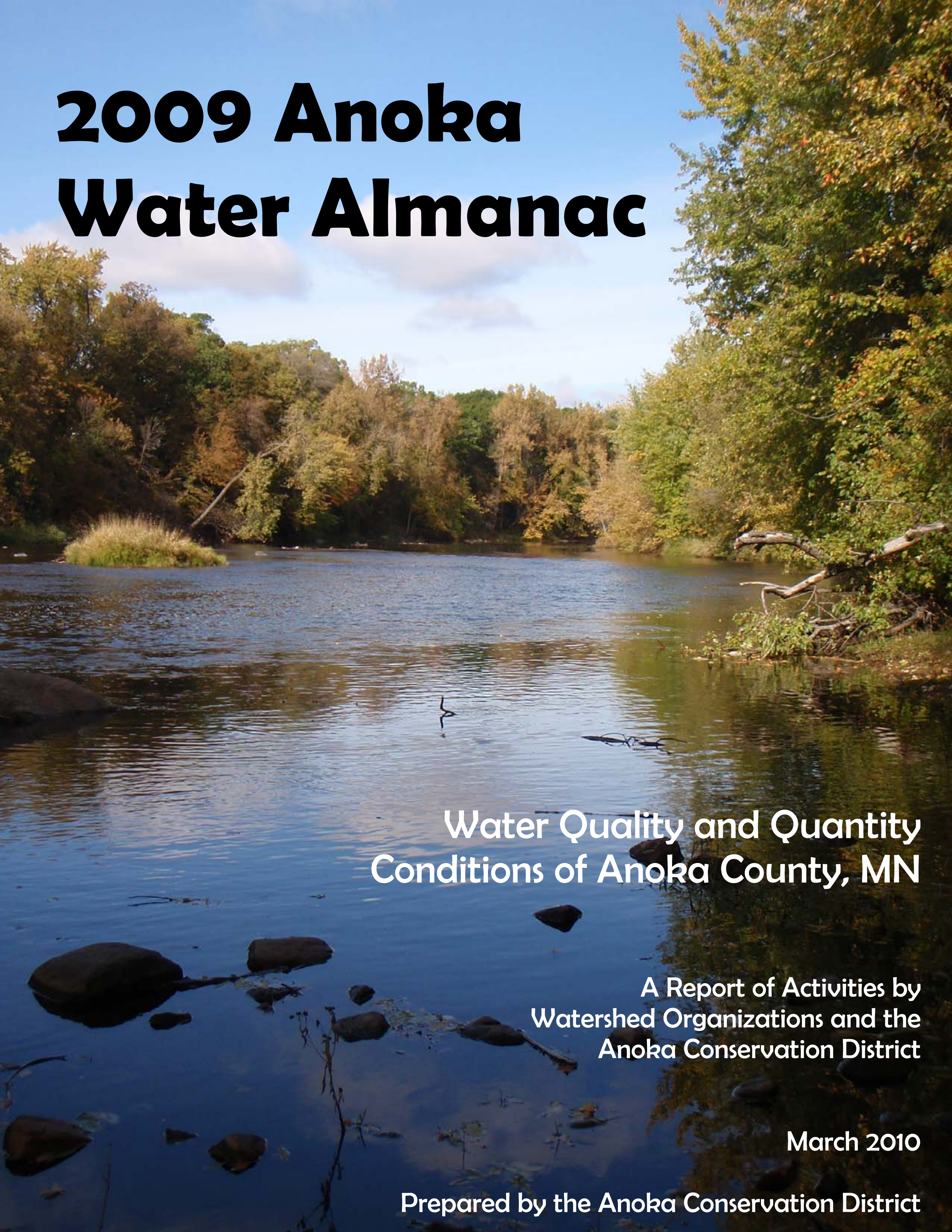

2009 Anoka Water Almanac

Water Quality and Quantity Conditions of Anoka County, MN

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

March 2010

Prepared by the Anoka Conservation District

2009 ANOKA WATER ALMANAC

Water Quality & Quantity Conditions of Anoka County, Minnesota

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

March 2010

Prepared by
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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, and groundwater. 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
  - cost share grants for erosion correction, lakeshore restorations, and rain gardens,
  - projects designed, installed, or planned, and
  - promotion of available grants for water quality improvement projects.
- Studies and analyses
  - Anoka County geologic atlas,
  - upstream to downstream water quality analyses,
  - water quality trend analyses,
  - precipitation storm analyses,
  - precipitation long term antecedent moisture analyses,
  - reference wetland vegetation inventories, and
  - reference wetland multi-year summary analyses.
- Public education efforts
  - newsletters and mailings,
  - workshops, and
  - websites.

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 2009. 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 2009 is presented in this almanac. For results of work completed in years past (for example, water quality monitoring on a particular lake) readers should refer to previous Water Almanacs. All data collected in 2009 and in years past is also available via the Data Access Tool at www.AnokaNaturalResources.com. If you are unable to locate the data you need, contact Anoka Conservation District staff for help.

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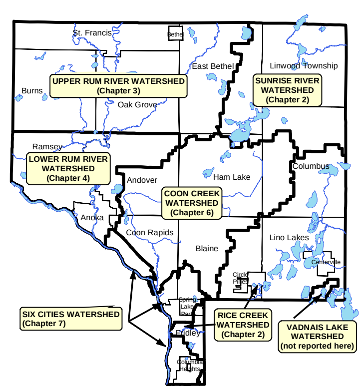
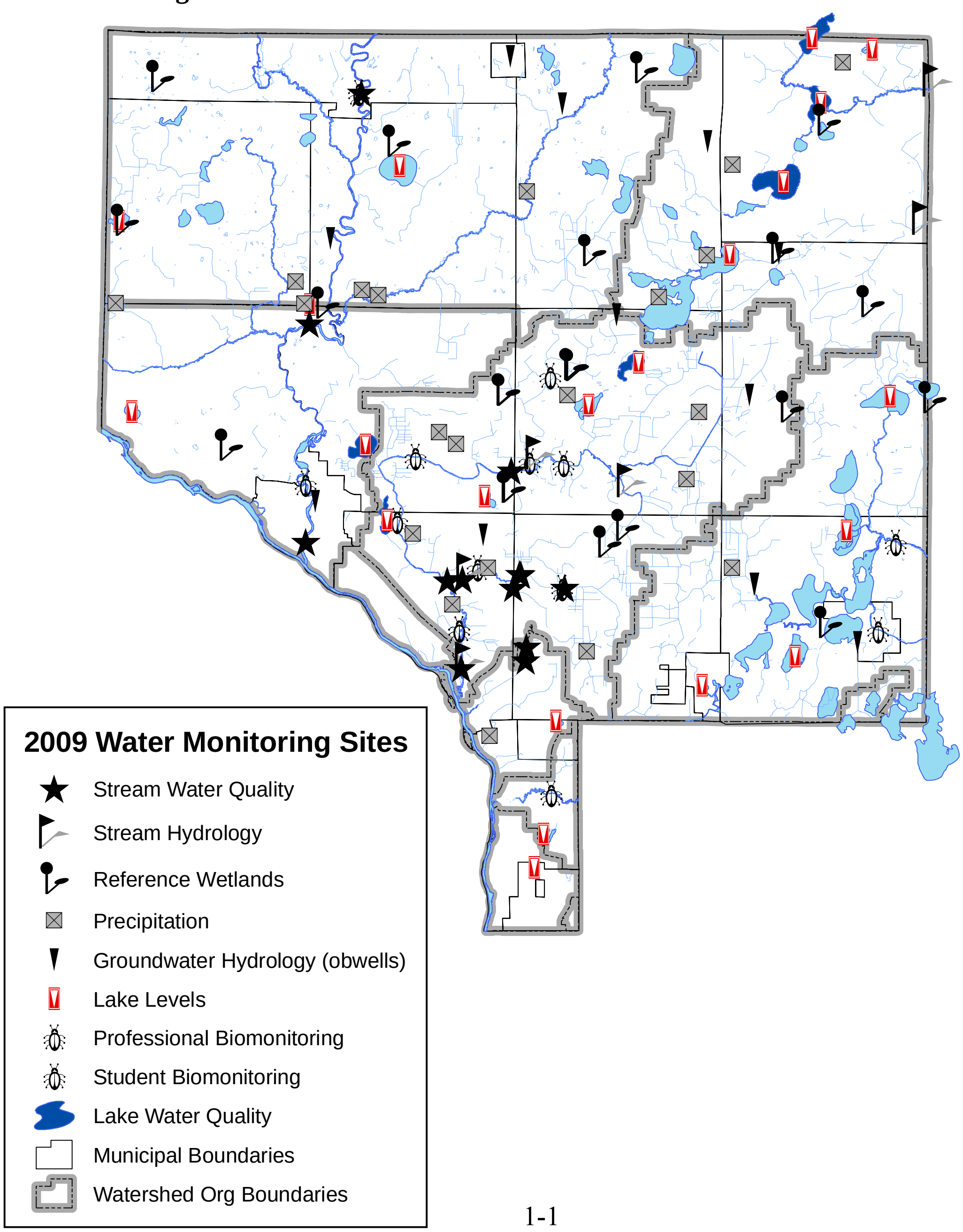


CHAPTER 1:
WATER RESOURCE MONITORING PRIMER

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 all 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 also presented in Chapter 1.

2009 Water Monitoring Sites

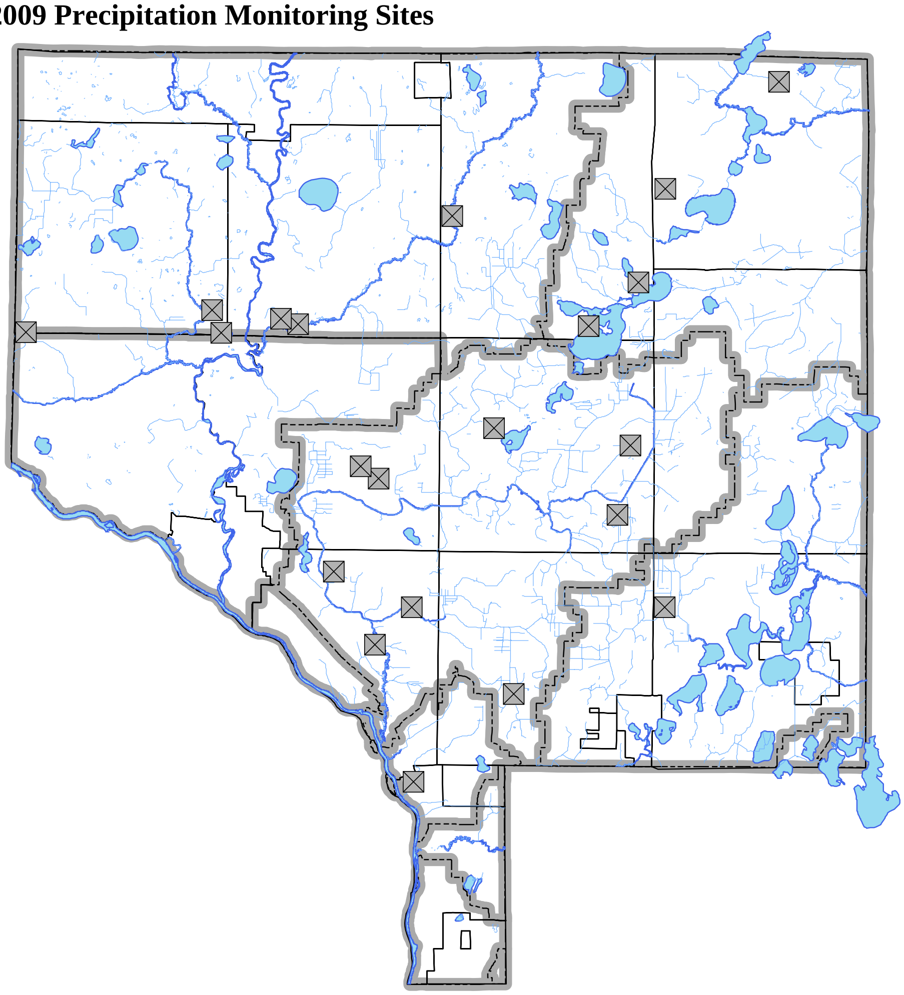


Precipitation

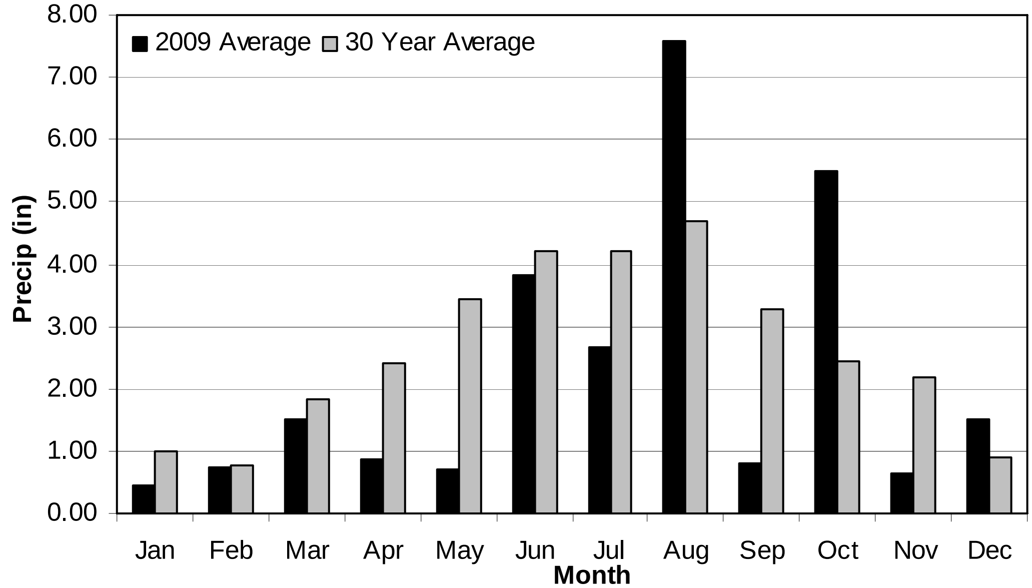
Precipitation data is useful for understanding the hydrology of water bodies, predicting flooding and groundwater limitations, and is needed to guide the use of special regulations that protect property and the environment in times of high or low water. Rainfall can vary substantially, even within one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

2009 Precipitation Monitoring Sites



2009 Anoka County Average Monthly Precipitation (average of all sites)



2009 Anoka County Monthly Precipitation at each Monitoring Site

Location or Volunteer	Location	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				0.83	0.81	4.05	2.67	7.12	0.68	5.44			21.60	15.33
Blaine Public Works	Blaine				0.29	0.14	2.00	1.19						3.62	3.33
Coon Rapids City Hall	Coon Rapids				0.91	0.45	3.68	1.93	6.29	0.55	5.44			19.25	12.90
Anoka Cons. District office	Ham Lake				0.97	0.93	4.18	3.47	9.41	1.04	6.41			26.41	19.03
Hoffman Sod Farm	Ham Lake				0.99	0.67	3.80	2.61			4.74			12.81	7.08
Northern Nat. Gas substation	Ham Lake				0.83			2.85	7.40	0.70	5.30			17.08	10.95
Cylinder rain gauges (read daily)															
N. Myhre	Andover	0.51	0.62	1.44	1.14	0.92	4.36	2.13	8.44	0.60	5.90	0.55	1.59	28.20	16.45
B. Guetzko	Nowthen	0.45	0.99	1.31	1.34	0.63	3.86		7.75		5.19	0.69	1.41	23.62	12.24
J. Rufsvold	Burns					0.29	4.25	3.21	8.78	1.05	5.58	0.74		23.90	17.58
S. Scherger	Coon Rapids				0.95	0.66	4.56	1.75	7.68	1.26	6.12			22.98	15.91
S. Solie	Coon Rapids				0.90	0.77	2.63	2.35	7.38					14.03	13.13
M. Gaynor	East Bethel			1.60	0.77	0.78	4.37	2.55	7.21	0.68				17.96	15.59
P. Arzdorf	East Bethel				1.12	0.65	4.16	2.63	7.79	0.84	5.70			22.89	16.07
A. Mercil	East Bethel	0.39	0.32	1.48	0.68	1.32	3.63	2.46	6.52	0.90	4.25	0.53	0.65	23.13	14.83
D. Hansen	Fridley				0.95	0.63	3.45	1.15	7.13	0.72	6.03	0.61		20.67	13.08
C. Ehler	Lino Lakes					0.40	4.03	3.89	7.05	0.53				15.90	15.90
B. Myers	Linwood				0.55	0.89	3.63	2.14	6.18	1.20	4.50			19.09	14.04
D. Kramer	Linwood				0.83	0.70	3.34	2.81	5.64	0.87	6.09	0.66		20.94	13.36
P. Freeman	Oak Grove	0.38	0.71	1.76	0.93	0.82	4.31	3.71	9.21	0.69	6.01	0.68		29.21	18.74
A. Dalske	Oak Grove	0.57	1.09	1.53	0.98	0.75	4.04	4.51	9.74	0.72	5.33	0.61	2.39	32.26	19.76
Y. Lyrenmann	Ramsey				0.77	0.80	4.39	3.41	7.40	0.70	5.44	0.80		23.71	16.70
2009 Average	County-wide	0.46	0.75	1.52	0.88	0.70	3.84	2.67	7.59	0.81	5.50	0.65	1.51	26.87	15.60
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

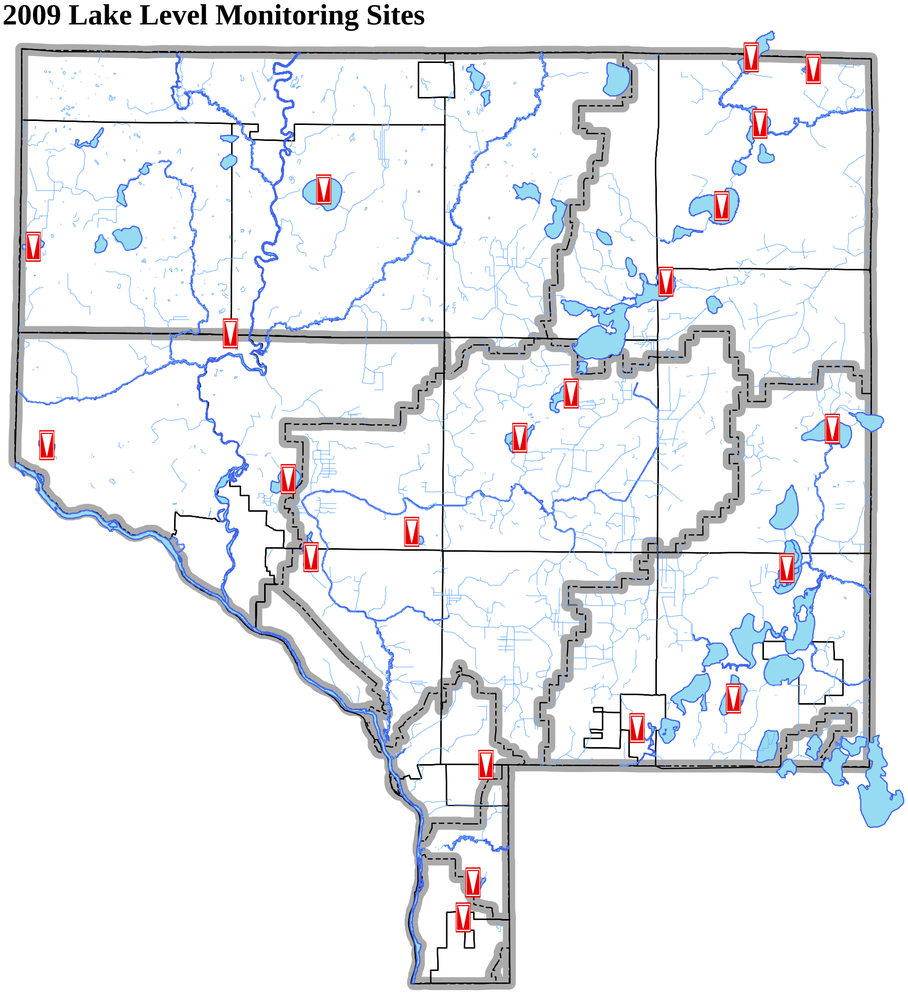
Lake Levels

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 22 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.

2009 Lake Level Monitoring Sites



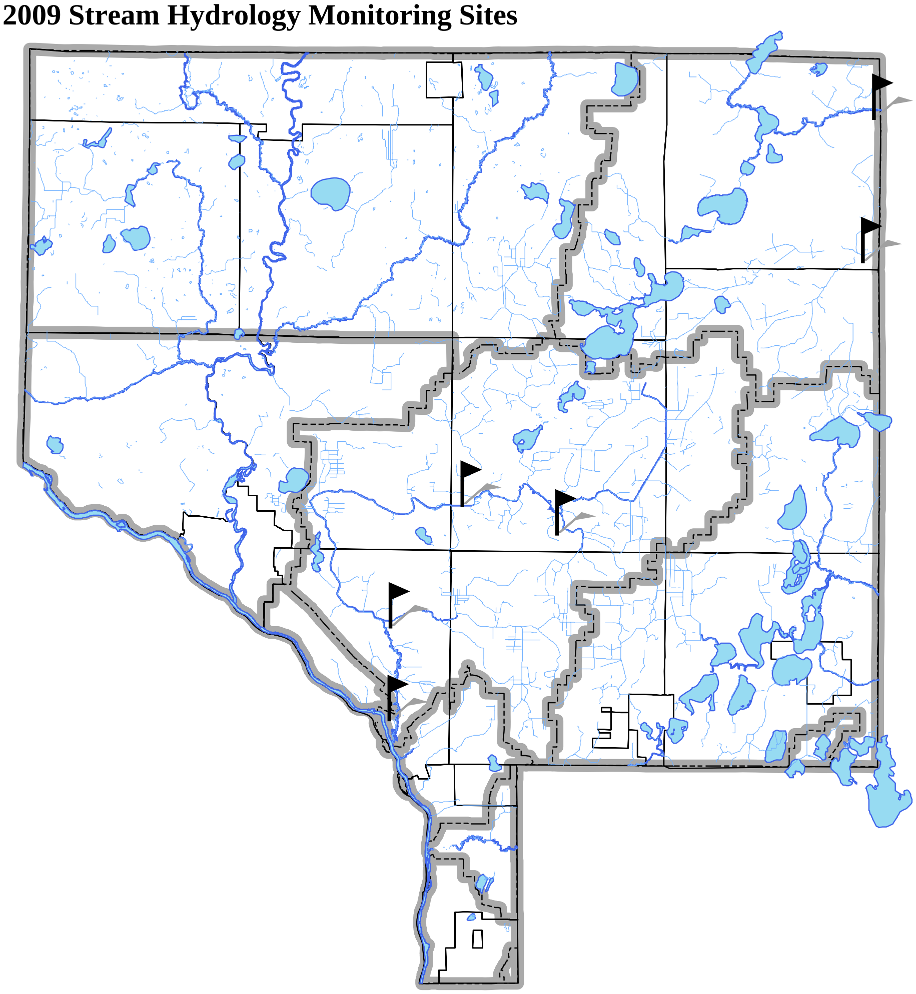
Stream Hydrology

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 6 stream sites in 2009. 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.

2009 Stream Hydrology Monitoring Sites

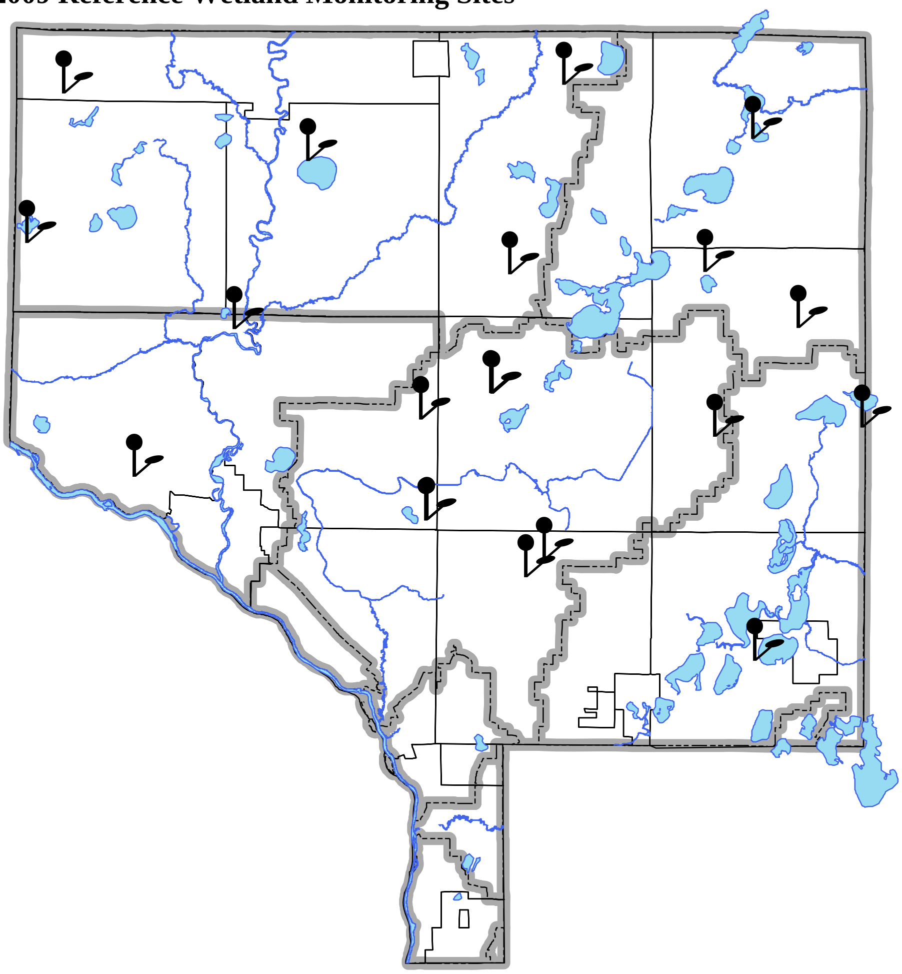


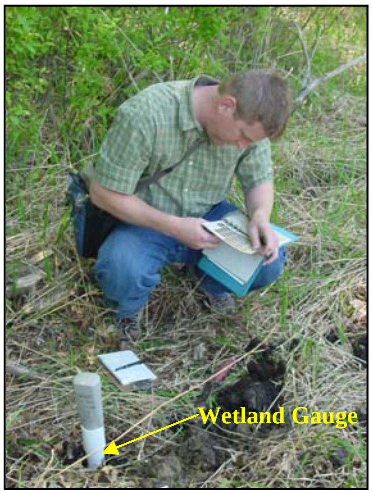
Wetland Hydrology

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 have been monitored for 10+ years.

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.

2009 Reference Wetland Monitoring Sites



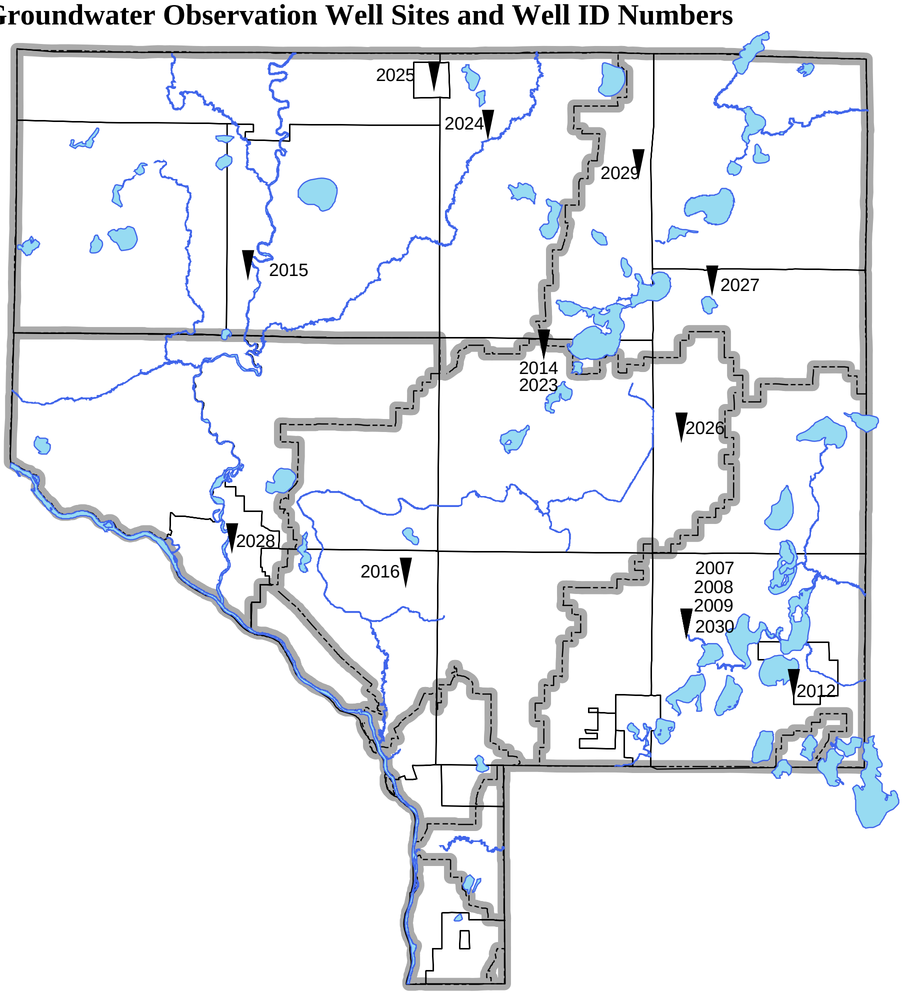


Groundwater Hydrology

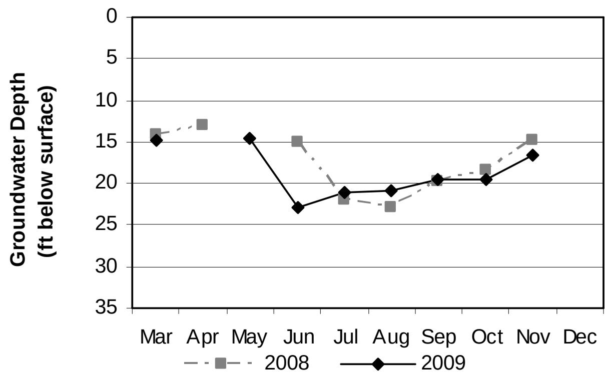
The Minnesota Department of Natural Resources (MN DNR) and ACD are interested in understanding Minnesota's groundwater quantity and flow. The MN DNR maintains a network of groundwater observation wells across the state. The ACD is contracted to take monthly water level readings at 15 wells in Anoka County from March to December. The MN DNR incorporates these data into a statewide database that aids in groundwater mapping. The data are reported by the MN DNR on their web site www.dnr.state.mn.us/waters/programs/gw_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 2008-2009. These results are not presented elsewhere in this report. Raw data can be downloaded from the MN DNR website.

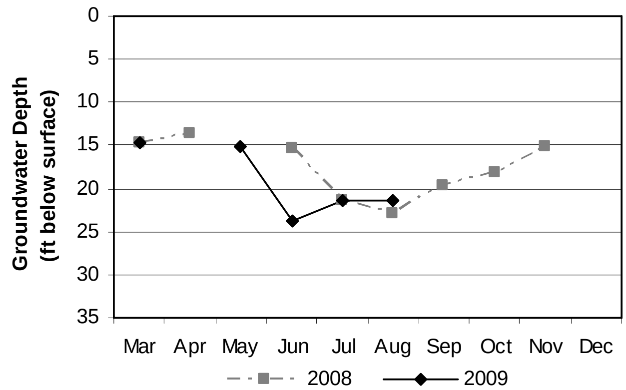
Groundwater Observation Well Sites and Well ID Numbers



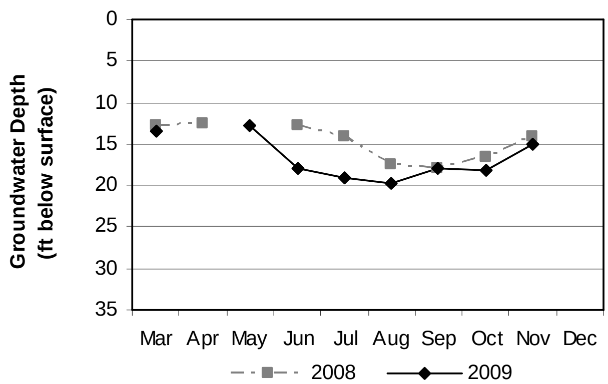
Observation Well #2007 (270 ft deep)—Lino Lakes



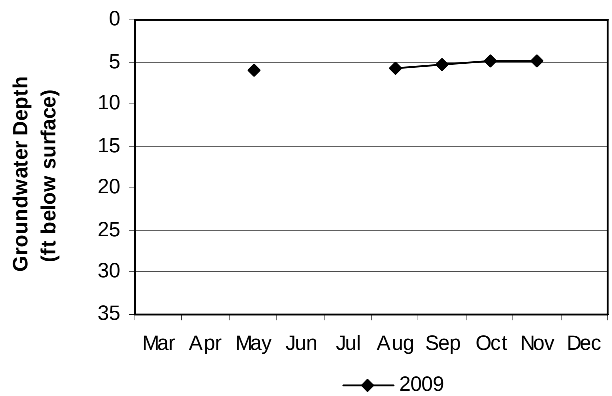
Observation Well #2008 (214 ft deep)—Lino Lakes



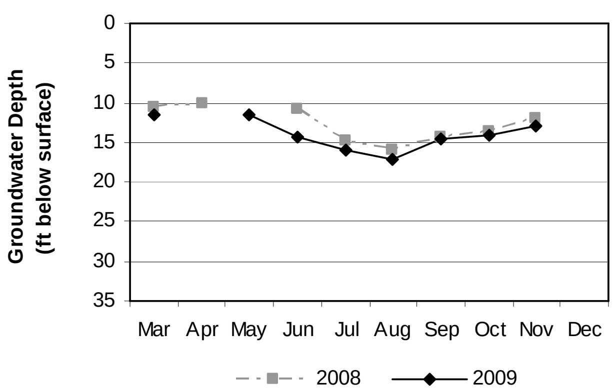
Observation Well #2009 (125 ft deep)—Lino lakes



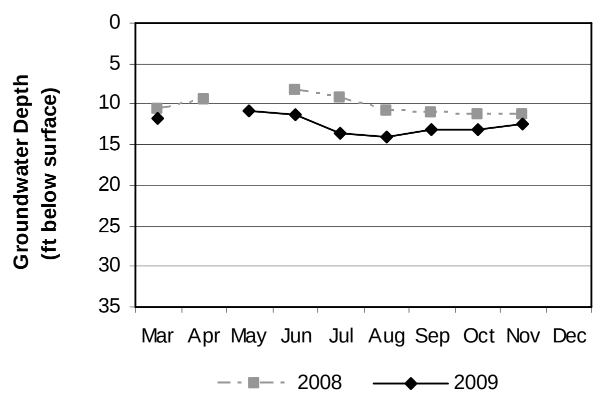
Observation Well #2030 (15 ft deep)—Lino Lakes



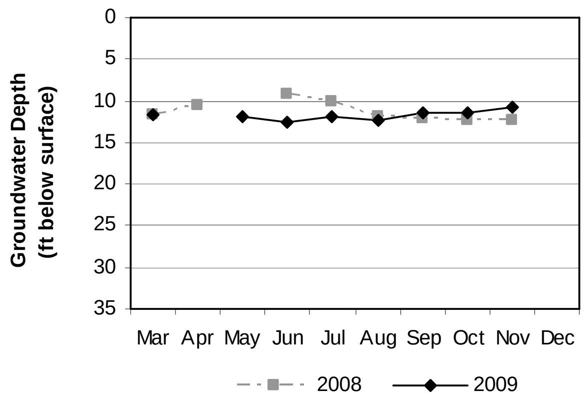
Observation Well #2012 (277 ft deep) – Centerville



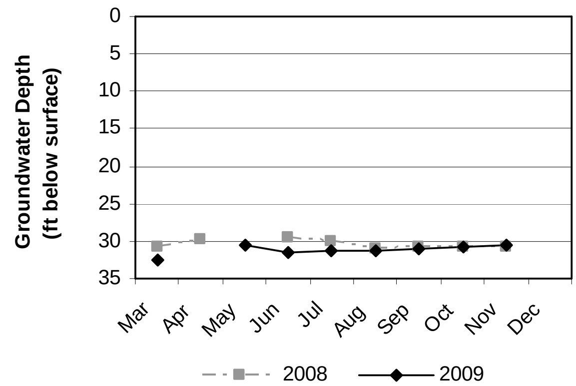
Observation Well #2023 (21 ft deep) – Ham Lake



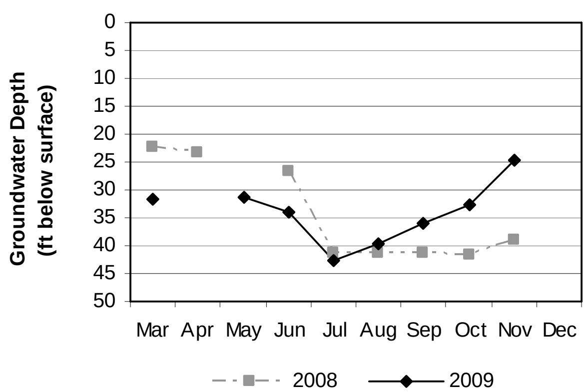
Observation Well #2014 (21 ft deep)—Ham Lake



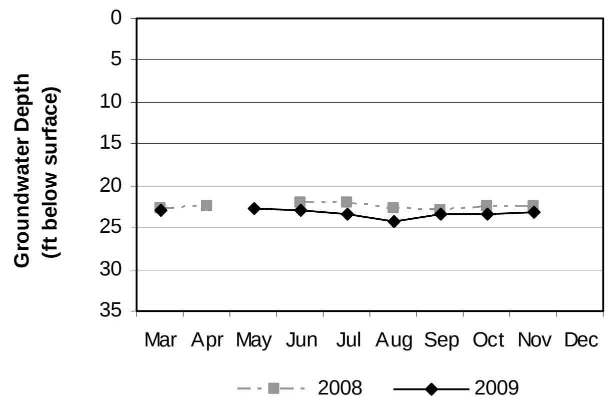
Observation Well #2015 (280 ft deep)—Ramsey



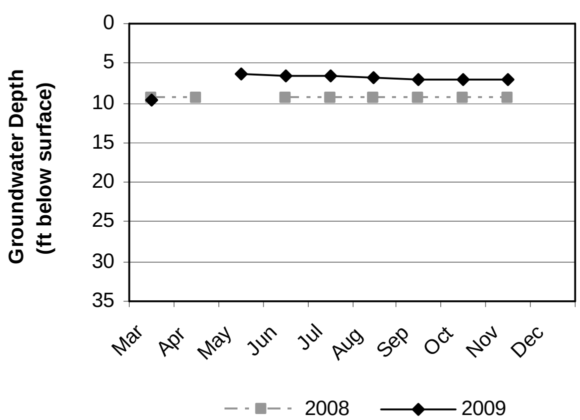
Observation Well #2016 (193 ft deep)—Coon Rapids



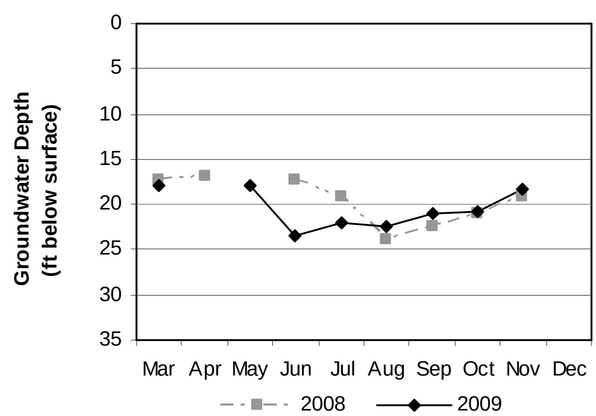
Observation Well #2024 (141 ft deep)—East Bethel



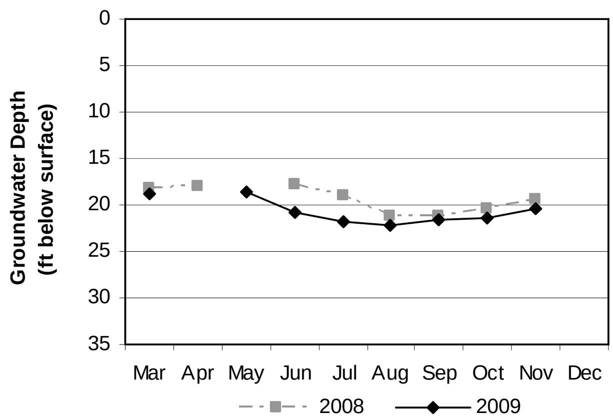
Observation Well #2025 (21 ft deep)—Bethel



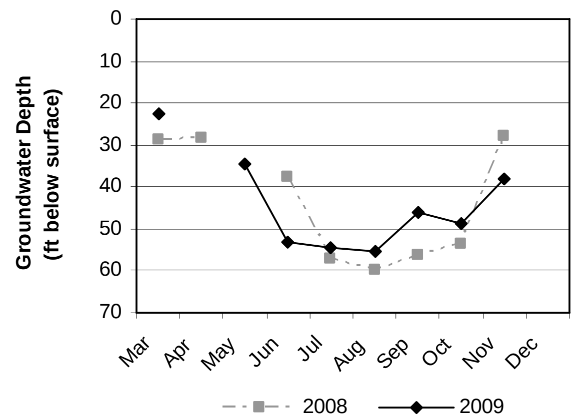
Observation Well #2026 (150 ft deep)—Carlos Avery #4



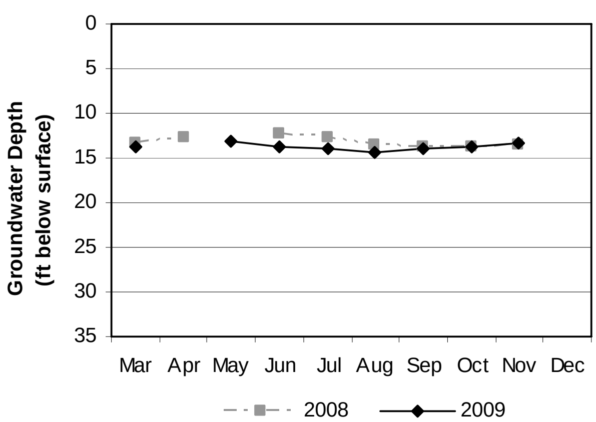
Observation Well #2027 (333 ft deep)—Columbus Twp.



Observation Well #2028 (510 ft deep)—Anoka



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

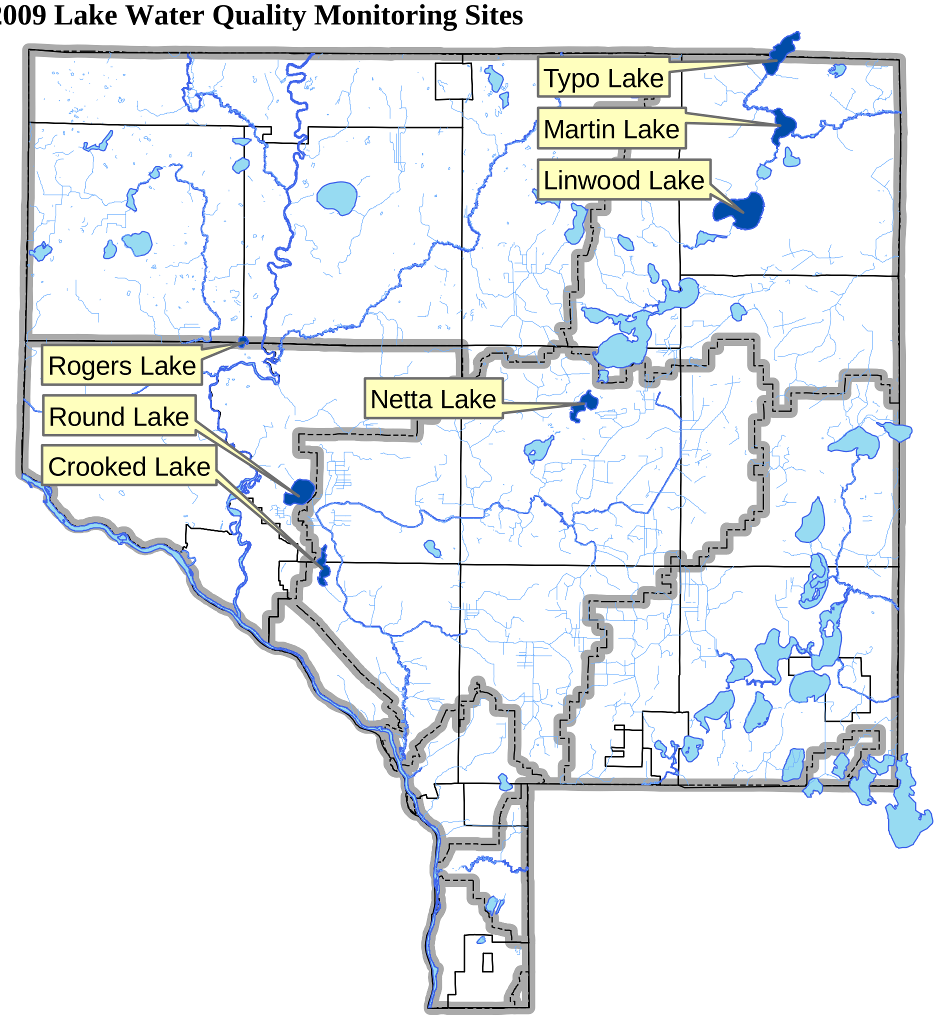


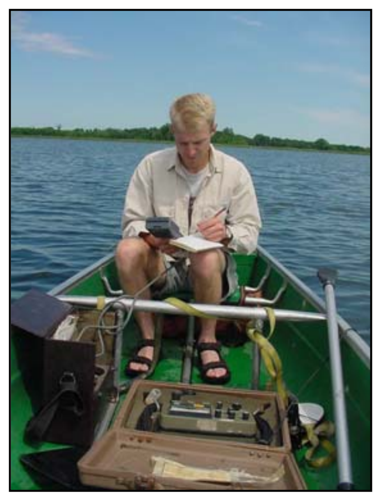
Lake Water Quality

Lake water quality monitoring in Anoka County began in the 1980's and was conducted primarily by the Metropolitan Council, Minnesota Pollution Control Agency (MPCA), and volunteer programs. The Anoka Conservation District (ACD) began a lake monitoring program in 1997 aimed at lakes that were not previously monitored. The purpose of these programs is to detect and diagnose water quality problems that may affect the suitability of lakes for recreation and that may adversely affect people or wildlife. The monitoring regime is designed to ensure all 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 website www.AnokaNaturalResources.com or the summary table on page 17. Otherwise, try the MPCA website.

2009 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. Conductivity, pH, turbidity, DO, 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.

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, STORET, 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 pH 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 submerged plants in the lake creating oxygen through photosynthesis. During the winter, ice can restrict the supply of oxygen to the lake (limited aeration and dark conditions under snow-covered ice limiting photosynthesis). Dissolved oxygen is consumed by organisms in the lake and by the 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- A Secchi disk is a device used to measure transparency or clarity of the lake. 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 0.1-foot intervals. The disk is lowered over the shaded side of the boat until it disappears and then pulled up to the point where it reappears again. The midpoint between these two points is the Secchi disk measurement. Shallow measurements typically indicate abundant algae and/or suspended solids.

Total Phosphorus (TP) - Phosphorus is an essential nutrient. Algal growth is normally limited by low phosphorous supplies. However, phosphorous inputs can rapidly stimulate growth of algae. A single pound of phosphorus can result in 500 pounds of algal growth. Large amounts of algae reduce water clarity, deplete dissolved oxygen levels when the algae decays, and degrade aesthetics for recreation. Minnesota Pollution Control Agency standards designate a lake in our ecoregion as "impaired" if average summertime phosphorus is >40 µg/L (or 60 ug/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 total 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 above (pg. 13) 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 adjacent table). 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.

Trophic state indices are calculated monthly. At the conclusion of the 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. least amount 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.

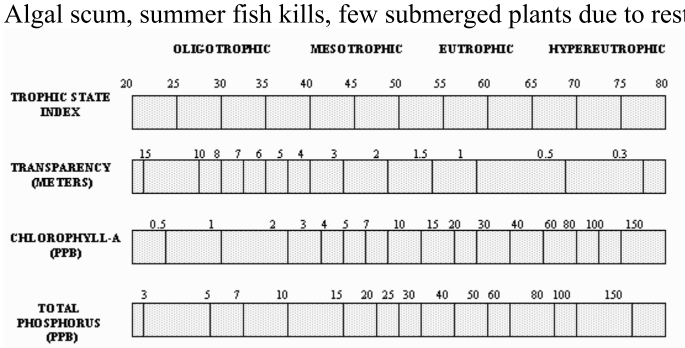
3. Eutrophic- In these lakes, the water is nutrient-rich. Productivity is high for both plants and fish. Abundant plant life, especially algae, results in poorer water clarity and can reduce the dissolved oxygen content when it decays. Algae blooms in the "dog days of summer" are commonplace. Bass and 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 ug/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, noticeable and excessive plant and 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 impaired due to ice over, which may lead to a winter 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 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 see 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)

Year→	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cenaiko																		B	A	A	A	B	A	A	A	A	A	A	B	
Centerville	D	C		C					D												C	C		C	C	A				
Coon	C				C					C					C			C	B	A	B	C	B		C		C		C	
Crooked				C		C				C					B	C	B	B	B		B		B	B		B	B		B	B
E. Twin	A	B		C						B						B		A	B	A	A		A			A			A	
Fawn									B									A	B	A	A	A	A		A		A		A	
George	A	A	A		A					A					B			A	B	A	A		A			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	
Golden	D					D	C	D	F	F	F	F		D			C	D	C	C	C	D	D	D	D	C	C	C	C	
Ham					C									A	B		A	A	B		C	C	B		B	B		B	A	
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	
Itasca																			A	B	B									
Laddie	D													B	B	B			C	B	B	B	B	B	B	B			B	
Linwood	B	C		C						C					C			C	C	C	C	C		C		C		C	C	C
Lochness																												A	B	
Martin				D														D	D	C	D	D		D		D		D	D	D
E. Moore	C	C	C	C	C	B	C	C							C				C	B	B	C	C	C		C				
W. Moore	C	C	F	C	B	C	F	C												B	B	C	C	C		C				
Mud														B						B	C									
Netta																		B	C	A		B		A	A		B	B		B
Peltier				D										D	F	D	D	D	D	D	D	F	F	D	D	D	F	D		
Pickerel	C															B		A	A	B	C									
Reshanau																											D	D	D	
Rogers																			C		C			B			D		B	B
Round																			B	A	B			A		B		C		C
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

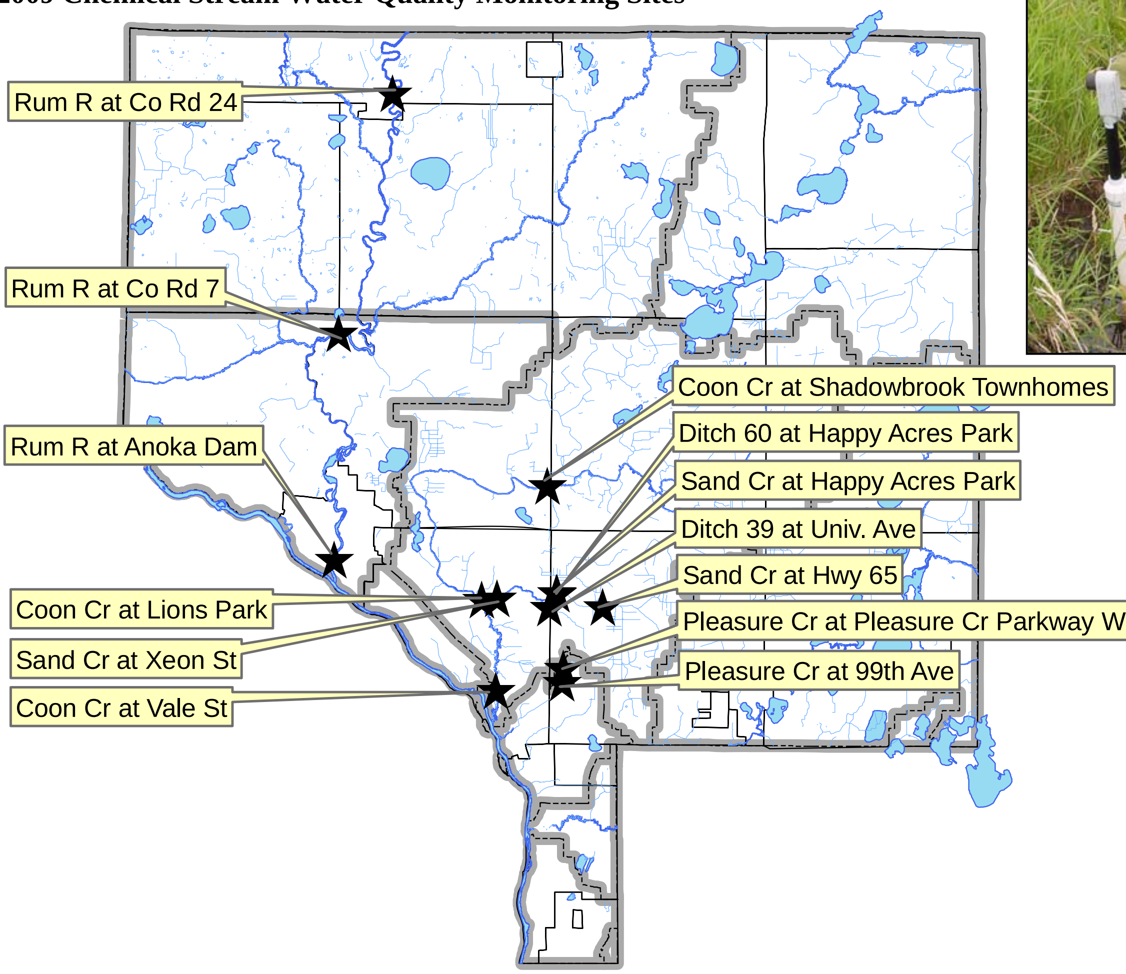
Stream Water Quality – Chemical Monitoring

Stream water quality monitoring is conducted to detect and diagnose water quality problems impacting the ecological integrity of waterways or impacting 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 2009 was conducted at three sites on the Rum River, two sites on Pleasure Creek, eight on the Coon Creek and Sand Creek drainage. 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.

2009 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;
- Total Suspended Solids;
- others for some special investigations.

DO was measured in the field using a YSI® DO 200 dissolved oxygen and temperature probe. Likewise, 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, and any other chemical 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. 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 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 from algae decay which impacts fish populations, and degrade aesthetics for recreation. Ideally, total phosphorus should be below 40 µg/L in lakes and 130 ug/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.

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

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

A- We make two comparisons: first, with published water quality values for the ecoregion and second, with other streams monitored by the ACD. 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.

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 used to conduct in-stream monitoring was 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	7.53
Conductivity	mS/cm	.389	.298	0.318
Turbidity	FNRU		7.1	9
Dissolved Oxygen	mg/L	-	-	7.14
Temperature	°F		71.6	
Salinity	%		0	0.01
Total Phosphorus	µg/L	220	130	126
Total Suspended Solids	mg/L		13.7	14
Chloride	mg/L		8	12

[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, such as midges, 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 2009 there were approximately 541 students from seven high schools who monitored seven sites. Since 2000 approximately 3,746 students have participated. The experience affords students an opportunity to learn scientific methodologies and become involved in local natural resource management.

