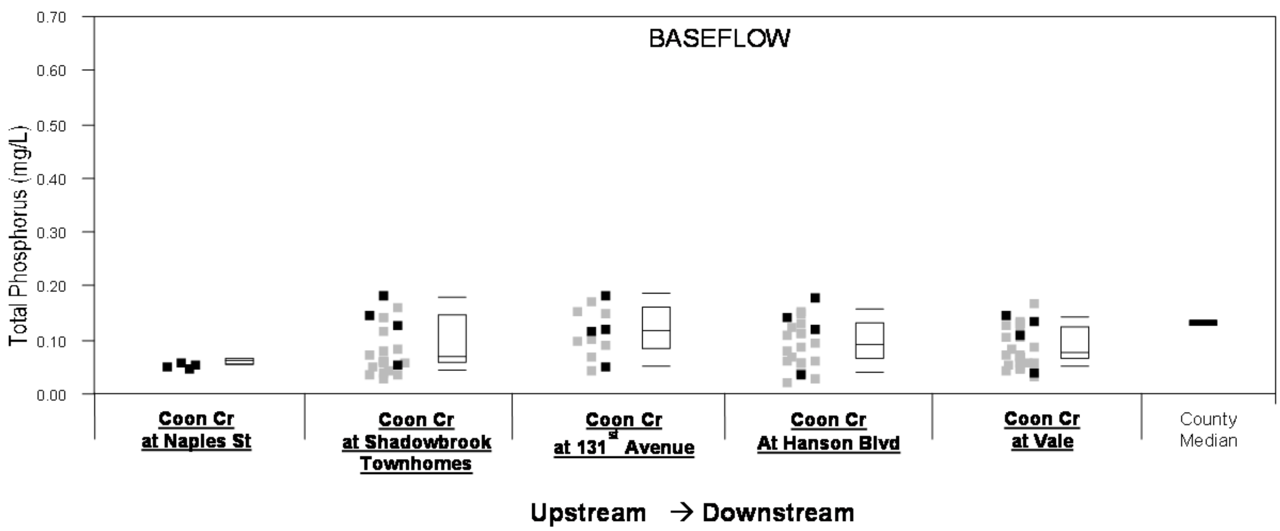
Phosphorus reduction during storms needs to occur throughout the watershed. The highest priority should be addressing phosphorus from urban stormwater runoff in the lower portion of the watershed. This is the area with the highest TP. Also, this is the area with the highest levels of other pollutants, such as total suspended solids. Improvements to stormwater treatment in this area could address multiple problems.

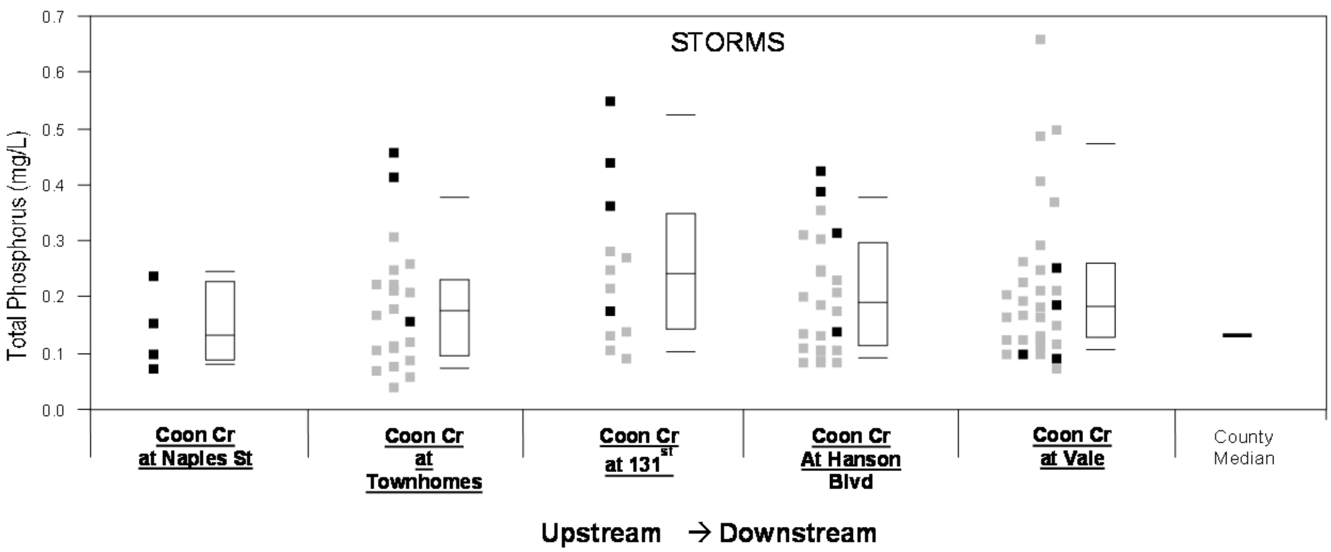
Median total phosphorus in Coon Creek. Data is from Vale St for all years through 2012.

	Total Phosphorus (ug/L)	State Standard*	N
Baseflow	82	100	32
Storms	187		32
All	132		64
Occasions > state standard			43 (31 storms, 12 baseflow)

*New state standards are under development. The standard listed is the likely new threshold.

Total phosphorus at Coon Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. 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 measures by defraction of a beam of light sent though the water sample, and is therefore most sensitive to large particles.

In Coon Creek TSS and turbidity were low upstream and during baseflow, but increase dramatically during storms and in downstream reaches (see figures below). Presently the state water quality standard allows turbidty of >25 NTU during no more than 10% of measurements. That standard is being changed to TSS of 30 mg/L. In either case, the stream likely exceeds state water quality standards.

During baseflow TSS and turbidity were acceptably low and showed little upstream to downstream increase. Median turbidity during baseflow from upstream to downstream were 10, 9, 15, 9, and 12 FRNU, respectively. This is similar to the countywide median of 8 FRNU. At the same time, 6 of 32 (19%) baseflow measurements are greater than MPCA's present water quality standard of 25. Median TSS during baseflow from upstream to downstream was 6, 8, 7, 11, and 9 mg/L, respectively. This is lower than the median for streams county-wide of 12 mg/L. Only 1 of 32 (3%) of TSS measurements exceeded the new, proposed water quality standard of 30 mg/L.

During storms TSS and turbidity were higher, and there was some modest increase from upstream to downstream. Median TSS and turbidity during storms were both 1.7 to 4.5 times higher than during baseflow (comparison is among site medians). Median storm TSS was 21, 13, 19, 23, and 39 mg/L from upstream to downstream. Median storm turbidity was 44, 15, 48, 30, and 39 FNRU from upstream to downstream.

During storms, TSS was often similarly high at all sites (see figures below). Bank erosion, bedload 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 are high throughout the watershed, it is safe to say the problem is not geographically isolated.

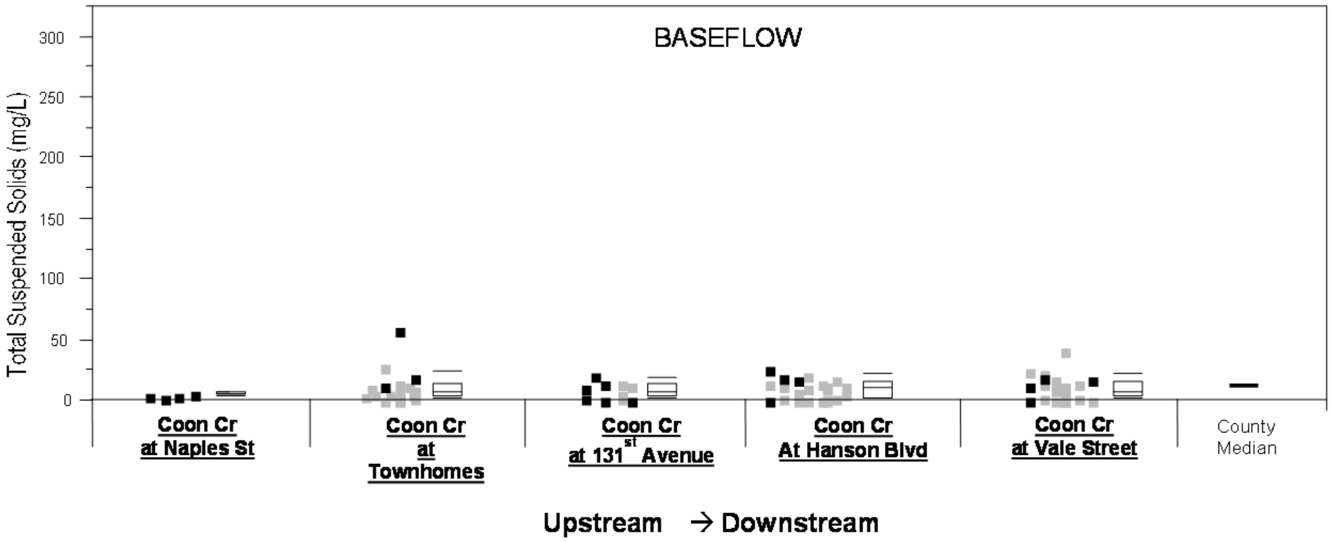
Research should be done to determine the extent to which bed load transport of sediment is contributing to high turbidity and TSS. Presently, it appears that it has the potential to be important. High suspended solids in the upper watershed, where land uses are rural residential and sod fields is surprising, given that these are not often sources of high suspended solids. This lends suspicion that near-channel and in-channel sources may be important in the upper watershed. It may be important farther downstream too. On the other hand, Hydrolab continuous turbidity monitoring during storms has found that turbidity does not increase as flow increases, as would be expected if bed load were dominant.

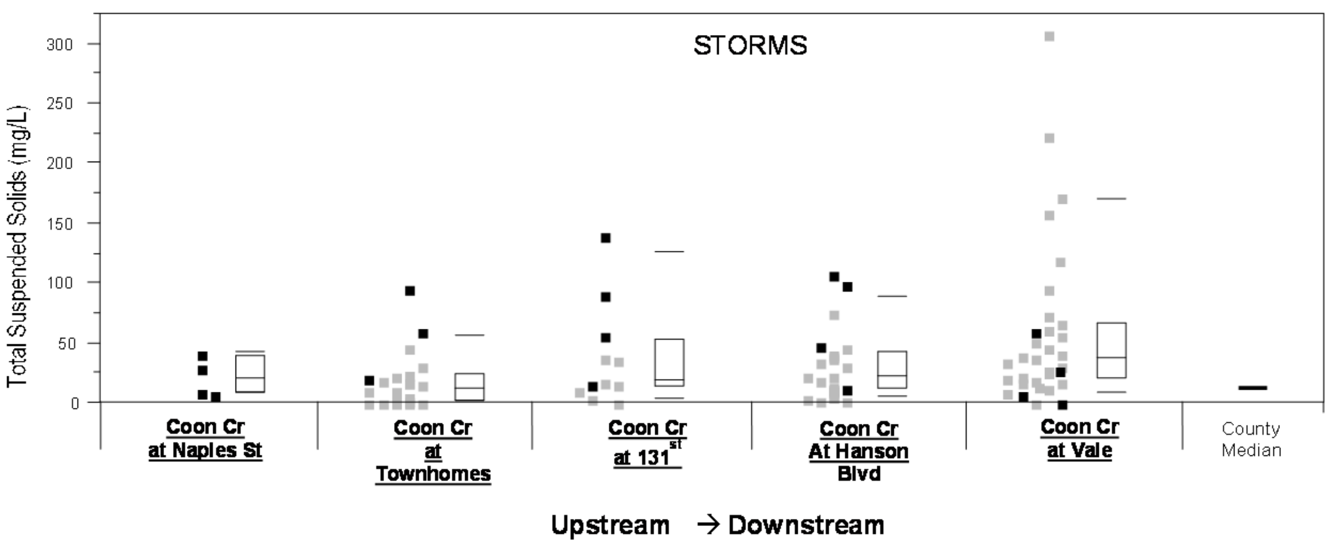
Median turbidity and suspended solids in Coon Creek. Data is from Vale St for all years through 2012.

	Turbidity (FNRU)	Total Suspended Solids (mg/L)	State Standard*	N
Baseflow	12	8.5	30 mg/L TSS	32
Storms	39	38.5		32
All	22	18		64
Occasions > new state TSS standard				18

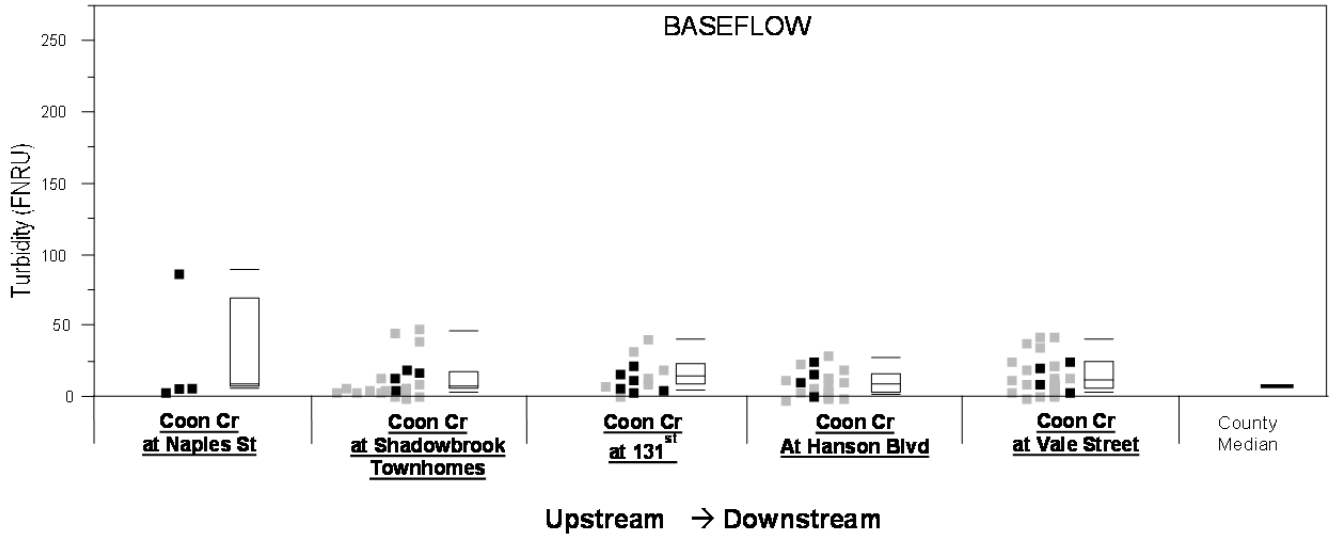
*New state standards are under development. The standard listed is the likely new threshold.

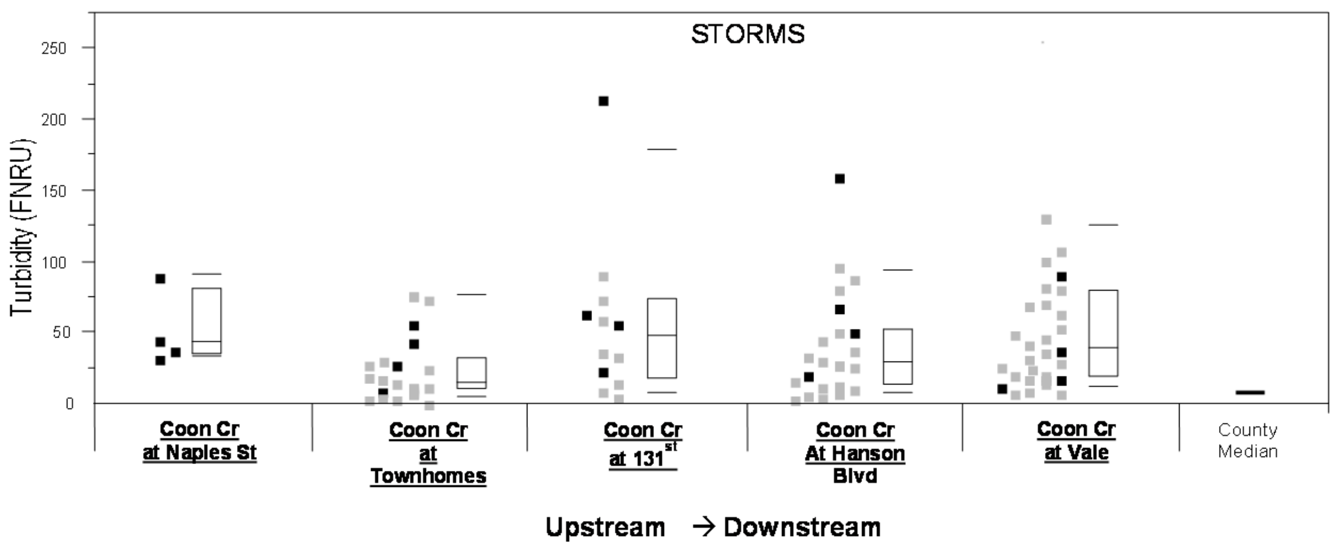
Total suspended solids at Coon Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Turbidity at Coon Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





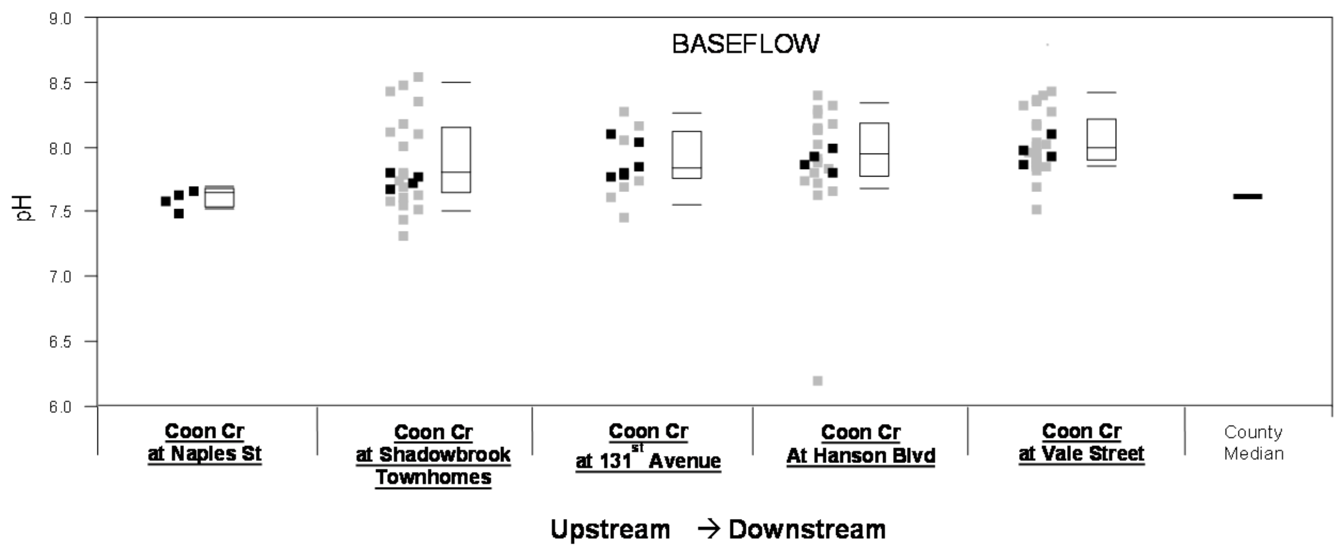
pH

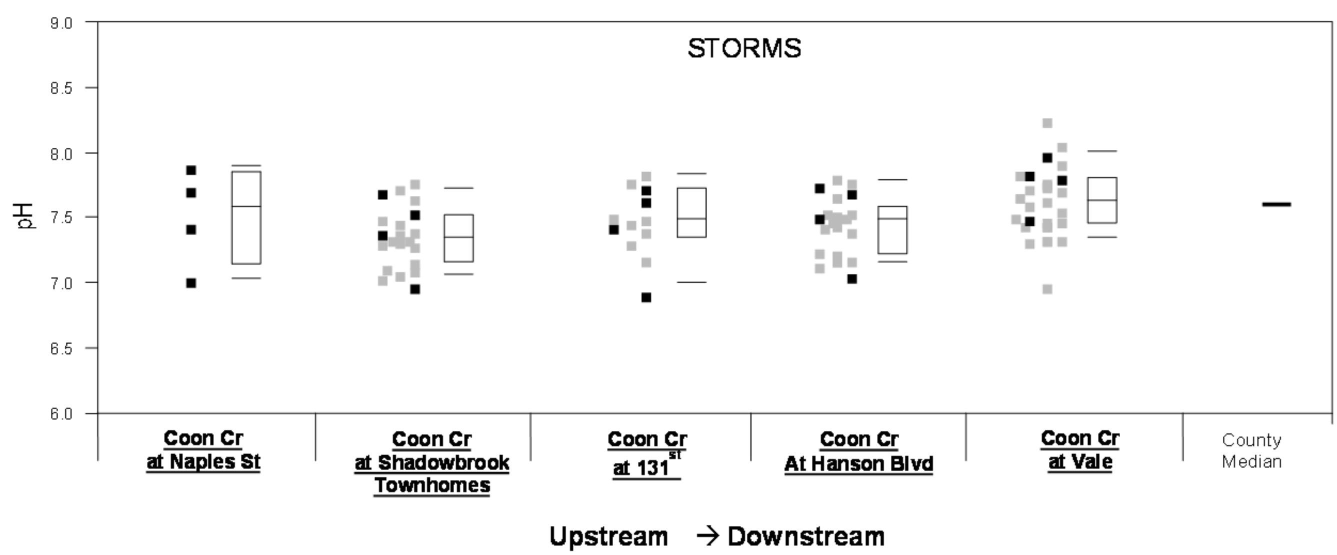
pH was within the expected range at all sites, with rare exceptions. pH is expected to be between 6.5 and 8.5 according to MPCA water quality standards. While occasional readings outside of this range did occur, they were not large departures that generate concerns. pH was notably lower during all storm events, but this is not surprising because rainfall has a lower pH and the creek serves as a stormwater conveyance for four cities.

Median pH in Coon Creek. Data is from Vale St for all years through 2012.

	pH	State Standard	N
Baseflow	8.01	6.5-8.5	32
Storms	7.65		32
All	7.90		64
Occasions outside state standard			3, all sites

pH at Coon Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





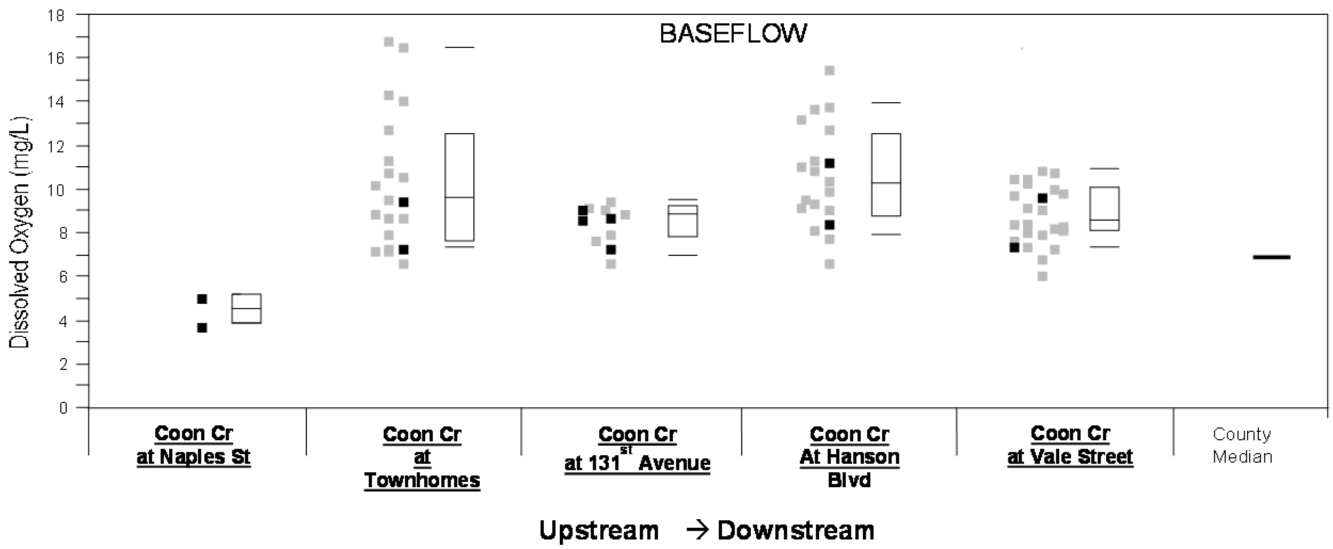
Dissolved Oxygen

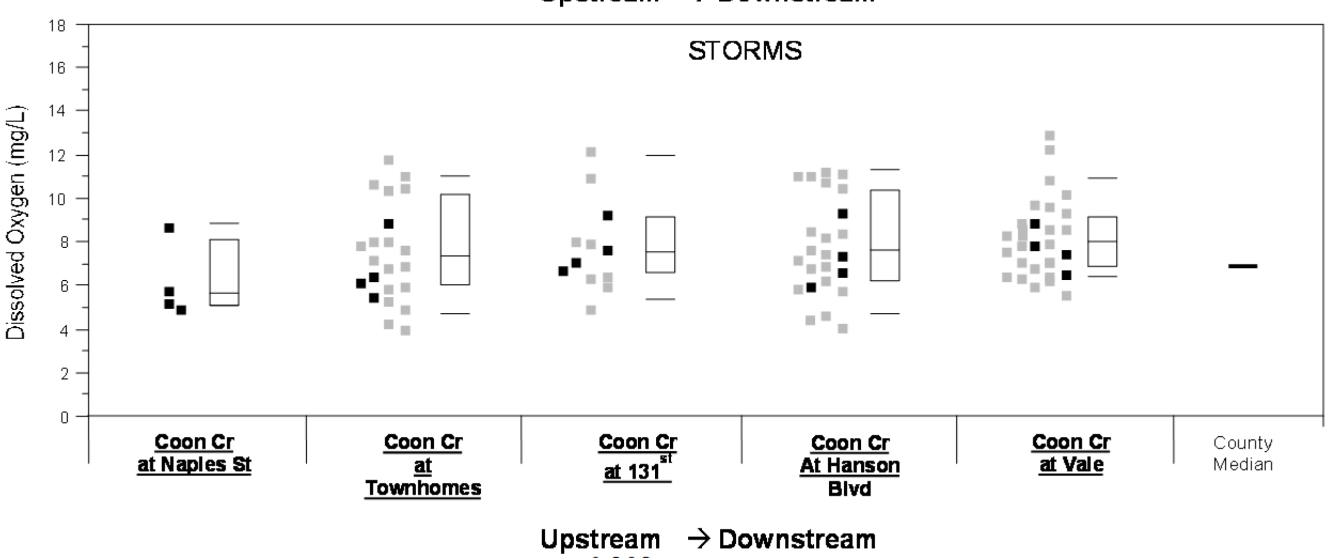
Dissolved oxygen was similar at all sites and adequate for most aquatic live (i.e. >5 mg/L). On two occasions it dropped below 5 mg/L at Shadowbrook Townhomes, and did so three times at Lions Park. The other sites had no instances of dissolved oxygen below 5 mg/L. In sum, no dissolved oxygen problems are present.

Median dissolved oxygen in Coon Creek. Data is from Vale St for all years through 2012.

	Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	8.73	5 mg/L daily minimum	32
Storms	8.14		32
All	8.64		64
Occasions <5 mg/L			2 at Lions Park, 2 at Shadowbrook Townhomes, 1 at Naples St

Dissolved oxygen at Coon Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



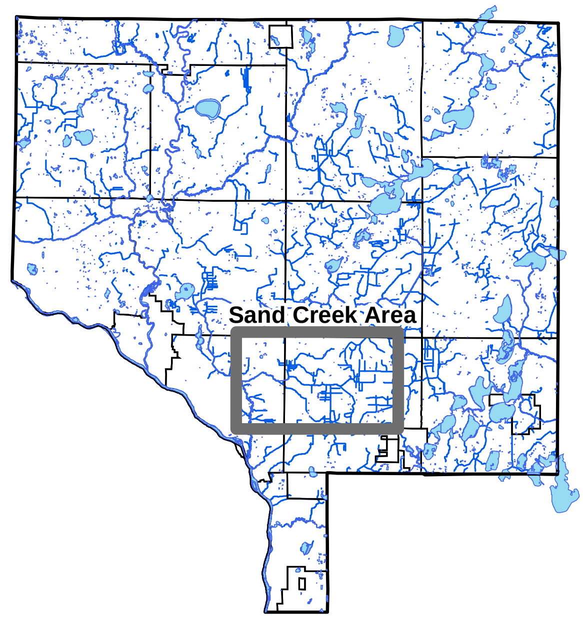


SAND CREEK SYSTEM

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	2010-2012
Sand Cr (Ditch 41) at Highway 65	2009-2012
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	2010-2012
Sand Cr at Xeon Street	2007-2012



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, after 1995. Farther downstream there are no in-line ponds and older development. A number of ditch tributaries exist throughout the watershed, and many reaches of Sand Creek itself have been ditched.

Sand Creek drains to Coon Creek, which then drains to the Mississippi River. At its confluence with Coon Creek, Sand Creek it is about 15 feet wide and 2.5-3 feet deep during baseflow. Sand Creek has not been listed as “impaired” by the MN Pollution Control Agency for exceeding any water quality parameters.

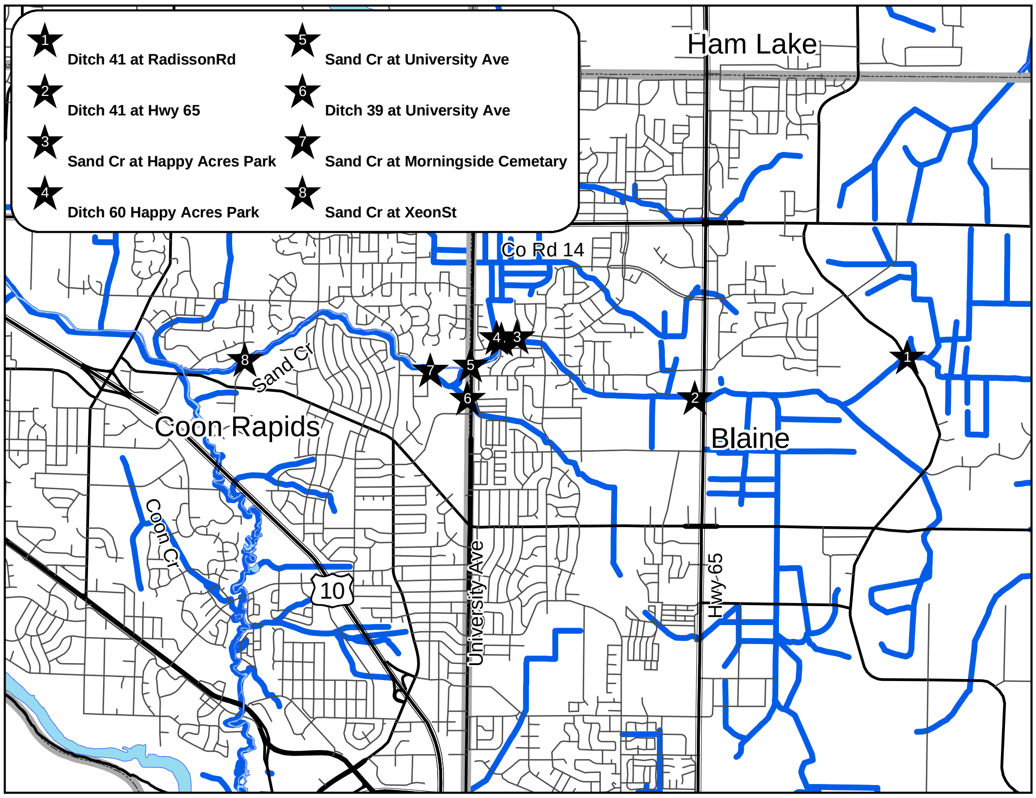
Methods

Sand Creek and its tributaries were monitored during both storm and baseflow conditions 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. 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, conductivity, turbidity, temperature, salinity, and dissolved oxygen. Beginning in 2009 transparency tube measurements were added, as well as photo-documentation of water appearance. Parameters tested by water samples sent to a state-certified lab included total phosphorus, total suspended solids, chlorides, hardness, and sulfate.

During every sampling the water level (stage) was recorded using a staff gauge surveyed to sea level elevations. Stage was also continuously recorded using a datalogging electronic gauge at the Xeon Street stream crossing (farthest downstream).

Sand Creek Monitoring Sites



Results and Discussion

The results presented below include all years of monitoring at all sites. We focus upon an upstream-to-downstream comparison of water quality, as well as an overall assessment. Overall, with the exception of dissolved pollutants water quality in Sand Creek is good, especially for a creek with a suburban watershed. Phosphorus is low.

Sand Creek water degrades Coon Creek for some parameters but not others. Sand Creek phosphorus, total suspended solids, and turbidity were all lower than Coon Creek. Dissolved pollutants were notably higher in Sand Creek than Coon Creek. Coon Creek has several water quality problems, including dissolved pollutants, phosphorus, and suspended solids.

Following is a parameter-by-parameter summary, including a management discussion:

- Dissolved pollutants, as measured by conductivity and chlorides, substantially higher than the median for other streams in Anoka County, but also much lower than state water quality standards. Conductivity was two times greater than the county median, while chlorides were four times greater. There was little change in these parameters from upstream to downstream. Both were slightly lower during baseflow than storms, indicating pollutants migrating through the shallow water table are an important source to the stream. Dissolved pollutants are at a higher concentration in Sand Creek than Coon 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, agricultural chemicals, and road runoff.

- <u>Phosphorus</u> was low in Sand Creek. Yet, it may violate the proposed new state standard of 100 ug/L, which it violated in 27% of samples. Most of these exceedances were during storms. Phosphorus increases modestly during storms. Phosphorus does not increase noticably from upstream to downstream in Sand Creek. Phosphorus in Sand Creek is lower than Coon Creek.

  Management discussion: Some stormwater treatment retrofits, including a new stormwater pond and network of rain gardens, were installed in 2012. These activities and others like them will be helpful at lowering storm-related phosphorus in Sand Creek. Achieving state water quality standards is within reach for Sand Creek.

- <u>Suspended solids and turbidity</u> are reasonably low in Sand Creek, with the exception of occasional higher readings during storms at Xeon Street (farthest downstream). Median TSS is low compared to the new proposed state water quality standard of 30 mg/L, but that standard was exceeded in 5 samples (10%). This may or may not constitute a violation of state water quality standards for the stream overall – it will be a borderline case.

  Management discussion: Because it is so close to water quality standards, and because it flows into Coon Creek which has high suspended solids, efforts should be made to lower these pollutants in Sand Creek. The Coon Creek Watershed District is already installing projects toward this end.

- <u>pH and dissolved oxygen</u> were with the range considered normal and healthy for streams in this area.

Conductivity, Chlorides, and Salinity

Conductivity 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. Conductivity is the broadest measure of dissolved pollutants we used. It measures electrical conductivity of the water; pure water with no dissolved constituents has zero conductivity. Chlorides 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 noteworthy that Sand Creek is upstream from the drinking water intakes on the Mississippi River for the Twin Cities.

Sand Creek dissolved pollutant levels are often double the level typically found in Anoka County streams, but lower than the levels that broadly impact stream biota (see table and figures below). Considering all sites in all years, median conductivity in Sand Creek is two times greater than the median for all Anoka County streams (0.720 mS/cm compared to 0.362 mS/cm). Chlorides were even higher. Sand Creek median chlorides were four times greater than the median of all Anoka County streams (67 mg/L vs 17 mg/L). This is still less than the Minnesota Pollution Control Agency's chronic water quality standard for chloride of 230 mg/L.

It's not surprising that Sand Creek, which lies in a suburban area, would have greater dissolved pollutants than the county-wide median. The county spans rural to urban areas. Sand Creek's upper watershed has an abundance of current and retired sod farms, where salt-containing chemicals are used. The watershed also 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 other 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). This suggests dissolved pollutant concentrations in all parts of the watershed are similar. Several of the tributaries have dissolved pollutants higher than the main stem.

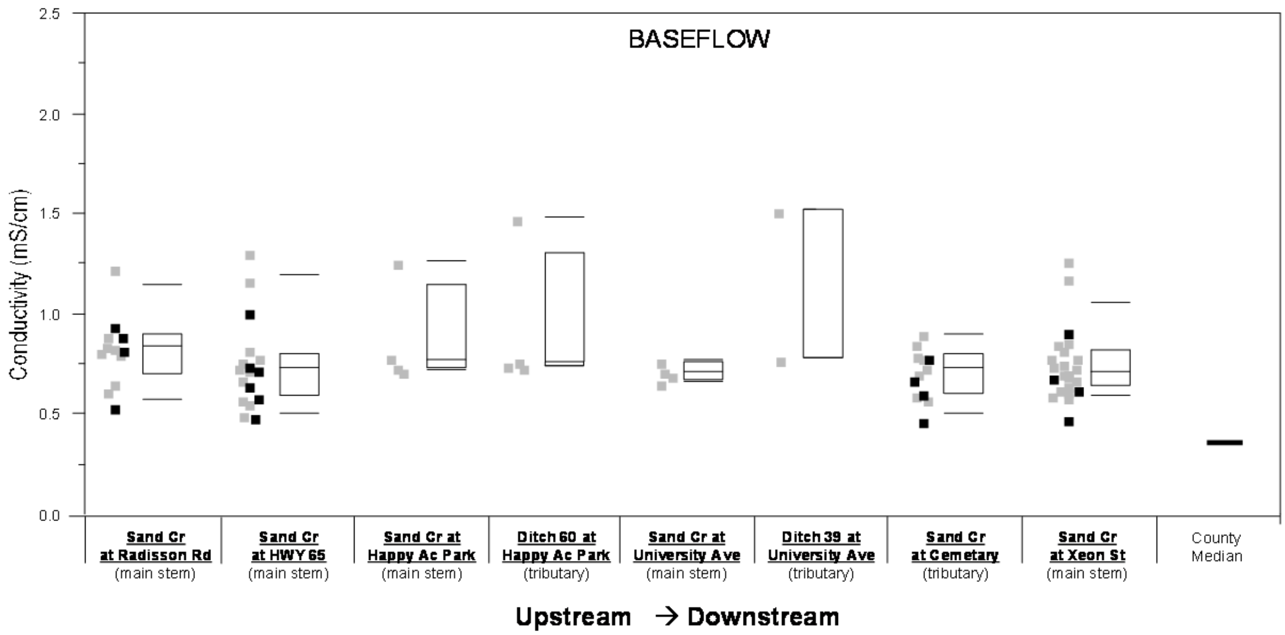
Dissolved pollutants were slightly lower during storms than during baseflow (see figures below). Dissolved pollutants can easily infiltrate into the shallow groundwater that feeds streams during baseflow. If this has occurred, dissolved pollutants will be high during baseflow. If road runoff was the primary dissolved pollutant source, then readings would be highest during storms. The mean conductivity from all Sand Creek sites during baseflow was 15% higher than during storms (0.750 vs 0.650 mS/cm). The mean chlorides from all Sand Creek sites during baseflow were 11% higher than during storms (68 vs 61 mS/cm). This is not to say that rain runoff is free of dissolved pollutants; rather the concentration is lower than in the shallow groundwater. From a management standpoint, 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 and treating them before infiltration should be a high priority.

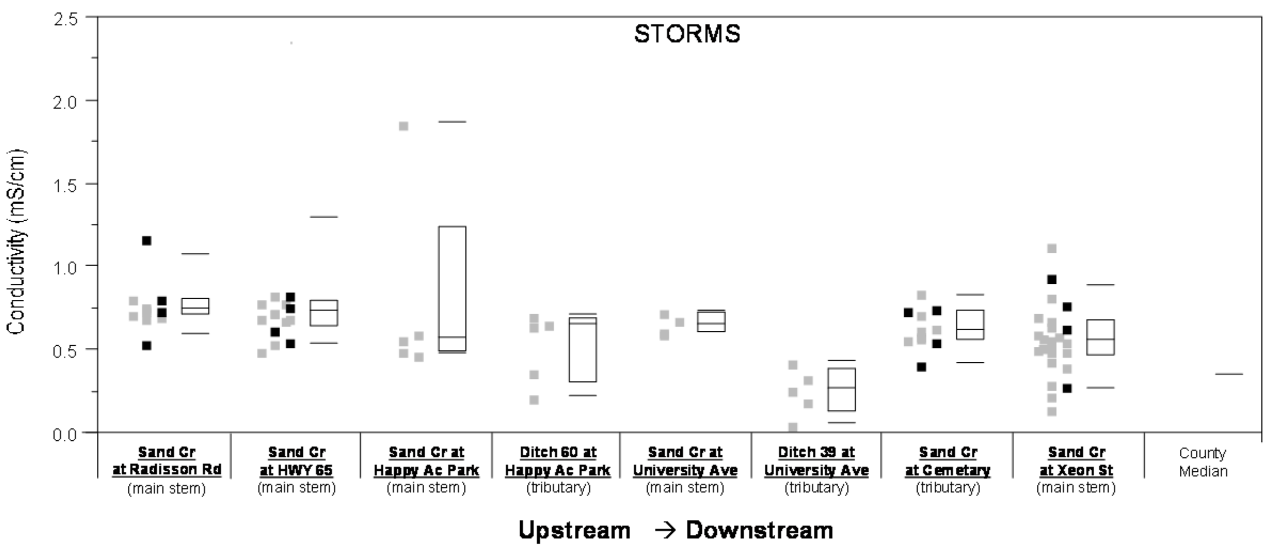
Sand Creek degrades Coon Creek with dissolved pollutants. Both creeks were monitored just before they join. Across all years monitored, Sand Creek's median conductivity was 29% higher than Coon Creek (0.665 vs 0.515 mS/cm). Sand Creek's median chlorides were 42% higher than Coon Creek (74 vs 52 mg/L).

Median conductivity and chlorides in Sand Creek. Data is from Xeon St for all years through 2012.