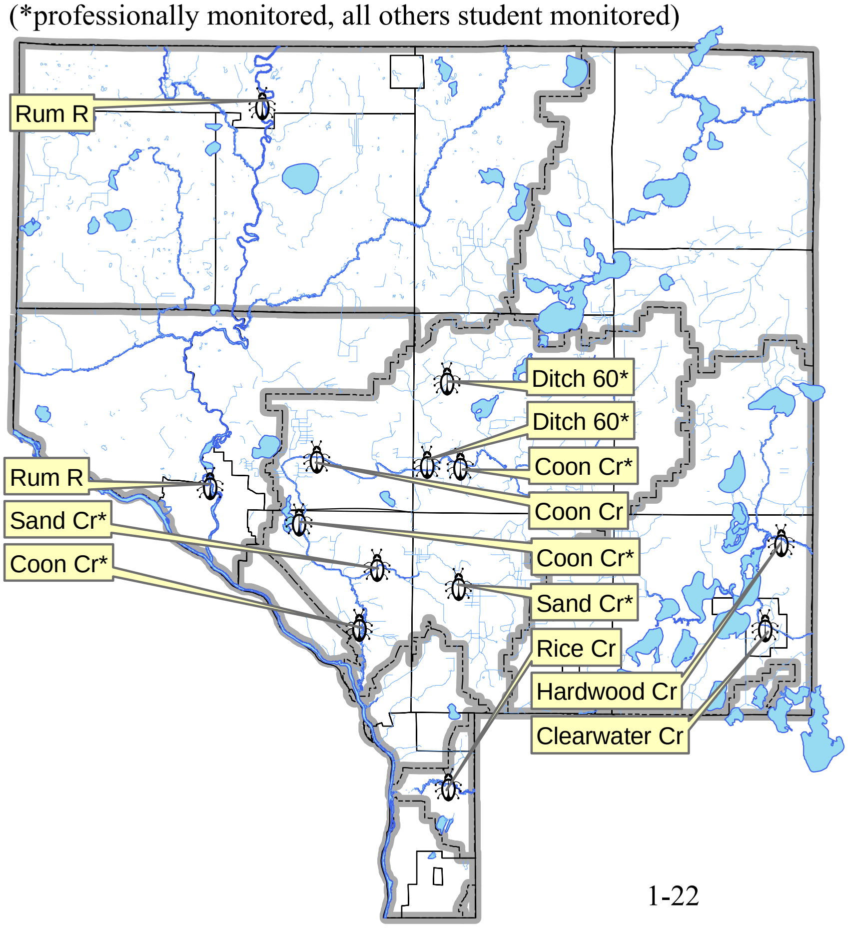
In 2009 seven sites were monitored by professionals without student involvement. These sites were all within the Coon Creek drainage. The purpose was to examine sites listed by the MCPA as "impaired" for biota based on a single sample and to compare the biotic community in ditched and unditched stream reaches.

The Anoka County biomonitoring program is part of a metro-wide program coordinated by the Volunteer Stream Monitoring Partnership (VSMP; see website www.vsmp.org) based at the University of Minnesota, St. Paul campus. This program ensures consistent methodologies are employed throughout the region and provides a central location for data storage and analysis.

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

2009 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 100 individual macroinvertebrates must be captured for a representative sample. 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 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 diversity 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 2009, 13 sites were monitored for benthic macroinvertebrates. High school classes, with ACD staff supervision, sampled six of these sites.

2009 Biomonitoring Sites and Groups who Monitored the Site

Monitoring Group	Stream
Andover HS	Coon Creek
Anoka HS	Rum River (near Anoka)
Blaine HS	Coon Creek at Egret Blvd
Centennial HS	Clearwater Creek
Forest Lake Area Learning Center	Hardwood Creek
St. Francis HS	Rum River (St. Francis)
Totino Grace HS	Rice Creek
ACD	Coon Creek at 131st Ave
ACD	Coon Creek at Egret Blvd
ACD	Coon Creek at Hwy 65
ACD	Ditch 41 at Ulysses St
ACD	Ditch 58 at 165th Ave
ACD	Sand Creek at Olive St

CHAPTER 2:
SUNRISE RIVER WATERSHED

Task	Partners	Page
Lake Levels	SRWMO, ACD, volunteers	2-26
Lake Water Quality	SRWMO, ACD, ACAP	2-28
Stream Hydrology	SRWMO, ACD	2-35
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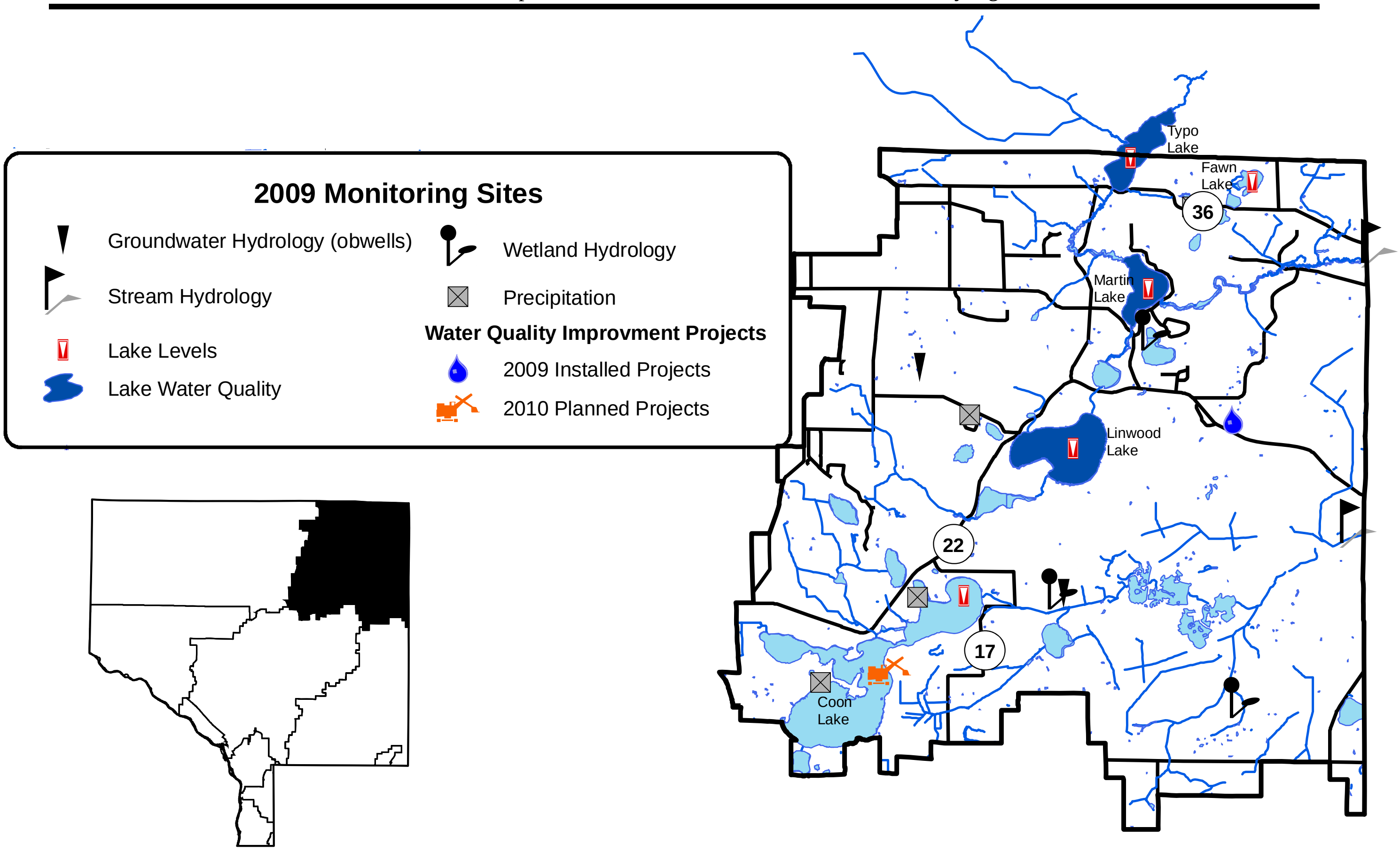
Water Quality Improvement Projects	SRWMO, ACD, landowner	2-42
Anoka County Geologic Atlas	All Anoka Co. watershed organizations, ACD, MN Geologic Survey, MN DNR	2-45
SRWMO Website	SRWMO, ACD	2-47
SRWMO 2008 Annual Report to BWSR	SRWMO, ACD	2-49
SRWMO 3rd Generation Watershed Plan	SRWMO, ACD	2-50
Financial Summary		2-51
Recommendations		2-51
Groundwater Hydrology (obwells)	ACD, MNDNR	See Chapter 1
Precipitation	ACD, volunteers	See Chapter 1

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).

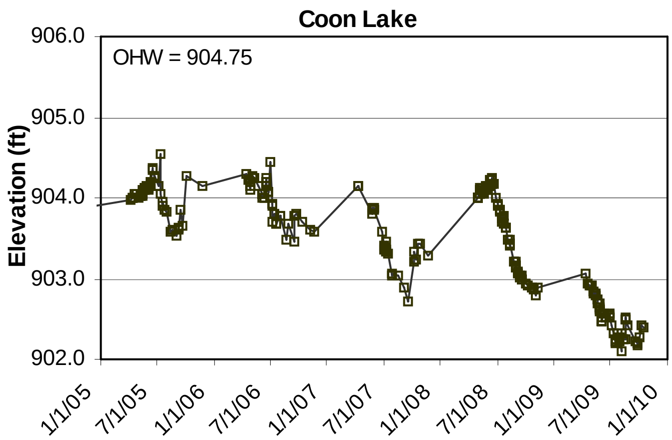
Purpose: To understand lake hydrology, including the impact of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

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

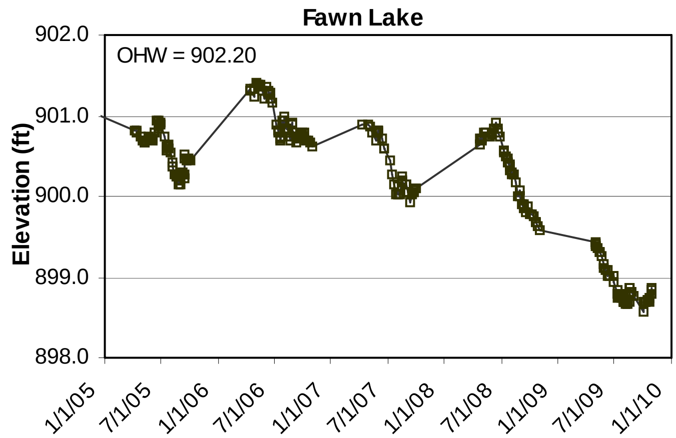
Results: Lake levels were measured by volunteers 21 to 47 times, depending upon the lake. Water levels at all lakes were low due to drought conditions in 2009, as well as below normal precipitation in the previous two years. In 2009 Coon and Fawn Lakes had continuously falling water levels until late summer when more substantial rainfall fell and lake levels were sustained. Both lakes fell nearly 1 foot during 2009. Martin, Typo, and Linwood Lakes dropped little and maintained low water levels throughout most of the summer. They rose in late summer in response to rainfall, but total increases were less than 0.5 foot.

All lake level data can be downloaded from the Minnesota DNR website using the "LakeFinder" tool. Only the last five years are shown in the graphs on the following page. Ordinary High Water Levels (OHW), the elevation below which a DNR permit is needed to perform work, are listed for each lake on the graph.

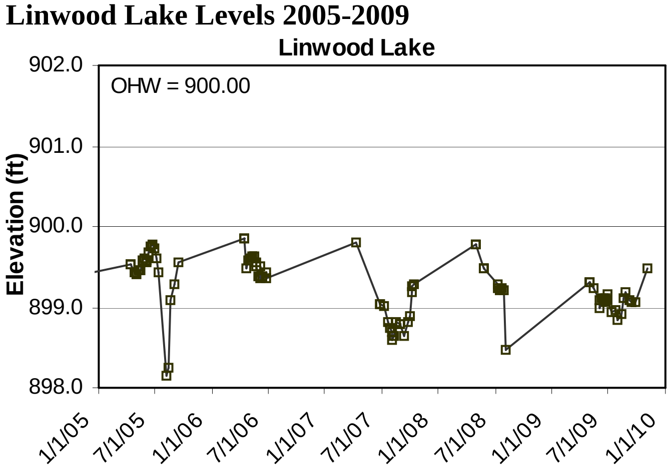
Coon Lake Levels 2005-2009



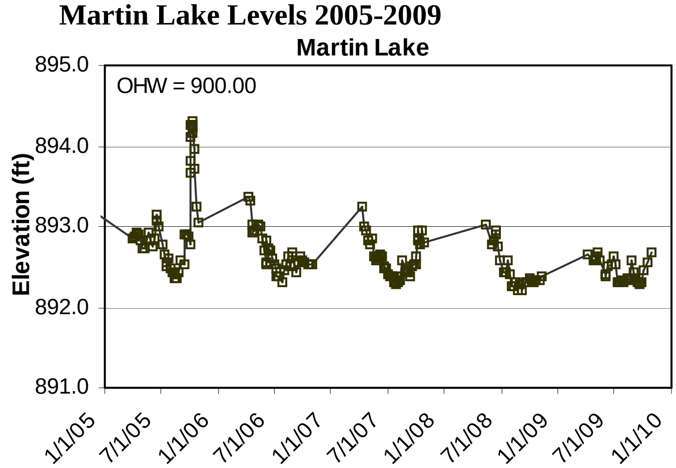
Fawn Lake Levels 2005-2009



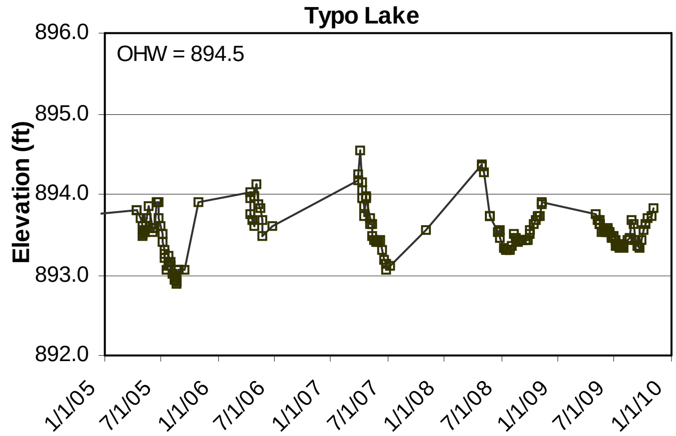
Linwood Lake Levels 2005-2009



Martin Lake Levels 2005-2009



Typo Lake Levels 2005-2009



Sunrise River Watershed Lake Levels Summary

Lake	Year	Average	Min	Max
Coon	2005	904.03	903.54	904.54
	2006	903.96	903.45	904.45
	2007	903.42	902.72	904.16
	2008	903.68	902.80	904.25
	2009	902.51	902.11	903.05
Fawn	2005	900.57	900.14	900.94
	2006	900.94	900.62	901.40
	2007	900.37	899.92	900.90
	2008	900.32	899.59	900.91
	2009	898.89	898.56	899.42
Linwood	2005	899.40	898.15	899.79
	2006	incomplete data		
	2007	898.94	898.60	899.81
	2008	incomplete data		
	2009	899.10	898.84	899.49
Martin	2005	893.03	892.35	894.31
	2006	892.67	892.32	893.36
	2007	892.61	892.28	893.25
	2008	892.48	892.21	893.02
	2009	892.47	892.28	892.68
Typo	2005	893.40	892.90	893.90
	2006	incomplete data		
	2007	893.67	893.06	894.54
	2008	893.62	893.32	894.38
	2009	893.52	893.33	893.82

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.

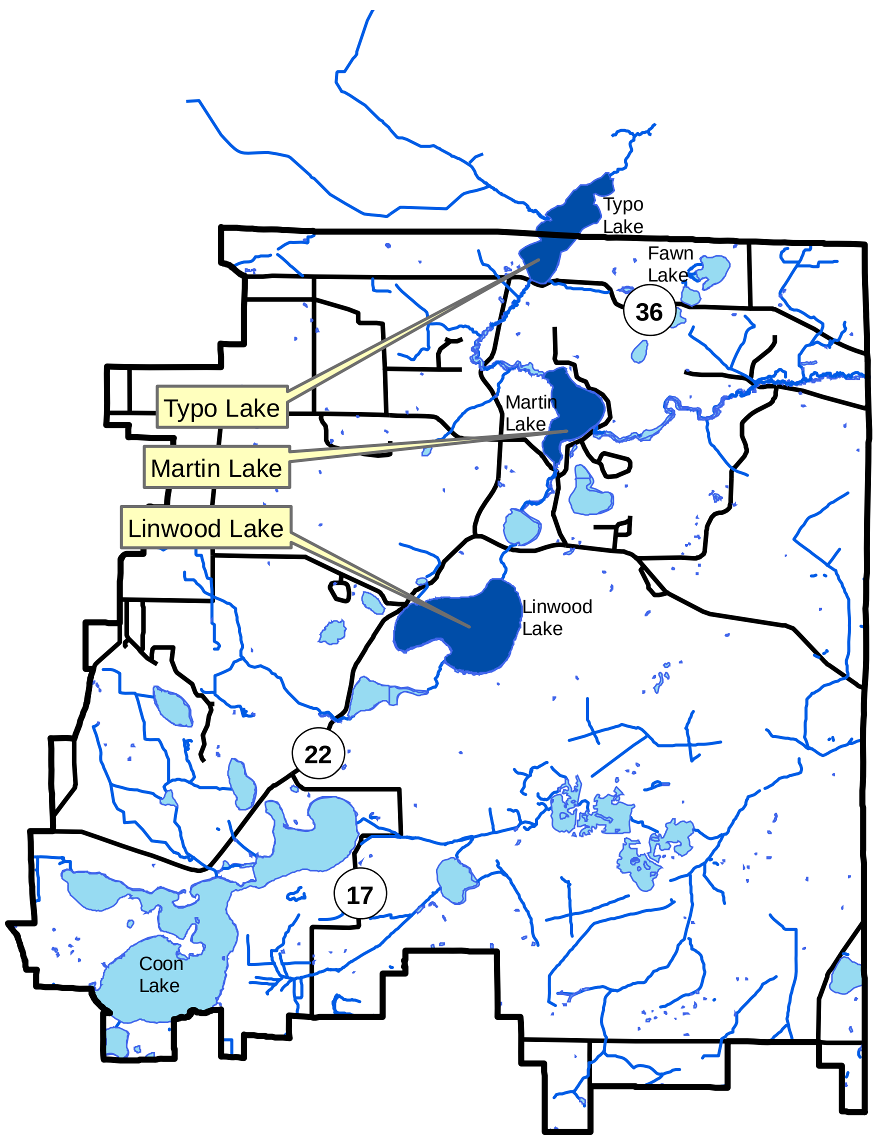
Locations: Linwood Lake

Martin Lake

Typo 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



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.

2009 Results

In 2009 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 2009 total phosphorus averaged 49 ug/L, chlorophyll-a averaged 20.7 ug/L, and Secchi transparency averaged 0.9 m. This is on the poor end of the range observed in other years; only one previous year had higher total phosphorus and three years had poorer transparency. However chlorophyll-a was in the middle of the range observed in other years. ACD staff's subjective observations of the lake's physical characteristics were that there was only "some algae" in mid-May but "definite" or "high" algae the remainder of the summer. After mid-May ACD staff subjectively ranked the lake as having some impairment of swimming.

Trend Analysis

Fifteen 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). Water quality has not significantly changed from 1980 to 2009 (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth; $F_{2,12}=1.35$, $p=0.30$).

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 ug/L for deep lakes. The state has since added separate standards for shallow lakes. Linwood likely meets the definition of a shallow lake – maximum depth of <15 ft or >80% of the lake shallow enough to support aquatic plants (generally <15 ft). The water quality standard for shallow lakes in this ecoregion is total phosphorus <60 ug/L, chlorophyll-a <20 ug/L, and Secchi transparency >1m. In the last 10 years Linwood has been substantially lower than the phosphorus standard, but it has occasionally exceeded the other two standards. Regardless, water quality improvement is needed.

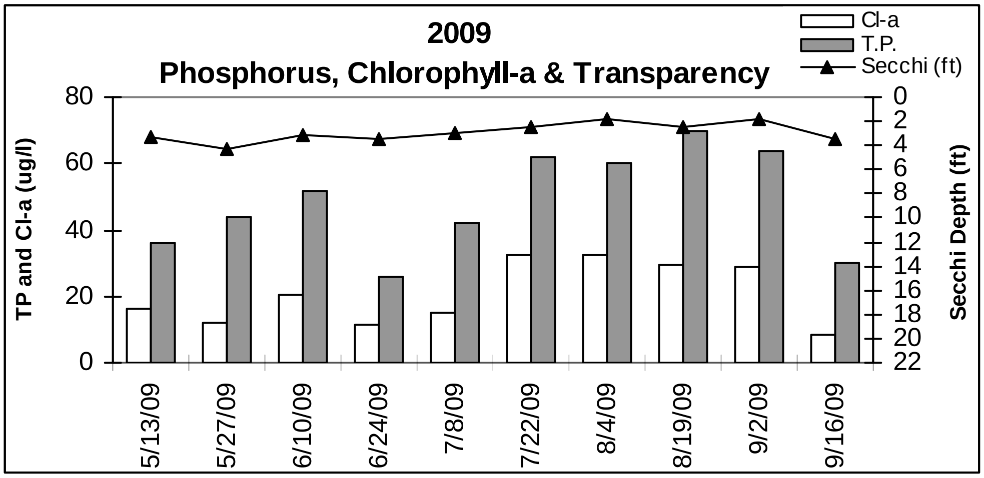
It is likely that major factors degrading water quality originate from the lake itself and/or its developed shoreline. The primary inlet to Linwood Lake comes from Boot Lake, a scientific and natural area, and it likely has good water quality. Threats to this lake may include rough fish, failing shoreland 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.

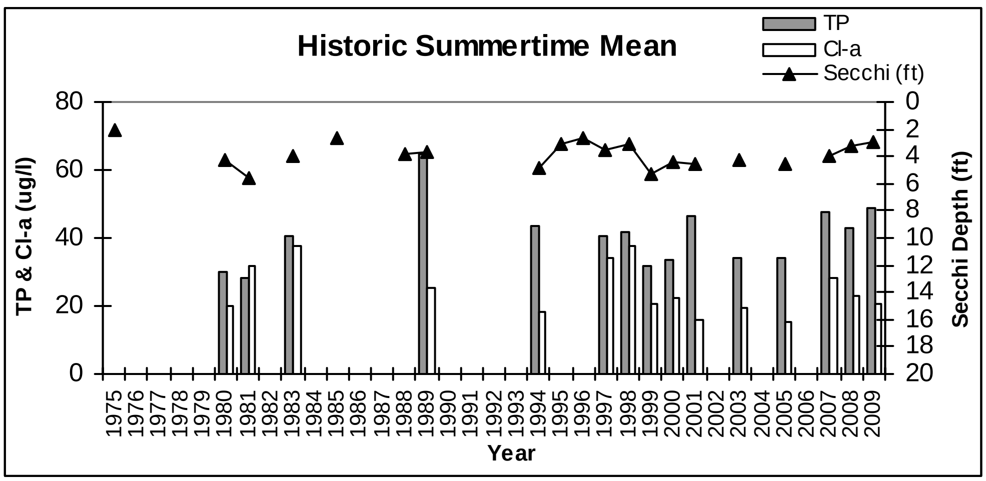
2009 Linwood Lake Water Quality Data

Linwood Lake 2009		Date	5/13/2009	5/27/2009	6/10/2009	6/24/2009	7/8/2009	7/22/2009	8/4/2009	8/19/2009	9/2/2009	9/16/2009			
		Time	12:40	11:50	11:35	11:45	11:45	12:15	11:50	11:05	12:00	10:30			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	7.91	8.00	8.24	8.44	8.28	8.09	8.28	7.75	8.62	8.69	8.23	7.75	8.69
Conductivity	mS/cm	0.01	0.280	0.306	0.282	0.263	0.266	0.276	0.249	0.265	0.254	0.239	0.268	0.239	0.306
Turbidity	FNRU	1	14	13	14	15	20	17	24	22	30	14	18	13	30
D.O.	mg/l	0.01	11.30	9.00	10.60	10.79	9.21	11.16	9.67	5.70	9.22	9.76	9.64	5.70	11.30
D.O.	%	1	110%	95%	109%	132%	110%	127%	111%	66%	102%	114%	108%	66%	132%
Temp.	°C	0.1	15.5	17.9	16.8	25.9	24.5	21.2	22.6	22.7	20.6	23.2	21.1	15.5	25.9
Temp.	°F	0.1	59.9	64.2	62.2	78.6	76.1	70.2	72.7	72.9	69.1	73.8	70.0	59.9	78.6
Salinity	%	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.01
Cl-a	ug/l	1	16.2	12.1	20.4	11.7	15.1	32.5	32.5	29.2	28.9	8.4	20.7	8.4	32.5
T.P.	mg/l	0.005	0.036	0.044	0.052	0.026	0.042	0.062	0.060	0.070	0.064	0.030	0.049	0.026	0.070
T.P.	ug/l	5	36	44	52	26	42	62	60	70	64	30	49	26	70
Secchi	ft	0.10	3.30	4.30	3.10	3.50	3.00	2.40	1.75	2.40	1.80	3.50	2.91	1.75	4.30
Secchi	m	0.1	1.0	1.3	0.9	1.1	0.9	0.7	0.5	0.7	0.5	1.1	0.9	0.5	1.3
Field Observations															
Physical			2.0	3.0	4.0	4.0	3.0	3.0	4.0	3.0	4.0	3.0	3.3	2.0	4.0
Recreational			1.0	3.0	3.0	3.0	3.0	3.0	4.0	3.0	4.0	3.0	3.0	1.0	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
	1975	1980	1981	1983	1985	1988	1989	1994	1995	1996	1997	1998	1999	2000	2001	2003	2005	2007	2008	2009
TP (ug/L)		30.0	28.5	40.7			64.8	43.3			40.6	41.8	31.6	33.4	46.6	34.2	34.0	47.4	42.8	49.0
Cl-a (ug/L)		20.0	32.0	37.9			25.1	18.3			34.4	37.8	20.4	22.4	16.1	19.4	15.3	28.3	23.1	20.7
Secchi (m)	0.64	1.30	1.70	1.20	0.82	1.17	1.12	1.45	0.96	0.82	1.06	0.85	1.62	1.57	1.39	1.32	1.4	1.2	1	0.9
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	5.3	4.4	4.6	4.3	4.6	3.9	3.3	2.9

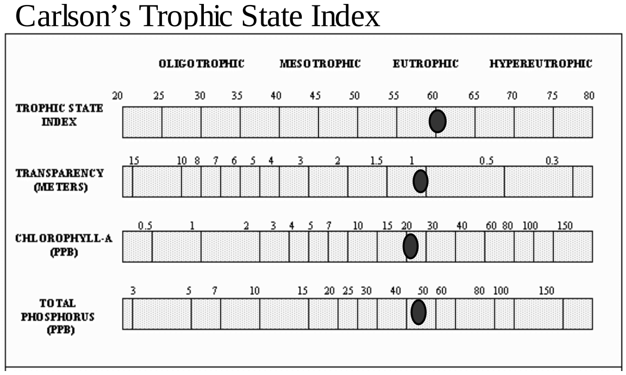
Carlson's Tropic State Indices

TSIP		53	52	58			64	58			58	58	54	54	59	55	55	60	58	60
TSIC		60	65	66			62	59			65	66	60	61	57	60	57	63	62	60
TSIS	66	56	52	57	63	58	58	55	61	63	59	62	53	55	56	56	55	57	60	62
TSI		57	57	60			62	57			61	62	56	57	57	57	56	60	60	61

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
TP		A	B	C			B	A			C	C	A	A	C	C	C	C	C	C
Cl-a		A	A	A			A	A			A	A	A	A	B	B	B	C	C	C+
Secchi	F	A	A	A	D	D	A	A	D	D	A	A	A	A	C	C	C	C-	D	D
Overall		**B**	**C**	**C**			**C**	**C**			**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**

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.

2009 Results

In 2009 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. 2009 had some of the worst water quality of all monitored years. Average total phosphorus (106 ug/L) was the second highest of 11 years that it has been monitored; only 2007 was higher. Chlorophyll-a was the third highest. Secchi transparency was the poorest of all years monitored, with an average of only 1.5 feet. 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, except for better water quality in mid-May.

In 2009 Martin Lake had a severe late spring algae bloom; this is unusual for the lake. In mid-May the water was brown, but by the end of May it was strongly green. On June 10 a film of bright green algae covered the lake. By late June algae levels fell. A second severe algae bloom occurred in late July through August, but this is typical.

The conditions in Martin Lake were reflective of conditions in upstream Typo Lake, which drains into Martin Lake. Typo Lake has severe water quality problems, and was especially poor in 2007 and 2009, likely because of internal loading driven by drought-induced low water.

Trend Analysis

Eleven 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). 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; $F_{2,8}=4.58$, $p=0.05$). However, further examination of the data reveals that no water quality parameter alone has changed significantly, and the direction of their changes is mixed. It is concluded that no true trend is likely present. This lake needs improvement regardless.

Discussion

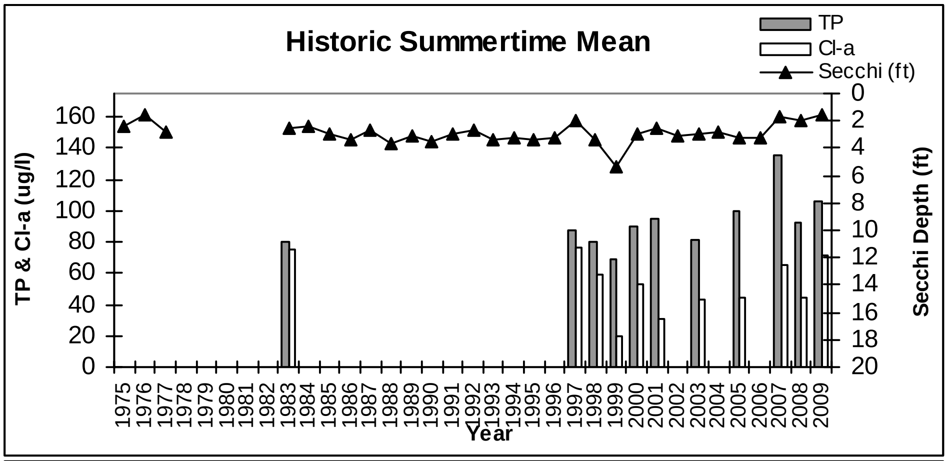
Martin Lake, along with Typo Lake upstream, were the subject of an intensive TMDL study from 2001-03 by the Anoka Conservation District. This study documented the source of nutrients to the lake, the degree to which each is impacting the lake, and put forward lake rehabilitation strategies. Delays have occurred in approval of this study and plan, but it is expected to be finalized in 2010. In the meantime, the ACD, Sunrise River WMO, and Martin Lakers Association are pursuing some small lake water quality improvement projects.

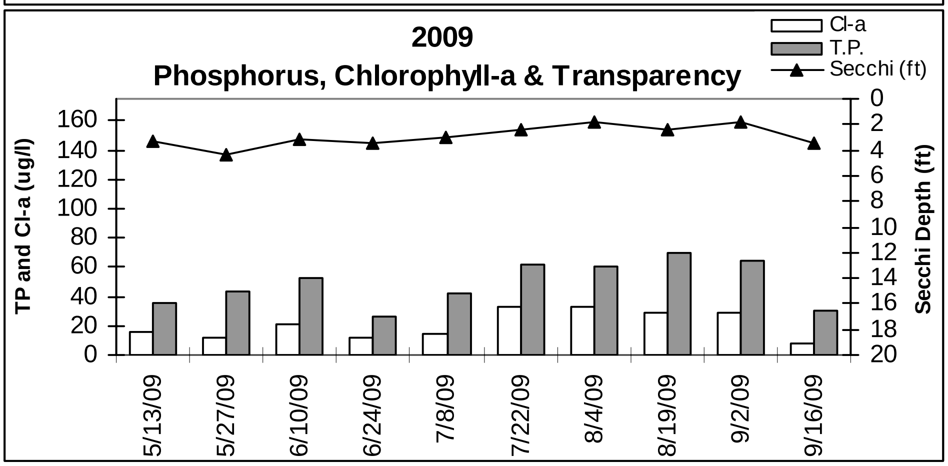
2009 Martin Lake Water Quality Data

Martin Lake 2009		Date	5/13/2009	5/27/2009	6/10/2009	6/24/2009	7/8/2009	7/22/2009	8/4/2009	8/19/2009	9/2/2009	9/16/2009			
		Time	13:10	12:15	12:10	12:10	12:10	12:40	12:15	11:20	12:20	11:00			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.22	8.50	8.58	9.37	7.94	8.84	8.90	8.70	9.05	9.24	8.73	7.94	9.37
Conductivity	mS/cm	0.01	0.300	0.274	0.250	0.216	0.244	0.251	0.224	0.227	0.235	0.219	0.244	0.216	0.300
Turbidity	FNRU	1	43.00	40.00	62.00	30.00	31.00	43.00	49.00	40.00	50.00	36.00	42	30	62
D.O.	mg/l	0.01	12.75	11.36	10.96	12.12	11.11	15.17	12.80	7.16	10.55	11.98	11.60	7.16	15.17
D.O.	%	1	128%	120%	112%	151%	132%	172%	149%	83%	116%	139%	130%	83%	172%
Temp.	°C	0.1	15.7	18.0	16.8	26.9	22.5	21.7	23.1	23.0	20.4	22.8	21.1	15.7	26.9
Temp.	°F	0.1	60.3	64.4	62.2	80.4	72.5	71.1	73.6	73.4	68.7	73.0	70.0	60.3	80.4
Salinity	%	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Cl-a	ug/l	1	103.0	53.5	76.0	15.5	16.6	49.4	65.6	248.0	60.2	26.5	71.4	15.5	248.0
T.P.	mg/l	0.005	0.075	0.085	0.129	0.061	0.073	0.143	0.149	0.140	0.136	0.066	0.106	0.061	0.149
T.P.	ug/l	5	75	85	129	61	73	143	149	140	136	66	106	61	149
Secchi	ft	0.1	1.2	1.8	1.1	1.9	1.7	1.4	1.0	1.8	1.0	1.6	1.5	1.0	1.9
Secchi	m	0.1	0.4	0.5	0.3	0.6	0.5	0.4	0.3	0.5	0.3	0.5	0.4	0.3	0.6
Field Observations															
Physical			2.00	4.00	5.00	4.00	4.00	4.00	5.00	4.00	4.00	4.00	4.0	2.0	5.0
Recreational			1.00	4.00	4.00	4.00	3.50	4.00	4.00	4.00	4.00	4.00	3.7	1.0	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
Year	1975	1976	1977	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
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
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
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
TSI				68											

Martin Lake Water Quality Report Card

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

Martin Lake Summertime Historic Means

Agency	CLMP	CLMP	ACD	MC	ACD	ACD	ACD	CLMP	ACD	CLMP	ACD	ACD	ACD	CAMP	CAMP
Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
TP (ug/L)			88.0	80.0	61.7	89.4	95.4		81.9		100		135.0	92.0	106.0
Cl-a (ug/L)			77.0	58.8	18.0	52.5	31.4		43.3		44.3		65.8	44.1	71.4
Secchi (m)	1.02	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
Secchi (ft)	3.4	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
Carlson's Tropic State Indices															
TSIP			69	67	64	68	69		68		71		75	69	71
TSIC			73	71	59	67	63		68		68		72	68	73
TSIS	60	60	67	60	52	63	65	65	62	62	60	60	70	67	73
TSI			70	66	58	66	66		66		66		72	68	72

Martin Lake Water Quality Report Card

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
TP			D	D	C	D	D		D		D		D	D	D
Cl-a			D	D	B	C	C		C		C		D	C	D
Secchi	D	D	F	D	C	D	D	D	D	D	D	D	F	F	F
Overall			**D**	**D**	**C**	**D**	**D**		**D**		**D**		**D**	**D**	**D**

Typo Lake

Linwood Township, Lake ID # 03-0009

Background

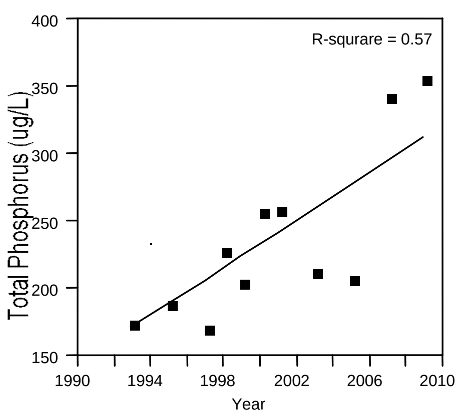
Typo Lake is located in the northeast portion of Anoka County and the southeast portion of Isanti County. It has a surface area of 290 acres and maximum depth of 6 feet (1.82 m), though most of the lake is about 3 feet deep. The lake has a mucky, loose, and unconsolidated bottom in some areas, while 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.

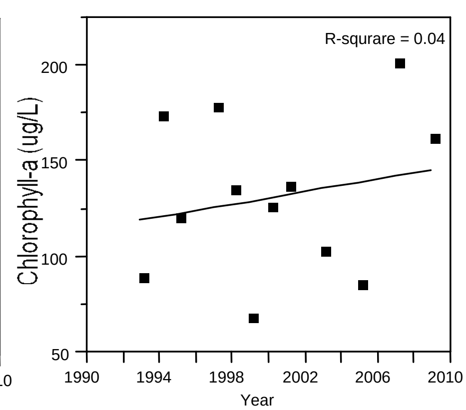
2009 Results

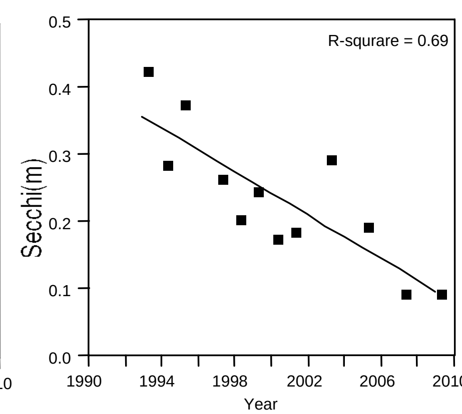
In 2009 Typo Lake had extremely poor water quality compared to other lakes in this region (NCHF Ecoregion), receiving an overall F letter grade. This is the same letter grade as the previous eleven years monitored, but 2007 and 2009 were the worst of all. In those two years total phosphorus averaged 340 and 353 ug/L, respectively. Algae levels were lower in 2009 (116 ug/l) than 2007 (201 (ug/L), and similar to previous years. In both 2007 and 2009 a bright white Secchi disk could be seen only 5-6 inches below the surface, on average. The greatest transparency in those two years was one foot. The reason for the especially poor conditions in 2007 and 2009 seems to be drought-induced low water levels. The lake's major inlet was monitored in 2007 and found to be similar to previous years or better. 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 by substantially in the late summer of both years when ample rains fell.

Trend Analysis

Twelve 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, and '09). Water quality has significantly deteriorated from 1993 to 2009 (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,9}$=7.85, p=0.01). Total phosphorus and chlorophyll-a have increased, while Secchi transparency has declined (see figures below). The trend toward poorer phosphorus and transparency were particularly strong, with R-squared values of 0.57 and 0.69, respectively. It is interesting that a lake with a long history of extremely poor water quality continues to get poorer.







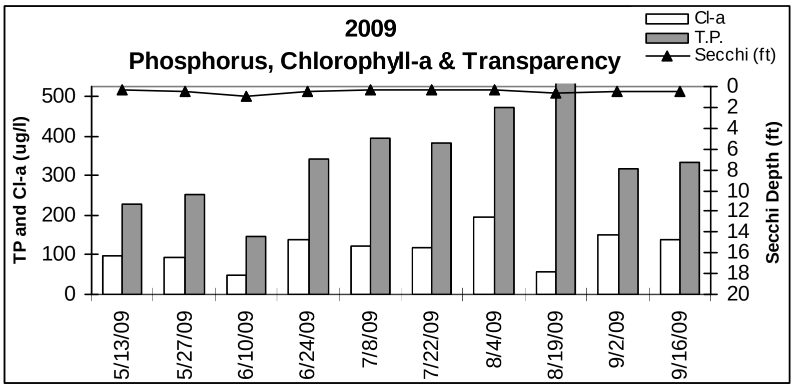
Discussion

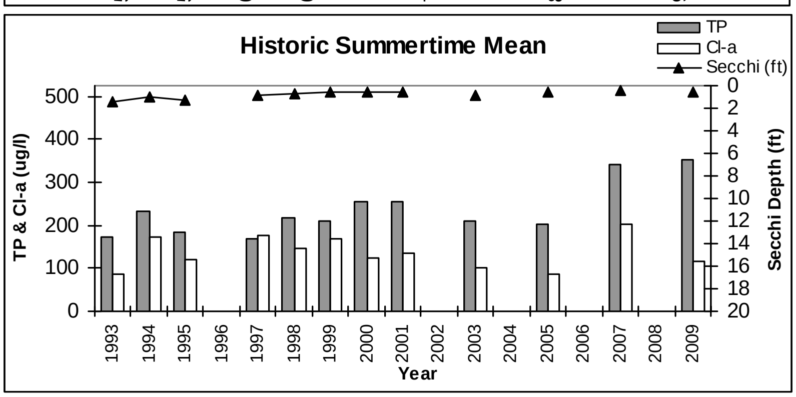
Typo Lake, along with Martin Lake downstream, were the subject of an intensive TMDL study from 2001-03 by the Anoka Conservation District. This study documented the source of nutrients to the lake, the degree to which each is impacting the lake, and put forward lake rehabilitation strategies. Some factors impacting water quality on Typo Lake include rough fish, high phosphorus inputs from a ditched wetland west of the lake, and lake sediments. The study report was completed in early 2006, however it is still waiting for review and approval by the MPCA. In the meantime, the ACD and Sunrise River WMO are pursuing some lake water quality improvement projects.

Typo Lake Water Quality Results

2009 Typo Lake		Date	5/13/09	5/27/09	6/10/09	6/24/09	7/8/09	7/22/09	8/4/09	8/19/09	9/2/09	9/16/09			
		Time	13:40	12:50	12:30	12:45	12:35	13:10	12:40	11:50	12:50	11:30			
	Units	R.L.*	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	Average	Min	Max
pH		0.1	8.12	8.25	8.10	8.53	9.15	8.80	9.09	8.59	9.32	9.14	8.71	8.10	9.32
Conductivity	mS/cm	0.01	0.271	0.648	0.281	0.287	0.209	0.230	0.199	0.220	0.222	0.217	0.278	0.199	0.648
Turbidity	FNRU	1	150	183	96	164	241	197	239	270	183	193	192	96	270
D.O.	mg/l	0.01	9.95	8.60	9.45	10.61	10.71	8.04	11.63	7.15	13.21	8.97	9.83	7.15	13.21
D.O.	%	1	100%	88%	92%	132%	128%	90%	136%	80%	145%	103%	109%	80%	145%
Temp.	°C	0.1	16.3	16.4	14.8	27.1	24.8	21.4	23.5	21.5	20.4	22.7	20.9	14.8	27.1
Temp.	°F	0.1	61.3	61.5	58.6	80.8	76.6	70.5	74.3	70.7	68.7	72.9	69.6	58.6	80.8
Salinity	%	0.01	0.01	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02
Cl-a	ug/l	1.0	97.9	95.4	48.8	138.0	123.0	117	197	56	151	138	116.2	48.8	197.0
T.P.	mg/l	0.005	0.228	0.253	0.148	0.342	0.396	0.384	0.474	0.654	0.317	0.333	0.353	0.148	0.654
T.P.	ug/l	5	228	253	148	342	396	384	474	654	317	333	353	148	654
Secchi	ft	0.1	0.3	0.4	1.0	0.5	0.3	0.3	0.3	0.6	0.4	0.4	0.5	0.3	1.0
Secchi	m	0.1	0.1	0.1	0.3	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.3
Field Observations															
Physical			5.00	5.00	5.00	5.00	5.0	5.0	5.00	5.00	5.00	5.00	5.0	5.0	5.0
Recreational			4.00	4.00	4.00	4.00	4.0	4.0	4.00	4.00	4.00	4.00	4.0	4.0	4.0

*reporting limit





Lake Typo Summertime Historic Mean

Agency	CLMP	CLMP	MPCA	MPCA	MPCA	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD
Year	1974	1975	1993	1994	1995	1997	1998	1999	2000	2001	2003	2005	2007	2009
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
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
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
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
Carlson's Tropic State Indices														
TSIP			78	83	79	78	82	81	83	82	81	81	88	89
TSIC			75	81	78	82	79	72	74	77	76	74	83	77
TSIS	81	79	72	78	74	79	82	80	86	85	77	83	93	93
TSI			75	81	77	79	81	78	81	81	78	79	88	86

Lake Typo Water Quality Report Card

Year	74	75	93	94	95	97	98	99	2000	2001	2003	2005	2007	2009
TP			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
Secchi	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**

Stream Hydrology

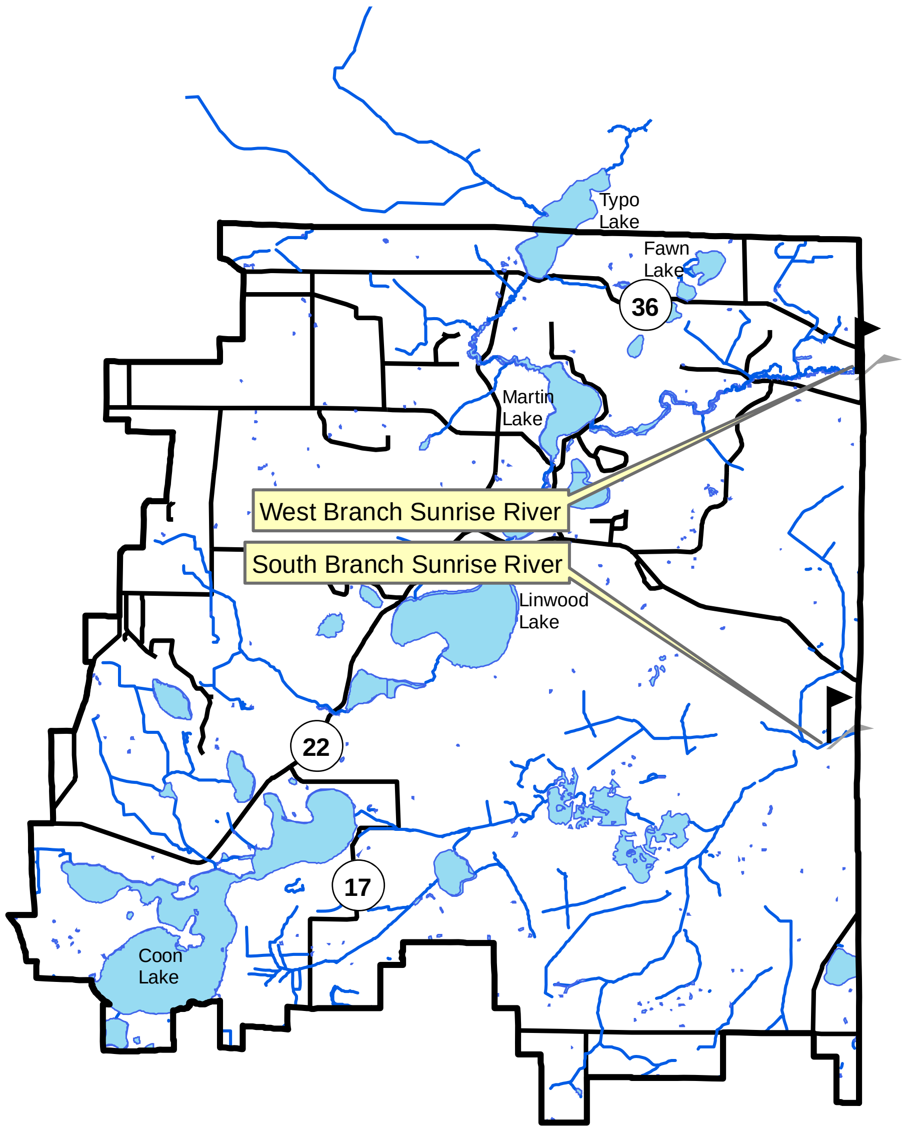
Description: Continuous water level monitoring in streams.

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

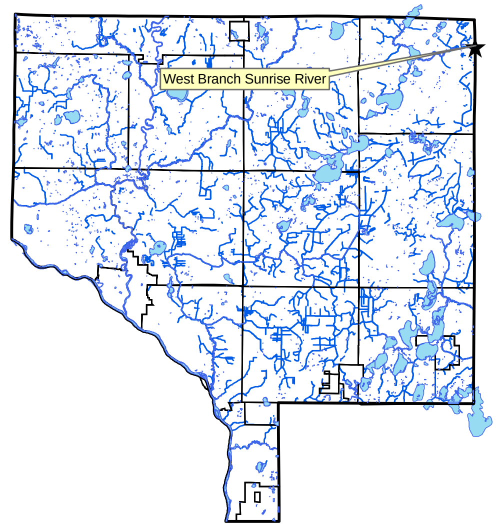
Sunrise Watershed Stream Hydrology Monitoring Sites



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) = $2.9171(\text{stage}-883.5)^3 - 7.9298(\text{stage}-883.5)^2 + 10.131(\text{stage}-883.5) + 10.18$ $R^2=0.94$

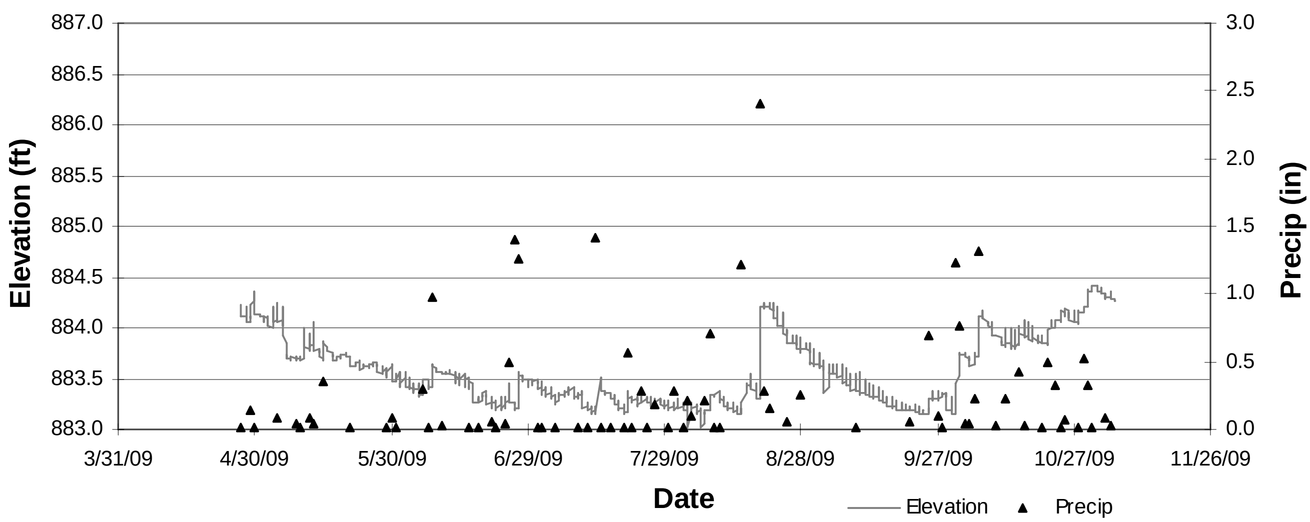
This rating curve was first prepared in 2002. Five additional flow-stage measurements were taken in 2008-09 to keep the equation updated.

Summary of All Monitored Years

Percentiles	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2008	2009	All Years thru 2009
Min	883.78	884.25	885.25	884.06	883.41	883.65	884.36	883.28	883.84	884.33	883.76	883.31	883.02	883.02
2.5%	884.00	884.31	885.35	884.12	883.50	883.76	884.50	883.64	883.93	884.44	883.87	883.40	883.17	883.32
10.0%	884.14	884.48	885.42	884.22	883.52	883.81	884.63	883.73	884.02	884.58	884.04	883.51	883.21	883.66
25.0%	884.48	884.79	885.71	884.58	883.55	883.91	885.13	883.83	884.31	884.69	884.50	883.64	883.30	884.23
Median (50%)	884.77	885.51	886.06	884.80	883.68	884.25	885.59	884.62	884.59	884.93	885.06	883.89	883.48	884.98
75.0%	885.39	886.03	886.46	884.99	884.21	885.60	886.18	885.66	885.10	885.29	885.27	884.99	883.83	884.98
90.0%	885.88	886.58	887.10	885.21	884.42	886.69	886.48	886.12	886.03	885.61	885.59	885.74	884.12	886.36
97.5%	886.90	886.82	887.61	885.65	885.75	887.05	886.84	886.74	886.82	885.92	886.06	886.04	884.31	887.05
Max	887.13	887.14	887.81	885.77	886.02	887.05	886.89	886.91	886.89	886.67	886.14	886.17	884.42	887.81

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

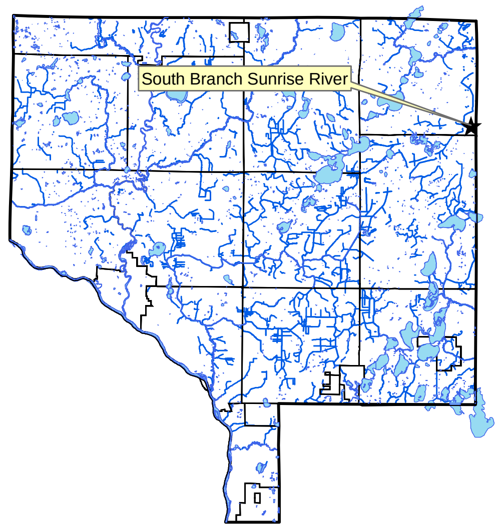
2009 Hydrograph



SOUTH BRANCH OF SUNRISE RIVER

At Hornsby St, Linwood Township

Notes



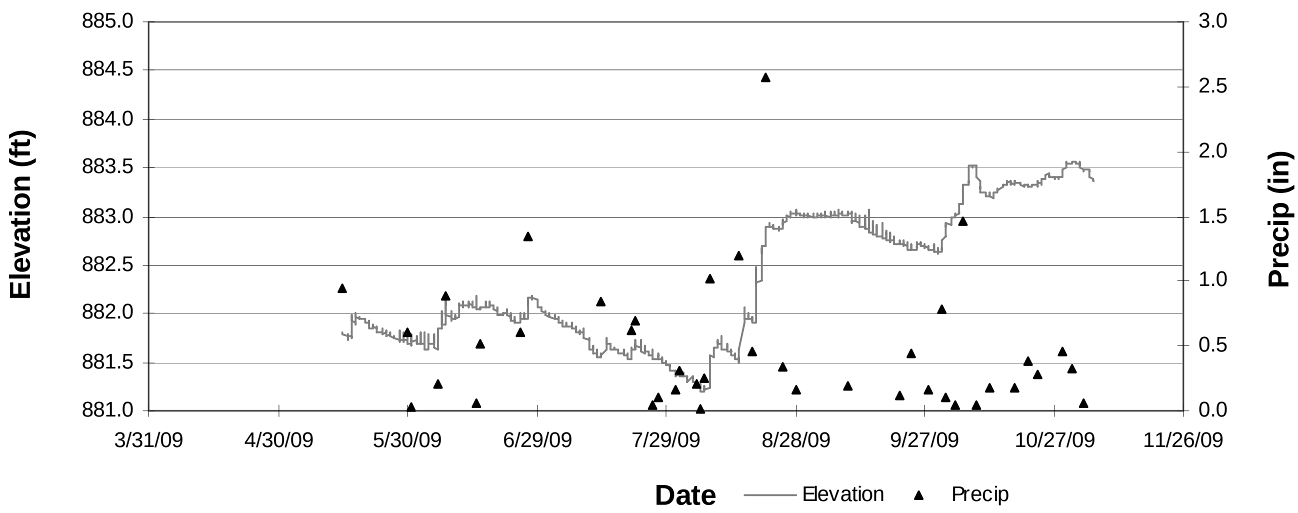
This monitoring site is the bottom of this watershed in Anoka County, at the closest accessible point to the Anoka-Chisago County boundary. Upstream, this river drains from Coon Lake and through the Carlos Avery Wildlife Management Area. The Sunrise River Watershed Management Organization monitors this 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.