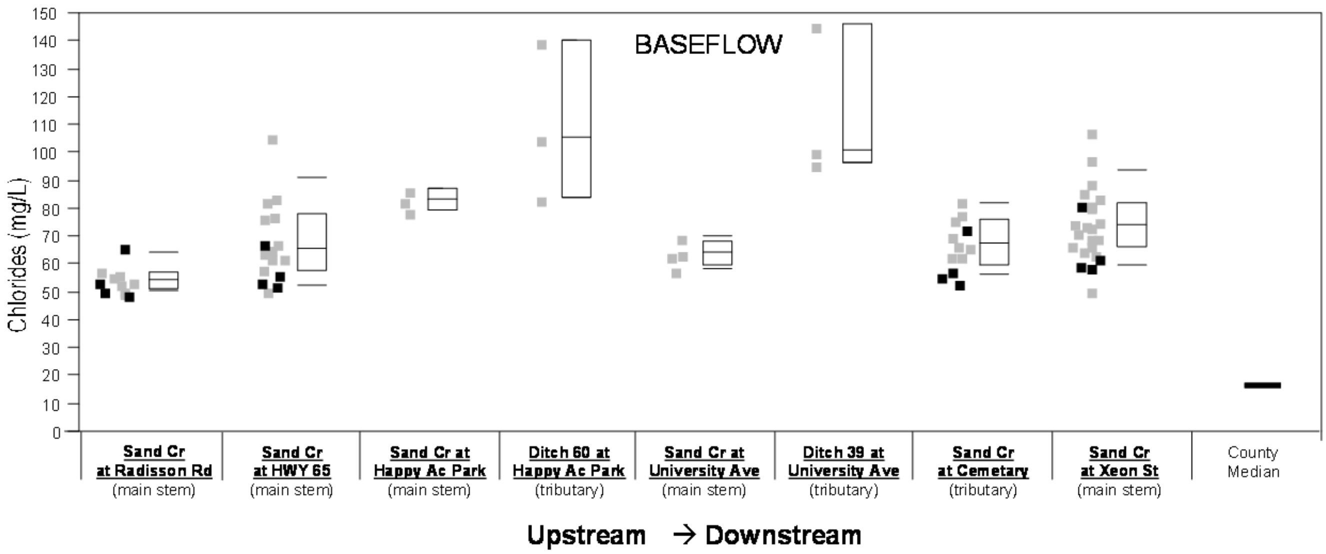
	Conductivity (mS/cm)	**Chlorides (mg/L)**	**State Standard**	**N**
Baseflow	0.725	75	Conductivity – none Chlorides 860 mg/L acute, 230 mg/L chronic	24
Storms	0.572	63		24
All	0.665	72		48
Occasions > state standard				0

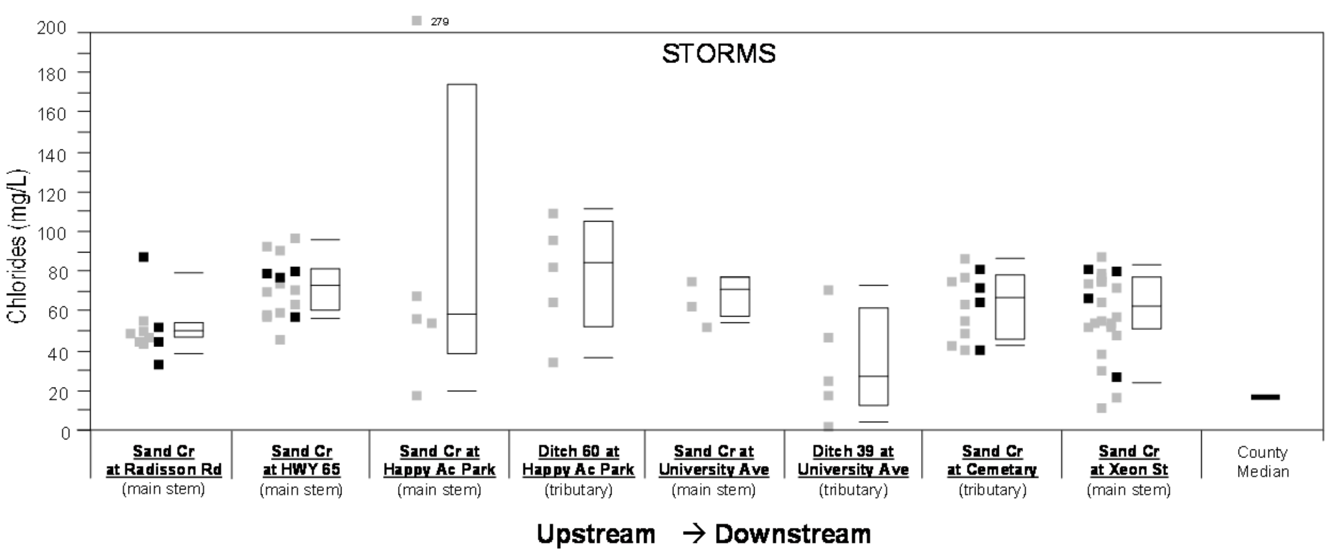
Conductivity at Sand Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Chlorides at Sand Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Recent research has shown that chloride toxicity is heavily dependent upon water hardness, and to a lesser degree, sulfate levels in the water. Therefore, these parameters were measured in 2011 and 2012. This data is summarized in the table below.

Sulfate and hardness at Sand Creek. The median of eight measurements taken in 2011 from Sand Creek at Xeon Street is shown. No other years of data are available. Data from other sites are available.

	Sand Creek at Xeon Street
Sulfate (mg/L)	119
Hardness (mg/L CaCO3)	142.3

Iowa has revised its water quality standards to reflect the impact of sulftates and hardness on chloride toxicity, and Minnesota is in the process of doing so. Iowa has developed the following equations to calculate acute and chronic chloride standards for each waterbody:

Acute chloride standard = $287.8(\text{Hardness})^{0.205797}(\text{Sulfate})^{-0.07452}$

Chronic chloride standard = $177.87(\text{Hardness})^{0.205797}(\text{Sulfate})^{-0.07452}$

These equations are applied to Sand Creek data in the table below.

Sand chloride standards using Iowa equations that account for sulfate and hardness. Data used are eight hardness and sulfate measurements in Sand Creek at Xeon Street in through 2012. Sand Creek observations listed are only from Xeon Street because that is the site with highest observed chlorides and therefore the most likely to exceed state standards.

	Stream-specific chloride standard as calculated with Iowa equations	**Current Minnesota Standard**	**Sand Creek Observations**
Acute (one hour average)	**559 mg/L**	**860 mg/L**	**109 mg/L =** Maximum observed
Chronic (four day average)	**346 mg/L**	**230 mg/L**	**72.0 mg/L =** Median of all observations

The effect of these site-specific standards for Sand Creek, once adopted in Minnesota, would be to make the acute standard more strict and the chronic standard less strict. Presently, Sand Creek is far below the chronic standard, and making the standard less strict only makes it less likely Sand Creek will be in violation. However, there is a greater likelihood that Sand Creek might exceed the acute standard, particularly during winter or snowmelt when chlorides are likely to be highest. The only winter monitoring that has occurred has been late in the snowmelt process.

Total Phosphorus

Total phosphorus (TP) is a common nutrient pollutant. It is limiting for most algae growth. TP was low in Sand Creek (see table and figures below). Median Sand Creek TP for all sites in all years during baseflow (61 ug/L) and storms (68 ug/L) were below the median for Anoka County streams (135 ug/L) and below the water quality standard that the MN Pollution Control Agency is likely to adopt (100 ug/L).

Nonetheless, Sand Creek will likely be found to be in violation (impaired) for excess phosphorus. While the median phosphorus level is below 100 ug/L, the stream at Xeon Street exceeds that level in 27% of samples. Most of these exceedences occur during storms. Retrofitting stormwater treatment for improved phosphorus capture is already a priority of the Coon Creek Watershed District; a new stormwater pond and network of rain gardens were installed in 2012.

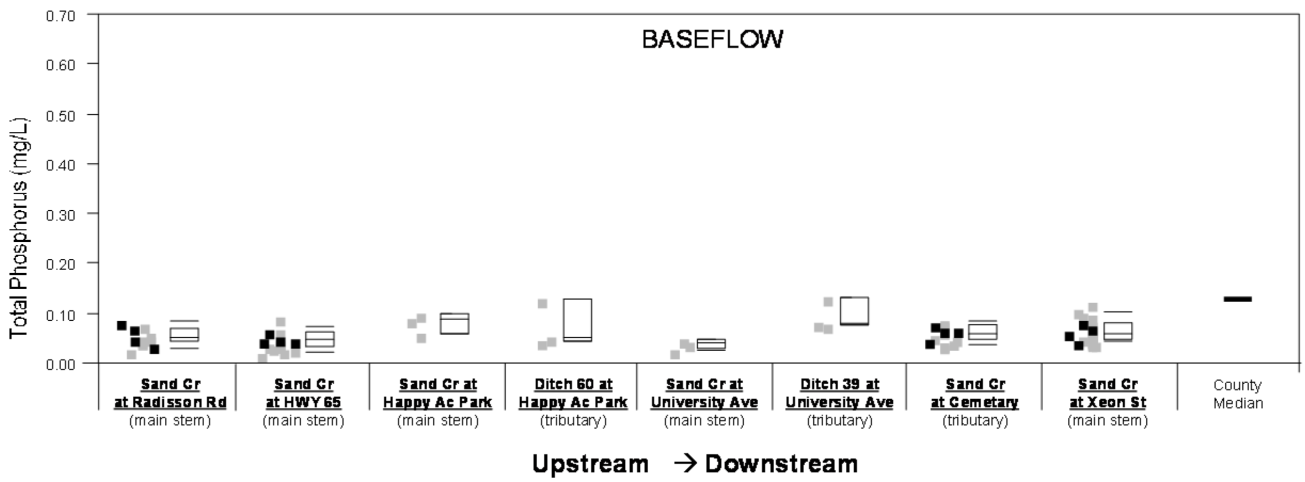
Sand Creek TP is lower than Coon Creek. In Coon Creek, just before the confluence with Sand Creek, the median TP is 122 ug/L. The median in Sand Creek at this same junction is 81 ug/L.

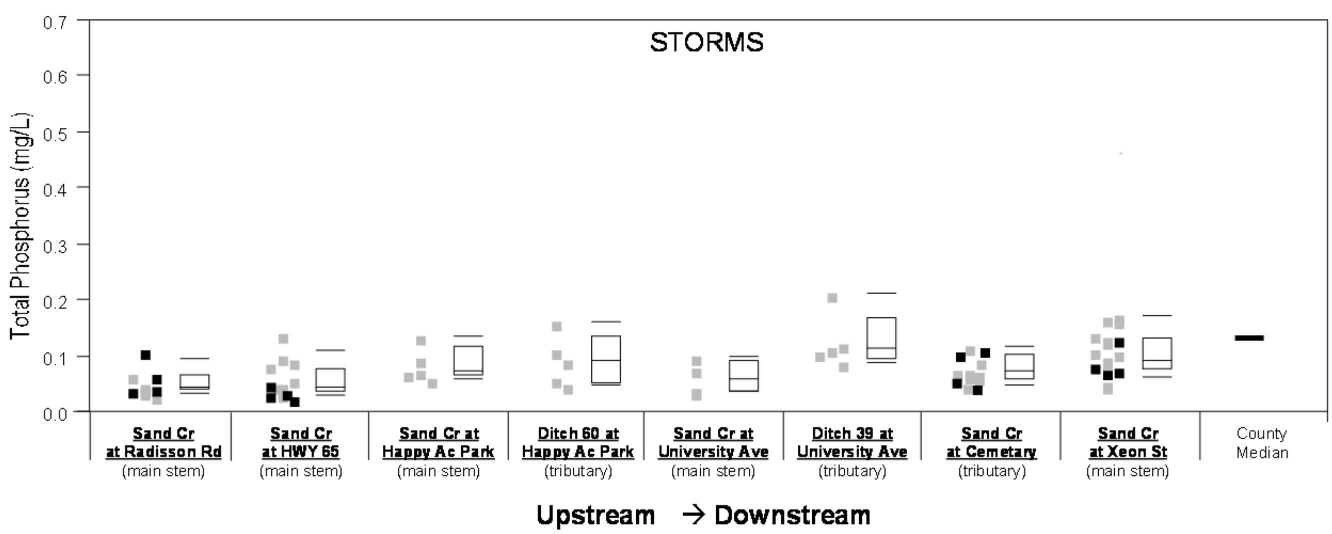
Median total phosphorus in Sand Creek. Data is from Xeon St for all years through 2012.

	Total Phosphorus (ug/L)	State Standard*	N
Baseflow	64	100	24
Storms	93		24
All	81		48
Occasions > state standard			10 during storms, 3 baseflow

*New state standards are under development. The standard listed is the likely new threshold.

Total phosphorus at Sand Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. 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 measures by defraction of a beam of light sent though the water sample, and is therefore most sensitive to large particles.

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 during baseflow was 4.5 mg/L, but 12.5 mg/L during storms. Both are low compared to the new proposed state water quality standard of 30 mg/L, but that standard was exceeded in 5 samples (10%). This may or may not constitute a violation of state water quality standards for the stream overall – it will be a borderline case.

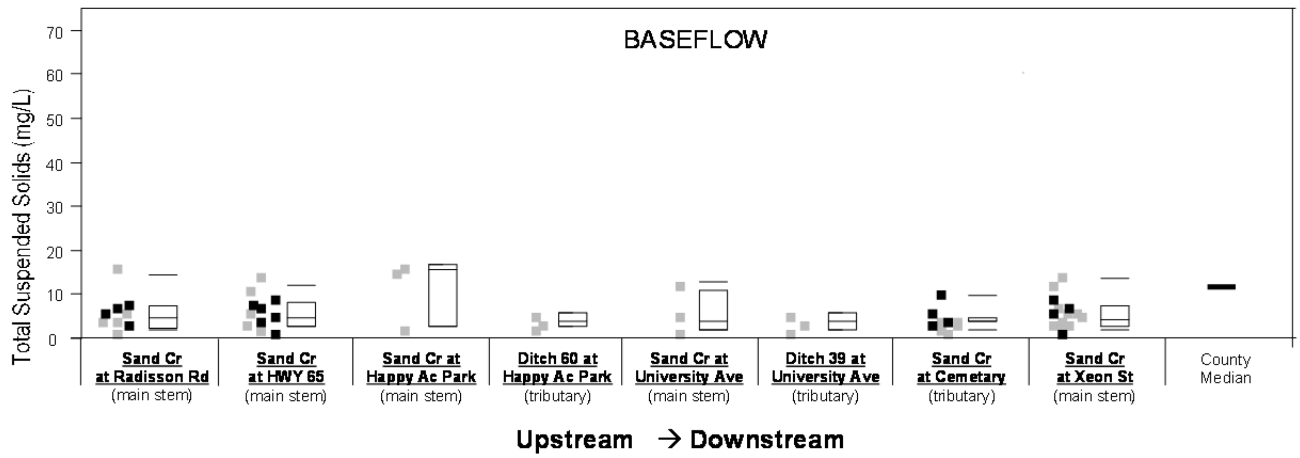
Because it is so close to water quality standards, and because it flows into Coon Creek which has high suspended solids, efforts should be made to lower these pollutants in Sand Creek. The Coon Creek Watershed District is already installing projects toward this end.   Projects in the lower watershed are most needed. While there are some instances of higher turbidity in the upper watershed, this is related to algal production in upstream lakes.

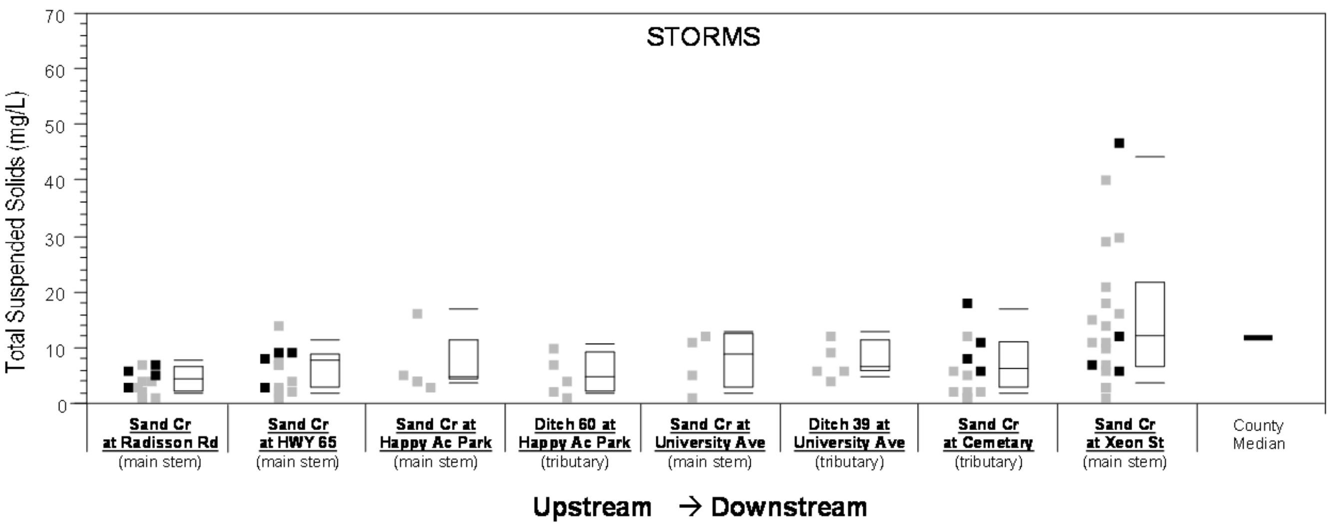
Median turbidity and suspended solids in Sand Creek. Data is from Xeon St for all years through 2012.

	Turbidity (FNRU)	**Total Suspended Solids (mg/L)**	**State Standard***	**N**
Baseflow	7.8	4.5	30 mg/L TSS	24
Storms	7.5	12.5		24
All	7.7	7.0		48
Occasions > new state TSS standard				4 during storms, 1 baseflow

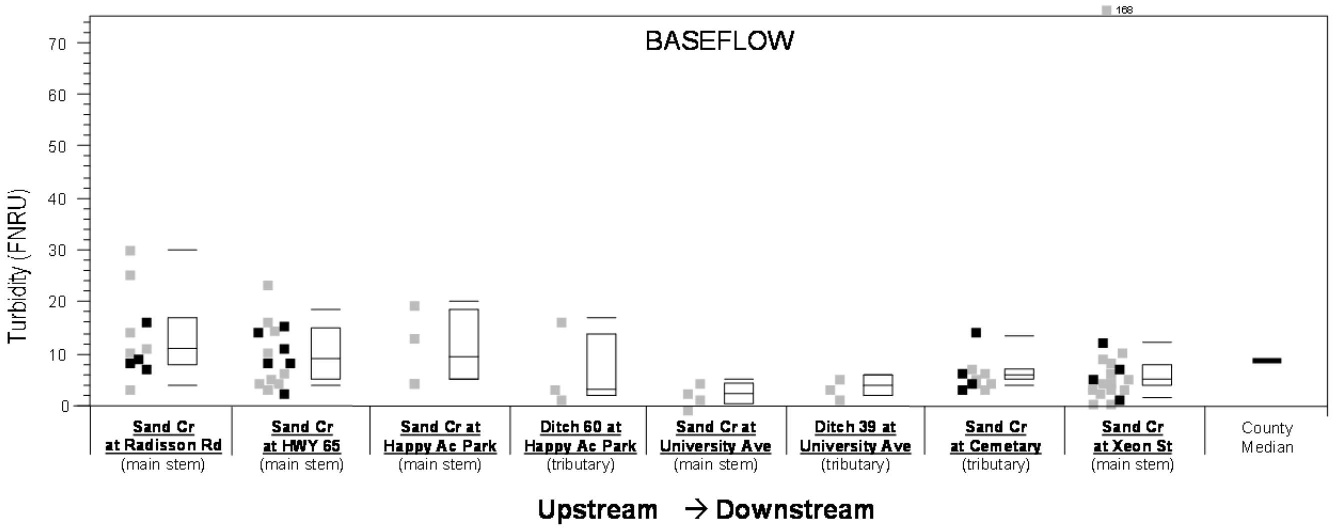
*New state standards are under development. The standard listed is the likely new threshold.

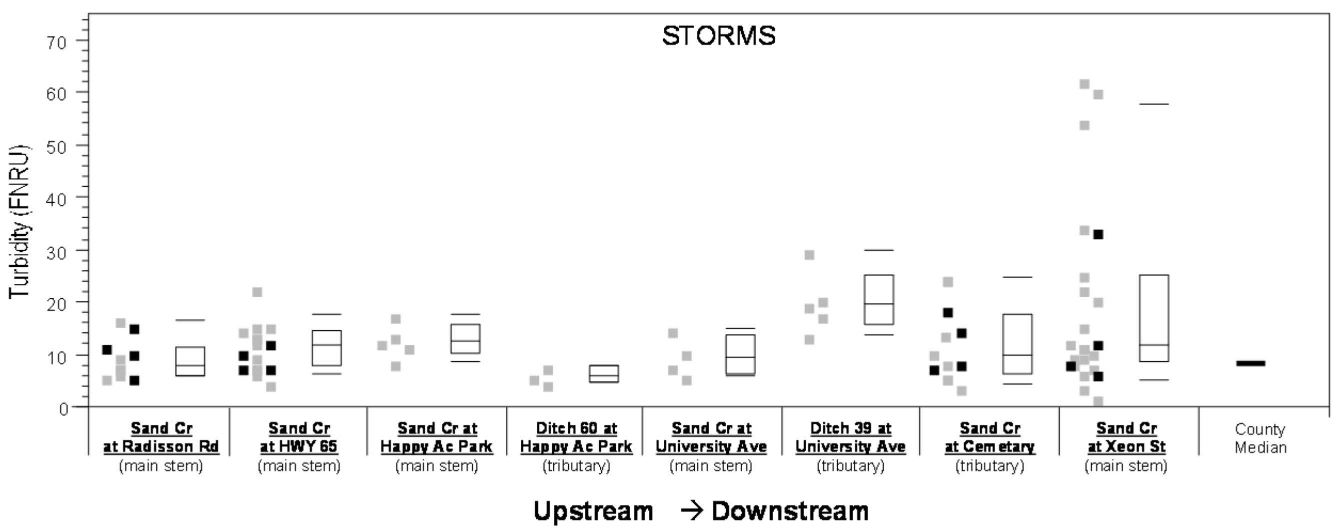
Total suspended solids at Sand Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Turbidity at Sand Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





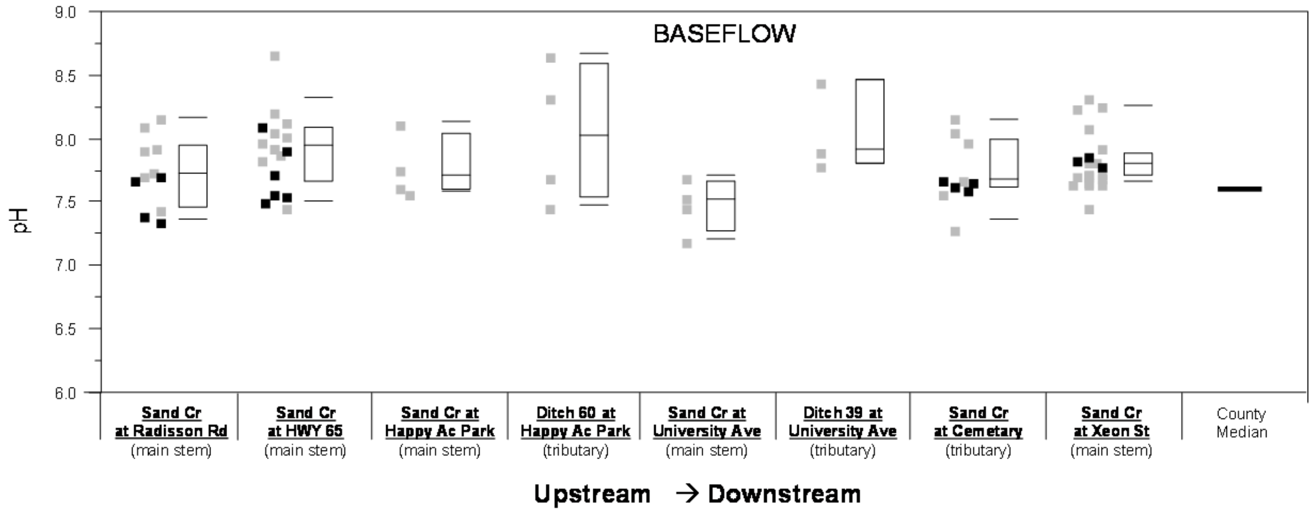
pH

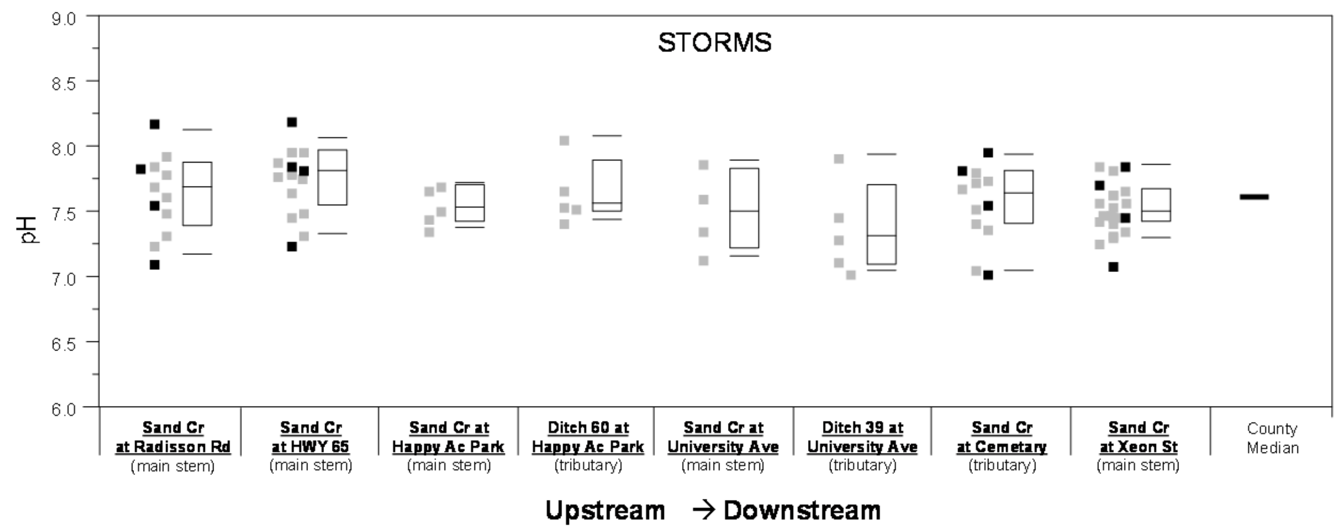
Sand Creek pH was within the expected range at all sites and during all conditions (see figures below), ranging from 7.05 to 8.71. The median was 7.73. The Minnesota Pollution Control Agency water quality standards set an expectation for pH between 6.5 and 8.5. At all sites pH was lower during storms because rainwater has a lower pH.

Median pH in Sand Creek. Data is from Xeon St for all years through 2012.

	pH	State Standard	N
Baseflow	7.82	6.5-8.5	24
Storms	7.51		24
All	7.70		48
Occasions outside state standard			1

pH at Sand Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Dissolved Oxygen

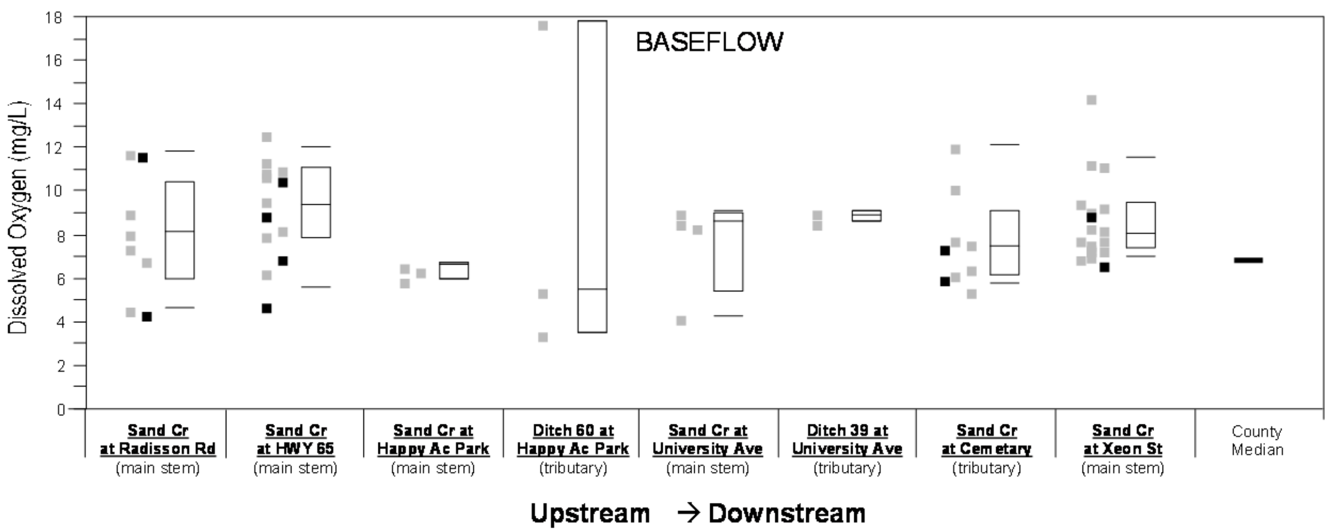
Dissovled oxygen (DO) essential for aquatic life. Fish, invertebrates, and other aquatic life suffer if DO is below 5 mg/L. Low DO can be a symptom of organic pollution, the decomposition of which reduces oxygen.

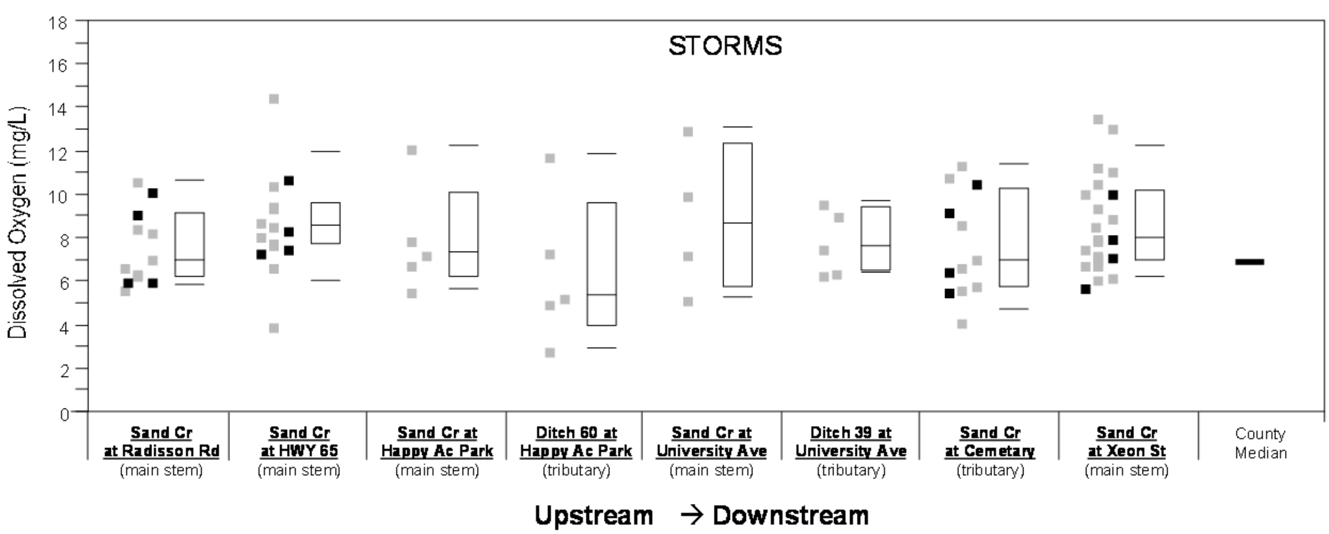
Dissolved oxygen in Sand Creek was within the acceptable level (>5 mg/L) on 95% of the site visits (see table figure below). On eight occasions it dropped below 5 mg/L, but only one of these was within the main stem. They occurred at five different sites, suggesting there is not a chronic problem at any one locality. Three were during storms and five during baseflow, suggesting the issue is not flow-dependent. Five were during drought conditions in 2009 and 2012. Overall, we do not have concerns about dissolved oxygen levels in Sand Creek.

Median dissolved oxygen in Sand Creek. Data is from Xeon St for all years through 2012.

	Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	8.16	5 mg/L daily minimum	24
Storms	8.16		24
All	8.16		24
Occasions <5 mg/L			0 at Xeon St., 8 at other sites

Dissolved Oxygen at Sand Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating lines).





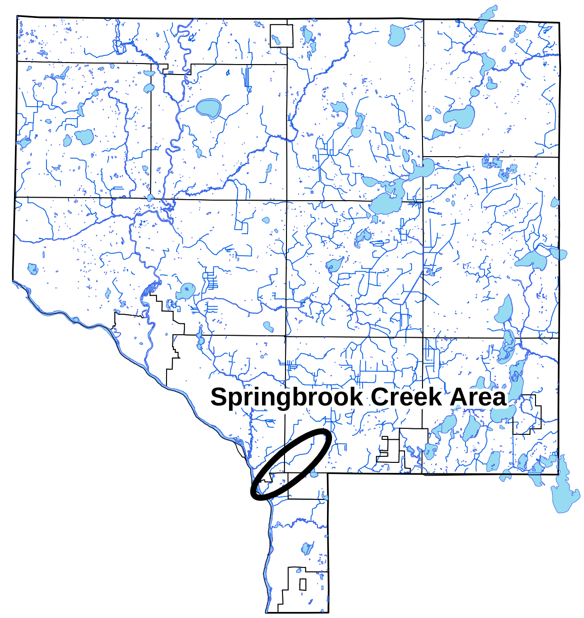
SPRINGBROOK CREEK

Springbrook at 79th Way, Fridley STORET SiteID = S006-140

Years Monitored

Springbrook at 79th Way 2012

Other sites around the Springbrook Nature Center were monitored a few occasions in the early 2000's but are not included in this report.



Background

Springbrook 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, 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 feet 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 2000's Springbrook was the subject of a multi-partner project to monitor and improve water quality. Funding was from a MN Pollution Control Agency grant and the City of Fridley served as a fiscal agent. During that project several projects to better treat stormwater and rehabilitate the Nature Center impoundment were initiated. Water monitoring at that time produced little data, but enough to indicate sizable water quality and hydrology problems existed.

Springbrook Creek is listed as "impaired" by the MN Pollution Control Agency for impaired biota, but new methods (Tiered Aquatic Life Standards) currently under development will take into consideration the fact that the creek is a public ditch and therefore has 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 in the near future.

Methods

Springbrook was monitored during both storm and baseflow conditions 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. In cases, especially drought 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, conductivity, turbidity, temperature, salinity, and dissolved oxygen. Parameters tested by water samples sent to a state-certified lab included total phosphorus, total suspended solids, chlorides, hardness, and sulfate. During every sampling the water level (stage) was recorded using a staff gauge surveyed to sea level elevations. Stage was also continuously recorded using a datalogging electronic gauge.

Results and Discussion

Springbrook Creek has some prominent water quality concerns. While it is currently listed as impaired by the State only for a poor invertebrate biota, these data suggest that other impairments exist. Chlorides, phosphorus, and suspended solids all approach or exceed State standards at least occasionally. At least one more year of monitoring will be needed before enough data exists to make these determinations.

Following is a parameter-by-parameter summary, including a management discussion:

- Dissolved pollutants, as measured by conductivity and chlorides, are higher in Springbrook than any other Anoka Count stream except nearby Pleasure Creek, which is similar. Conductivity was two times greater than the median for Anoka County streams, while chlorides were nine times greater. Both were elevated during storms and baseflow, but consistently higher concentrations were during storms. On one of eight 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 was relatively low in Springbrook Creek, and similar to other nearby waterbodies. However, a 100 mg/L state standard is likely to be established soon, which many streams including Springbrook would probably exceed. Phosphorus is consistently highest during storms in Springbrook.

  Management discussion: Additional treatment within the stormwater conveyance system will help reduce phosphorus.

- Suspended solids and turbidity are low in Springbrook during baseflow, but during storms approach or exceed the proposed state water quality standard.

  Management discussion: Additional treatment within the stormwater conveyance system will help reduce suspended solids.

- pH and dissolved oxygen were with the range considered normal and healthy for streams in this area.

Conductivity, Chlorides, and Salinity

Conductivity 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. Conductivity is the broadest measure of dissolved pollutants we used. It measures electrical conductivity of the water; pure water with no dissolved constituents has zero conductivity. Chlorides 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 noteworthy that Springbrook Creek discharges into the Mississippi River just upstream from drinking water intakes for the Twin Cities.

Conductivity and chlorides in Springbrook Creek are higher than at any other stream in Anoka County, except nearby Pleasure Creek which is similar. Springbrook dissolved pollutant levels are multi-fold higher than the concentrations typically found in Anoka County streams and approaching levels that impact stream biota (see table and figures below). Median conductivity in Springbrook was two times greater than the median for all Anoka County streams (0.753 mS/cm compared to 0.362 mS/cm). Conductivity was high both during storms (median 1.045 mS/cm) and baseflow (median 0.662 mS/cm).

Chlorides were even higher – nine times higher than the average of other Anoka County streams. Springbrook median chlorides were 159 mg/L compared to 17 mg/L for other Anoka County streams. Median chlorides during storms (216 mg/L) were 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.

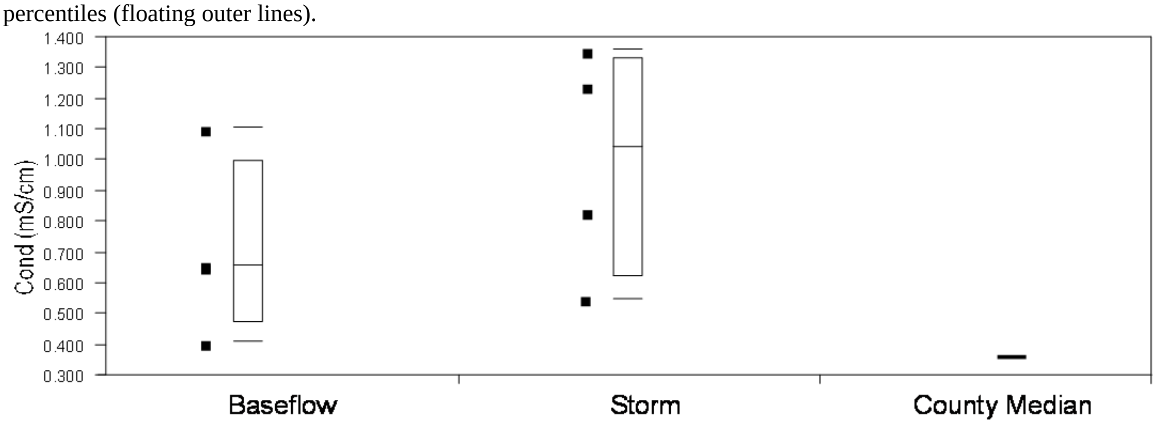
Springbrook's high dissolved pollutants are likely from stormwater runoff, with road deicing salts as one, but not the only, contributor. Greater road densities and a long history of road salting contribute to high chlorides. Chlorides are persistent in the environment; not effectively broken down by stormwater treatment or time. They migrate into the shallow groundwater which feeds the stream during baseflow. This explains why chlorides are high during baseflow. However, at Springbrook stormwater runoff carries even higher concentrations of dissolved pollutants. This is unlike most area streams where baseflow dissolved pollutants is highest, and road deicing salts are likely the largest culprit. The water washing off roads, roofs, and parking lots contains a mixture of different dissolved pollutants.

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.

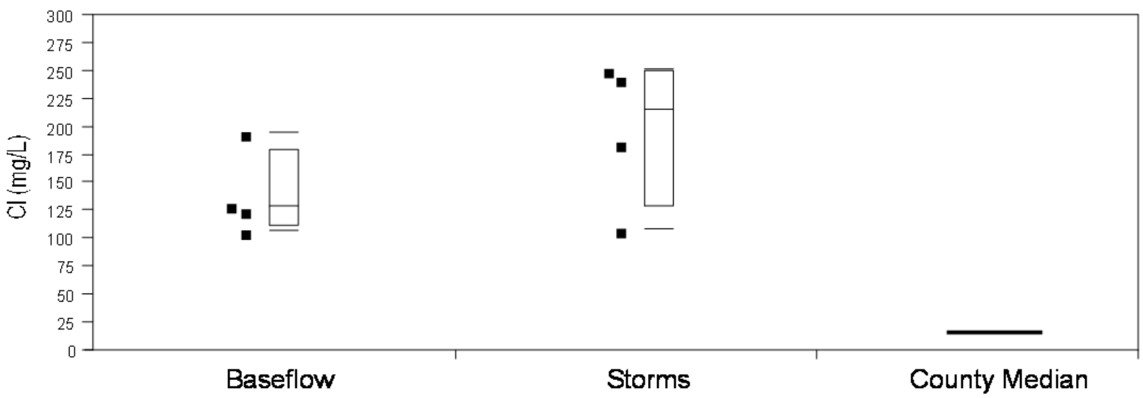
Median conductivity and chlorides in Springbrook Creek. Data is from 2012.

	Conductivity (mS/cm)	**Chlorides (mg/L)**	**State Standard**	**N**
Baseflow	0.662	129	Conductivity – none Chlorides 860 mg/L acute, 230 mg/L chronic	4
Storms	1.045	216		4
All	0.753	159		8

Conductivity at Springbrook Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Chlorides at Springbrook Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Recent research has shown that chloride toxicity is heavily dependent upon water hardness, and to a lesser degree, sulfate levels in the water. Therefore, these parameters were measured six times in 2012. This data is summarized in the table below.

Sulfate and hardness at Springbrook Creek. The median of eight measurements taken in 2011 from Springbrook Creek at 79th Way is shown. No other years of data are available. Data from other sites are available.

	Springbrook at 79th Way
Sulfate (mg/L)	24
Hardness (mg/L CaCO3)	160.5

Iowa has revised its water quality standards to reflect the impact of sulftates and hardness on chloride toxicity, and Minnesota is in the process of doing so. Iowa has developed the following equations to calculate acute and chronic chloride standards for each waterbody:

$$\text{Acute chloride standard} = 287.8(\text{Hardness})^{0.205797}(\text{Sulfate})^{-0.07452}$$

$$\text{Chronic chloride standard} = 177.87(\text{Hardness})^{0.205797}(\text{Sulfate})^{-0.07452}$$

These equations are applied to Springbrook Creek data in the table below.

Springbrook Creek chloride standards using Iowa equations that account for sulfate and hardness. Data used are eight hardness and sulfate measurements in Springbrook Creek at 79th Way in 2012.

	Stream-specific chloride standard as calculated with Iowa equations	**Current Minnesota Standard**	**Springbrook Creek Observations**
Acute (one hour average)	**646 mg/L**	**860 mg/L**	**253 mg/L** = Maximum observed
Chronic (four day average)	**399 mg/L**	**230 mg/L**	**170.0 mg/L** = Average of all observations

The effect of these site-specific standards for Springbrook Creek, once adopted in Minnesota, would be to make the acute standard more strict and the chronic standard less strict. Presently, Springbrook is approaching the chronic standard and may exceed it during snowmelt. While an adjusted chronic standard would make it less likely that Springbrook would be in violation, the chloride levels in the creek are still highly undesirable.

Total Phosphorus

Total phosphorus (TP) is a common nutrient pollutant. It is limiting for most algae growth. Median Springbrook Creek TP during baseflow (0.087 mg/L) and storms (0.138 mg/L) were typical for Anoka County streams (0.135 mg/L; see table and figures below).

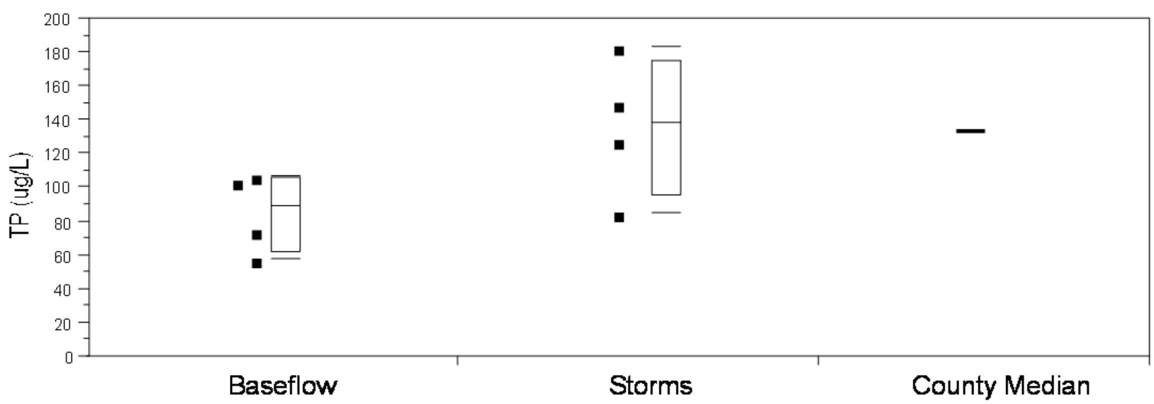
The MN Pollution Control Agency is likely to adopt 0.100 mg/L as a new phosphorus standard for streams. Based on data collected to date, Springbrook would probably violate this standard and then be designated as "impaired."

Median total phosphorus in Springbrook Creek. Data is from 2012.

	Total Phosphorus (ug/L)	State Standard*	N
Baseflow	90.5	100	4
Storms	140.5		4
All	106.5		8
Occasions > state standard			5

*New state standards are under development. The standard listed is the likely new threshold.

Total phosphorus at Springbrook Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. 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 measures by defraction of a beam of light sent though the water sample, and is therefore most sensitive to large particles. Suspended solids are important because they carry other pollutants, affect water appearance, and can harm stream biota.

TSS and turbidity were both low during baseflow and higher during storms (see table and figures below). The highest observed TSS was 56 mg/L, and the highest turbidity was 43 FNRU. During baseflow neither TSS nor turbidity exceeded 5.