Summary of All Monitored Years

Percentiles	2009	All Years
Min	881.20	881.20
2.5%	881.34	881.34
10.0%	881.57	881.57
25.0%	881.74	881.74
Median (50%)	882.09	882.09
75.0%	883.01	883.01
90.0%	883.34	883.34
97.5%	883.52	883.52
Max	883.56	883.56

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

2009 Hydrograph



Wetland Hydrology

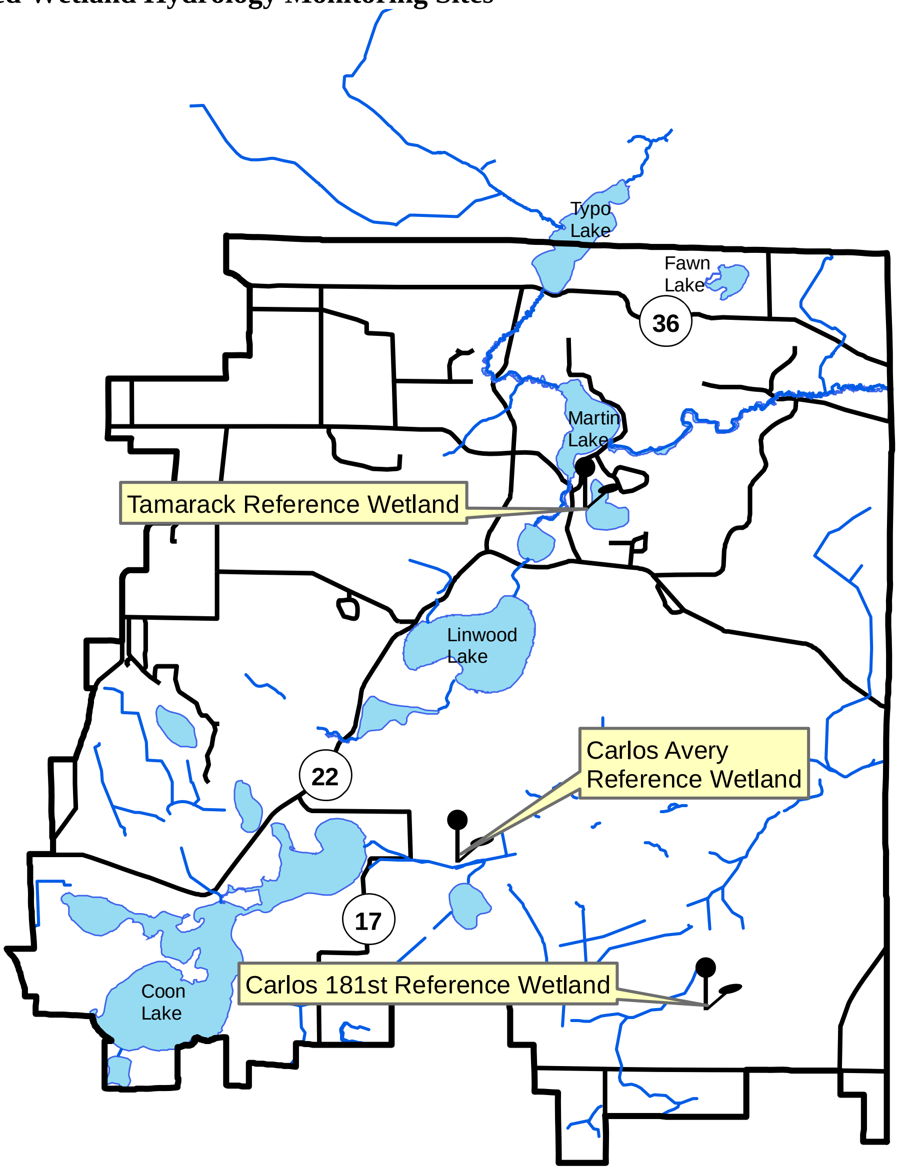
Description: Continuous groundwater level monitoring at a wetland boundary, to a depth of 40 inches. County-wide, the ACD maintains a network of 18 wetland hydrology monitoring stations.

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.

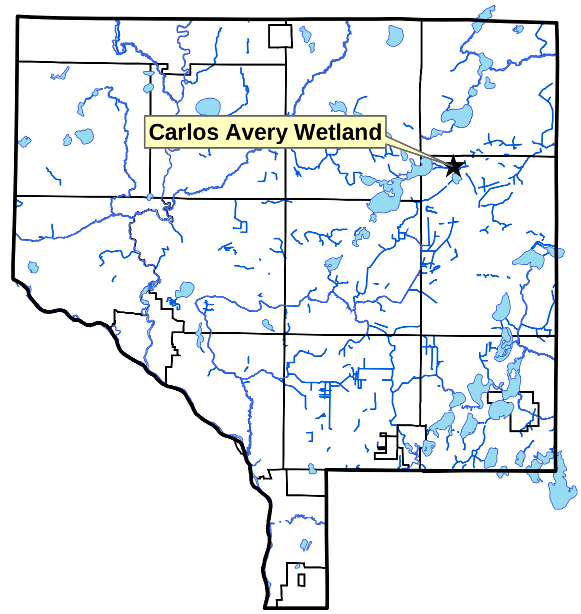
Sunrise Watershed Wetland Hydrology Monitoring Sites



Wetland Hydrology Monitoring

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

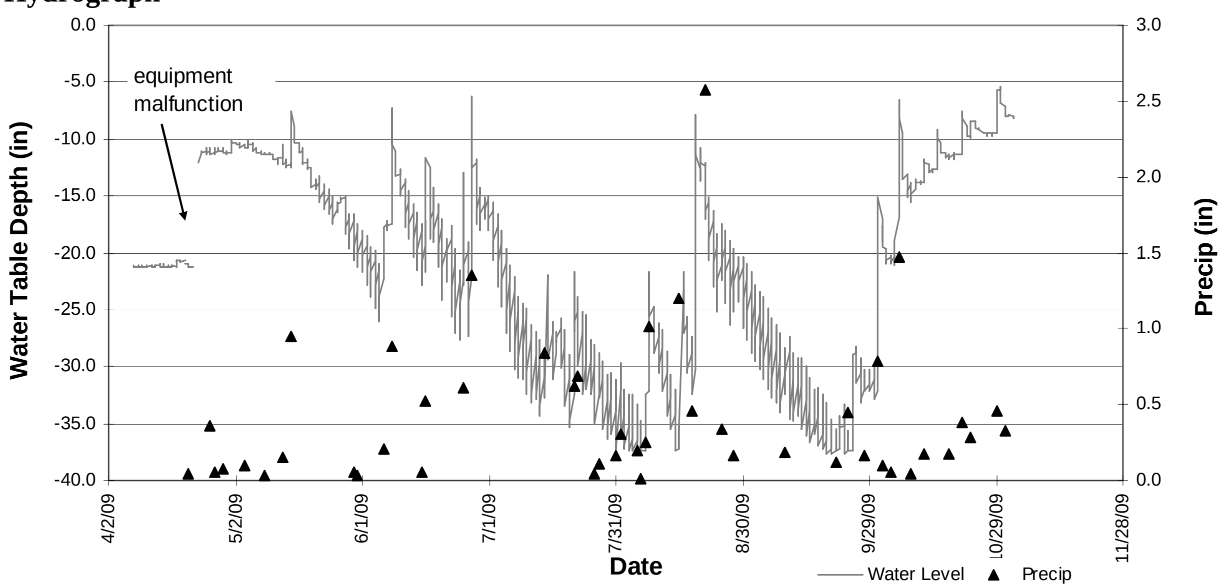
Surrounding Soils: Lino loamy fine sand

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.

2009 Hydrograph

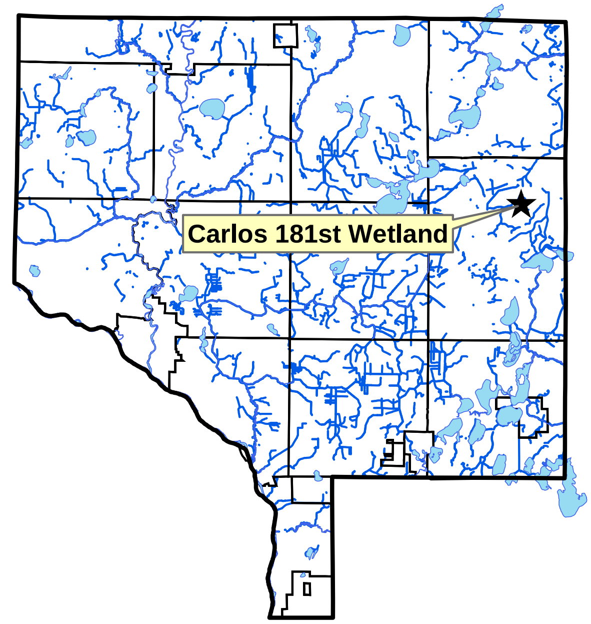


Well depths were 40 inches, so a reading of–40 indicates water levels were at an unknown depth greater than or equal to 40 inches.

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	-

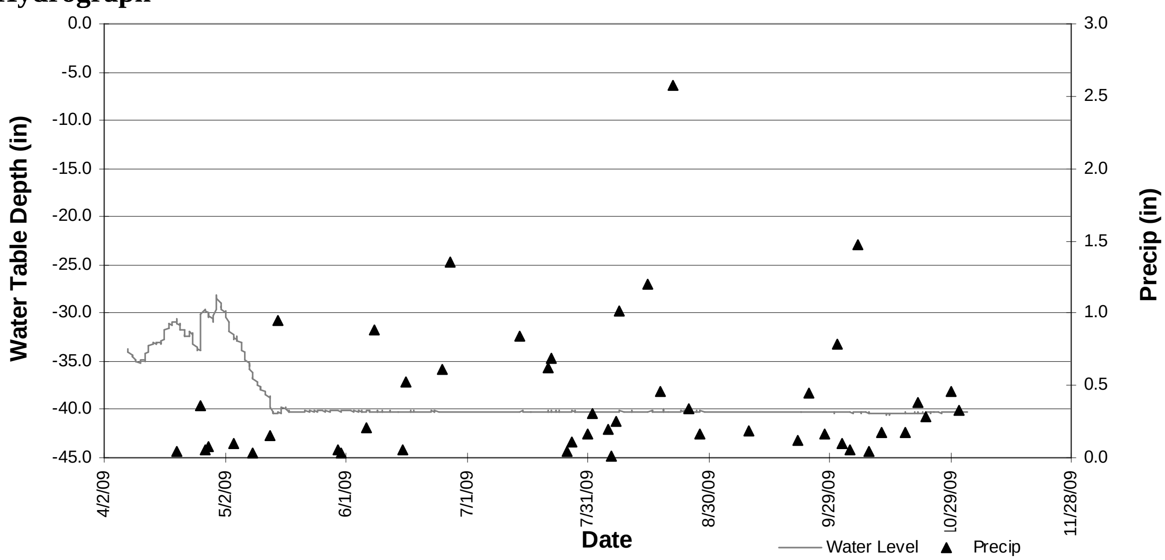
Surrounding Soils: Soderville fine sand

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.

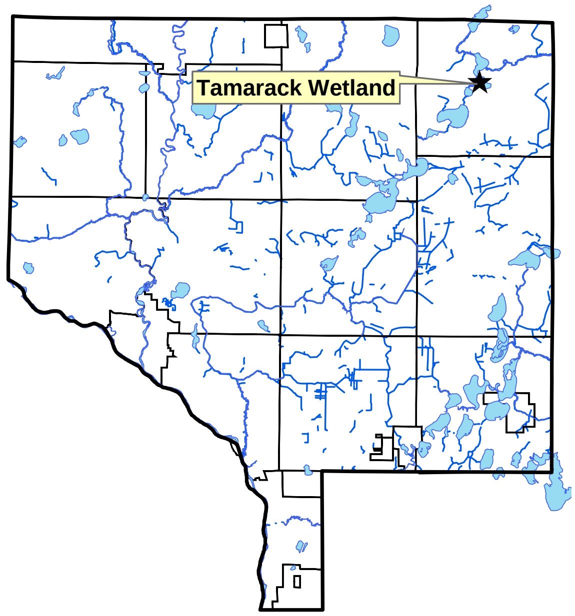
2009 Hydrograph



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	-

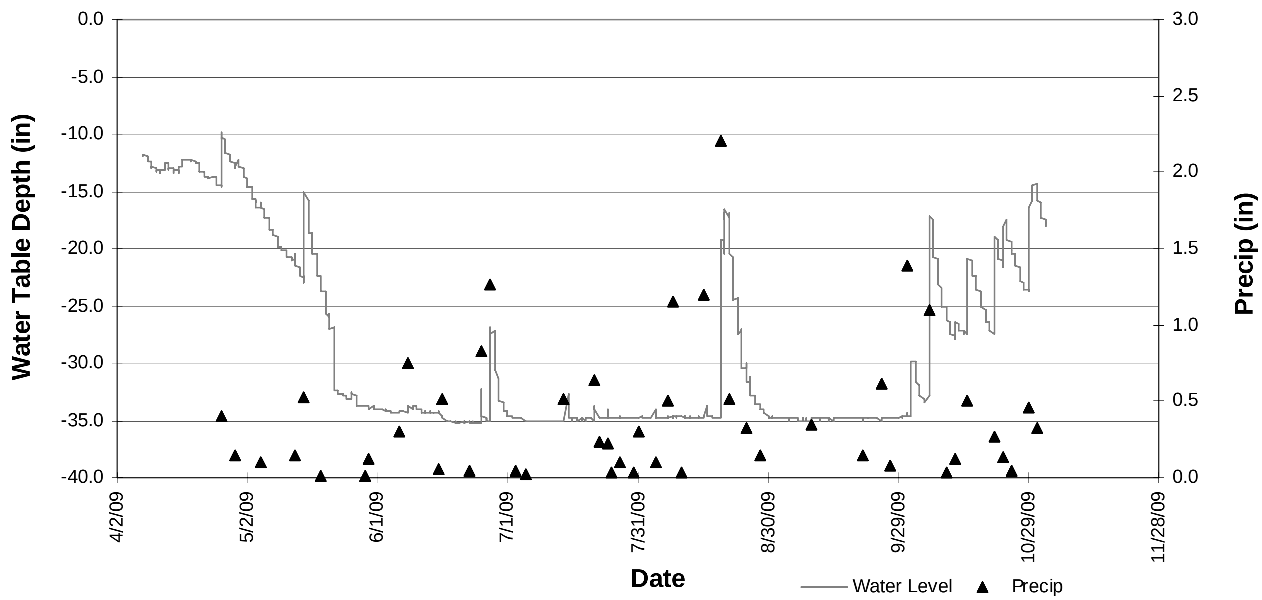
Surrounding Soils: Sartell fine sand

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.

2009 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 Improvement Projects

Description: The Sunrise River Watershed Management Organization (SRWMO) and Anoka Conservation District (ACD) partner to encourage projects that will benefit lake and stream water quality. These projects include lakeshore restorations, rain gardens, erosion correction, and others. Promotion occurs by approaching landowners with known problems, presentations to lake associations and other community groups, community newsletters, and website postings. The ACD assists interested landowners with design, materials acquisition, installation, and maintenance. The SRWMO offers cost share grants. 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.

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

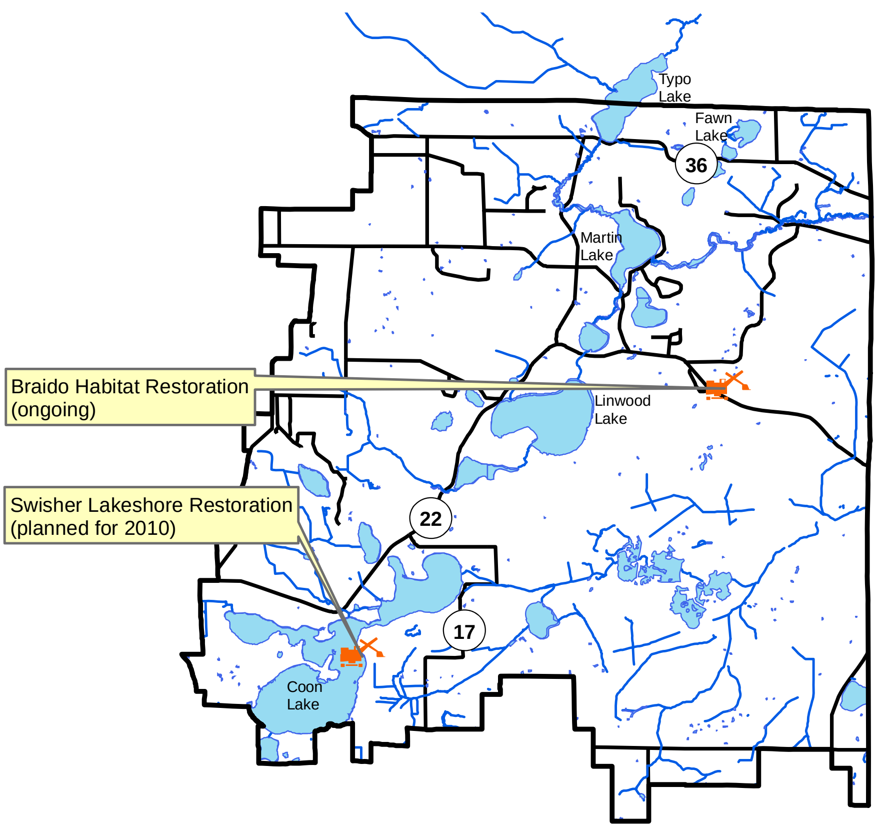
Locations: Throughout the watershed.

Results:

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
Fund Balance		**$4,338.17**

Map of Projects



2010 Swisher Lakeshore Restoration Project, Coon Lake

This project is tentatively scheduled, but seems unlikely. After project planning, it came to light that the homeowners do not own the lakeshore. Therefore this project will only occur if the owner, the City of East Bethel, agrees to go forward. Cost share funds for this project have been rescinded.

This project, as originally planned, would restore a portion of Coon Lake shoreline with native plants and provide some erosion protection. The project has been designed by the Anoka Conservation District. Benefits of this project will include filtering runoff to the lake, preventing erosion, and near-shore wildlife habitat. Additionally, a large amount of trash will be removed from the area. In part, this project will correct some past illegal lakeshore modifications (another reason cost share funds were recinded).

The project will involve stabilizing a lakeshore area and seeding it with native plants. The process of seeding will include herbicide treatment of existing weedy vegetation, seeding, straw mulch, watering, and maintenance by mowing during the first year or more. Erosion control will include an erosion control blanket and coconut-fiber biolog if lake water levels necessitate it. In total, this project will encompass 60 linear feet of shoreline and 2,925 square feet. The grant contract specifies the project must be maintained for at least five years.

Braido Habitat Restoration, Linwood Township


Rain Garden

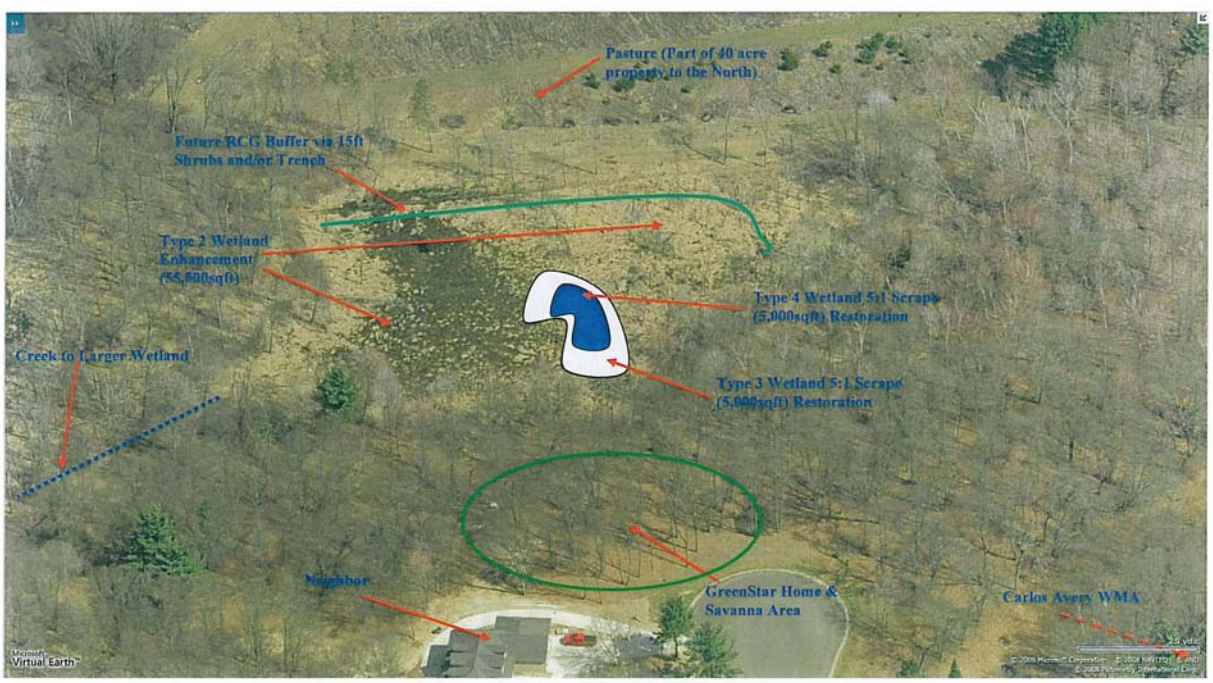

Wetland prepared for seeding

The Braido property is located in an area of importance for habitat. It is near the Carlos Avery Wildlife Management Area, Martin-Island-Linwood Regional Park, is within a Metro Conservation Corridor, DNR Regionally Significant Ecological Area, and is a Minnesota County Biological Survey site of biodiversity significance. The Braido's have begun a project to improve multiple aspects of the habitat on their property. Work began in 2009 and will continue in 2010.

This project will restore a wetland and surrounding upland. A 1.5 acre wetland that is dominated by invasive reed canary grass will be restored to native vegetation. Reed canary grass and its seeds have been removed by scraping the wetland bottom. The area is being seeded and maintained. On the upland portions of the property, the invasive small tree European buckthorn is being removed from 5.2 acres. Of this, 0.36 acres will be restored to oak savannah by planting prairie grasses and wildflowers. Tree and shrub plantings will occur in other areas.

Additionally, the Braido's have built a rain garden to capture runoff from the driveway of their new Green Star/Energy Star home. The rain garden provides a place for storm water to infiltrate and includes native plants. The rain garden was completed in 2009.

This work is funded by several sources. The landowners are contributing cash as well as 600+ hours of labor. Other labor is being performed by Prairie Restorations, Inc. A grant for the upland work and rain garden plants was awarded from the Anoka Conservation District and the Anoka County Ag Preserves program. A grant for work in and around the wetland was awarded from the MN Board of Water and Soil Resources Native Buffers program. The Minnesota Waterfowl Association has approved the project and may provide some technical or financial support. Because water quality is not the focus of this project, the Sunrise River Watershed Management Organization did not contribute funding.



* Note that the buckthorn was not specifically indicated because it is over most of the lot

Anoka County Geologic Atlas

Description: A map-based report of groundwater and geology to be used for community planning and groundwater management. The Atlas provides detailed information about groundwater:

- Aquifers, including identifying future water sources,
- Aquifer sustainability,
- Recharge areas,
- Sensitivity to pollution,
- Flow directions,
- Connections to lakes, streams, and wetlands,
- Chemistry,
- Wellhead protection, and others...

Results are provided as GIS files and paper maps, and are especially useful to community planners.

Geologic Atlases are a partnership of the MN Geological Survey, MN DNR, and local governments. 94% of funding was secured by the MN Geological Survey (MGS) and MN Department of Natural Resources (DNR) from the Legislative-Citizen Commission for Minnesota Resources (LCCMR). A required local contribution totaling 6% of project expenses was provided by the seven Anoka County watershed organizations and the Anoka Conservation District. Completion of the project requires 4-5 years.

Purpose: To gain knowledge about groundwater and geology that enables improved management of groundwater, including availability, pollution prevention, and pollution management.

Locations: Throughout Anoka County

Results: An Anoka County Geologic Atlas began in 2009 with financial support from all seven Anoka County Watershed Management Organizations and the Anoka Conservation District. These funds were used to locate approximately 9,500 groundwater wells, with approximately an additional 500 to be located in early 2010. Boring logs from these wells and others already in the County Well Index will be used to create the geologic atlas. The MGS has already begun the process of using these wells to create the geologic atlas. Thereafter the DNR will perform a groundwater analysis for the atlas. In total, the geologic atlas is expected to be completed around 2014.

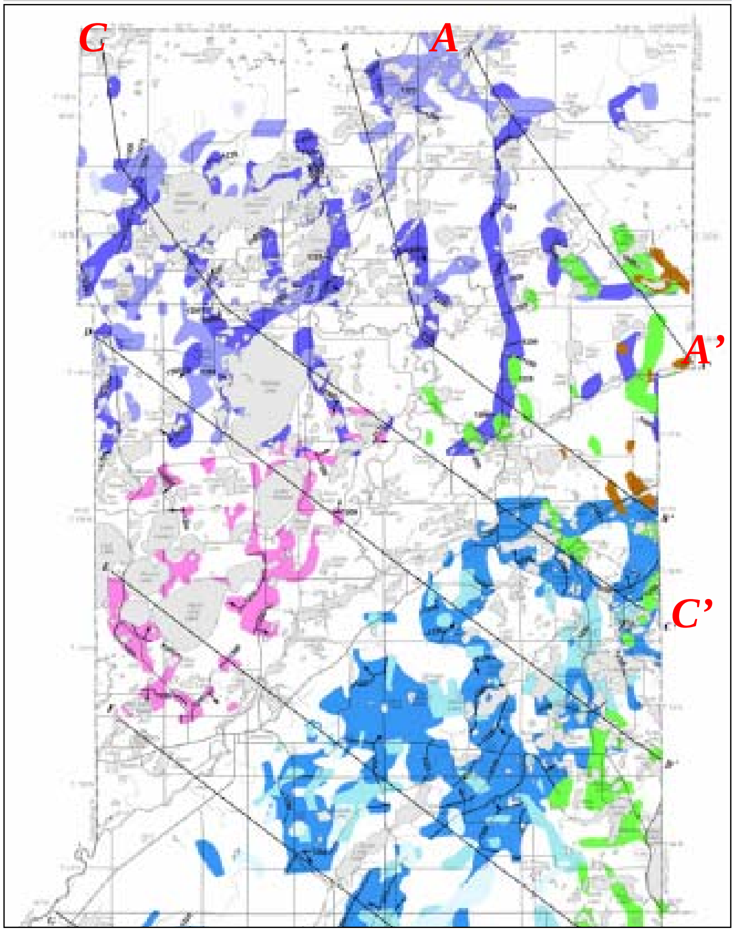
An example of portions of a geologic atlas from Crow Wing County are on the following page.

EXAMPLE GEOLOGIC ATLAS WORK PRODUCTS

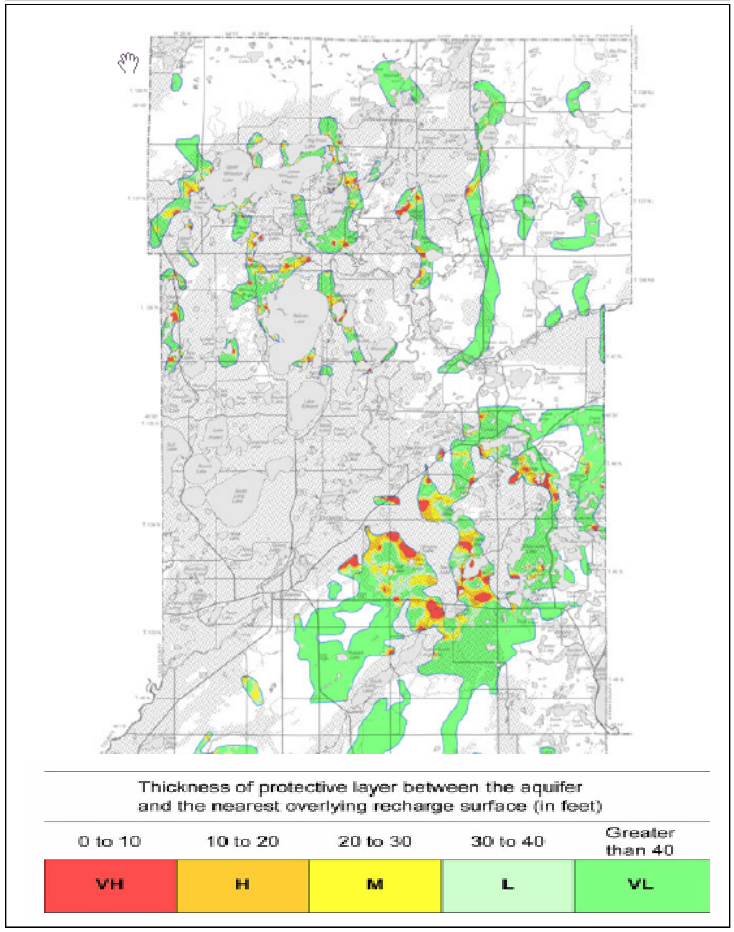
Crow Wing County Geologic Atlas

Excerpted from: Peterson, T. 2008. Hydrogeology, Pollution Sensitivity, and Lake and -Groundwater Interaction. MN Ground Water Association Newsletter 27-3.

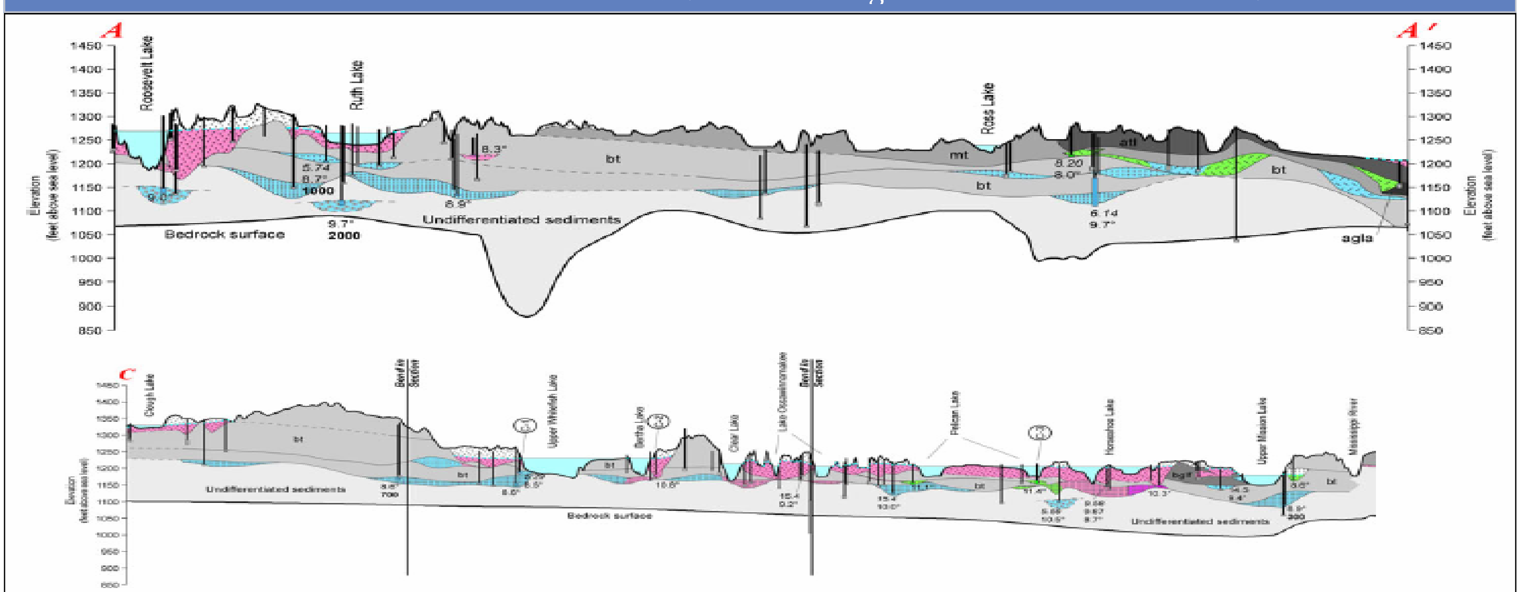
Extent and Distribution of Buried Aquifers Including Direction of Flow



Pollution Sensitivity of Buried Aquifers



Selected hydro-geologic cross sections showing groundwater residence time. Cross sections A-A' and the Northwest 2/3 of C-C' are shown. See above figure for cross section location.



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.

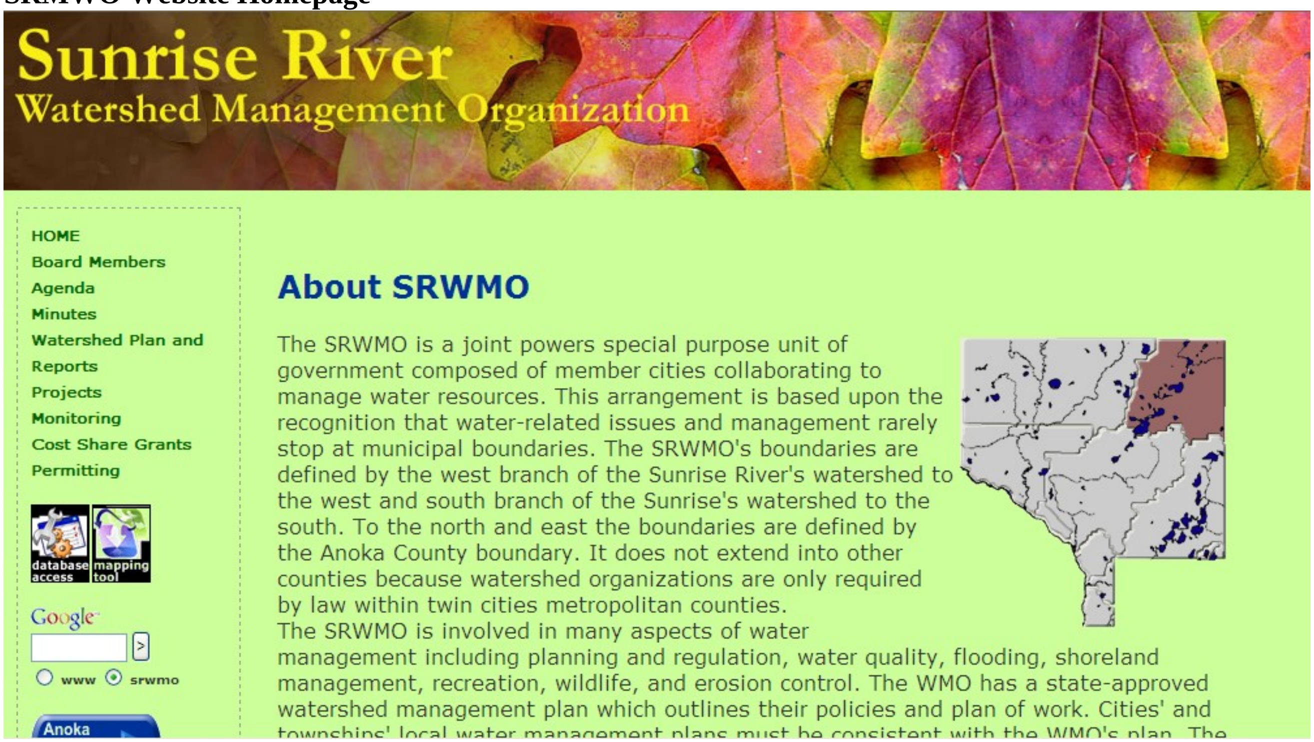
Information about the SRWMO includes:

- 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:

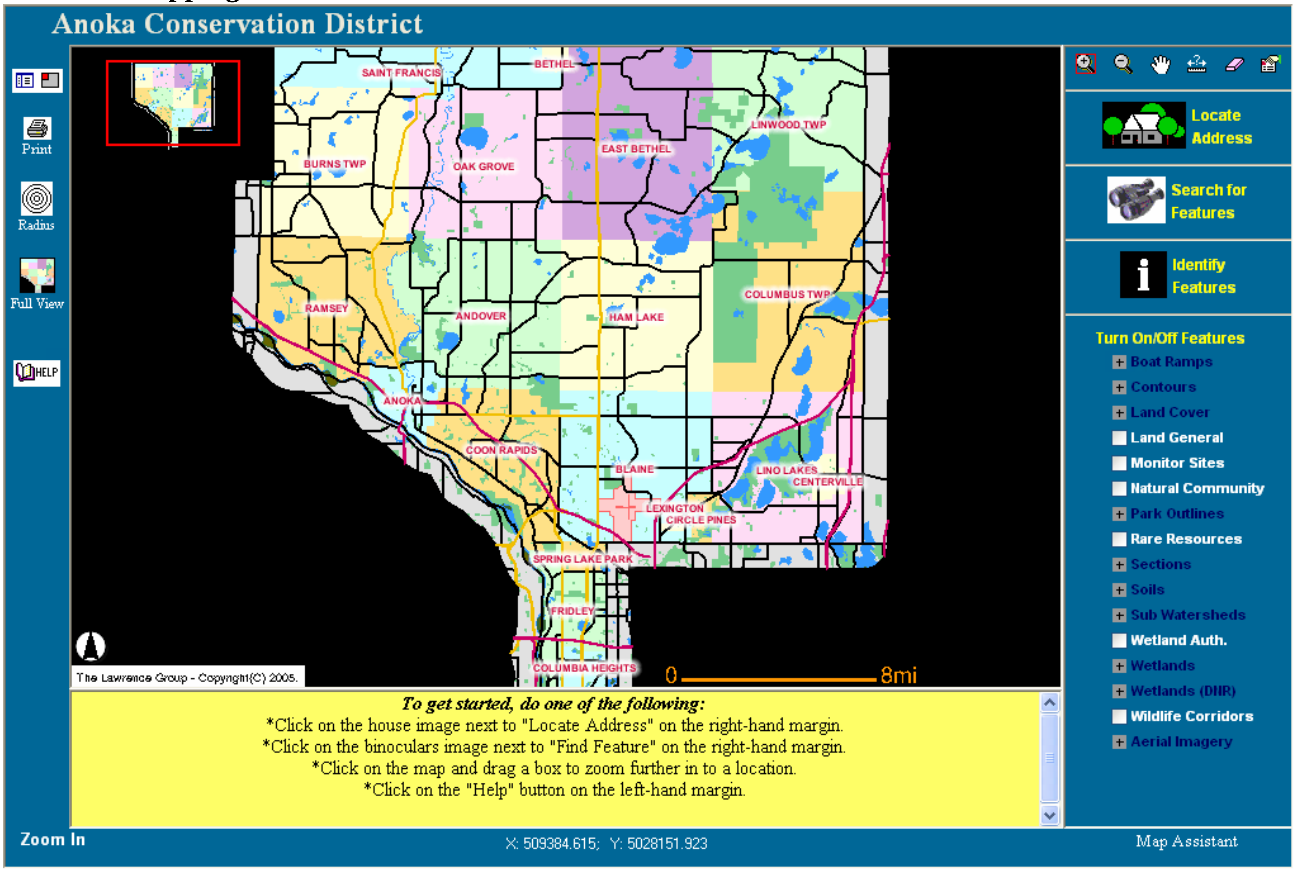
- an interactive mapping tool that shows natural features and aerial photos
- an interactive data download tool that allows users to access all water monitoring data that has been collected
- narrative discussions of what the monitoring data mean

SRMWO Website Homepage

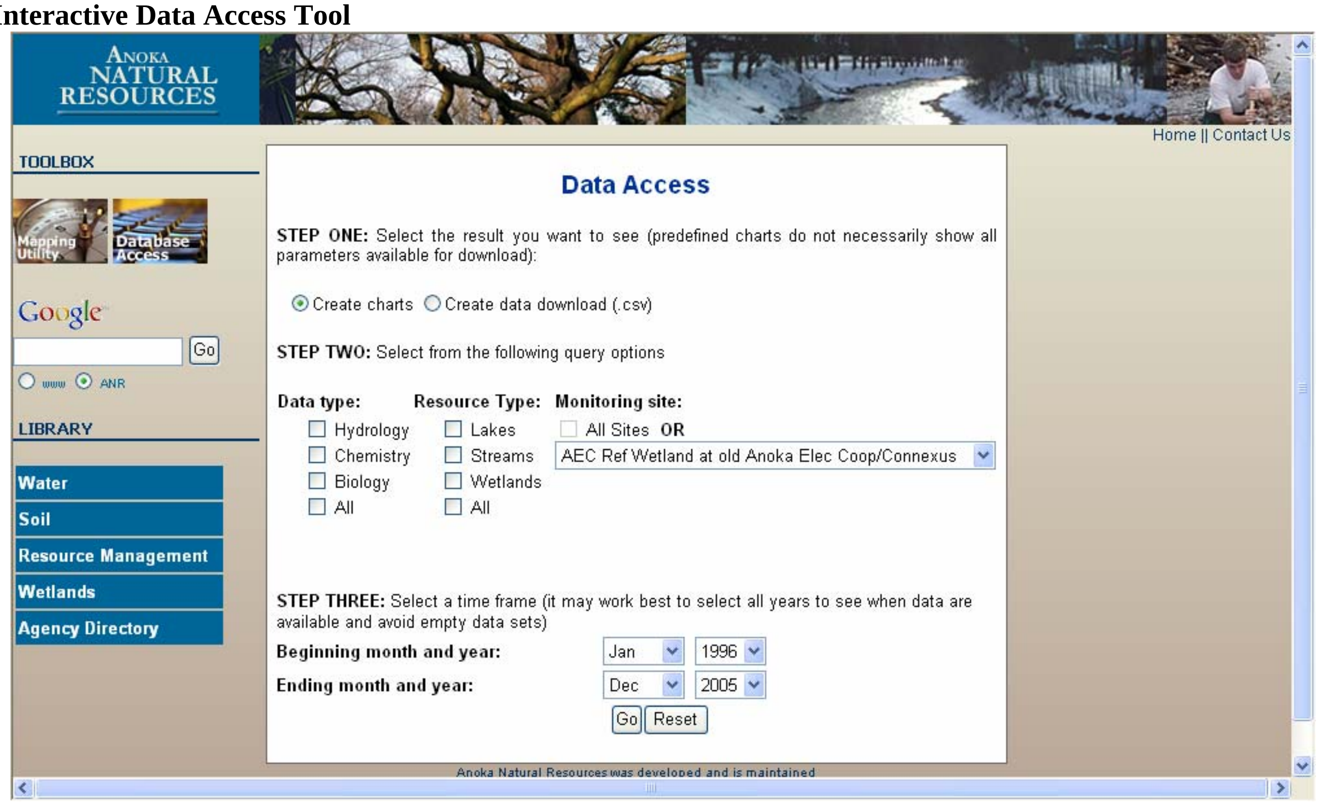


more on next page

Interactive Mapping Tool



Interactive Data Access Tool



SRWMO 2008 Annual Report to BWSR

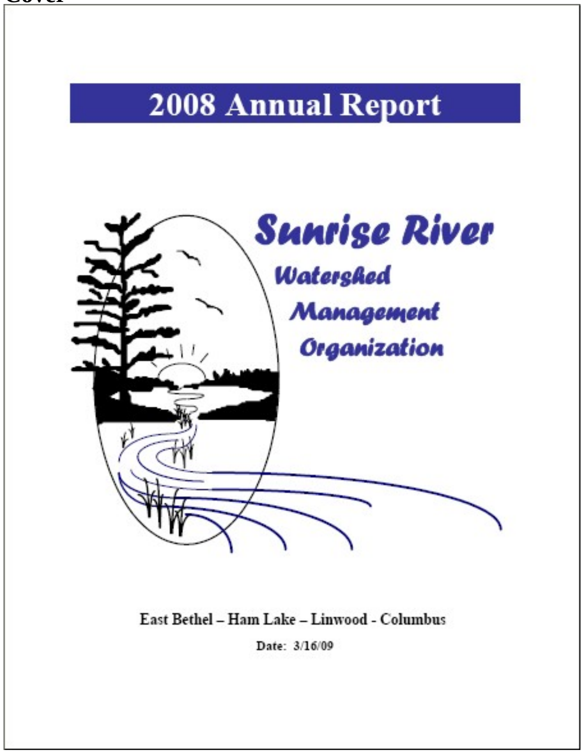
Description: The Sunrise River Watershed Management Organization (SRWMO) is required by law to submit an annual report to the Minnesota Board of Water and Soil Resources (BWSR), the state agency with oversight authorities. This report consists of an up-to-date listing of SRWMO Board members, activities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

Purpose: To document required 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 2008 Sunrise River WMO Annual Report. ACD provided copies of this report and a cover letter to the SRWMO Board on March 16, 2009. This allowed one month for review and to request changes, though no such requests were made. The Chair submitted the report to BWSR.

Cover



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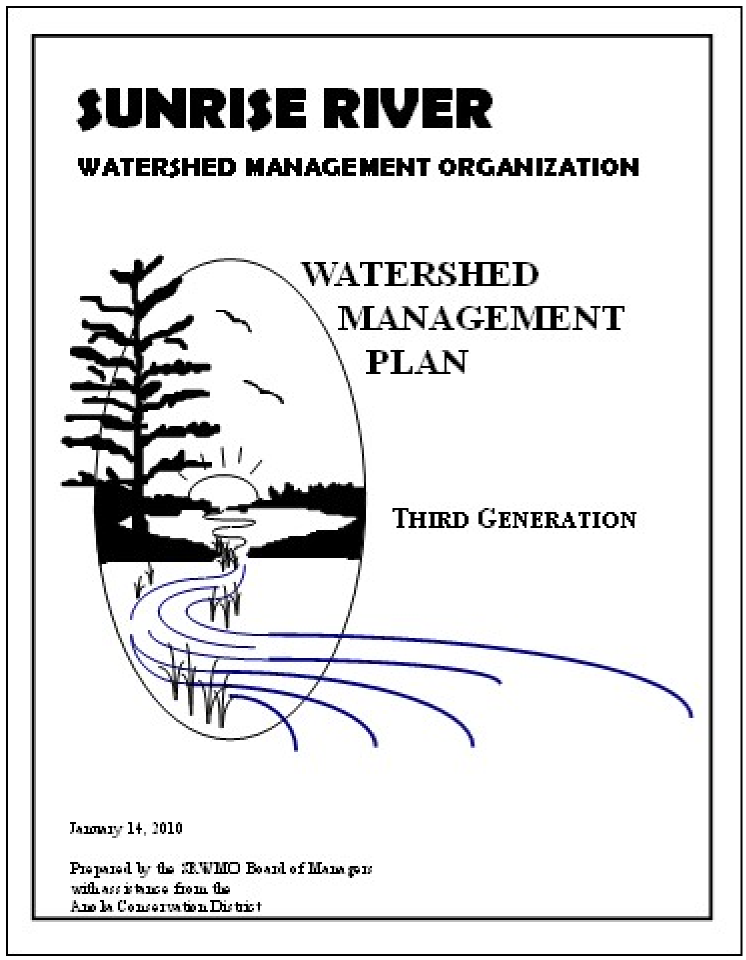
SRWMO 3rd Generation Watershed Plan

Description: The Sunrise River Watershed Management Organization (SRWMO) is required by law to update its watershed management plan generally every 10 years. This plan is analogous to a city's comprehensive plan. It sets the organization's goals, policies, and actions. It also estimates the financial impact of the activities. Updating the plan is typically a 12-18 month project when required review periods are included. The current plan expires December 31, 2009.

Purpose: To provide direction to the SRWMO for the next 10 years.

Locations: Watershed-wide

Results: In 2008 the SRWMO solicited bids to assist with the planning process. The Anoka Conservation District was selected from four proposals received. Beginning in October 2008 the Anoka Conservation District began the planning process with the SRWMO Board.



Work accomplished in chronological order:

- Evaluated the current watershed management plan, which has been in effect for the last 10 years, with the SRWMO Board.
- Create a space on the SRWMO website where information about the planning process is being posted.
- Held a public input meeting.
- Eight work sessions with the SRWMO Board to set goals, policies, and action plans.
- Formed and facilitated a technical advisory committee (TAC) that met three times develop standards for stormwater, wetlands, and septic systems. Participants included staff from member cities, state review agencies, and the Anoka Conservation District.
- Produced a draft watershed management plan.
- Submitted the draft plan to state agencies and others for 60 and 45-day review periods, as required by law.
- Held a public hearing on the draft plan on November 19, 2009.
- Advised the SRWMO Board on revising the organization's joint powers agreement.

The draft watershed management plan will be sent to the Minnesota Board of Water and Soil Resources in early 2010 for final approvals. Once approved, the plan will be printed and distributed to member communities, state agencies, and SRWMO Board members.

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.

Sunrise River Watershed Financial Summary

Sunrise River Watershed	Website	Ref Wet	Lake Lvl	Ob Well	Stream Level	Lake WQ	WMO annual rpt to BWSR	Geologic Atlas	SRWMO planning	Total
Revenues										
SRWMO	420	1575	600	0	1050	2955	400	4310	28857	40167
State	0	0	0	360	0	0	0	0	0	360
Anoka Conservation District	1473	0	785	380	375	750	284	1167	0	5213
County Ag Preserves	0	0	0	0	0	1076	0	0	0	1076
Other Service Fees	0	0	0	0	0	0	0	14	0	14
Local Water Planning	0	0	0	0	0	0	0	0	0	0
TOTAL	1893	1575	1385	740	1425	4781	684	5490	28857	46830
Expenses-										
Capital Outlay/Equip	4	3	3	2	11	26	0	54	102	206
Personnel Salaries/Benefits	1061	845	1203	640	1191	3125	488	4899	23290	36743
Overhead	71	63	83	46	94	204	101	239	1662	2563
Employee Training	12	10	20	9	13	23	22	40	376	525
Vehicle/Mileage	15	12	18	9	19	48	8	85	363	577
Rent	52	48	56	33	67	153	65	150	1101	1726
Program Participants	0	0	0	0	0	0	0	0	0	0
Program Supplies	676	13	3	1	30	1201	0	24	586	2532
Equipment Maintenance	0	0	0	0	0	0	0	0	0	0
TOTAL	1893	994	1385	740	1425	4781	684	5490	27480	44872
NET	0	581	0	0	0	0	0	0	1377	1958

Recommendations

- **Finalize update of SRWMO watershed management plan in 2010.**
- **Finalize the Typo and Martin Lake Total Maximum Daily Load (TMDL) Study and Implementation Plan**. This project has been delayed at the MN Pollution Control Agency (MPCA). The MPCA and Anoka Conservation District have a work planned to finish it in 2010.
- **Do projects to improve water quality in Typo and Martin Lakes**. The TMDL study of these lakes and TMDL Implementation Plan will contain specific recommendations.
- **Improve stormwater treatment before discharge into lakes**; notably Martin and Coon.
- **Actively follow development of St. Croix River and Sunrise River TMDLs**, and become involved as appropriate.
- **Work cooperatively with other agencies doing a study of the entire Sunrise River watershed,** including the US Army Corps of Engineers and Chisago County.
- **Continue the SRWMO cost share grant program** to encourage water quality projects.
- **Promote and install more water quality improvement projects**. Some problems are well-documented and grants are available.

Chapter 3:
Upper Rum River Watershed

Task	Partners	Page
Lake Level Monitoring	URRWMO, ACD, MN DNR, volunteers	3-54
Lake Water Quality Monitoring	LRRWMO, ACD, ACAP	3-55
Stream Water Quality – Chemical Monitoring	URRWMO, ACD, MC	3-59
Stream Water Quality – Biological Monitoring	ACD, ACAP, St. Francis High School	3-68
Wetland Hydrology	ACD, ACAP	3-71
Water Quality Improvement Projects	URRWMO, ACD, Landowners	3-77
Anoka County Geologic Atlas	All Anoka Co. watershed organizations, ACD, MN Geologic Survey, MN DNR	3-78
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URRWMO Annual Newsletter	URRWMO, ACD	3-82
URRWMO 2008 Annual Report to BWSR	URRWMO, ACD	3-83
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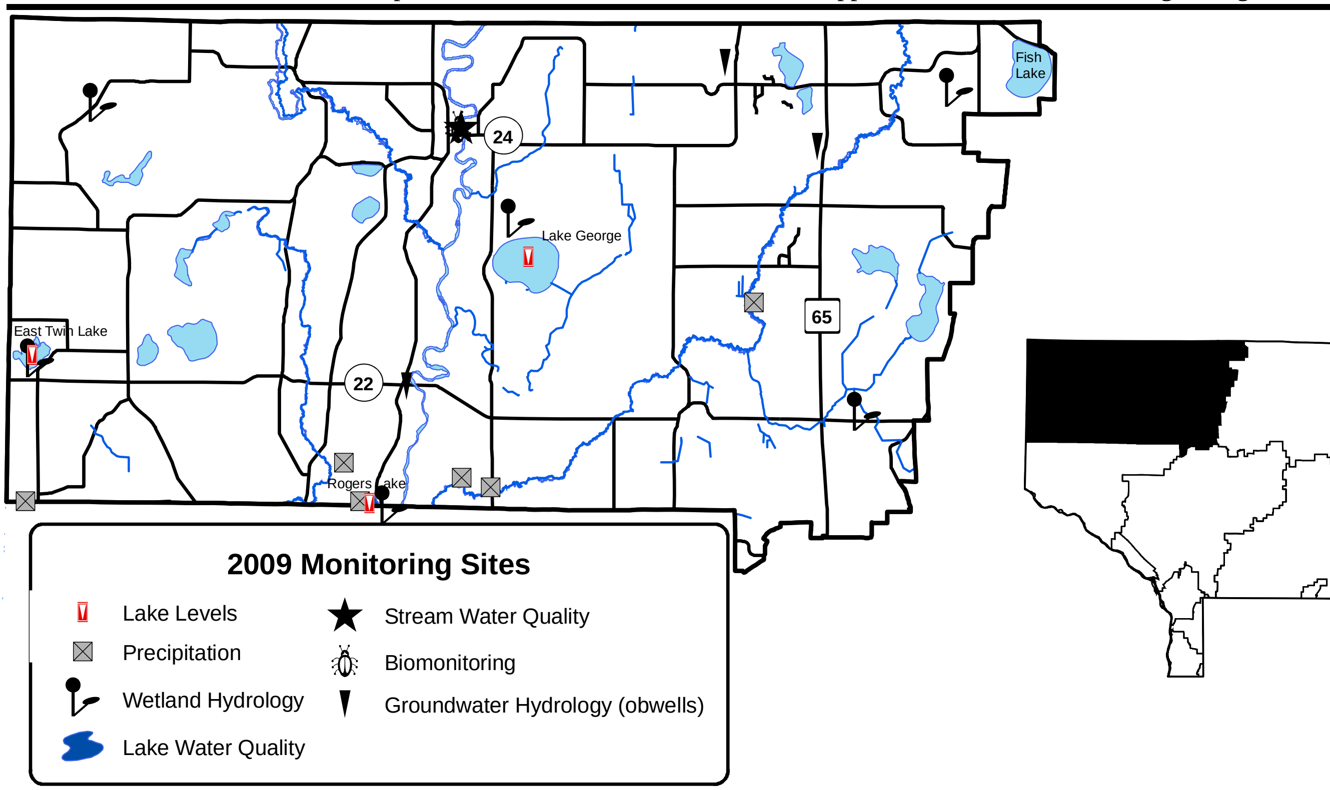
Groundwater Hydrology (obwells)	ACD, MNDNR	Chapter 1
Precipitation	ACD, volunteers	Chapter 1

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

Results: Water levels on Lake George, Rogers, and East Twin Lakes were measured 19, 26, and 27 times, respectively, by volunteers. All three lakes were affected by drought conditions in 2009 and all lakes are likely linked to the shallow water table.

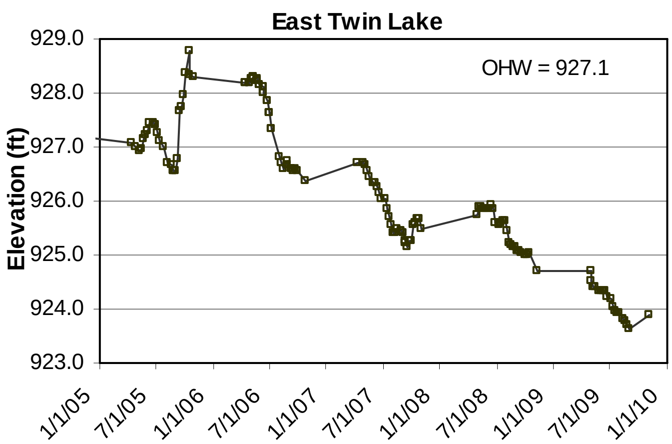
East Twin Lake has declined nearly continuously since late 2006. In 2006 water was abnormally high due to a beaver dam that was removed in 2006. Water declines in the following years were initially due to this dam removal, but more recently reflect drought. Water levels are now more than 4 feet lower than in 2006.

Lake George water levels have been relatively constant, but low, in recent years. Little water has been flowing into or out of the lake. Management of the lake’s only inlet, County Ditch #19, is of interest - residents have complained it is clogged and needs maintenance.