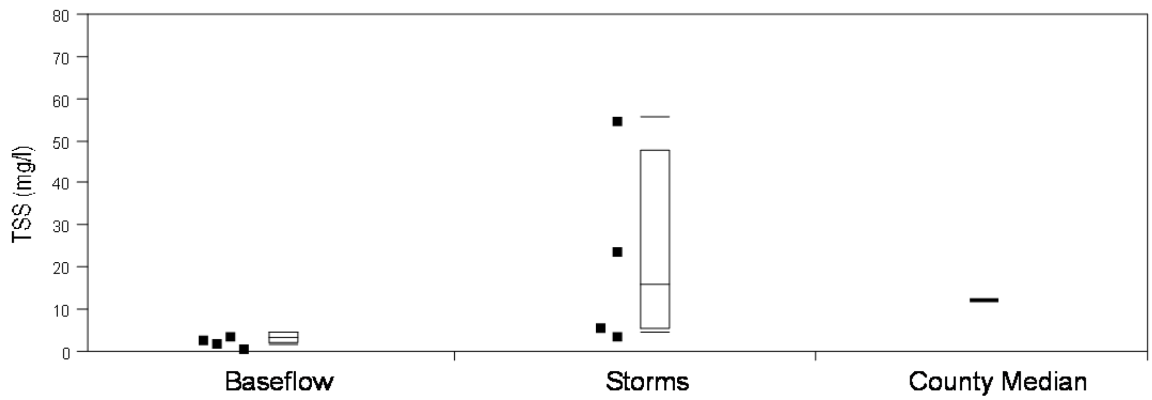
The MN Pollution Control Agency is in the process of modifying the state water quality standard in this region. The new standard will likely be 30 mg/L TSS, with no turbidity standard. In 2012 only one of eight samples exceeded this standard. 20 samples will be needed for the MPCA to determine if water quality standards for suspended solids are being met.

Median turbidity and suspended solids in Springbrook Creek. Data is from 2012.

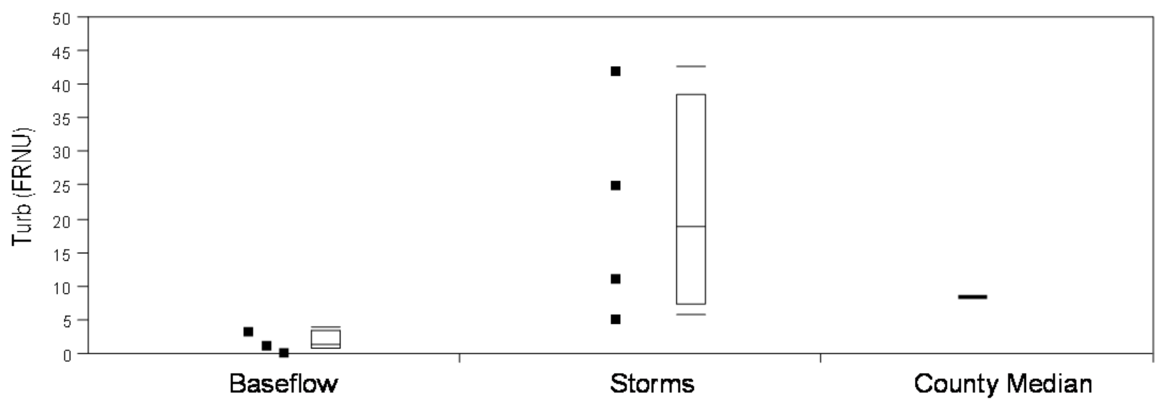
	Turbidity (FNRU)	Total Suspended Solids (mg/L)	State Standard*	N
Baseflow	1.5	3.5	30 mg/L TSS	4
Storms	19	16		4
All	5	5		8
Occasions > new state TSS standard				1

*New state standards are under development. The standard listed is the likely new threshold.

Total suspended solids at Springbrook Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Turbidity at Springbrook Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



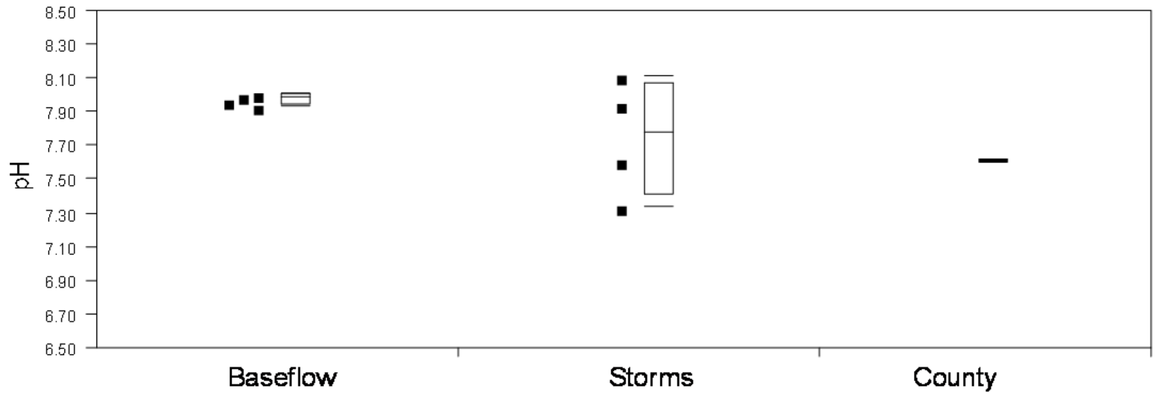
pH

Springbrook Creek pH was within the expected range at all sites and during all conditions (see table and figure below), ranging from 7.35 to 8.13. The Minnesota Pollution Control Agency water quality standards set an expectation for pH between 6.5 and 8.5.

Median pH in Springbrook Creek. Data is from 2012.

	pH	State Standard	N
Baseflow	8.0	6.5-8.5	4
Storms	7.79		4
All	7.97		8
Occasions outside state standard			0

pH at Springbrook Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



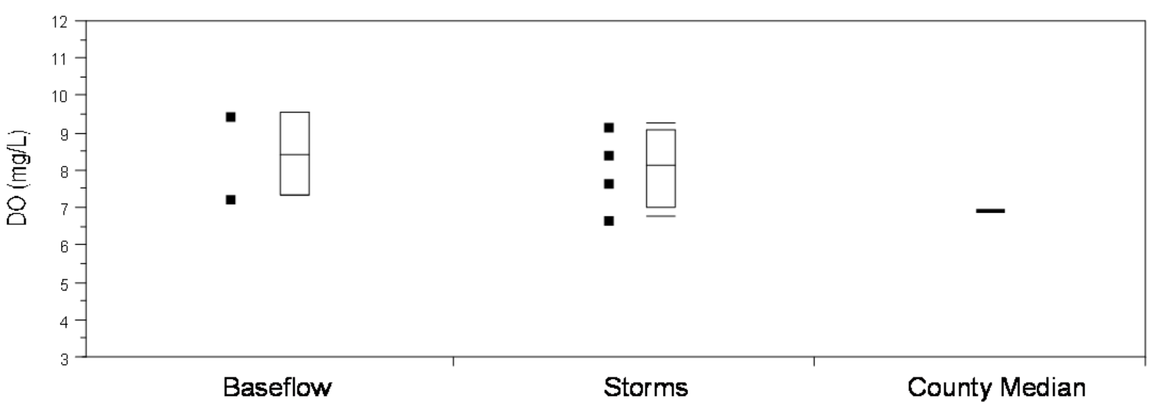
Dissolved Oxygen

Dissovled oxygen (DO) essential for aquatic life. Fish, invertebrates, and other aquatic life suffer if DO is below 5 mg/L. Low DO can be a symptom of organic pollution, the decomposition of which reduces oxygen. Dissolved oxygen in Springbrook Creek was within the acceptable level (>5 mg/L) during all site visits (see table and figure below).

Median dissolved oxygen in Springbrook Creek. Data is from 2012.

	Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	8.51	5 mg/L daily minimum	4
Storms	8.19		4
All	8.19		8
Occasions <5 mg/L			0

Dissolved Oxygen at Springbrook Creek. Dots are individual readings. Black dots are 2011 readings; grey dots are from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



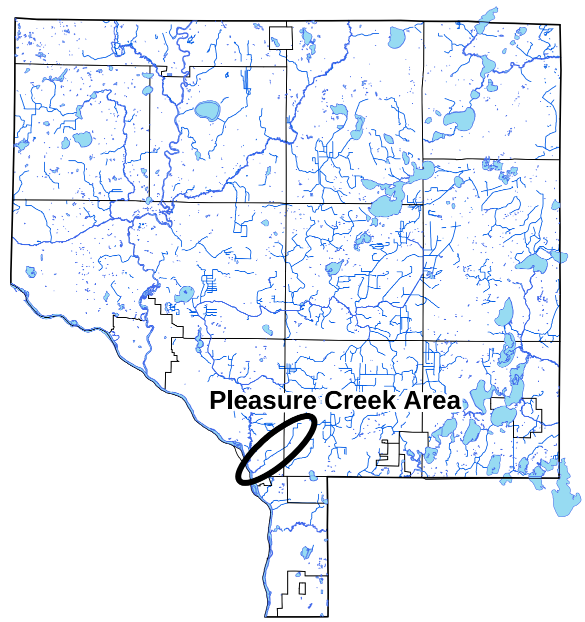
Stream Water Quality Monitoring

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
Pleasure Cr at 86th Ave	2006, 2007, 2012 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 feet wide and 0.5 to 1 foot deep 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, particularly E. coli. In 2009, monitoring moved even farther upstream to further diagnose pollutant sources. In 2012 monitoring was moved back to the bottom of the watershed to continue overall water quality assessment.

Pleasure Creek is listed as "impaired" by the MN Pollution Control Agency for impaired biota, but new methods (Tiered Aquatic Life Standards) currently under development will take into consideration the fact that the creek is a public ditch and therefore has lower aquatic life expectations, at least in some reaches. While recent monitoring data is insufficient to officially assess Springbrook for most other impairments, the data to date suggest that other impairment designations are in the near future, especially E. coli and total phosphorus.

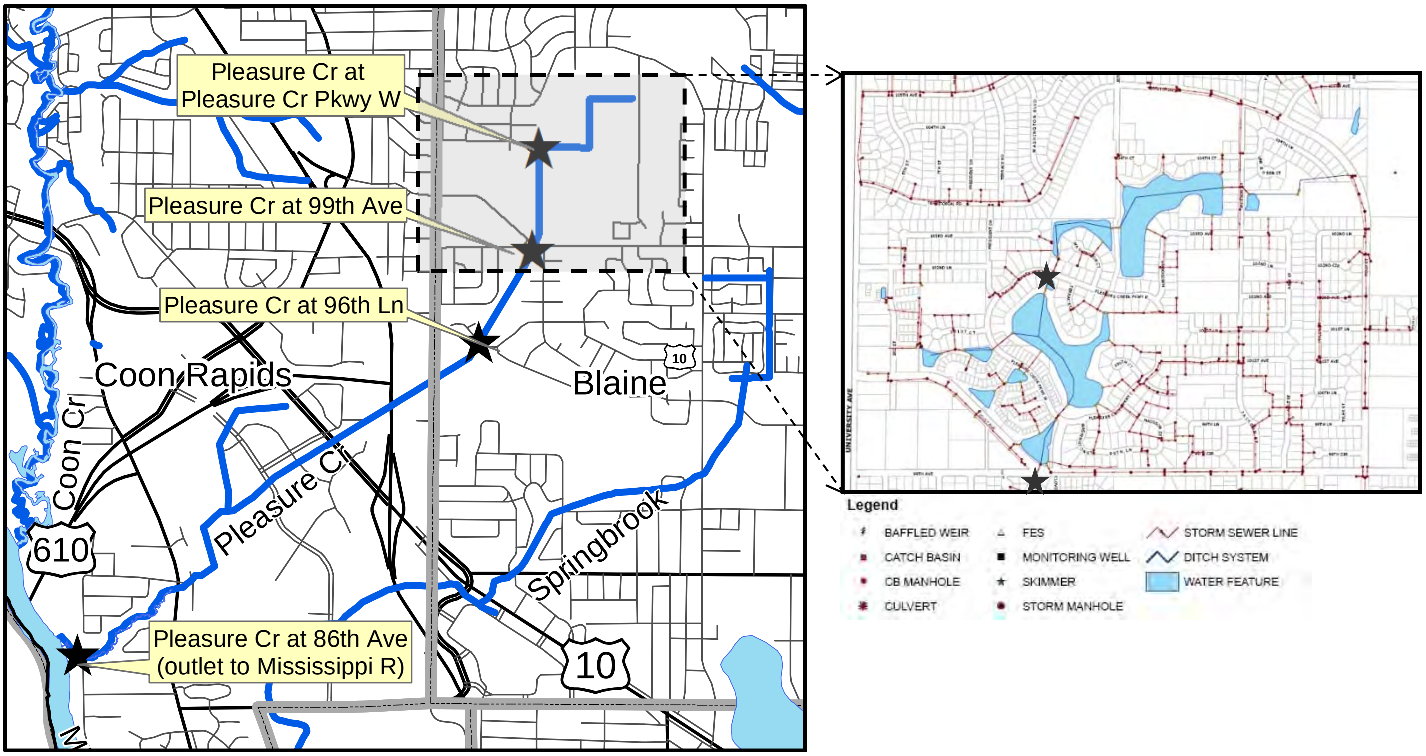
Methods

Pleasure Creek was monitored during both storm and baseflow conditions 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. 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, conductivity, turbidity, temperature, salinity, and dissolved oxygen. Beginning in 2009 transparency tube measurements were added, as well as photo-documentation of water appearance. 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.

During every sampling the water level (stage) was recorded using a staff gauge surveyed to sea level elevations. Stage was also continuously recorded using a datalogging electronic gauge at the 86th Avenue stream crossing (farthest downstream).

Pleasure Creek Monitoring Sites



Results and Discussion

Pleasure Creek has some prominent water quality concerns. While it is currently listed as impaired by the State only for a poor invertebrate biota, these data suggest that other impairments exist, particularly for total phosphorus and E. coli bacteria.

Following is a parameter-by-parameter summary, including a management discussion:

- <u>Dissolved pollutants</u>, as measured by conductivity and chlorides, are higher in Pleasure Creek than any other Anoka Count stream except nearby Springbrook, which is similar. Both were elevated during storms and baseflow, but consistently higher concentrations were during storms.

  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.

- <u>Phosphorus</u> was relatively low in Pleasure Creek during baseflow, but higher during storms at the farthest downstream monitoring site. Due to the higher readings during storms, Pleasure Creek is likely to exceed a soon-to-be-adopted state standard of 100 mg/L. The observed readings during storms are similar to most other streams in the area.

Management discussion: Additional treatment within the stormwater conveyance system is needed, particularly around East River Road.

- Suspended solids and turbidity were both low during baseflow and storms at the upstream sites, but higher during storms at the farthest downstream site. The low turbidity and TSS at the upstream sites is probably reflective of the effectiveness of large stormwater ponds in that area.

  Management discussion: Additional treatment within the stormwater conveyance system is needed, particularly around East River Road.

- pH and dissolved oxygen were with the range considered normal and healthy for streams in this area.

- E. coli bacteria are high throughout Pleasure Creek during storms. Human sewage is not the source. Stormwater runoff, and likely stormwater ponds themselves are sources of the bacteria.

  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.

Conductivity, Chlorides, and Salinity

Conductivity 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. Conductivity is the broadest measure of dissolved pollutants we used. It measures electrical conductivity of the water; pure water with no dissolved constituents has zero conductivity. Chlorides 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 noteworthy that Pleasure Creek discharges into the Mississippi River just upstream from drinking water intakes for the Twin Cities.

Conductivity and chlorides in Pleasure Creek are higher than at any other stream in Anoka County, except nearby Springbrook which is similar. Pleasure Creek chlorides are highest at the farthest downstream site (see table and figures below). Median conductivity at the three upstream sites was were 0.643, 0.509, and 0.697 mS/cm (upstream to downstream). At the downstream site (86th Ave) median conductivity was 0.950, or about 50% higher. By comparison, the median for all streams in Anoka County is 0.362 mS/cm. There is no state water quality standard for conductivity.

Chlorides increased at the downstream site even more dramatically than conductivity. Median chlorides at the three upstream sites were 70, 71, and 67 mg/L (upstream to downstream). At the downstream site (86th Ave) median chlorides was 159 mg/L, or about double. The median for all streams in Anoka County is 17 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 is likely to be highest.

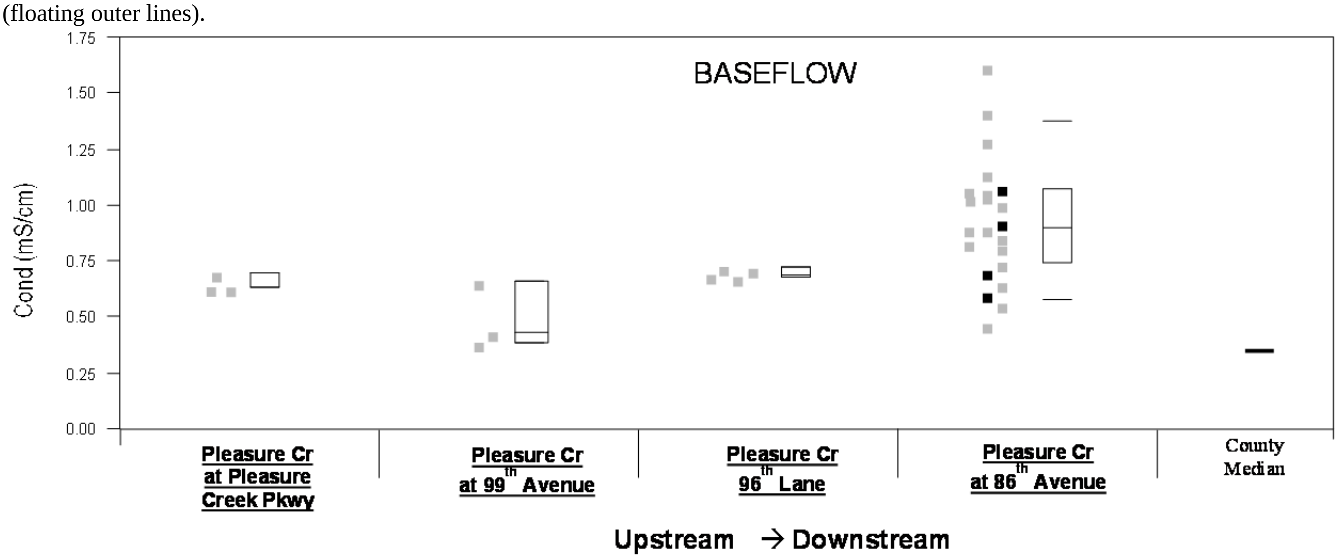
Both conductivity and chlorides where slightly higher during storms than baseflow. Median conductivity was 0.960 mS/cm during storms and 0.911 mS/cm during baseflow. Median chlorides were 178 mg/L during storms and 147 mg/L during baseflow. This result suggests that dissolved pollutants are high in the shallow groundwater that feeds the stream during baseflow, but slightly higher in stormwater runoff. Illicit discharges may be contributing during baseflow. While road deicing salts are likely a prevalent source of dissolved pollutants, they are not the only source, as evidenced by high dissolved pollutants during wash-off from mid-summer storms.

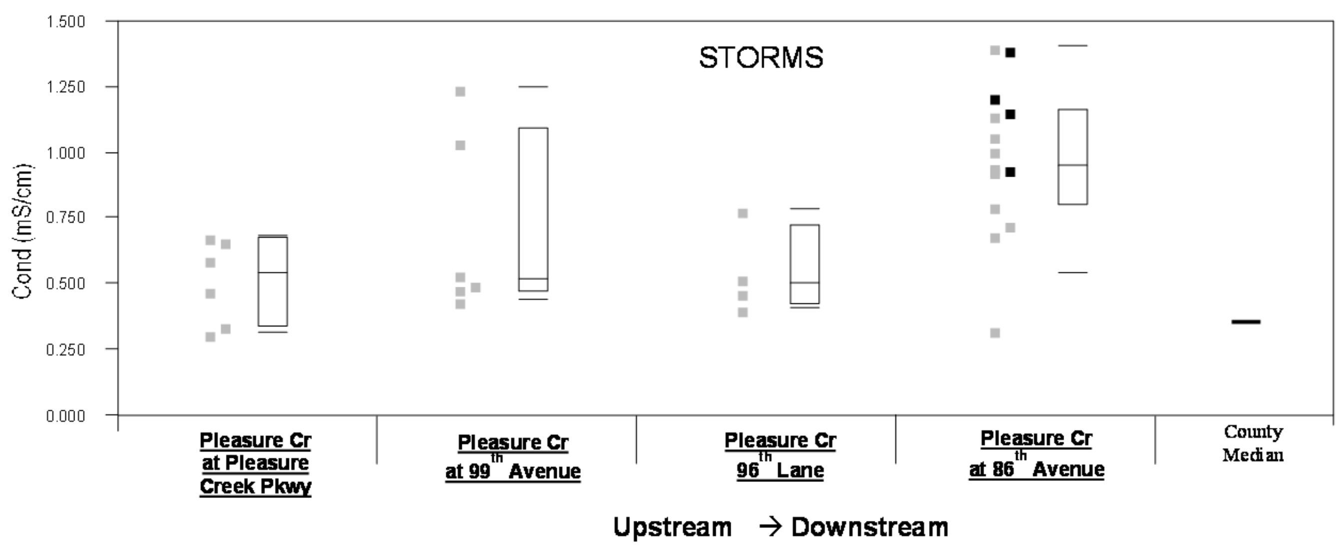
Dissolved pollutants are especially difficult to manage once in the environment. They are not removed by stormwater settling ponds. Infiltration practices can provide some treatment through biological processes in the soil, but also risk contaminating groundwater. The first approach to dissolved pollutant management must be to minimize their release into the environment.

Median conductivity and chlorides in Pleasure Creek at 86th Ave. Data is from all years through 2012.

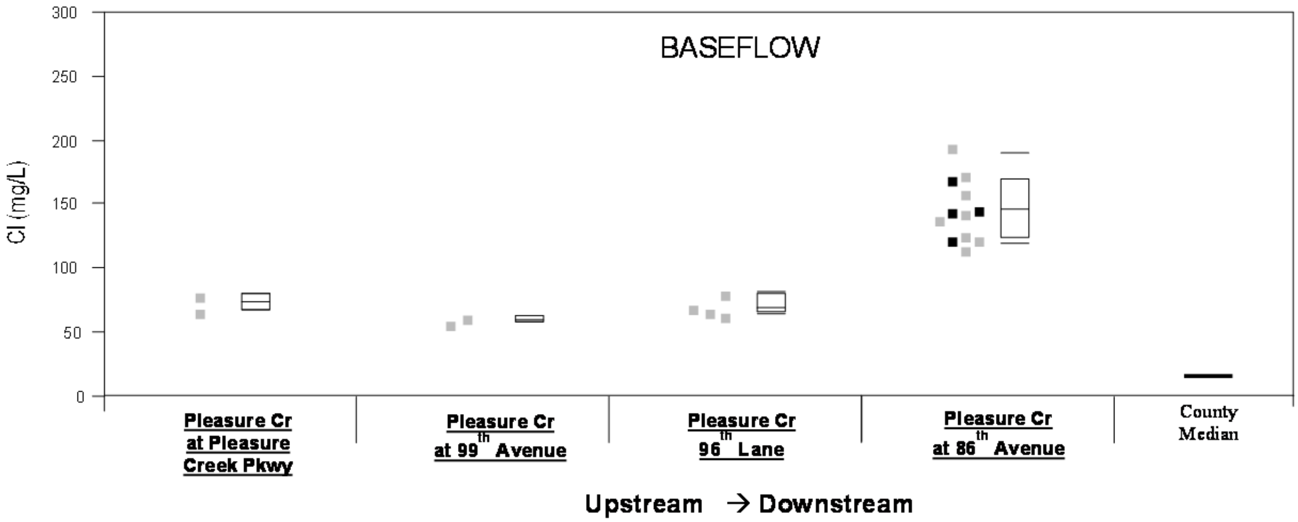
	Conductivity (mS/cm)	Chlorides (mg/L)	State Standard	N
Baseflow	0.911	147	Conductivity – none Chlorides 860 mg/L acute, 230 mg/L chronic	28
Storms	0.960	178		22
All	0.950	159		50

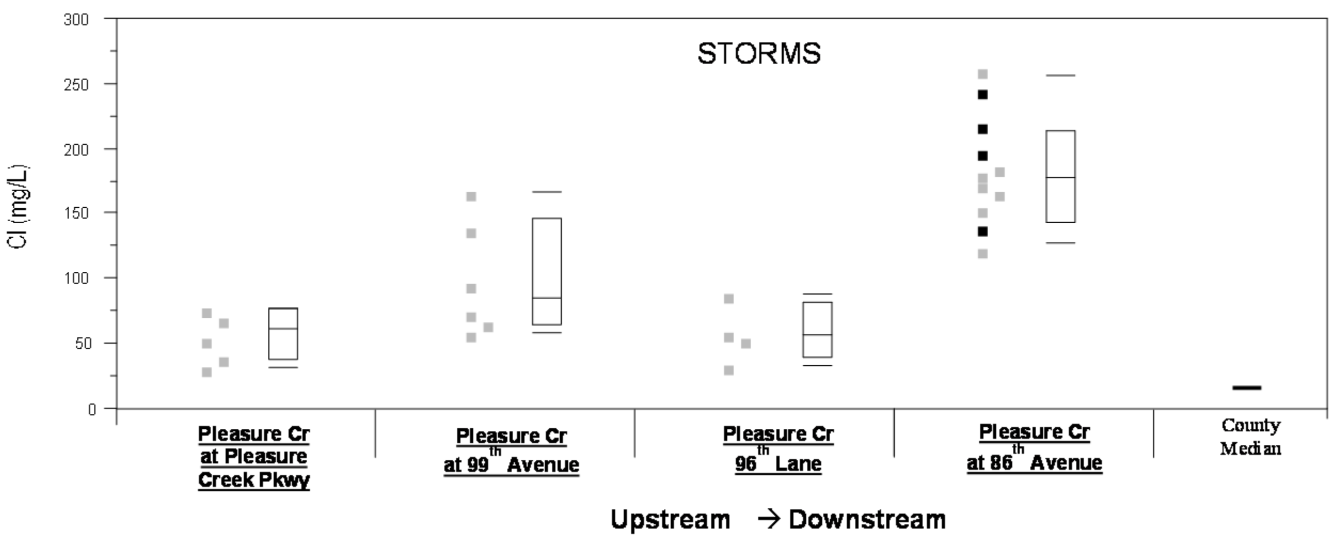
Conductivity at Pleasure Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Chlorides at Pleasure Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Recent research has shown that chloride toxicity is heavily dependent upon water hardness, and to a lesser degree, sulfate levels in the water. Therefore, these parameters were measured six times in 2012. This data is summarized in the table below.

Sulfate and hardness at Pleasure Creek. The median of eight measurements taken in 2012 from Sand Creek at 86th Avenue is shown. No other years of data are available. Data from other sites are available.

	Pleasure Cr at 86th Ave
Sulfate (mg/L)	58.35
Hardness (mg/L CaCO3)	247.5

Iowa has revised its water quality standards to reflect the impact of sulftates and hardness on chloride toxicity, and Minnesota is in the process of doing so. Iowa has developed the following equations to calculate acute and chronic chloride standards for each waterbody:

Acute chloride standard = $287.8(\text{Hardness})^{0.205797}(\text{Sulfate})^{-0.07452}$

Chronic chloride standard = $177.87(\text{Hardness})^{0.205797}(\text{Sulfate})^{-0.07452}$

These equations are applied to Pleasure Creek data in the table below.

Pleasure Creek chloride standards using Iowa equations that account for sulfate and hardness. Data used are eight hardness and sulfate measurements in Springbrook Creek at 79th Way in 2012.

	Stream-specific chloride standard as calculated with Iowa equations	**Current Minnesota Standard**	**Pleasure Creek Observations**
Acute (one hour average)	**661 mg/L**	**860 mg/L**	**262 mg/L** = Maximum observed
Chronic (four day average)	**408 mg/L**	**230 mg/L**	**120 mg/L** = Average of all observations

The effect of these site-specific standards for Pleasure Creek, once adopted in Minnesota, would be to make the acute standard more strict and the chronic standard less strict. Presently, Pleasure Creek is approaching the chronic standard and may exceed it during snowmelt. While an adjusted chronic standard would make it less likely that Pleasure Creek would be in violation, the chloride levels in the creek are still highly undesirable.

Total Phosphorus

Total phosphorus (TP) is a common nutrient pollutant. It is limiting for most algae growth. TP was low in Pleasure Creek during baseflow, and higher during storms (see table and figures below). The phosphorus concentrations during baseflow were lower than most other streams in the area, and similar to other streams during storms.

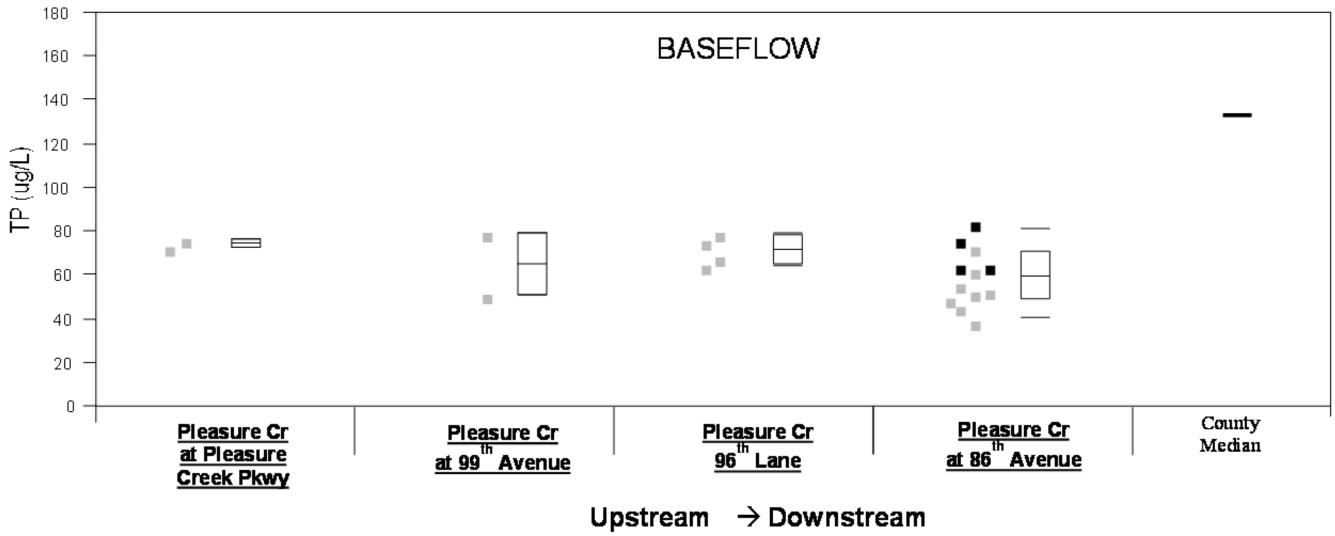
The MN Pollution Control Agency is likely to adopt 0.100 mg/L as a new phosphorus standard for streams. Based on data collected to date, Pleasure Creek would probably violate this standard during storms and then be designated as "impaired."

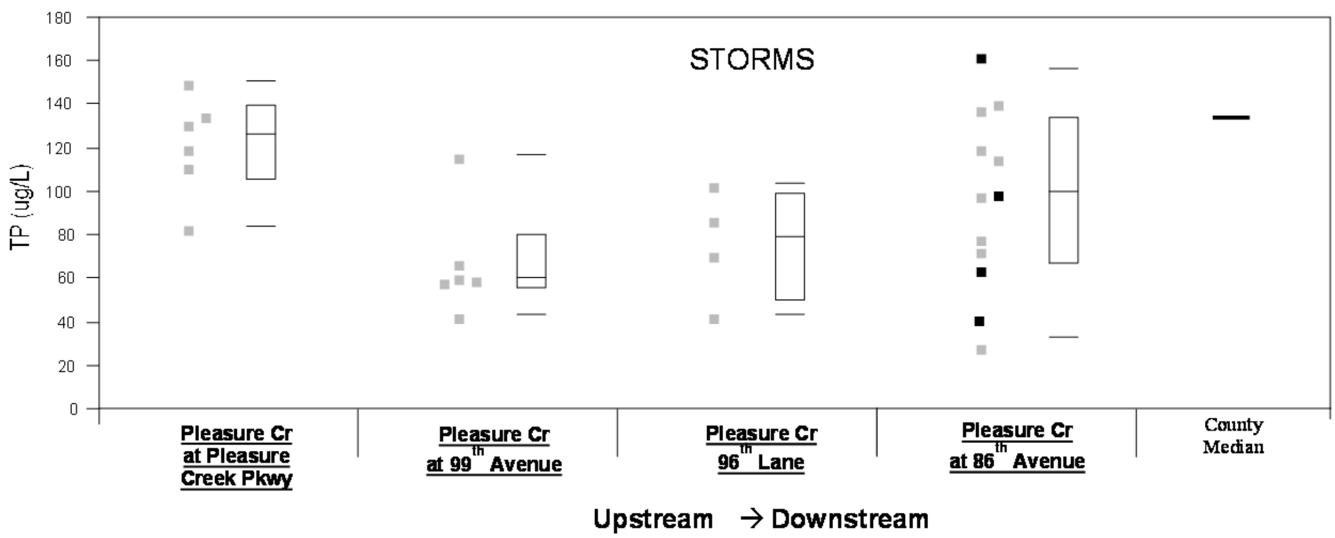
Median pH in Pleasure Creek. Data is from the 86th Avenue site and all years through 2012.

	Total Phosphorus (ug/L)	**State Standard***	**N**
Baseflow	60.5	100	28
Storms	100.5		22
All	70.0		50
Occasions > state standard			7, all during storms

*New state standards are under development. The standard listed is the likely new threshold.

Total phosphorus at Pleasure Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. 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 measures by defraction of a beam of light sent though the water sample, and is therefore most sensitive to large particles. Suspended solids are important because they carry other pollutants, affect water appearance, and can harm stream biota.

TSS and turbidity were both low during baseflow and storms at the upstream sites, but higher during storms at the farthest downstream site (see table and figures below). The low turbidity and TSS at the upstream sites is probably reflective of the effectiveness of large stormwater ponds in that area. Farther downstream there is also one large stormwater pond just upstream of East River Road, but at the outfall to the Mississippi a short distance downstream suspended solids are higher than elsewhere in Pleasure Creek.

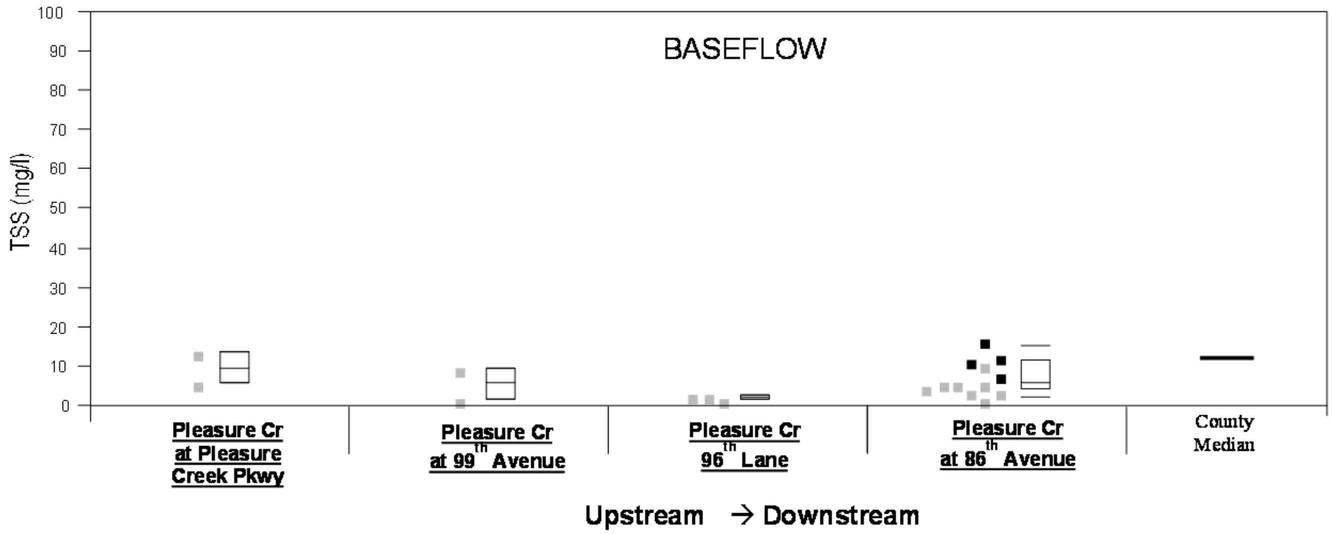
The MN Pollution Control Agency is in the process of modifying the state water quality standard in this region. The new standard will likely be 30 mg/L TSS, with no turbidity standard. At the outfall to the Mississippi River Pleasure Creek will likely exceed this standard during storms and be considered impaired. More than the required 20 samples needed for assessment have been collected, so the impaired designation will likely follow shortly after the new state standard is adopted. Additional stormwater treatment around and downstream of East River Road will be helpful at achieving the water quality standard.

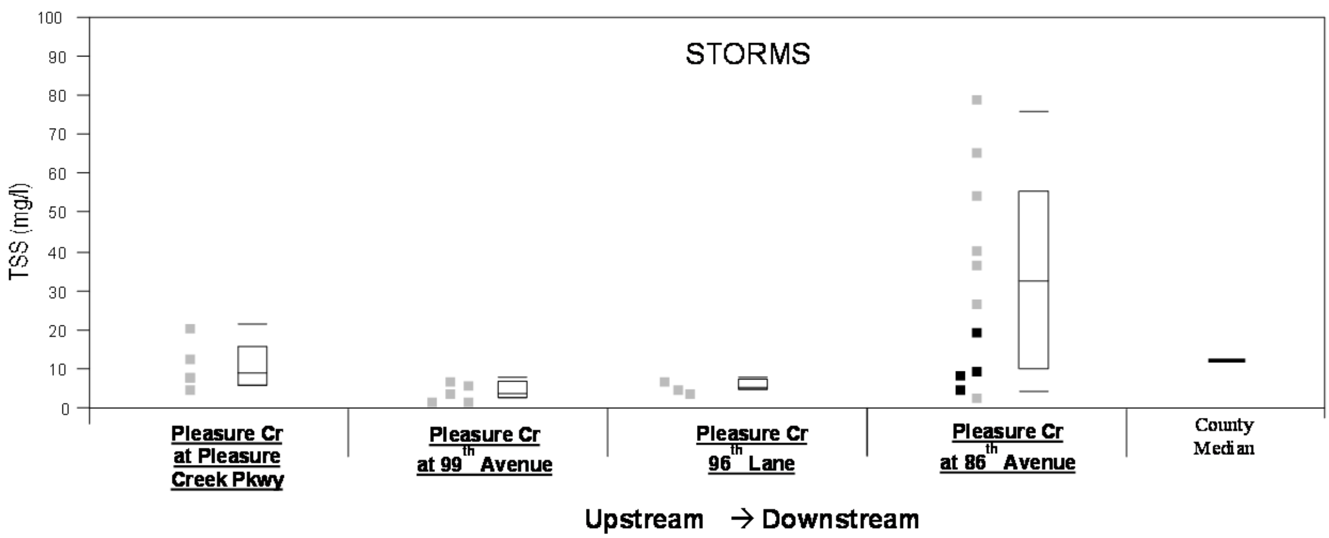
Median turbidity and suspended solids in Pleasure Creek. Data is from the 86th Avenue site and all years through 2012.

	Turbidity (FNRU)	Total Suspended Solids (mg/L)	State Standard*	N
Baseflow	7	6	30 mg/L TSS	28
Storms	20	33		22
All	12	11		50
Occasions > new state TSS standard				6, all during storms

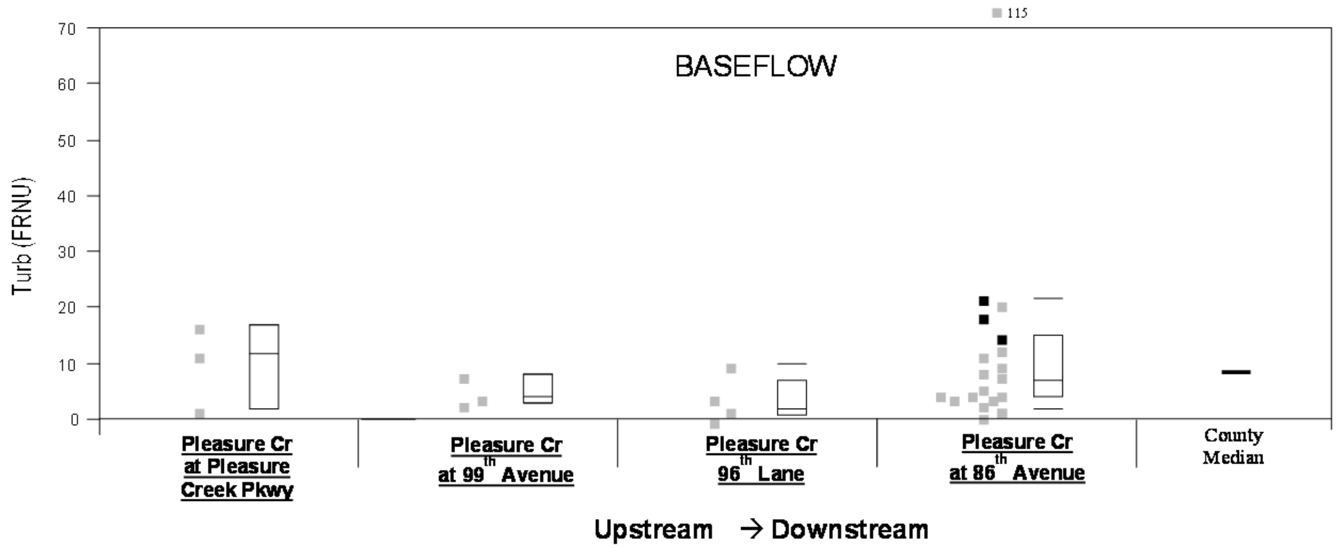
*New state standards are under development. The standard listed is the likely new threshold.

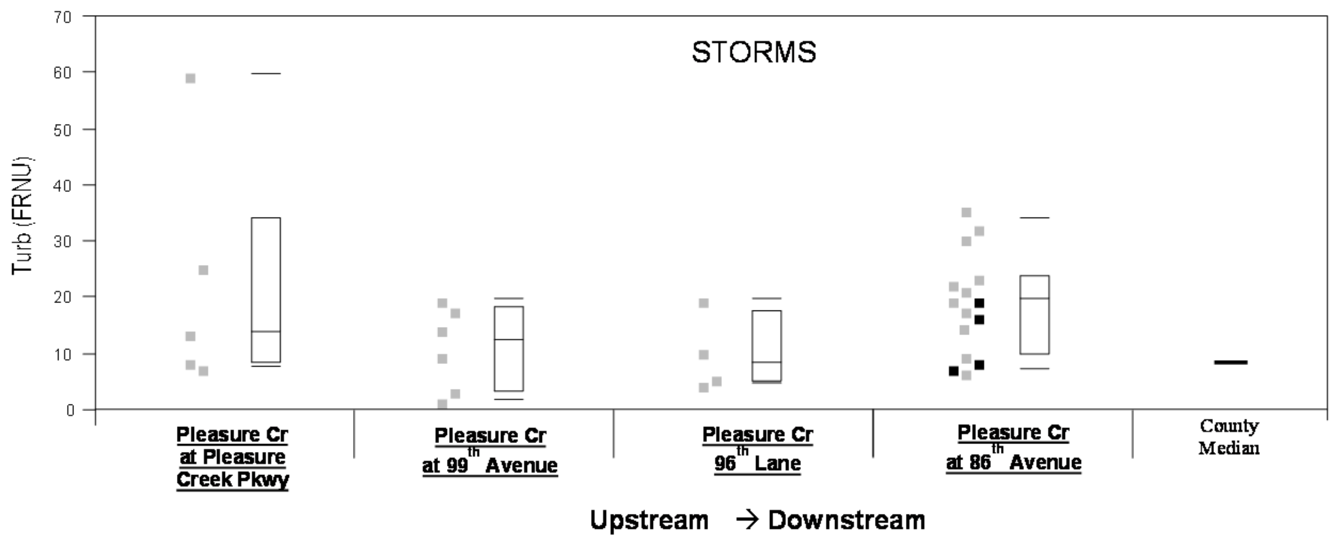
Total suspended solids at Pleasure Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Turbidity at Pleasure Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





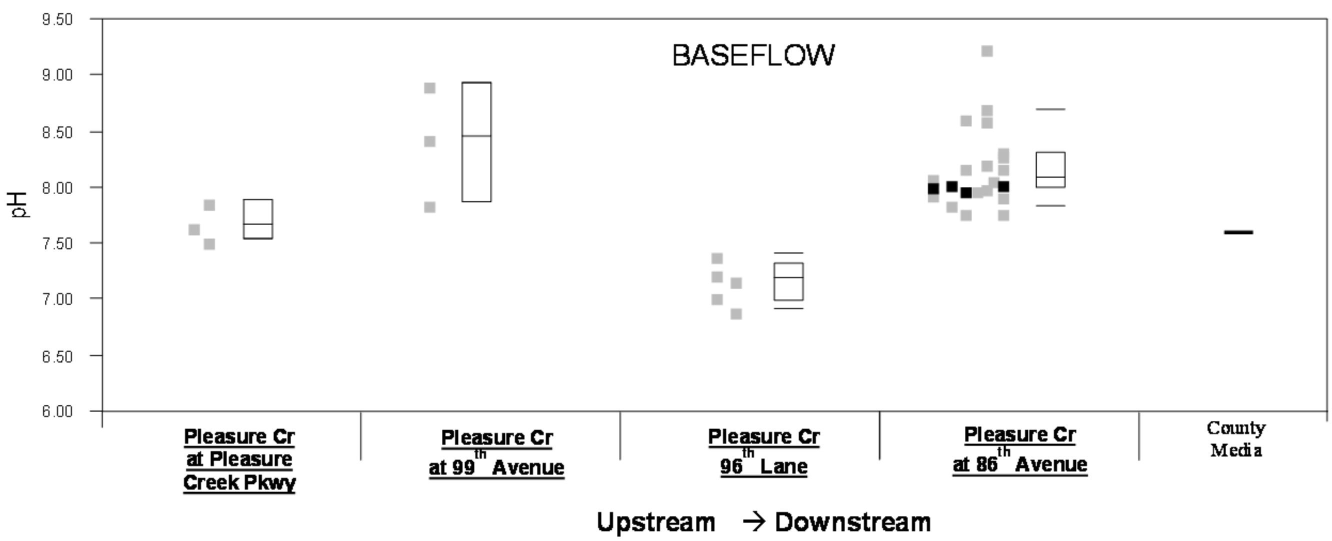
pH

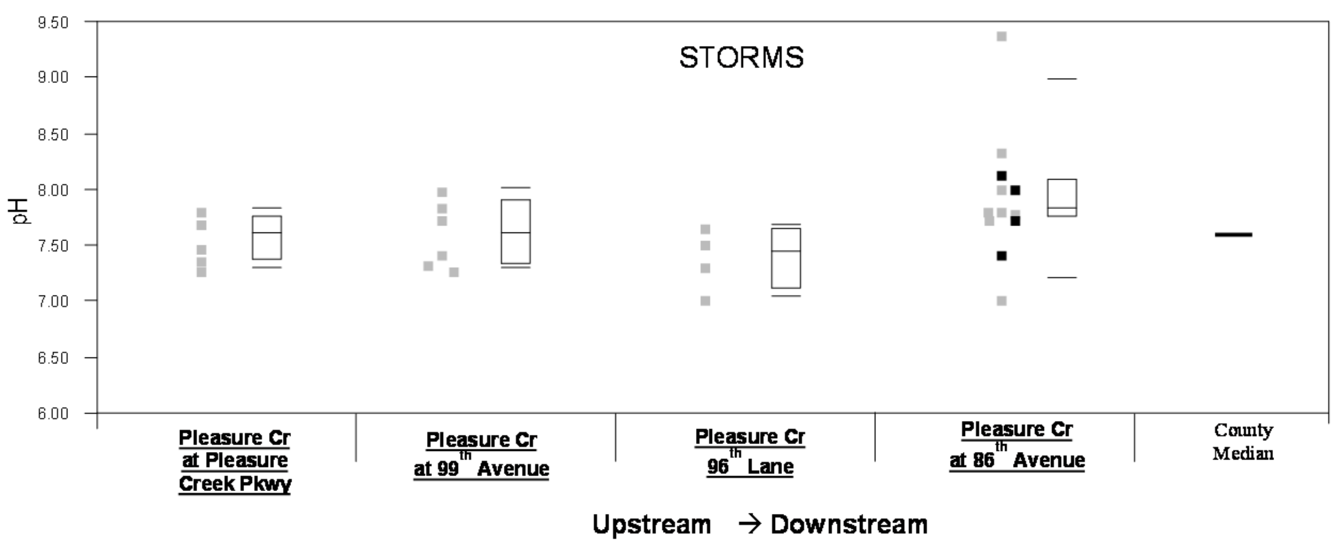
Sand Creek pH was within the expected range at all sites and during all conditions (see figures below), ranging from 7.05 to 8.71. The median was 7.73. The Minnesota Pollution Control Agency water quality standards set an expectation for pH between 6.5 and 8.5.

Median pH in Pleasure Creek. Data is from the 86th Avenue site and all years through 2012.

	pH	State Standard	N
Baseflow	8.12	6.5-8.5	28
Storms	7.85		22
All	8.06		50
Occasions outside state standard			1

pH at Pleasure Creek. Dots are individual readings. Black dots are 2012 readings; grey dots are from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Dissolved Oxygen

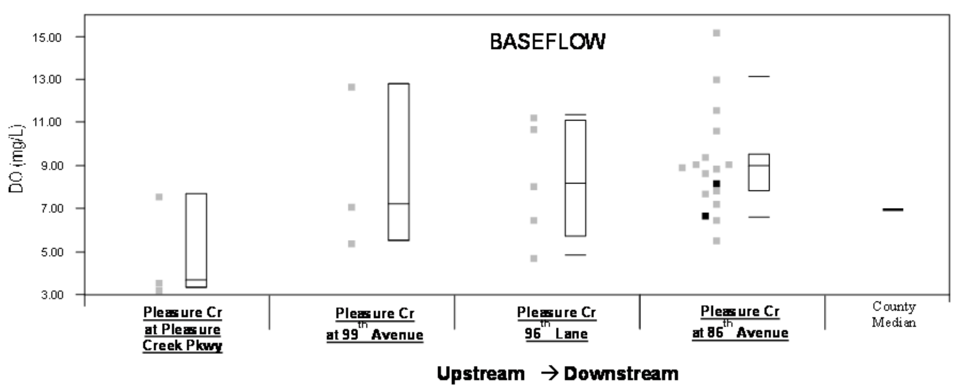
Dissovled oxygen (DO) essential for aquatic life. Fish, invertebrates, and other aquatic life suffer if DO is below 5 mg/L. Low DO can be a symptom of organic pollution, the decomposition of which reduces oxygen.

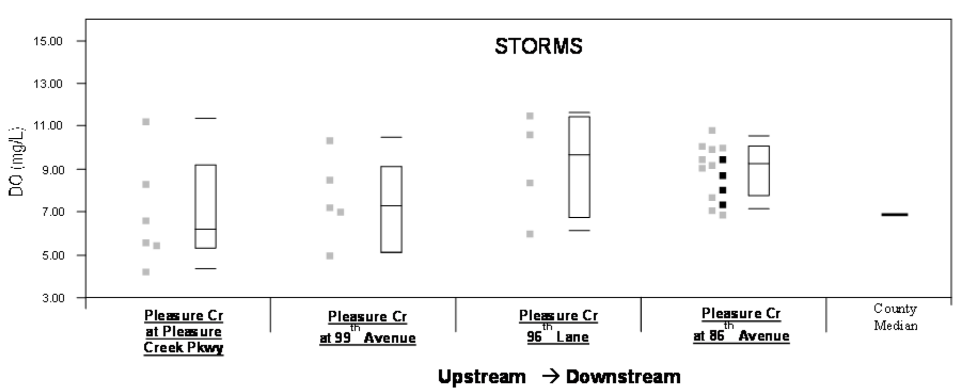
Dissolved oxygen in Pleasure Creek was generally within the acceptable level (>5 mg/L; see table and figure below). No instances of DO <5mg/L were not observed at 86th Avenue and 96th Lane. One of nine measurements at 99th Avenue was <5mg/L. Three of 9 measurements at the farthest upstream monitoring site, Pleasure Creek Parkway, were <5mg/L. The fact that one-third of measurements had low dissolved oxygen at this farthest upstream monitoring site is not particularly concerning because readings were within the inflow of a small stormwater pre-treatment basin which is sheltered (little wind mixing), had little flow, and had accumulated a lot of organic matter (its job as a pre-treatment basin).

Median dissolved oxygen in Pleasure Creek. Data is from the 86th Avenue site and all years through 2012.

	Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	9.03	5 mg/L daily minimum	28
Storms	9.39		22
All	9.12		50
Occasions <5 mg/L			0*

Dissolved Oxygen at Pleasure Creek. Dots are individual readings. Black dots are 2011 readings; grey dots are from previous years. 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 bacteria was monitored in several years, but not in 2012. E. coli, a bacteria found in the feces of warm blooded animals, is unacceptably high in Pleasure Creek. E. coli is an easily testable 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 colony forming units per 100 milliliters of water (cfu/100mL) or if the geometric mean of five samples taken within 30 days is greater than 126 cfu/100mL. Pleasure Creek exceeds both criteria (see figure on following page). The creek has not yet been listed as “impaired” by the State, but a water quality problem exists regardless. Sources of the bacteria likely include headwaters storm water ponds and storm water runoff from throughout the watershed.

Enough data is available for the downstream monitoring site (outlet to Mississippi River) to clearly document exceedances of the “impaired” criteria. At the upstream sites not enough data has been gathered, but the E. coli values observed are similar to the downstream site. At the farthest-downstream monitoring site three of four samples in May 2007 exceeded 1260 cfu/100mL (261, 1986, and two samples exceeded the test limits of 2420 cfu/100mL). In 2006, five samples taken between 5/24 and 6/21 had a geometric mean of 318 cfu/100mL. In 2007 five samples were taken between 5/24 and 6/20, but calculating their geometric mean is impossible because two of the samples exceed the test’s capacity of 2420 cfu/100mL. If we conservatively replace those readings with 2420 cfu/100mL, then geometric mean is 934 cfu/100mL. On all accounts, Pleasure Creek at the outlet to the Mississippi River exceeds the State of Minnesota E. coli standard for contact with the water.

E. coli levels were highest and most variable at the outlet to the Mississippi River during storms (see figures below). Average baseflow E. coli was 257 MPN/100mL (n=8; units MPN/100mL are comparable to cfu/100mL and differ in analytical method) and varied little (standard deviation 179). During storms average E. coli jumped to 935 MPN/100mL (n=9) and varied widely (standard deviation 1046). A large part of this variability might be explained by the intensity of the storm, phenology of the storm, and when during the storm the sampling was done. E. coli during storms is higher because storms flush bacteria from impermeable surfaces throughout the watershed, and because higher flows suspend and transport E. coli that were already present in the creek.

In 2008 monitoring occurred at the Blaine-Coon Rapids Boundary (96th Lane) to determine if the problem originated up or downstream of that point. Average baseflow E. coli was 235 MPN/100mL (n=4) and varied little (standard deviation 135). Average storm E. coli was 1102 MPN/100mL (n=3) and varied widely (standard deviation 1187). This is similar to the outlet to the Mississippi River, so it appears that an important bacteria source is within the City of Blaine. It is likely that urban runoff within Coon Rapids is also contributing E. coli to the stream.

In 2009 monitoring moved further upstream to diagnose the bacteria source. The portions of the watershed above the 2008 monitoring site are a network of stormwater ponds in the City of Blaine. 2009 monitoring was designed to determine which drainage areas to these ponds are bacteria sources or if the ponds themselves might be the source. One monitoring site split was mid-way through the pond network (Pleasure Cr Parkway W), while the other was at the outlet of the last pond (99th Avenue, see monitoring sites map above). Most monitoring (6 of 8 occasions) was during storms because the highest bacteria levels were found during storms in previous years. The results suggest that the ponds themselves are a source of E. coli, while additional bacteria may come from the neighborhoods around the ponds.

The monitoring site mid-way through the pond network (Pleasure Cr Parkway W) did have elevated E. coli during baseflow and storms, which suggests that the small drainage area upstream of this site contributes E. coli to the creek. Only two baseflow samples were taken and little flow was moving; E.

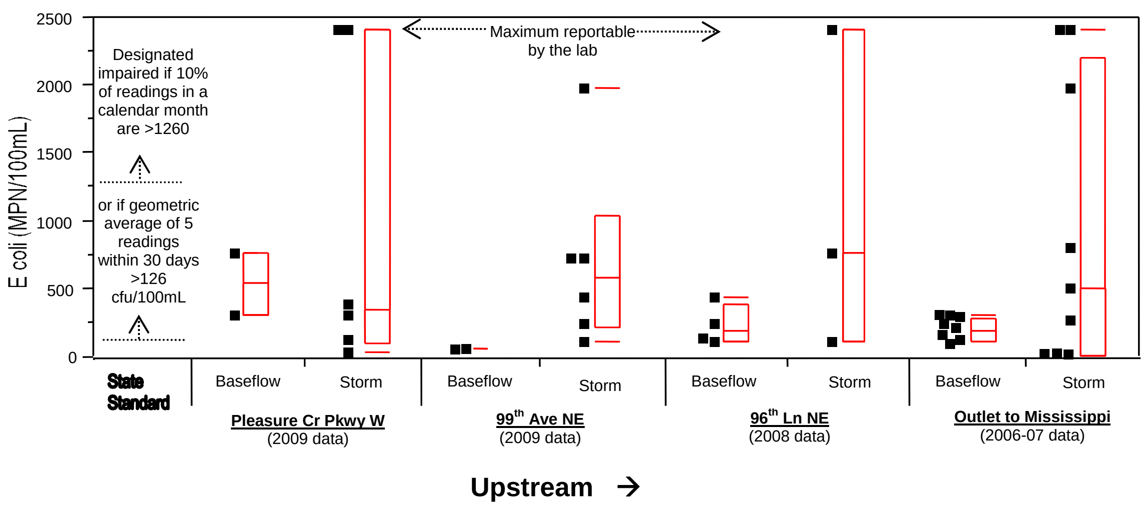
coli levels were 307 and 770 MPN/100mL, which is moderately high. This would seem to suggest that bacteria levels may have a regular, non-storm related presence in the ponds (i.e. the ponds are a bacteria source). During storms, six samples had widely different E. coli levels. On the low end, one storm had only 34 MPN/100mL and another had only 122 MPN/100mL. These readings are below the state water quality standard. Two other storms had moderate E. coli levels of 307 and 387 MPN/100mL. But during the other two storms E. coli levels were so high they exceeded the laboratory's maximum test result of 2420 MPN/100mL. E. coli levels were not correlated with precipitation totals or stream water level.

The monitoring site at the bottom of the pond network (99th Avenue) had low E. coli during baseflow. Only two samples were taken during baseflow, and the E. coli levels were low (55 and 58 MPN/100mL). While two samples are too few for a confident assessment, it suggests that few bacteria exit the last stormwater pond during baseflow. The last ponds are the largest and deepest, and therefore least likely to harbor bacteria and most likely to remove them during baseflow. While the smaller, shallower upper ponds may harbor E. coli, the larger, deeper lower ponds remove them during baseflow. Howerver, higher flows during storms can allow bacteria to pass through all of the ponds.

E. coli levels during storms at 99th Avenue were much more variable, similar to what was found in the ponds. While one storm sample had desirably low E. coli (104 MPN/100mL), others were high (248, 435, 727, 727, and 1986 MPN/100mL). This indicates some bacteria pass through the ponds, or are flushed from them, during storms. E. coli levels were not correlated with precipitation totals or stream water level.

There is some evidence that E. coli is not associated with nutrient-rich sources such as wastewater. Phosphorus in Pleasure Creek is low, especially for an urban stream (see phosphorus section of this report). If wastewater or other nutrient rich sources were significant, phosphorus would be higher.

E. coli Bacteria Results During Base and Storm Conditions. Dots are individual readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Fecal coliform and fecal streptococcus bacteria testing was done at 99th Avenue to determine if the bacteria source was human sewage. The feces of different animals have different ratios of these two bacteria types (see table below). Admittedly, this is an imperfect test for several reasons. First, pollution from multiple sources can alter the ratio. Second, bacterial ratios will change over time because of different die-off rates; fecal streptococci die-off faster thereby increasing the ratio and possibly resulting in incorrect determinations that the bacterial source is human. Research has found that these bacteria types can survive and reproduce outside of the digestive tracts of warm-blooded animals. The population dynamics of these "free-living" bacteria could affect the ratio. These limitations are important to recognize when interpreting the data.

Fecal coliform to fecal streptococcus bacteria ratios in the feces of various animals. (source: Microbiological examination of water and wastewater by Csuros and Csuros, 1999)

Source	Ratio	Source	Ratio
Human	4.4	Pig	0.4
Duck	0.6	Cow	0.2
Sheep	0.4	Turkey	0.1
Chicken	0.4		

Fecal coliform to fecal streptococcus ratios consistently indicated that the bacteria source is not human feces (i.e. ratio <4.4). On average, the ratio was 0.30 (n=8, standard deviation 0.31). The highest observed ratio was 1.03 and lowest was 0.03. There was no apparent difference between storms (n=6, average 0.30, standard deviation 0.36) and baseflow (n=2, average 0.28, standard deviation 0.07).

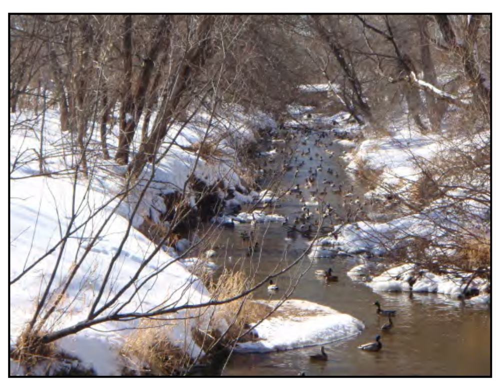
Likely bacterial sources include:

- **Urban stormwater**. It is well documented that urban stormwater runoff has elevated E. coli. There is no reason to believe that this is not true across Pleasure Creek's watershed. The absence of a step-wise increase in bacteria downstream suggests that bacterial concentrations of stormwater entering the stream are not greater than those already in the stream.

  It should be noted that no animal concentrations for feedlots are known to exist in the watershed that would contribute significant fecal or coliform bacteria.

- **Stormwater ponds**. Although stormwater ponds generally remove pollutants by allowing settling there are many documented instances throughout the U.S. where the ponds accumulate fecal bacteria that are then flushed out during larger storms. Research has shown that these bacteria can survive and reproduce outside of the intestines of warm-blooded animals. Survival is longest when the water temperature is lower, sun exposure is less, and bacterivorous predators (nematodes, ciliates, rotifers, etc) are fewer. Some bacteria are attached to particles that settle within stormwater ponds but are still vulnerable to resuspension during storms, while others are "free" and less likely to settle.

  Of particular interest are the 11 stormwater ponds that the creek flows through in its headwaters in the City of Blaine. These ponds and the developments around them were built post-1995. Some are small and shallow and serve as forebays to the larger, deeper ponds. The stormwater pond network in Blaine is likely a source of bacteria, collecting them from polluted runoff, harboring them, and releasing them (especially during storm flushing). Smaller, shallower upper ponds are the most suitable for bacterial survival. The larger, deeper lower ponds are less suitable for bacteria and seem to remove them from the system during baseflow but not during storms. While these ponds do a good job removing



Waterfowl congregating on Pleasure Creek near Evergreen Blvd in Coon Rapids, February 2010. 250+ ducks were present in about 350 meters of creek.

suspended solids in all conditions, they do not regulate water rate and volume during storms well. These storm flushes can provide a means for transporting bacteria. The fact that suspended solids seem to be captured by the ponds during storms but not bacteria seems inconsistent and deserves more research.

- **Waterfowl**. Waterfowl congregations on Pleasure Creek primarily occur in winter. During this time several hundred ducks have been observed in Coon Rapids near Evergreen Boulevard (see photo). The ducks keep the water from icing over.

  In the summer small waterfowl congregations do occur in places around the watershed, but none are large. Waterfowl usage of the network of stormwater ponds that the creek flows through in Blaine would be of greatest concern, but few birds congregate there. The ponds are encircled with a >25 foot wide buffer of unmowed vegetation designed to filter runoff, but which also discourages waterfowl. Some birds do use the ponds for resting or feeding on the water, but no concentrations of more than 10 birds were seen by staff during monitoring. The stormwater ponds in Coon Rapids near the railroad tracks have not been checked for summer waterfowl congregations.

Possible, but likely minor, bacterial sources include:

- **Stormwater sumps/catch basins**. The catch basins below many curbside gutters are designed to capture solids. The dark, moist environment with consistently moderate temperatures might be favorable for bacteria, although this is not well documented or researched to our knowledge. Any bacteria in these basins would be flushed out by larger storms. Catch basin sumps have been found to capture solids during small storms but some is flushed out during intense storms.
- **Sanitary sewer.** Sanitary sewer could contribute either through leaking pipes or if a wastewater pipe improperly intersects with a storm water pipe. The extent of this occurring is unknown. Dry-weather screening of stormwater outfalls for illicit discharges could be used to detect any such problems. The lower bacterial concentrations during baseflow suggests this may not be an issue, as does the fecal coliform to streptococcus ratio.

<u>Summary of E. coli Findings</u>

In total, the results of the monitoring efforts can be summarized as follows:

- E. coli bacteria contamination is throughout Pleasure Creek, from the headwaters to the outlet to the Mississippi River.
- Bacteria levels during baseflow minimally exceed state water quality standards on a regular basis.
- Bacteria levels during storm flows grossly exceed state water quality standards on a regular basis.
- The source is not human feces.
- Urban stormwater runoff is a likely E. coli source watershed-wide.
- The stormwater pond network in Blaine is likely a source of bacteria, collecting them from polluted runoff, harboring them, and releasing them (especially during storm flushing). Smaller, shallower upper ponds are the most suitable for bacterial survival. The larger, deeper lower ponds are less suitable for bacteria and seem to remove them from the system during baseflow but not during storms.

We recognize that most of these conclusions cannot be supported with 100% confidence. However, the limited amount of work done to date is consistent in pointing to these conclusions.

It is worth noting that understanding of E. coli impairments and tools to effectively address them are lacking. Historically, E. coli was viewed as an indicator of sewage pollution. In some cases it is. Today we know E. coli levels are elevated in virtually every urban environment, most animal agriculture areas, and even in some forested areas. Elevated E. coli has been documented in places that are counter-intuitive, such as water draining from rooftops. E. coli's ability to survive outside of the gut of warm-blooded animals means that it may not always be a good indicator of the presence of fecal pathogens. The extreme variability in bacterial counts in Pleasure Creek during similar storms illustrates our incomplete understanding of the situation and many factors that are probably affecting it. 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.

Stream Water Quality – Biological Monitoring (Students)

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 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.

Locations: Coon Creek at Crosstown Blvd. near Andover High School, Andover

Coon Creek at Erlandson Park (Egret St.)

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, as 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.

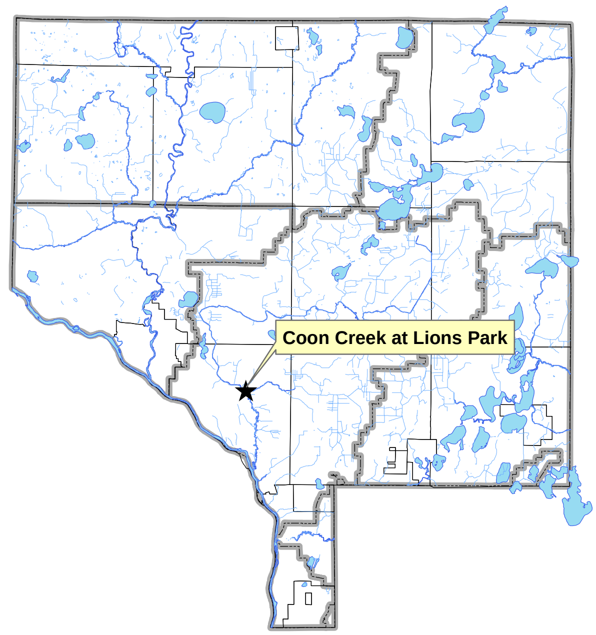
Family Biotic Index (FBI) — An index that utilizes known pollution tolerances for each family. Lower numbers indicate better stream quality.

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

% Dominant Family — High numbers indicates an uneven community, and likely poorer stream health.

COON CREEK

at Erlandson Park (Egret St.), Coon Rapids



Last Monitored

By ACD staff in 2011

Monitored Since

Spring 1999

Student Involvement

20 students in 2012, approximately 60 since 1999

Background

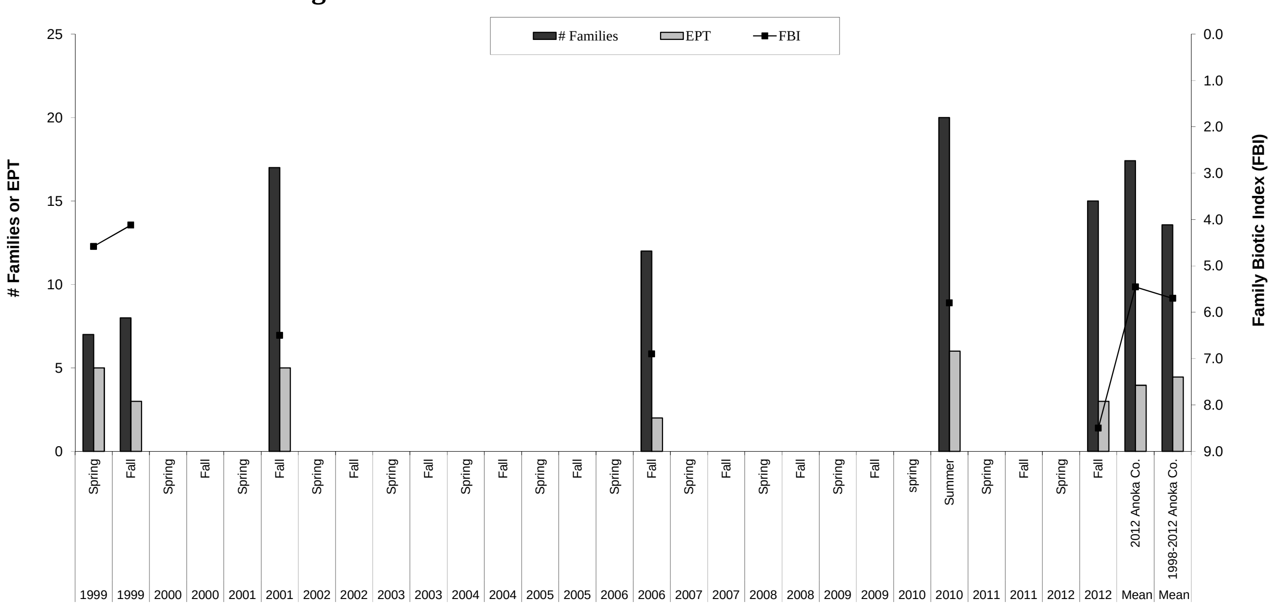
Coon Creek originates in the southern part of the Carlos Avery Wildlife Management Area in western Columbus. It flows west, then south, and empties into the Mississippi River at Coon Rapids Dam Regional Park. Coon Creek has a number of ditch tributaries. The stream flows from rural residential settings to high density urban areas. Upstream reaches have been ditched while lower reaches have not.

The Hanson Boulevard sampling site is within the Lions Park. The park is forested and lawn, but surrounding areas are urban residential. This site is in the lower part of the watershed and therefore carries relatively larger flows. This site has been ditched, and lacks riffles and pools. All of the bottom is sandy, and in-stream habitat is largely limited to reed canary grass at the water's edge.

Results

This site has been sampled very little in the past. In 2012 a class from Blaine High School sampled invertebrates. In 2012, the number of families found and number of sensitive EPT families was similar to the average for Anoka County, but the family biotic index was very poor. Most of the families found were generalists, and not indicative of high quality stream conditions. In other years the invertebrate community indicated somewhat better stream health. Lack of habitat and poor water quality probably both have a negative impact on invertebrate communities at this site.

Summarized Biomonitoring Results for Coon Creek at Hanson Blvd.



Biomonitoring Data for Coon Creek at Hanson Blvd

Year	1999	1999	2001	2006	2010	2012	Mean	Mean
Season	Spring	Fall	Fall	Fall	Summer	Fall	2012 Anoka Co.	1998-2012 Anoka Co.
FBI	4.58	4.12	6.50	6.90	5.80	8.50	5.5	5.7
# Families	7	8	17	12	20	15	17.4	13.6
EPT	5	3	5	2	6	3	4.0	4.4
Date	10-Jun	5-Nov	26-Oct	4-Oct	1-Sep	10-Oct		
sampling by	?	?	CRHS	SLPLH	MPCA	BHS		
sampling method	MH	MH	MH	MH	MH	MH		
# individuals	68	130	122	79	323	155		
# replicates	1	1	1	1	1	1		
Dominant Family	hydropsychidae	hydropsychidae	corixidae	corixidae	chironomidae	coenegrionidae		
% Dominant Family	53	66	35.2	19.0	55.1	32.9		
% Ephemeroptera	27.9	9.2	12.3	12.7	16.4	1.9		
% Trichoptera	55.9	69.2	20.5	7.6	9	0		
% Plecoptera	0	0	0	0.0	0	0		

Discussion

Coon Creek contains both ditched and natural stream reaches. Both have been biologically monitored professionally and by students. The Hanson Boulevard site has been ditched. Despite being located in a park, in-stream habitat is poor. Moreover, it is in the downstream half of the watershed, and water quality generally deteriorated downstream in Coon Creek. It is likely that both lack fo habitat and water quality negatively affect the invertebrate community at Lions Park.

More detailed comparison of ditched and natural stream reaches in Coon Creek is provided in reporting of professional biomonitoring.

Stream Water Quality – Biological Monitoring (Professional)

Description: Stream biomonitoring uses biota present in the stream, in this case invertebrates, as a gauge of stream health. Invertebrates are captured using standard procedures from the U.S. EPA or MPCA. Interpretation of results is based on the knowledge that different families of macroinvertebrates have different water and habitat quality requirements. Therefore, a census of stream macroinvertebrates yields information about stream health. Because invertebrates are affected by all aspects of habitat and water quality over time, biomonitoring provides a holistic picture of 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.

Locations: Ditch 58 at Andover Blvd

Sand Cr at Olive St

Coon Cr at Egret Blvd

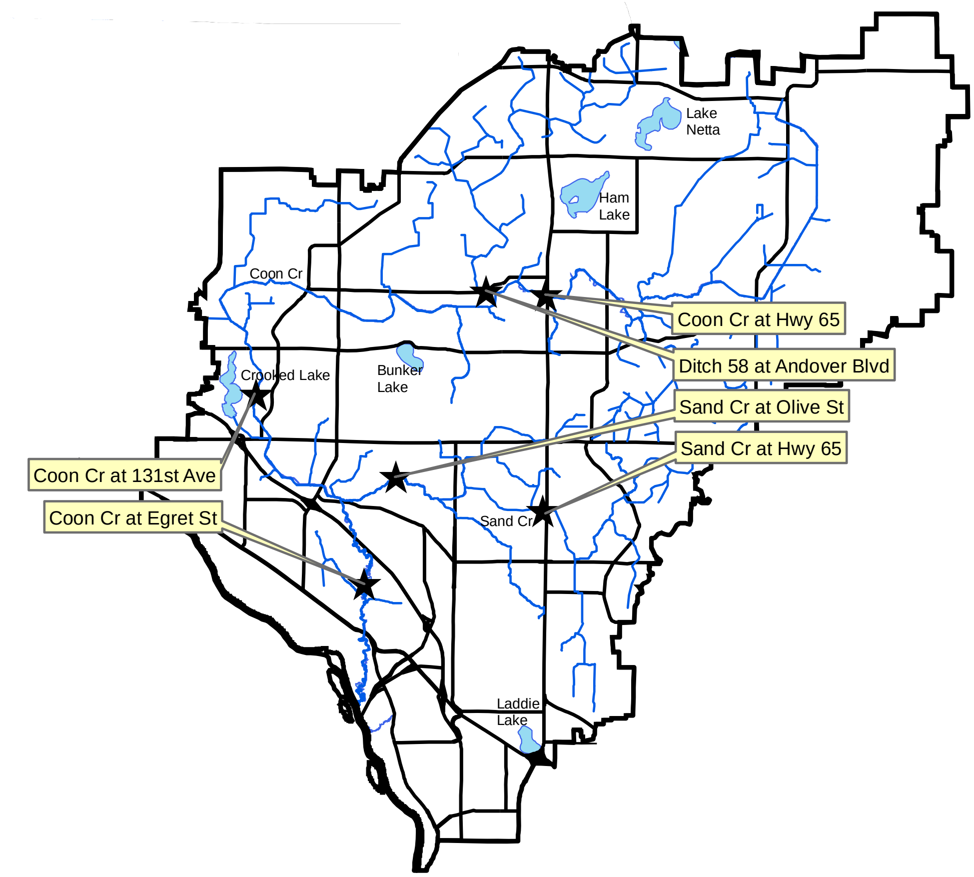
Coon Cr at 131st St

Coon Cr at Hwy 65

Ditch 41 at Hwy 65

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

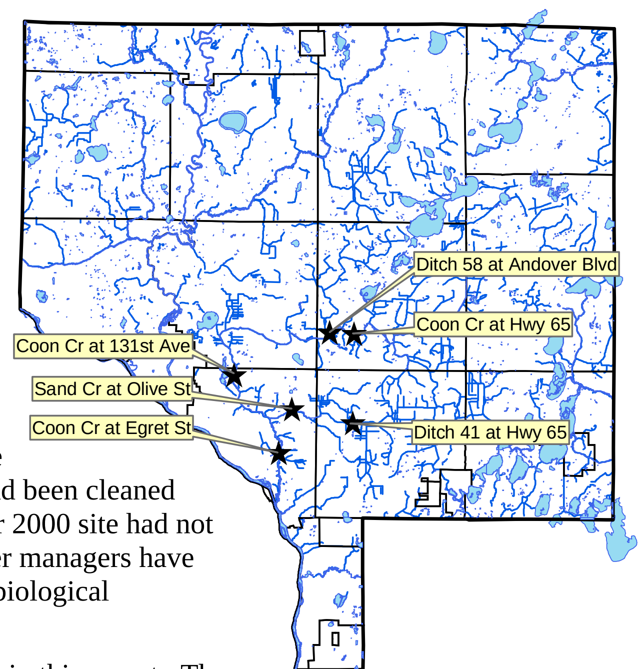
Coon Creek Watershed Professional Biomonitoring Sites



COON CREEK SYSTEM

		Monitored by					
Maintenance Regime	**Site**	**2000**	**2008**	**2009**	**2010**	**2011**	**2012**
Unmaintained	Ditch 58 at 165th Ave.		ACD	ACD			
Not ditched or cleaned	Ditch 58 at Andover Blvd.			ACD	MPCA	ACD	ACD
in last 10 years	Sand Creek at Olive St.	MPCA		ACD	MPCA	ACD	ACD
	Coon Creek at Egret St.	MPCA	ACD	ACD	ACD	ACD	ACD
Maintained	Ditch 59-4 at Bunker Lake Blvd.		ACD				
Ditched or cleaned	Ditch 41 at Highway 65		ACD	ACD	ACD	ACD	ACD
in last 10 years	Coon Creek at Highway 65	MPCA	ACD	ACD	MPCA	ACD	ACD
	Coon Creek at 131st Ave.		ACD	ACD	ACD	ACD	ACD
Other, non-study sites	Coon Creek at Vale St				MPCA		
	Coon Creek at Hanson Blvd				MPCA		
	Coon Creek at Naples St				MPCA		
	Ditch 11 at 149th Ave				MPCA		
MPCA = MN Pollution Control Agency, ACD = Anoka Conservation District							

Background



Coon Creek is a major drainage through central Anoka County. Development in the watershed ranges from rural residential (upstream) to urbanized (downstream). Upstream reaches have a history of ditching and cleaning, and many ditch tributaries exist. Farther downstream, ditching activity has been minimal, but the effects of the urban environment are more pronounced. The creek has been monitored both chemically and biologically.

The Minnesota Pollution Control Agency (MPCA) has listed Coon Creek as biologically impaired based on single samples from two sites in August of 2000, with additional biological samples taken in 2010. One of these reaches is an actively maintained ditch that had been cleaned not long before 2000 biological monitoring. The other 2000 site had not received maintenance in the past 10 years. Local water managers have questioned the robustness of the data and appropriate biological expectations for an actively managed ditch.

The Coon Creek Watershed District initiated the study in this report. The purpose of this work is to:

- compare the macroinvertebrate communities between maintained and unmaintained creek reaches,
- examine the effects of ditching on habitat,
- examine the effects of habitat on macroinvertebrate communities,
- examine the effect of total suspended solids, a common invertebrate stressor, on invertebrate communities, and
- compare the biological integrity of the Coon Creek system with similar nearby streams, and
- revisit biotic indices of stream health that were first measured in 2000 and used to designate the stream as "impaired."

Professional biomonitoring was conducted for this study within the stream and ditch reaches identified in the table above. All sites within each year were examined twice per year – in August when the MPCA performs invertebrate monitoring and again at the beginning of October for comparison with student stream biomonitoring performed at other sites. Professional biomonitoring is more rigorous and more comprehensive than student biomonitoring programs. All of the field work, identifications, and analyses are performed by professional aquatic ecologists. The sampling methods used were the same as those used by the MPCA, the US EPA's multi-habitat method. In addition, the MCPA's Stream Habitat Assessment (MSHA) worksheet was completed for each site. Going beyond MPCA's standard operating procedures, water chemistry data was collected, including pH, conductivity, turbidity, temperature, dissolved oxygen (DO), salinity, and total suspended solids (TSS). TSS is of interest because impaired water studies (TMDLs) for biological impairments have often identified TSS as an important stressor.

Several measures of stream biological health were calculated. Invertebrates were identified to the family level. Total number of families present, EPT, and FBI indices were determined. The number of different families identified within each sample provides an overall measure of the species richness. EPT is a count of families belonging to the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). With a few exceptions, macroinvertebrates in these three orders are sensitive to pollution. Therefore, more EPT families present in a stream indicate a healthier system. FBI, the Family Biotic Index, incorporates pollution tolerance scores for each family present.

The MPCA calculates similar invertebrate indices, but does so at the genus level. This allows accounting for the differing pollution tolerances that sometimes occur among genus in the same family. Because genus level identifications were not available for many sites in this study, all MPCA data was analyzed at the family level. We felt using the less precise family level indices for many sites was preferred over using genus level data and including only a few sites in the analysis.

Results and Discussion

Summary

The community of invertebrates and fish observed in a stream is one way to measure stream health. Because this biota is present in the stream continuously and exposed to all facets of stream ecology, they provide a holistic picture of stream health. In this study, we examined invertebrate data collected by professional aquatic ecologists. The purposes of the study were to investigate the impact of ditch maintenance on the invertebrate community, the impact of habitat and suspended solids on invertebrates, and compare the six Coon Creek sites that were part of our study with 8 other Coon Creek sites and 15 other sites across the county that had been monitored by professionals and supervised student groups to provide a relative ranking of the health of all these stream sites. Overall, this study provides insight into the extent of invertebrate community impairments and possible stressors causing these impairments.

The data used in this study are limited in several ways and therefore the results should be interpreted with caution. Limitations include a relatively small number of sampling sites, changes in sampling sites across years, and the statistical non-independence of different sampling sites located within the same stream or ditch. However, data from 2008-2012 support of the following general conclusions:

- Sites that have not been cleaned with a backhoe or similar equipment (unmaintained sites) have higher habitat MPCA Stream Habitat Assessment (MSHA) scores in all categories, including land use, substrate, and channel morphology scores, and lower turbidity values. All of these observations are consistent with better stream habitat for macroinvertebrates at unmaintained sites, but the differences were not dramatic.
- Turbidity and TSS, common stressors of invertebrate communities, were similar at maintained and unmaintained sites. The dataset for this analysis was small, including only measurements taken immediately prior to professional biomonitoring, and therefore this is not a robust analysis.

- Family Biotic Index (FBI) was correlated with overall MSHA score. A more sensitive invertebrate community (lower FBI) occurs where there is better habitat (higher MSHA scores). The number of families and EPT families was not correlated with MSHA score, presumably because a high number of families can be dominated by insensitive, generalist families.
- Total number of families, FBI, and EPT indices of stream health did not differ among unmaintained reaches of stream and those that have been maintained (ditched or cleaned) in the last 10 years. It is likely that ditch maintenance is indeed a stressor, but other stressors also exist and affect all sites, such that invertebrate communities are stressed in both maintained and unmaintained channels.
- TSS is inversely correlated with two invertebrate indices; higher TSS results in poorer stream health scores for Family Biotic Index and number of families. It appears TSS may be a stressor of the invertebrate community.
- Invertebrate indices for Coon Creek sites are distributed widely over the spectrum observed in other streams locally, and the sites designated by the MPCA as "impaired" are at or better than the county average.
- Data collected at four sites by the MPCA in 2000 and/or 2010 were compared data collected by the Anoka Conservation District in other years. Data from the two sources are generally consistent.
- We compared MPCA's index of biological integrity (IBI) scores to MPCA thresholds for both fish and invertebrates. Of four sites, one did not have data provided by MPCA. Of the three remaining, one would be impaired due to an invertebrate IBI score poorer than MPCA's threshold and two had fish IBI scores below the threshold. However, none of these sites will be listed as impaired because all were deemed "not assessable" due to "channelization" (in reality Coon Cr at Egret St is not channelized). MPCA is developing tiered standards for ditches.
- MPCA's new tiered aquatic life standards, once adopted, will set lower biological expectations for ditched portions of Coon Creek.
- Many sites in the Coon Creek watershed had FBI scores typical for Anoka County but were borderline cases for impairment designations. If our "average" streams are impaired, this is an indication that either MPCA's standards are flawed or many Anoka County streams are biologically impaired.
- Coon Creek at Egret Street had one of the best family biotic index scores in Anoka County, but based on genus level data receives an IBI score poorer than MPCA's threshold.

Overall, impairment of the invertebrate community is variable throughout the Coon Creek system. Impairment designations for portions of the creek are appropriate, but possibly not for the entire system. Moreover, there is more than one stressor on the invertebrate community. While ditch maintenance seems like a likely culprit in actively maintained ditches, it appears that other stressors. Even in some unmaintained stream reaches habitat deterioration is likely a stressor. TSS, and perhaps other water quality parameters, affect both maintained ditches and other stream segments. Flow rates and volumes may be a stressor.

New information and procedures at the MPCA should help refine invertebrate impairment designations for Coon Creek. First, the agency monitored seven sites in 2010, which is better than the two that were monitored in 2000 and used to designate the system as impaired. Additionally, the MPCA is developing tiered biological expectations for different types of streams. The portions of Coon Creek that are actively maintained as ditches deserve lower biological expectations.

In 2012 the Coon Creek Watershed District, MPCA, and partners have begun a Watershed Restoration And Protection Project (WRAPP) study. It will begin with a stressor identification process for biota. This process will be an extension of the work presented in this report, and will direct efforts to protect and improve Coon Creek's overall health, while setting realistic expectations about the waterbody's beneficial uses.

Effect of Management Activity on Habitat, Turbidity, and Total Suspended Solids

A habitat assessment was conducted at each site following the Minnesota Pollution Control Agency's Stream Habitat Assessment (MSHA) protocol. MSHA scores, TSS levels, and turbidity levels were compared between maintained and unmaintained sites to examine the effect of management type. Overall, the 2008-2012 data suggest unmaintained sites have higher values of overall MSHA score, land use, substrate, and channel morphology scores, but the differences are not dramatic. These are consistent with better stream habitat for macroinvertebrates.

The MSHA evaluates stream habitat on a scale of 0-100 (100 being best), which is a summation of subjective scores rating surrounding land use, quality of the riparian zone, substrate characteristics, available in-stream cover, and channel morphology components of habitat quality. MSHA scores from 2008-2012 were averaged because no significant landscape modifications had occurred around any of the sampling locations. All of the Coon Creek sites scored poorly for habitat.

The effects of stream and ditch maintenance on the MSHA habitat scores are consistent with expectations (Figure 1). The unmaintained sites have slightly higher MSHA scores, indicating better overall stream condition and habitat. If habitat was the only possible stressor on invertebrate communities, we would expect higher indices of stream health in unmaintained sections of the waterway; this was not the case.

Water quality measurements were taken at each site immediately prior to biomonitoring. Turbidity and total suspended solids (TSS) results are included in our analyses in this section. Temperature, dissolved oxygen, conductivity, salinity, flow rates, and pH were also taken in the field, but are included in this analysis between maintained and unmaintained sites because they were similar across all locations and/or any significant variation would likely be due to location in the stream system (upstream or downstream) rather than management type.