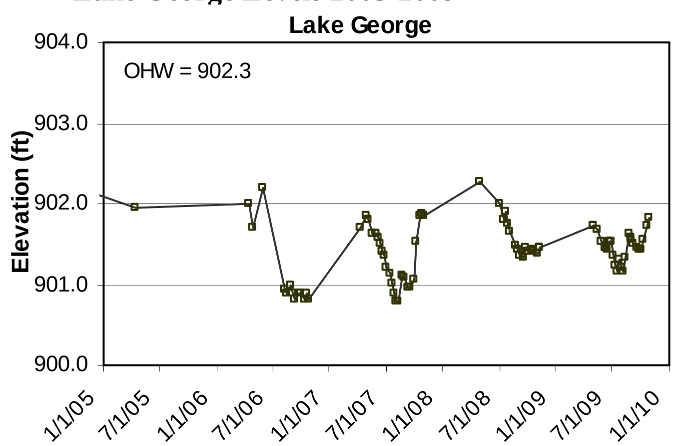
Rogers Lake has declined nearly continuously since the beginning of 2006, with a total drop of over two feet. It did increase 0.4 feet due to surplus rain in August and October.

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

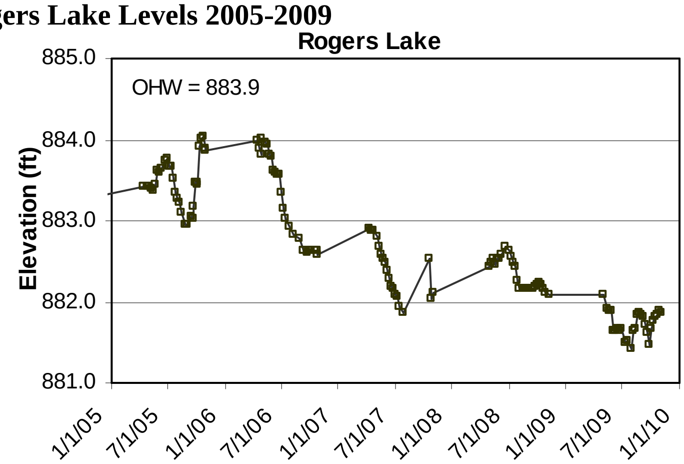
East Twin Lake Levels 2005-2009



Lake George Levels 2005-2009



Rogers Lake Levels 2005-2009



Upper Rum River Watershed Lake Levels Summary

Lake	Year	Average	Min	Max
East Twin	2005	926.67	926.05	927.33
	2006	927.61	926.37	928.29
	2007	925.79	925.15	926.71
	2008	925.45	924.70	925.94
	2009	924.13	923.62	924.72
George	2005	not available		
	2006	901.13	900.82	902.20
	2007	901.36	900.78	901.88
	2008	901.59	901.33	902.27
	2009	901.48	901.16	901.82
Rogers	2005	883.48	882.95	884.04
	2006	883.28	882.59	884.02
	2007	882.19	881.79	882.91
	2008	882.33	882.09	882.69
	2009	881.73	881.43	882.08

Lake Water Quality

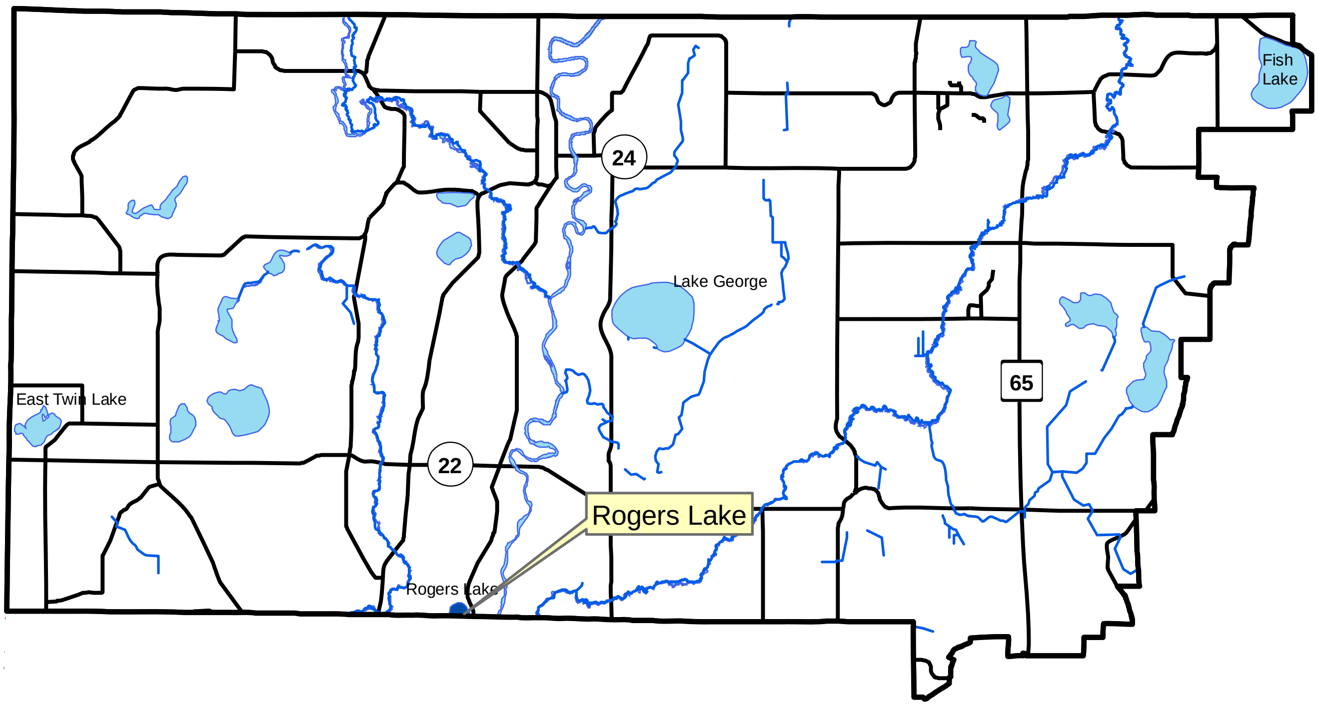
Description: May through September twice-monthly monitoring of the following parameters: total phosphorus, chlorophyll-a, Secchi transparency, dissolved oxygen, turbidity, temperature, conductivity, pH, and salinity.

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

Locations: Rogers 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.

Upper Rum River Watershed Lake Water Quality Monitoring Sites



Rogers Lake

Cities of Oak Grove, Ramsey, and Nowthen, LAKE ID # 03-0104

Background

Rogers Lake is in west-central Anoka County, and lies partially within the jurisdictional areas of both the Lower and Upper Rum River Watershed Management Organizations. It has a surface area of 40 acres and a maximum depth of 6 feet. The shoreline is about 1/3 developed, primarily on the western shore. There are no streams of any consequence entering or leaving this lake; it is an isolated basin with a small watershed. There is no public access. Rogers Lake is designated as "impaired" for excess nutrients by the MPCA.

Water Quality Results

In 2009 Rogers Lake received an overall B letter grade for water quality, but there are ecological concerns about the lake. The lake's condition has changed significantly within the last 2-4 years. The water became clearer and plant growth exploded between 2006 and 2008. This condition continued in 2009.

In 2006 total phosphorus was high (averaged 110 ug/L), the water was brown and turbid (average 12 FNRU), and algae levels were relatively high (average chlorophyll-a 38.5 mg/L). Plants were limited by the turbid water, and ACD staff estimated 40% of the lake had plants growing to the surface. Floating-leaved plant species were most abundant, probably because light levels were low below the surface. Other monitored years before 2006 had better water quality, but similar aquatic plant growth.

In 2008 and 2009 water quality was notably better and plant growth dramatically increased. In 2008 average phosphorus was 32 ug/L, better than the state water quality standard of 40 ug/L. In 2009 average phosphorus was 50 ug/L, but this was driven by a single high reading of 170 ug/L (contaminated sample?). Excluding that high reading the average phosphorus in 2009 was 37 ug/L. Chlorophyll-a was low in 2008 (12.3 ug/L) and even lower in 2009 (7.1 ug/L). The water was clear in both years (average turbidity 3 FNRU both years). Plants grew densely and to the surface across 95% of the lake. The entire water column was filled with plants. Species included curly-leaf pondweed, large-leaf pondweed, floating-leaf pondweed, water shield, and lilies. Large-leaf pondweed was most abundant. Curly-leaf pondweed was least abundant.

The plant abundance is benefiting some aspects of water quality but negatively affecting recreation and the fishery. Abundant plants are consuming phosphorus, out-competing algae, and minimizing sediment disturbance so the water is clearer. However the abundance of plants eliminates almost all boating, swimming and fishing. Decomposition of the abundant plants consumes oxygen, depleting it below levels needed by most fish. The layer of plants at the surface reduces wind mixing that would oxygenate water. By early June dissolved oxygen levels dropped below 4 mg/L. Dissolved oxygen levels decreased further later in summer, remaining below 2 mg/L for over three months. No dead fish were seen, but a resident said similar conditions occurred in 2007, likely killing most fish at that time. Schools of 1" bullheads and tadpoles were the only aquatic animals seen in 2009.

The water quality in 2008-09 was not unusual for this lake but the abundance of plants was unusual. Water quality records from 1998, 2000, and 2003 are similar to 2008 and 2009. But a review of aerial photos shows that before 2007 there was much less plant growth on the lake (see photos below). In 2000, 2003, and 2006 aerial photos plants grew to the surface on <40% of the lake. Similar or less plant growth is seen in 1938, 1953, 1964, and 1970 aerial photos. In 2008-09 plants covered 95% of the lake almost the entire open water season.

Trend Analysis

Six years of water quality monitoring have been conducted by the Anoka Conservation District and Secchi depths were taken by citizens one other year. This is not enough data to perform a trend analysis.

Discussion

In recent years Rogers Lake has traded one problem for another. In 2006 and earlier the lake had high phosphorus, algae, and turbity. In more recent years water has been clear, but aquatic plants have increased many-fold. This has created recreational and low dissolved oxygen problems. Generally, a rich aquatic plant community is desirable and healthy in a shallow lake, but here it has arguably become excessive and problematic.

The reason for the explosion in aquatic plant growth is not clear. While plant growth is expected to increase with clearer water, there were no changes in the watershed or lake management that would have created clearer water. The abundant plant species in Rogers Lake are not generally aggressive or problematic in other lakes. Low water levels, cooler than usual spring weather in consecutive years, and past illegal herbicide treatments are possible reasons for vegetation changes in the lake.

While some plant management may be beneficial for this lake, little is legally allowed. The purpose of plant management would be to reduce spring plant growth as a way of reducing the amount of decaying plant material later in summer. This should result in higher summer dissolved oxygen. It will also increase open water areas for recreation, such as canoeing. It should not be designed to eliminate plants; plants are essential to the health of shallow lakes. Generally less no more than 15% of the lake should be treated and treatment should be targeted toward critical species and areas.

Little vegetation management is legal on Rogers Lake for the following reasons:

- Rogers Lake is classified as a natural environment lake, and no herbicide use is allowed under state rules. Mechanical clearing of an area up to 2500 square feet per property is allowed without a permit.
- Where floating leaf vegetation (lilies, water shield) is present, only mechanical clearing of a 15 foot wide channel to open is allowed without a permit. Obtaining a permit for greater areas is highly unlikely. There is no open water to try to reach. Lilies and water shield are almost everywhere on Rogers Lake, eliminating almost all allowable vegetation clearing.
- State rules discourage vegetation control on shallow lakes, which are healthiest when plant-dominated.
- Invasive species are not a problem. Vegetation control is generally not allowed or discouraged for native species that are most abunant on Rogers Lake.
- Overriding the noted problems about low dissolved oxygen and open water for recreation are the fact that there should be little expectation for a fishery or open water recreation on such a shallow lake.

In summary, the only allowable vegetation clearing on Rogers Lake is (a) mechanical clearing of an area 2500 square feet in the rare instances where no floating leaf vegetation would be impacted and (b) a 15 foot channel where floating leaf plants are present. Please see the DNR website or publications for more detailed information on state aquatic vegetation rules before proceeding with any work.

In the end, the current plant-dominated condition of Rogers Lake should be adopted as the best condition for this lake. Ecologically, a shallow lake of this type is healthiest when it is plant dominated. State water quality standards and state plant management rules are designed to promote this condition. Admittedly, for Rogers Lake there is a negative side – reduced recreational suitability and reduced dissolved oxygen. These conditions are common for this type of lake in a healthy condition.

Aerial photos showing increase in aquatic plants, particularly between 2006 and 2008. Light green areas are aquatic plants. Black areas are open water.

2000 2003 2006 2008

Photos of aquatic plant growth in Rogers Lake.


May 27, 2009


June 10, 2009

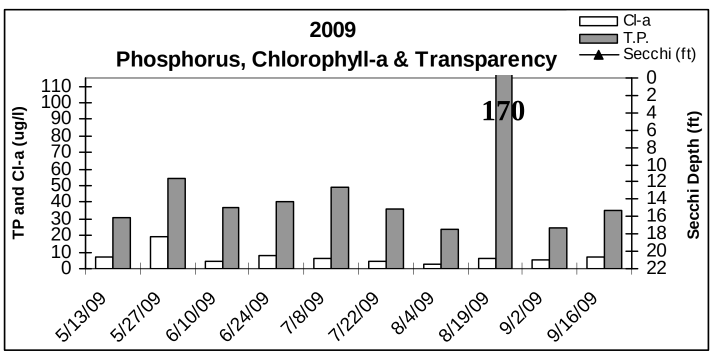

August 4, 2009

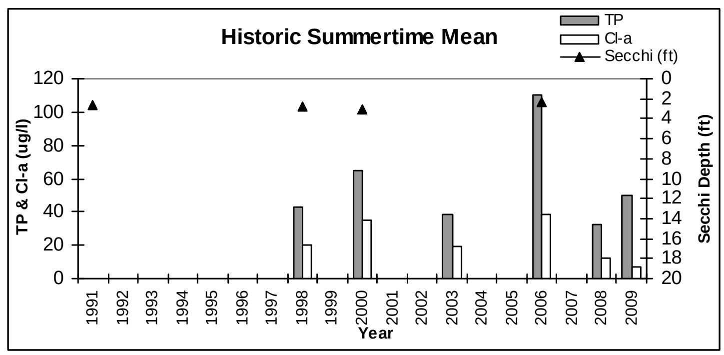

Decomposing large-leaf pondweed.

Rogers Lake Water Quality Results

Rogers Lake 2009	Units	R.L.*	5/13/2009 10:50 Results	5/27/2009 10:30 Results	6/10/2009 10:10 Results	6/24/2009 10:15 Results	7/8/2009 10:15 Results	7/22/2009 10:40 Results	8/4/2009 10:25 Results	8/19/2009 9:45 Results	9/2/2009 10:15 Results	9/16/2009 9:20 Results	Average	Min	Max
pH		0.1	7.17	6.47	6.93	5.81	5.73	5.76	5.60	5.64	5.30	5.52	5.99	5.30	7.17
Conductivity	mS/cm	0.010	0.780	0.083	0.075	0.074	0.069	0.061	0.059	0.062	0.061	0.063	0.139	0.059	0.780
Turbidity	FNRU	1	4	3	0	3	7	2	3	2	4	3	3	0	7
D.O.	mg/L	0.01	7.78	4.03	2.81	1.39	1.16	1.13	0.21	1.63	1.25	2.22	2.36	0.21	7.78
D.O.	%	1	78%	42%	26%	16%	13%	10%	2%	18%	12%	20%	24%	2%	78%
Temp.	°C	0.1	16.0	17.6	14.9	24.5	21.6	19.9	21.0	20.2	18.0	19.4	19.3	14.9	24.5
Temp.	°F	0.1	60.8	63.7	58.8	76.1	70.9	67.8	69.8	68.4	64.4	66.9	66.8	58.8	76.1
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	ug/L	1	7.4	19.4	4.7	7.5	5.8	4.8	2.3	6.2	5.0	7.4	7.1	2.3	19.4
T.P.	mg/L	0.005	0.031	0.054	0.037	0.040	0.049	0.036	0.024	0.170	0.025	0.035	0.050	0.024	0.170
T.P.	ug/L	5	31	54	37	40	49	36	24	170	25	35	50	24	170
Secchi	ft	0.1	>max depth	>4.8	>4.7	>4	>4	>4	>4	>4	>4	>4			
Secchi	m	0.1	>max depth	>1.5	>1.4	>1.2	>1.2	>1.2	>1.2	>1.2	>1.2	>1.2			
Field Observations															
Physical			1.0	1.5	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	1.5	2.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	4.0	1.0	5.0

*reporting limit





Rogers Lake Historical Means

Agency	CAMP	ACD	ACD	ACD	ACD	ACD	ACD
Year	91	98	2000	2003	2006	2008	2009
TP (ug/L)		42.70	64.70	38.4	110.0	32	50
Cl-a (ug/L)		20.30	35.10	19.4	38.5	12.3	7.1
Secchi (m)	0.81	0.85	0.91	n/a	0.7	n/a	n/a
Secchi (ft)	2.7	2.8	3.00	n/a	2.3	n/a	n/a

Carlson's Trophic State Index

TSIP		58	62	57	72	54	61
TSIC		60	62	60	67	55	50
TSIS	63	62	63	n/a	65	n/a	n/a
TSI		59*	62*	58*	68	55*	55*

Rogers Lake Water Quality Report Card

Year	91	98	2000	2003	2006	2008	2009
TP		C	C	C	D	B-	C
Cl-a		C	C	B	C	B	A
Secchi	D	n/a*	n/a*	n/a*	D-	n/a*	n/a*
Overall		**C**	**C**	**B**	**D**	**B**	**B**

*Secchi transparency not included because as secchi depth exceeded lake depth

Stream Water Quality - Chemical Monitoring

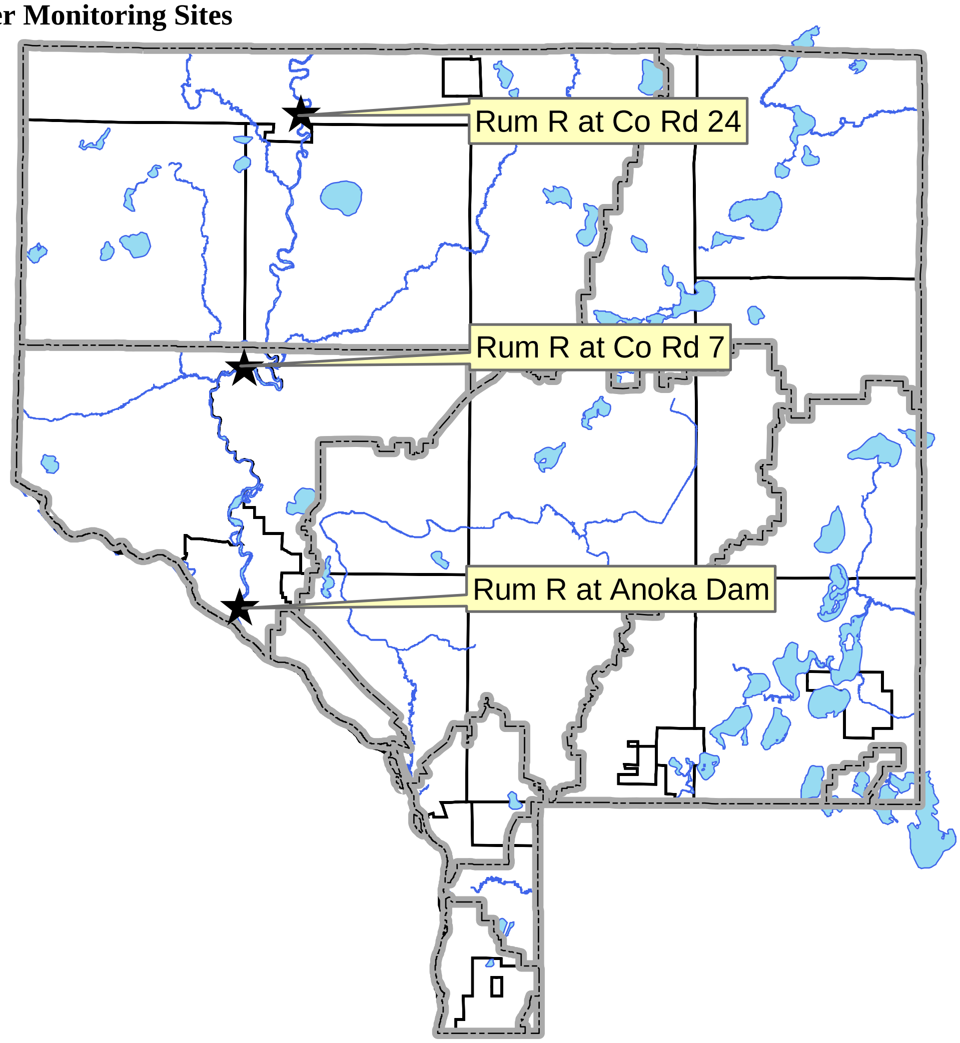
Description: In the Upper Rum River Watershed in 2009 stream monitoring was accomplished through two complimentary programs. First, the Upper Rum River Watershed Management Organization (URRWMO) monitored the Rum River near its entry into their jurisdictional area and at its exit (boundary between the URRWMO and LRRWMO). Secondly, the Metropolitan Council monitored the Rum River near its outlet to the Mississippi through their Watershed Outlet Monitoring Program (WOMP). The Anoka Conservation District did the field work for both projects, ensured monitoring for both programs was conducted simultaneously so the data could be compared, and reports the data together for a more comprehensive analysis of the river from upstream to downstream.

Purpose: To understand water quality and hydrology throughout the twin cities metropolitan area. To detect water quality trends and problems, and diagnose the source of problems.

Locations: Rum River at the Anoka Dam, City of Anoka

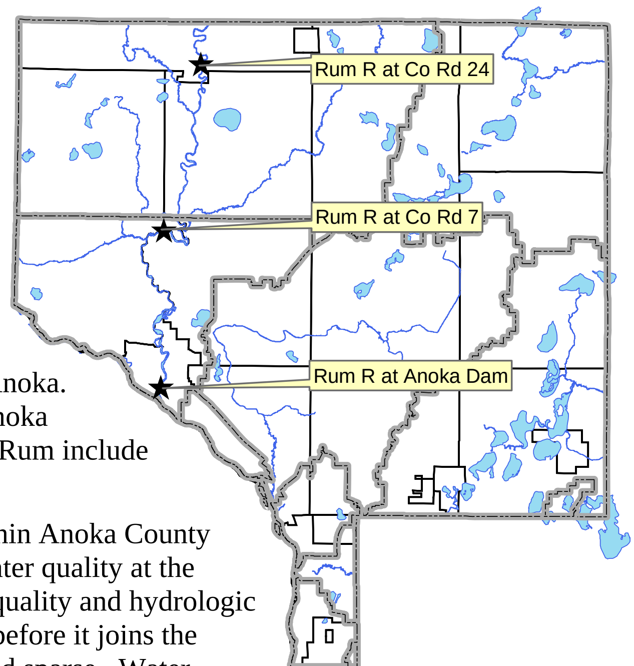
Results: Results are presented on the following page, with a focus on comparing river conditions from upstream to downstream. More detailed reporting for the WOMP monitoring station, including additional parameters and analysis are presented elsewhere by the Metropolitan Council (see http://www.metrocouncil.org/Environment/RiversLakes/).

2009 Rum River Monitoring Sites



RUM RIVER

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



Years Monitored

At Co. Rd. 24 – 2004, 2009

At Co. Rd. 7 – 2004, 2009

At Anoka Dam – 1996-2009 by the Met Council WOMP program

Background

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

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

Methods

In 2004 and 2009, monitoring was conducted at three locations simultaneously to determine if Rum River water quality changes in Anoka County, and if so, generally where changes occur. The URRWMO funded monitoring near where the river enters Anoka County (Co. Rd 24) and midway through the county near the lower boundary of their jurisdictional area (Co. Rd. 7). The Metropolitan Council monitored at the Anoka Dam, where there has been ongoing monitoring since 1996. The Anoka Conservation District did the field work for both projects, ensured monitoring for both programs was conducted simultaneously so the data could be compared, and reports the data together for a more comprehensive analysis of the river from upstream to downstream.

The river 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. 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. Ten additional parameters were tested by the Metropolitan Council at their laboratory for the Anoka Dam site only and are not reported here. During every sampling the water level (stage) was recorded. The monitoring station at the Anoka Dam includes automated equipment that continuously tracks water levels and calculates flows. Water level and flow data for other sites was obtained from the US Geological Survey, who maintains a hydrological monitoring site at Viking Boulevard.

The purpose of this report is to make an upstream to downstream comparison of Rum River water quality. It includes only parameters and dates that were simultaneously tested at all three sites. It does not include additional parameters tested at the Anoka Dam or additional monitoring events at that site. For that information, see Metropolitan Council reports at http://www.metrocouncil.org/Environment/RiversLakes.

Results and Discussion

Overall, Rum River water quality is good throughout Anoka County, however it does decline below the County Road 7 bridge (i.e. in the Cities of Andover, Anoka, and Ramsey). The declines in water quality below that point are modest, as are declines in water quality during storms. Dissolved pollutants (as measured by conductivity and chlorides), total phosphorus, turbidity, and total suspended solids were all generally near or below the median of all 40+ Anoka County streams that have been monitored.

Although water quality is good, several areas of concern were noted. First, dissolved pollutants increased at each monitoring site downstream. Dissolved pollutants were highest during baseflow, indicating pollutants have infiltrated into the groundwater which feeds the river and tributaries during baseflow. Road deicing salts are likely the most significant dissolved pollutant. Secondly, total suspended solids increased notably below County Road 7. This was most pronounced during storms.

It is important to recognize the limitations of this report. The data is only from 2004 and 2009 when all three sites were monitored simultaneously to allow comparisons. The dataset is relatively small. 2009 was a drought year and the flows and storms sampled were lower than normal. We did not sample any flood-like conditions when river water quality is likely worst. If a more detailed analysis of river water quality is desired, data from many years and a variety of conditions is available for the Anoka Dam site through the Metropolitan Council.

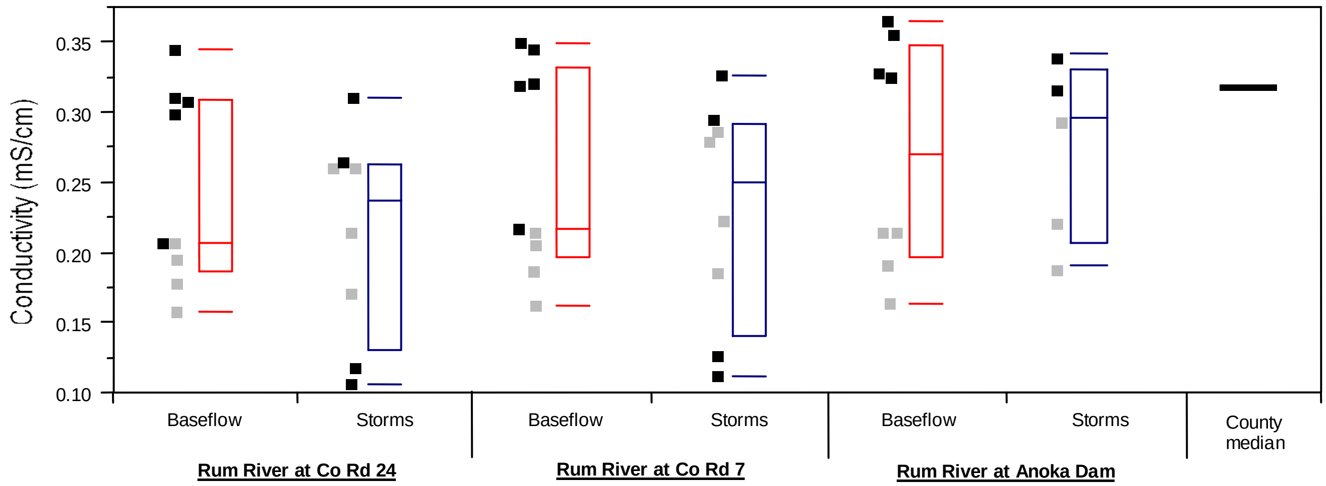
On the following pages data are presented and discussed for each parameter. The last section outlines management recommendations. The Rum River is an exceptional waterbody, and its protection and improvement should be a high priority.

Conductivity and chlorides

Conductivity and chlorides are measures 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. They can also be of concern because the Rum River is upstream from the Twin Cities drinking water intakes on the Mississippi River.

Conductivity is acceptably low in the Rum River, but increases downstream (see figure below) and during baseflow. Across all three sites conductivity averaged 0.247 mS/cm, which is lower than the median for 40+ Anoka County streams of 0.318 mS/cm. The maximum observed conductivity was 0.363 mS/cm. Conductivity was lowest at all sites 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 most other nearby streams too, studied extensively, and the largest cause has been found to be road salts that have infiltrated into the shallow aquifer. Geologic materials also contribute, but to a lesser degree. Baseflow conductivity increases from upstream to downstream, reflecting greater road densities and deicing salt application. Storm conductivity, while lower than baseflow, did also increase from upstream to downstream. This is reflective of greater stormwater runoff and pollutants associated with the more densely developed lower watershed.

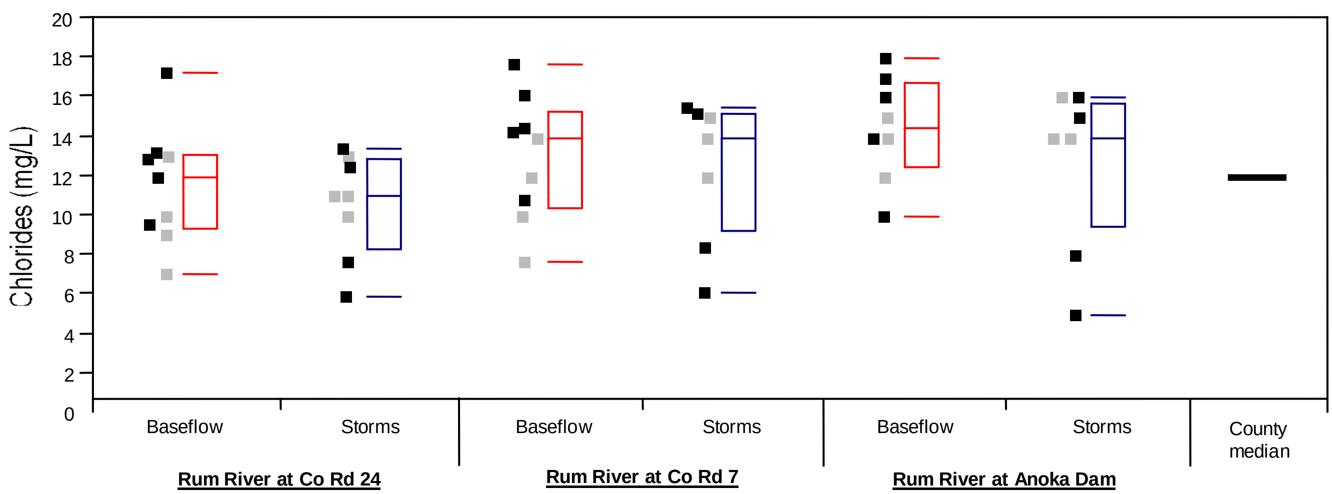
Conductivity results during baseflow and storm conditions Grey dots are individual readings from 2004; black dots are 2009 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Upstream → Downstream

Chloride results parallel those found for conductivity (see figure below), supporting the hypothesis that chloride is an important cause of the conductivity. Chloride levels in the Rum River (median 11, 14, and 14 mg/L from upstream to downstream) are similar to the median for Anoka County streams of 12 mg/L. The highest observed value was 18 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. Like conductivity, chlorides were slightly higher during baseflow than storms at each site and increased from upstream to downstream. Road deicing salt infiltration into the shallow groundwater is likely the primary contributor, as described above.

Chloride results during baseflow and storm conditions Grey dots are individual readings from 2004; black dots are 2009 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

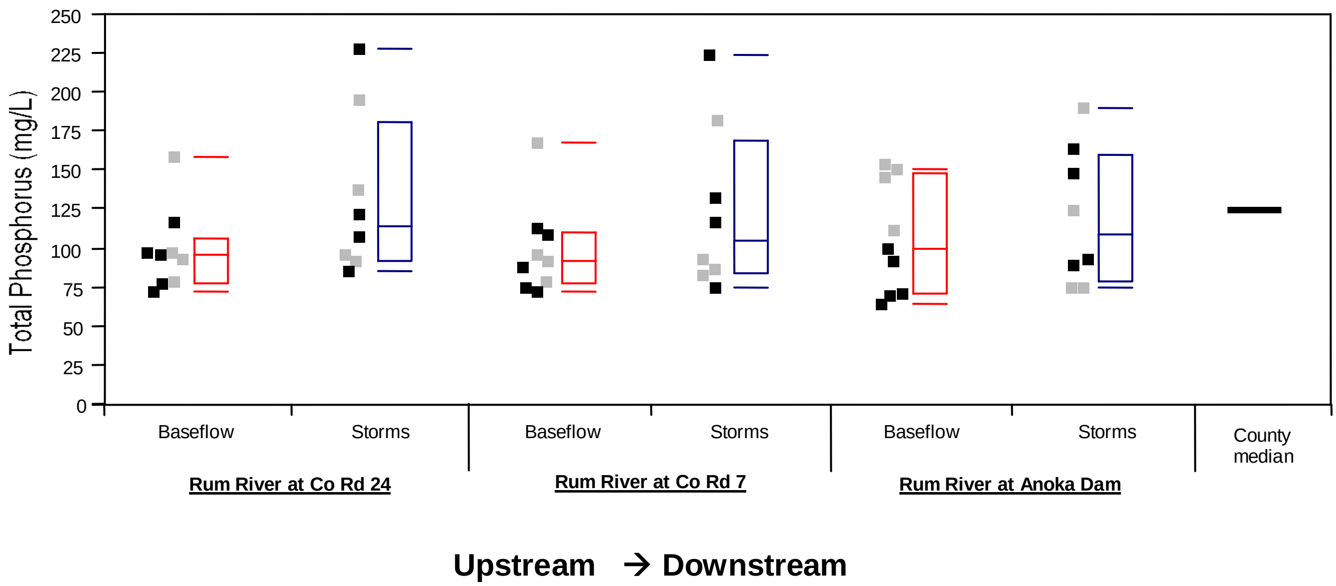


Upstream → Downstream

Total Phosphorus

Total phosphorus in the Rum River is acceptably low and is similar to the median for all other monitored 40+ Anoka County streams (see figure below). This nutrient is one of the most common pollutants in our region, and can be associated with urban runoff, agricultural runoff, wastewater, and many other sources. The median phosphorus concentration at each of the three monitored sites was 99, 95, and 101 ug/L; there is no trend of increasing phosphorus downstream. All sites occasionally experience phosphorus concentrations higher than the median for Anoka County streams of 126 ug/L. All of the highest observed total phosphorus readings were during storms, including the maximums at each site of 230, 226, and 192 ug/L (upstream to downstream). In all, phosphorus in the Rum River is at acceptable levels but should continue to be an area of pollution control effort as the area urbanizes.

Total phosphorus results during baseflow and storm conditions Grey dots are individual readings from 2004; black dots are 2009 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. Suspended solids in the Rum River are moderately high, but only at the Anoka Dam and during storms. The results for turbidity and TSS differ, lending insight into the types of particles that are problematic.

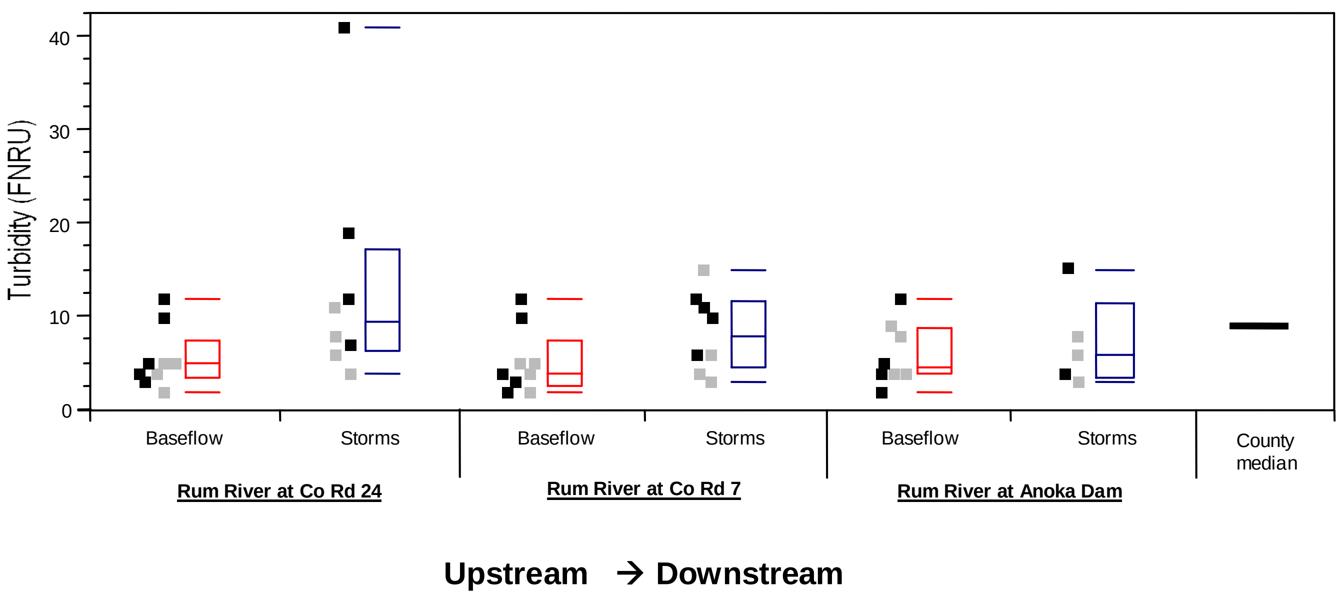
Turbidity was low, with only slight increases during storms and no apparent increase at downstream monitoring sites (see figure below). The median turbidity at each site was 6, 5, and 5 FNRU (upstream to downstream), which is lower than the median for Anoka County streams of 9 FNRU. The maximum observed was 41 FNRU, but this seemed to be an isolated event given that the next highest was 19. The Rum River's turbidity did not regularly exceed the Minnesota Pollution Control Agency's water quality standard of 25 NTU.

TSS was low at the upper two monitoring sites, with slight increases during storms (see figure below). The countywide TSS median for streams is 14 mg/L. Overall median TSS in the Rum River was 8 and 9 mg/L at County Roads 24 and 7, respectively. During storms median TSS was 2 and 4 mg/L higher than during baseflow for the two sites. Maximum TSS observed at these two sites were 28 and 23 mg/L. The maximum readings and slight increases during storms are not unexpectedly high for a large river, and are within the range that should be considered healthy.

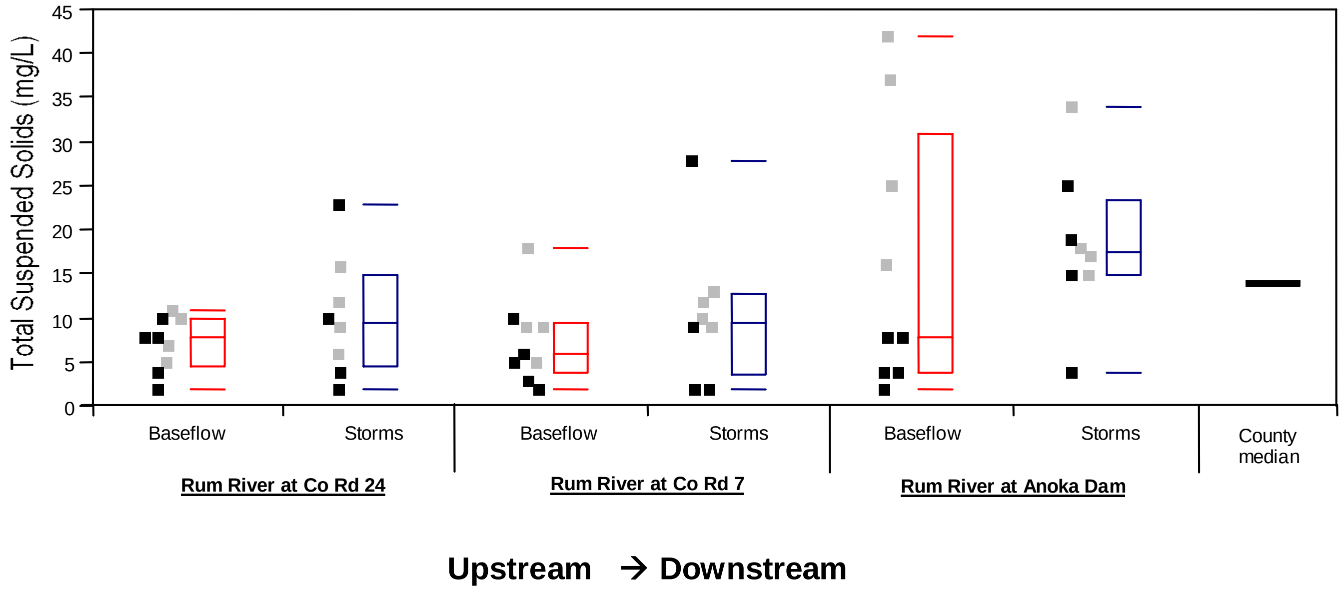
TSS increased noticeably between County Road 7 and the Anoka Dam (see figure below). At the Anoka Dam median TSS was similar to the other sites during baseflow (8 mg/L), but the three highest baseflow readings (25, 37, and 42 mg/L) were much higher than experienced at upstream sites. During storms TSS was only once below 15 mg/L and the maximum was 34 mg/L. While this does not exceed the Minnesota Pollution Control Agency's surrogate turbidity standard of 100 mg/L TSS, it is undesirable to have such notable water quality deterioration in such a short stretch of the river.

It should be noted that the data presented here do not include monitoring of any large flood events. The water is known to become muddier during such floods. In fact, the data presented in this report is skewed toward lower flow conditions that are likely to carry lower suspended solids because 2009 was a drought year. Notice in the figure below that 2009 generally had lower TSS than 2004.

Turbidity results during baseflow and storm conditions Grey dots are individual readings from 2004; black dots are 2009 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



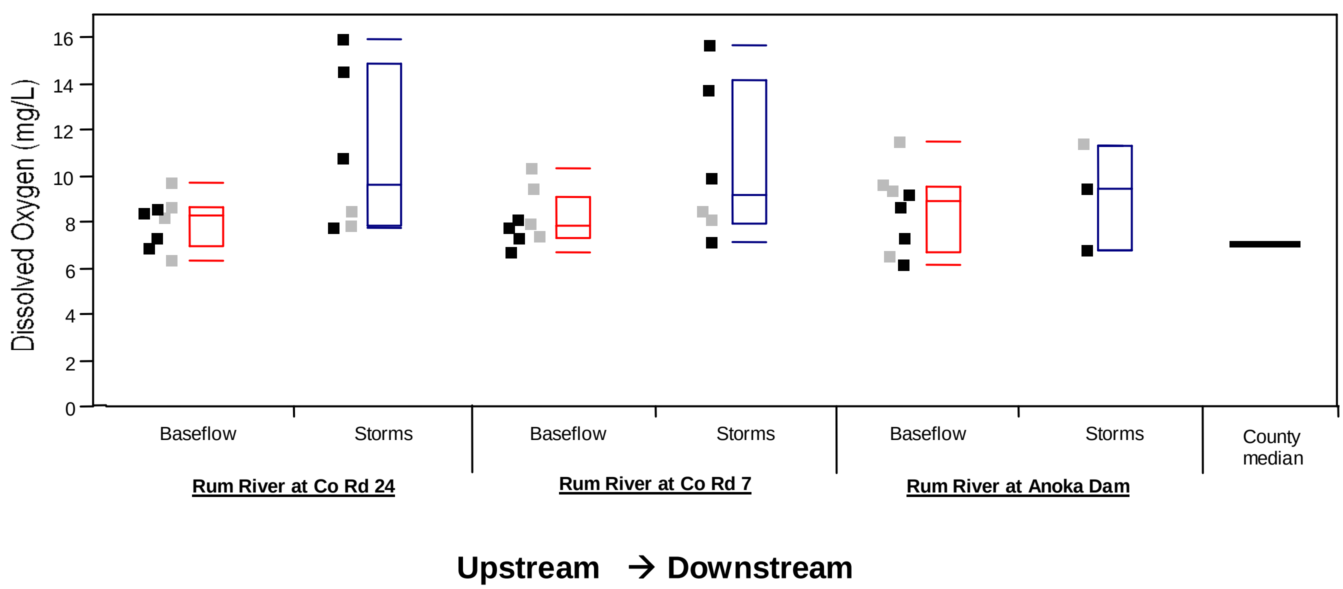
Total suspended solids results during baseflow and storm conditions Grey dots are individual readings from 2004; black dots are 2009 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution consumes oxygen when it decomposes. If oxygen levels fall below 4 mg/L aquatic life begins to suffer. In the Rum River dissolved oxygen was always above 6 mg/L at all monitoring sites.

Dissolved oxygen results during baseflow and storm conditions Grey dots are individual readings from 2004; black dots are 2009 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

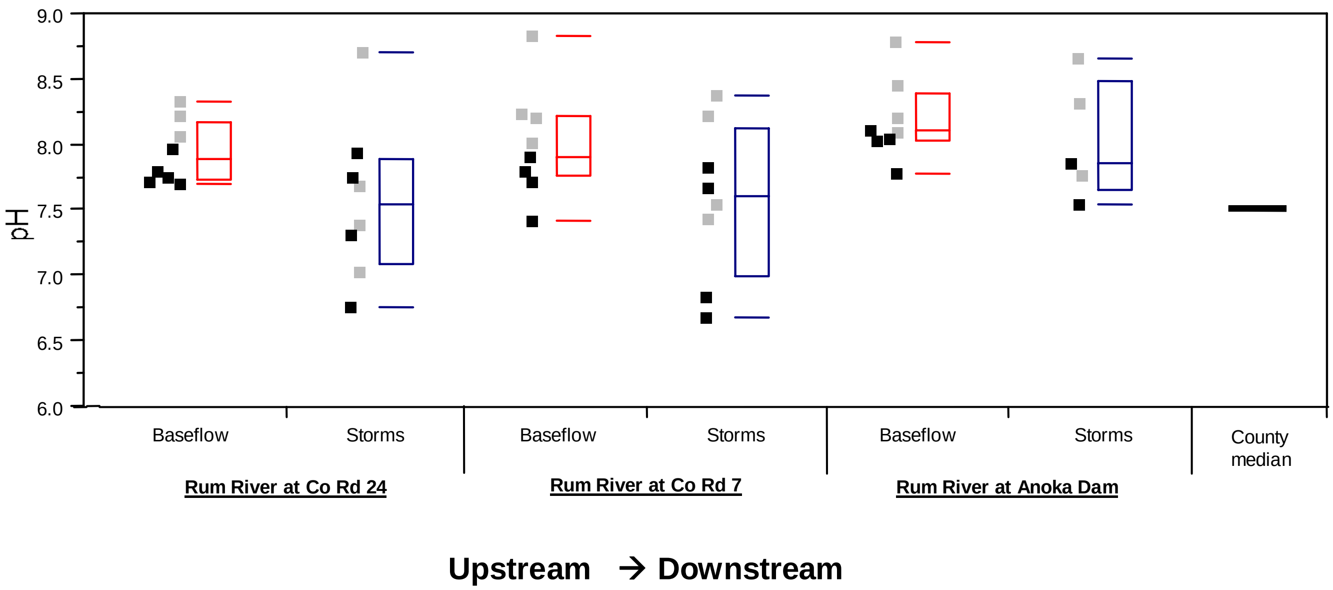


pH

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. The Rum River is regularly within this range (see figure below). Each of the three sites exceeded 8.5 on one occasion, but the highest was only 8.85. This rare and modest exceedance of the state water quality standard is not concerning.

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 Grey dots are individual readings from 2004; black dots are 2009 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Recommendations

While the Rum River's water quality is generally good, it does show some deterioration in the downstream areas that are most developed. Protection of the Rum River should be a high priority for local officials. Large population increases are expected for the Rum River's watershed within Anoka County and have the potential to degrade water quality unless carefully sited and managed. Development pressure is likely to be especially high near the river because of its scenic and natural qualities. Measures to maintain the Rum River's good water quality should include:

- Enforce the building and clear-cutting setbacks from the river required by state scenic rivers laws to avoid bank erosion problems and protect the river's scenic nature.
- Use the best available technologies to reduce pollutants delivered to the river and its tributaries through the storm sewer system. Any new development should consider low impact development strategies that minimize stormwater runoff production. Aggressive stormwater treatment should be pursued in all areas of the watershed, not just those adjacent to the river.
- Seek improvements to the existing stormwater conveyance system below County Road 7. Total suspended solids in the river increase significantly in this portion of the watershed, reaching their highest concentrations during storms.
- Utilize all practical means to reduce road deicing salt applications. These may include more efficient application methods, application only in priority areas, alternate chemicals, or others. Road salt infiltration into the shallow groundwater has become a regional problem.

- Survey the river by boat for bank erosion problems and initiate projects to correct them.
- Continue education programs to inform residents of the direct impact their actions have on the river's health.
- Continue regular water quality monitoring. In addition to continuous monitoring of the Rum River by Metropolitan Council's Watershed Outlet Monitoring Program (WOMP), additional upstream monitoring should be conducted every 2-3 years. Monitoring should be coordinated to occur on the same days as the Met Council testing so direct comparisons are possible. Additionally, periodic monitoring of the primary tributary streams should also occur every 2-3 year. The Upper and Lower Rum River Watershed Management Organizations are best suited to do this watershed-level monitoring and should coordinate.

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.

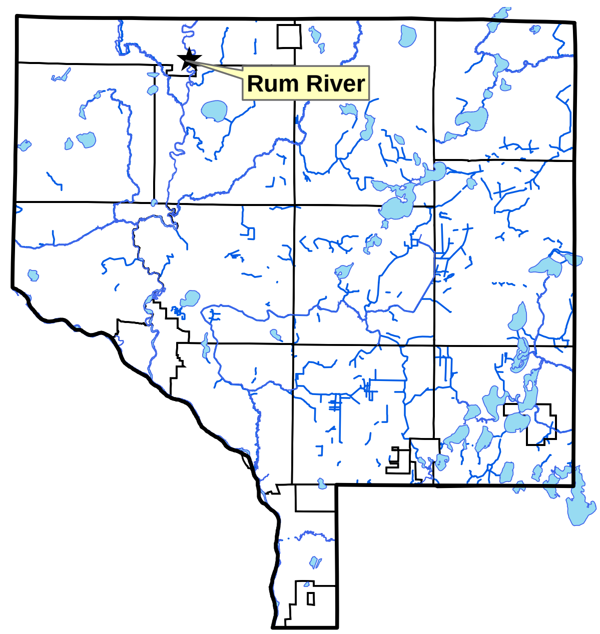
FBI	Stream Quality Evaluation
0.00-3.75	Excellent
3.76-4.25	Very Good
4.26-5.00	Good
5.01-5.75	Fair
5.76-6.50	Fairly Poor
6.51-7.25	Poor
7.26-10.00	Very Poor

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

Biomonitoring

RUM RIVER

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



Last Monitored

By St. Francis High School in 2009

Monitored Since

2000

Student Involvement

112 students in 2009, approx 980 since 2000

Background

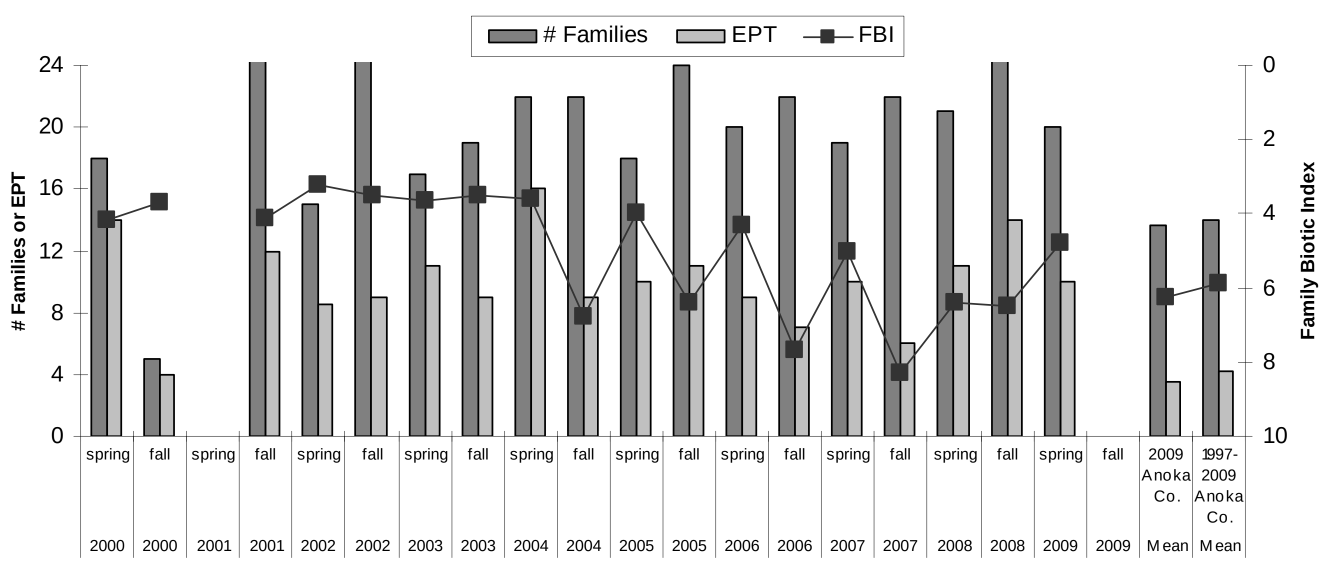
The Rum River originates from Lake Mille Lacs, and flows south through western Anoka County where it joins the Mississippi River in the City of Anoka. Other than the Mississippi, this is the largest river in the county. In Anoka County the river has both rocky ripples as well as pools and runs with sandy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

Results

St. Francis High School classes monitored the Rum River in both spring and fall 2009, with Anoka Conservation District oversight. The fall data was not usable because a portion of the sample was lost. Biological data for 2009, and historically, indicate the Rum River in northern Anoka County has the best conditions of all streams and rivers monitored throughout Anoka County. In 2009 the number of families, number of EPT families, and Family Biotic Index (FBI) were substantially above the county averages. Twenty families were found in spring 2009 and 35 in fall 2008; the next highest number of families ever found at 25 other Anoka County monitored streams is 24.