Turbidity and TSS were similar at maintained and unmaintained sites (Figure 2). The data presented include only measurements taken immediately prior to professional biomonitoring, and is therefore a small dataset. More extensive water quality monitoring has been conducted at two of the six professional biomonitoring sites.

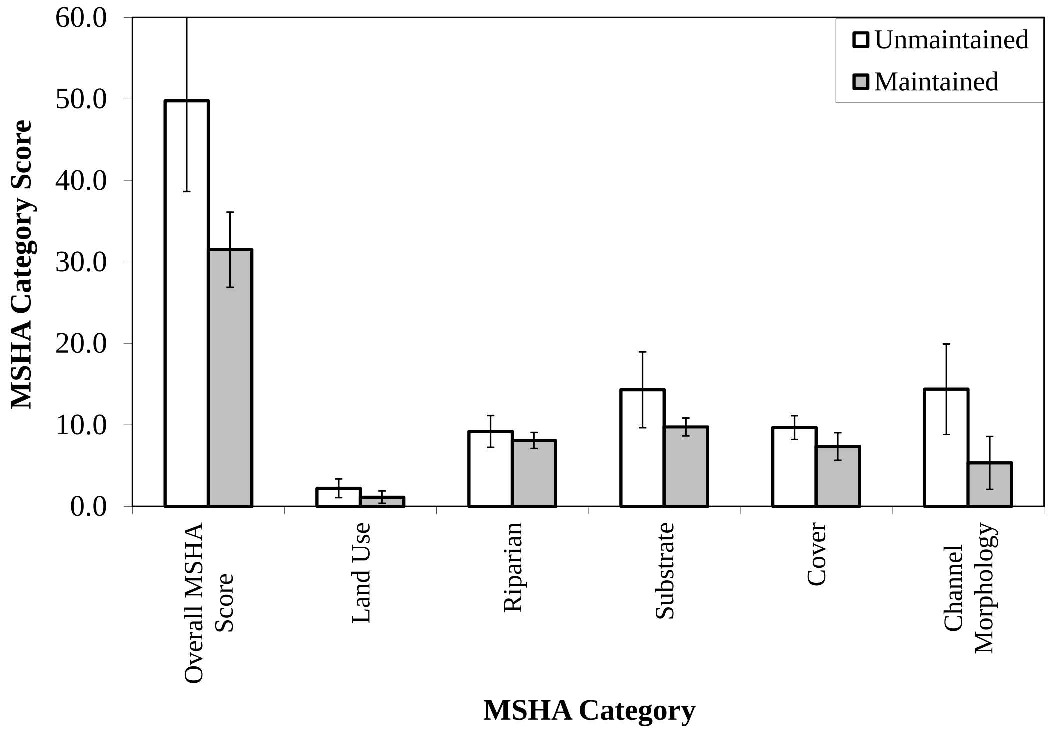


Figure 1. Comparison of MSHA scores for maintained and unmaintained sites (± 1 standard deviation). Scores shown are averages from 2008 to 2012.

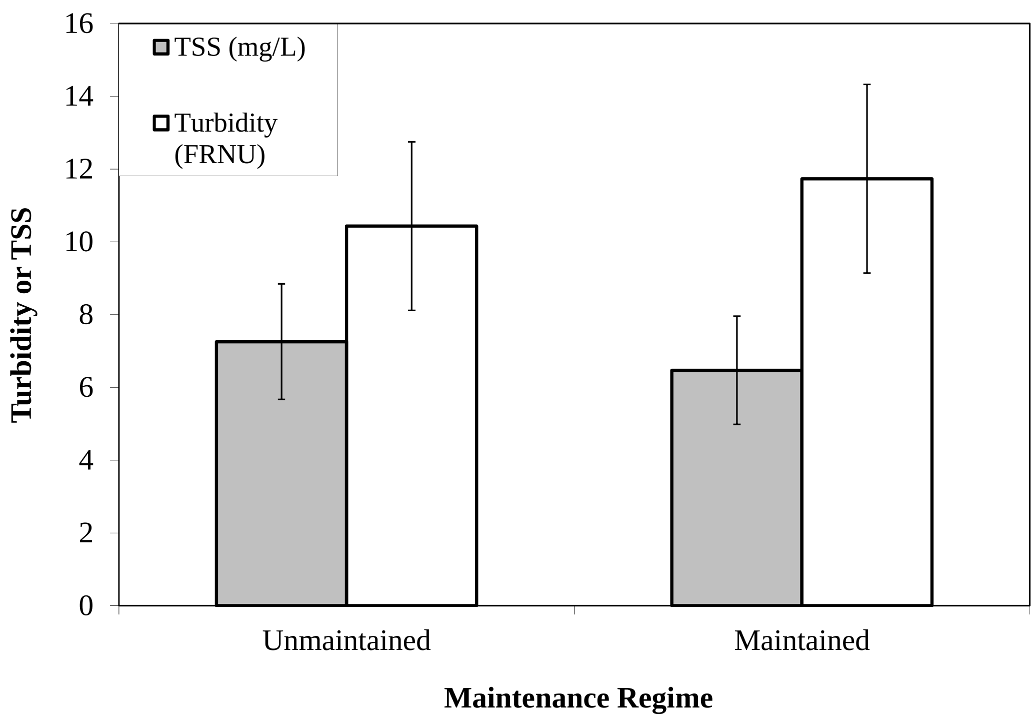


Figure 2. Comparisons of average turbidity and TSS (± 1 standard deviation) for maintained and unmaintained sites from 2008-2012. Data shown are turbidity and TSS measurements collected immediately prior to professional invertebrate monitoring.

Relationship between habitat and biotic indices

MSHA score provides a quantitative estimate of overall stream habitat by assessing in-stream and near-stream habitat parameters. Habitat quality has previously been shown to influence biotic communities in a positive manner. We assessed the relationship between MSHA scores and biotic indices of stream health to gain insight into factors affecting invertebrate communities.

Only Family Biotic Index (FBI) was correlated with overall MSHA score (Figure 3). As expected, the relationship is positive. A more sensitive invertebrate community (lower FBI) occurs where there is better habitat (higher MSHA scores).

The lack of a relationship between habitat and the other invertebrate indices highlights the weaknesses of those indices compared to FBI. The number of families is not as robust of an indice because there may be many families present that are tolerant poor stream health. EPT is a somewhat better indice because it counts only families in only three orders that tend to be pollution sensitive. However there are a number of EPT families which can tolerate poor stream health.

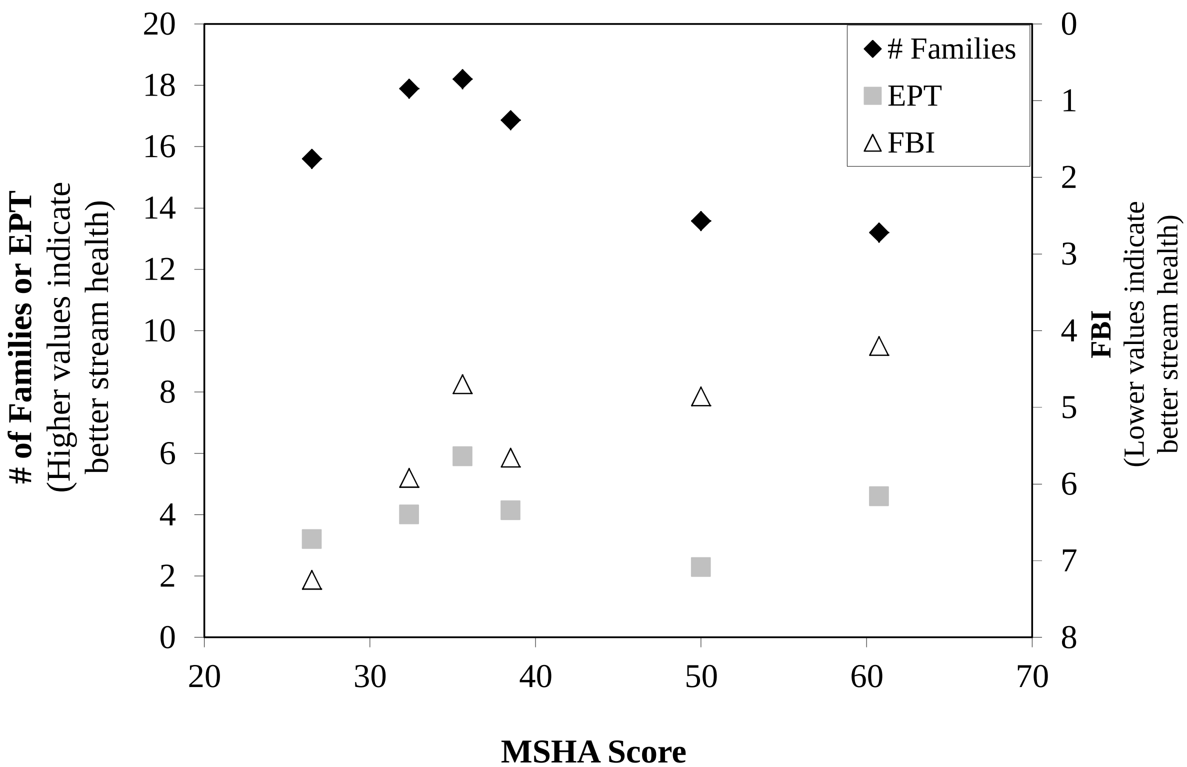


Figure 3. Relationships between invertebrate indices of stream health and MSHA score.

Effect of Management Activity on Invertebrate Indices

The table at the beginning of this section provides lists professional biomonitoring sites and categorizes them as either "maintained" or "unmaintained." Maintained sites are those where active ditch maintenance with a backhoe or similar equipment has occurred within the last 10 years. Unmaintained sites are those that have not been maintained in the last 10 years. Biotic indices of stream health from maintained and unmaintained sites were compared to examine the effect of management activity.

Total number of families, EPT, and FBI did not to differ between unmaintained and maintained sites (Figure 4). Conventional knowledge tells us that ditch maintenance is likely a stressor, but this analysis suggests other stressors also exist and affect all sites, such that invertebrate communities are stressed in both maintained and unmaintained channels.

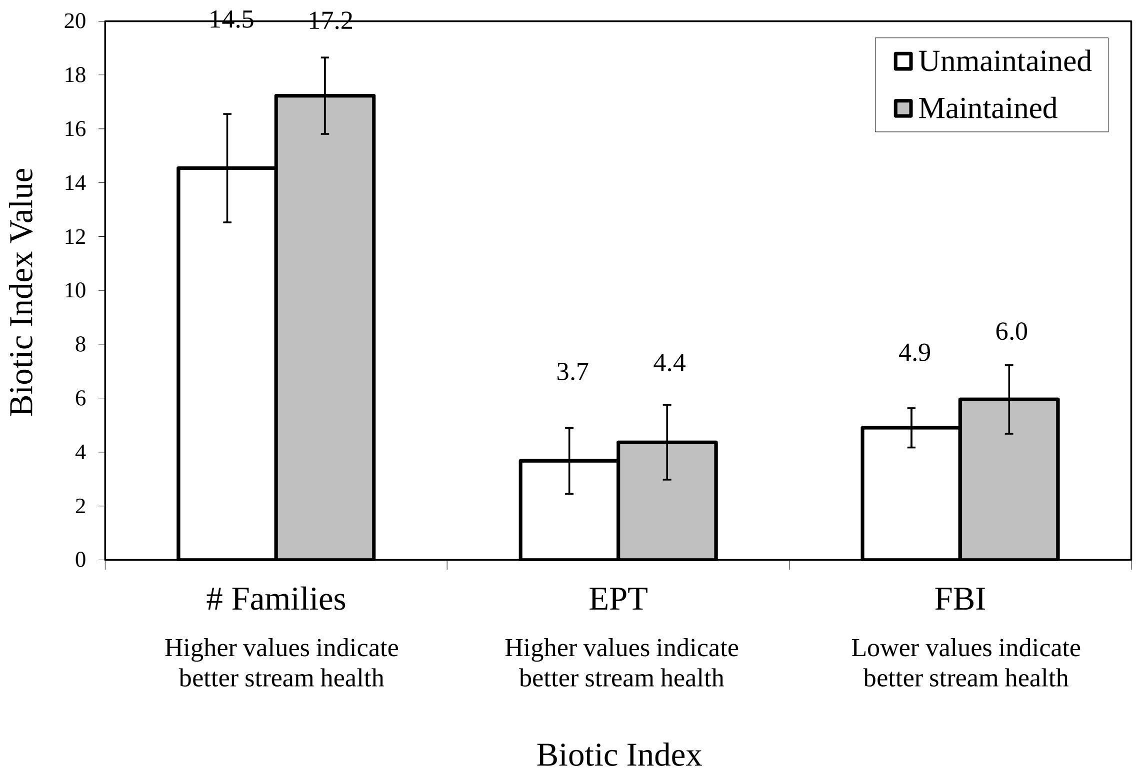


Figure 4. Average biotic index scores (± 1 standard deviation) for compiled data from 2008-2012 in unmaintained and maintained sites. Note that higher values for number of families and the EPT index indicate better stream health, while lower FBI values indicate better stream health.

Relationship between suspended solids on invertebrate indices

Total suspended solids (TSS) have the potential to significantly affect macroinvertebrate communities. Therefore, assessing the relationship of TSS with total number of families, EPT, and FBI may provide some insight to causes of the impaired biota status. Figure 5 displays the relationships between the three invertebrate indices and TSS from the 2008-2012.

TSS is inversely correlated with two invertebrate indices; higher TSS results in poorer stream health scores for Family Biotic Index and number of families. It appears TSS may be a stressor of the invertebrate community, however the TSS dataset used is small. Additional TSS data has been collected throughout the Coon Creek watershed.

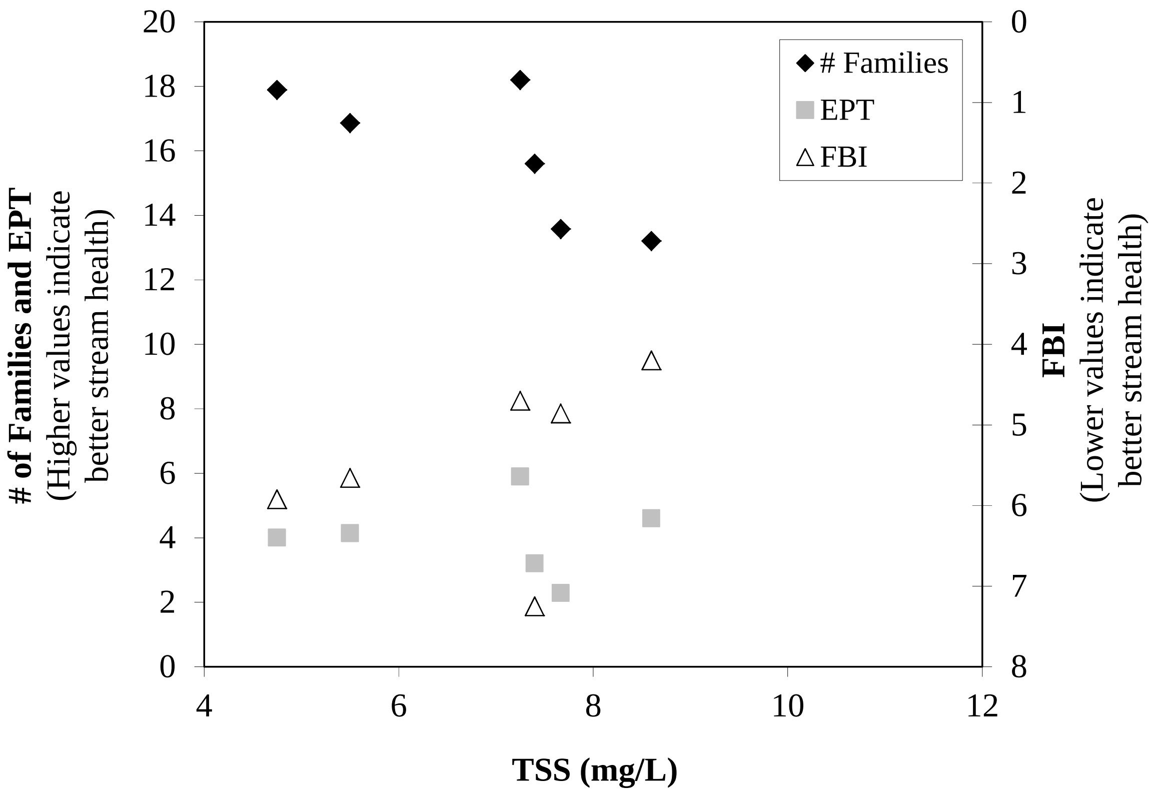


Figure 5. Relationships between total number of families, EPT, and FBI macroinvertebrate indices and TSS (mg/L). TSS data are from samples taken immediately prior to invertebrate sampling, and represent an average of all available data. The data presented is only from the six sites classified as “maintained” or “unmaintained” for this study.

Comparison between Coon Creek and other local streams

Comparison of the biotic indices of stream health between Coon Creek watershed sites with other sites across Anoka County provides perspective for the overall health of the Coon Creek system. The ranking of sites within the Coon Creek system from best to worst stream health (based on invertebrate data) is useful for prioritizing stream restoration efforts by the Coon Creek Watershed District. Overall, invertebrate indices for Coon Creek sites are distributed widely over the range seen in other streams locally, and the sites designated by the MPCA as “impaired” are at or better than the county average.

This analysis includes the six Coon Creek sites studied as “maintained or unmaintained” as well as nine other Coon Creek watershed sites and 13 sites outside of the Coon Creek watershed. The data from all of these sites was collected by a variety of groups, including professional staff at the MPCA and Anoka Conservation District (ACD), and the student biomonitoring program.

In the student biomonitoring program, ACD staff oversee high school science classes which collect the invertebrates and perform initial identifications. ACD staff perform final identifications and quality assurance procedures. The methods used by all groups were the same. The advantage of student biomonitoring is greater sampling effort accomplished by 20-30 students. The disadvantage is that students lack professional experience and some level of rigor.

When comparing all sites county-wide it is important to consider the number of times each has been sampled. Substantial variability can be observed between sampling occasions due to weather, flows, time of year, and other factors. Figure 6 provides the number of sampling occasions at each site. At sites with few monitoring occasions, we have reduced confidence.

The average number of families is a basic measurement of diversity, regardless of each invertebrate family’s pollution sensitivity (Figure 7). Nine of the 15 Coon Creek watershed sites have above average number of families. While there may be more families at these sites, many were generalists. It is worth noting that all Coon Creek sites that had more families than the county average, except two, were monitored by professionals. One might speculate whether professionals tend to find more families than students because of more experience and rigor.

The number of EPT families is the sum of families from three generally pollution sensitive orders (mayflies, stoneflies, and caddisflies; Figure 8). The EPT orders are generally pollution sensitive and higher numbers are generally reflective of better stream health. Just five of the Coon Creek watershed sites have more EPT families than the county average. Generally, these Coon Creek sites with higher EPT were those in downstream reaches of the watershed (i.e. higher stream order, less channel ditching).

Family Biotic Index (FBI) is calculated from both the number of families and the pollution tolerance of each family (Figure 9). While the Coon Creek watershed sites again span the spectrum observed in the county, the extremes are noteworthy. The 2nd, 3rd, and 4th best average FBI scores are from Coon Creek watershed sites. As with the EPT scores, these are sites in the downstream reaches of the watershed. The site that ranked 2nd best county-wide was Coon Creek at Coon Hollow (Vale St), where only one sampling has occurred so there is lower certainty in the accuracy. On the other hand, the site that ranked 3rd best county-wide was Coon Creek at Egret Street which the 2000 MPCA sampling found had and “impaired” invertebrate community.

The qualitative guidelines for interpreting the FBI scores are as follows 0-3.75 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. 20 of 28 sites monitored county-wide have average, multi-year FBI scores above five, indicating fair to poor stream health. Based on this invertebrate index, most streams in the county have substandard health.

Figure 6. Number of invertebrate monitoring samples taken at all monitored sites in Anoka County. Sites with grey bars are within the Coon Creek watershed.

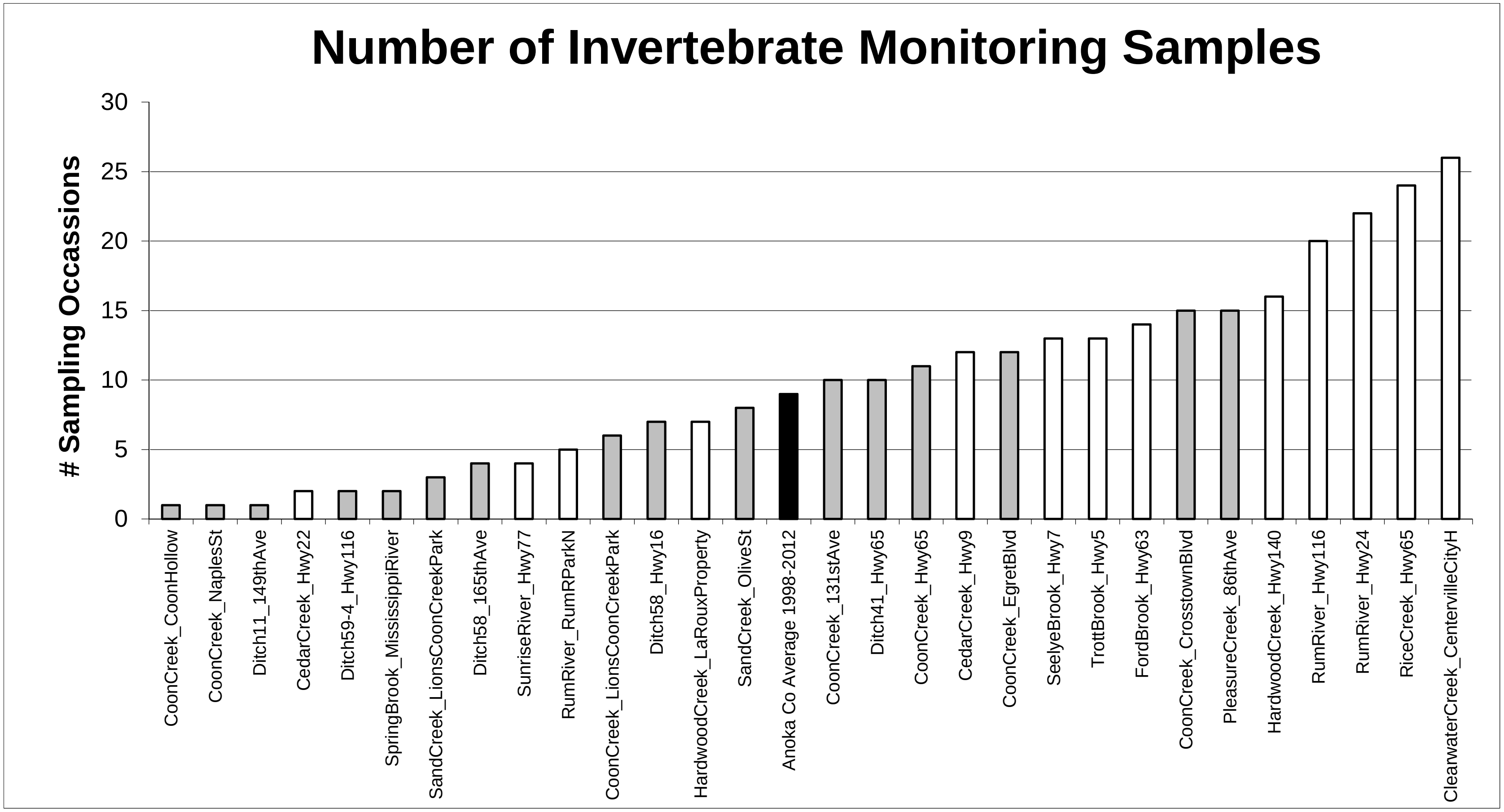


Figure 7. Average number of invertebrate families observed at each monitored site in Anoka County. Higher numbers of families (i.e. higher diversity) is generally reflective of better stream health. Sites with grey bars are within the Coon Creek watershed.

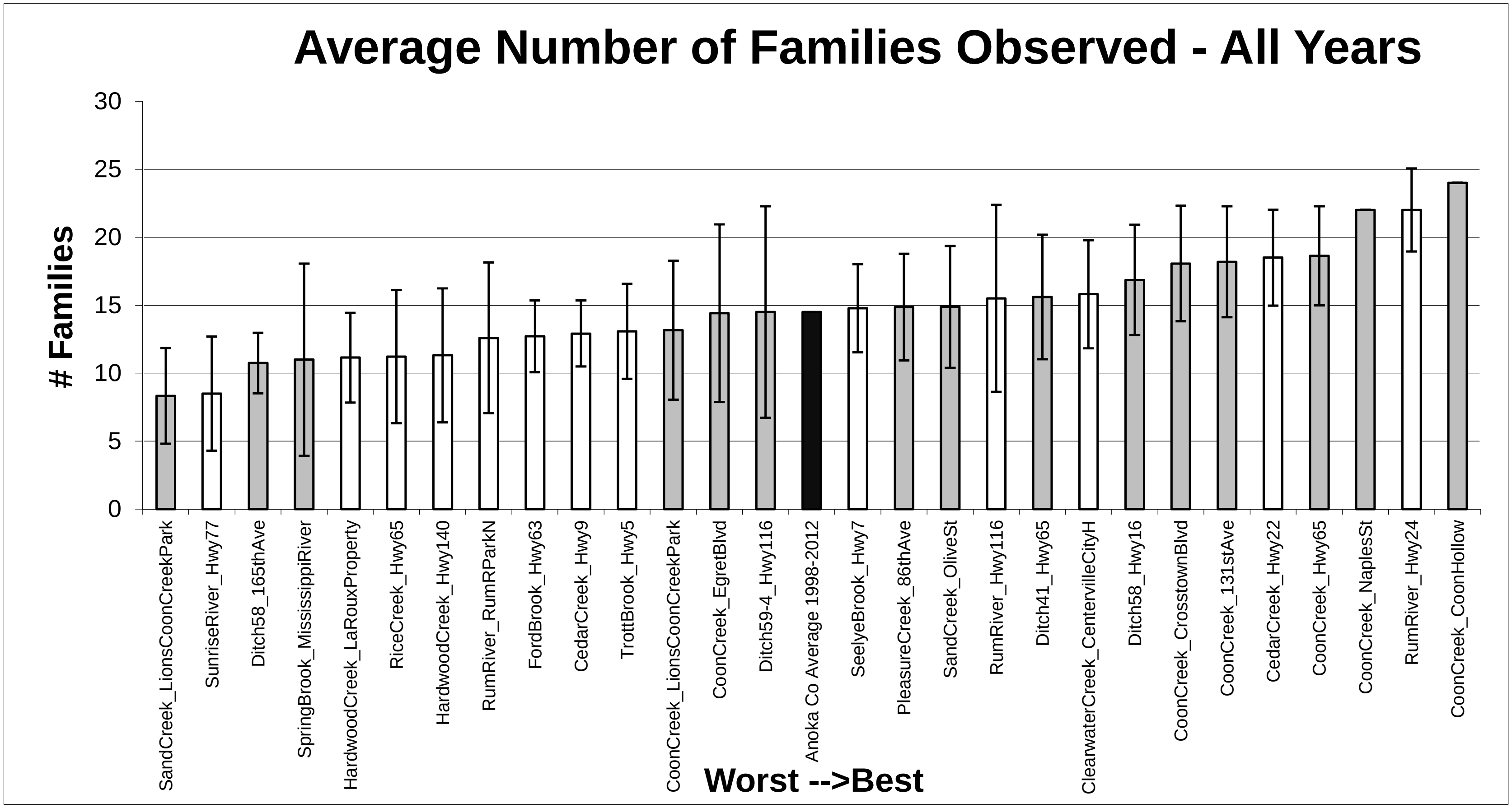


Figure 8. Average number of invertebrate families in the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) observed at each monitored site in Anoka County. The EPT orders are generally pollution sensitive; higher numbers are generally reflective of better stream health. Sites with grey bars are within the Coon Creek watershed.

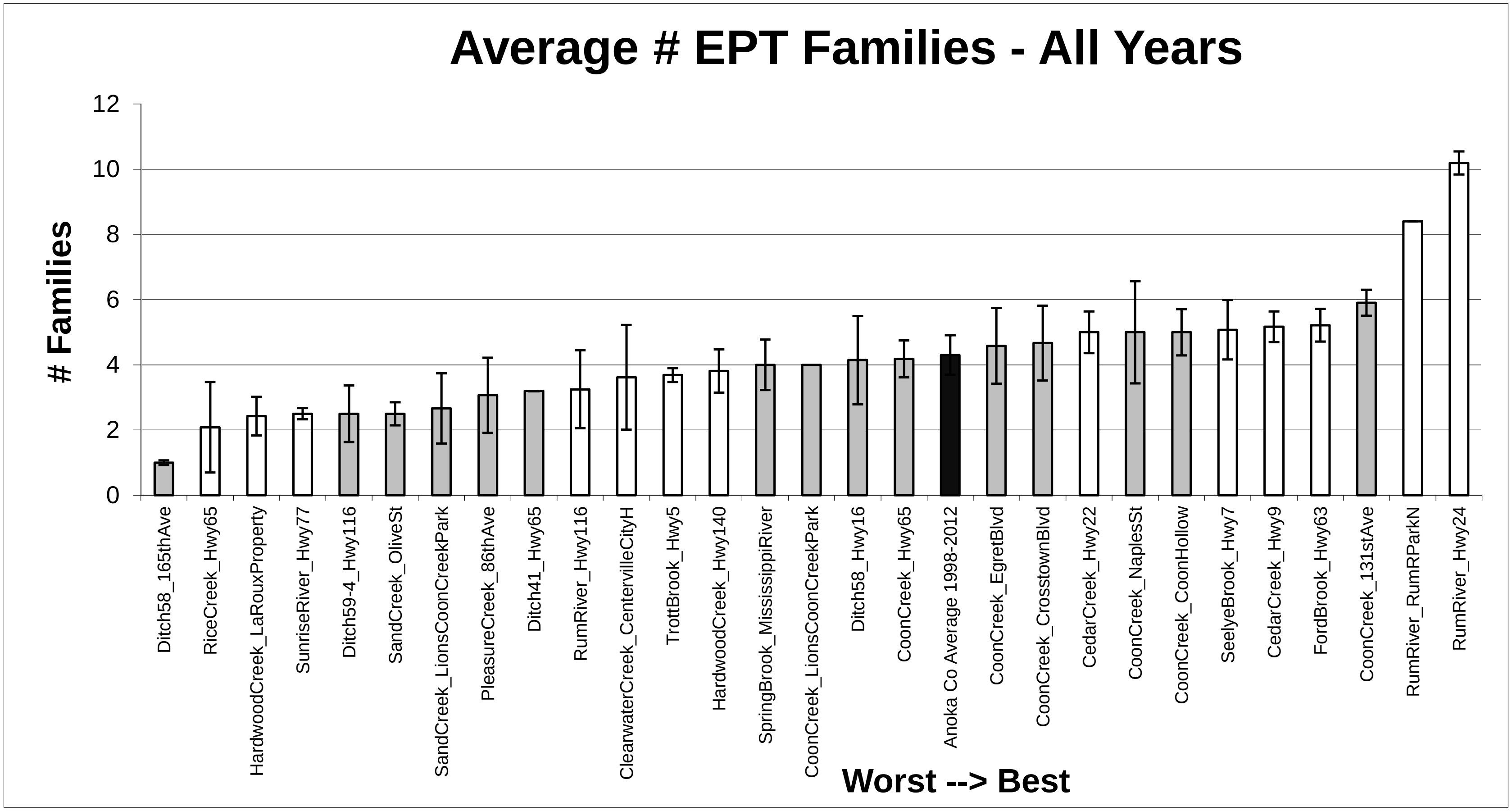
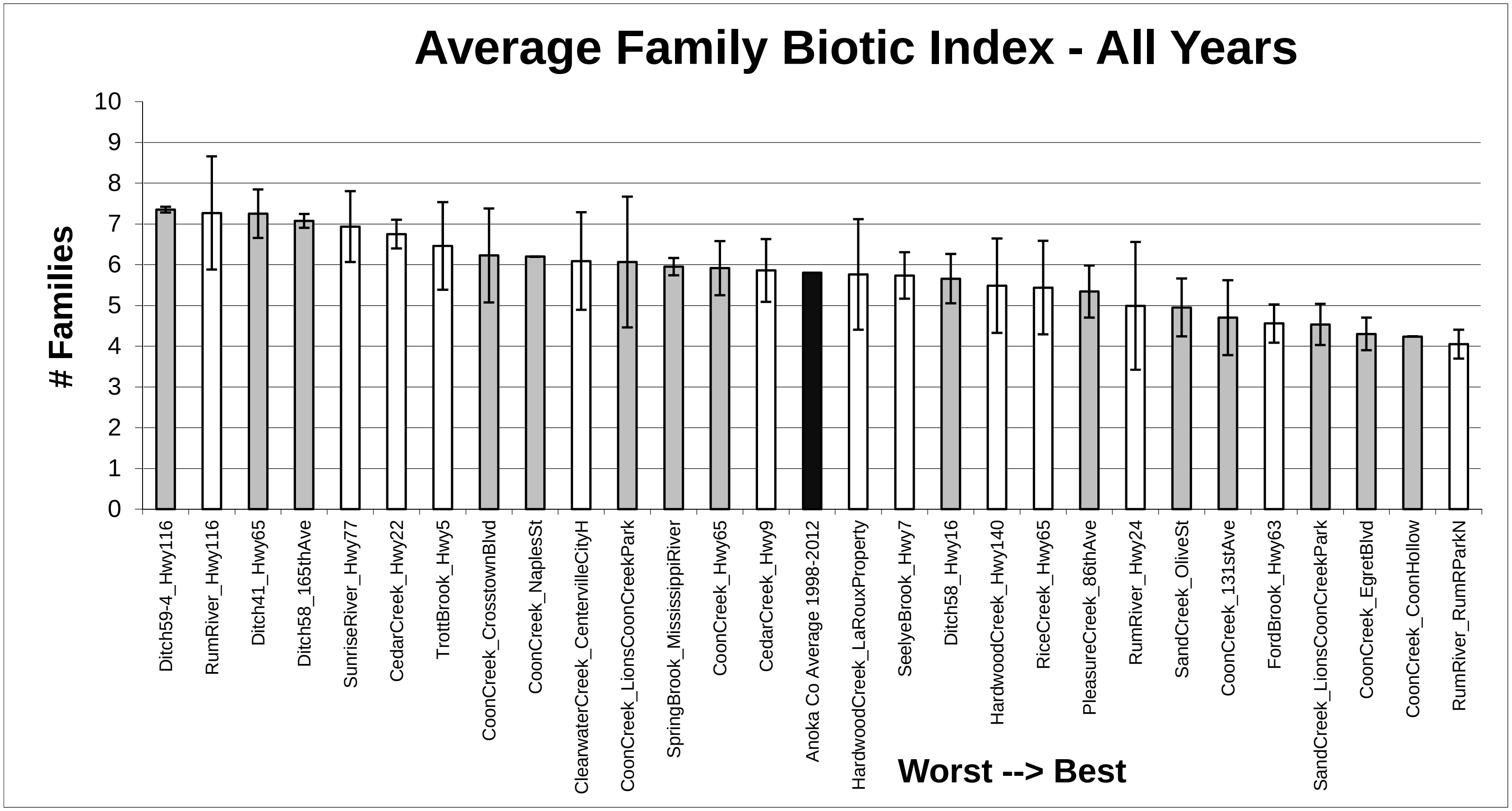


Figure 9. Average family biotic index (FBI) score observed at each monitored site in Anoka County. FBI scores are calculated from the pollution tolerance value of each invertebrate family that was found. Lower FBI scores are reflective of better stream health. Sites with grey bars are within the Coon Creek watershed.

The qualitative guidelines for interpreting the FBI scores are as follows 0-3.75 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.



Re-evaluation of Impaired Biota Designations

In 2000 the MPCA sampled two Coon Creek sites and found impaired invertebrate communities. The sites were Coon Creek at Highway 65 and Egret Street. Since 2000, professional biomonitoring has been conducted at these sites by the Coon Creek Watershed District and Anoka Conservation District. Additionally, the MPCA monitored these sites in 2010. These new data were used to re-examine the 2000 findings.

We analyzed both family and genus level data. The family-level analysis included all data from 2008 to 2012, including the MPCA data (we converted MPCA's genus level data to family level for the purpose of making direct comparisons). The genus level analysis includes only MPCA data from 2000 and 2010. Genus level identifications allow sorting the sometimes different tolerances of the different genus within each family, and is therefore better.

<u>Coon Creek at Highway 65</u>

Family level – See Figure 10. Invertebrate data from 2000 had more family richness than other years. The family biotic index and number of sensitive EPT families has remained similar across years. The family biotic index at this site is similar to the median for Anoka County streams.

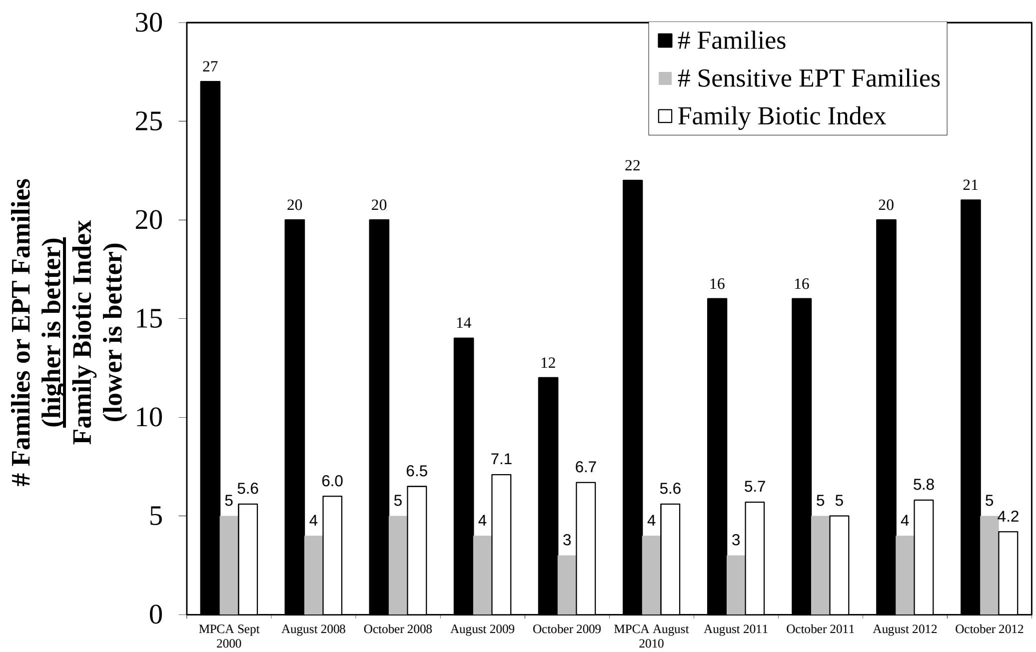


Figure 10. Comparison of family-level invertebrate indices of stream health at Coon Creek at Highway 65.

Genus Level – This site's invertebrate IBI is mildly better than MPCA thresholds (high IBI scores are good), but the fish IBI scores are mildly worse than the threshold.

Coon Cr at Hwy 65	Invertebrate IBI Score	Invertebrate IBI Threshold	Fish IBI Score	Fish IBI Threshold
2000	52.54	46.8	37	40
2010	48.03 46.12 (replicate)	46.8	36	40

Conclusion – MPCA's data states this site is "not assessable" and lists the reason of "channelized." If the site were deemed assessable, should not be listed as impaired based upon invertebrate data, but is a borderline case. However, an impaired biota based on fish IBI scores would occur.

Coon Creek at Egret Street

Family level – See Figure 11. Recent invertebrate biotic indices are better than those from 2000. The family biotic index at this site is one of the best in Anoka County.

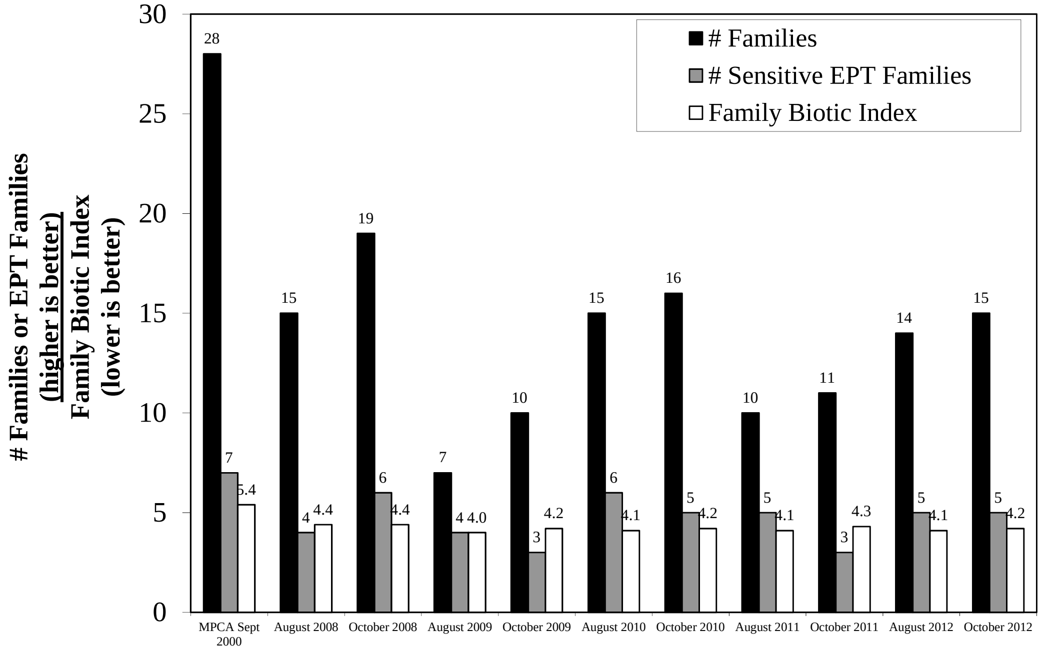


Figure 11. Comparison of family-level invertebrate indices at Coon Creek at Egret St.

Genus Level – This site is slightly poorer than MPCA thresholds for invertebrate data (high MIBI scores are good). Based on invertebrates, it would be found impaired, but is a borderline case. The fish IBI score at this site is substantially worse than the threshold/expectation.

Coon Cr at Egret St	Invertebrate IBI Score	Invertebrate IBI Threshold	Fish IBI Score	Fish IBI Threshold
2000	Not sampled		Not sampled	
2010	46.69	46.8	27	50

Conclusion – MPCA's data states this site is "not assessable" and lists the reason of "channelized." In fact, the stream at this site is not channelized. If the site were deemed assessable, it would be found impaired based on both invertebrate and fish IBI scores.

Sand Creek at Olive Street

Family level – See Figure 12. Recent invertebrate biotic indices are similar those from 2000. The family biotic index at this site is substantially better than the median for Anoka County streams.

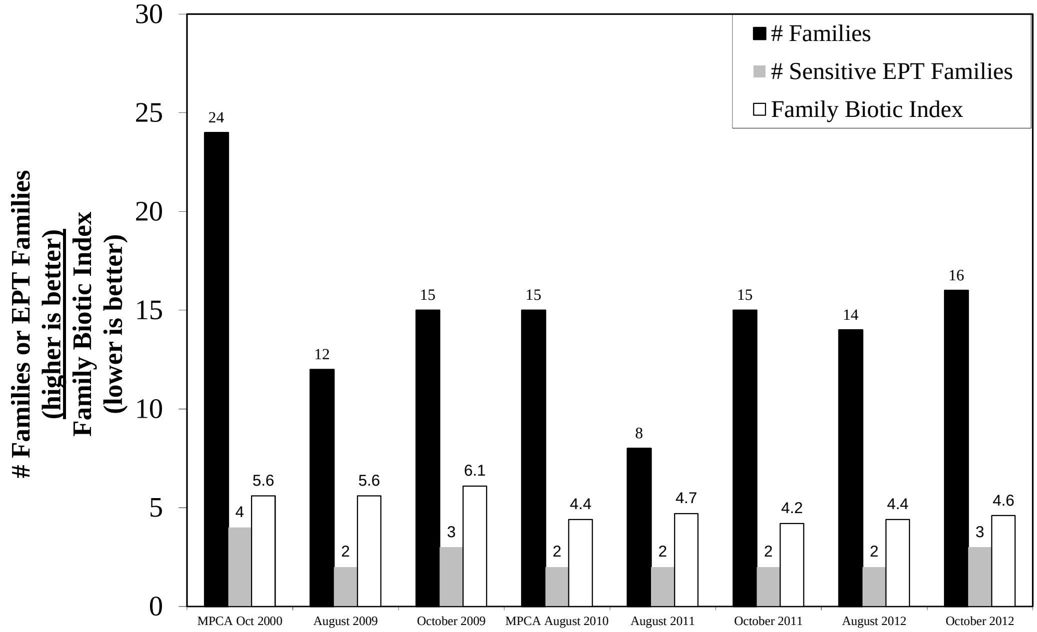


Figure 12. Comparison of family-level invertebrate indices at Sand Creek at Olive St.

Genus Level – MPCA provided the raw data for this site, but not the IBI scores.

Sand Cr at Olive St	Invertebrate IBI Score	Invertebrate IBI Threshold	Fish IBI Score	Fish IBI Threshold
2000	Not sampled		Not sampled	
2010	Sampled, but score not provided by MPCA		Sampled, but score not provided by MPCA	

Conclusion – MPCA IBI scores should be obtained. Family level invertebrate data suggests relatively good stream conditions.

Ditch 58 at Andover Blvd

Family level – See Figure 13. Invertebrate biotic indices have been similar across years. The family biotic index at this site is similar to the median for Anoka County streams.

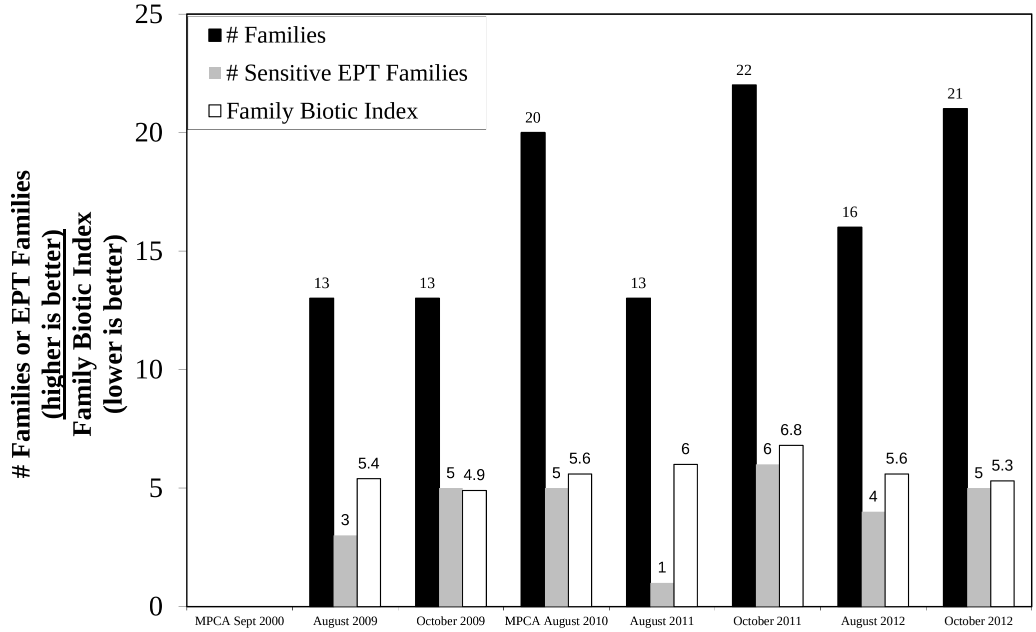


Figure 13. Comparison of family-level invertebrate indices at Ditch 58 at Andover Blvd.

Genus Level – This site is better than MPCA thresholds for invertebrate data (high MIBI scores are good). The fish IBI score is equal to the threshold, indicating a near impaired condition.

Coon Cr at Egret St	Invertebrate IBI Score	Invertebrate IBI Threshold	Fish IBI Score	Fish IBI Threshold
2000	Not sampled		Not sampled	
2010	55.94	46.8	40	40

Conclusion – MPCA's data states this site is "not assessable" and lists the reason of "channelized." If the site were deemed assessable, the invertebrate IBI score is better than the threshold and the fish IBI score is equal to the threshold.

Wetland Hydrology

Description: Continuous groundwater level monitoring at a wetland boundary to a depth of 40 inches. County-wide, the ACD maintains a network of 18 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)

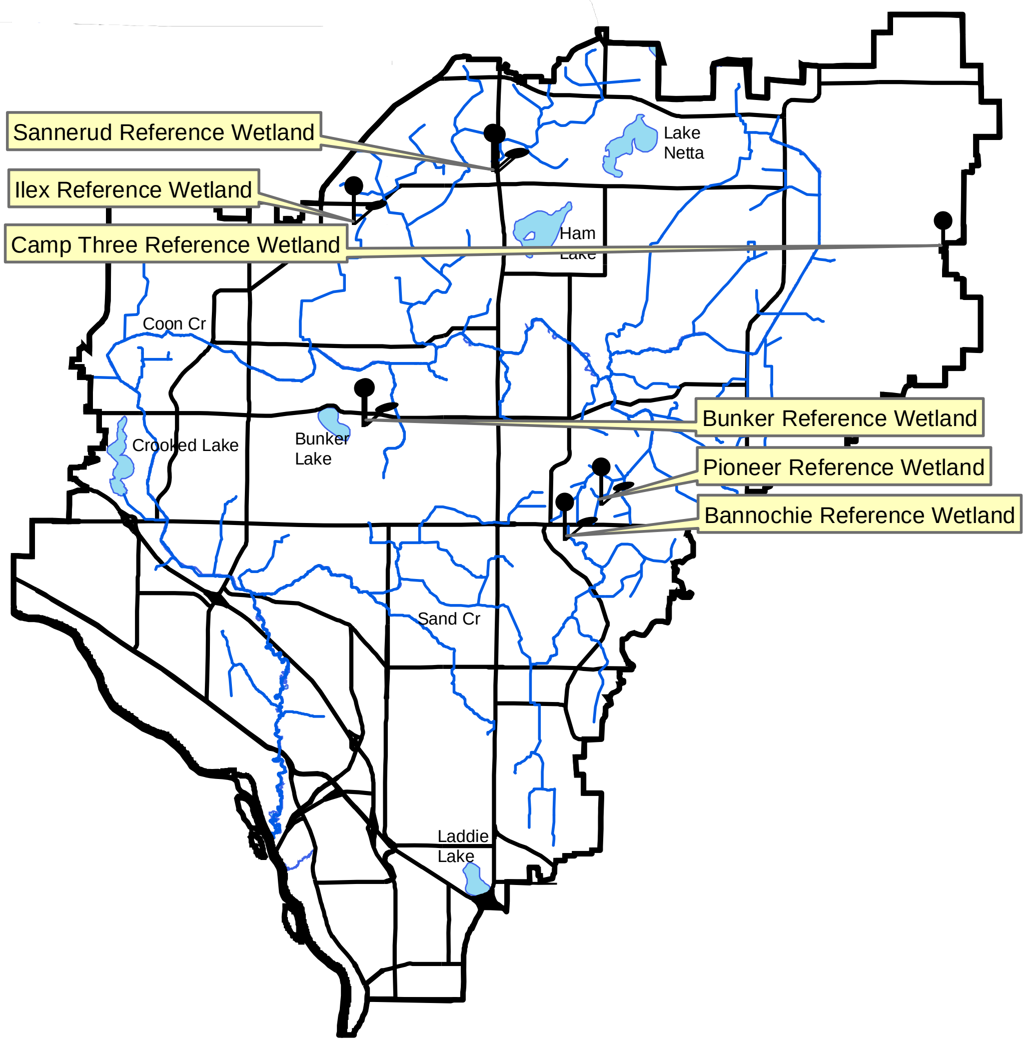
Pioneer Park Wetland, Pioneer Park off Main St., Blaine

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. Raw data and updated graphs can be downloaded from www.AnokaNaturalResources.com using the Data Access Tool.

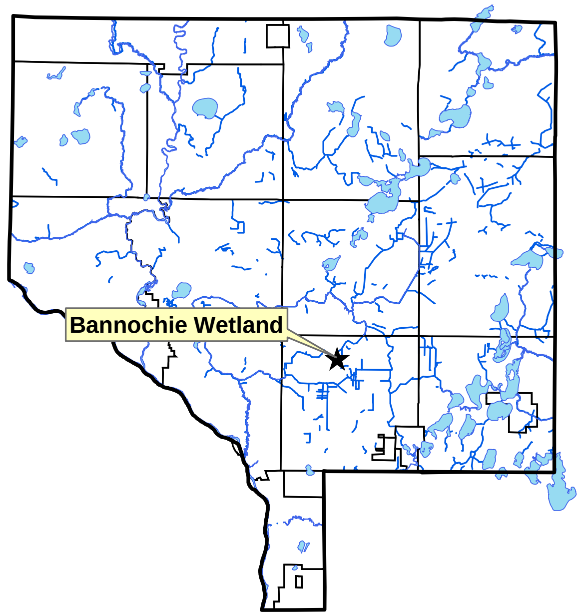
Coon Creek Watershed 2012 Wetland Hydrology Monitoring Sites



Wetland Hydrology Monitoring

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	-

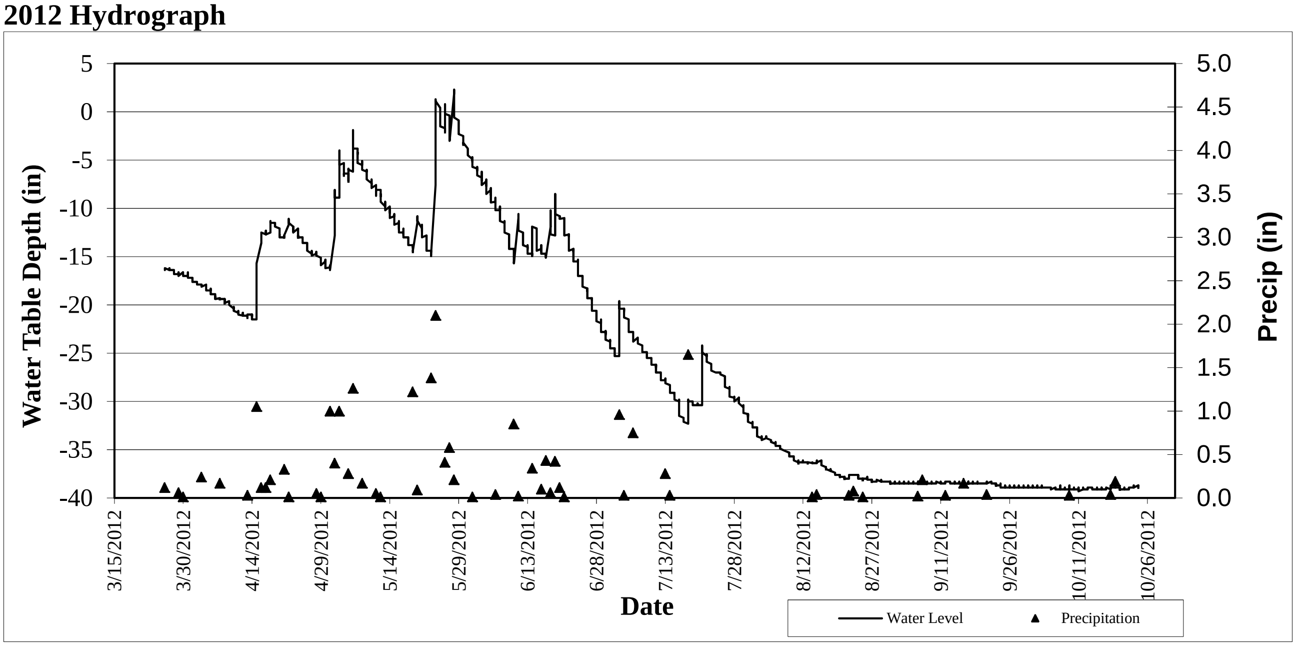
Surrounding Soils: Rifle and some Zimmerman fine sand

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.

2012 Hydrograph

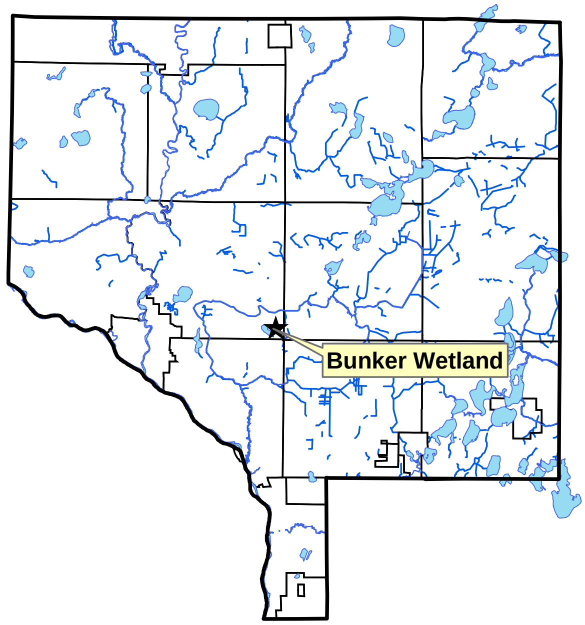


Well depth was 39 inches, so a reading of –39 or less indicates water levels were at an unknown depth greater than or equal to 39 inches.

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	-

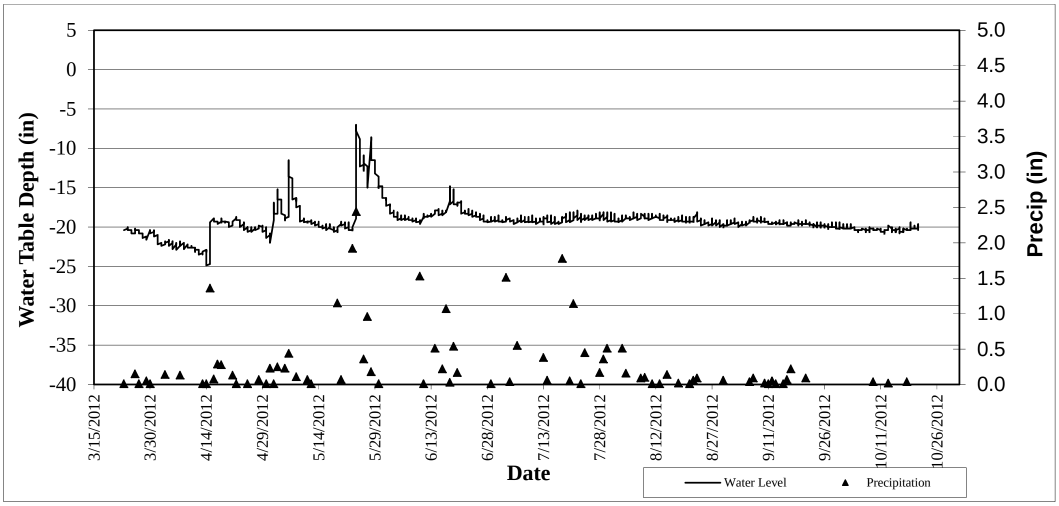
Surrounding Soils: Zimmerman fine sand

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 inches 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.

2012 Hydrograph



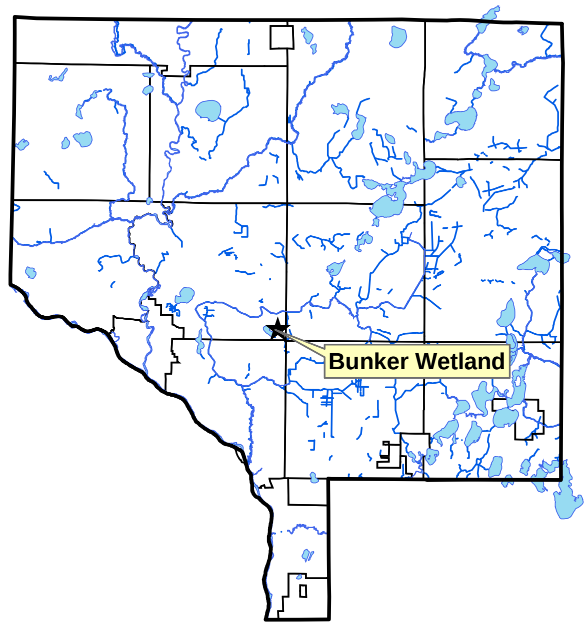
Well depth was 36 inches, so a reading of –36 indicates water levels were at an unknown depth greater than or equal to 36 inches.

Wetland Hydrology Monitoring

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	-

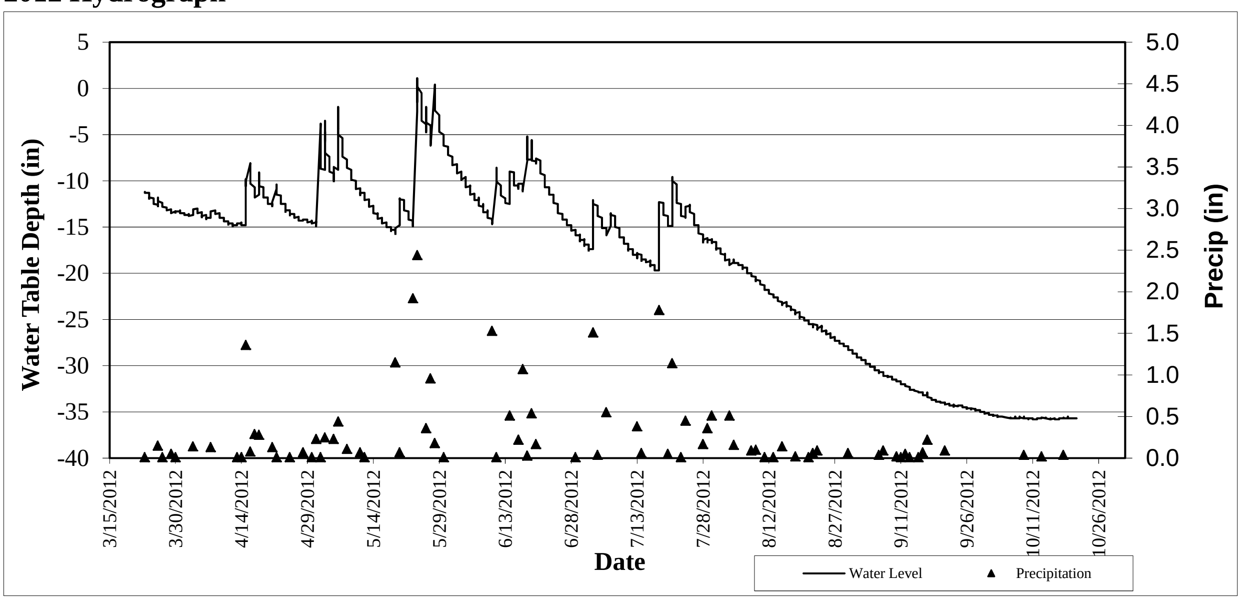
Surrounding Soils: Zimmerman fine sand

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.

2012 Hydrograph



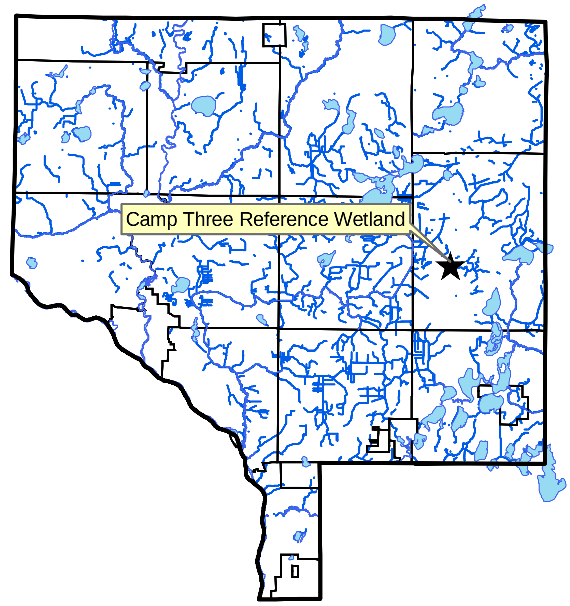
Well depth was 40 inches, so a reading of –40 indicates water levels were at an unknown depth greater than or equal to 40 inches.

Wetland Hydrology Monitoring

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

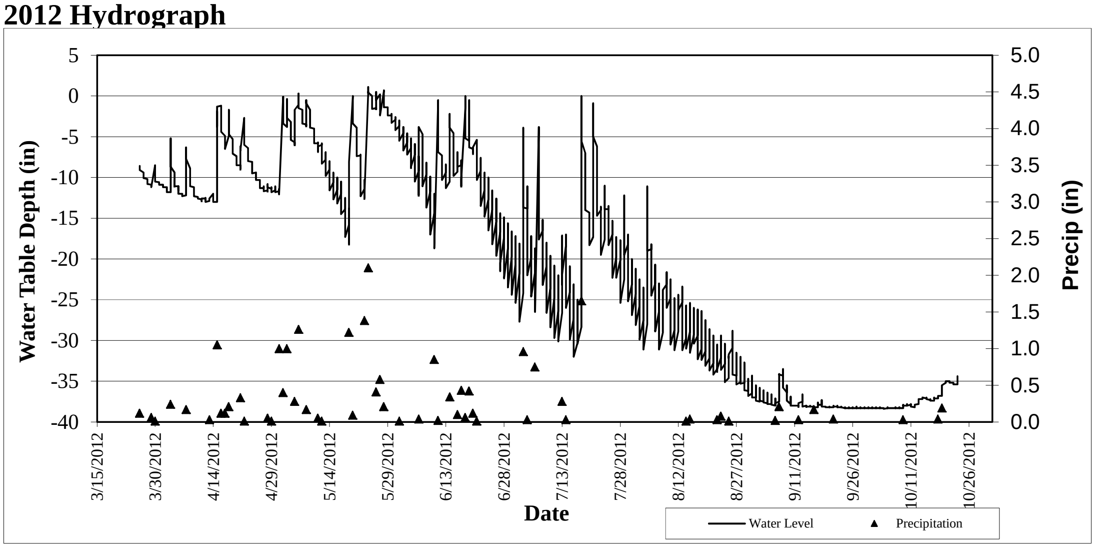
Surrounding Soils: Zimmerman Fine Sand

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 inches throughout summer 2008. This may have been due to water control structures elsewhere in the Carlos Avery Wildlife Management Area.

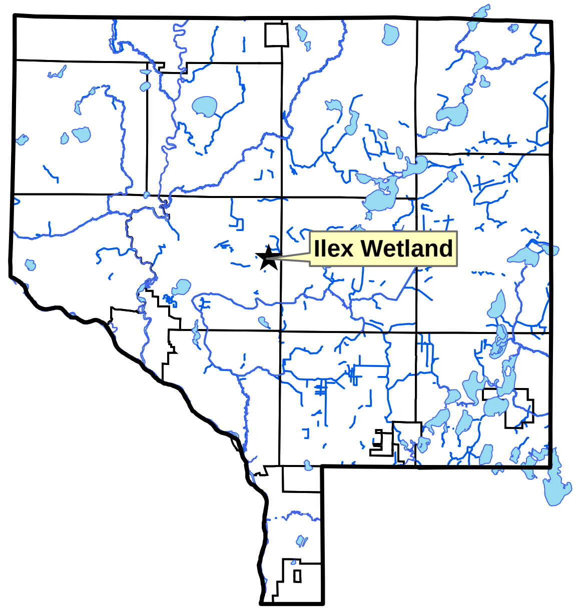
2012 Hydrograph



Well depth was 40 inches, so a reading of –40 indicates water levels at an unknown depth greater than or equal to 40 inches.

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	-

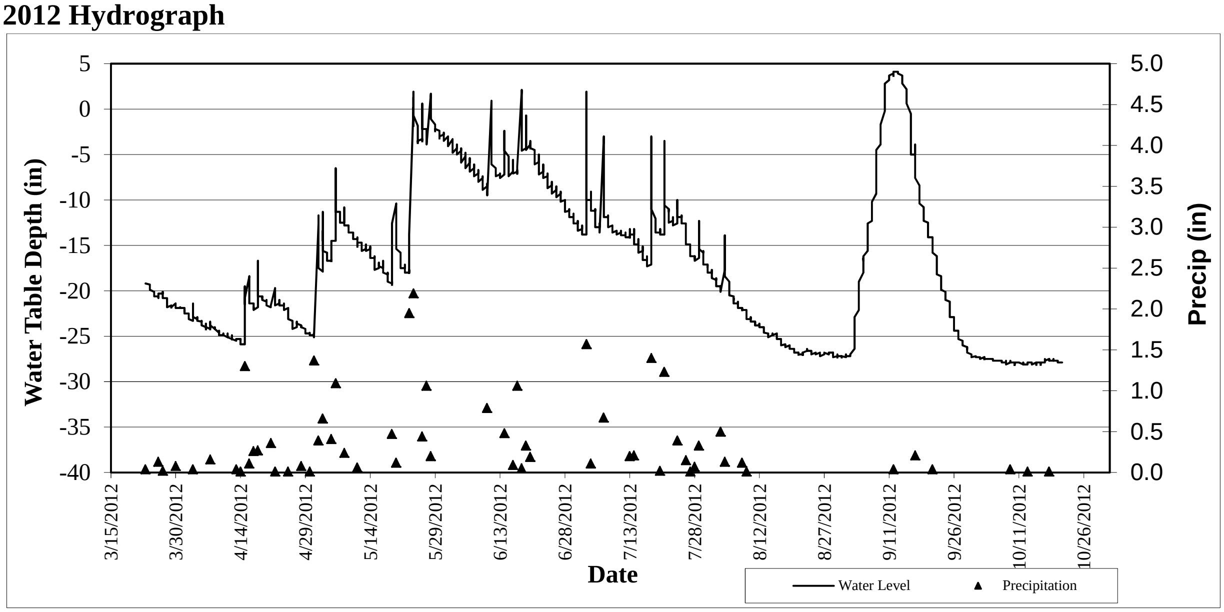
Surrounding Soils: Loamy wet sand and Zimmerman fine sand

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 inches of the surface and seldom within 40 inches. 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.

2012 Hydrograph



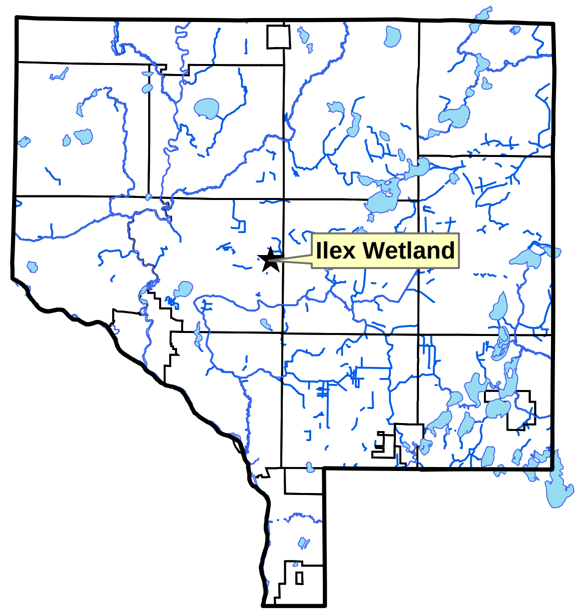
Well depth was 40 inches, so a reading of –40 indicates water levels at an unknown depth greater than or equal to 40 inches.

Wetland Hydrology Monitoring

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	-

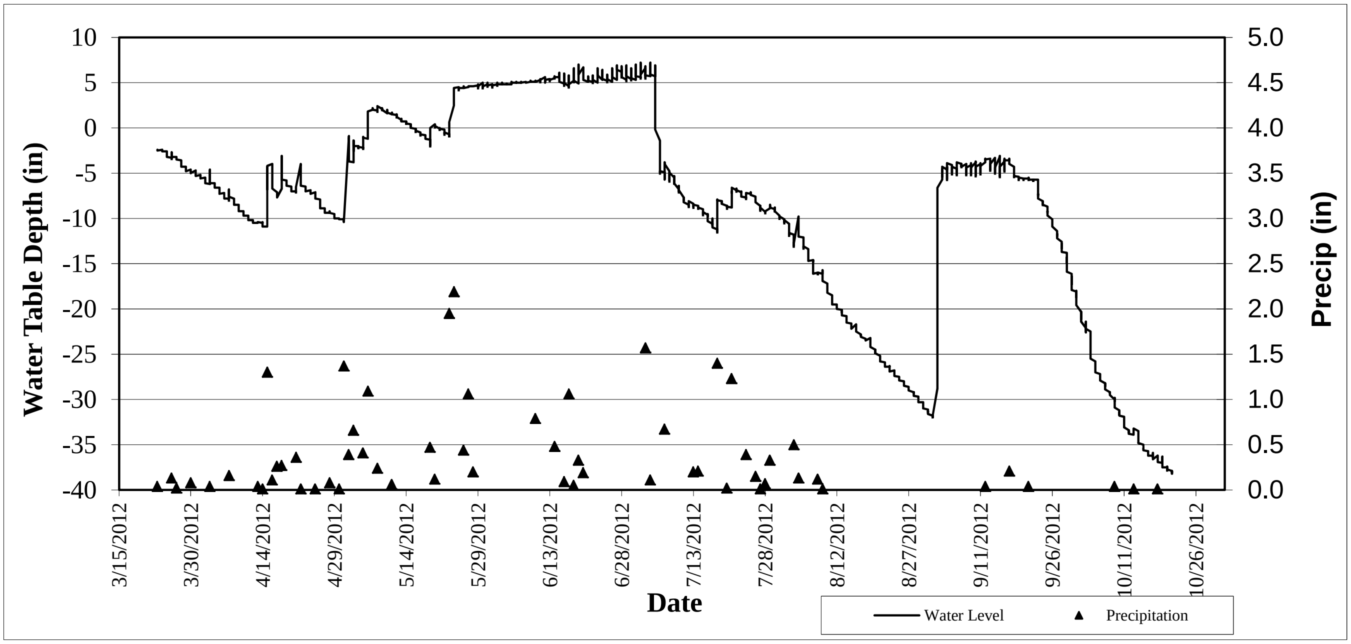
Surrounding Soils: Loamy wet sand and Zimmerman fine sand

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.

2012 Hydrograph

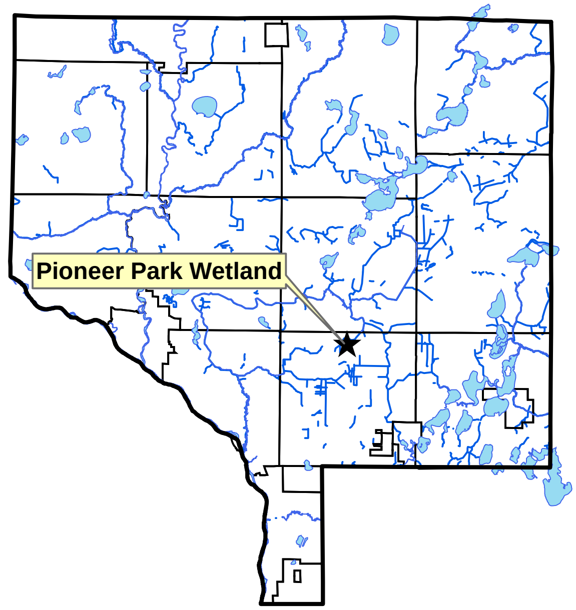


Well depth was 40 inches, so a reading of –40 indicates water levels were at an unknown depth greater than or equal to 40 inches.

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	-

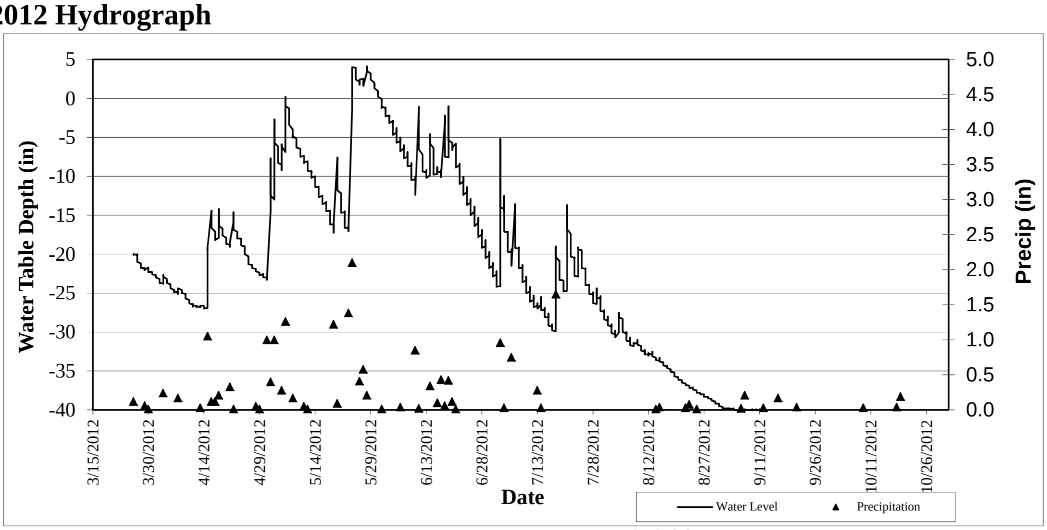
Surrounding Soils: Rifle and loamy wet sand.

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.

2012 Hydrograph

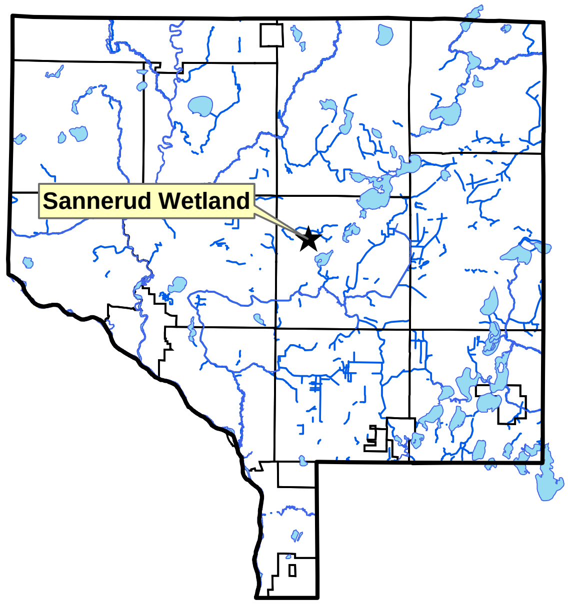


Well depth was 40 inches, so a reading of –40 indicates water levels at an unknown depth greater than or equal to 40 inches.

Wetland Hydrology Monitoring

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	-

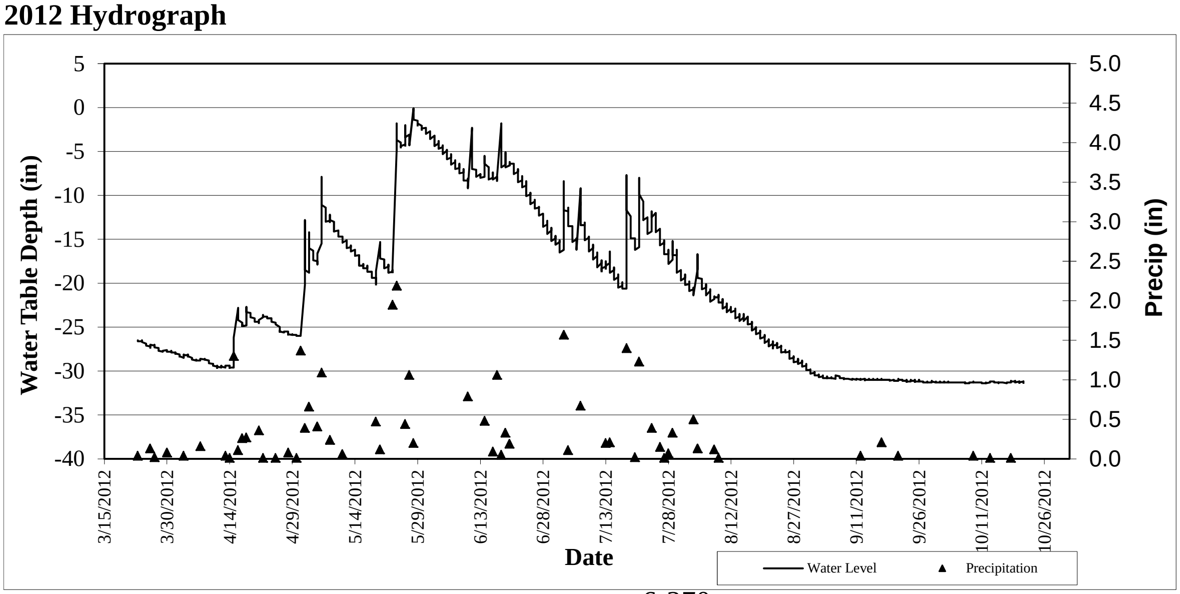
Surrounding Soils: Zimmerman and Lino.

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 inches deep.

2012 Hydrograph

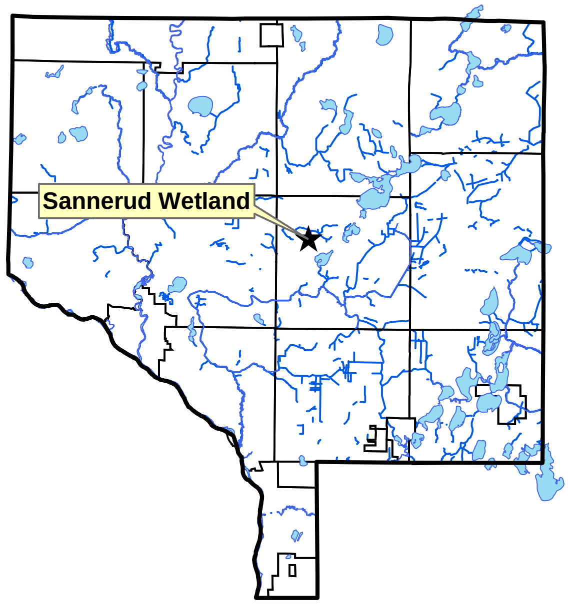


Well depth was 43.5 inches, so a reading of –43.5 indicates water levels were at an unknown depth greater than or equal to 43.5 inches.

Wetland Hydrology Monitoring

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	-

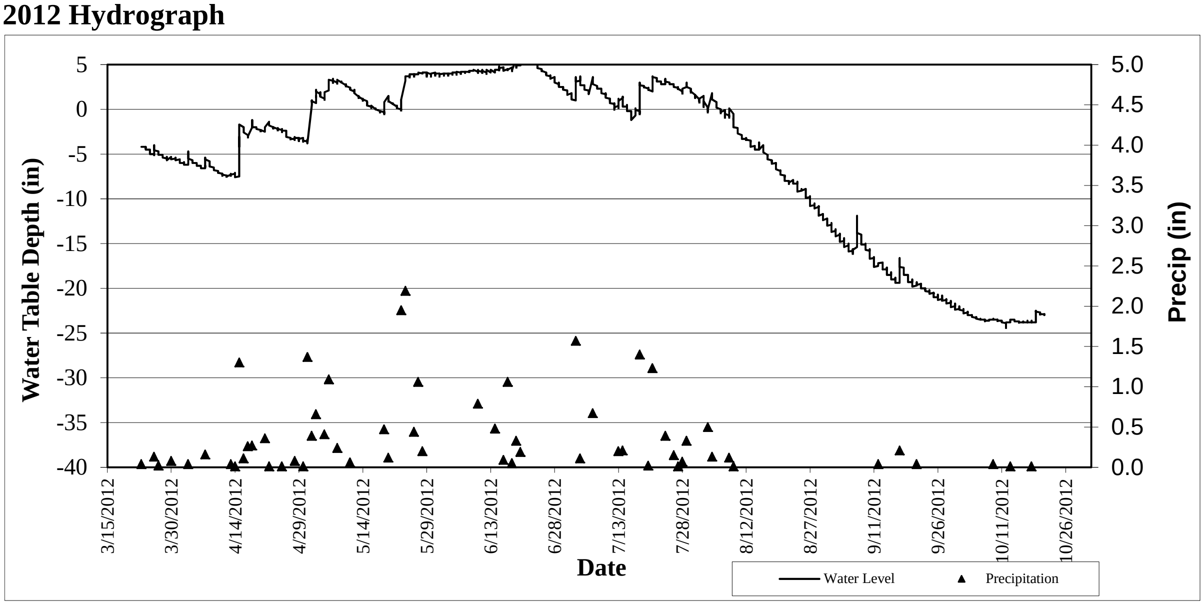
Surrounding Soils: Zimmerman and Lino.

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.

2012 Hydrograph



Well depth was 38.5 inches, so a reading of –38.5 indicates water levels were at an unknown depth greater than or equal to 38.5 inches.

Reference Wetland Analyses

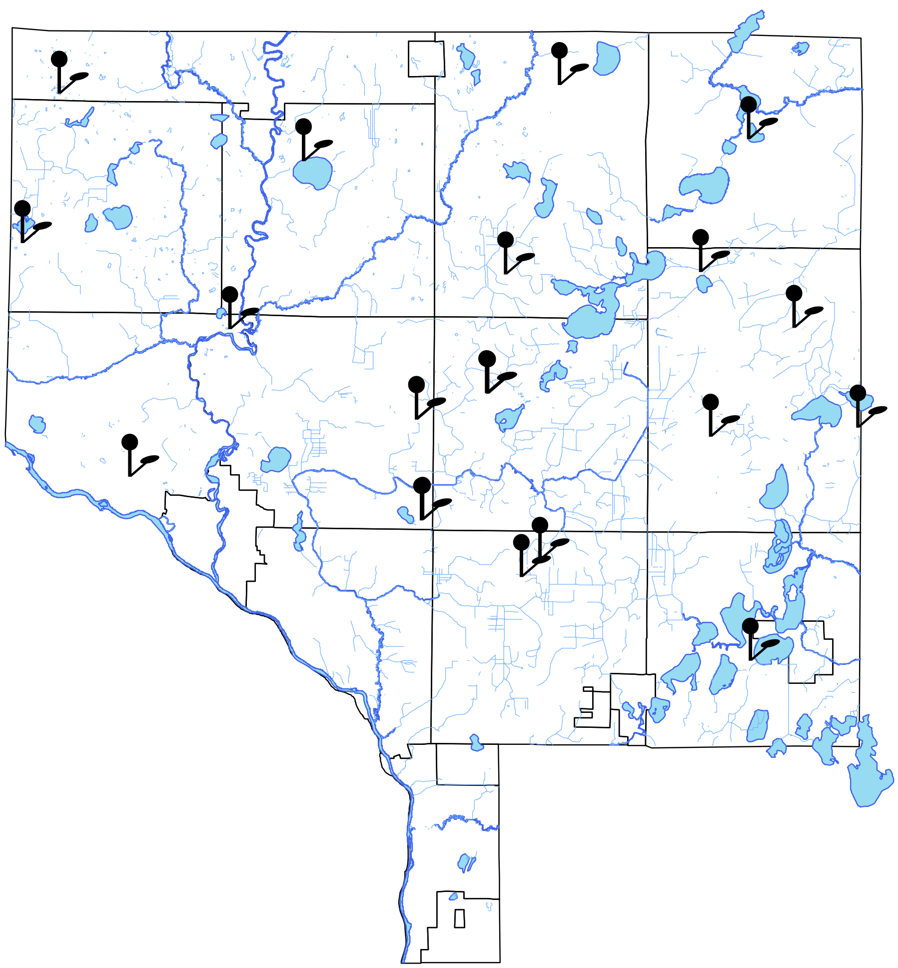
Description: This section includes analyses of wetland hydrology data that has been collected at 18 reference wetland sites. Shallow groundwater levels at the edge of these wetlands are recorded every four hours. Many have been monitored since 1996. These analyses summarize this enormous multi-year, 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.