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

Year	2000	2000	2001	2001	2002	2002	2002	2003	2003	2003	2003	2004	2004
Season	spring	fall	spring	fall	spring	spring	fall	spring	spring	fall	fall	spring	fall
FBI	4.16	3.70	not sampled	6.30	3.80	2.90	4.80	4.10	3.20	3.70	3.60	3.60	6.80
# Families	18	5		29	10	20	25	18	16	12	26	22	22
EPT	14	4		12	7	10	9	11	10	6	11	16	9
Date	5/24	?		23-Oct	3-Jun	29-May	8-Oct	30-May	29-May	10-Oct	1-Oct	19-May	29-Sep
sampling by	ACD	Xroads		SFHS	Xroads	SFHS	SFHS	Xroads	SFHS	Xroads	SFHS	SFHS	SFHS
sampling method	MH	MH		MH	MH	MH	MH	MH	MH	MH	MH	MH	MH
# individuals	125	233		152.5	164	112	133	132	104	278	102	151	468
# replicates	1	1		2	1	2	2	1	2	1	2	3	2
Dominant Family	heptageniidae	hydropyschidae		corixidae	hydropyschidae	perlodidae	hydropsychidae	hydropyschidae	hydropsychidae	baetidae	oligoneuridae	hydropsychidae	corixidae
% Dominant Family	22	81.5		21	64	36.6	19.9	41.6	48.3	61.2	30.9	40.5	38.2
% Ephemeroptera	46.4	1.7		18	6.1	11.2	20.3	11.4	11	78.1	51	31.7	15.4
% Trichoptera	20.8	87.6		9.2	70.1	29	20.3	42.4	54.1	13.3	13.7	48.9	1.5
% Plecoptera	7.2	9.4		3.9	15.2	45.1	13.2	12.9	31.1	0.4	9.8	13.9	2.6

Year	2005	2005	2006	2006	2007	2007	2008	2008	2009	2009	Mean	Mean
Season	spring	fall	spring	fall	spring	fall	spring	fall	spring	fall	2009 Anoka Co.	1997-2009 Anoka Co.
FBI	4.00	6.40	4.30	7.70	5.00	8.30	6.40	6.50	4.80	Unusable	6.3	5.9
# Families	18	24	20	22	19	22	21	35	20	sample	13.6	13.9
EPT	10	11	9	7	10	6	11	14	10		3.6	4.2
Date	25-May	29-Sep	25-May	2-Oct	16-May	11-Oct	27-May	30-Sep	29-Apr	13-Oct		
sampling by	SFHS	SFHS	SFHS	SFHS	SFHS	SFHS	SFHS	SFHS	SFHS	SFHS		
sampling method	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH		
# individuals	138	272	152	187	262	502	348	156	267			
# replicates	1	2	2	2	2	2	2	4	2			
Dominant Family	perlodidae	gyrinidae	hydropsychidae	corixidae	hydropsychidae	corixidae	corixidae	corixidae	corixidae			
% Dominant Family	29.7	22.4	35.3	66.3	42.7	58.8	57.5	61.4	24.3			
% Ephemeroptera	50	25	20.8	9.9	17.2	2	11.9	17.9	18.7			
% Trichoptera	11.6	5.9	35.3	4.8	44.3	1	5.9	6.9	20.2			
% Plecoptera	31.2	8.1	22.4	1.6	8	0.2	17.1	2.1	27.7			

Supplemental Stream Chemistry Readings

Parameter	5-29-03	5-19-03	9-29-04	9-29-05	5-25-06	10-2-06	5-16-07	10-11-07	5-27-08	9-30-08	4-29-09	10-13-09
pH	7.86	8.26	9.05	8.05	7.70	7.94	8.53	7.76	7.73	7.70	7.62	7.87
Conductivity (mS/cm)	0.274	0.163	0.168	0.194	0.265	0.351	0.278	0.242	0.284	0.341	0.266	0.291
Turbidity (NTU)	4	5	8	10	14	6	11	17	7	4	6	na
Dissolved Oxygen (mg/L)	na	na	9.13	8.86 (87%)	8.00 (86%)	10.87 (106%)	10.34 (106%)	9.66 (89%)	10.18 (101%)	7.83 (76%)	10.53 (97%)	12.22 (93%)
Salinity (%)	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01
Temperature (C)	17.8	16.0	14.4	14.0	18.3	14.7	16.8	12.3	15.3	13.4	12.2	5.2

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.
- 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.
- Survey the river by boat for bank erosion problems and initiate projects to correct them.
- 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

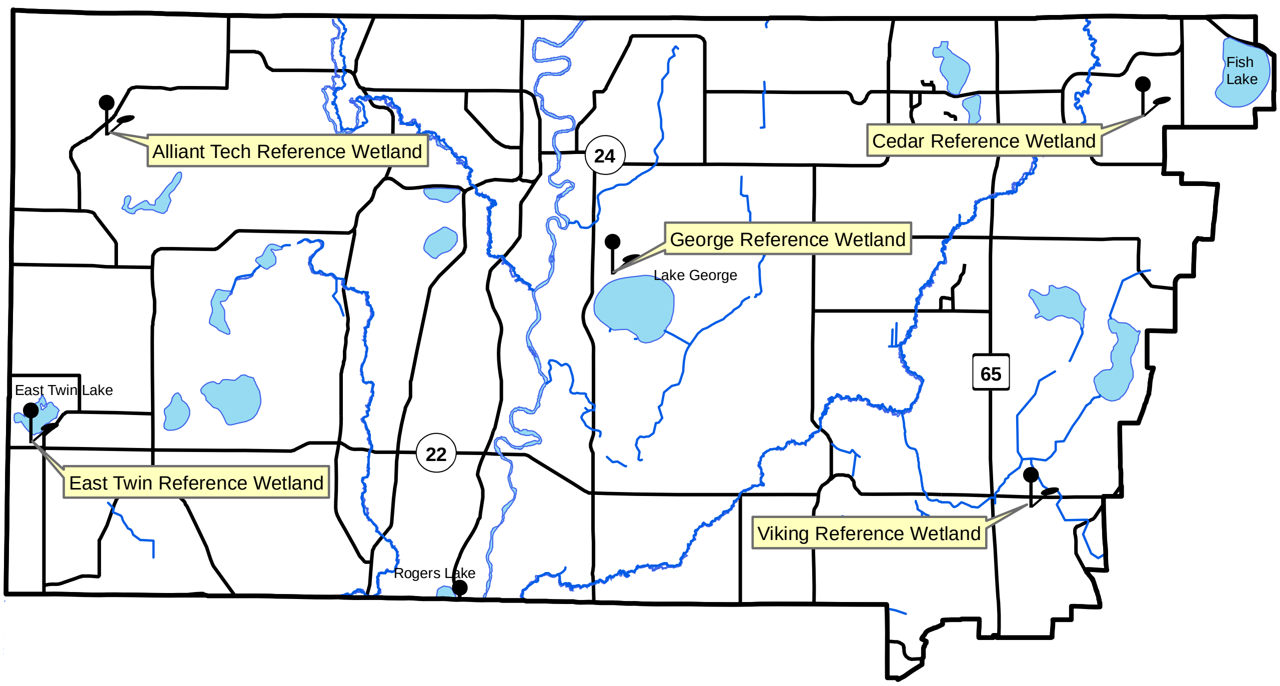
East Twin Reference Wetland, East Twin Township Park, Nowthen

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.

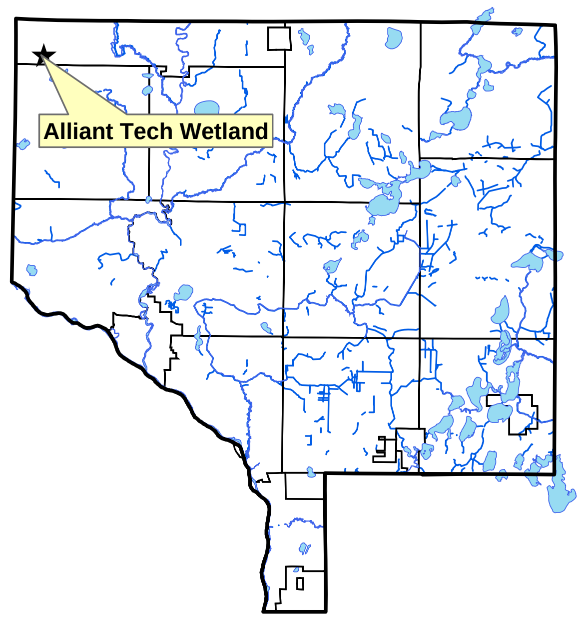
Upper Rum River Watershed Wetland Hydrology Monitoring Sites



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	-

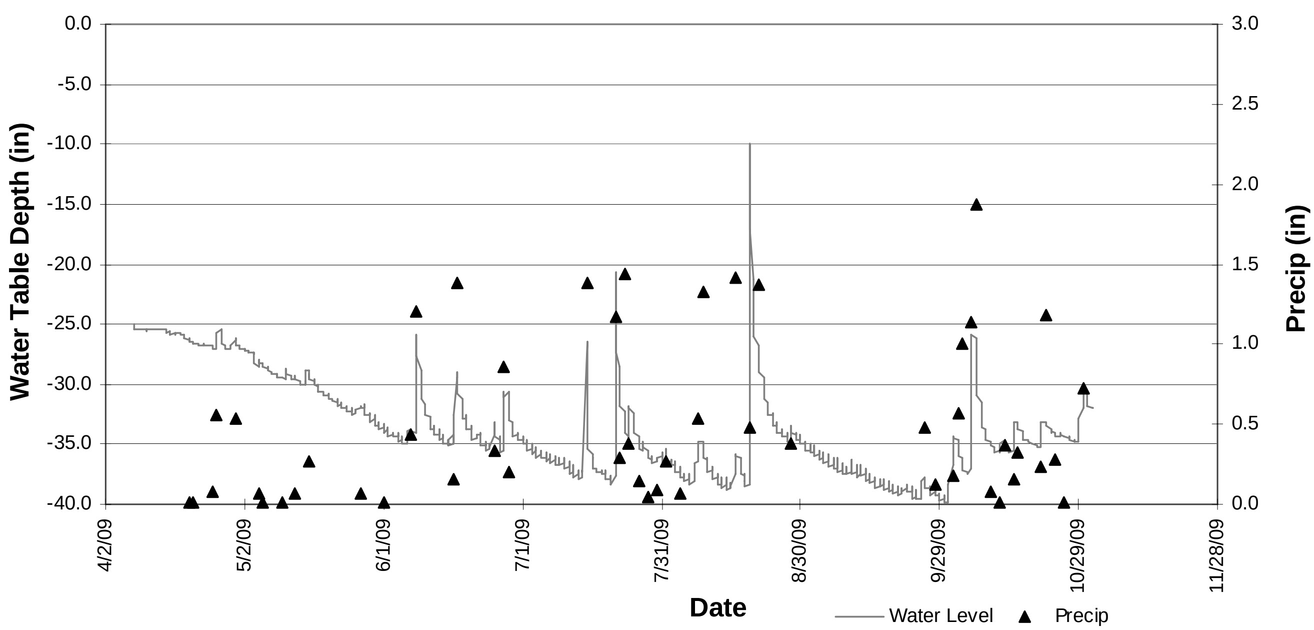
Surrounding Soils: Emmert

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.

2009 Hydrograph

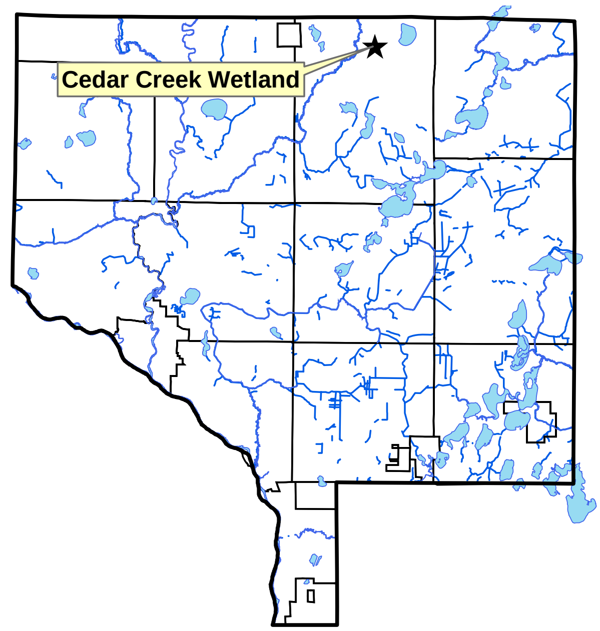


Well depth was 40 inches, so a reading of–40 indicates water levels were at an unknown depth greater than or equal to 40 inches.

Wetland Hydrology Monitoring

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

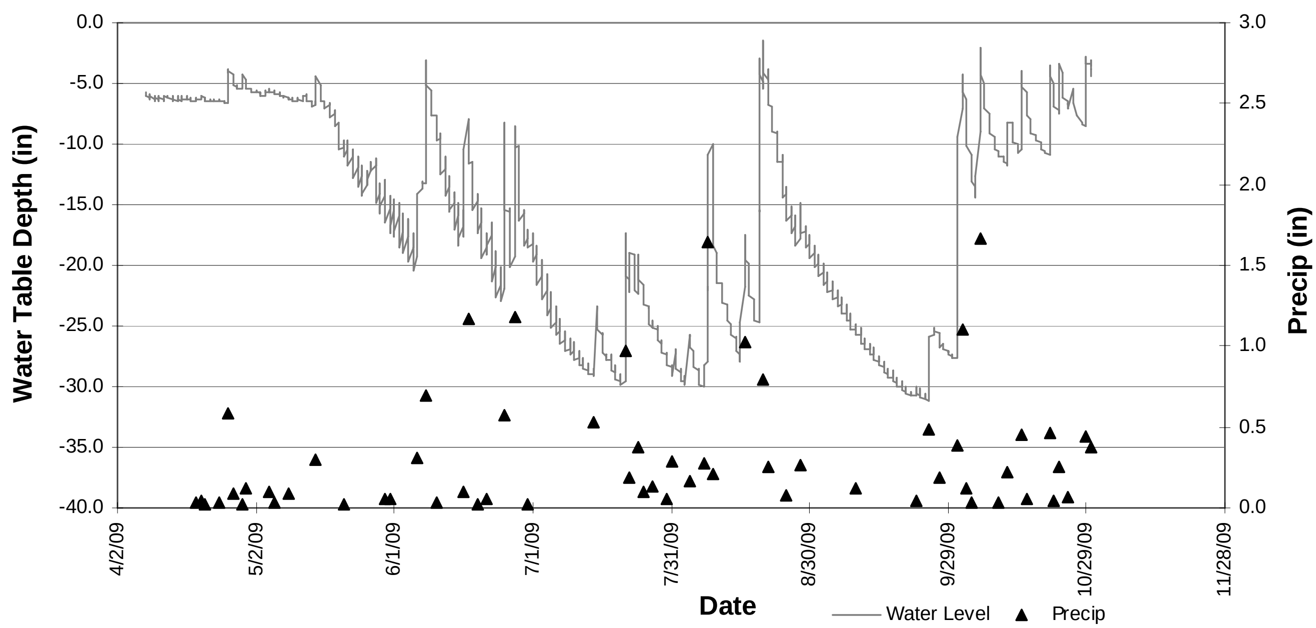
Soils at Well Location: not yet available

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.

2009 Hydrograph

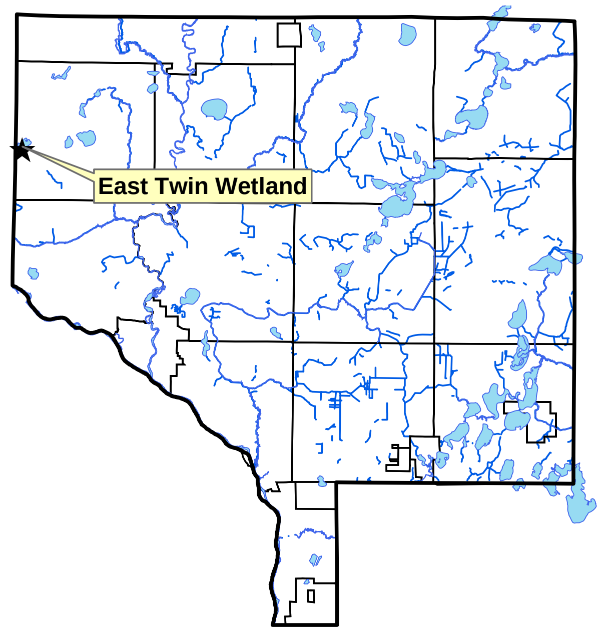


Well depth was 37 inches, so a reading of–37 indicates water levels were at an unknown depth greater than or equal to 37 inches.

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	-

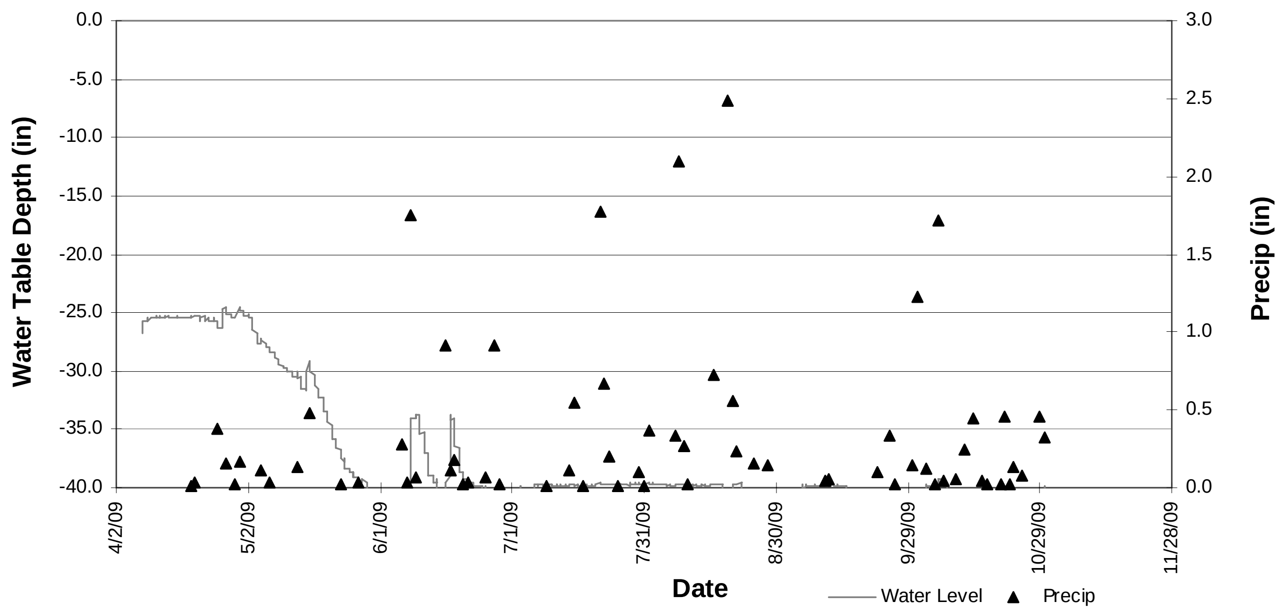
Surrounding Soils: Lake Beach, Growton and Heyder fine sandy loams

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.

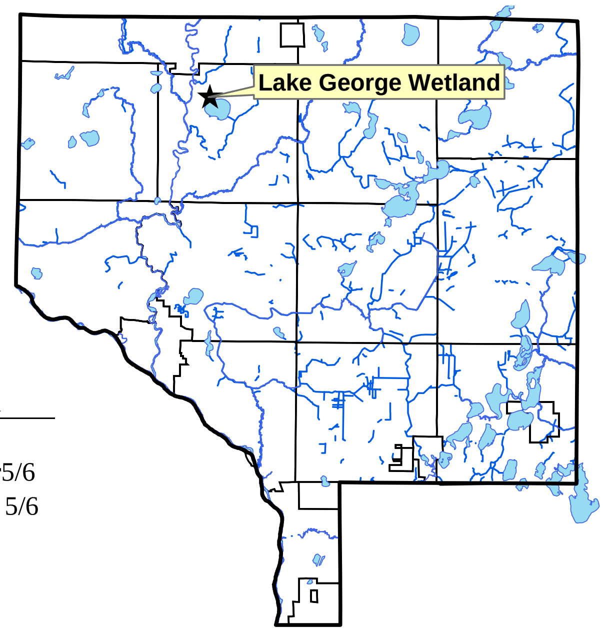
2009 Hydrograph



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.

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

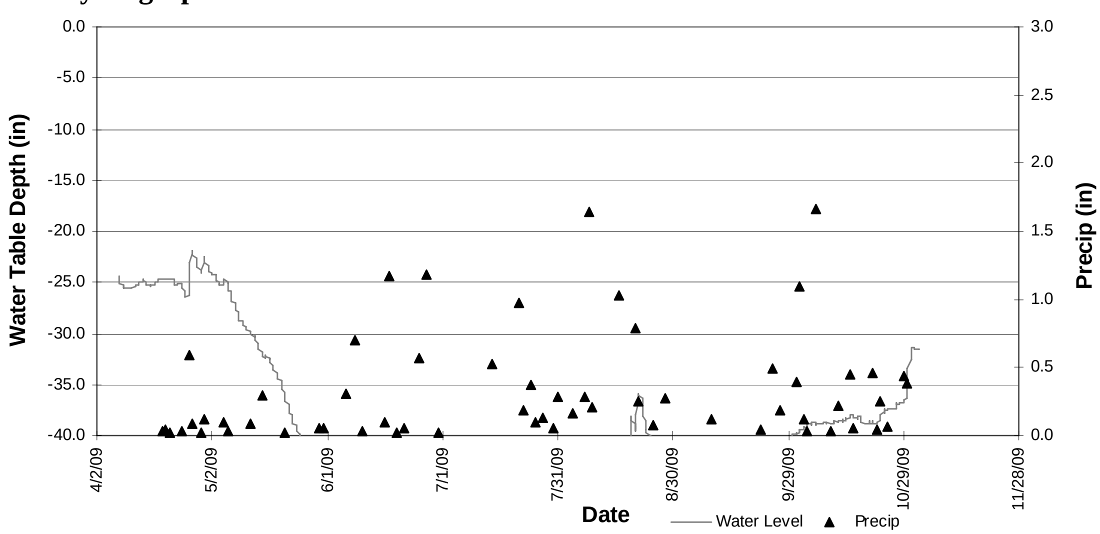
Surrounding Soils: Lino loamy fine sand and Zimmerman fine sand

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.

2009 Hydrograph

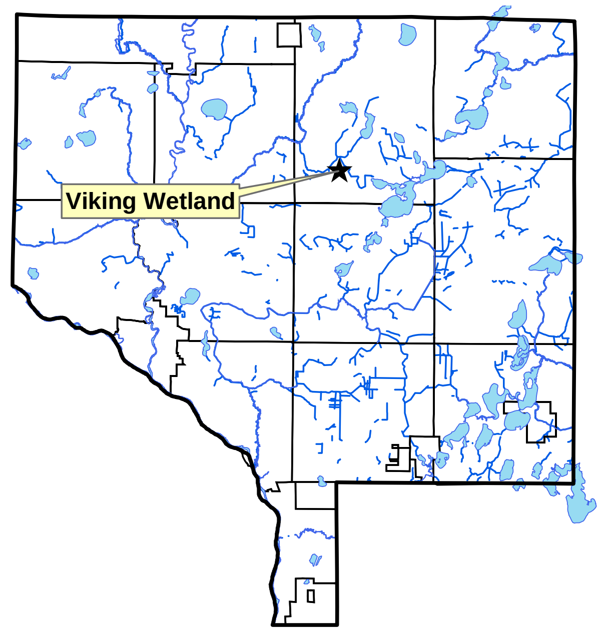


Well depth was 40 inches, so a reading of–40 indicates water levels were at an unknown depth greater than or equal to 40 inches.

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

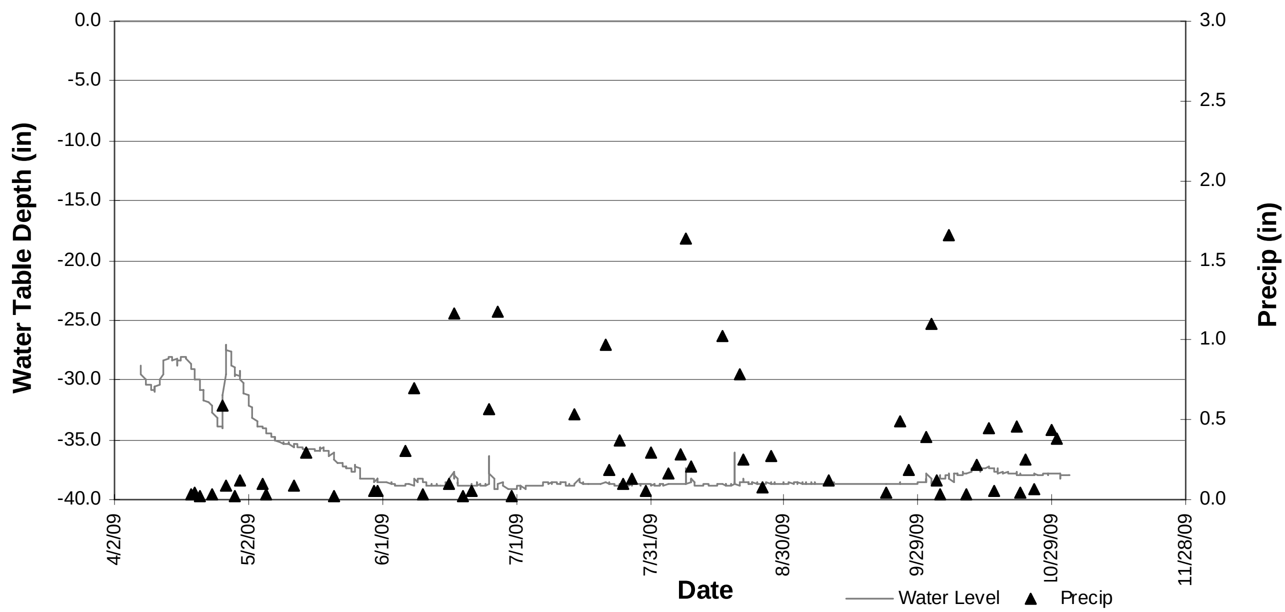
Surrounding Soils: Zimmerman fine sand

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).

2009 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 Improvement Projects

Description: In 2006 the Upper River Watershed Management Organization (URRWMO) partnered with the Anoka Conservation District's Water Quality Cost Share Program. The URRWMO contributed $990 to be used as cost share grants for projects that improve water quality in lakes, streams, or rivers with the URRWMO area. Eligible projects included those that correct erosion, filter runoff to waterbodies, or restore native shoreline vegetation adjacent to a lake or stream. The funds may be used for up to 75% of the costs of materials and designing the project. Labor, aesthetic components of the project, and other costs, along with 25% of materials are the grant applicant's responsibility. The ACD's cost share grant policies apply and ACD administers the grant program.

The Anoka Conservation District (ACD) and Upper Rum River WMO have both undertaken some efforts to promote these types of projects and the availability of cost share, but to date no projects have used this funding. Most recently, in 2007 the URRWMO did a customized mailing to 20 homeowners on East Twin and George Lakes who had been identified as having erosion problems or likely to develop problems. The ACD periodically does presentations to lake associations and other community groups, community newsletters, and 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: No projects have utilized the cost share funds, so they will remain available in subsequent years. The availability of these funds is an important component of recent and upcoming efforts to promote water quality improvement practices.

Cost Share Fund Balance:

2006 URRWMO Contribution	+	$ 990
2006 Expenditures		$ 0
2007 URRWMO Contribution	+	$ 1,000
2007 Expenditures		$ 0
2008 Expenditures		$ 0
2009 Expenditures		$ 0
Fund Balance		**$ 1,990**

Anoka County Geologic Atlas

Description: A map-based report of groundwater and geology to be used for community planning and groundwater management. The Atlas provides detailed information about groundwater:

- Aquifers, including identifying future water sources,
- Aquifer sustainability,
- Recharge areas,
- Sensitivity to pollution,
- Flow directions,
- Connections to lakes, streams, and wetlands,
- Chemistry,
- Wellhead protection, and others...

Results are provided as GIS files and paper maps, and are especially useful to community planners.

Geologic Atlases are a partnership of the MN Geological Survey, MN DNR, and local governments. 94% of funding was secured by the MN Geological Survey (MGS) and MN Department of Natural Resources (DNR) from the Legislative-Citizen Commission for Minnesota Resources (LCCMR). A required local contribution totaling 6% of project expenses was provided by the seven Anoka County watershed organizations and the Anoka Conservation District. Completion of the project requires 4-5 years.

Purpose: To gain knowledge about groundwater and geology that enables improved management of groundwater, including availability, pollution prevention, and pollution management.

Locations: Throughout Anoka County

Results: An Anoka County Geologic Atlas began in 2009 with financial support from all seven Anoka County Watershed Management Organizations and the Anoka Conservation District. These funds were used to locate approximately 9,500 groundwater wells, with approximately an additional 500 to be located in early 2010. Boring logs from these wells and others already in the County Well Index will be used to create the geologic atlas. The MGS has already begun the process of using these wells to create the geologic atlas. Thereafter the DNR will perform a groundwater analysis for the atlas. In total, the geologic atlas is expected to be completed around 2014.

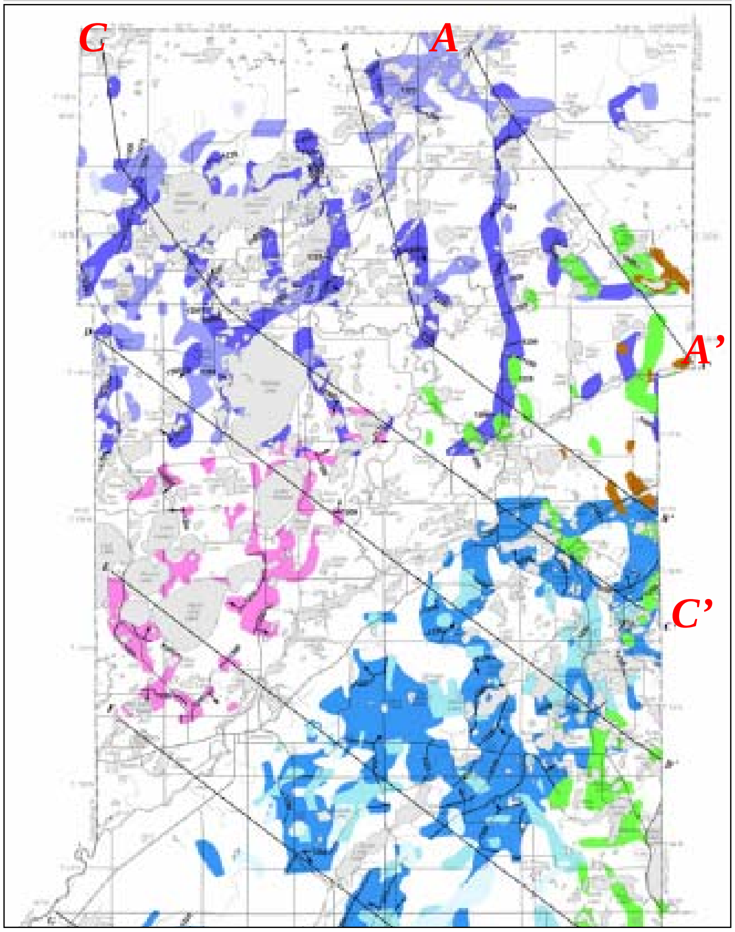
An example of portions of a geologic atlas from Crow Wing County are on the following page.

Example Geologic Atlas Work Products

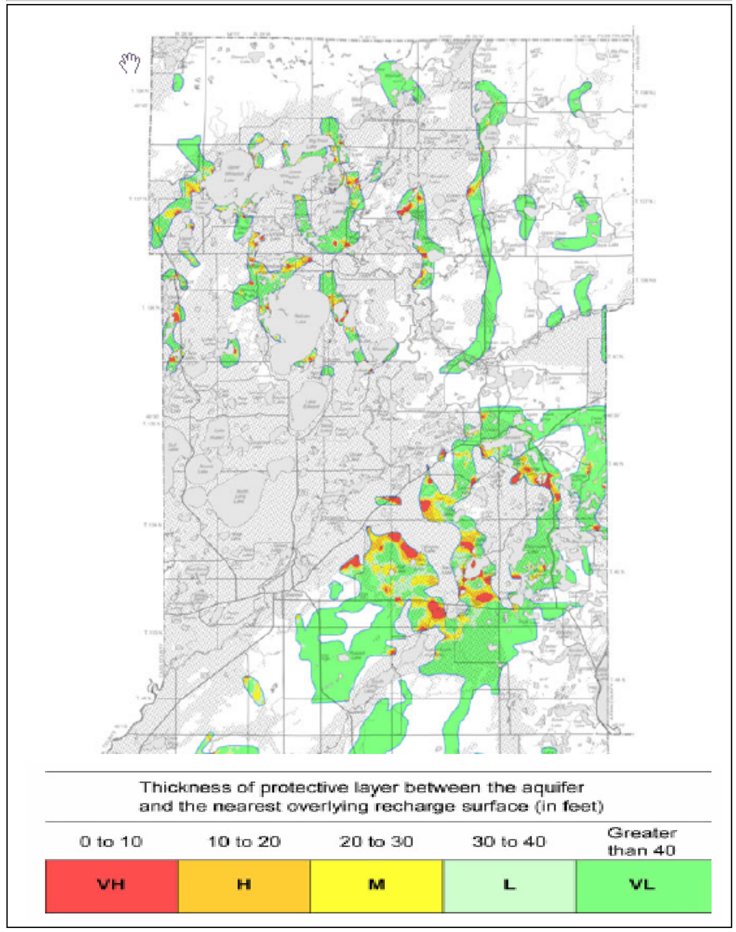
Crow Wing County Geologic Atlas

Excerpted from: Peterson, T. 2008. Hydrogeology, Pollution Sensitivity, and Lake and -Groundwater Interaction. MN Ground Water Association Newsletter 27-3.

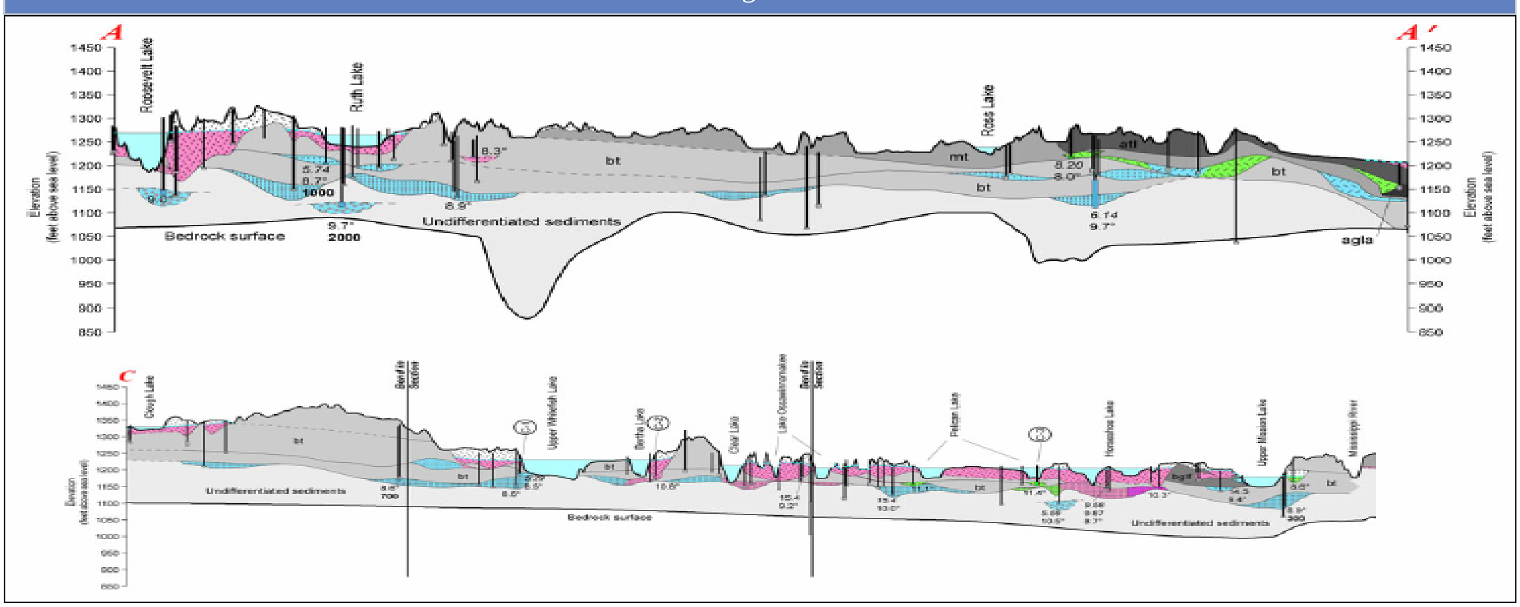
Extent and Distribution of Buried Aquifers Including Direction of Flow



Pollution Sensitivity of Buried Aquifers



Selected hydro-geologic cross sections showing groundwater residence time. Cross sections A-A' and the Northwest 2/3 of C-C' are shown. See above figure for cross section location.



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

Location: www.AnokaNaturalResources.com/URRWMO

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

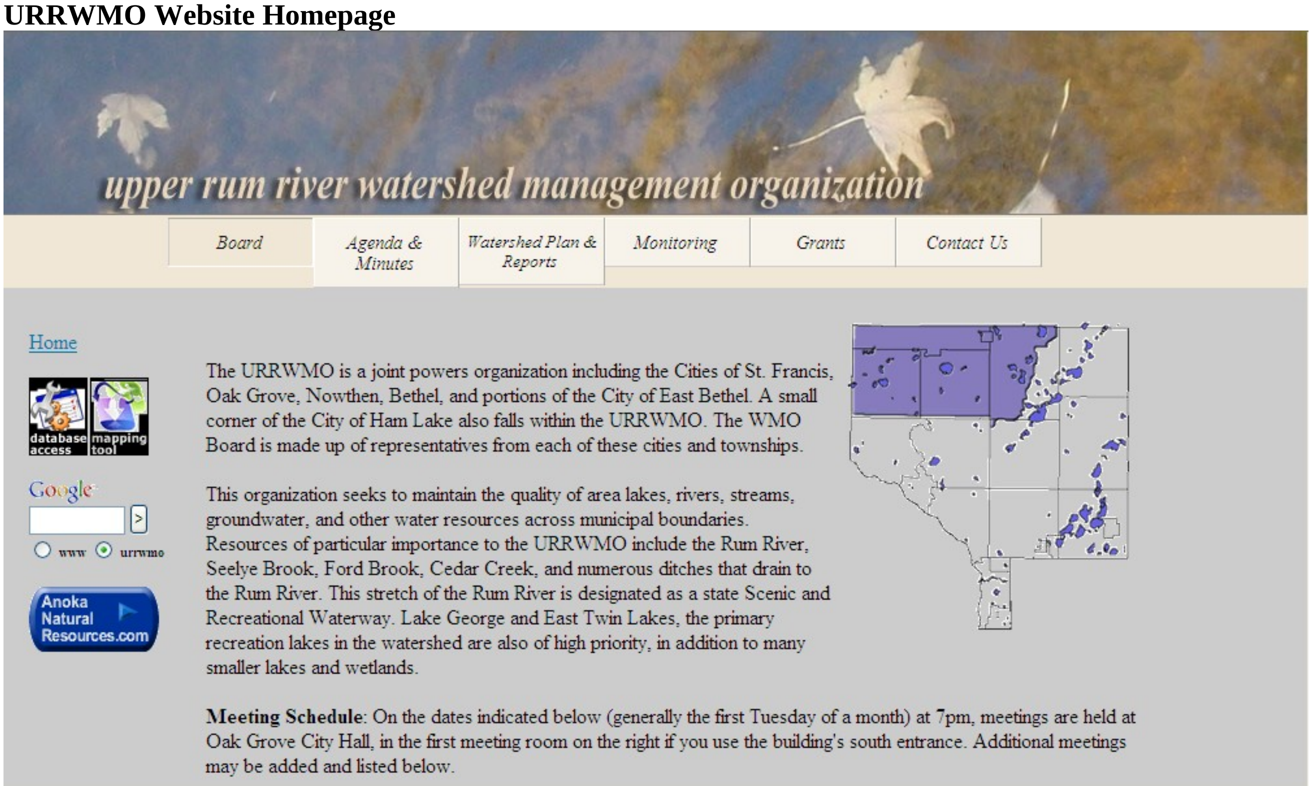
Information about the URRWMO includes:

- 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:

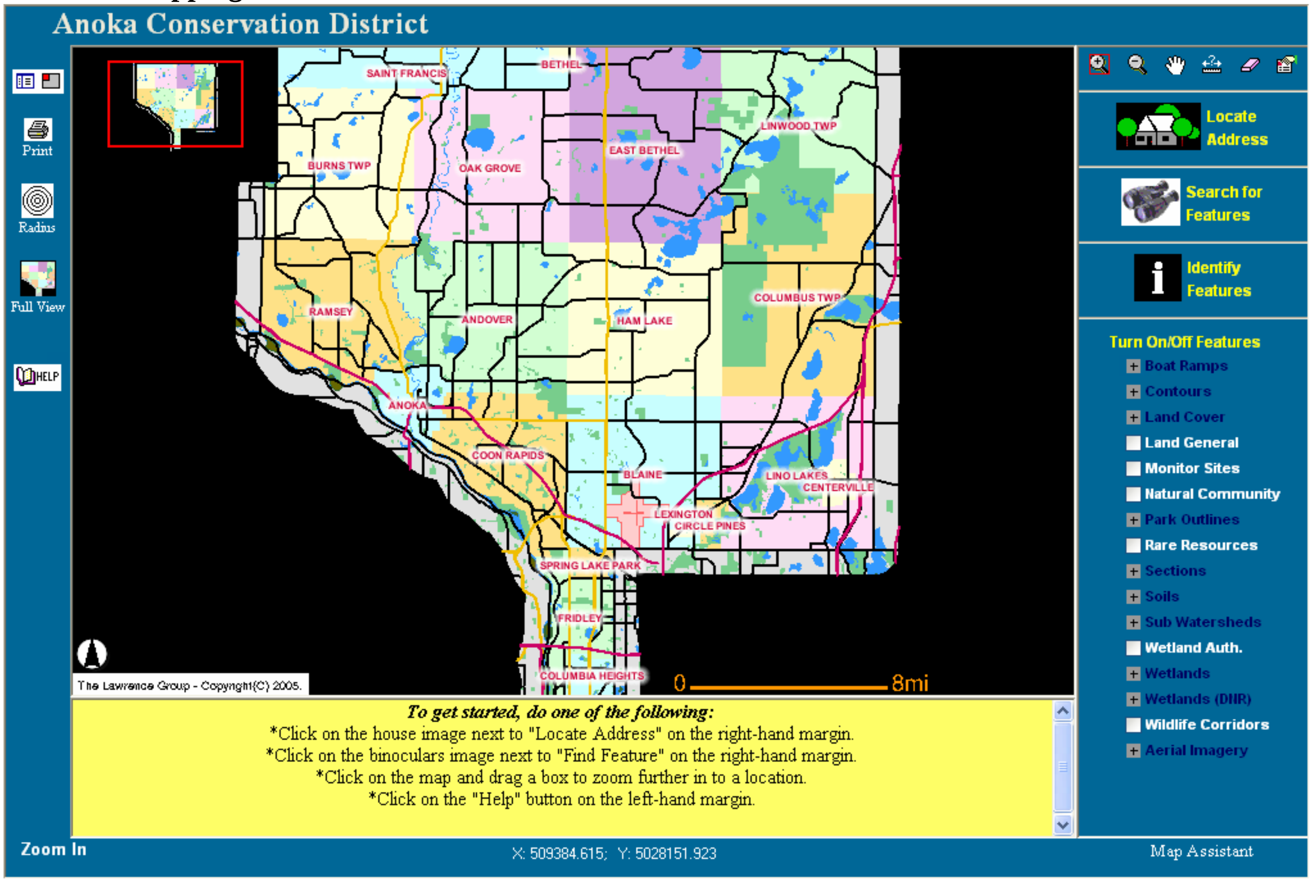
- an interactive mapping tool that shows natural features and aerial photos
- an interactive data download tool that allows users to access all water monitoring data that has been collected
- narrative discussions of what the monitoring data mean

URRWMO Website Homepage

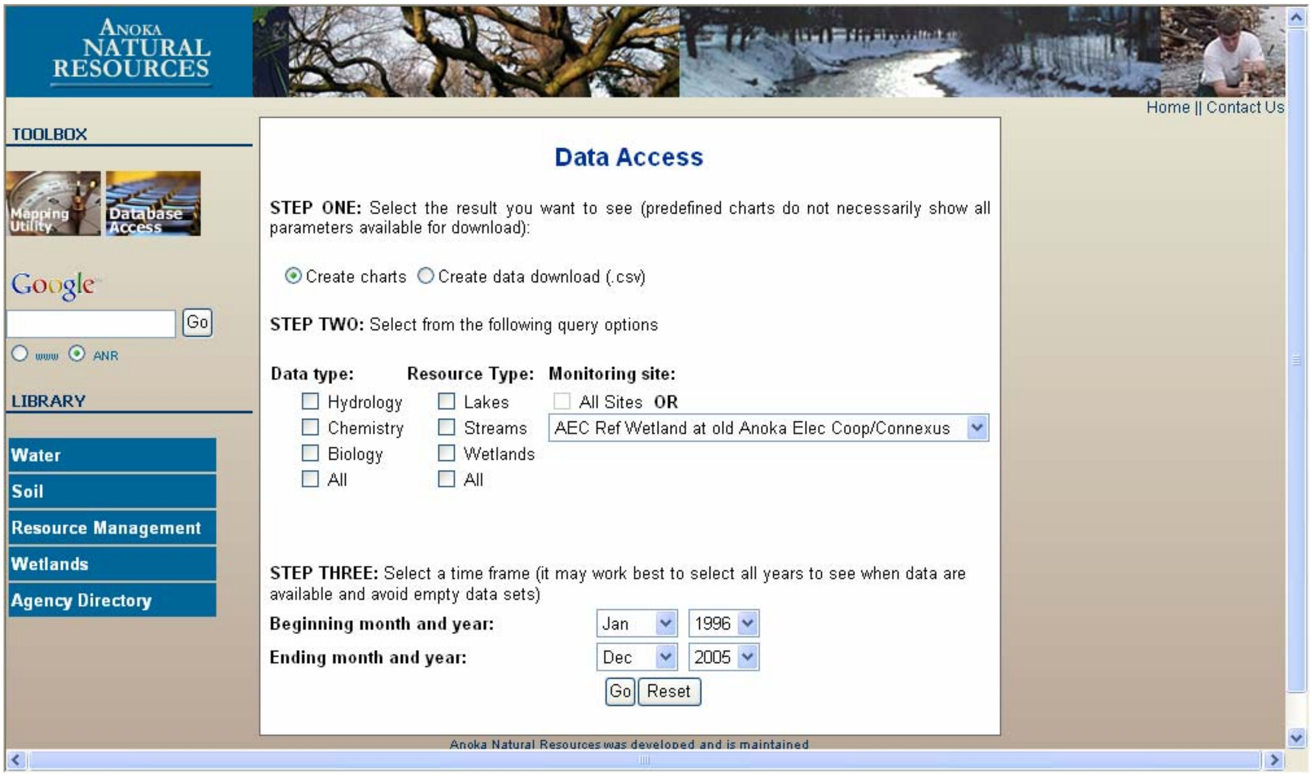


more on next page

Interactive Mapping Tool



Interactive Data Access Tool



URRWMO Annual Newsletter

Description: The URRWMO Watershed Management Plan calls for an annual URRWMO newsletter in addition to the website. The URRWMO will produce a newsletter article about the URRWMO, its programs, related educational information, and the URRWMO website address for further information. In 2009 a featured topic was cost share grants available to residents for water quality improvement projects. The article is sent to each member city with a request that they include it in their city newsletters. This article was 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 drafted the annual newsletter article, allowed review by the URRWMO Board. The finalized article was sent to each member community on May 6, 2009 with a request that they include it in their city newsletter. Contents of the article included:

- a map of the URRWMO area,
- description of the URRWMO role,
- 2009 monitoring plans,
- cost share grant information for residential water quality improvement projects,
- URRWMO meeting schedule,
- URRWMO website address, and
- phone number for more information.

2009 URRWMO Newsletter Article

UPPER RUM RIVER
WATERSHED MANAGEMENT ORGANIZATION
monitors rivers, lakes, and offers grants to residents

The Upper Rum River Watershed Management Organization (URRWMO) was formed through a joint powers agreement of cities in northern Anoka County that drain to the Rum River, including Bethel, East Bethel, Ham Lake, Nowthen, Oak Grove, and St. Francis. The URRWMO is a special purpose unit of government aimed at managing water – lakes, rivers, streams, wetlands, and groundwater. State law requires local watershed organizations throughout the seven-county metro. The need for these organizations comes from the nature of watersheds. Water does not stop at city boundaries, and no one city can effectively manage it alone. Representatives from each member city are on the URRWMO Board.

The URRWMO area is blessed with high quality water bodies. This stretch of the Rum River is designated as a state Scenic and Recreational Waterway. Lake George and East Twin Lakes have some of the clearest water in Anoka County. Smaller waterways like Cedar Creek, Ford Brook, Seelye Brook, and numerous wetlands are important too.

Rum River

The URRWMO monitors lakes and streams on a rotating basis in order to identify trends and problems, and to guide future projects. In 2008 Lake George and East Twin Lake were monitored. This year, the Rum River will be the focus. The river will be monitored at the top (northern St. Francis) and bottom (southern Oak Grove) of the watershed to see how the river's water quality changes within our cities. Other agencies will be doing monitoring of the Rum River upstream and downstream too.

Ultimately, we are all responsible for caring for lakes and rivers. Understanding that we all benefit when water quality is improved or protected, the URRWMO offers grants to encourage water quality projects on private property. Cost share grants are available to landowners for projects that will improve water quality, such as by correcting erosion, filtering stormwater runoff, and/or restoring native vegetation adjacent to a lakes and streams. The grants are competitive, and the highest ranking projects will be those that will most directly benefit a public waterbody. Applications are accepted at any time on a first-come, first-serve basis.

Grants cover 50-70% of project materials. Remaining costs and labor are the responsibility of the landowner. The Anoka Conservation District (ACD) offers free on-site consultations to landowners about water quality projects and can assist with project design. The grants are also administered through the Anoka Conservation District. Contact Jamie Schurbon at the Anoka Conservation District at 763-434-2030 extension 12.

More information about the URRWMO can be found on their website at www.AnokaNaturalResources.com/urrwmo. Citizens are welcome to attend URRWMO meetings. Remaining 2009 meetings will be May 5, August 4, and November 10 at 7:00 p.m. at the Oak Grove City Hall.

A lakeshore restoration with native plants that filters runoff, provides fish and wild habitat, and looks beautiful.

URRWMO 2008 Annual Report to BWSR

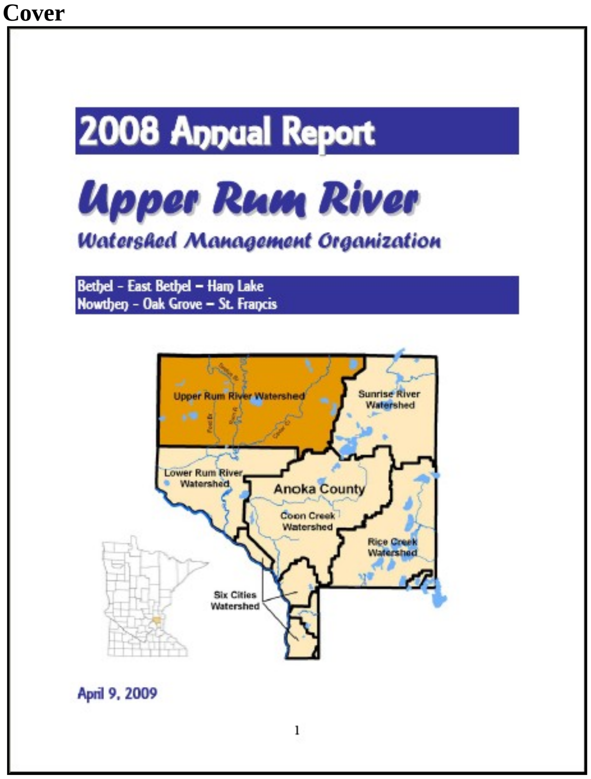
Description: The Upper Rum River Watershed Management Organization (URRWMO) is required by law to submit an annual report to the Minnesota Board of Water and Soil Resources (BWSR), the state agency with oversight authorities. This report consists of an up-to-date listing of URRWMO Board members, activities 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 2008 Upper Rum River WMO Annual Report. ACD provided copies of this report and a cover letter to the entire URRWMO Board on March 25, 2009 for review. On April 9, 2009 the final draft was sent to the URRWMO Chair, Ed Faherty. The Chair submitted the report to BWSR.

Cover


2008 Annual Report

Upper Rum River

Watershed Management Organization

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

April 9, 2009

1

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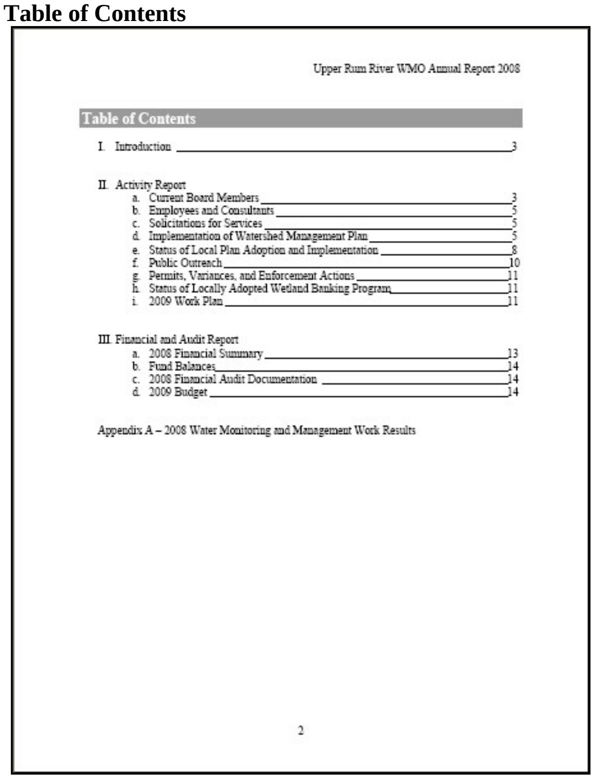
Upper Rum River WMO Annual Report 2008

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Review of Municipal Local Water Plans

Description: The URRWMO Watershed Management Plan specifies:

"The URRWMO shall review local water management plans and evaluate their consistency with the Watershed Plan. All local water management plans shall be consistent with the URRWMO Watershed Management Plan. Member communities shall have two years from the date of the Board of Water and Soil Resource's approval of this Plan to adopt their local water management plans."

The URRWMO's Watershed Management Plan was completed in 2007, so all member community local water plans should be completed in 2009. The URRWMO is the approval authority for these local water plans.

Purpose: To provide consistency water management across the watershed and ensure the URRWMO's goals for water resources are met.

Locations: Watershed-wide

Results: The URRWMO contracted the Anoka Conservation District to perform a technical review of municipal local water plans to ensure they were consistent with the URRWMO Watershed Management Plan. ACD staff reviewed local water management plans as they are completed, provided a summary of their consistency with the URRWMO Plan, and presented findings to the URRWMO Board. This work occurred in both 2008 and 2009.

All six URRWMO municipalities have updated their local water plans. In all cases the URRWMO required some changes for consistency with the URRWMO's plan. Changes have been made to all. The URRWMO approved all of these municipal local water plans in 2009.

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.

Upper Rum River Watershed Financial Summary

Upper Rum River Watershed	Website	Ref Wet	Lake Lvl	Ob Well	Stream WQ	Student Biom	UR city water plan reviews	WMO annual rpt to BWSR	Geologic Atlas	Annual Newsletter Prep	Total
Revenues											
URRWMO	260	0	240	0	1890	0	0	400	5000	250	8040
State	0	0	0	360	0	0	0	0	0	0	360
Anoka Conservation District	1633	0	314	380	0	746	3040	284	4916	172	11485
County Ag Preserves	0	1657	0	0	0	540	0	0	0	0	2196
Other Service Fees	0	0	0	0	0	0	0	0	57	0	57
Local Water Planning	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1893	1657	554	740	1890	1285	3040	684	9973	422	22139
Expenses-											
Capital Outlay/Equip	4	6	1	2	2	3	0	0	97	0	116
Personnel Salaries/Benefits	1061	1409	481	640	1027	1100	2368	488	8899	382	17855
Overhead	71	105	33	46	67	54	337	101	434	17	1265
Employee Training	12	16	8	9	18	12	70	22	72	2	241
Vehicle/Mileage	15	20	7	9	16	16	34	8	155	4	284
Rent	52	80	22	33	43	39	232	65	273	17	857
Program Participants	0	0	0	0	0	0	0	0	0	0	0
Program Supplies	676	21	1	1	335	62	0	0	43	0	1139
Equipment Maintenance	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1893	1657	554	740	1509	1285	3040	684	9973	422	21758
NET	0	0	0	0	381	0	0	0	0	0	381

Recommendations

- **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. Treatments should occur in early spring, occur on no more than 15% of the lake, be coordinated, and proceed under DNR permits.
- **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.
- **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.