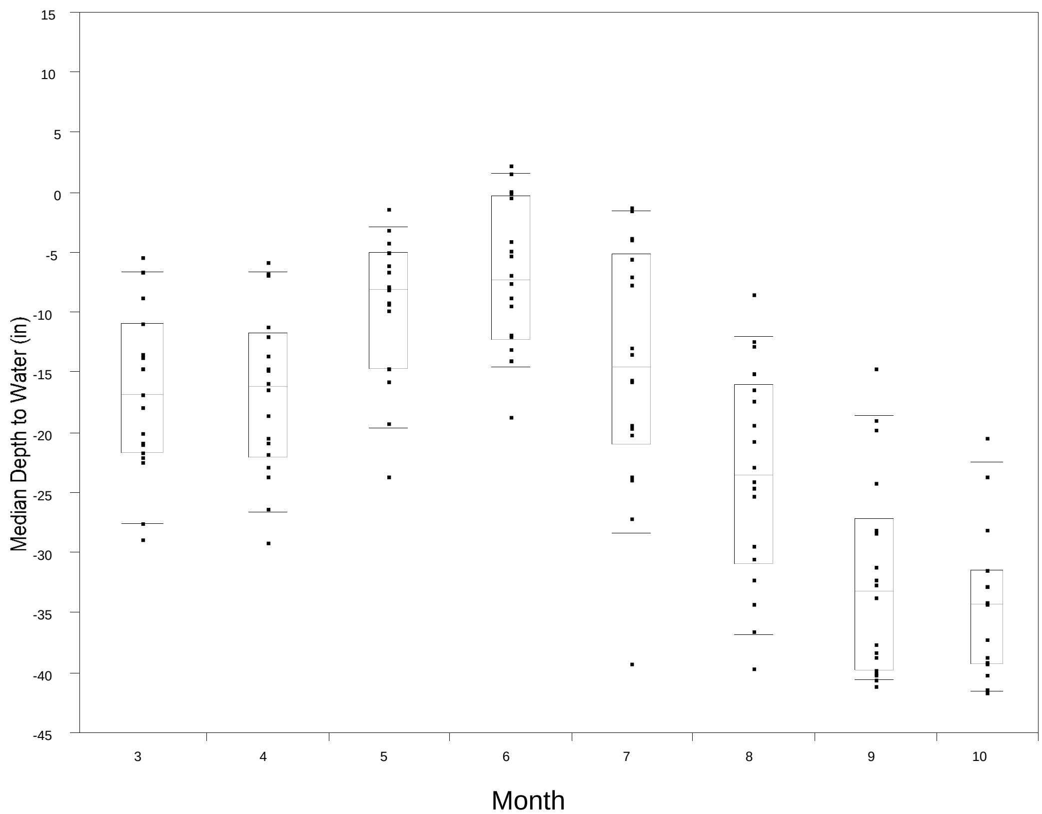
Locations: All 18 reference wetland hydrology monitoring sites in Anoka County.

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



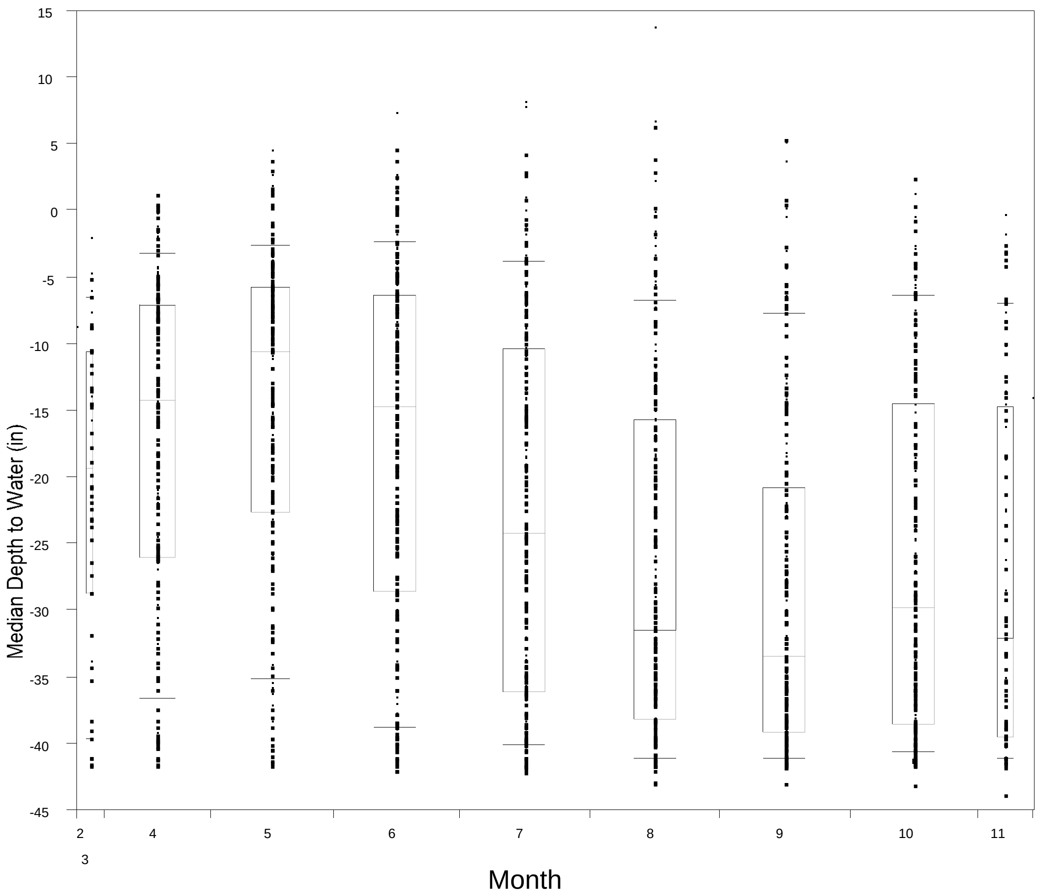
2012 Reference Wetland Water Levels Summary: Each dot represents the median depth to the water table at the edge of one reference wetland for a given month in 2011. The quantile boxes show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentile (floating horizontal lines). Maximum well depths were 40 to 45 inches, so a reading <40 inches likely indicates water was below the well at an unknown depth.



Quantiles

Month	minimum	10.0%	25.0%	median	75.0%	90.0%	maximum
3	-28.7	-27.3	-21.4	-16.6	-10.6	-6.4	-5.1
4	-29	-26.39	-21.8	-15.95	-11.525	-6.41	-5.6
5	-23.5	-19.45	-14.425	-7.8	-4.8	-2.63	-1.1
6	-18.5	-14.27	-11.975	-7	-0.1	1.87	2.5
7	-39.1	-28.21	-20.775	-14.3	-4.9	-1.27	-1
8	-39.5	-36.71	-30.725	-23.25	-15.85	-11.71	-8.2
9	-41	-40.46	-39.65	-33	-26.925	-18.37	-14.5
10	-41.5	-41.32	-39.1	-34.1	-31.3	-22.18	-20.2

1996-2012 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 2011. 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 inches, so a reading <40 inches likely indicates water was below the well at an unknown depth.



Quantiles

Month	minimum	10.0%	25.0%	median	75.0%	90.0%	maximum
2	-8.6	-8.6	-8.6	-8.6	-8.6	-8.6	-8.6
3	-41.6	-39.54	-28.625	-19.3	-10.575	-6.4	-1.9
4	-41.6	-36.5	-25.95	-14.2	-7.1	-3.14	1.2
5	-41.6	-35.06	-22.6	-10.6	-5.7	-2.6	4.6
6	-42	-38.7	-28.55	-14.65	-6.3	-2.35	7.4
7	-42.2	-40.1	-36.05	-24.1	-10.3	-3.7	8.3
8	-43	-41.1	-38.1	-31.4	-15.7	-6.68	13.9
9	-43	-41	-39.1	-33.45	-20.775	-7.69	5.3
10	-43.1	-40.6	-38.5	-29.8	-14.4	-6.3	2.4
11	-43.8	-41.1	-39.5	-32	-14.65	-6.88	-0.2
12	-14	-14	-14	-14	-14	-14	-14

Discussion:

The purpose of reference wetland data is to help assure 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, excavations, 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 a disputed, 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 18 reference wetlands (except during winter), and the raw water level data are available through the Data Access tool at www.AnokaNaturalResources.com, or from the Anoka Conservation District.

Reference Wetland Vegetation Transects

Description: This project is designed to track hydrology and vegetation changes in high quality wetlands that are under a number of pressures. The goal is to understand changes occurring to these wetlands and others that are similar. The project includes monitoring of hydrology and vegetation in multiple years. Shallow groundwater hydrology is monitored every year at the wetland edge and in the middle of the wetland as part of the Anoka Conservation District's Reference Wetland Program. Vegetation is monitored each year by assessing percent cover of various species along transects that were established in 2007.

Purpose: To understand the influence of pressures upon this, and other similar wetlands, especially with respect to hydrology and vegetation. Pressures include increased traffic on adjacent highways and potential future road expansions, building and increased impervious surface, dewatering associated with nearby construction projects, depression of the water table due to climate or groundwater usage, and the presence (and possible expansion) of the invasive reed canary grass. Of particular interest is how wetland hydrology will affect invasive species expansion.

Locations: Bunker Reference Wetland, City of Andover

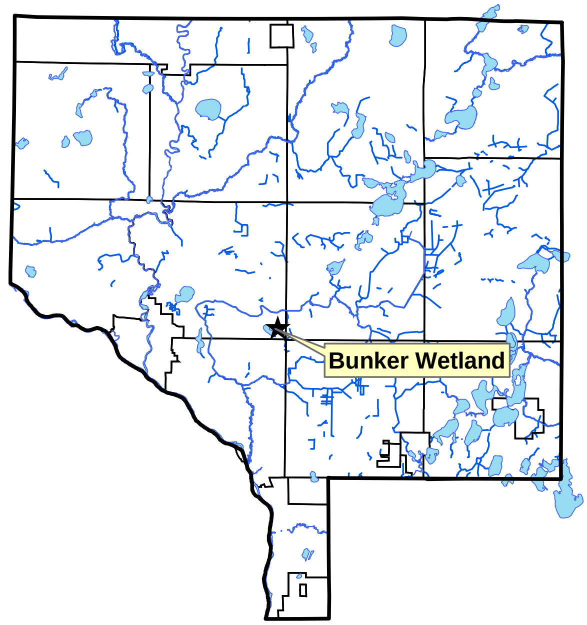
Sannerud Reference Wetland, City of Ham Lake

Results: On the following pages

BUNKER REFERENCE WETLAND

Bunker Hills Regional Park, Andover

Wetland Description



The Bunker Hills reference wetland is approximately; a one-acre sized Circular 39, depressional Type 2 inland fresh wet meadow. The wetland is located in a concave landscape position with no discernable outlet, but is in close proximity to two similar type wetlands. One of similar size, located to the west, and a second, much larger wetland, located to the south.
The soils in the Bunker Hills are mapped by the Anoka County Soil Survey as the very poorly drained (water table within 0-2 feet) *Isanti Fine Sandy Loam.* While that classification is accurate on the perimeter, the interior is more akin to *Rife Mucky Peat* with the depth of the organic material ranging from a few inches to greater than four feet. In general, the organic deposits deepen towards the center of the basin. The surrounding uplands are a mix prairie and oak. The upland soils are mapped as the excessively well drained (water table > 6-feet) *Zimmerman Fine Sand*, which rapidly conducts water through its soil column.

The hydrology appears to be both surface water and groundwater driven. The hydrology data indicates the water table is generally within a few inches of the surface during the early spring and draws down to 30-40 inches during mid-summer. In addition, during the summer months the water tables rise and fall rapidly in response to rain events, while fall season data indicates a recharging water table.

There are three distinct vegetative communities within the wetland. Located along the perimeter is an invasive dominated community, with Reed Canary Grass as the primary species. The interior of the basin contains a diverse native, and an invasive/native species mix. Listed below are the specific plant species, with percent cover. The communities are further illustrated in the attached Bunker Hills Reference Wetland Vegetation Inventory figures.

Photo of Bunker Wetland in April

Introduction

At the request of the Coon Creek Watershed District, the Anoka Conservation District (ACD) is continuing to study the vegetation communities of the Bunkers Hills Reference Wetland. This site is located in the SW ¼ of the NE ¼ of Section 36 Township 32N Range 24W, Andover, Mn. Locally it is in the northeast corner of Bunker Hills Regional Park.
Study of this wetland has been two-fold. First, to measure the wetland hydrology on a continuous basis, as part of the ACD's network of reference wetlands. This data helps to understand how shallow water tables fluctuate during the growing season, and over long periods of time.

In 1996, the ACD placed a well on the wetland edge to measure growing season hydrology. We found, with the exception of the first two years, the water levels were at or below the required level. In fact, Seven out of ten years failed to meet wetland hydrology standards. We also found the water table was decreasing over time. Thus, the edge was no longer considered a jurisdictional wetland. This created the question of how the water table is reacting to changes in the local landscape. Therefore, in 2006 it was decided to move the well down slope, and add an additional well in the center of the wetland. This allows us to capture the full range of hydrology readings throughout the growing season.

The second goal is to inventory the plant species and assign plant community boundaries. Then monitor the vegetation communities observing how the species composition and boundaries change over time. Particular interest is the progression of invasive/exotic plant species as a result of changes in hydrology due to influence of various pressures upon this wetland.

Data Collection Methods

Two perpendicular transects each with seven sample plots each were established. Each plot used 1-meter quadrants for the herbaceous layer, 15-foot radius for the shrub/vine layer, and 30-foot radius for the tree layer. Sample sites that over lapped into the upland, or other plant communities were modified, while keeping the same square footage to stay within the wetland, and respective plant community.

Within each plot, vegetation was identified and cataloged to the species level with both common and scientific names, percent aerial coverage, indicator status and weather the species is native or invasive. These data were then used to establish plant community composition and aerial photograph interpretation was used to extrapolate the boundaries throughout the wetland. Due to seasonal vegetative variation, the community species composition is collected at the same time of year.

The boundary location and plot data were recorded with a hand held Garmin GPS unit with WAAS (Wide Area Augmentation System) correction and uploaded into Arc Map 9.1. These data were then used to create the vegetation inventory figures.

Collectively these data will serve to monitor plant community composition and boundaries over time. Listed below are brief narratives of each plant community along with a plant species table. Please note the sample sites are grouped with their respective plant community rather than in numeric order. For illustration of sample site locations, see the attached vegetation inventory figures.

Results

1. **Monotypic Non-Native**

   This plant community, while having a few sparsely placed native species, has a greater than 100 percent aerial coverage of non-native species Reed Canary Grass *(Phalaris arundinacea).* This species is very aggressive and out competes native species. It spreads by the use of underground roots (stolons) and seed. This species thrives in soil and hydrologically disturbed areas.

   This community is approximately one third of the total wetland, and is located in the northeast portion. The boundary is diffuse, which may indicate it is creeping towards, and possibly overtaking the native plant communities. This boundary will continue to be monitored for encroachment into the adjacent native communities.

Sample Site 1-1

Scientific Name	Common Name	%Cover	Native/Invasive	Indicator
Phalaris arundinacea	Reed Canary Grass	120	Invasive	FACW
Solidago gigantia	Giant Goldenrod	5	Native	FACW
Rubus flagellaris	Dewberry	5	Native	FACU

Sample 1-2

Scientific Name	Common Name	%Cover	Native/Invasive	Indicator
Phalaris arundinacea	Reed Canary Grass	120	Invasive	FACW

Sample 1-3

Scientific Name	Common Name	%Cover	Native/Invasive	Indicator
Phalaris arundinacea	Reed Canary Grass	100	Invasive	FACW

Sample 2-1

Scientific Name	Common Name	%Cover	Native/Invasive	Indicator
Phalaris arundinacea	Reed Canary Grass	100	Invasive	FACW
Rubus strigosis	Raspberry	10	Native	FACW
Solidago Canadensis	Canada Goldenrod	2	Native	FACU

Sample 2-2

Scientific Name	Common Name	%Cover	Native/Invasive	Indicator
Phalaris arundinacea	Reed Canary Grass	90	Invasive	FACW
Urtica dioca	Stinging Nettle	2	Native	FAC
Carex lacustris	Lake Sedge	5	Native	OBL

2. Diverse Native/Non- Native Mix

This plant community is comprised of a mixture of native and non-native species, with clear boundaries. The plant community is comprised of species such as, Red Raspberry *(Rubus strigosis)*, Quaking Aspen *(Populas tremulas)*, and Reed Canary Grass *(Phalaris arundinacea)* these are species commonly associated with wetland edges, where the hydrology fluctuates and inundation in not common. There is high percentage of Reed Canary Grass, which may at some time overwhelm the natives, thus merging with the adjacent monotypic non-native plant community. It also may encroach into the native community.

Sample 1-7

Scientific Name	Common Name	%Cover	Native/Invasive	Indicator
Phalaris arundinacea	Reed Canary Grass	90	Invasive	FACW
Rubus strigosis	Raspberry	30	Native	FACW
Populus trembulas	Quacking Aspen	10	Native	FAC

Sample 2-7

Scientific Name	Common Name	%Cover	Native/Invasive	Indicator
Phalaris	Reed Canary	90	Invasive	FACW

arundinacea	Grass			
Rubus strigosis	Raspberry	30	Native	FACW
Populus trembulas	Quacking Aspen	30	Native	FAC

3. Diverse Native

The center of this wetland contains the native species and is the most diverse of all the plant communities. It has a clear boundary, but is adjacent to the non-native community. Therefore, encroachment will be closely monitored. The native diversity is likely due to the hydrology being less affected than the perimeter. The early 2011 growing season had higher than normal precipitation leading to prolonged inundation. This caused the formation of algae mats in some of the sample plots. This also may have caused the facultative species of Canada Thistle, and Stinging Nettle to decrease in population.

Sample 1-4

Scientific Name	Common Name	%Cover	Native/Invasive	Indicator
Polygonum sagittatum	Tear thumb	40	Native	OBL
Lycopus uniflorus	Northern Bugleweed	40	Native	OBL
Carex lacustris	Lake Sedge	10	Native	OBL
Polygonum amphibium	Water Smartweed	10	Native	OBL
Thelypteris thelypteroides	Marsh Fern	2	Native	FACW
Solidago gigantia	Giant Goldenrod	2	Native	FACW
Circium Arvence	Canada Thistle	5	Invasive	FACU

Sample 1-5

Scientific Name	Common Name	%Cover	Native/Invasive	Indicator
Solidago gigantia	Giant Goldenrod	40	Native	FACW
Thelypteris thelypteroides	Marsh Fern	30	Native	FACW
Rubus flagellaris	Dewberry	30	Native	FACU
Calamagrostis canadensis	Canada blue-joint	10	Native	OBL
Carex lacustris	Lake Sedge	10	Native	OBL
Polygonum amphibium	Water Smartweed	10	Native	OBL

Sample 1-6

Scientific Name	Common Name	%Cover	Native/Invasive	Indicator
Solidago gigantia	Giant Goldenrod	40	Native	FACW
Carex lacustris	Lake Sedge	10	Native	OBL
Rubus strigosis	Raspberry	20	Native	FACU
Polygonum sagittatum	Tear thumb	30	Native	OBL

Sample 2-3

Scientific Name	Common Name	%Cover	Native/Invasive	Indicator
Carex lacustris	Lake Sedge	80	Native	OBL
Cirsium arvense	Canada Thistle	<1	Invasive	FACU

Lycopus uniflorus	Northern Bugleweed	30	Native	OBL
Polygonum sagittatum	Tear thumb	20	Native	OBL
Circium Arvence	Canada Thistle	5	Invasive	FACU

Sample 2-4

Scientific Name	Common Name	%Cover	Native/Invasive	Indicator
Carex lacustris	Lake Sedge	40	Native	OBL
Lycopus uniflorus	Northern Bugleweed	30	Native	OBL
Rubus strigosis	Raspberry	10	Native	FACW
Polygonum sagittatum	Tear thumb	20	Native	OBL
Polygonum amphibium	Water Smartweed	10	Native	OBL
Solidago gigantia	Giant Goldenrod	5	Native	FACW

Sample 2-5

Scientific Name	Common Name	%Cover	Native/Invasive	Indicator
Polygonum hydropiper	Marshpepper smartweed	40	Native	OBL
Lycopus uniflorus	Northern Bugleweed	40	Native	OBL
Solidago gigantia	Giant Goldenrod	20	Native	FACW
Carex lacustris	Lake Sedge	20	Native	OBL
Polygonum amphibium	Water Smartweed	10	Native	OBL

Sample 2-6

Scientific Name	Common Name	%Cover	Native/Invasive	Indicator
Carex lacustris	Lake Sedge	70	Native	OBL
Lycopus uniflorus	Northern Bugleweed	30	Native	OBL
Polygonum sagittatum	Tear thumb	30	Native	OBL
Polygonum amphibium	Water Smartweed	10	Native	OBL
Circium Arvence	Canada Thistle	5	Invasive	FACU

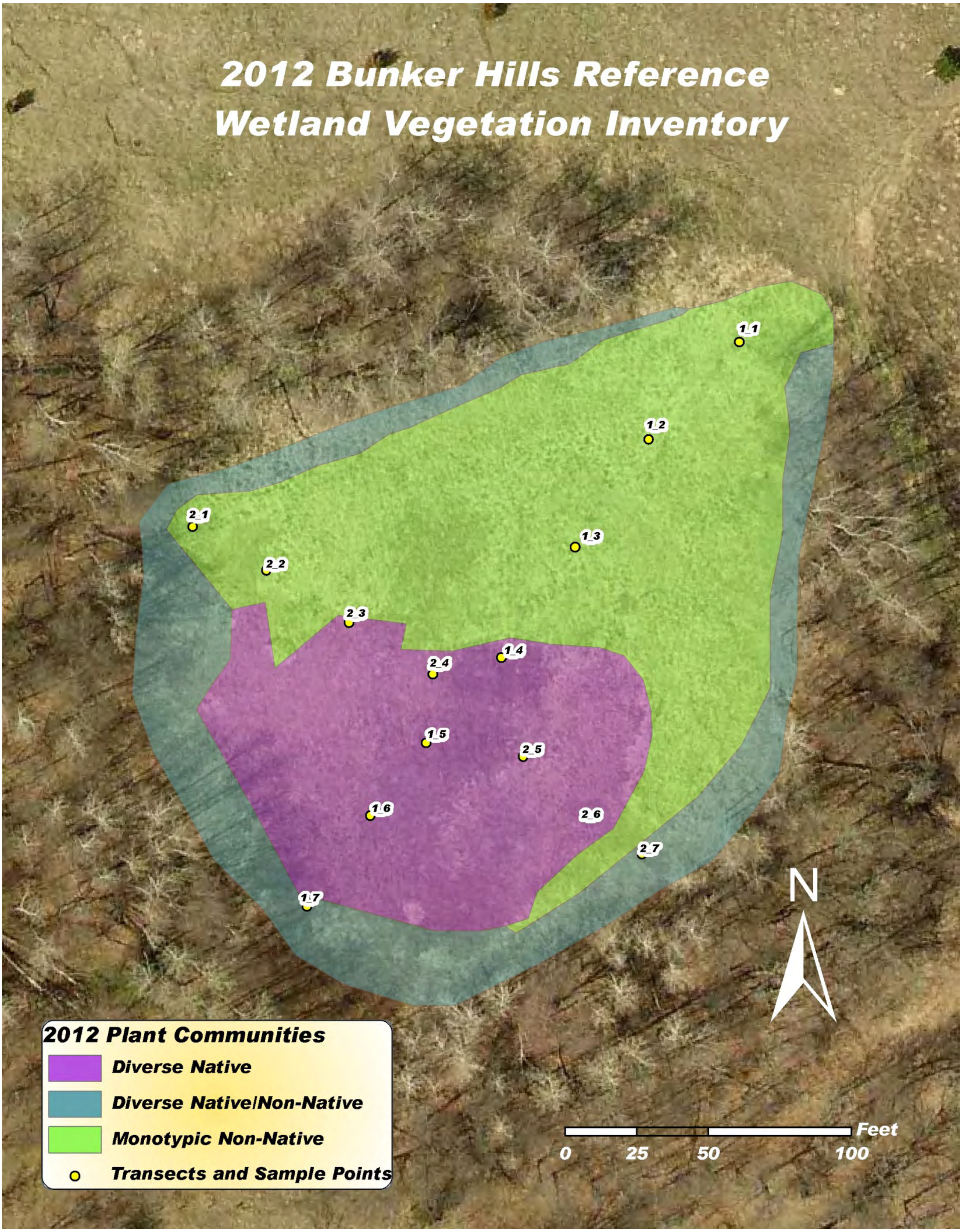
CONCLUSION

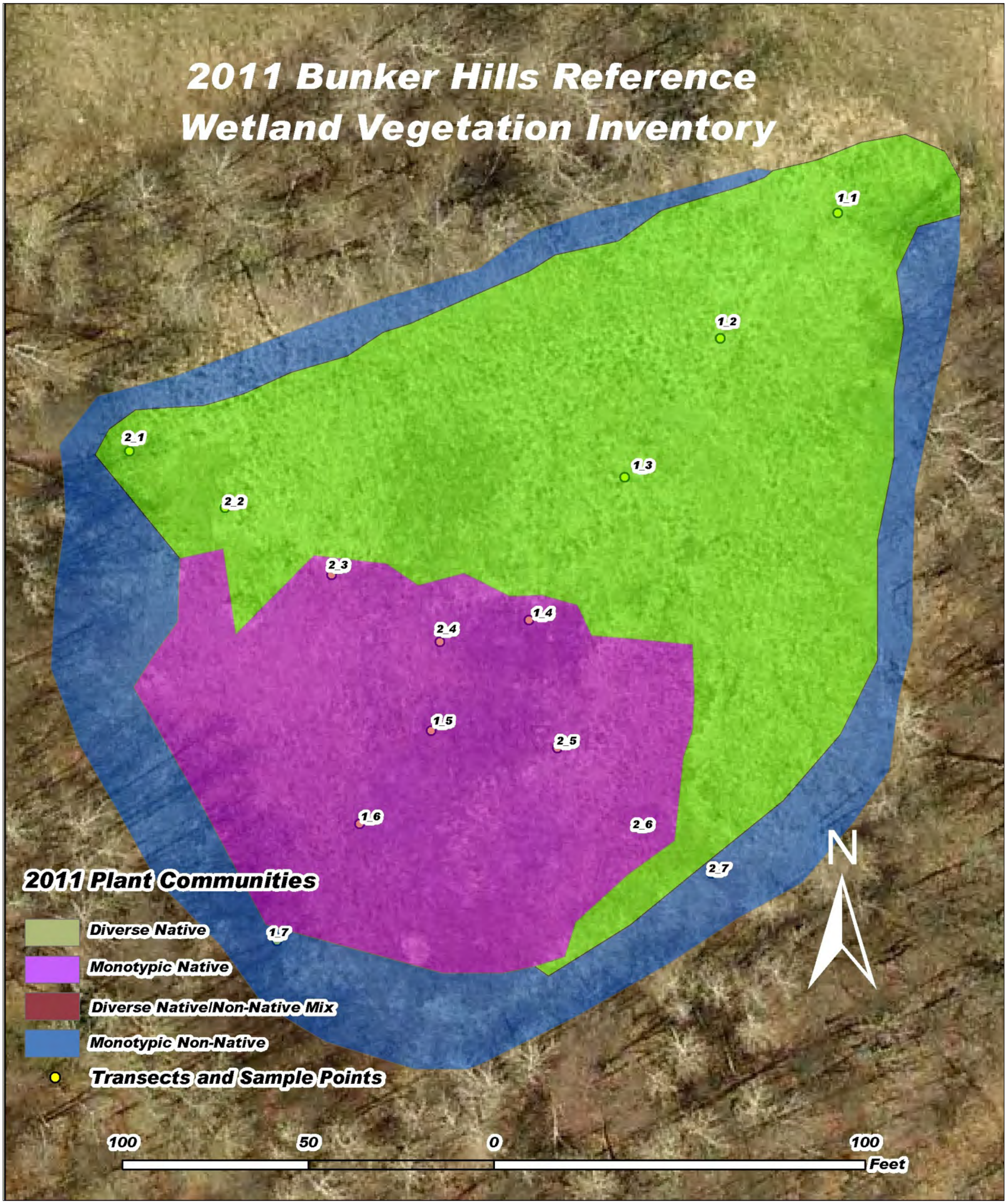
We now have four years of vegetative data, in which to compare. During this period, the species composition has resulted in some boundary changes, and minor species composition changed. For illustration of the boundary changes, refer to the attached figures for 2009-2012.

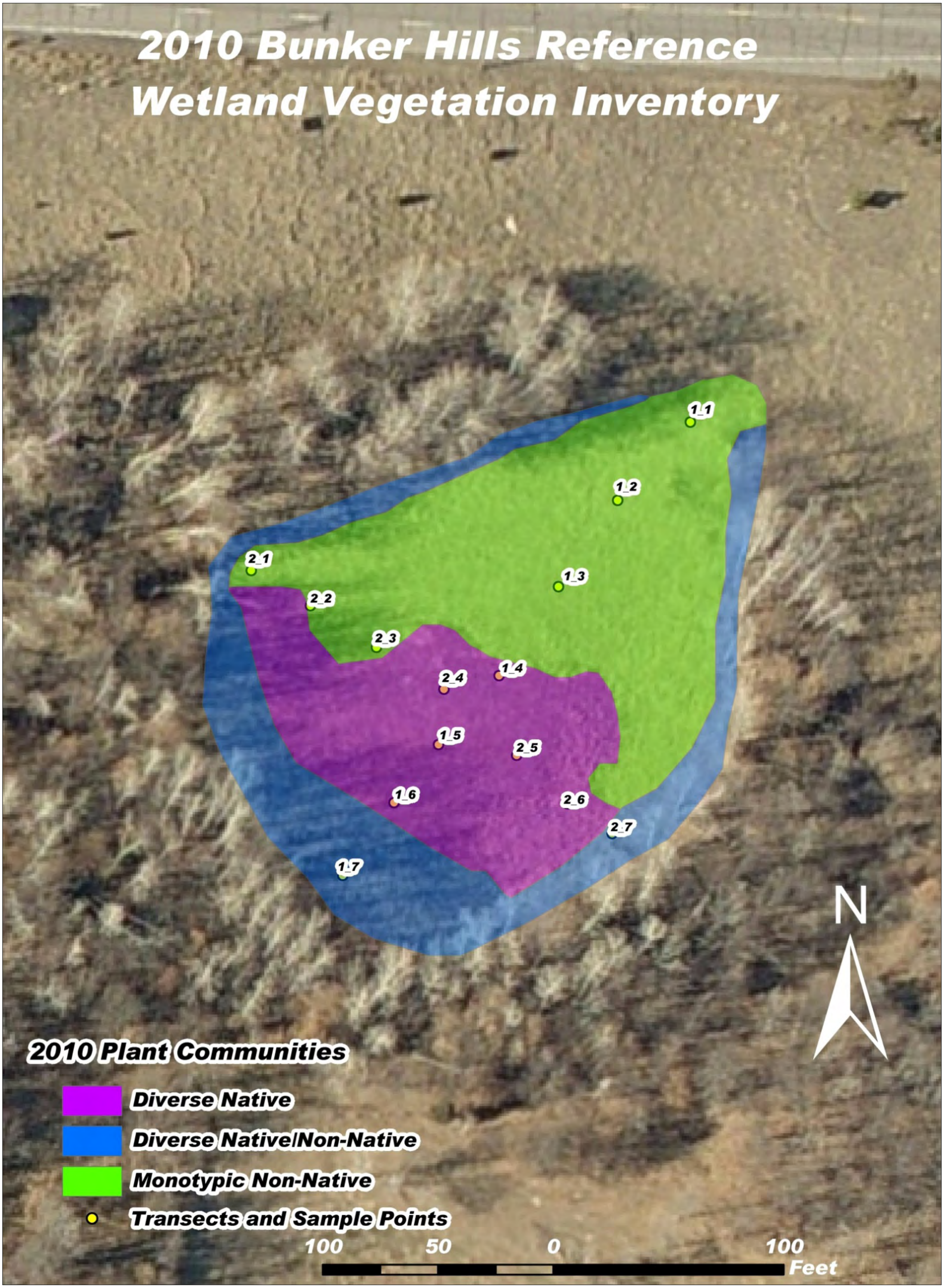
The Monotypic invasive plant community remains relatively unchanged, although appears to be gradually moving inward towards the native plant communities. This is seen as increased invasive species aerial converge in composition of the Diverse Native/Invasive community.

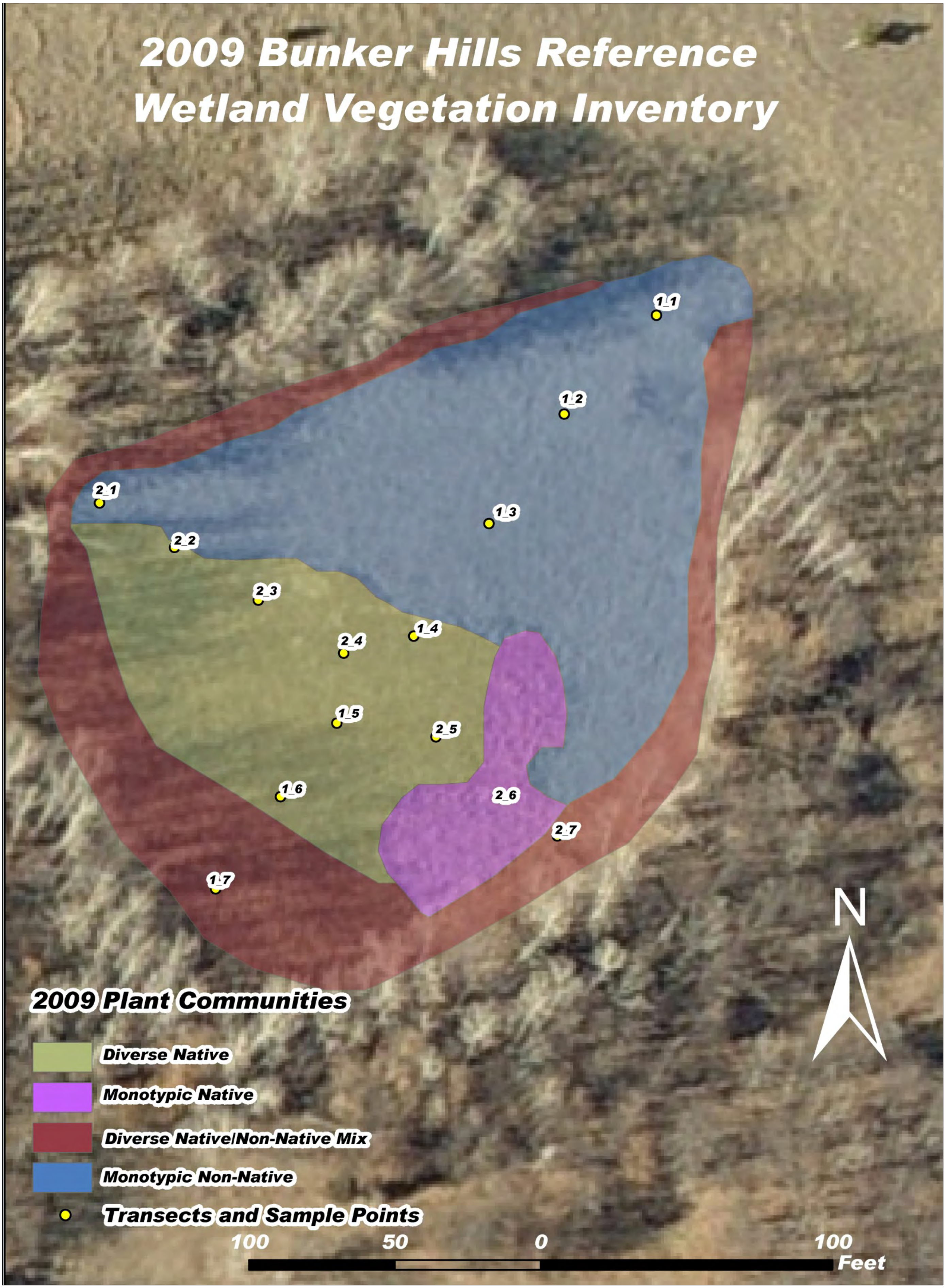
The Diverse Native community appears to be largely unchanged. In 2011 there was prolonged inundation that suppressed the invasive Canada Thistle species. However 2012 has been drier and much of the thistle has been reestablished.

These types of wetlands were fire dependent, but since land-use is largely residential fire is no longer part of the system. As time passes this basin will eventually become a monotype of Reed Canary Grass. This wetland would be an excellent candidate for restoration. It is part of a park system, we know a great deal about the hydrology, and a part of the native community still exists. Further monitoring of this wetland is expected during the 2013 growing season.


2012 Bunker Hills Reference
Wetland Vegetation Inventory
1_1
1_2
1_3
1_4
1_5
1_6
1_7
2_1
2_2
2_3
2_4
2_5
2_6
2_7
N
2012 Plant Communities
Diverse Native
Diverse Native/Non-Native
Monotypic Non-Native
Transects and Sample Points
Feet
0
25
50
100


2011 Bunker Hills Reference
Wetland Vegetation Inventory
1_1
1_2
1_3
1_4
1_5
1_6
1_7
2_1
2_2
2_3
2_4
2_5
2_6
2_7
N
2011 Plant Communities
Diverse Native
Monotypic Native
Diverse Native/Non-Native Mix
Monotypic Non-Native
Transects and Sample Points
100
50
0
100
Feet


2010 Bunker Hills Reference
Wetland Vegetation Inventory
1_1
1_2
2_1
1_3
2_2
2_3
2_4
1_4
1_5
2_5
1_6
2_6
2_7
1_7
N
2010 Plant Communities
Diverse Native
Diverse Native/Non-Native
Monotypic Non-Native
Transects and Sample Points
100
50
0
100
Feet

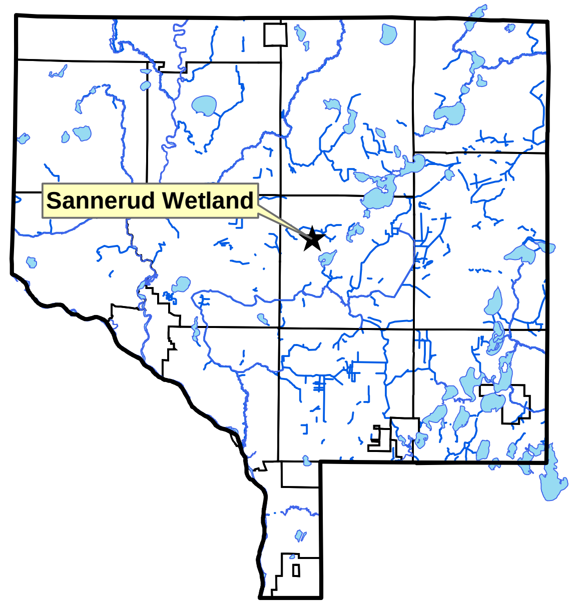

2009 Bunker Hills Reference
Wetland Vegetation Inventory
1_1
1_2
2_1
1_3
2_2
2_3
1_4
2_4
1_5
2_5
1_6
2_6
2_7
1_7
N
2009 Plant Communities
Diverse Native
Monotypic Native
Diverse Native/Non-Native Mix
Monotypic Non-Native
Transects and Sample Points
100
50
0
100
Feet

Wetland Vegetation Transect

SANNERUD REFERENCE WETLAND

W side of Hwy 65 at 165th Ave, Ham Lake

Wetland Description



The Sannerud wetland is approximately 18.9 acres, and is classified as a Circular 39 Type 2 Inland fresh sedge meadow. This wetland is a depressional basin with deep organic soil deposits e.g. > 51 inches. The soil is classified as *Rifle Mucky Peat* with a sandy substrate. The surrounding uplands are oak woodlands on the somewhat poorly drained (water table within 2-4 feet) *Lino Fine Sand*, and the excessively well drained (water Table > 6-feet) *Zimmerman Fine Sand* soils. Both of these sandy soils rapidly conduct water, and discharge to the wetland.

Hydrology of this wetland shows typical early season high water tables, which are at or above the ground surface, and decrease as the growing season progresses. The responses to rain events are pronounced especially on the wetland edge. A contributing factor is the high permeable rates of the upland soils. There is an inlet ditch on the east side of the wetland coming from under TH 65, and a created outlet ditch on the southwest corner. Both have been over grown and appear to be non-functional.

The dominate plant species within this wetland are native sedges and grasses, specifically *Carex buxbaumii* (Buxbuam's Sedge), *Carex interior* (inland Sedge) and *Calamagrostis canadensis* (Canada bluejoint). These are native species indicative of a high quality wetland habitat. Located on the perimeter of the wetland are various mixtures of *Rubus flagellaris* (Dew Berry), *Phalaris arundinacea* (Phalaris arundinacea), *Calamagrostis canadensis* (Canada Bluejoint), and *Populas trembelodies* (Quaking Aspen).

Introduction

At the request of the Coon Creek Watershed District, and with the permission of the property owners, the Anoka Conservation District (ACD) continues to study the wetland hydrology, and plant communities of the Sannerud wetland. The site is located in the SE ¼ of the SW ¼ of Section 8 Township 32N, Range 23W, Ham Lake, and Mn, northwest of the intersection of Highway 65 and Constance Boulevard.

Study of this wetland has been two-fold. First, to measure the wetland hydrology on a continuous basis, as part of the ACD's network of reference wetlands. This data helps to understand how shallow water tables fluctuate during the growing season, and over long periods of time.

The second goal, which began in 2007, is to inventory the plant species and assign plant community boundaries. Then monitor the vegetation communities observing how the species composition and boundaries change over time. Particular interest is the progression of invasive/exotic plant species as a result of changes in hydrology due to influence of various pressures upon this wetland. This wetland is likely to experience substantial changes at its periphery. These changes include increased traffic on the adjacent highway, potential road expansions, development, and increased impervious surface, which leads to the possible expansion of the invasive species such as Reed Canary Grass.

Data Collection Methods

Data plots were established by two means. They were either along transects across multiple plant communities, or as a single plot within a small community. Each data plot collected plant species and percent aerial coverage data by using 1-meter quadrants for the herbaceous layer, 15-foot radius for shrub/vine layers, and 30-foot radius for tree layers. Sample sites that over lapped into upland, or other plant communities were modified, while keeping the same square footage, to stay within the respective plant community.

Within each plot, vegetation was identified and cataloged to the species level with both common and scientific names, percent aerial coverage, indicator status and weather the species is native or invasive. These data were then used to establish plant community composition and aerial photograph interpretation was used to extrapolate the boundaries throughout the wetland. Due to seasonal vegetative variation, the community species composition is collected at the same time of year (mid- summer), but monitored throughout the growing season.

The boundary location and plot data were recorded with a hand held Garmin GPS unit with WAAS (Wide Area Augmentation System) correction and uploaded into Arc Map 9.1. These data were then used to create the community maps. In years past the community maps were categorized based on specific species resulting in ten communities. However, since these communities change in composition they are now grouped as either (1) Native or (2) Dominant Native/Non-native invasive mix (3) Dominant Non-native invasive/native mix. While the individual communities are still recognized and depicted on the map, the focus is on whether the community is native or invasive and if the boundary is moving.

Collectively these data will serve to monitor plant community composition and boundaries over time. Listed below are brief narratives of each plant community along with a plant species table. Please note the sample sites are grouped with their respective plant community rather than in numeric order. For illustration of sample site locations, see the attached vegetation inventory figures.

After consultation and additional carex (sedge) species identification training this year a corrections on a misidentified carex species were made, which resulted an additional carex species being identified.

Results

The data produced three plant communities types based on the percentage of native vs. invasive species composition. These three communities were further broken down into subcategories based on dominant species listed in descending order. Subsequently, the sample plot I.D. numbers will correlate with the plant communities, rather than numerical order.

Listed below are the main communities followed by the sub categories. Although there are 10 sub communities, for the purpose of this report, plant communities descriptions are of the three main plant communities. The data plots identify species composition in each sub community. The Plant Community Maps depict and label each sub community in accordance with the numbered listed below the three main plant communities, along with sample plot locations.

- Native
  - Calamagrostis Canadensis, Carex buxbaumii, Carex interior
  - Calamagrostis canadensis, Spirea tomentosa, , Carex interior, Carex buxbaumii
  - Rubus flagellaris, Carex buxbaumii, Carex interior
  - Spirea tomentosa, Carex buxbaumii, Carex interior Rubus flagellaris
- Dominate Native/Invasive mix,
  - Carex buxbaumii, Carex interior, Carex buxbaumii, Calamagrostis canadensis, Phalaris arundinacea, Rubus flagellaris, Spirea tomentosa, Populus tremulodies
  - Rubus flagellaris, Carex lacustris, Phalaris arundinacea, Carex interior, Carex buxbaumii
  - Spirea tomentosa, Carex buxbaumii, Carex interior, Phalaris arundinacea, Rubus flagellaris
- Dominate Invasive/Native mix
  - Phalaris arundinacea, Acer rubrum, Populus tremulodies
  - Phalaris arundinacea, Carex buxbaumii, Calamagrostis Canadensis, Carex interior
  - Phalaris arundinacea, Populus trembelodies

1. Native Plant Communities

This plant community encompasses 73% (13.8 acres) of the total wetland area, and is located mostly in the interior of the basin where the organic deposits are the thickest and the hydrology is the most stable.

By far the most dominant plant species are *Carex buxbaumii, Carex interior* and *Calamagrostis Canadensis.* These communities are comprised of the following species data.

Sample 1-2

Scientific Name	Common Name	% Coverage	Native/Invasive
Carex buxbaumii	Buxbaum's Sedge	50	Native
Carex interior	Inland Sedge	50	Native
Calamagrostis canadensis	Canada Blue Joint	30	Native
Salaix nigra	Black Willow	5	Native
Spirea tomentosa	Steeple Bush	5	Native

Sample 1-3

Scientific Name	Common Name	% Coverage	Native/Invasive
Carex buxbaumii	Buxbaum's Sedge	50	Native
Carex interior	Inland Sedge	50	Native
Calamagrostis canadensis	Canada Blue Joint	40	Native
Spirea tomentosa	Steeple Bush	5	Native

Sample 1-4

Scientific Name	Common Name	% Coverage	Native/Invasive
Carex buxbaumii	Buxbaum's Sedge	50	Native
Carex interior	Inland Sedge	50	Native
Calamagrostis canadensis	Canada Blue Joint	20	Native
Typha angustifolia	Narrow-leaf Cattail	10	Native

Sample 2-2

Scientific Name	Common Name	% Coverage	Native/Invasive
Calamagrostis canadensis	Canada Blue Joint	100	Native
Carex buxbaumii	Buxbaum’s Sedge	40	Native
Carex interior	Inland Sedge	30	Native
Salaix nigra	Black Willow	10	Native

Sample 2-3

Scientific Name	Common Name	% Coverage	Native/Invasive
Calamagrostis canadensis	Canada Blue Joint	100	Native
Carex buxbaumii	Buxbaum’s Sedge	40	Native
Carex interior	Inland Sedge	30	Native

Sample 2-4

Scientific Name	Common Name	% Coverage	Native/Invasive
Calamagrostis canadensis	Canada Blue Joint	100	Native
Carex buxbaumii	Buxbaum’s Sedge	40	Native
Carex interior	Inland Sedge	30	Native

Sample 3-3

Scientific Name	Common Name	% Coverage	Native/Invasive
Calamagrostis canadensis	Canada Blue Joint	100	Native
Carex buxbaumii	Buxbaum’s Sedge	40	Native
Carex interior	Inland Sedge	30	Native

Sample 3-4

Scientific Name	Common Name	% Coverage	Native/Invasive
Calamagrostis canadensis	Canada Blue Joint	100	Native
Carex buxbaumii	Buxbaum’s Sedge	40	Native
Carex interior	Inland Sedge	30	Native

Sample 4-2

Scientific Name	Common Name	% Coverage	Native/Invasive
Calamagrostis canadensis	Canada Blue Joint	100	Native
Carex buxbaumii	Buxbaum’s Sedge	20	Native
Carex interior	Inland Sedge	30	Native
Salix exigua	Sandbar Willow	20	Native

Sample 4-3

Scientific Name	Common Name	% Coverage	Native/Invasive
Calamagrostis canadensis	Canada Blue Joint	100	Native
Carex interior	Inland Sedge	30	Native

Carex buxbaumii	Buxbaum's Sedge	20	Native
Polygonum amphibium	Water Smartweed	5	Native

Sample 4-4

Scientific Name	Common Name	% Coverage	Native/Invasive
Carex buxbaumii	Buxbaum's Sedge	50	Native
Carex interior	Inland Sedge	50	Native
Calamagrostis canadensis	Canada Blue Joint	20	Native

These groups of sample plots were taken in adjacent smaller native plant communities that necessitated their own boundaries due to species composition. Theses are native species commonly found along wetland edges.

Sample 5-2

Scientific Name	Common Name	% Coverage	Native/Invasive
Calamagrostis canadensis	Canada Blue Joint	60	Native
Rubus flagellaris	Raspberry	40	Native
Carex buxbaumii	Buxbaum's Sedge	20	Native
Carex interior	Inland Sedge	30	Native
Spirea tementosa	Steeple Bush	20	Native
Salix Peteolaris	Meadow Willow	20	Native

Sample 10-2

Scientific Name	Common Name	% Coverage	Native/Invasive
Calamagrostis canadensis	Canada Blue Joint	60	Native
Rubus flagellaris	Raspberry	40	Native
Carex interior	Inland Sedge	20	Native
Carex buxbaumii	Wooly-fruit sedge	20	Native
Salix Peteolaris	Meadow Willow	20	Native
Spirea tementosa	Steeple Bush	20	Native

Sample 5-3

Scientific Name	Common Name	% Coverage	Native/Invasive
Rubus flagellaris	Raspberry	60	Native
Calamagrostis canadensis	Canada Blue Joint	40	Native
Carex interior	Inland Sedge	20	Native
Carex buxbaumii	Buxbaum's Sedge	20	Native
Spirea tementosa	Steeple Bush	20	Native

Sample 3-2

Scientific Name	Common Name	% Coverage	Native/Invasive
Spirea tementosa	Steeple Bush	40	Native
Carex buxbaumii	Buxbaum's Sedge	40	Native
Carex interior	Inland Sedge	20	Native
Rubus flagellaris	Raspberry	40	Native

2. Dominant Native/Non-native invasive mix

This plant community encompassed 11%, (2.1 acres) of the wetland and is located either along the perimeter or between the perimeter and the interior basin. The dominate species in these plant communities are the Dew Berry and Canada Blue-joint Grass, with various trees and shrubs. This is where the organic soils were the thinnest, (4-16 inches) and the hydrology has the most bounce. Listed below are the sample data taken within these plant communities.

Sample Site 1-1

Scientific Name	Common Name	% Coverage	Native/Invasive
Rubus flagellaris	Dew Berry	70	Native
Calamagrostis canadensis	Canada Blue Joint	30	Native
Phalaris arundinacea	Reed Canary Grass	20	Invasive
Populas trembeloidies	Quaking Aspen (S)	20	Native
Carex buxbaumii	Buxbaum's Sedge	10	Native
Carex interior	Inland Sedge	10	Native
Betula papyrifera	Paper Birch (s)	10	Native
Acer rubrum	Red Maple (T)	10	Native
Spirea tementosa	Steeple Bush	5	Native
Salix petiolaris	Meadow Willow	5	Native

Sample 4-1

Scientific Name	Common Name	% Coverage	Native/Invasive
Carex buxbaumii	Buxbaum's Sedge	40	Native
Carex interior	Inland Sedge	20	Native
Rubus flagellaris	Dew Berry	30	Native
Salix exigua	Sandbar Willow	20	Native
Phalaris arundinacea	Reed Canary Grass	20	Invasive
Fraxinus pennsylvanicum	Green Ash	10	Native
Cornus stolonifera	Red-osier Dogwood (s)	10	Native
Acer rubrum	Red Maple (T)	10	Native
Ilex verticillata	Winterberry (S)	5	Native
Spirea tementosa	Steeple Bush	5	Native

Sample 9-2

Scientific Name	Common Name	% Coverage	Native/Invasive
Carex buxbaumii	Buxbaum's Sedge	40	Native
Carex interior	Inland Sedge	20	Native
Rubus flagellaris	Dew Berry	30	Native
Salix exigua	Sandbar Willow	20	Native
Phalaris arundinacea	Reed Canary Grass	20	Invasive
Acer rubrum	Red Maple	10	Native
Fraxinus pennsylvanicum	Green Ash	10	Native

Sample 6-1

Scientific Name	Common Name	% Coverage	Native/Invasive
Rubus flagellaris	Dew Berry	80	Native
Carex buxbaumii	Buxbaum's Sedge	30	Native
Carex interior	Inland Sedge	20	Native
Carex lacustris	Lake Sedge	20	Native
Phalaris arundinacea	Reed Canary Grass	15	Invasive

Sample 7-1

Scientific Name	Common Name	% Coverage	Native/Invasive
Calamagrostis canadensis	Canada Blue Joint	80	Native
Carex interior	Buxbaum's Sedge	20	Native
Carex buxbaumii	Inland Sedge	30	Native
Phalaris arundinacea	Reed Canary Grass	10	Invasive

3. Dominant Non-native invasive/native mix

This non-native plant community encompassed 16%, (2.0 acres) of the wetland and is located along the perimeter of the wetland. The dominate species in these plant communities is Reed Canary Grass. This is also where the organic soils were the thinnest, (4-16 inches) and the hydrology has the most bounce.

Sample 2-1

Scientific Name	Common Name	% Coverage	Native/Invasive
Phalaris arundinacea	Reed Canary Grass	60	Invasive
Carex interior	Inland Sedge	20	Native
Carex buxbaumii	Buxbaum's Sedge	20	Native
Calamagrostis canadensis	Canada Blue Joint	30	Native
Typha angustifolia	Narrow-leaf Cattail	10	Native

Sample 3-1

Scientific Name	Common Name	% Coverage	Native/Invasive
Phalaris arundinacea	Reed Canary Grass	100	Invasive
Rubus flagellaris	Dew Berry	40	Native
Populas trembeloidies	Quaking Aspen (S)	30	Native
Betula papyrifera	Paper Birch (s)	30	Native
Solidago gigantia	Giant Goldenrod	10	Native

Sample 5-1

Scientific Name	Common Name	% Coverage	Native/Invasive
Phalaris arundinacea	Reed Canary Grass	80	Invasive
Calamagrostis canadensis	Canada Blue Joint	10	Native
Carex interior	Inland Sedge	10	Native
Carex buxbaumii	Buxbaum's Sedge	10	Native

Sample 8-1

Scientific Name	Common Name	% Coverage	Native/Invasive
Phalaris arundinacea	Reed Canary Grass	80	Invasive
Populus trembeloidies	Quaking Aspen (S)	50	Native
Calamagrostis canadensis	Canada Blue Joint	20	Native

Sample 9-1

Scientific Name	Common Name	% Coverage	Native/Invasive
Phalaris arundinacea	Reed Canary Grass	80	Invasive
Populus trembeloidies	Quaking Aspen (S)	50	Native
Calamagrostis canadensis	Canada Blue Joint	20	Native

Sample 10-1

Scientific Name	Common Name	% Coverage	Native/Invasive
Phalaris arundinacea	Reed Canary Grass	80	Invasive
Populus trembeloidies	Quaking Aspen (S)	50	Native
Calamagrostis canadensis	Canada Blue Joint	20	Native

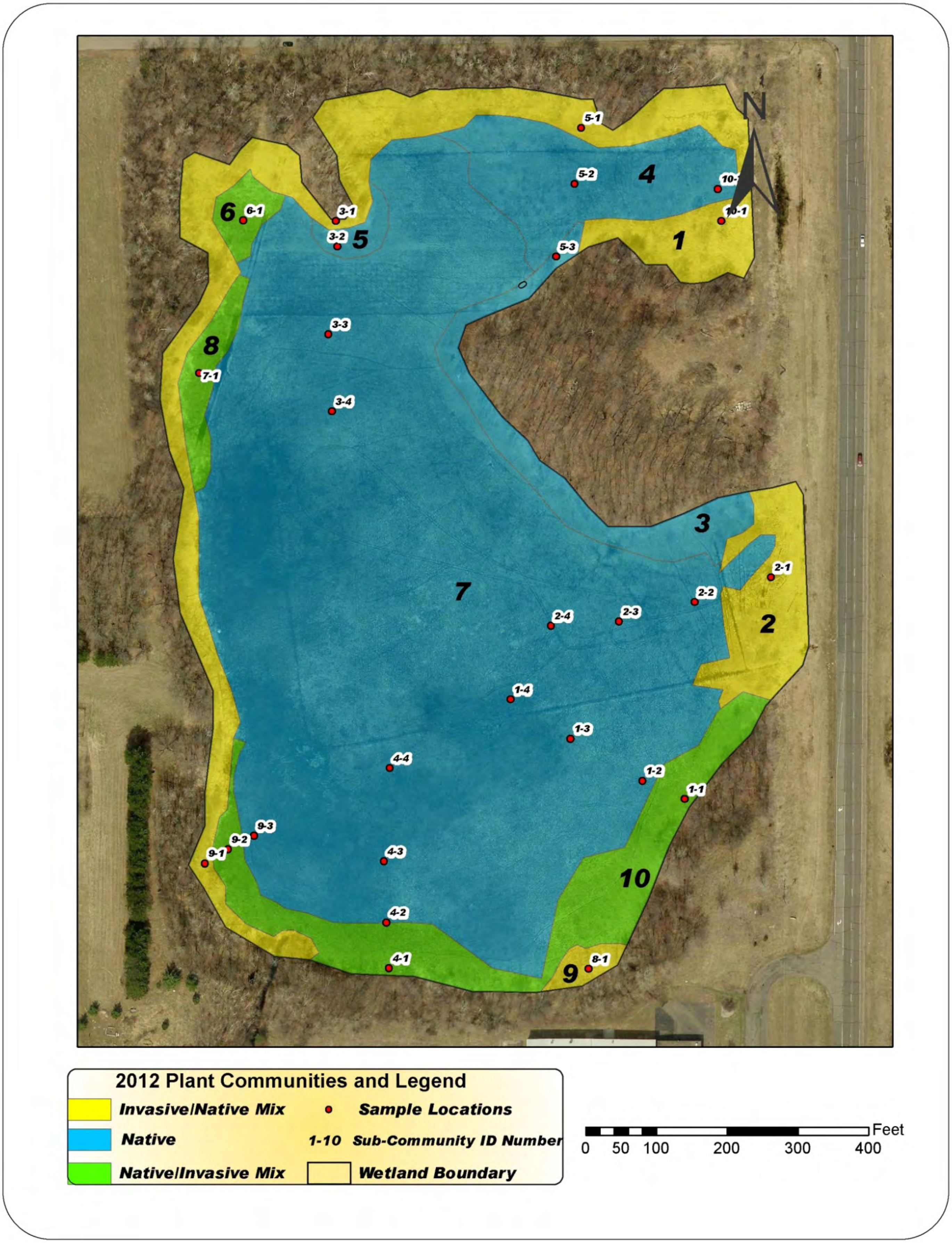
CONCLUSION

Though five years have eclipsed since the plant community survey began, we have yet to see any appreciable changes. There have been changes in species composition, leading to changes in plant community names, but not enough to alter boundaries. For 2012 there were three changes of consequence, a species identification correction, the addition of two species in the native plant communities, and the loss of a native shrub.

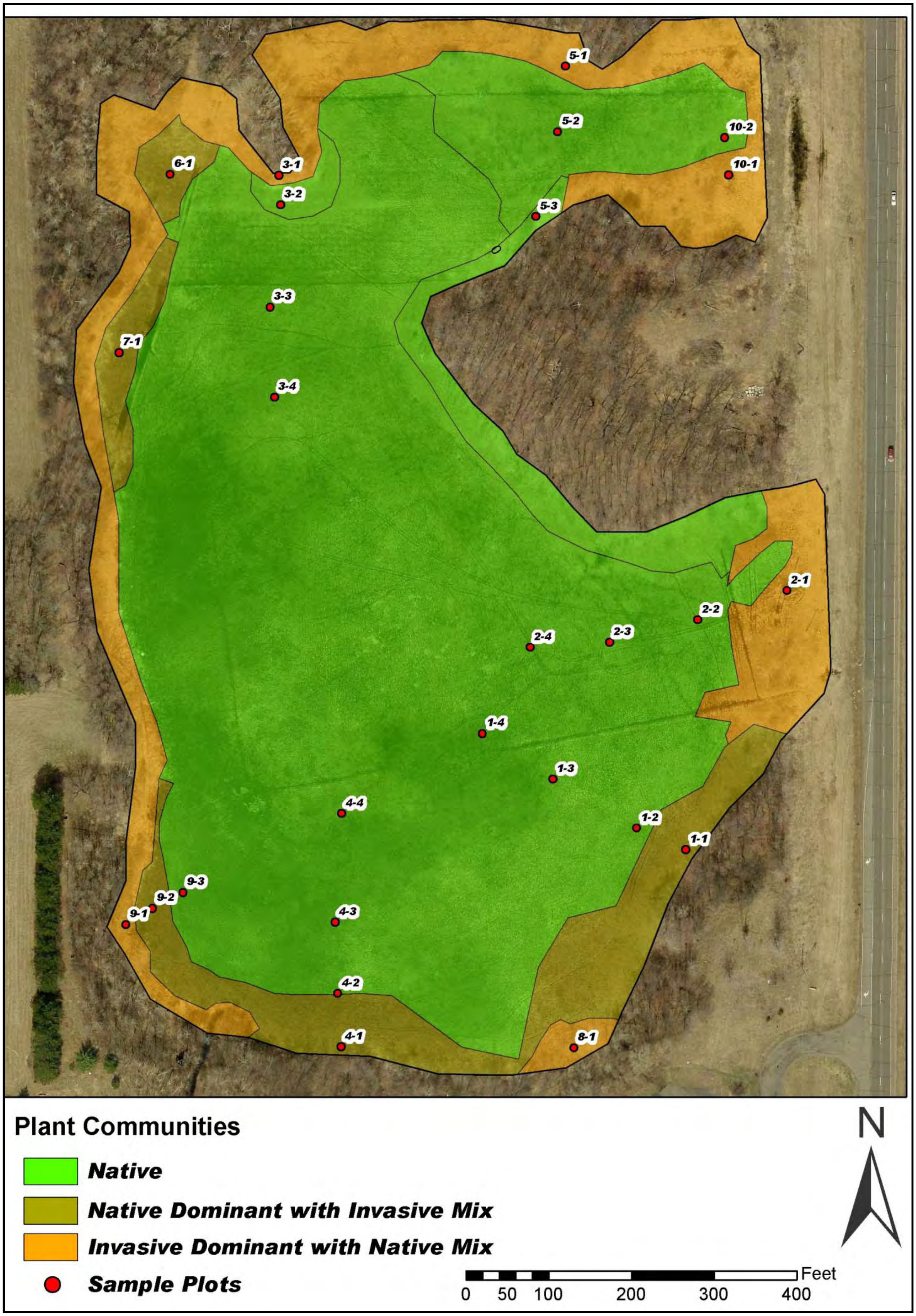
Carex buxbaumii, and Carex interior, have now been correctly identified to the species level. These species were always present, but misidentified as Carex stricta. All three of these species are commonly found in sedge meadows of the Anoka Sandplain, and one is not more indicative of a particular system or its quality. This correction does however add diversity to the species composition. The second change is that Meadow willow has begun to increase it aerial coverage on the northern section of the wetland. It is common that willows increase their coverage overtime unless kept in check by fire. As these systems are fire dependent, and the areas are fire suppressed the willow coverage will continue to increase. The third change is the loss of the Paper Birch species. In 2011 the water tables were very high and it appears to have drowned out the shrubs. Possibly the increased water table has spurred the willow species increase.

The invasive species boundary appears stable, most likely due to the hydrological patters of the basin. Therefore, the question of whether the invasive species, will invade in to the interior will rest on how the hydrology changes over time.

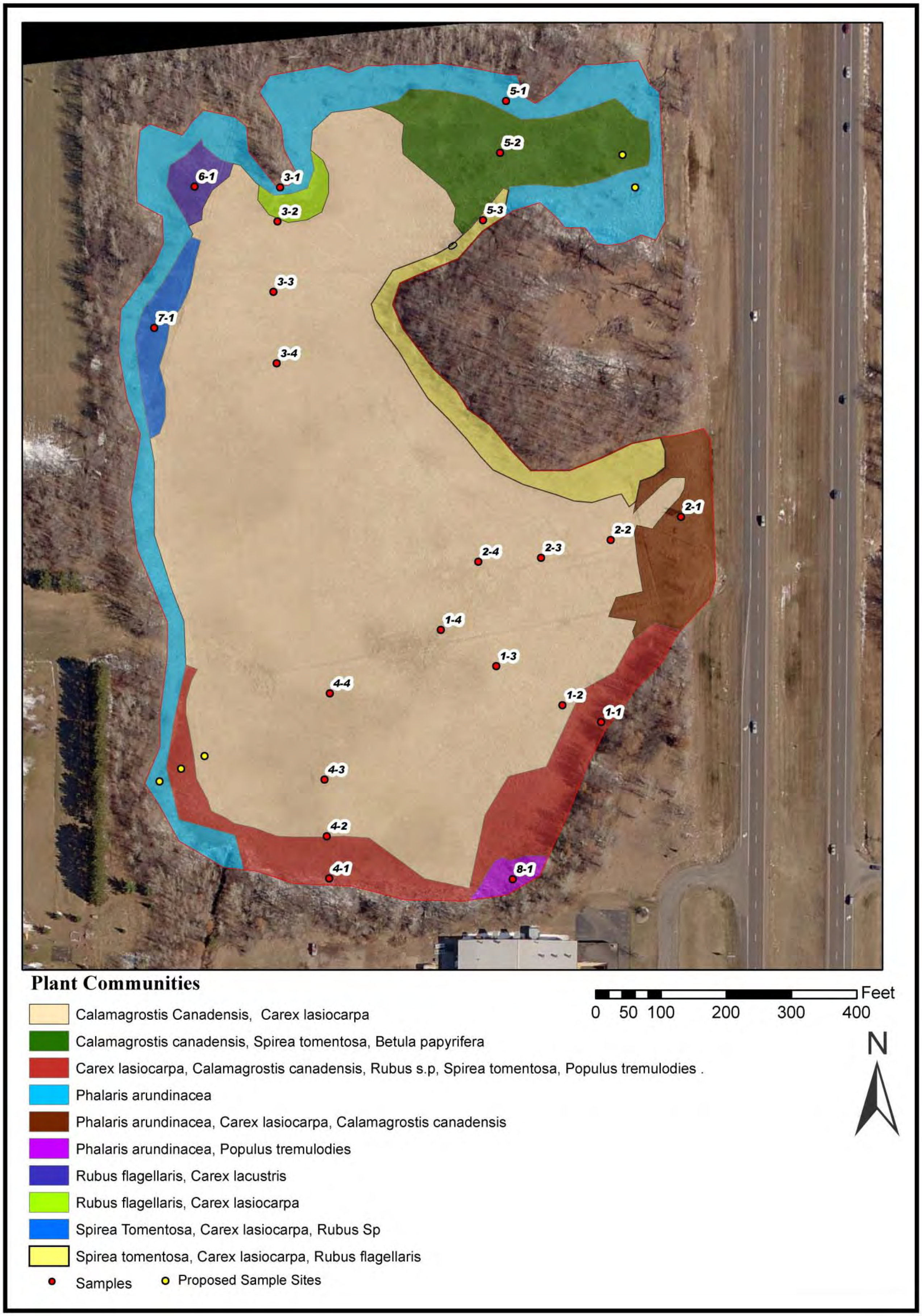
2012 PLANT COMMUNITIES MAP WITH DATA PLOT LOCATIONS



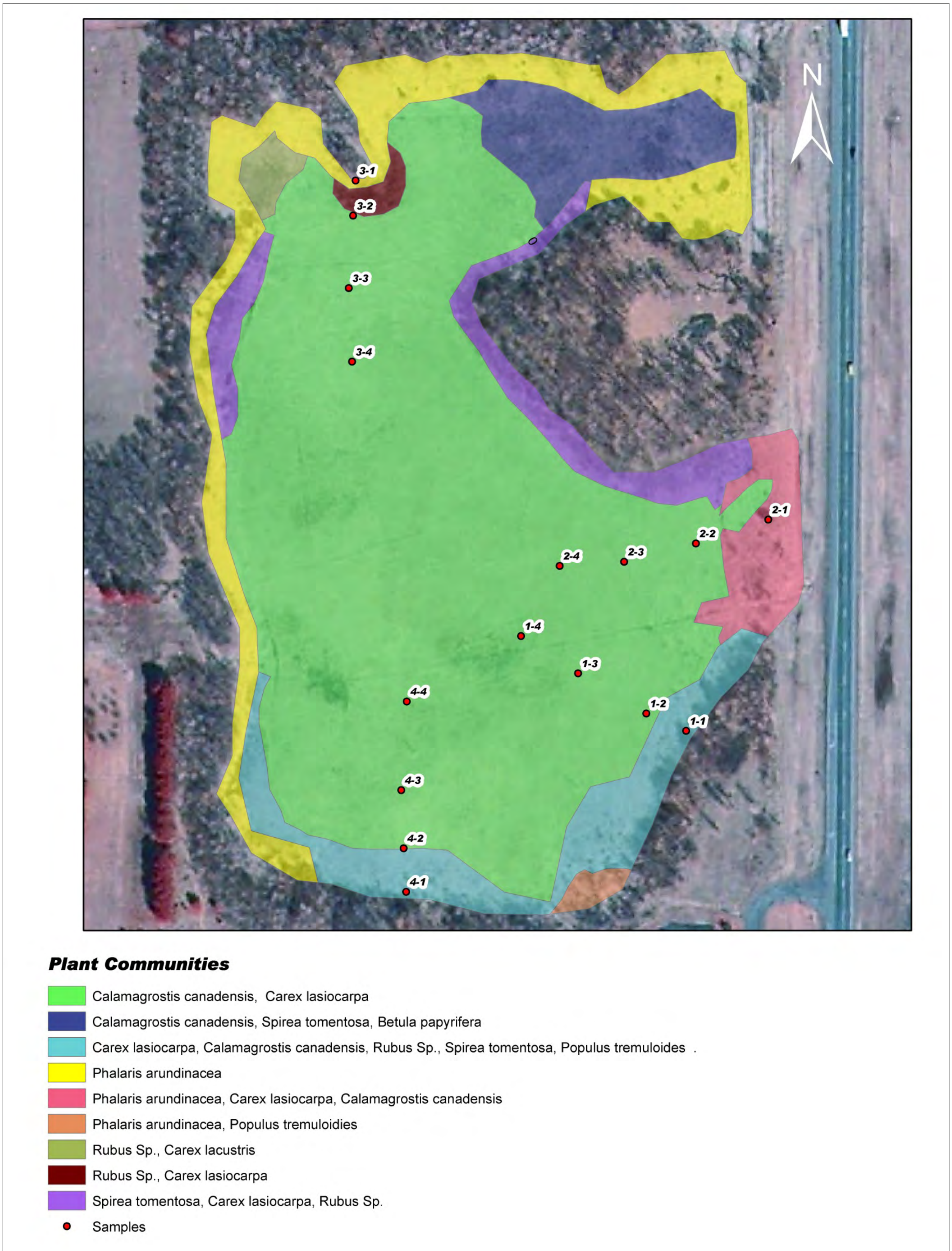
2011 PLANT COMMUNITIES MAP WITH DATA PLOT LOCATIONS



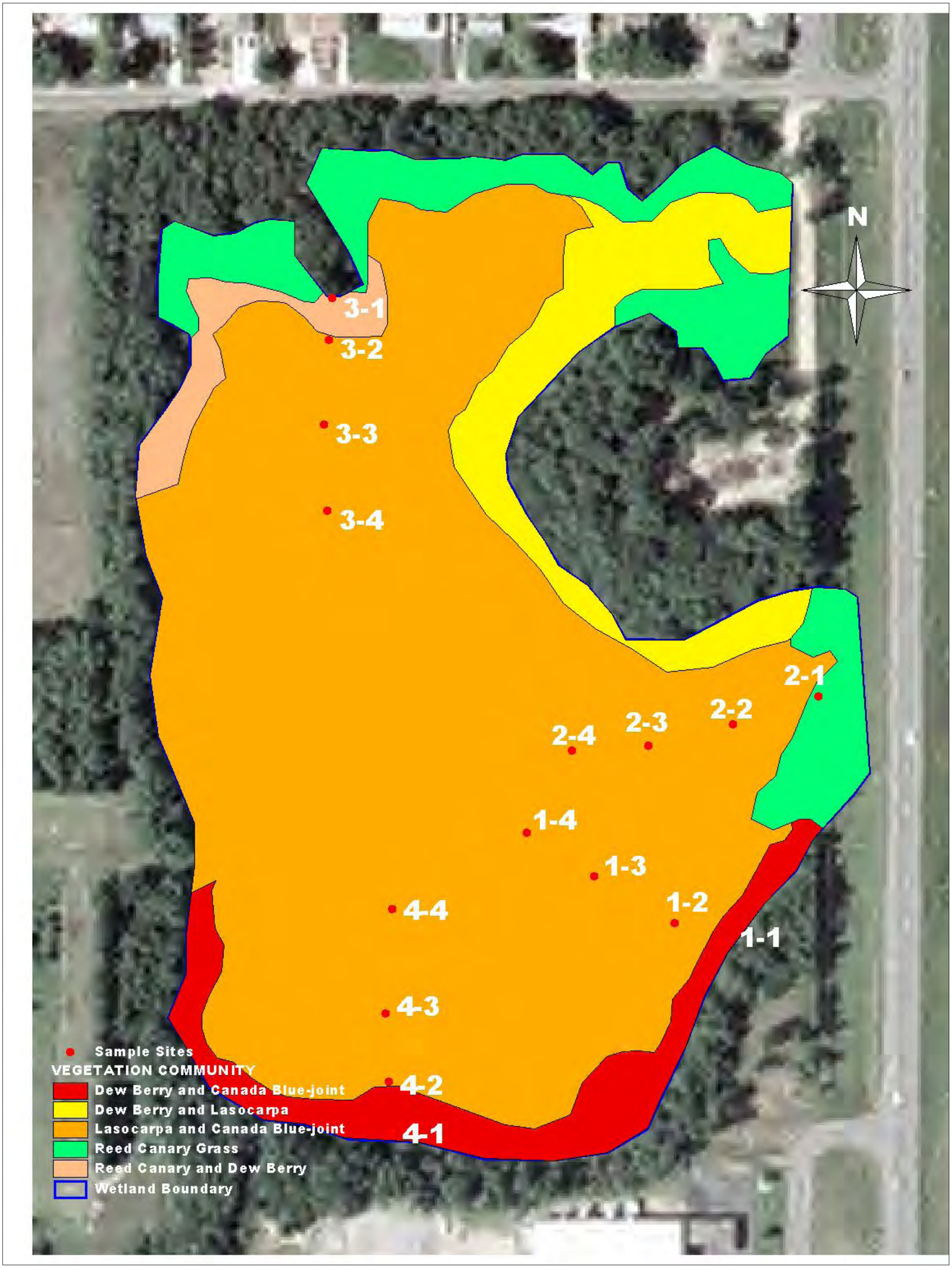
2010 PLANT COMMUNITIES MAP WITH DATA PLOT LOCATIONS



2008 PLANT COMMUNITIES MAP WITH DATA PLOT LOCATIONS



2007 PLANT COMMUNITIES MAP WITH DATA PLOT LOCATIONS



Stormwater Retrofit Analysis – Lower Coon Creek

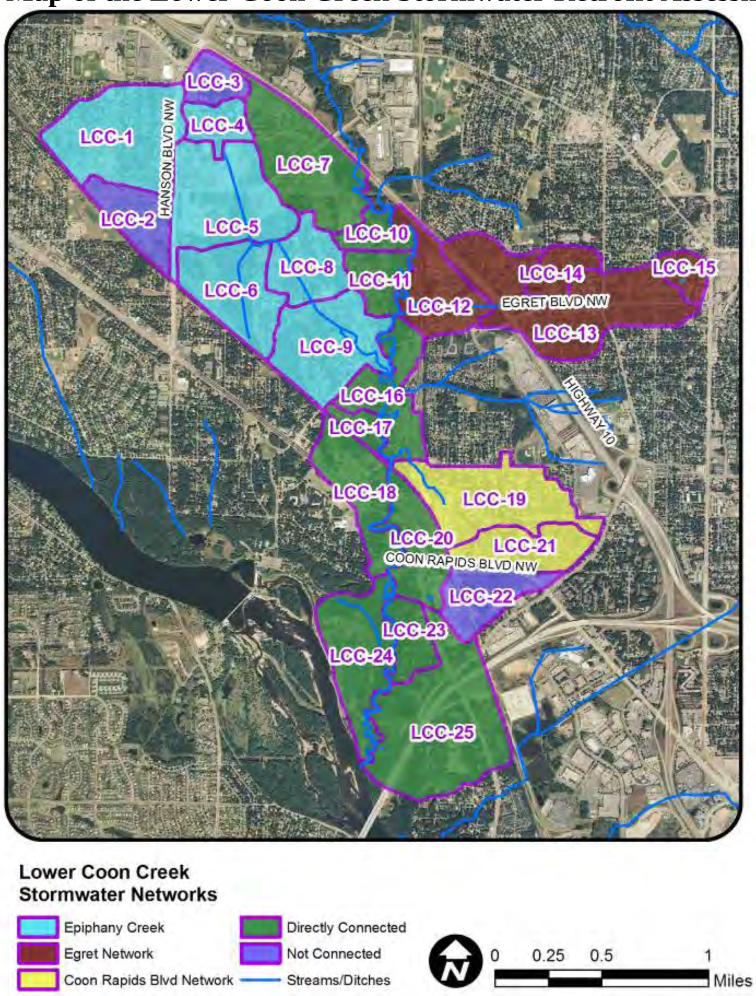
Description: This stormwater retrofit assessment takes a systematic approach to identifying and prioritizing water quality improvement projects that provide the greatest amount of stormwater treatment per dollar spent. Lower Coon Creek was chosen because water quality is known to deteriorate in this section of the creek before the confluence with the Mississippi River. The subwatershed is approximately 2,313 acres and is located entirely in the City of Coon Rapids.

Purpose: To improve stormwater quality and reduce the volume of runoff that most greatly contribute to the degradation of Coon Creek and its tributaries.

Results: This stormwater retrofit analysis was completed in 2012, and a full report is available at www.anokaswcd.org. The Lower Coon Creek subwatershed contributes an estimated 949 acre feet of runoff, 911 pounds of phosphorus and 265,460 pounds of total suspended solids to Coon Creek each year. Forty-four stormwater retrofit projects were identified. For each, pollutant reduction, volume reduction and cost were estimated. Projects were ranked by cost effectiveness (pounds of pollutant reduced per dollar spent). Project types included:

- Maintenance of, or alterations to, existing stormwater treatment practices,
- Residential curb-cut rain gardens,
- New stormwater ponds, and
- Permeable pavement.

Map of the Lower Coon Creek Stormwater Retrofit Assessment Area



Stormwater Retrofit Analysis – Oak Glen Creek

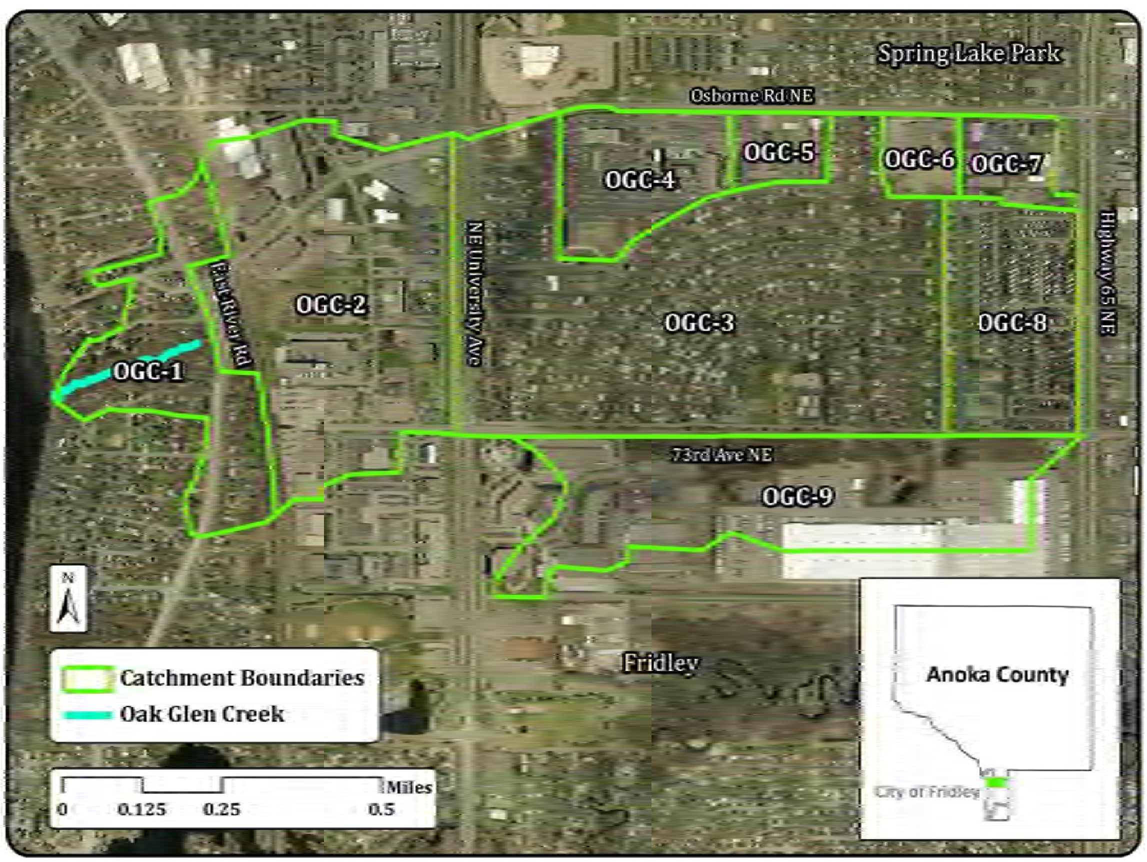
Description: This stormwater retrofit assessment takes a systematic approach to identifying and prioritizing water quality improvement projects that provide the greatest amount of stormwater treatment per dollar spent. Oak Glen Creek was chosen because torrential volumes of stormwater flow through the creek on a regular basis, causing large erosion problems. Moreover, the urbanized subwatershed has little stormwater treatment. The subwatershed is 573 acres of industrial, commercial, and residential. All of this stormwater is in pipes, except for the small stretch of open channel just before discharge into the Mississippi River.

Purpose: To improve stormwater quality and reduce the volume of runoff that most greatly contribute to the degradation of Oak Glen Creek and the Mississippi River.

Results: This stormwater retrofit analysis was completed in 2012, and a full report is available at www.anokaswcd.org. The Oak Glen Creek subwatershed contributes an estimated 415 acre feet of runoff, 353 pounds of phosphorus and 147,519 pounds of total suspended solids to the creek each year. Seventeen stormwater retrofit projects were identified. For each, pollutant reduction, volume reduction and cost were estimated. Projects were ranked by cost effectiveness (pounds of pollutant reduced per dollar spent). Project types included:

- Maintenance of, or alterations to, existing stormwater treatment practices,
- Residential curb-cut rain gardens,
- Parking lot rain gardens in commercial and industrial land uses,
- Permeable asphalt,
- Impervious land cover disconnect, and
- Depavement.

Map of the Oak Glen Creek Stormwater Retrofit Assessment Area



Sand Creek Rain Garden Promotion and Design

Description: This rain garden promotion and design effort is part of a grant project with the Coon Creek Watershed District (CCWD) and City of Coon Rapids. In 2010, CCWD received a grant from the MPCA to construct a new stormwater pond and install a series of residential rain gardens to improve the water quality in Sand Creek. ACD was contracted to manage the promotion and design portion of the rain garden project.

Purpose: To improve stormwater quality and reduce the volume of runoff entering the stormwater system from neighborhoods that contribute to degradation of Sand Creek and Coon Creek.

Results: In fall 2011, ACD staff approached over 30 properties in a residential neighborhood to the south of Sand Creek looking for landowners interested in participating in the rain garden program. Interested landowners attended educational meetings held by ACD and some eventually signed contracts for rain garden construction on their property. In 2012 ACD staff oversaw the construction process for nine rain gardens at strategic locations. Project designs were completed by Metro Landscape Restoration Program staff with project dollars provided by ACD and the Clean Water Fund (CWF) from the Clean Water, Land and Legacy Amendment. Long term maintenance will be conducted by the landowners under an agreement with the CCWD. Together, these nine rain gardens will reduce stormwater runoff volumes into Sand Creek by 1,620,594 gallons/yr, suspended solids by 2000 lbs/yr, and phosphorus by 8.76 lbs/yr.

Installation sites of nine rain gardens installed in the Sand Creek subwatershed in 2012.

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.

Note in the table below that all precipitation related work, including monitoring and analysis, is grouped as CCWD rain. Likewise, all reference wetland work, including monitoring, analysis, and vegetation mapping, are grouped as Ref Wet.

Coon Creek Watershed Financial Summary

Coon Creek Watershed	CCWD Rain	Ref Wet	CCWD Veg Survey	Lake Lvl	Stream Level	Rating curve	Lake WQ	Stream WQ	CCWD Hydrolab	Student Biomon	Pro Biomon	CCWD Pollutant Load	Lower Coon Cr Retro Assess*	Oak Glen Creek Assessment	Oak Glen Creek Corridor Admin	Oak Glen Creek Corridor Project Development	Oak Glen Creek Corridor TA/Engineering	Sand Cr Retro Promo*	Sandcreek Retro Install	Mississippi River Inventory	Total
Revenues																					
CCWD	4150	3850	1085	510	4400	3600	2190	14630	1330	795	7650	0	14280	0	0	0	0	5110	4480	0	68060
State	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5000	5000
Anoka Conservation District	0	0	0	0	0	0	0	0	781	0	0	287	21619	9431	1164	5894	1861	7824	0	1367	50229
County Ag Preserves	0	0	0	0	0	0	649	0	0	145	0	0	0	0	0	0	0	0	0	0	794
Regional/Local	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Service Fees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Local Water Planning	0	0	0	63	0	0	432	1902	220	0	0	0	0	0	0	0	0	0	0	0	2617
TOTAL	4150	3850	1085	573	4400	3600	3270	16532	2331	940	7650	287	35899	9431	1164	5894	1861	12934	4480	6367	126699
Expenses-																					
Capital Outlay/Equip	39	28	11	5	23	46	28	102	27	11	92	6	91	2	18	38	33	3	61	115	779
Personnel Salaries/Benefits	3343	2581	595	491	3409	2665	2059	8770	1918	745	5062	239	31409	7946	990	5108	1614	11985	2677	5584	99191
Overhead	239	205	71	39	276	204	179	718	180	60	470	29	2336	722	95	383	96	456	274	368	7400
Employee Training	6	6	1	1	12	2	3	25	3	1	11	0	193	57	1	12	2	69	1	5	413
Vehicle/Mileage	74	57	9	10	74	53	45	174	38	16	81	4	551	146	18	123	30	104	44	101	1749
Rent	138	114	30	23	176	99	86	417	86	30	233	10	1319	558	41	231	55	274	103	194	4217
Program Participants	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Program Supplies	10	19	0	3	109	0	872	6327	79	77	164	0	0	0	0	0	32	43	0	0	7736
McKay Expenses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	3850	3009	718	573	4081	3071	3270	16532	2331	940	6114	287	35899	9431	1164	5894	1861	12934	3159	6367	121486
NET	300	841	367	0	319	529	0	0	0	0	1536	0	0	0	0	0	0	0	1321	0	5214

* Financial summary for these items includes both 2011 and 2012 because revenues were received from CCWD in 2011.

Recommendations

- **Create a watershed-wide prioritized list of water quality projects to install.** Such lists have been created for each subwatershed where retrofit assessment studies have been complete, but projects should be prioritized watershed-wide.
- **Continue installing stormwater retrofits for water quality improvement.** Water quality monitoring shows most water quality problems are associated with storms; baseflow water quality is good in most locations.
- **Complete the Coon Creek Watershed Restoration and Protection Project (WRAPP),** which will include TMDL's for impaired waters and protection plans for those in good condition.
- **Develop rating curves for additional sites in the Coon Creek Watershed.** Flow estimations are needed for pollutant loading calculations.
- **Create monitoring and water quality improvement needs for Pleasure and Springbrook Creeks**, which have recently become part of the Coon Creek Watershed District. Past work on these waterbodies has been limited, but substantial problems are known.
- **Increase the usage of reference wetland data** among wetland regulatory personnel as a means for efficient, accurate wetland determinations. It is also use for analyzing long term trends in shallow water table hydrology.
- **Reduce road salt use.** Elevated chlorides are pervasive throughout shallow aquifers and the streams that feed them.
- **Continue hydrolab continuous water quality monitoring of Coon Creek.** This continuous data is useful for diagnosing pollutant magnitudes, sources, and developing management strategies.
- **Begin E. coli bacteria monitoring in streams.** 2011 data collected by the MPCA in Coon Creek at Vale Street found state water quality standards for bacteria were exceeded.