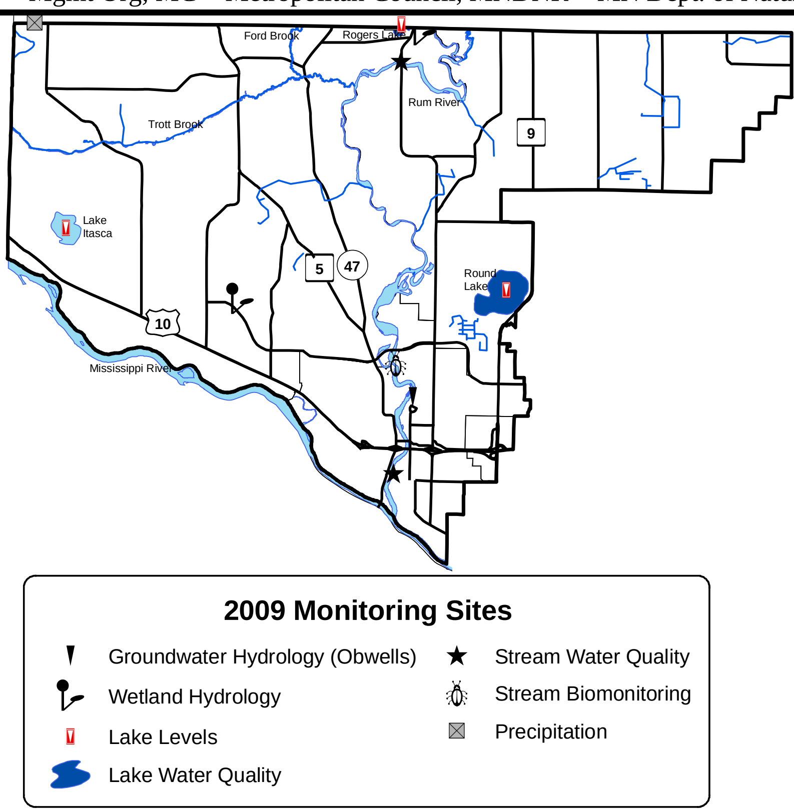
Continued on next page

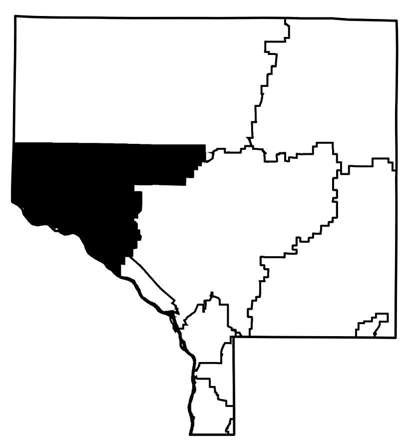
- **Coordinate monitoring of the Rum River** with the neighboring Lower Rum River WMO and the Metropolitan Council, who runs a monitoring site at the Anoka Dam.
- **Promote water quality improvement projects** for lakes, streams, and rivers. Cost share grants are available through the URRWMO and ACD 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.
- **Monitor water quality of Lake George and East Twin Lake every three years** to track any trends or changes. Next monitoring should be in 2011.

CHAPTER 4:
LOWER RUM RIVER WATERSHED

Task	Partners	Page
Lake Levels	LRRWMO, ACD, volunteers, MN DNR	4-88
Lake Water Quality	LRRWMO, ACD, ACAP	4-90
Stream Water Quality – Chemical	MC, ACD	4-96
Stream Water Quality – Biological	LRRWMO, ACD, ACAP, Anoka High School	4-105
Wetland Hydrology	LRRWMO, ACD, ACAP	4-108
Water Quality Improvement Projects	LRRWMO, ACD, landowners	4-111
Conservation Workshops	ACD, ACAP, cities	4-112
Anoka County Geologic Atlas	All Anoka Co. watershed orgs, ACD, MGS, MN DNR	4-113
LRRWMO Website	LRRWMO, ACD	4-115
Financial Summary		4-117
Recommendations		4-117
Groundwater Hydrology (obwells)	ACD, MNDNR	Chapter 1
Precipitation	ACD, volunteers	Chapter 1

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, MGS = MN Geological Survey





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.

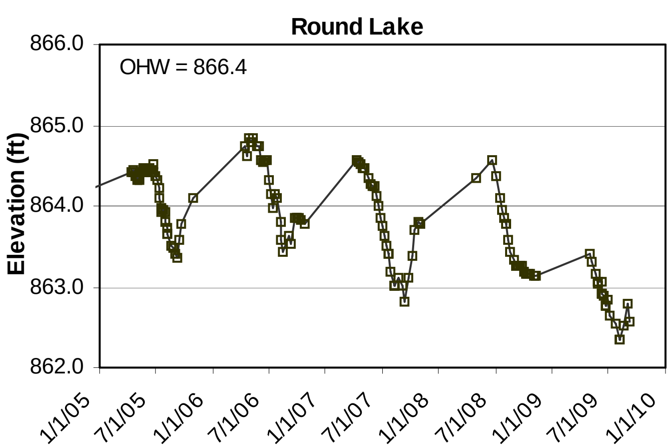
Locations: Lake Itasca, Round Lake, Rogers Lake

Results: Water levels were measured 19 to 27 times, despite difficulties caused by record or near-record low water due to drought. Water levels on all three lakes dropped until late July when more substantial rainfall began. Round Lake reached a record low. Itasca Lake was 0.62 ft higher than its record low from 2000. Rogers Lake was still about two feet higher than its record low, but over three feet lower than the record high. Water levels became so low that volunteers were unable to read the lake gauge with binoculars, and Anoka Conservation District staff began taking readings by trudging through the near-shore muck in chest waters.

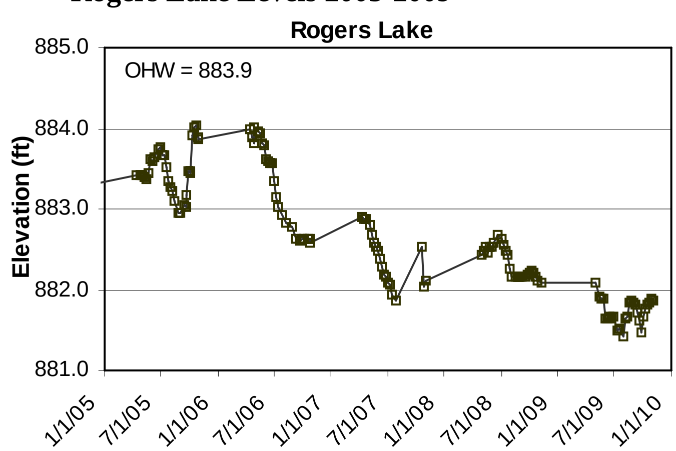
Ordinary High Water Levels (OHW), the elevation below which a DNR permit is needed to perform work, are listed for each lake on the graph.

Round Lake levels and others receded dramatically. Two weeks before this photo was taken the lake gauge was in the water.

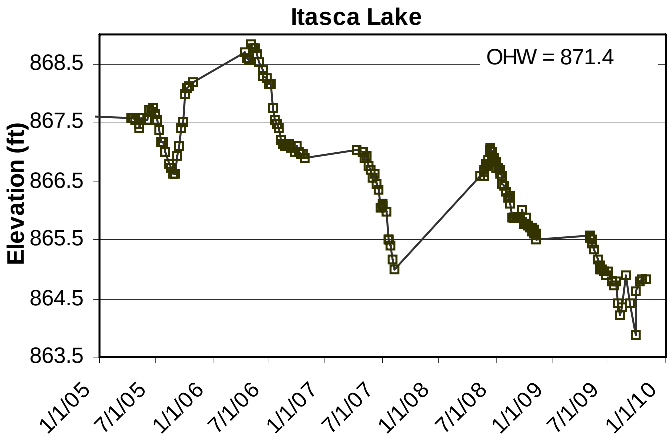
Round Lake Levels 2005-2009



Rogers Lake Levels 2005-2009



Lake Itasca Levels 2005-2009



Lower Rum River Watershed
Lake Levels Summary

Lake	Year	Average	Min	Max
Itasca	2005	867.39	866.61	868.19
	2006	867.81	866.90	869.77
	2007	866.25	865.01	867.03
	2008	866.36	865.50	867.05
	2009	864.90	863.86	865.57
Rogers	2005	883.48	882.95	884.04
	2006	883.28	882.59	884.02
	2007	882.19	881.79	882.91
	2008	882.33	882.09	882.69
	2009	881.73	881.43	882.08
Round	2005	864.14	863.37	864.51
	2006	864.21	863.44	864.85
	2007	864.21	863.44	864.85
	2008	863.52	863.09	864.54
	2009	862.84	862.35	863.41

Lake Water Quality

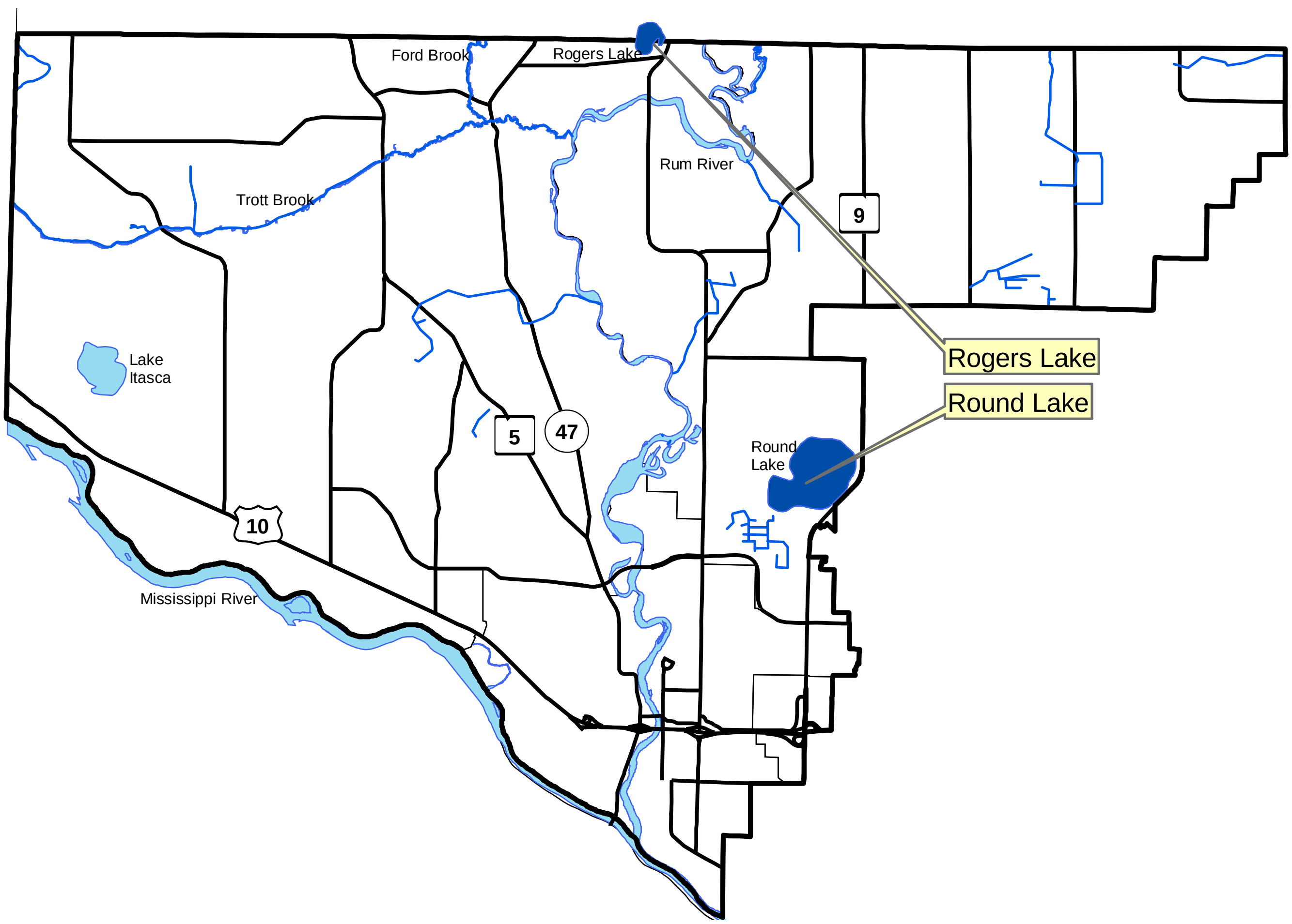
Description: May through September twice-monthly monitoring of the following parameters: total phosphorus, chlorophyll-a, Secchi transparency, dissolved oxygen, turbidity, temperature, conductivity, pH, and salinity.

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

Locations: Rogers Lake
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.

Lower Rum River Watershed Lake Water Quality Monitoring Sites



Rogers Lake

Cities of Oak Grove, Ramsey, and Nowthen, LAKE ID # 03-0104

Background

Rogers Lake is in west-central Anoka County, and lies partially within the jurisdictional areas of both the Lower and Upper Rum River Watershed Management Organizations. It has a surface area of 40 acres and a maximum depth of 6 feet. The shoreline is about 1/3 developed, primarily on the western shore. There are no streams of any consequence entering or leaving this lake; it is an isolated basin with a small watershed. There is no public access. Rogers Lake is designated as "impaired" for excess nutrients by the MPCA.

Water Quality Results

In 2009 Rogers Lake received an overall B letter grade for water quality, but there are ecological concerns about the lake. The lake's condition has changed significantly within the last 2-4 years. The water became clearer and plant growth exploded between 2006 and 2008. This condition continued in 2009.

In 2006 total phosphorus was high (averaged 110 ug/L), the water was brown and turbid (average 12 FNRU), and algae levels were relatively high (average chlorophyll-a 38.5 mg/L). Plants were limited by the turbid water, and ACD staff estimated 40% of the lake had plants growing to the surface. Floating-leaved plant species were most abundant, probably because light levels were low below the surface. Other monitored years before 2006 had better water quality, but similar aquatic plant growth.

In 2008 and 2009 water quality was notably better and plant growth dramatically increased. In 2008 average phosphorus was 32 ug/L, better than the state water quality standard of 40 ug/L. In 2009 average phosphorus was 50 ug/L, but this was driven by a single high reading of 170 ug/L (contaminated sample?). Excluding that high reading the average phosphorus in 2009 was 37 ug/L. Chlorophyll-a was low in 2008 (12.3 ug/L) and even lower in 2009 (7.1 ug/L). The water was clear in both years (average turbidity 3 FNRU both years). Plants grew densely and to the surface across 95% of the lake. The entire water column was filled with plants. Species included curly-leaf pondweed, large-leaf pondweed, floating-leaf pondweed, water shield, and lilies. Large-leaf pondweed was most abundant. Curly-leaf pondweed was least abundant.

The plant abundance is benefiting some aspects of water quality but negatively affecting recreation and the fishery. Abundant plants are consuming phosphorus, out-competing algae, and minimizing sediment disturbance so the water is clearer. However the abundance of plants eliminates almost all boating, swimming and fishing. Decomposition of the abundant plants consumes oxygen, depleting it below levels needed by most fish. The layer of plants at the surface reduces wind mixing that would oxygenate water. By early June dissolved oxygen levels dropped below 4 mg/L. Dissolved oxygen levels decreased further later in summer, remaining below 2 mg/L for over three months. No dead fish were seen, but a resident said similar conditions occurred in 2007, likely killing most fish at that time. Schools of 1" bullheads and tadpoles were the only aquatic animals seen in 2009.

The water quality in 2008-09 was not unusual for this lake but the abundance of plants was unusual. Water quality records from 1998, 2000, and 2003 are similar to 2008 and 2009. But a review of aerial photos shows that before 2007 there was much less plant growth on the lake (see photos below). In 2000, 2003, and 2006 aerial photos plants grew to the surface on <40% of the lake. Similar or less plant growth is seen in 1938, 1953, 1964, and 1970 aerial photos. In 2008-09 plants covered 95% of the lake almost the entire open water season.

Trend Analysis

Six years of water quality monitoring have been conducted by the Anoka Conservation District and Secchi depths were taken by citizens one other year. This is not enough data to perform a trend analysis.

Discussion

In recent years Rogers Lake has traded one problem for another. In 2006 and earlier the lake had high phosphorus, algae, and turbity. In more recent years water has been clear, but aquatic plants have increased many-fold. This has created recreational and low dissolved oxygen problems. Generally, a rich aquatic plant community is desirable and healthy in a shallow lake, but here it has arguably become excessive and problematic.

The reason for the explosion in aquatic plant growth is not clear. While plant growth is expected to increase with clearer water, there were no changes in the watershed or lake management that would have created clearer water.

The abundant plant species in Rogers Lake are not generally aggressive or problematic in other lakes. Low water levels, cooler than usual spring weather in consecutive years, and past illegal herbicide treatments are possible reasons for vegetation changes in the lake.

While some plant management may be beneficial for this lake, little is legally allowed. The purpose of plant management would be to reduce spring plant growth as a way of reducing the amount of decaying plant material later in summer. This should result in higher summer dissolved oxygen. It will also increase open water areas for recreation, such as canoeing. It should not be designed to eliminate plants; plants are essential to the health of shallow lakes. Generally less no more than 15% of the lake should be treated and treatment should be targeted toward critical species and areas.

Little vegetation management is legal on Rogers Lake for the following reasons:

Rogers Lake is classified as a natural environment lake, and no herbicide use is allowed under state rules. Mechanical clearing of an area up to 2500 square feet per property is allowed without a permit.

Where floating leaf vegetation (lilies, water shield) is present, only mechanical clearing of a 15 foot wide channel to open is allowed without a permit. Obtaining a permit for greater areas is highly unlikely. There is no open water to try to reach. Lilies and water shield are almost everywhere on Rogers Lake, eliminating almost all allowable vegetation clearing.

State rules discourage vegetation control on shallow lakes, which are healthiest when plant-dominated.

Invasive species are not a problem. Vegetation control is generally not allowed or discouraged for native species that are most abunant on Rogers Lake.

Overriding the noted problems about low dissolved oxygen and open water for recreation are the fact that there should be little expectation for a fishery or open water recreation on such a shallow lake.

In summary, the only allowable vegetation clearing on Rogers Lake is (a) mechanical clearing of an area 2500 square feet in the rare instances where no floating leaf vegetation would be impacted and (b) a 15 foot channel where floating leaf plants are present. Please see the DNR website or publications for more detailed information on state aquatic vegetation rules before proceeding with any work.

In the end, the current plant-dominated condition of Rogers Lake should be adopted as the best condition for this lake. Ecologically, a shallow lake of this type is healthiest when it is plant dominated. State water quality standards and state plant management rules are designed to promote this condition. Admittedly, for Rogers Lake there is a negative side – reduced recreational suitability and reduced dissolved oxygen. These conditions are common for this type of lake in a healthy condition.

Aerial photos showing increase in aquatic plants, particularly between 2006 and 2008. Light green areas are aquatic plants. Black areas are open water.

2000 2003 2006 2008

Photos of aquatic plant growth in Rogers Lake.


May 27, 2009


June 10, 2009

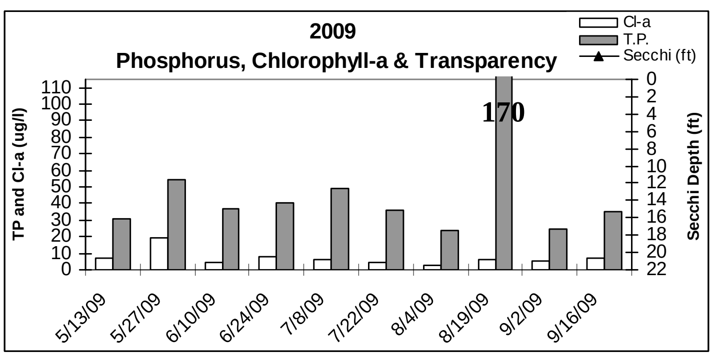

August 4, 2009

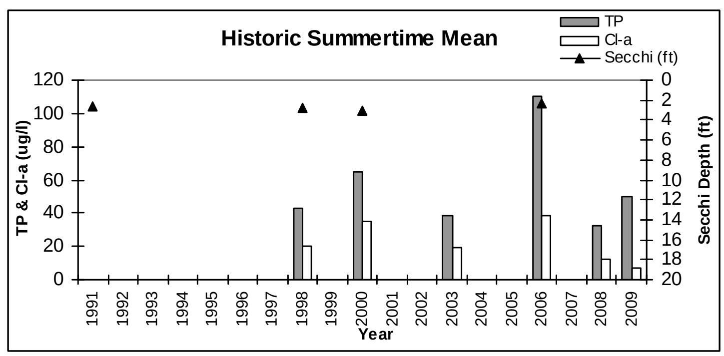

Decomposing large-leaf pondweed.

Rogers Lake Water Quality Results

Rogers Lake 2009	Units	R.L.*	5/13/2009 10:50 Results	5/27/2009 10:30 Results	6/10/2009 10:10 Results	6/24/2009 10:15 Results	7/8/2009 10:15 Results	7/22/2009 10:40 Results	8/4/2009 10:25 Results	8/19/2009 9:45 Results	9/2/2009 10:15 Results	9/16/2009 9:20 Results	Average	Min	Max
pH		0.1	7.17	6.47	6.93	5.81	5.73	5.76	5.60	5.64	5.30	5.52	5.99	5.30	7.17
Conductivity	mS/cm	0.010	0.780	0.083	0.075	0.074	0.069	0.061	0.059	0.062	0.061	0.063	0.139	0.059	0.780
Turbidity	FNRU	1	4	3	0	3	7	2	3	2	4	3	3	0	7
D.O.	mg/L	0.01	7.78	4.03	2.81	1.39	1.16	1.13	0.21	1.63	1.25	2.22	2.36	0.21	7.78
D.O.	%	1	78%	42%	26%	16%	13%	10%	2%	18%	12%	20%	24%	2%	78%
Temp.	°C	0.1	16.0	17.6	14.9	24.5	21.6	19.9	21.0	20.2	18.0	19.4	19.3	14.9	24.5
Temp.	°F	0.1	60.8	63.7	58.8	76.1	70.9	67.8	69.8	68.4	64.4	66.9	66.8	58.8	76.1
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	ug/L	1	7.4	19.4	4.7	7.5	5.8	4.8	2.3	6.2	5.0	7.4	7.1	2.3	19.4
T.P.	mg/L	0.005	0.031	0.054	0.037	0.040	0.049	0.036	0.024	0.170	0.025	0.035	0.050	0.024	0.170
T.P.	ug/L	5	31	54	37	40	49	36	24	170	25	35	50	24	170
Secchi	ft	0.1	>max depth	>4.8	>4.7	>4	>4	>4	>4	>4	>4	>4			
Secchi	m	0.1	>max depth	>1.5	>1.4	>1.2	>1.2	>1.2	>1.2	>1.2	>1.2	>1.2			
Field Observations															
Physical			1.0	1.5	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	1.5	2.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	4.0	1.0	5.0

*reporting limit





Rogers Lake Historical Means

Agency	CAMP	ACD	ACD	ACD	ACD	ACD	ACD
Year	91	98	2000	2003	2006	2008	2009
TP (ug/L)		42.70	64.70	38.4	110.0	32	50
Cl-a (ug/L)		20.30	35.10	19.4	38.5	12.3	7.1
Secchi (m)	0.81	0.85	0.91	n/a	0.7	n/a	n/a
Secchi (ft)	2.7	2.8	3.00	n/a	2.3	n/a	n/a

Carlson's Trophic State Index

TSIP		58	62	57	72	54	61
TSIC		60	62	60	67	55	50
TSIS	63	62	63	n/a	65	n/a	n/a
TSI		59*	62*	58*	68	55*	55*

Rogers Lake Water Quality Report Card

Year	91	98	2000	2003	2006	2008	2009
TP		C	C	C	D	B-	C
Cl-a		C	C	B	C	B	A
Secchi	D	n/a*	n/a*	n/a*	D-	n/a*	n/a*
Overall		**C**	**C**	**B**	**D**	**B**	**B**

*Secchi transparency not included because as secchi depth exceeded lake depth

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 a cattails and has submerged vegetation throughout, including carpets of the macrophyte-like algae Chara. 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 only wintertime fishing occurs. Wildlife usage of the lake is high.

2009 Results

In 2009 Round Lake had average water quality compared to other lakes in this region (NCHF Ecoregion), receiving an overall C letter grade. The lake was slightly eutrophic. Average total phosphorus and chlorophyll-a were the highest of the seven monitored years, at 45 ug/L and 16.2 ug/L, respectively. Average Secchi transparency was 5.5 feet, the second poorest of monitored years (1998 was poorer).

In 2009 the lake experienced a spring algae bloom. In mid-May chlorophyll-a was the highest of the year at 47 ug/L. Yet Anoka Conservation District staff noted the water was "fairly clear" and there was only "some algae." This suggests the sample may have not been representative. From late May through August algae levels were lower, then increasing through August and September. Secchi transparency followed, starting as clear at 10 feet in June and reduced to 3-4 feet in August and September. Total phosphorus remained fairly steady throughout 2009 at about 40 ug/L, but increased slightly to around 55 ug/L in late August and September.

Trend Analysis

Seven years of water quality monitoring have been conducted by the Anoka Conservation District (1998-2000, '03, '05, '07, and '09). This is not enough data for a powerful statistical test of trend analysis. If the test is attempted it does find a significant declining water quality trend (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,4}$=8.00, p=0.04). Examined individually, all three parameters are trending poorer but the relationship is weak for transparency (R^2=0.04) and chlorophyll-a (R^2=0.15), and strongest for TP (R^2=0.57).

Discussion

There are few obvious impacts to the lake. Shoreline development and recreational use is light and the lake has a healthy aquatic plant community. Because long term data are lacking for this lake it is unclear what is "normal" water quality, but poorer recent years are concerning. Possible factors affecting water quality include low water levels and expansion of Round Lake Boulevard, but evidence that this is the case is weak.

The low water levels could be negatively affecting water quality by making the unconsolidated bottom sediments more susceptible to wind mixing. These sediments could be a source of non-algal turbidity or phosphorus. Water depths above the muck were less than two feet over approximately 80% of the basin in 2009.

Comparing 2000 and 2009 allows some insight into the effect of low water on water quality because both years had low water. 2009 lake levels were lowest, with an average of 862.84 ft and minimum of 862.35 ft. In 2000 water levels reached a similar low of 862.37 ft, but averaged a foot higher at 863.89. Water quality was much poorer in 2009 than 2000 (total phosphorus 24 vs 45 ug/L, chlorophyll-a 3.7 vs 16 ug/L, Secchi transparency 8.8 vs 5.5 ft). TP, chlorophyll-a, and Secchi transparency did all become poorer in late summer 2000 when water levels dropped lowest, but it is difficult to determine if this was due to water levels or normal seasonal variation. Therefore, it seems possible that low water contributed to poor water quality, but it is not likely the sole cause.

Another possible impact on water quality is the expansion of Round Lake Boulevard in summer 2004. This road is 100-300 feet from the lake along the entire eastern shore. It was expanded from two lanes to four. Several new stormwater treatment basins were installed next to the roadway to help protect the lake. Yet some residents were concerned. Water quality has gotten progressively poorer each of the three monitored years since the road was expanded. It seems unlikely that the road would be responsible for this water quality change given the practices in place to protect the lake and the fact that surrounding areas are residential, but it cannot be ruled out.

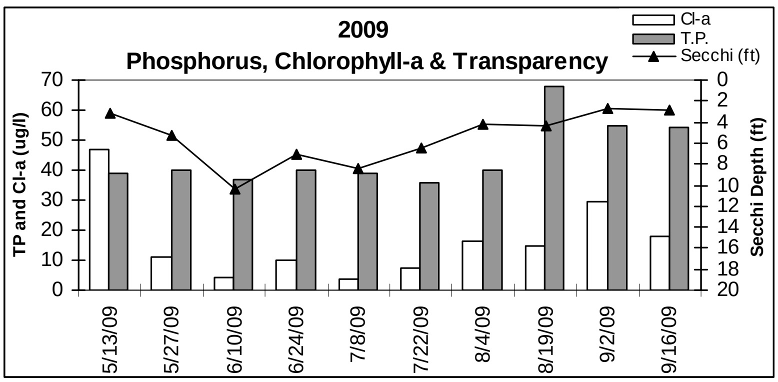
In the end, the reason for poorer water quality in recent years is uncertain. There are no apparent management changes that should be made. This leaves future monitoring and re-evaluation as the only recommendation.

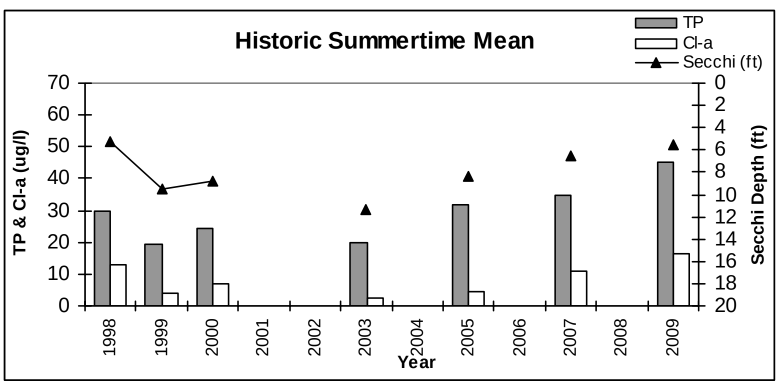
2009 Round Lake Water Quality Data

Round Lake 2009		Date	5/13/2009	5/27/2009	6/10/2009	6/24/2009	7/8/2009	7/22/2009	8/4/2009	8/19/2009	9/2/2009	9/16/2009			
		Time	10:10	9:30	9:35	9:35	9:35	10:00	9:45	9:00	9:30	8:45			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.07	7.61	7.75	8.20	8.41	8.44	8.16	7.91	8.54	8.09	8.12	7.61	8.54
Conductivity	mS/cm	0.010	0.375	0.444	0.429	0.417	0.383	0.397	0.375	0.410	0.377	0.415	0.402	0.375	0.444
Turbidity	FNRU	1	13.00	7.00	0.00	3.00	2.00	3.00	8.00	5.00	19.00	14.00	7	0	19
D.O.	mg/L	0.01	8.95	6.41	10.23	8.09	8.77	9.06	8.77	7.26	10.79	7.62	8.60	6.41	10.79
D.O.	%	1	89%	65%	103%	102%	103%	103%	102%	94%	119%	88%	97%	65%	119%
Temp.	°C	0.1	15.2	16.7	15.8	27.4	23.9	21.8	22.8	22.7	20.4	22.7	20.94	15.20	27.40
Temp.	°F	0.1	59.4	62.1	60.4	81.3	75.0	71.2	73.0	72.9	68.7	72.9	69.7	59.4	81.3
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	ug/L	1	46.7	10.8	4.1	10.2	3.7	7.6	16.4	14.9	29.6	17.8	16.2	3.7	46.7
T.P.	mg/L	0.005	0.039	0.040	0.037	0.040	0.039	0.036	0.040	0.068	0.055	0.054	0.045	0.036	0.068
T.P.	ug/L	5	39	40	37	40	39	36	40	68	55	54	45	36	68
Secchi	ft	0.1	3.1	5.3	10.4	7.0	8.4	6.4	4.3	4.3	2.8	2.9	5.5	2.8	10.4
Secchi	m	0.1	0.9	1.6	3.2	2.1	2.6	2.0	1.3	1.3	0.8	0.9	1.7	0.8	3.2
Field Observations															
Physical			2.00	2.50	2.00	2.00	2.00	3.00	3.50	3.00	3.00	3.50	2.7	2.0	3.5
Recreational			2.00	2.50	2.00	2.00	2.00	3.00	3.50	3.00	3.00	3.50	2.7	2.0	3.5

*reporting limit

Round Lake Water Quality Results





Round Lake Summertime Historic Mean

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

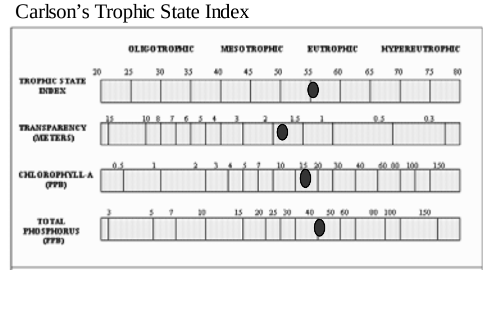
Carlson's Tropic State Indices

TSIP	53	47	50	47	54	55	59
TSIC	56	44	48	39	46	54	58
TSIS	55	45	46	42	47	50	52
TSI	55	45	48	43	49	53	56

Round Lake Water Quality Report Card

Year	98	99	2000	2003	2005	2007	2009
TP	B	A	B	A	B	C	C
Cl-a	B	A	A	A	A	B+	B
Secchi	C	B	B	A	B	C	C
Overall	**B**	**A**	**B**	**A**	**B**	**C**	**C**

Carlson's Trophic State Index



Stream Water Quality - Chemical Monitoring

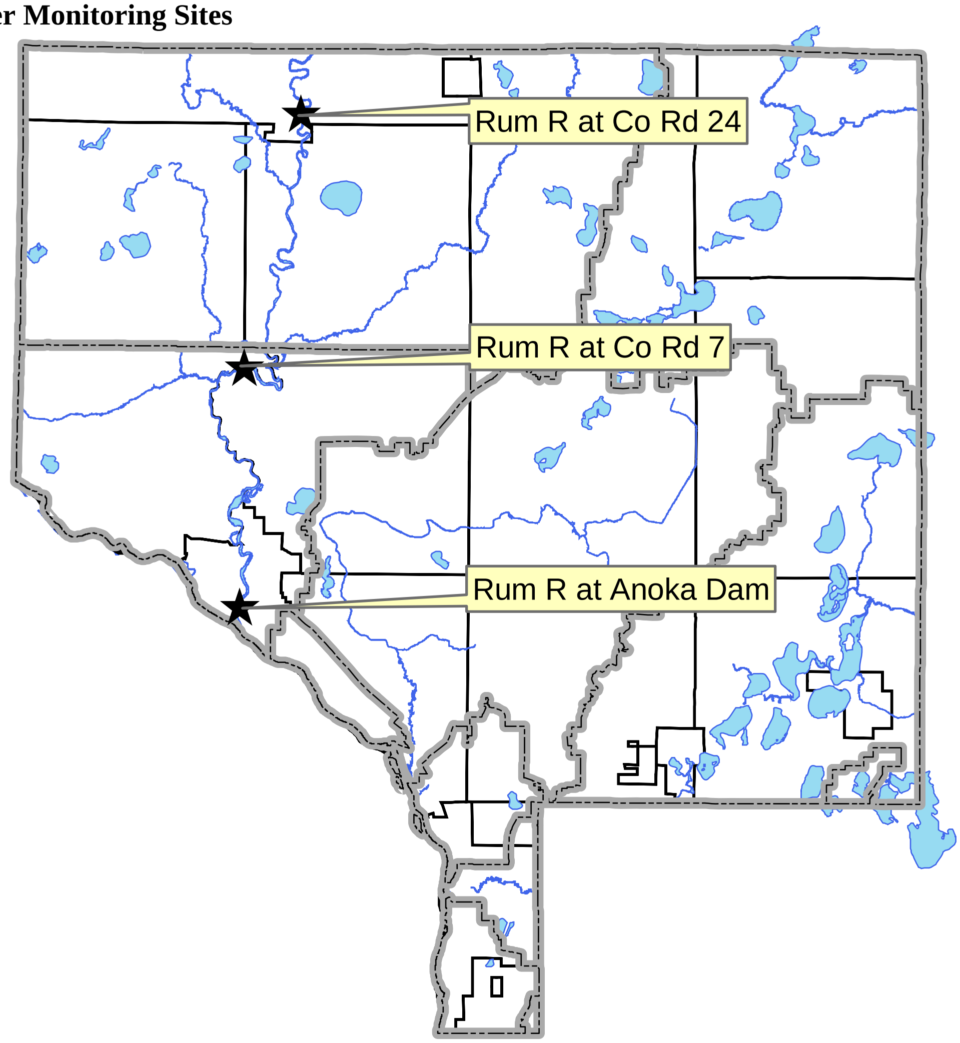
Description: In the Lower Rum River Watershed in 2009 stream monitoring was accomplished through two complimentary programs. First, the Upper Rum River Watershed Management Organization (URRWMO) monitored the Rum River at the boundary between the URRWMO and LRRWMO, as well as at another upstream site. Secondly, the Metropolitan Council monitored the Rum River near its outlet to the Mississippi through their Watershed Outlet Monitoring Program (WOMP). The Anoka Conservation District did the field work for both projects, ensured monitoring for both programs was conducted simultaneously so the data could be compared, and reports the data together for a more comprehensive analysis of the river from upstream to downstream.

Purpose: To understand water quality and hydrology throughout the twin cities metropolitan area. To detect water quality trends and problems, and diagnose the source of problems.

Locations: Rum River at the Anoka Dam, City of Anoka

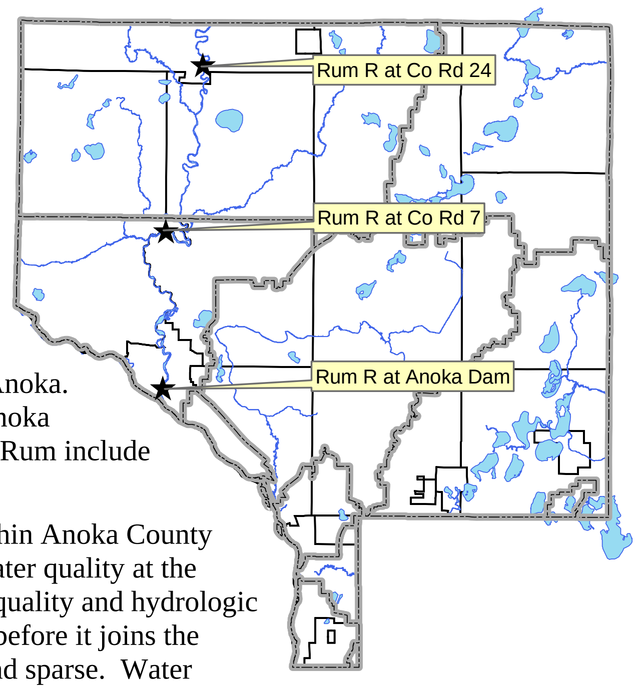
Results: Results are presented on the following page, with a focus on comparing river conditions from upstream to downstream. More detailed reporting for the WOMP monitoring station, including additional parameters and analysis are presented elsewhere by the Metropolitan Council (see http://www.metrocouncil.org/Environment/RiversLakes/).

2009 Rum River Monitoring Sites



RUM RIVER

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



Years Monitored

At Co. Rd. 24 – 2004, 2009

At Co. Rd. 7 – 2004, 2009

At Anoka Dam – 1996-2009 by the Met Council WOMP program

Background

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

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

Methods

In 2004 and 2009, monitoring was conducted at three locations simultaneously to determine if Rum River water quality changes in Anoka County, and if so, generally where changes occur. The URRWMO funded monitoring near where the river enters Anoka County (Co. Rd 24) and midway through the county near the lower boundary of their jurisdictional area (Co. Rd. 7). The Metropolitan Council monitored at the Anoka Dam, where there has been ongoing monitoring since 1996. The Anoka Conservation District did the field work for both projects, ensured monitoring for both programs was conducted simultaneously so the data could be compared, and reports the data together for a more comprehensive analysis of the river from upstream to downstream.

The river 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. 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. Ten additional parameters were tested by the Metropolitan Council at their laboratory for the Anoka Dam site only and are not reported here. During every sampling the water level (stage) was recorded. The monitoring station at the Anoka Dam includes automated equipment that continuously tracks water levels and calculates flows. Water level and flow data for other sites was obtained from the US Geological Survey, who maintains a hydrological monitoring site at Viking Boulevard.

The purpose of this report is to make an upstream to downstream comparison of Rum River water quality. It includes only parameters and dates that were simultaneously tested at all three sites. It does not include additional parameters tested at the Anoka Dam or additional monitoring events at that site. For that information, see Metropolitan Council reports at http://www.metrocouncil.org/Environment/RiversLakes.

Results and Discussion

Overall, Rum River water quality is good throughout Anoka County, however it does decline below the County Road 7 bridge (i.e. in the Cities of Andover, Anoka, and Ramsey). The declines in water quality below that point are modest, as are declines in water quality during storms. Dissolved pollutants (as measured by conductivity and chlorides), total phosphorus, turbidity, and total suspended solids were all generally near or below the median of all 40+ Anoka County streams that have been monitored.

Although water quality is good, several areas of concern were noted. First, dissolved pollutants increased at each monitoring site downstream. Dissolved pollutants were highest during baseflow, indicating pollutants have infiltrated into the groundwater which feeds the river and tributaries during baseflow. Road deicing salts are likely the most significant dissolved pollutant. Secondly, total suspended solids increased notably below County Road 7. This was most pronounced during storms.

It is important to recognize the limitations of this report. The data is only from 2004 and 2009 when all three sites were monitored simultaneously to allow comparisons. The dataset is relatively small. 2009 was a drought year and the flows and storms sampled were lower than normal. We did not sample any flood-like conditions when river water quality is likely worst. If a more detailed analysis of river water quality is desired, data from many years and a variety of conditions is available for the Anoka Dam site through the Metropolitan Council.

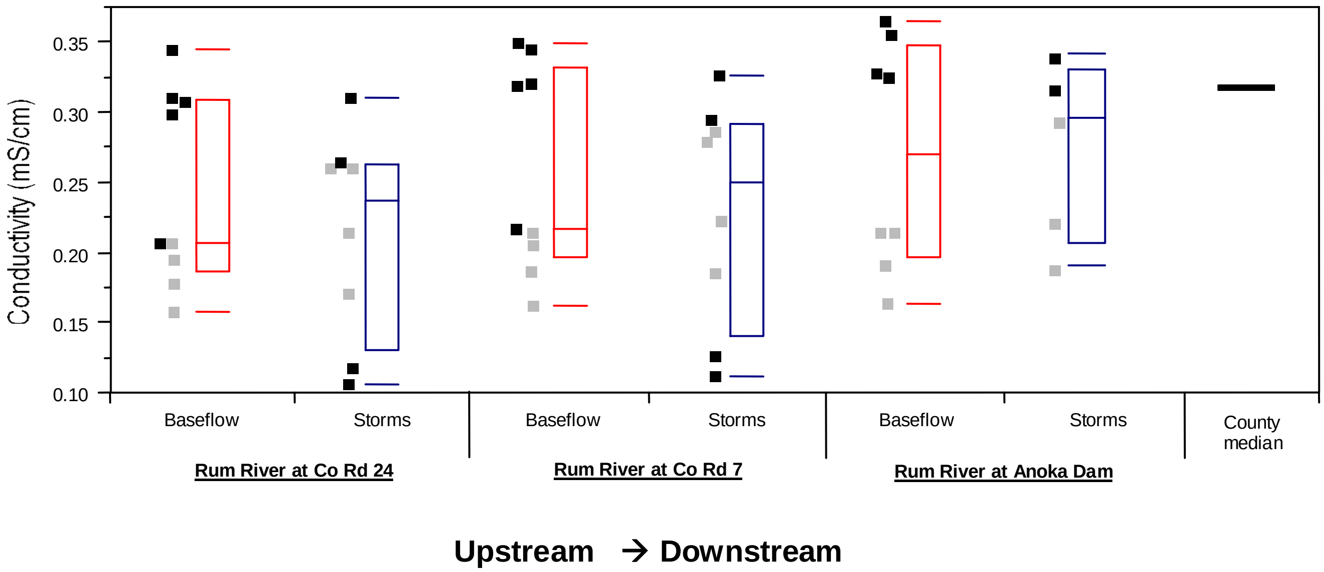
On the following pages data are presented and discussed for each parameter. The last section outlines management recommendations. The Rum River is an exceptional waterbody, and its protection and improvement should be a high priority.

Conductivity and chlorides

Conductivity and chlorides are measures 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. They can also be of concern because the Rum River is upstream from the Twin Cities drinking water intakes on the Mississippi River.

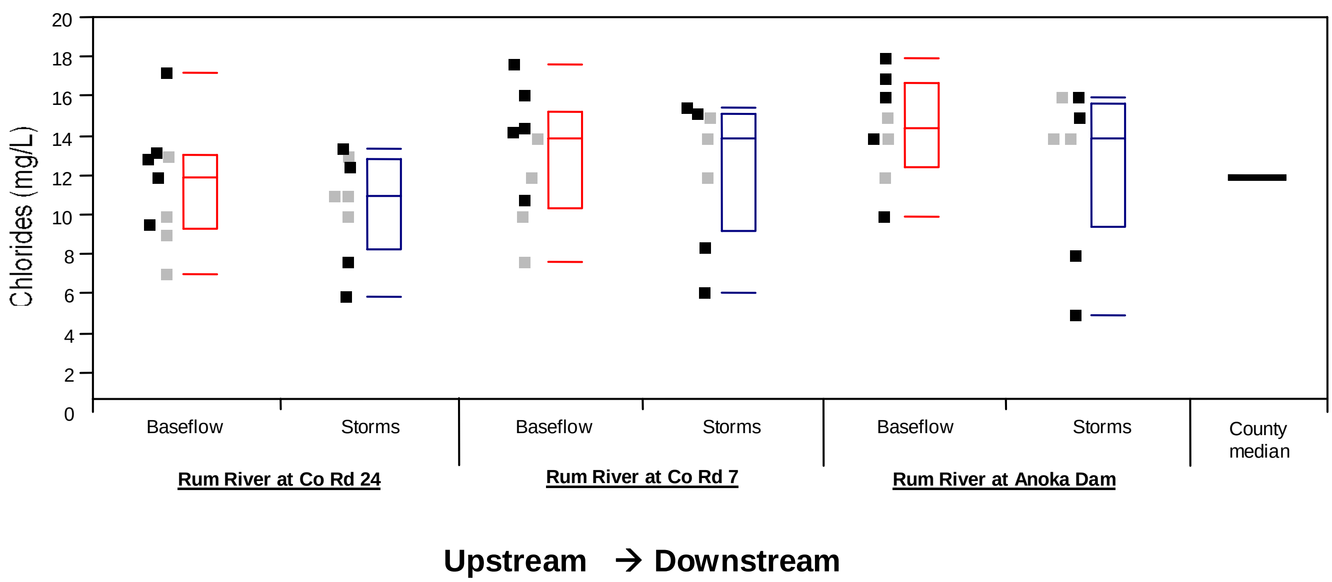
Conductivity is acceptably low in the Rum River, but increases downstream (see figure below) and during baseflow. Across all three sites conductivity averaged 0.247 mS/cm, which is lower than the median for 40+ Anoka County streams of 0.318 mS/cm. The maximum observed conductivity was 0.363 mS/cm. Conductivity was lowest at all sites 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 most other nearby streams too, studied extensively, and the largest cause has been found to be road salts that have infiltrated into the shallow aquifer. Geologic materials also contribute, but to a lesser degree. Baseflow conductivity increases from upstream to downstream, reflecting greater road densities and deicing salt application. Storm conductivity, while lower than baseflow, did also increase from upstream to downstream. This is reflective of greater stormwater runoff and pollutants associated with the more densely developed lower watershed.

Conductivity results during baseflow and storm conditions Grey dots are individual readings from 2004; black dots are 2009 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Chloride results parallel those found for conductivity (see figure below), supporting the hypothesis that chloride is an important cause of the conductivity. Chloride levels in the Rum River (median 11, 14, and 14 mg/L from upstream to downstream) are similar to the median for Anoka County streams of 12 mg/L. The highest observed value was 18 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. Like conductivity, chlorides were slightly higher during baseflow than storms at each site and increased from upstream to downstream. Road deicing salt infiltration into the shallow groundwater is likely the primary contributor, as described above.

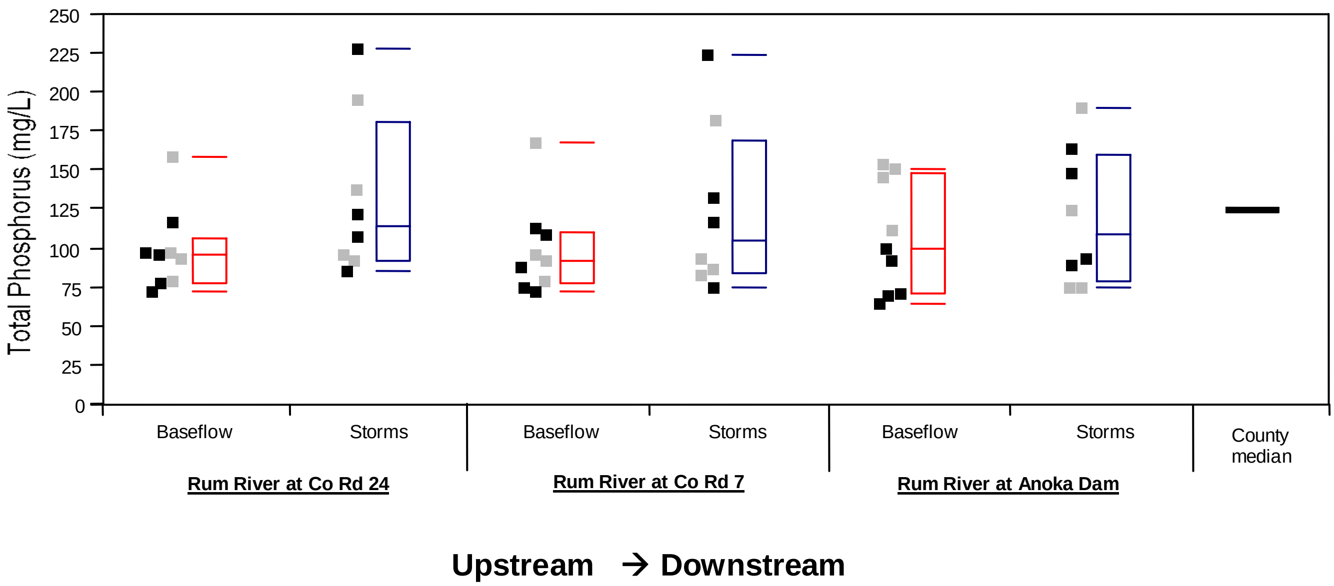
Chloride results during baseflow and storm conditions Grey dots are individual readings from 2004; black dots are 2009 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Total Phosphorus

Total phosphorus in the Rum River is acceptably low and is similar to the median for all other monitored 40+ Anoka County streams (see figure below). This nutrient is one of the most common pollutants in our region, and can be associated with urban runoff, agricultural runoff, wastewater, and many other sources. The median phosphorus concentration at each of the three monitored sites was 99, 95, and 101 ug/L; there is no trend of increasing phosphorus downstream. All sites occasionally experience phosphorus concentrations higher than the median for Anoka County streams of 126 ug/L. All of the highest observed total phosphorus readings were during storms, including the maximums at each site of 230, 226, and 192 ug/L (upstream to downstream). In all, phosphorus in the Rum River is at acceptable levels but should continue to be an area of pollution control effort as the area urbanizes.

Total phosphorus results during baseflow and storm conditions Grey dots are individual readings from 2004; black dots are 2009 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. Suspended solids in the Rum River are moderately high, but only at the Anoka Dam and during storms. The results for turbidity and TSS differ, lending insight into the types of particles that are problematic.

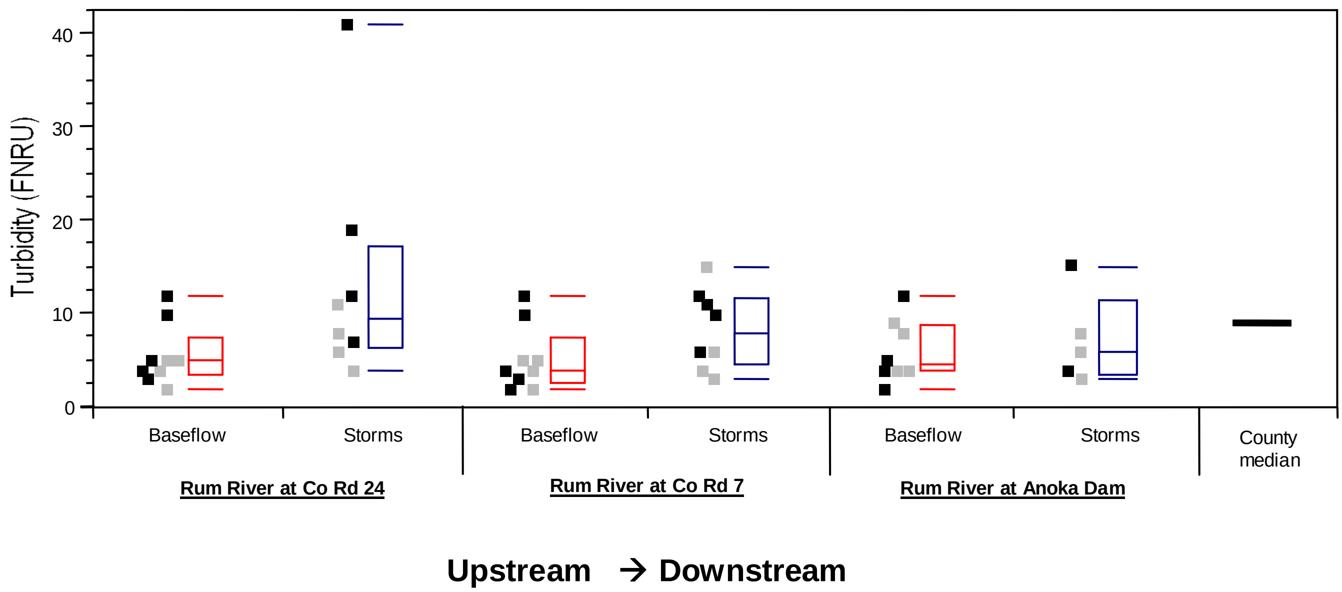
Turbidity was low, with only slight increases during storms and no apparent increase at downstream monitoring sites (see figure below). The median turbidity at each site was 6, 5, and 5 FNRU (upstream to downstream), which is lower than the median for Anoka County streams of 9 FNRU. The maximum observed was 41 FNRU, but this seemed to be an isolated event given that the next highest was 19. The Rum River's turbidity did not regularly exceed the Minnesota Pollution Control Agency's water quality standard of 25 NTU.

TSS was low at the upper two monitoring sites, with slight increases during storms (see figure below). The countywide TSS median for streams is 14 mg/L. Overall median TSS in the Rum River was 8 and 9 mg/L at County Roads 24 and 7, respectively. During storms median TSS was 2 and 4 mg/L higher than during baseflow for the two sites. Maximum TSS observed at these two sites were 28 and 23 mg/L. The maximum readings and slight increases during storms are not unexpectedly high for a large river, and are within the range that should be considered healthy.

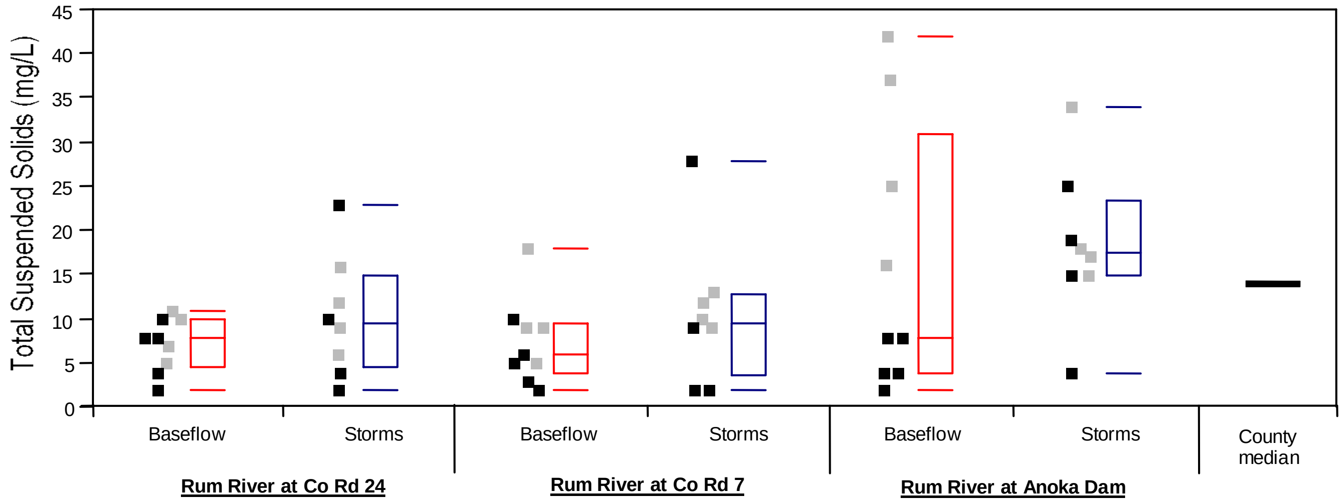
TSS increased noticeably between County Road 7 and the Anoka Dam (see figure below). At the Anoka Dam median TSS was similar to the other sites during baseflow (8 mg/L), but the three highest baseflow readings (25, 37, and 42 mg/L) were much higher than experienced at upstream sites. During storms TSS was only once below 15 mg/L and the maximum was 34 mg/L. While this does not exceed the Minnesota Pollution Control Agency's surrogate turbidity standard of 100 mg/L TSS, it is undesirable to have such notable water quality deterioration in such a short stretch of the river.

It should be noted that the data presented here do not include monitoring of any large flood events. The water is known to become muddier during such floods. In fact, the data presented in this report is skewed toward lower flow conditions that are likely to carry lower suspended solids because 2009 was a drought year. Notice in the figure below that 2009 generally had lower TSS than 2004.

Turbidity results during baseflow and storm conditions Grey dots are individual readings from 2004; black dots are 2009 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 results during baseflow and storm conditions Grey dots are individual readings from 2004; black dots are 2009 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

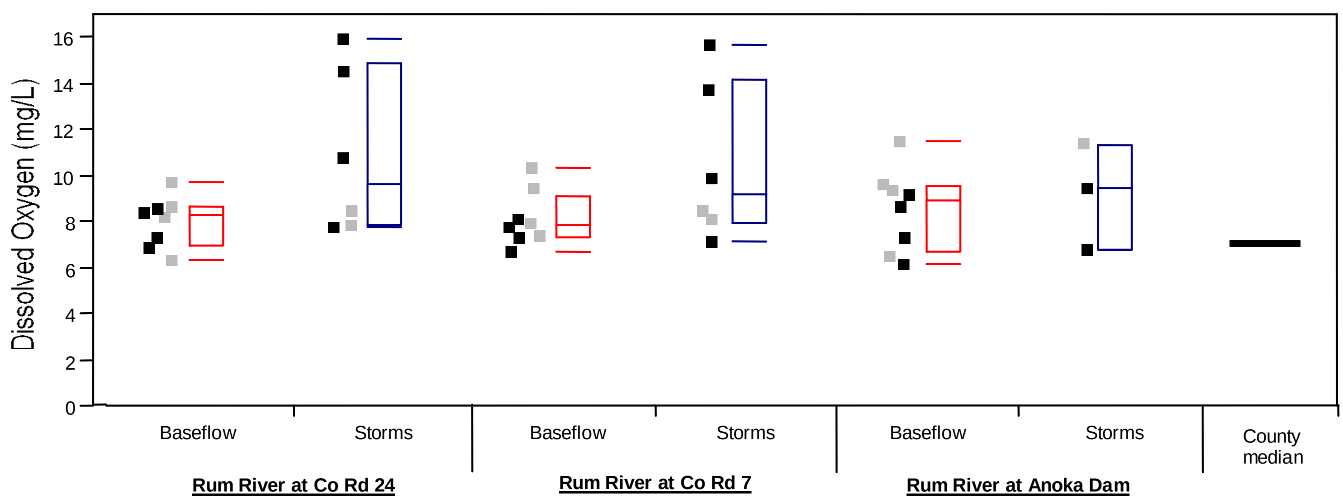


Upstream → Downstream

Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution consumes oxygen when it decomposes. If oxygen levels fall below 4 mg/L aquatic life begins to suffer. In the Rum River dissolved oxygen was always above 6 mg/L at all monitoring sites.

Dissolved oxygen results during baseflow and storm conditions Grey dots are individual readings from 2004; black dots are 2009 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



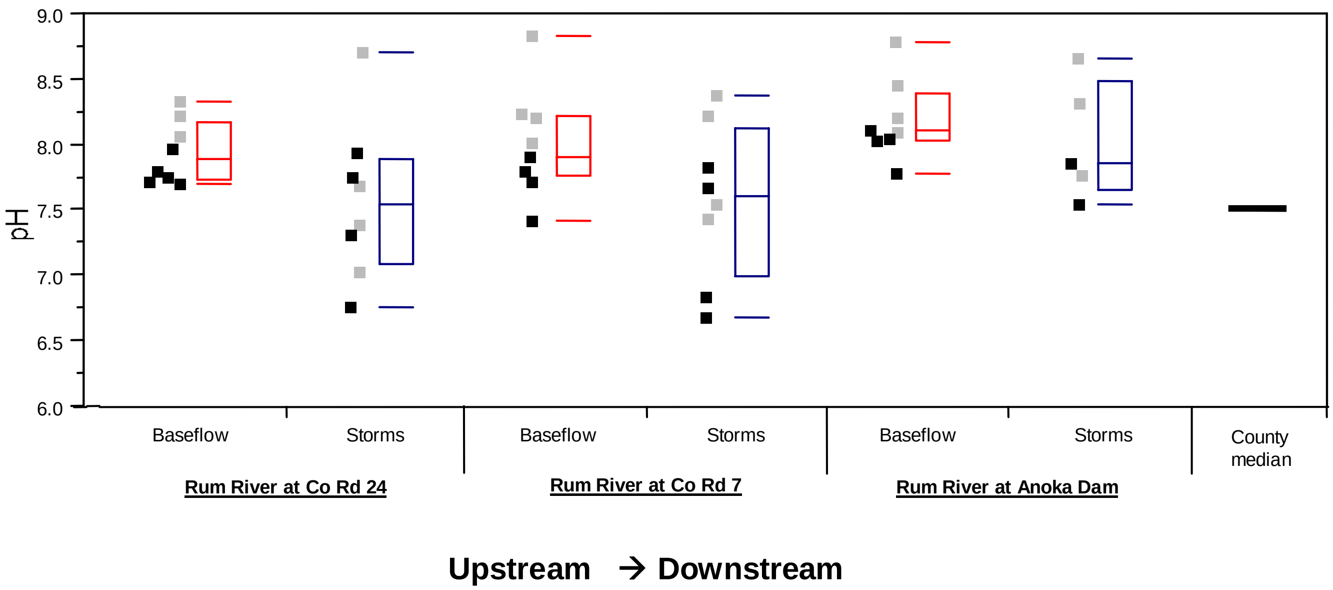
Upstream → Downstream

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 Rum River is regularly within this range (see figure below). Each of the three sites exceeded 8.5 on one occasion, but the highest was only 8.85. This rare and modest exceedance of the state water quality standard is not concerning.

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 Grey dots are individual readings from 2004; black dots are 2009 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Recommendations

While the Rum River's water quality is generally good, it does show some deterioration in the downstream areas that are most developed. Protection of the Rum River should be a high priority for local officials. Large population increases are expected for the Rum River's watershed within Anoka County and have the potential to degrade water quality unless carefully sited and managed. Development pressure is likely to be especially high near the river because of its scenic and natural qualities. Measures to maintain the Rum River's good water quality should include:

- Enforce the building and clear-cutting setbacks from the river required by state scenic rivers laws to avoid bank erosion problems and protect the river's scenic nature.
- Use the best available technologies to reduce pollutants delivered to the river and its tributaries through the storm sewer system. Any new development should consider low impact development strategies that minimize stormwater runoff production. Aggressive stormwater treatment should be pursued in all areas of the watershed, not just those adjacent to the river.
- Seek improvements to the existing stormwater conveyance system below County Road 7. Total suspended solids in the river increase significantly in this portion of the watershed, reaching their highest concentrations during storms.
- Utilize all practical means to reduce road deicing salt applications. These may include more efficient application methods, application only in priority areas, alternate chemicals, or others. Road salt infiltration into the shallow groundwater has become a regional problem.

- Survey the river by boat for bank erosion problems and initiate projects to correct them.
- Continue education programs to inform residents of the direct impact their actions have on the river's health.
- Continue regular water quality monitoring. In addition to continuous monitoring of the Rum River by Metropolitan Council's Watershed Outlet Monitoring Program (WOMP), additional upstream monitoring should be conducted every 2-3 years. Monitoring should be coordinated to occur on the same days as the Met Council testing so direct comparisons are possible. Additionally, periodic monitoring of the primary tributary streams should also occur every 2-3 year. The Upper and Lower Rum River Watershed Management Organizations are best suited to do this watershed-level monitoring and should coordinate.

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 Industry Ave, 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.

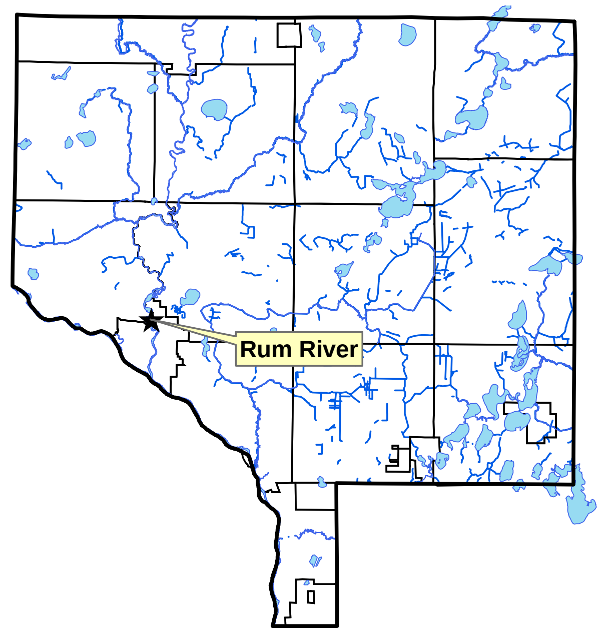
Family Biotic Index (FBI) — An index that utilizes known pollution tolerances for each family. Lower numbers indicate better stream quality.

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 2009

Monitored Since

2001

Student Involvement

113 students in 2009, approx 373 since 2001

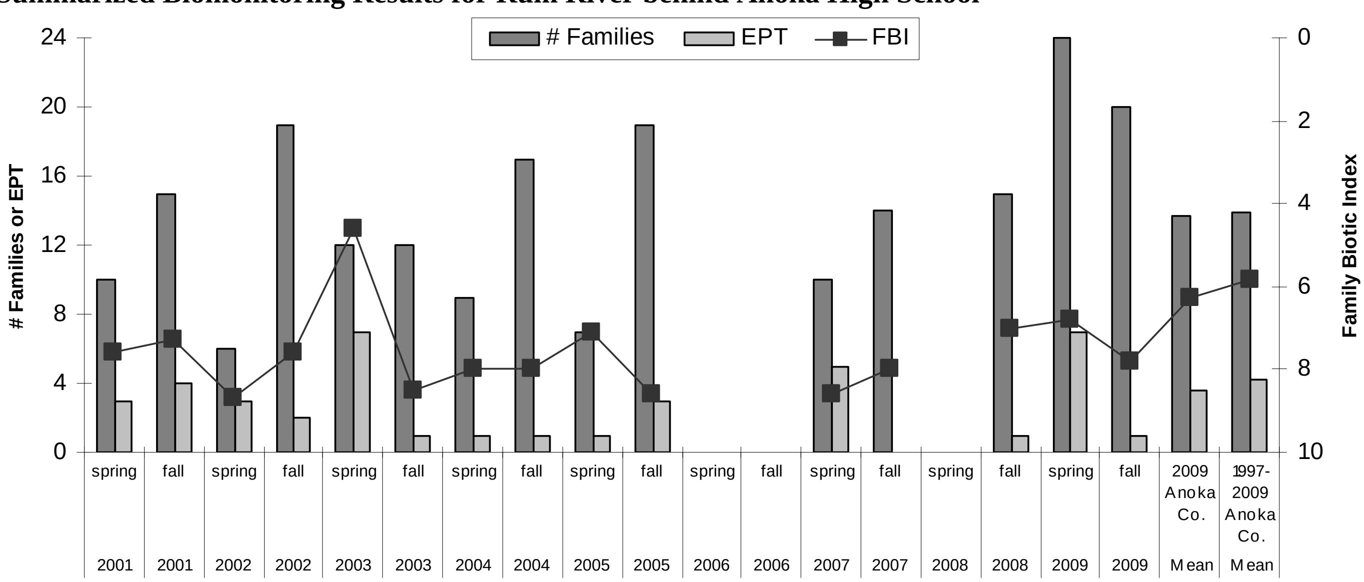
Background

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. Other than the Mississippi, this is the largest river in the county. 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. Sampling is not conducted in the main channel. Rather, it occurs in a backwater area. Water is not flowing in this location and the bottom is mucky. This site is not particularly representative of this reach of the river.

Results

Anoka High School monitored this site in both spring and fall 2009. The results for this site in 2009 were slightly better than most previous years, though this may be due to doubling of the number of students sampling compared to previous years. In 2009 more families (24 and 20) were found than every before at this site, nearly double the county-wide average. In the spring a high number of pollution-sensitive EPT families were found (7), but only one was found in fall. Because most species were not particularly sensitive to pollution, the Family Biotic Index was lower than the county average and similar to previous years. The various indices, taken together and across years, indicate a below average macroinvertebrate community.

Summarized Biomonitoring Results for Rum River behind Anoka High School



Biomonitoring Data for Rum River at Anoka High School

Year	2001	2001	2002	2002	2003	2003	2004	2004	2005	2005	2007	2007	2008	2009	2009	Mean	Mean
Season	spring	fall	spring	fall	spring	fall	spring	fall	spring	fall	spring	fall	fall	spring	fall	2009 Anoka Co.	1997-2009 Anoka Co.
FBI	7.60	7.30	5.90	7.60	4.60	8.50	8.00	8.00	7.10	8.60	8.6	8	7	6.80	7.80	6.3	5.9
# Families	10	15	6	19	12	12	9	17	7	19	10	14	15	24	20	13.6	13.9
EPT	3	4	3	2	7	1	1	1	1	3	5	0	1	7	1	3.6	4.2
Date	5/24	10/17	5/28	10/9	6/2	10/10	6/9	10/4	17-May	24-Oct	5/7	10/22	10/13	8-May	28-Sep		
sampling by	AHS	AHS	ACD	AHS	ACD	AHS	ACD	AHS	AHS	AHS	AHS	AHS	AHS	AHS	AHS		
sampling method	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH		
# individuals	100	178	179	144	126	569	192	572	124	360	208	244	626	880	585		
# replicates	1	1	1	2	1	1	1	1	1	1	1	1	1	1	2		
Dominant Family	corixidae	hemiptera	corixidae	taltridae	baetidae	corixidae	corixidae	corixidae	siphlonuridae	corixidae	corixidae	coenagrionidae	baetidae	siphlonuridae	hyalellidae		
% Dominant Family	66	30.9	91.1	20.1	51.6	43.9	33.9	57.3	82.3	69.7	91.8	37.3	26.5	40.7	39.1		
% Ephemeroptera	7	16.9	4.5	1.4	73	0.5	24.5	0.2	82.3	1.7	5.3	0	26.5	48.2	0.9		
% Trichoptera	0	0	0	0	2.4	0	0	0	0	0	0	0	0	0.1	0		
% Plecoptera	4	0	0.6	0	7.1	0	0	0	0	0	0.5	0	0	2.6	0		

AHS = Anoka High School, ACD = Anoka Conservation District

Supplemental Stream Chemistry Readings

Parameter	6-2-03	10-10-03	6-9-04	10-4-04	5-17-05	10-24-05	5-7-07	10-22-07	10-10-08	5-8-09	9-28-09
pH	7.66	8.63	8.27	9.12	8.45	8.04	8.50	7.42	7.75	7.91	7.82
Conductivity (mS/cm)	0.305	0.343	0.140	0.203	0.193	0.171	0.283	0.243	0.348	0.276	0.421
Turbidity (NTU)	3	1	3	2	5	5	17	13	3	6	5
Dissolved Oxygen (mg/L)	8.50	8.24	6.2	9.30	11.81	11.23 (95%)	11.41	9.72 (87%)	8.99 (85%)	10.82 (110%)	8.76 (87%)
Salinity (%)	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01
Temperature (C)	17.7	15.9	20.2	11.6	13.1	9.0	15.3	10.6	12.3	17.2	15.5

Discussion

Biomonitoring results for this site are much different from the monitoring farther 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 Anoka location the biotic indices indicate a poorer than average river health. The reason for this dramatic difference is probably habitat differences, and to a lesser extent, water quality.

The habitat and overall nature of the river is different in St. Francis and Anoka. In the upstream areas around St. Francis the river has a steeper gradient, moves faster, 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 heavily silt laden. The area is more developed, so there are more direct and indirect human impacts to the river.

Water quality declines downstream, though it is still quite good at all locations. Chemical monitoring in 2004 and 2009 revealed that total suspended solids, conductivity, and chlorides were all 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 quite 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 because those families generally favor rocky habitats and require high dissolved oxygen not found in stagnant areas.

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.

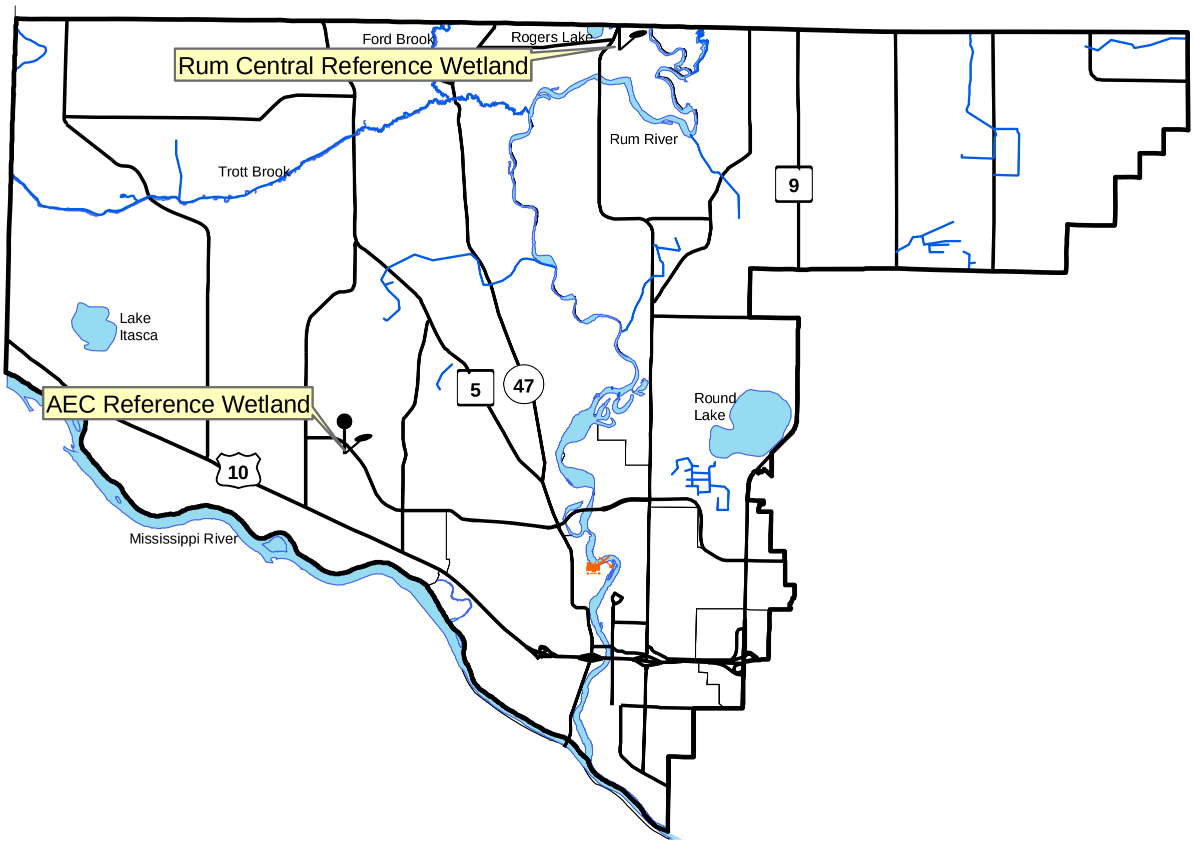
Purpose: To provide understanding of wetland hydrology, including the impact of climate and land use. These data aid in delineation of nearby wetlands by documenting hydrologic trends including the timing, frequency, and duration of saturation.

Locations: AEC Reference Wetland, Connexus Energy Property on Industry Ave, 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.

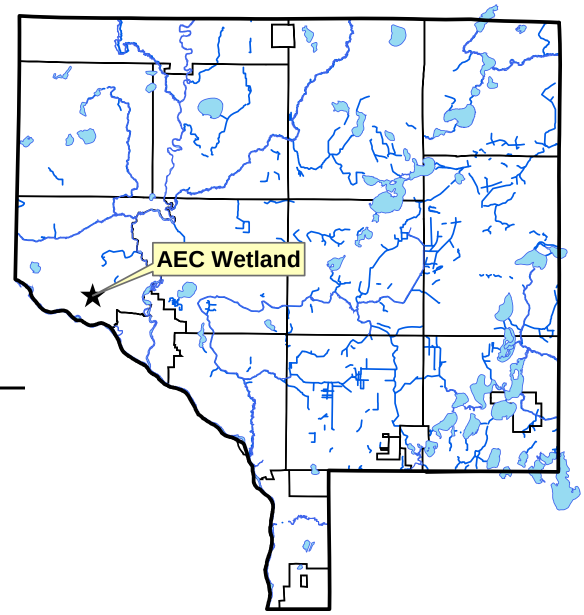
Lower Rum River Watershed Wetland Hydrology Monitoring Sites



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	-

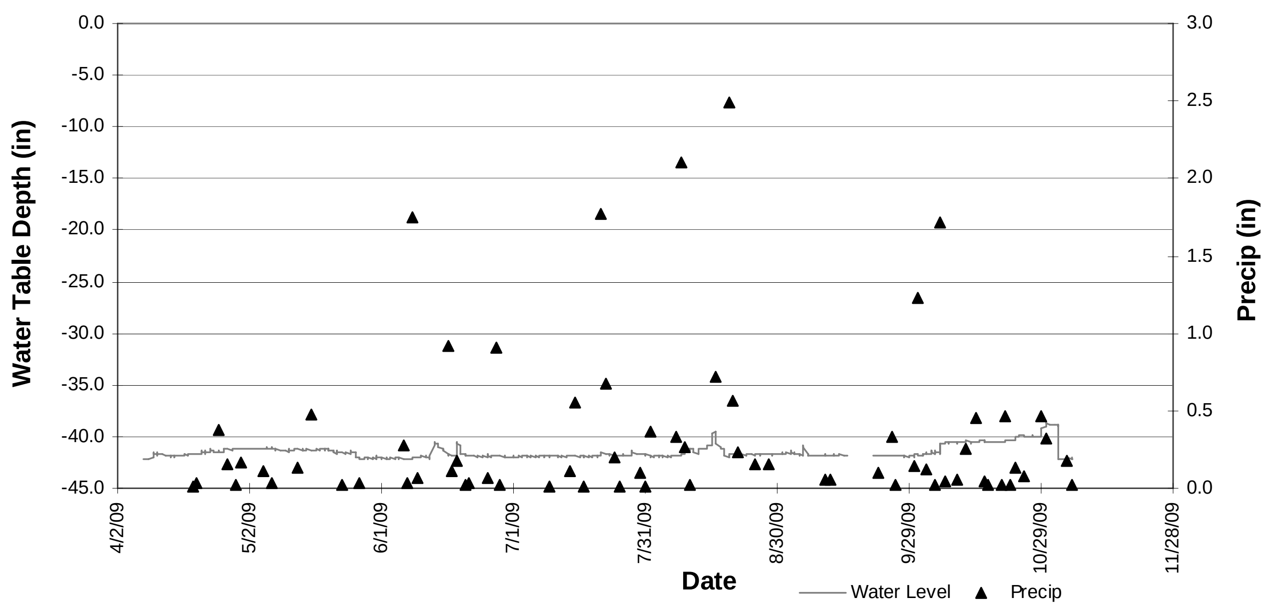
Surrounding Soils: Hubbard coarse sand

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.

2009 Hydrograph

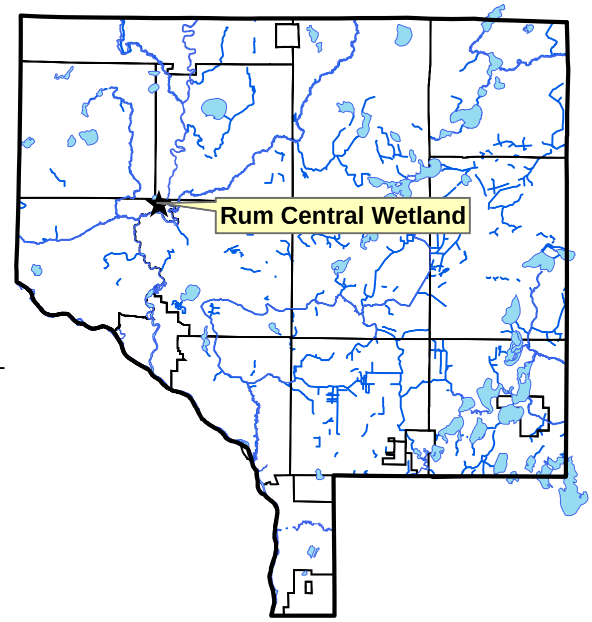


Well depth was 42 inches, so a reading of–42 indicates water levels were at an unknown depth greater than or equal to 42 inches.

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	-

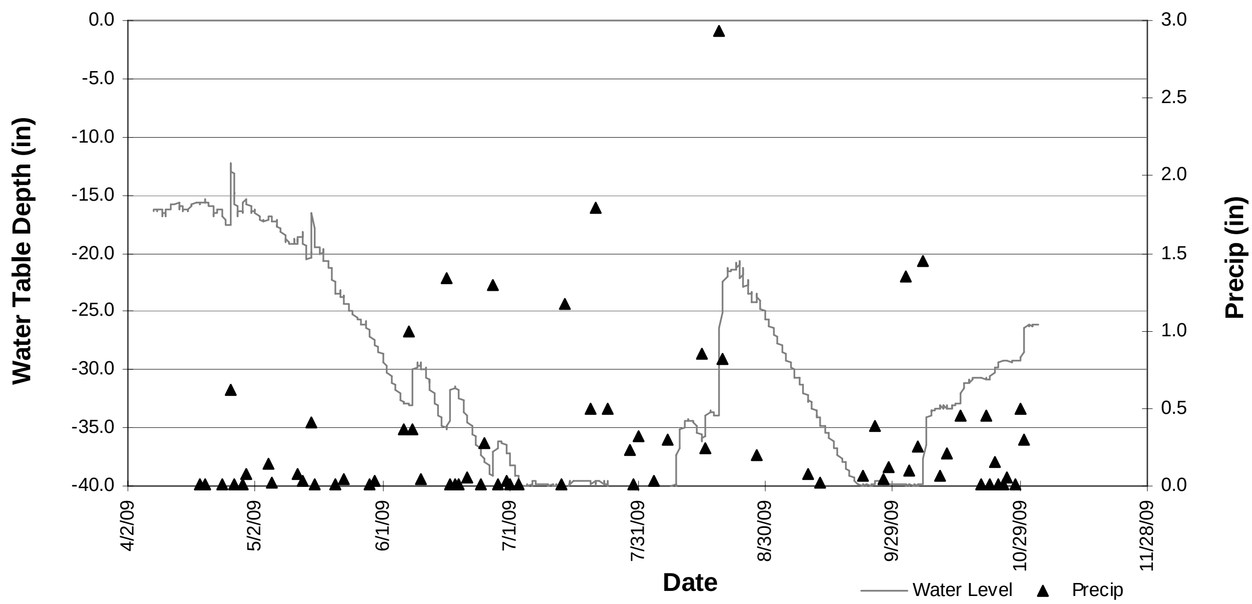
Surrounding Soils: Zimmerman fine sand

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.

2009 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.

Water Quality Improvement Projects

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 described individually below.

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
Fund Balance		**$1,571.58**

2008-09 Rusin Riverbank Stabilization

The only 2009 water quality improvement project in the LRRWMO was follow-up work on a project that was largely installed in 2008. This work was on the Rusin property's Rum Riverbank. In 2008 a cedar tree revetment was installed to correct erosion. In 2009 there was some minor stabilization of the higher bluff, which was a planned part of this project. In 2008 two water quality improvement projects utilized LRRWMO cost share funds. The property owner received 50% cost share grant for materials.

The bluff work in 2009 focused upon establishing plants where there were none. The slope is extremely steep, and bare soils were eroding. Scattered work occurred wherever bare soils were found. Erosion control blanket was stapled to the ground for temporary protection. 36 grass and 12 wildflower plugs were planted, along with approximately 25 shrub seedlings. In some places, the invasive species Siberian pea shrub, European buckthorn, honeysuckle, and prickly ash were removed to lessen competition and ensure the new seedlings would receive adequate sunlight.

The cedar tree revetments installed at the waterline on the Rusin and neighboring Herrala properties in 2008 are performing well. All trees have remained in place and erosion appears to have stopped. No maintenance is anticipated to be needed. The landowners are pleased with its performance.

Conservation Workshops

Description: The Anoka Conservation District, with assistance from participating cities, hosted conservation workshops for the public. Three workshops were offered, including rain gardens, watersmart, and shoreland management. Workshops were two hours in length, except for the rain garden workshop. The rain garden workshop was four hours and included hands-on rain garden construction outdoors. Cities provided promotion of the workshops and facilities. ACD staff taught the workshops.

Purpose: To assist and encourage landowners to install water quality improvement projects.
To encourage water conservation.

Results: The Anoka Conservation District partnered with the City of Ramsey to host a watersmart workshop in spring 2009. This workshop focused upon landscaping techniques for water conservation. Participation was approximately 10 residents.

Workshop promotional flier.

Participants learn landscaping techniques for water conservation at the watersmart workshop.

Anoka County Geologic Atlas

Description: A map-based report of groundwater and geology to be used for community planning and groundwater management. The Atlas provides detailed information about groundwater:

- Aquifers, including identifying future water sources,
- Aquifer sustainability,
- Recharge areas,
- Sensitivity to pollution,
- Flow directions,
- Connections to lakes, streams, and wetlands,
- Chemistry,
- Wellhead protection, and others...

Results are provided as GIS files and paper maps, and are especially useful to community planners.

Geologic Atlases are a partnership of the MN Geological Survey, MN DNR, and local governments. 94% of funding was secured by the MN Geological Survey (MGS) and MN Department of Natural Resources (DNR) from the Legislative-Citizen Commission for Minnesota Resources (LCCMR). A required local contribution totaling 6% of project expenses was provided by the seven Anoka County watershed organizations and the Anoka Conservation District. Completion of the project requires 4-5 years.

Purpose: To gain knowledge about groundwater and geology that enables improved management of groundwater, including availability, pollution prevention, and pollution management.

Locations: Throughout Anoka County

Results: An Anoka County Geologic Atlas began in 2009 with financial support from all seven Anoka County Watershed Management Organizations and the Anoka Conservation District. These funds were used to locate approximately 9,500 groundwater wells, with approximately an additional 500 to be located in early 2010. Boring logs from these wells and others already in the County Well Index will be used to create the geologic atlas. The MGS has already begun the process of using these wells to create the geologic atlas. Thereafter the DNR will perform a groundwater analysis for the atlas. In total, the geologic atlas is expected to be completed around 2014.

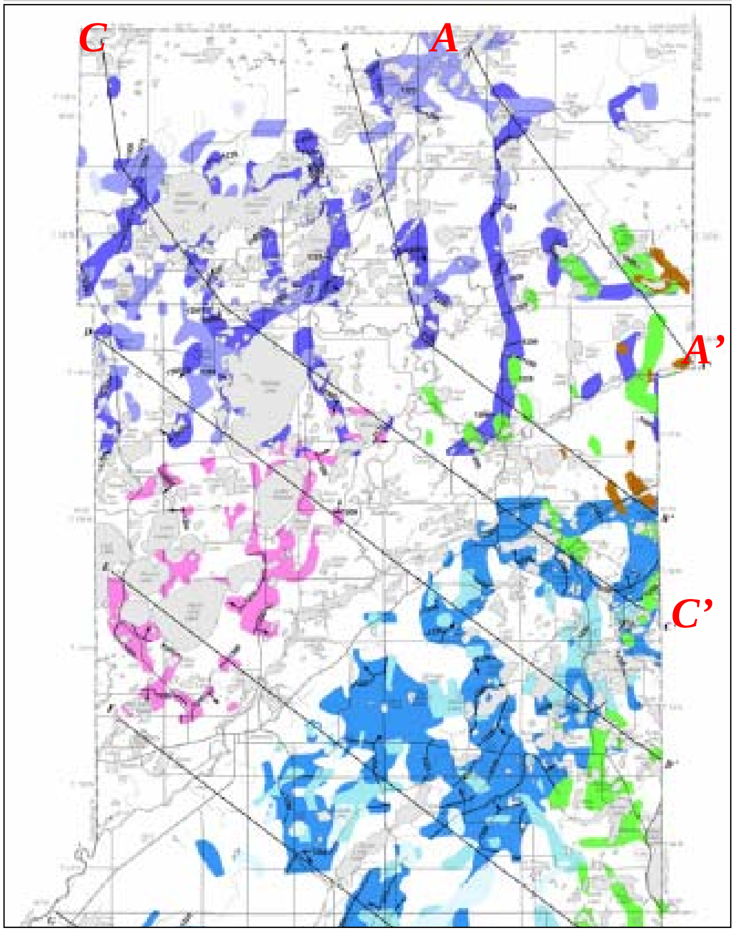
An example of portions of a geologic atlas from Crow Wing County are on the following page.

EXAMPLE GEOLOGIC ATLAS WORK PRODUCTS

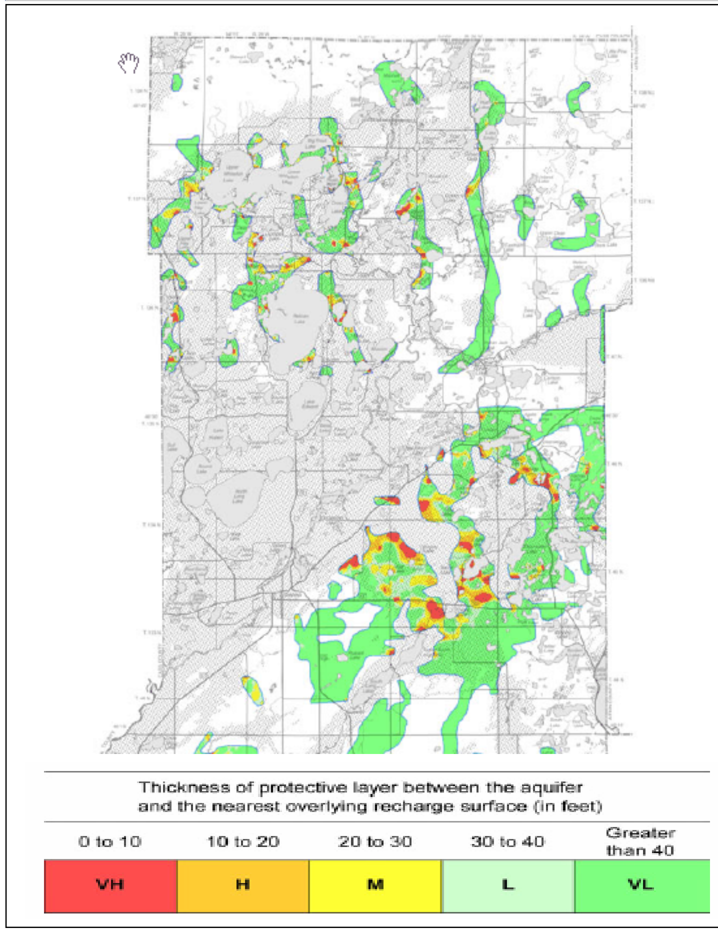
Crow Wing County Geologic Atlas

Excerpted from: Peterson, T. 2008. Hydrogeology, Pollution Sensitivity, and Lake and -Groundwater Interaction. MN Ground Water Association Newsletter 27-3.

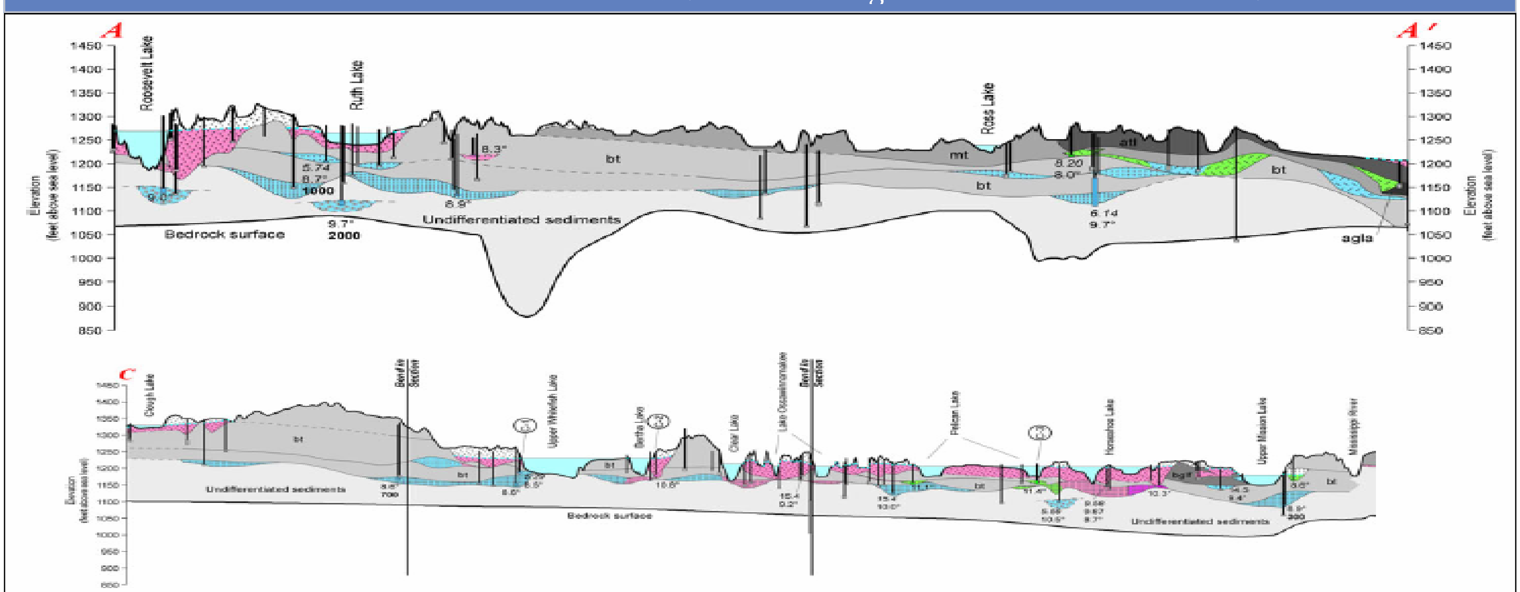
Extent and Distribution of Buried Aquifers Including Direction of Flow



Pollution Sensitivity of Buried Aquifers



Selected hydro-geologic cross sections showing groundwater residence time. Cross sections A-A' and the Northwest 2/3 of C-C' are shown. See above figure for cross section location.



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.

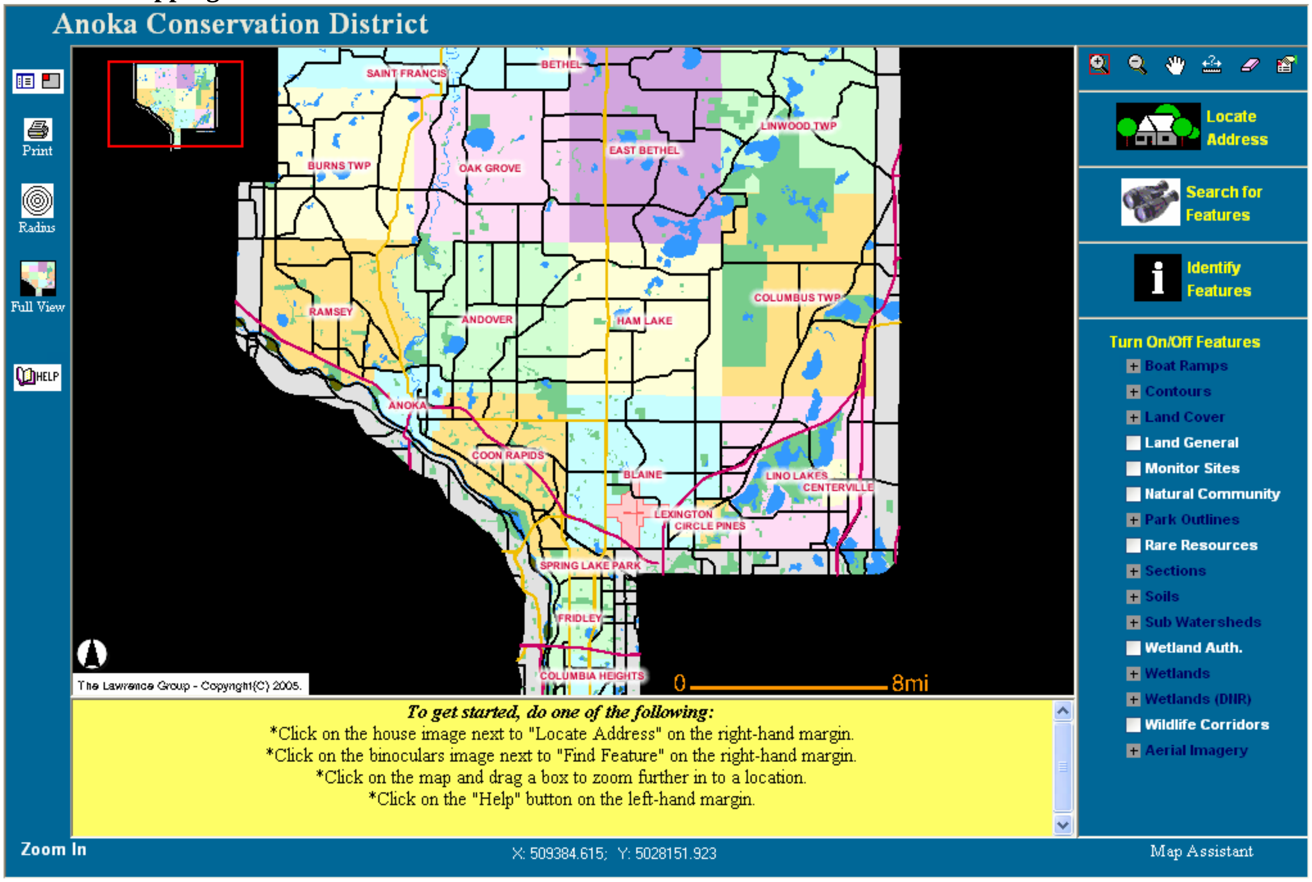
Other tools on the website include:

- 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

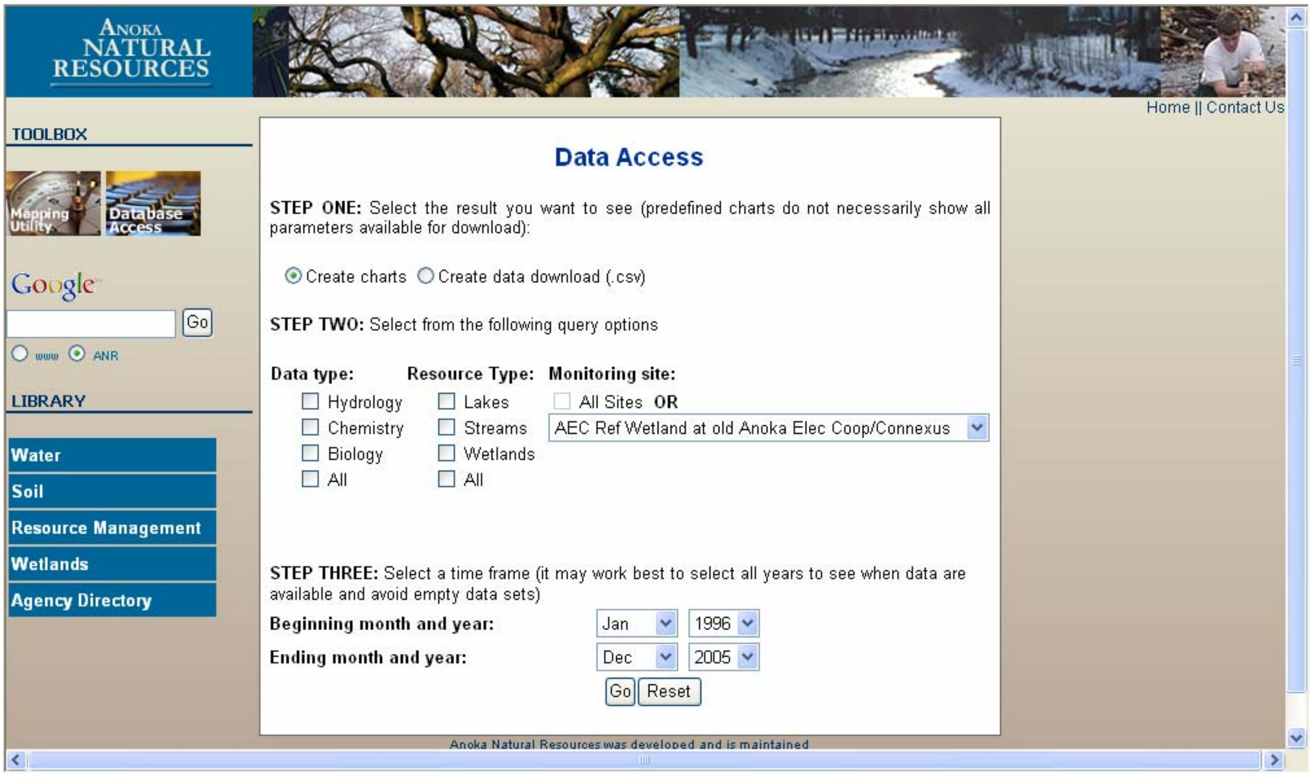
LRRWMO Website Homepage

more on next page

Interactive Mapping Tool



Interactive Data Access Tool



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.

Lower Rum River Watershed Financial Summary

Lower Rum River Watershed	Website	Ref Wet	Lake Lvl	Ob Well	Lake WQ	Stream WQ	WOMP	Student Biom	Geologic Atlas	Projects	Total
Revenues											
LRRWMO	380	525	510	0	1970	0	0	380	3410	52	7227
State	0	0	0	120	0	0	0	0	0	0	120
Anoka Conservation District	1513	0	321	127	500	1509	3272	525	923	0	8689
County Ag Preserves	0	138	0	0	717	0	0	380	0	0	1235
Other Service Fees	0	0	0	0	0	0	0	(0)	11	52	63
Local Water Planning	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1893	663	831	247	3187	1509	3272	1285	4344	104	17334
Expenses-											
Capital Outlay/Equip	4	2	2	1	18	2	14	3	42	0	89
Personnel Salaries/Benefits	1061	563	722	213	2083	1027	2722	1100	3876	0	13368
Overhead	71	42	50	15	136	67	216	54	189	0	840
Employee Training	12	7	12	3	16	18	36	12	31	0	147
Vehicle/Mileage	15	8	11	3	32	16	41	16	67	0	209
Rent	52	32	34	11	102	43	156	39	119	0	588
Program Participants	0	0	0	0	0	0	0	0	0	104	104
Program Supplies	676	8	2	0	800	335	86	62	19	0	1989
Equipment Maintenance	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1893	663	831	247	3187	1509	3272	1285	4344	104	17334
NET	0	0	0	0	0	0	0	0	0	0	0

Recommendations

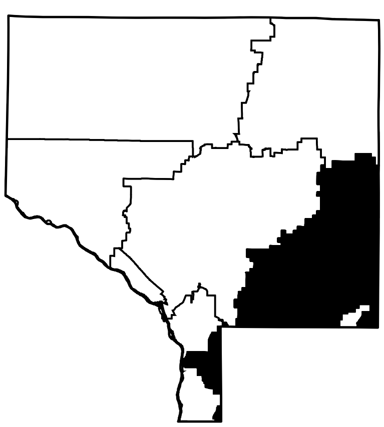
- **Facilitate resident efforts to control aquatic plant growth on Rogers Lake** as a means to improving low dissolved oxygen problems. Treatments should occur in early spring, occur on no more than 15% of the lake, be coordinated, and proceed under DNR permits.
- **Continue monitoring Round Lake** water quality at least every other year to determine if poorer water quality recently is within this lake's natural variation, due to low water levels, or is indicative of new negative influences on the lake.
- **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.
- **Coordinate monitoring of the Rum River** with the neighboring Upper Rum River WMO and the Metropolitan Council, who runs a monitoring site at the Anoka Dam.
- **Diagnose the cause of periodically low dissolved oxygen in Trott Brook.**
- **Continue lake level monitoring, especially on Round Lake** where residents have expressed concerns with levels. Other nearby lakes should be monitored for comparison and in case problems develop.

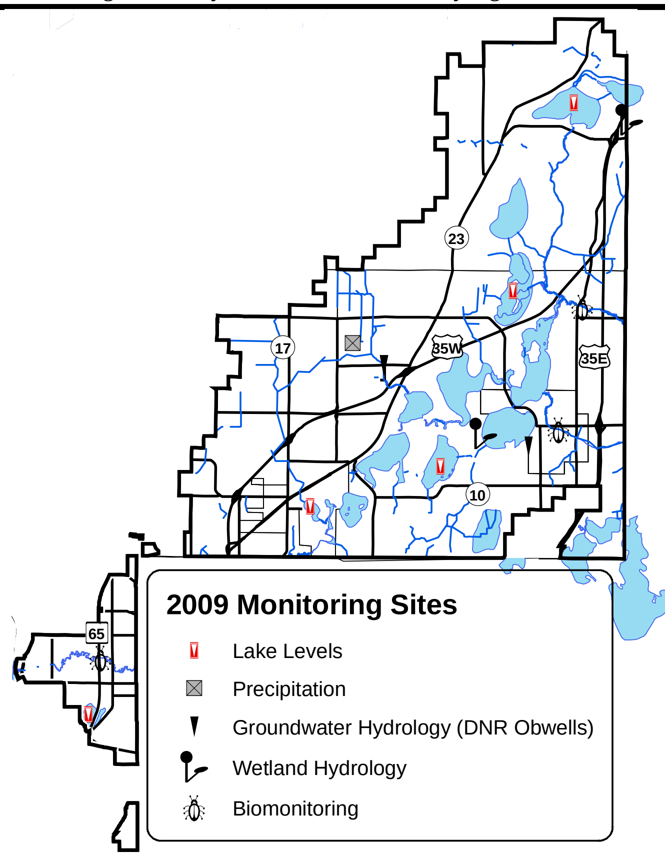
- **Maintain a cost share program for water quality improvement projects** on private properties. This program should be actively promoted by identifying problems and contacting landowners.
- **Encourage public works departments to implement measures to minimize road deicing salt applications**. Monitoring and special investigations in the LRRWMO have shown that road salts are one of the largest and most widespread sources of stream degradation in this watershed.
- **Promote groundwater conservation.** Water tables in the LRRWMO appear depressed due to regional over-pumping. Metropolitan Council models predict 3+ft drawdown of surface waters in parts of the LRRWMO by 2030, and 5+ft by 2050.
- **Incorporate the above recommendations into the LRRWMO Watershed Plan**. The Plan provides an organized and prioritized way to address these issues.

CHAPTER 5: RICE CREEK WATERSHED

Task	Partners	Page
Lake Levels	RCWD, ACD	5-120
Wetland Hydrology	RCWD, ACD	5-122
Stream Water Quality – Biological	RCWD, ACD, ACAP, Centennial HS, Forest Lake Area Learning Center, Totino Grace HS	5-125
Water Quality Improvement Projects	RCWD, ACD, landowners, others	5-132
Conservation Workshops	ACD, ACAP, cities	5-136
Rice Lake Subwatershed Assessment	RCWD, ACD	5-137
Anoka County Geologic Atlas	All Anoka County watershed Organizations, ACD, MGS, MNDNR	5-138
Financial Summary		5-140
Recommendations		5-141
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, MGS = MN Geological Survey, 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: Golden Lake, Howard Lake, Moore Lake, Reshanau Lake, and Rondeau Lake

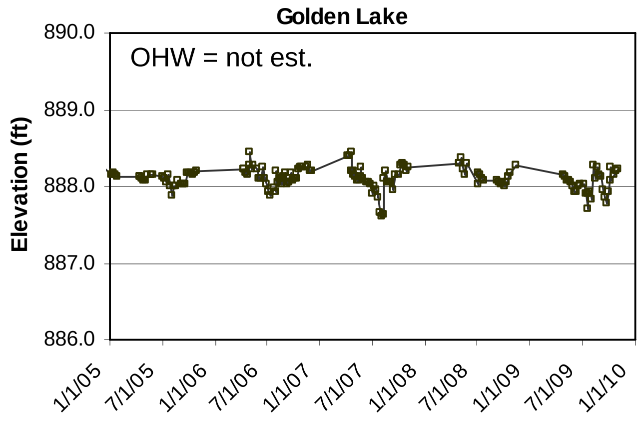
Results: Lake levels were measured by volunteers 19 to 35 times, depending upon the lake. New volunteers were secured for Rondeau and Reshanau Lakes as previous volunteers withdrew from monitoring. All of these lakes exhibited similar general trends; beginning high in spring, declining throughout summer, and rising slightly in late fall. There were large differences in the magnitude of changes despite their close proximity to each other, and in some cases, hydrologic connectedness. Moore Lake ranged 1.08 feet and Reshanau ranged 1.0 feet from their highest to lowest points. Howard Lake ranged 0.98 feet from its highest to lowest point and Rondeau Lake ranged 0.94 feet. On the other hand, Golden Lake was relatively steady, changing only 0.56 feet all year.

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

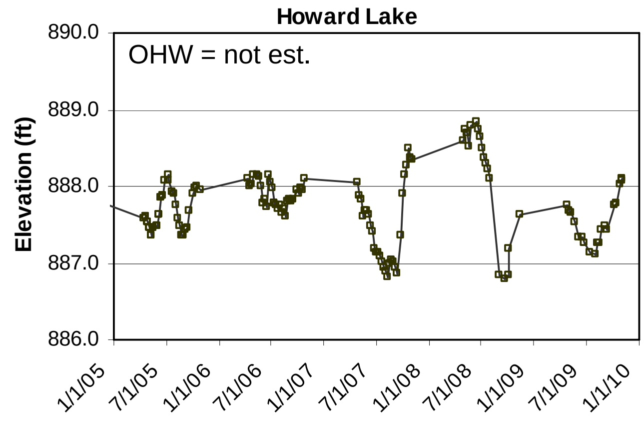
Rice Creek Watershed Lake Levels Summary

Lake	Year	Average	Min	Max
Golden	2005	888.10	887.87	888.20
	2006	888.14	887.88	888.44
	2007	888.09	887.60	888.44
	2008	888.15	888.01	888.37
	2009	888.03	887.70	888.26
Howard	2005	887.67	887.35	888.15
	2006	887.90	887.60	888.15
	2007	887.49	886.81	888.50
	2008	888.13	886.79	888.85
	2009	887.54	887.11	888.09
Moore	2005	877.23	876.77	878.07
	2006	877.25	876.93	877.81
	2007	876.99	876.21	877.71
	2008	877.10	876.64	877.66
	2009	876.96	876.47	877.55
Reshanau	2005	881.11	880.55	881.71
	2006	880.99	880.38	882.13
	2007	880.88	879.36	881.74
	2008	incomplete data		
	2009	881.03	880.58	881.58
Rondeau	2005	886.16	885.75	886.53
	2006	886.18	885.61	886.88
	2007	885.83	885.13	886.67
	2008	incomplete data		
	2009	885.93	885.47	886.41

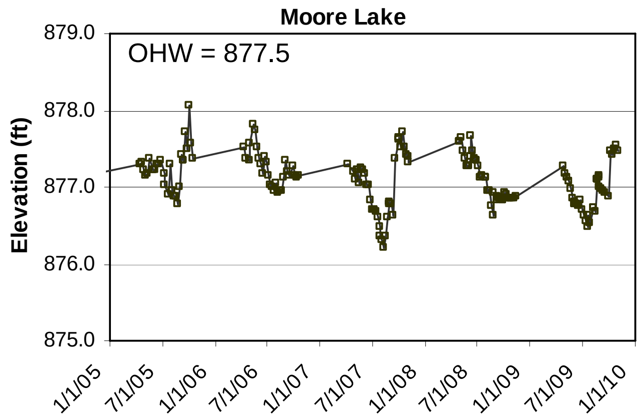
Golden Lake Levels 2005-2009



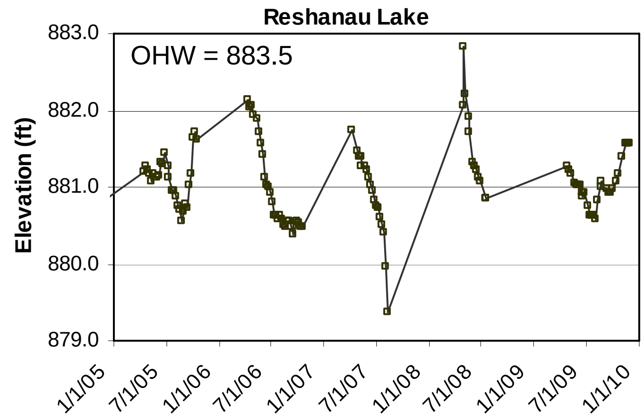
Howard Lake Levels 2005-2009



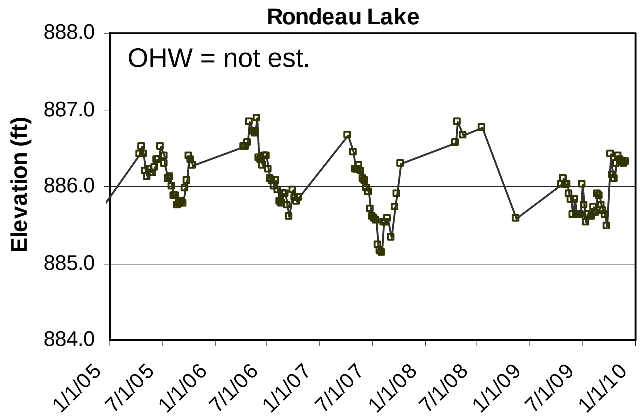
Moore Lake Levels 2005-2009



Reshanau Lake Levels 2005-2009



Rondeau Lake Levels 2005-2009



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.

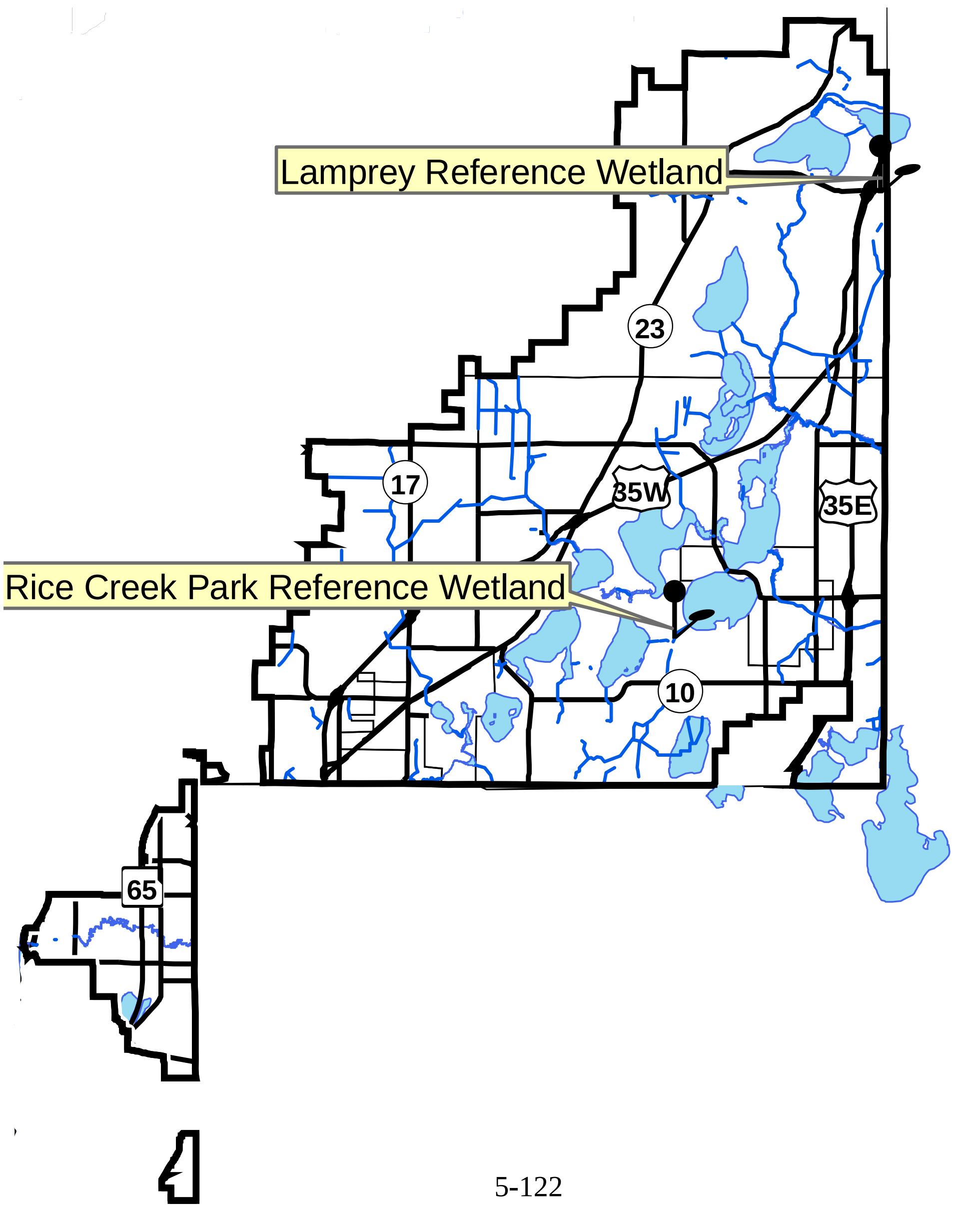
Purpose: To provide an understanding of wetland hydrology, including the impact of climate and land use. These data aid in delineation of nearby wetlands by documenting hydrologic trends including the timing, frequency, and duration of saturation.

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

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

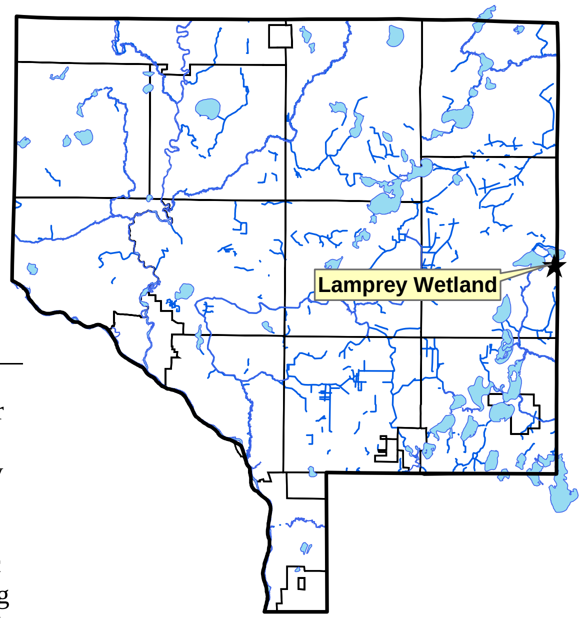
Results: See the following pages. Raw data and updated graphs can be downloaded from www.AnokaNaturalResources.com using the Data Access Tool.

Rice Creek Watershed Wetland Hydrology Monitoring Sites



LAMPREY REFERENCE WETLAND

Lamprey Pass Wildlife Mgmt Area, Columbus



Site Information

Monitored Since: 1999

Wetland Type: 4

Wetland Size: ~0.5 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

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

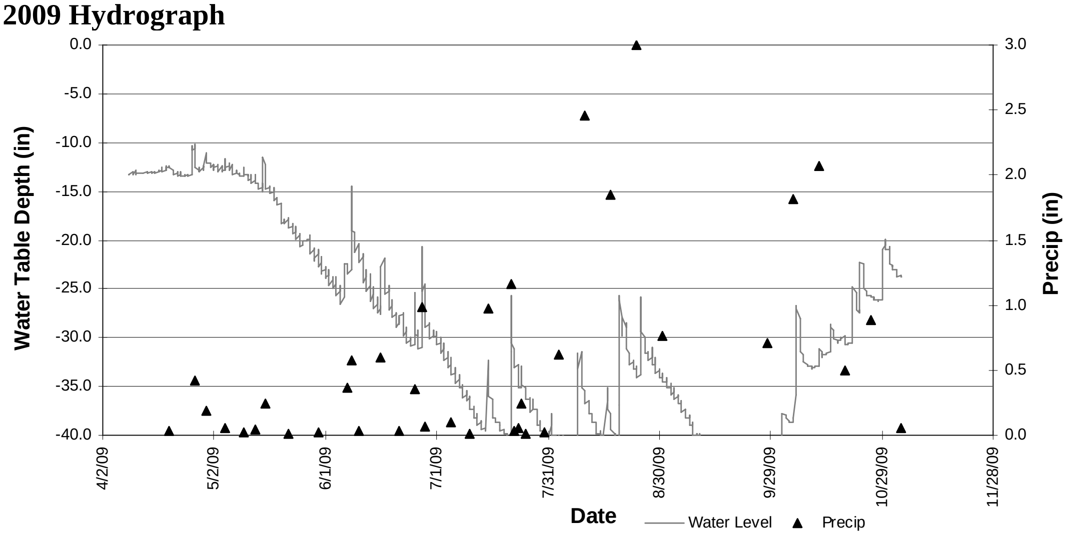
Surrounding Soils: Braham loamy fine sand

Vegetation at Well Location:

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

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

2009 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.

Wetland Hydrology Monitoring

RICE CREEK REFERENCE WETLAND

Rice Creek Chain of Lakes Regional Park, Lino Lakes

Site Information

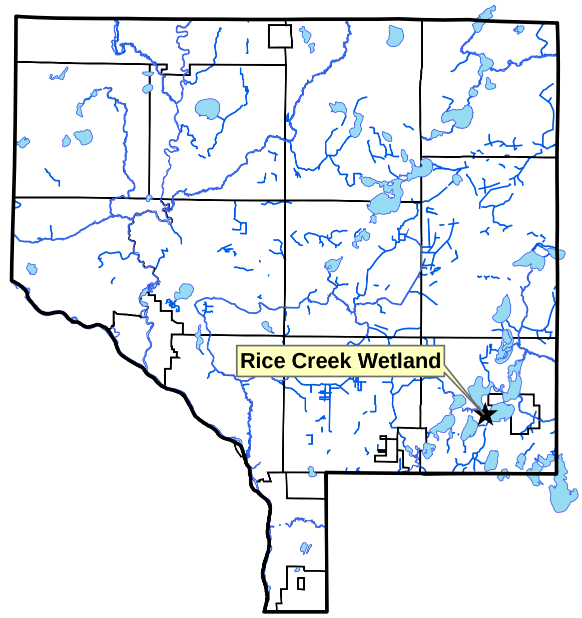
Monitored Since: 1996

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

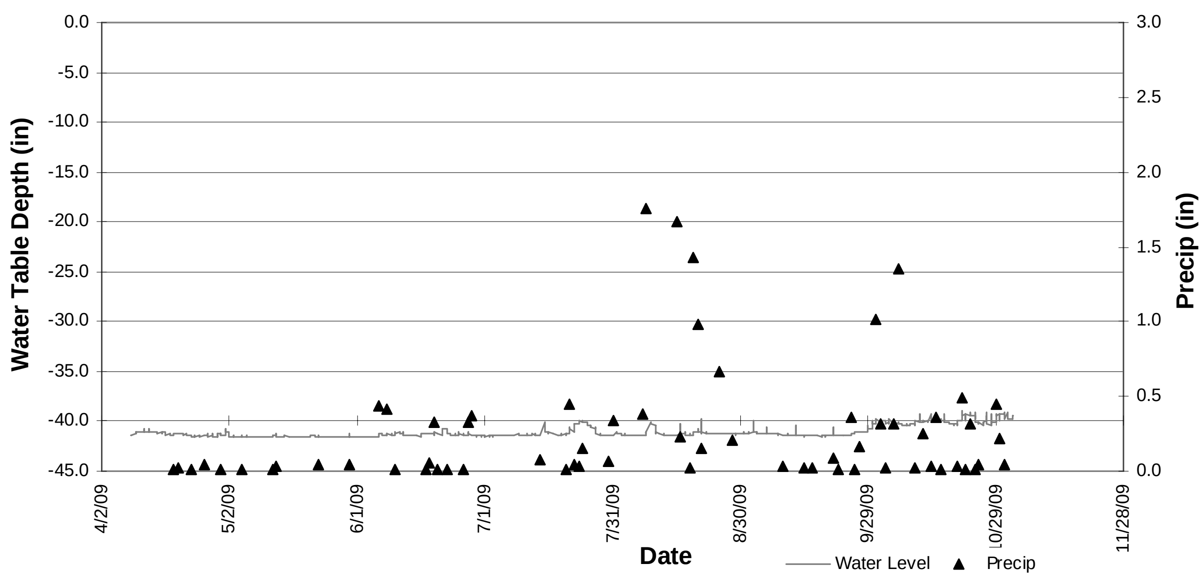
Surrounding Soils: Nessel fine sandy loam and Blomford loamy fine sand

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.

2009 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.

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 Hwy 140, 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.

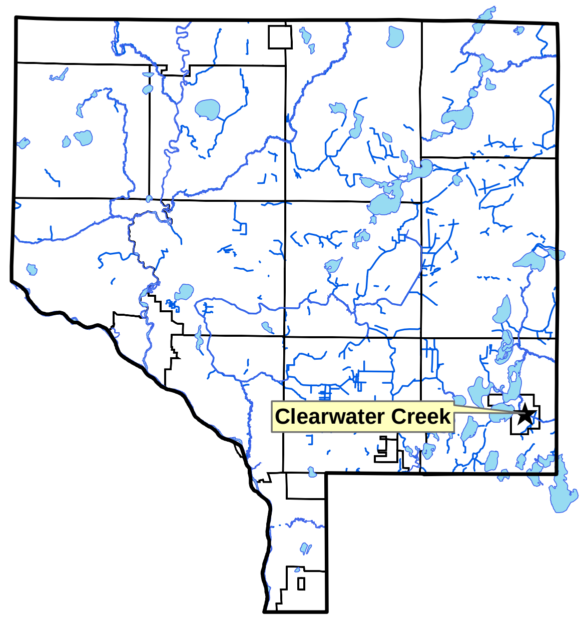
Family Biotic Index (FBI) — An index that utilizes known pollution tolerances for each family. Lower numbers indicate better stream quality.

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 2009

Monitored Since

1999

Student Involvement

56 students in 2009, approx 487 since 2001

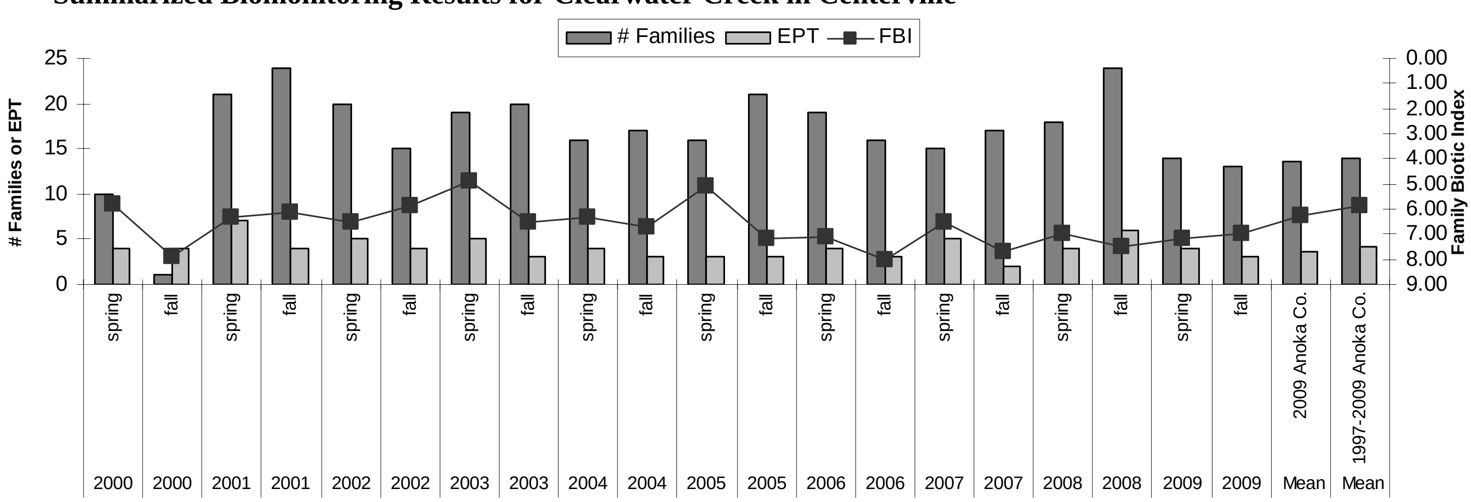
Background

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 are being 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 both spring and fall 2009, with oversight by the Anoka Conservation District. Overall, this stream has average or slightly below average conditions based upon the biological data. The number of families found in the summer and fall of 2009 (14 and 13 respectively), is less than in previous years, but is approximately average for Anoka County streams (13.6). The number of EPT families is typical of streams in this area. Still, the Family Biotic Index is poor. This is because there are few sensitive families. The families in high abundance are generalists that can survive in poor conditions. For example, in the last few years the most abundant families, representing 22-64% of captures, were corixidae (water boatmen), simulidae (blackfly larvae), and chironomidae (midges, which vary in pollution sensitivity).

Summarized Biomonitoring Results for Clearwater Creek in Centerville



Biomonitoring Data for Clearwater Creek in Centerville – All Years

Year	1999	1999	2000	2000	2001	2001	2002	2002	2003	2003	2004	2004
Season	spring	fall	spring	fall	spring	fall	spring	fall	spring	fall	spring	fall
FBI	6.16	4.16	5.80	7.90	6.30	6.10	6.50	5.90	4.90	6.50	6.30	6.70
# Families	12	8	10	11	21	24	20	15	19	20	16	17
EPT	5	3	4	4	7	4	5	4	5	3	4	3
Date	10-Jun	28-Oct	1-May	12-Oct	18-May	2-Oct	21-May	8-Oct	1-May	7-Oct	20-May	7-Oct
sampling by	?	?	CHS	CHS	CHS	CHS	CHS	CHS	CHS	CHS	CHS	CHS
sampling method	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH
mean # individuals/rep	134	142	128	72	92.3	81.5	60.3	115	171	187	366	153
# replicates	1	1	1	1	4	5	4	1	4	1	1	1
Dominant Family	hyalellidae	hydropsychidae	chironomidae	corixidae	caenidae	hyalellidae	hyalellidae	hyalellidae	hydropsychidae	hyalellidae	baetidae	hyalellidae
% Dominant Family	24.6	71.1	52	67.3	18.4	47.8	26.2	27	38	33.2	32.3	48.4
% Ephemeroptera	5.2	17.6	24.2	23.6	23.3	19	19.5	11.3	18.7	26.2	57.1	27.5
% Trichoptera	3.7	71.1	0	18.1	0.8	21.8	7.5	20	38.6	0.5	0.3	2.6
% Plecoptera	5.2	0	0	0	0.3	0	1.2	0	0.0	0.0	0.3	0.0

Year	2005	2005	2006	2006	2007	2007	2008	2008	2009	2009	Mean	Mean
Season	spring	fall	spring	Fall	spring	fall	spring	fall	spring	fall	2009 Anoka Co.	1997-2009 Anoka Co.
FBI	5.10	7.20	7.10	8.00	6.50	7.70	7.00	7.50	7.20	7.00	6.3	5.9
# Families	16	21	19	16	15	17	18	24	14	13	13.6	13.9
EPT	3	3	4	3	5	2	4	6	4	3	3.6	4.2
Date	5-May	27-Sep	18-May	3-Oct	18-May	9-Oct	8-May	1-Oct	20-May	9-Oct		
sampling by	CHS	CHS	CHS	CHS	CHS	CHS	CHS	CHS	CHS	CHS		
sampling method	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH		
mean # individuals/rep	376	250	211	238	213	200	180	450	238	386		
# replicates	1	1	1	1	1	1	1	1	1	1		
Dominant Family	baetidae	corixidae	coenagrionidae	corixidae	chironomidae (other)	corixidae	Simuliidae	Corixidae	Hyalellidae	Corixidae		
% Dominant Family	63.3	40.4	22.3	64.7	20.2	53	27.8	42.3	26.1	53.9		
% Ephemeroptera	74.7	18.8	24.6	6.3	34.7	17.5	10.6	4.7	28.2	8.5		
% Trichoptera	0.0	0.8	0.0	0.4	0.0	0.0	2.2	0.7	0.8	2.8		
% Plecoptera	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Supplemental Stream Chemistry Readings

Parameter	10/7/03	5/20/04	10/7/04	5/20/05	9/26/05	5/18/06	10/3/06	5/5/07	10/9/07	5/5/08	10/1/08	5/20/2009	10/9/09
pH	8.75	8.22	9.13	na	7.71	8.13	7.32	8.31	7.34	8.00	7.65	7.56	7.27
Conductivity (mS/cm)	0.624	0.274	0.314	0.352	0.293	0.451	0.578	0.639	0.400	0.452	0.607	0.699	0.558
Turbidity (NTU)	3	3	57	8	10	na	3	3	13	10	13	4	8
Dissolved Oxygen (mg/L)	9.84	na	9.72	8.43	9.25	11.52	6.18	12.57	6.52	11.84	8.74	4.85	9.25
Salinity (%)	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.02	0.02
Temperature (C)	12.7	18.3	13.1	13.4	15.1	15.4	14.3	15.8	15.3	14.3	9.5	16.9	7.6

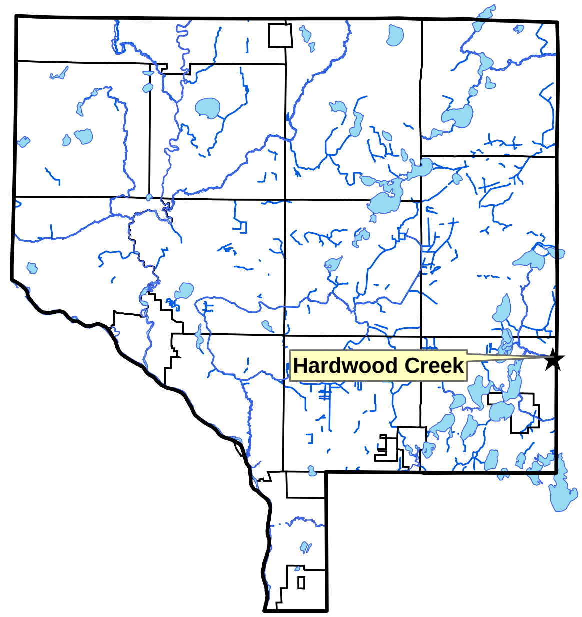
Discussion

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. In our supplemental water chemistry measurements we have found 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, the highly turbid condition noted in October 2004 was during a baseflow period when the water was barely moving. Likewise, high conductivity in fall 2003, 2006, 2007, 2008, and 2009 was during low water levels. Overall, this creek seems to provide enough habitat and good enough water quality for a variety of pollution-tolerant invertebrates, but more sensitive varieties are unable to survive.

The number of families found in this stream increased dramatically beginning in spring 2001. This is not necessarily due to an improvement in stream health. This coincided with increased sampling efforts (more students sampling) and improved execution of protocols. However, a notable decrease in total number of families was observed in 2009. The reason is unknown.

HARDWOOD CREEK

at Hwy 140, Lino Lakes and 165th Ave NW, Hugo



Last Monitored

By Forest Lake Area Learning Center in 2008

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 at Cecelia LaRoux property 600 m W of I-35

Student Involvement

12 students in 2009, approx 172 since 2001

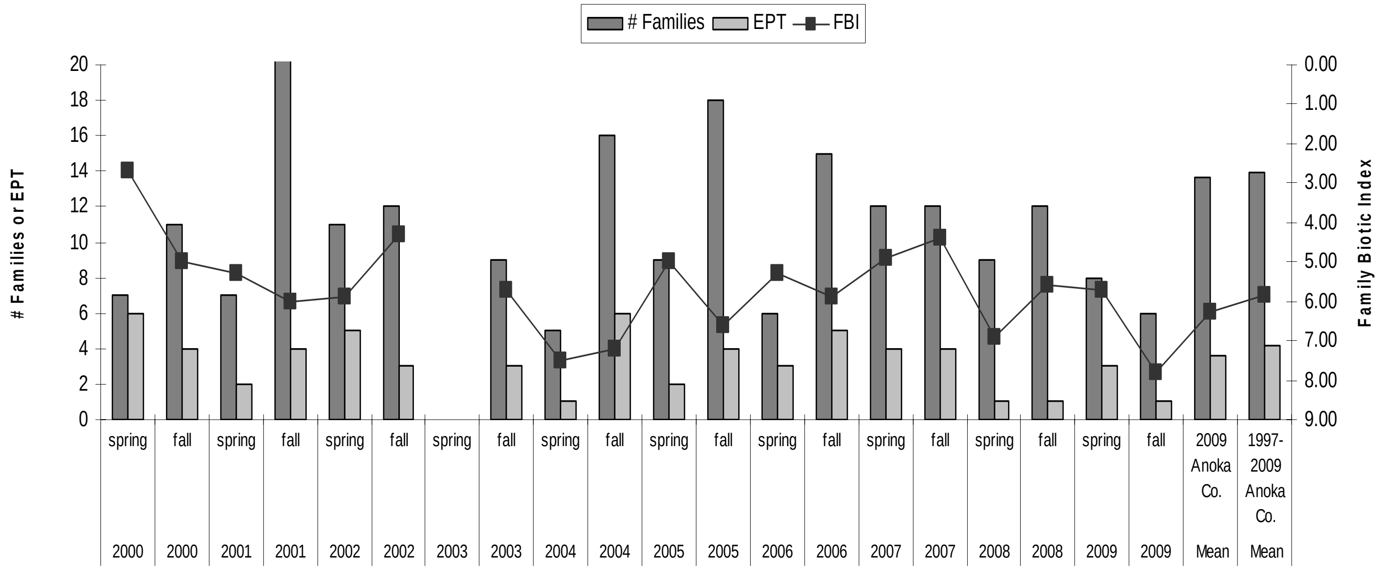
Background

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 monitoring site was the subject of a recent stream restoration project. All other monitoring sites have had poor habitat.

Results

Forest Lake Area Learning Center classes monitored Hardwood Creek in spring and fall 2009, facilitated by the Anoka Conservation District. This site was the subject of a recent stream restoration project that included rock veins, brush bundles, and willow staking. Compared to sites monitored in previous years, the number of families found, family biotic index (FBI), and number of EPT families were on the poor end of the range observed. Overall, biological data from all of the sites across many years indicates poorer than average stream health.

Summarized Biomonitoring Results for Hardwood Creek at Hwy 140, Lino Lakes



Biomonitoring Data for Hardwood Creek at Hwy 140, Lino Lakes – All Years

Year	1999	1999	2000	2000	2001	2001	2002	2002	2003	2003	2004	2004
Season	spring	fall	spring	fall	spring	fall	spring	fall	spring	fall	spring	fall
FBI	4.48	5.85	2.69	5.00	5.30	6.00	5.90	4.30		5.80	7.50	7.20
# Families	9	10	7	11	7	24	11	12		9	5	16
EPT	5	4	6	4	2	4	5	3		3	1	6
Date	10-Jun	28-Oct	17-May	?	1-May	11-Oct	22-May	30-Sep	27-May	29-Sep	12-May	6-Oct
sampling by	ACD	ACD	FLALC	FLALC	FLALC	FLALC	FLALC	FLALC	FLALC	FLALC	FLALC	FLALC
sampling method	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH
# individuals	60	137	82	144	92	187.5	165	365	samples lost	171	82	306
# replicates	1	1	1	1	1	2	1	1		1	1	2
Dominant Family	heptagenidae	chironomidae	perlidae	baetidae	simulidae	gastropoda	simulidae	hydropyschidae		hydropsychidae	hyalellidae	hyalellidae
% Dominant Family	57	62	68.3	32	63	13.7	73.9	79.7		43.3	78	34.4
% Ephemeroptera	80	26.3	29.3	49.3	30.4	12	10.3	9.3		7.6	0	17.8
% Trichoptera	1.7	0.7	1.2	22.2	0	2.9	4.2	79.7		43.3	2.4	4.1
% Plecoptera	6.7	0	68.3	0	0	0	0	0		0	0	0

Year	2005	2005	2006	2006	2007	2007	2008	2008	2009	2009	Mean	Mean
Season	spring	fall	spring	fall	spring	fall	spring	fall	spring	fall	2009 Anoka Co.	1997-2009 Anoka Co.
FBI	5.00	6.60	5.30	5.90	4.90	4.40	6.90	5.60	5.70	7.80	6.3	5.9
# Families	9	18	6	15	12	12	9	12	8	6	13.6	13.9
EPT	2	4	3	5	4	4	1	1	3	1	3.6	4.2
Date	31-May	25-Oct	10-May	10-Oct	8-May	5-Oct	15-May	8-Oct	19-May	8-Oct		
sampling by	FLALC	FLALC	FLALC	FLALC	FLALC	FLALC	FLALC	FLALC	FLALC	FLALC		
sampling method	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH		
# individuals	94	219	136	243	290	80	440	159	400	391		
# replicates	1	2	1	1	1	1	1	1	1	1		
Dominant Family	gammariidae	hyalellidae	hydropsychidae	heptageniidae	baetidae	heptageniidae	Simuliidae	Dystidae	Simuliidae	Corixidae		
% Dominant Family	48.9	43.4	60.3	53.1	27.9	48.8	49.1	57.2	67.3	74.7		
% Ephemeroptera	36.2	10	5.9	44.9	39.7	60	0	0.6	19.5	0.3		
% Trichoptera	0	19.2	60.3	5.3	1.4	2.5	0.2	0	0.8	0		
% Plecoptera	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Supplemental Stream Chemistry Readings

	Hwy 140 site									165th Ave site	Fenway Ave site		C. LaRoux Property	
Parameter	**5/27 2003**	**9/29 2003**	**5/12 2004**	**10/6 2004**	**5/31 2005**	**10/25 2005**	**5/10 2006**	**10/10 2006**	**5/8 2007**	**10/12 2007**	**5/15 2008**	**10/8 2008**	**5/19 2009**	**10/8 2009**
pH	7.39	9.08	8.66	9	10.33	8.1	7.27	8.05	7.97	7.26	7.13	7.46	8.1	7.43
Conductivity (mS/cm)	0.328	0.395	0.225	0.237	0.251	0.284	0.409	0.5	0.4	0.326	0.361	0.431	0.426	0.37
Turbidity (NTU)	9	3	10	na	27	21	13	4	3	5	13	11	6	22
Dissolved Oxygen (mg/L)	7.9	10.58	na	10.15	86.20%	12.25 (101%)	5.45	11.99	11.95	9.1	10.88 (101%)	7.14 (65%)	12.30 (125%)	11.50 (100%)
Salinity (%)	0.01	0.01	0	0	0	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
Temperature (C)	15.5	8	18.8	9	19.5	6.7	15.4	8.5	14.5	10.4	12.4	12.4	16.5	9.7

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 is coordinating a TMDL investigative study. Our biological monitoring does indicate a below-average biological community, but lends only modest insight into what might be causing this impairment. Habitat seems to be an important factor. Biological indices of stream health 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.

Forest Lake Area Learning Center students at Hardwood Creek in 2009

RICE CREEK

at Hwy 65, Locke Park, Fridley

Last Monitored

By Totino Grace High School in fall 2009

Monitored Since

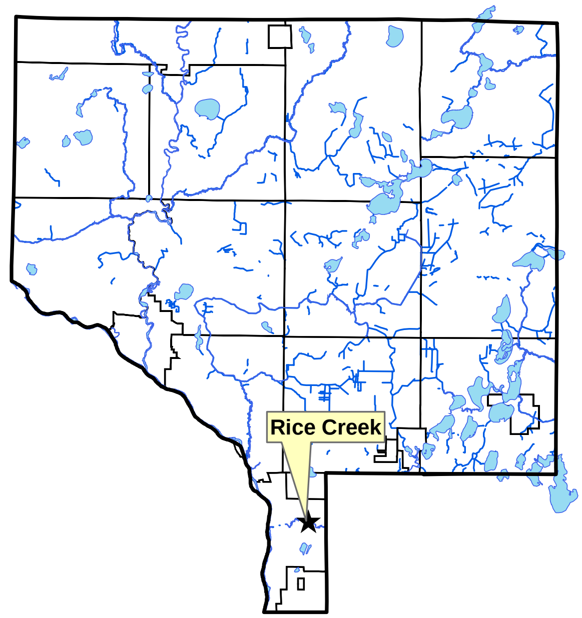
1999

Student Involvement

50 students in 2009, approx 653 since 2001

Background

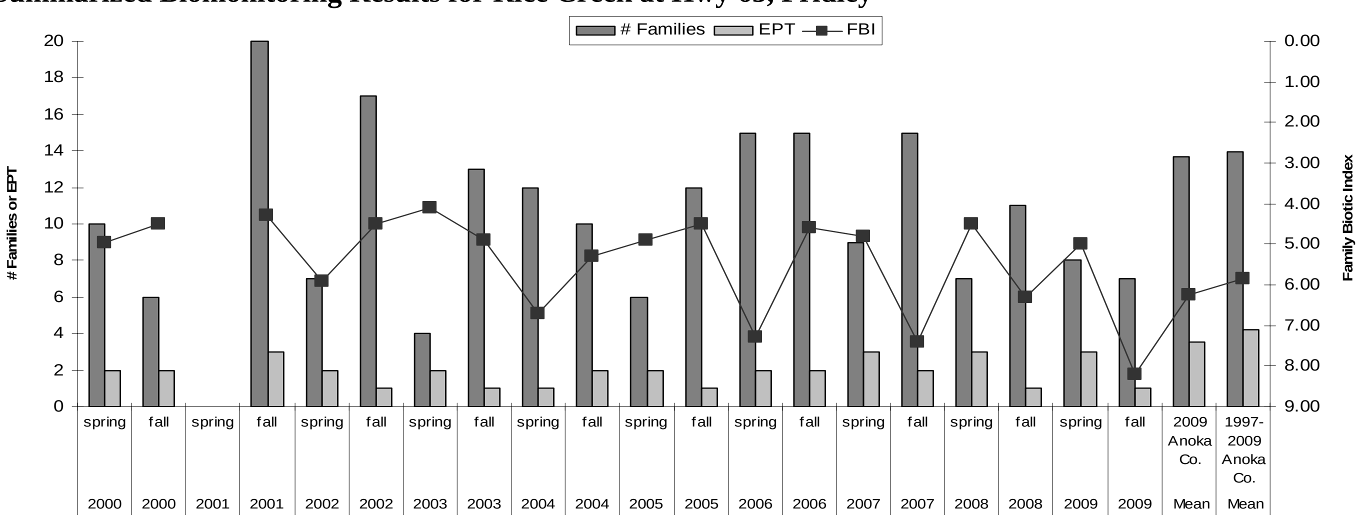
Rice Creek originates from Howard Lake in east-central Anoka County and flows south and west through the Rice Creek Chain of Lakes and eventually to the Mississippi River. Sampling is conducted in Locke Park, which encompasses a large portion of the stream's riparian zone in Fridley. This site is wooded. 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 2009, facilitated by the Anoka Conservation District (ACD). ACD staff monitored it in spring, when student biomonitoring was unavailable. At first glance, it may appear that Rice Creek has only a slightly below average condition. A closer examination reveals a more strongly impaired macroinvertebrate community. While the number of families found has been similar to the average for Anoka County streams on several occasions (though not recently), virtually all of these are generalist species that can tolerate polluted conditions. In 2008 and 2009 an especially low number of families (7 to 11), were found even though large groups of >50 students participated on several of these occasions. Those large sampling efforts are most likely to find low-abundance families. The number of EPT families has been low 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 19 creek samplings, often >50% of catches. Overall, the invertebrate community of Rice Creek at near Highway 65 is poor.

Summarized Biomonitoring Results for Rice Creek at Hwy 65, Fridley



Biomonitoring Data for Rice Creek at Hwy 65, Fridley – All Years

Year	1999	2000	2000	2001	2001	2002	2002	2003	2003	2004	2004
Season	fall	spring	fall	spring	fall	spring	fall	spring	fall	spring	fall
FBI	4.11	4.95	4.50	not sampled	4.30	5.90	4.50	4.10	4.90	6.70	5.30
# Families	3	10	6		20	7	17	4	13	12	10
EPT	1	2	2		3	2	1	2	1	1	2
Date	11/15	4/26	10/3		10/9	6/10	10/16	6/18	10/9	6/9	10/13
sampling by	?	BHS	CHHS		CHHS	ACD	CHHS	ACD	CHHS	ACD	TGHS
sampling method	MH	MH	MH		MH	MH	MH	MH	MH	MH	MH
mean # individuals/rep	110	226	174		112.5	120	129.3	104	91	68	103
# replicates	1	1	1		4	1	3	1	2	1	1
Dominant Family	hydropyschidae	hydropyschidae	hydropyschidae		hydropsychidae	simulidae	hydropsychidae	hydropsychidae	hydropsychidae	veliidae	hydropsychidae
% Dominant Family	92.7	66.4	78		88	51.7	83	96.2	58.2	19.1	65.0
% Ephemeroptera	0	0.4	10.9		1.3	0.8	0	1.9	0.0	0.0	1.0
% Trichoptera	92.7	66.4	77.6		88.2	27.5	83	96.2	58.2	8.8	65.0
% Plecoptera	0	0	0		0	0	0	0	0.0	0.0	0.0

Year	2005	2005	2006	2006	2007	2007	2008	2008	2009	2009	Mean	Mean
Season	spring	fall	spring	fall	spring	fall	spring	fall	spring	fall	2009 Anoka Co.	1997-2009 Anoka Co.
FBI	4.90	4.50	7.30	4.60	4.80	7.40	4.50	6.30	5.00	8.20	6.3	5.9
# Families	6	12	15	15	9	15	7	11	8	7	13.6	13.9
EPT	2	1	2	2	3	2	3	1	3	1	3.6	4.2
Date	11-May	19-Oct	17-May	27-Sep	10-May	2-Oct	23-May	10-Oct	11-May	8-Oct		
sampling by	TGHS	TGHS	ACD	TGHS	ACD	TGHS	ACD	TGHS	ACD	TGHS		
sampling method	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH		
mean # individuals/rep	149	378	106	166	116	132	180	104	148	111		
# replicates	1	1	1	3	1	2	1	1	1	1		
Dominant Family	hydropsychidae	hydropsychidae	corixidae	hydropsychidae	baetidae	corixidae	baetidae	hydropsychidae	baetidae	corixidae		
% Dominant Family	44.3	87.6	24.5	81.7	49.1	61.2	70.0	40.0	50.0	74.8		
% Ephemeroptera	22.1	0.0	3.1	0.2	49.1	0.4	74.4	0.0	50.7	0.0		
% Trichoptera	44.3	87.6	0	81.7	13.8	27.6	7.2	42.3	6.8	9.0		
% Plecoptera	0	0	0	0.0	0.0	0.0	0	0	0.0	0.0		

Supplemental Stream Chemistry Readings

Parameter	6/18/03	10/14/03	6/9/04	10/13/04	5/11/05	10/19/05	5/18/06	9/27/06	5/10/07	10/2/07	5/23/08	10/10/08	5/11/09	10/8/09
pH	7.86	8.22	8.14	9.12	8.84	8.02	8.23	7.80	8.25	7.85	8.12	7.73	8.23	4.76
Conductivity (mS/cm)	0.405	0.639	0.249	0.365	0.324	0.264	0.457	0.515	0.401	0.402	0.461	0.639	0.624	0.638
Turbidity (NTU)	7	6	6	6	5	7	na	13	65	25	15	13	16	18
Dissolved Oxygen (mg/L)	7.0	6.87	6.53	9.15	10.43	9.02	9.95	9.65	Na	9.06	9.56 (102%)	9.01 (85%)	12.29 (122.5%)	10.74 (97%)
Salinity (%)	0.01	0.02	0.00	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.02	0.02
Temperature (C)	25.6	11.0	22.0	13.1	16.8	13.7	16.8	14.8	20.6	16.8	19.0	12.9	14.5	11.2

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 probably degrade water quality.

Totino Grace High School students at Rice Creek.

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, and sometimes with grant funding from the watershed organization or the Anoka Conservation District.

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 are described individually below. Many other projects have also been completed by the Rice Creek Watershed District that are not reported here.

Hawkinson/Hegge Lakeshore Restoration Design, Locke Lake

At the Hawkinson/Hegge property on Locke Lake, substantial erosion was occurring. The project design will repair and stabilize the shoreline using "soft-engineering" techniques and native plantings. The plants will also provide runoff treatment and additional habitat along the shore. Cost share funding through the Rice Creek Watershed District has been approved and the landowners are hoping to install in 2010.

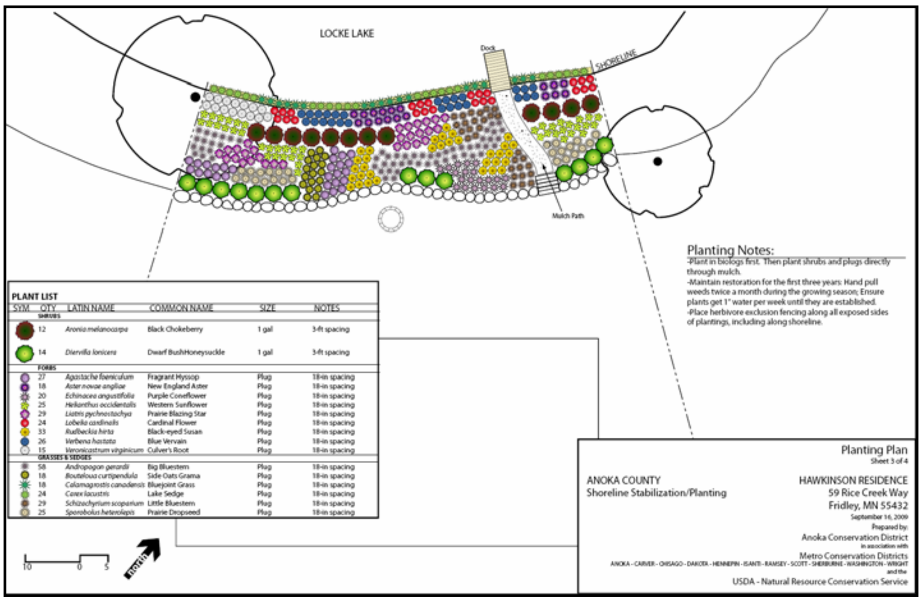


Image: Hawkinson/Hegge restoration plan featuring large groupings of native plants.

LeBlanc Lakeshore Restoration Design, Peltier Lake

The LeBlanc property on Peltier Lake had a few areas of moderate erosion that required some unique design features. The design calls for minor erosion areas to be treated with biologs and erosion control fabric. Areas with more significant erosion required the use of a unique system called Envirolok. In this system, bags filled with planting soil are stacked along the shore, and plants are planted directly into them. The bags provide stability while the plants establish for long-term stabilization. A substantial buffer was also designed for the property, and it incorporated some existing garden areas as well as a fire ring.

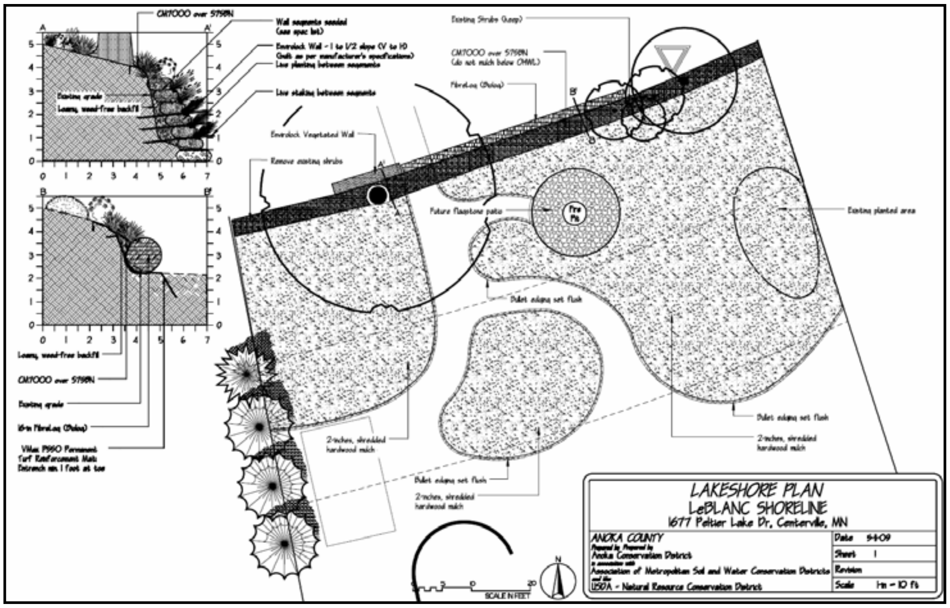


Image: LeBlanc stabilization plan featuring biologs and the Envirolok retaining wall system.

Svetin Lakeshore Restoration Design, Peltier Lake

Next-door to the LeBlanc property is the Svetin property. A design was created for the property to correct minor erosion issues, and to create a buffer of plants to filter runoff before it gets to the lake. An added benefit of the buffer is that it will reduce the number of geese that come ashore and make a mess of the yard.

Image: Svetin buffer planting designed to intercept and treat runoff before it gets to the lake.

Colberg Streambank Stabilization Design, Clearwater Creek

The flashy nature of Clearwater Creek in Centerville was causing substantial erosion on the Colberg property. ACD Landscape Restoration Specialists created a design to address the existing erosion and some of the underlying causes of the bank instability. The plan consists of the construction of a crib-wall planted with live branch cuttings in the area of severe erosion. Less severe areas are proposed to be treated with cedar tree revetments that will protect the bank and slow down the flow to allow sediment to rebuild the eroded areas. Rain gardens were designed for the top of the slope to reduce the amount of surface runoff flowing over the bank.

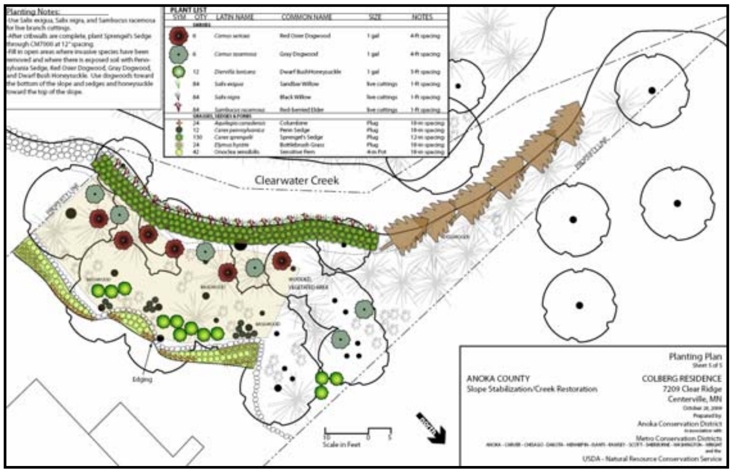
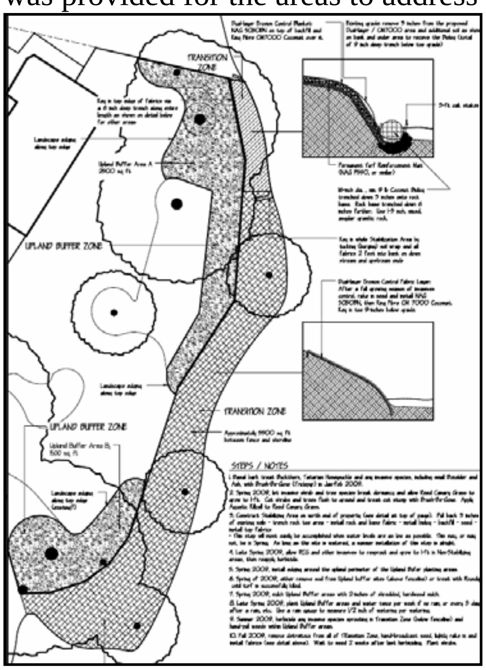
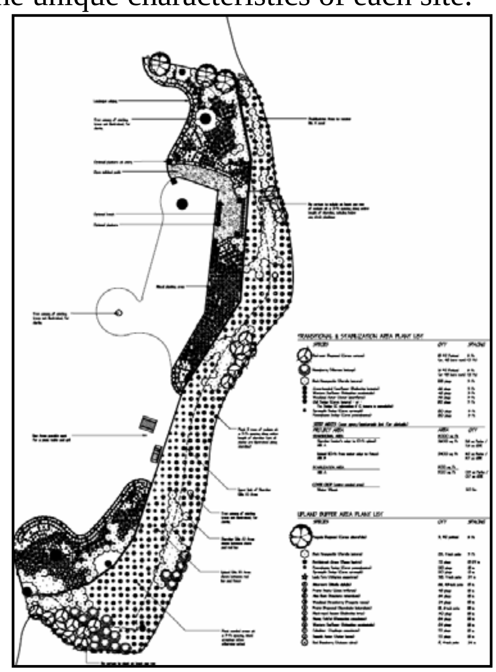


Image: The Colberg plan features several types of conservation practices to address both in-stream and upland causes of erosion.

Savre Streambank Stabilization Design, Rice Creek

Rice Creek flows along the border of the Savre property in Fridley. An area of the shoreline was eroding, and the majority of the buffer zone was either lawn or invasive reed canary grass. The project area was large and divided into a buffer area, stabilization area and shoreline area. Specific guidance was provided for the areas to address the unique characteristics of each site.





Helps Streambank Buffer Design, Rice Creek

The buffer design for the Helps property was done to beautify the area along the creek, treat stormwater runoff from the property, and filter runoff from a stormwater overflow pipe. The design called for groupings of native plants selected for their benefit to wildlife and placed strategically to frame-in views of the creek. A sweet grass swale will filter and direct stormwater runoff from the overflow pipe to the creek, while also providing stabilization to the soil during high flow storm events.

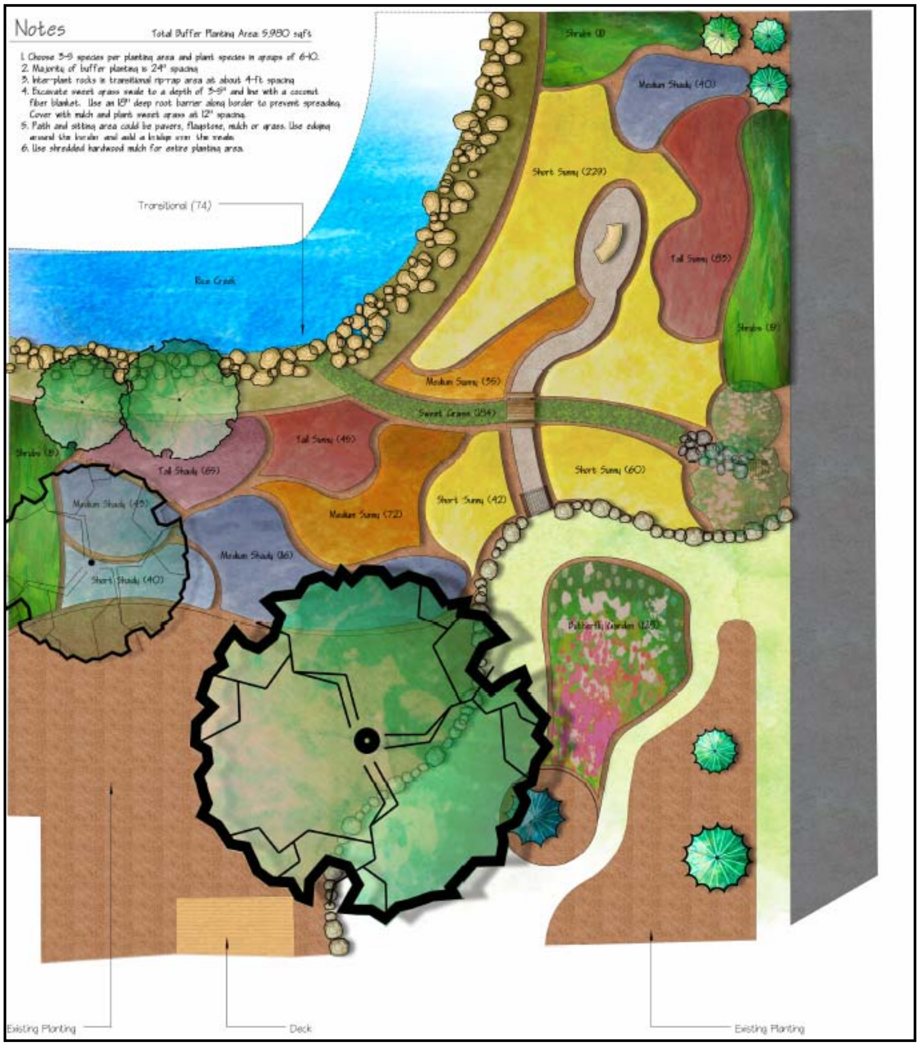


Image: The Helps plan features a sweet grass swale and transitional plantings to enhance the aesthetics of the rip-rap shoreline.

Other Activities in the Rice Creek Watershed District

The Anoka Conservation District provided technical assistance through on-site consultations, project guidance, project inspections, and provided additional resources to residents living in the Rice Creek Watershed District. The following is a list of landowners who were assisted by ACD, but for which no design work was done.

- Aveda Inc
- Gustafson
- Hauser
- Hinds
- Holien
- Johnson
- Newman
- Ojczyk
- Percy
- Peterson
- St. Joseph's Church
- Storlien
- Wolf

Conservation Workshops

Description: The Anoka Conservation District, with assistance from participating cities, hosted conservation workshops for the public. Three workshops were offered, including rain gardens, watersmart, and shoreland management. Workshops were two hours in length, except for the rain garden workshop. The rain garden workshop was four hours and included hands-on rain garden construction outdoors. Cities provided promotion of the workshops and facilities. ACD staff taught the workshops.

Purpose: To assist and encourage landowners to install water quality improvement projects.
To encourage water conservation.

Results: The Anoka Conservation District partnered with the Cities of Blaine and Lino Lakes to host workshops in spring 2009. Workshops included shoreland management, watersmart landscaping, and a two-part rain garden workshop that included a demonstration. Participation at each workshop ranged from 10 to 30.

Participants at the Lino Lakes rain garden workshop learn construction steps.

Rice Lake Subwatershed Assessment

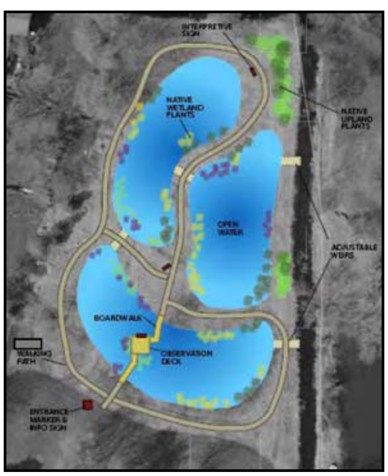
Description: The stormwater retrofit assessment takes a systematic approach to identifying and prioritizing water quality improvement projects that provide the greatest amount of stormwater treatment per dollar spent. The Rice Creek Watershed District identified Rice Lake as a high priority water resource and contracted with the Anoka Conservation District to assess the subwatershed in the cities of Lino Lakes, Blaine and Circle Pines. The goal is to implement projects in a systematic way that maximizes the use of limited financial resources by identifying and prioritizing projects according to cost-effectiveness.

Purpose: To improve stormwater quality and reduce the volume of runoff entering the stormwater system from neighborhoods that most greatly contribute to the degradation of Rice Lake.

Results: A total of 12 retrofit projects were analyzed for cost and pollutant removal. Two of the projects are retrofits that implement BMPs on school properties and a third is a stormwater wetland project at Shenandoah Park that will require additional modeling to determine treatment efficiency. The remaining nine projects are groupings of neighborhood rain garden retrofits. Cost effectiveness of each project for varying levels of phosphorus reduction was analyzed and reflects the installed cost as well as long term operation and maintenance. The Rice Creek Watershed District and Anoka Conservation District plan to begin installing the most beneficial projects in 2010. The full report is available on the Rice Creek Watershed District website.

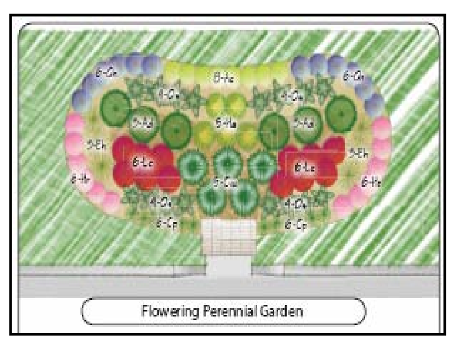
Table of some of the potential projects identified in the assessment process

Catchment	Retrofit Project	Number of BMPs	TP Reduction (%)	TP Reduction (lb/yr)	Estimated Installation Cost	Installed Cost/lb TP Reduction	Annual O&M Cost per BMP	Estimated Term Cost/lb/yr (includes O&M)
RL-2*	Neighborhood Retrofit	23	30%	10.2	$93,541	$9,171	$75	$1,086
RL-6	Neighborhood Retrofit	14	10%	8.8	$57,433	$6,526	$75	$772
RL-6	Centennial Campus Retrofit	13	70%	11.3	$34,125	$3,020	$15-$300	$410
RL-8*	Neighborhood Retrofit	7	30%	3.3	$29,349	$8,894	$75	$1,048
RL-9	Rice Lake Elementary	6	50%	4.1	$12,150	$2,963	$100	$450
RL-13	Neighborhood Retrofit	22	10%	12.4	$89,529	$7,220	$75	$855



Stormwater Wetland Concept

Campus Retrofit Concept



Rain Garden Concept

Anoka County Geologic Atlas

Description: A map-based report of groundwater and geology to be used for community planning and groundwater management. The Atlas provides detailed information about groundwater:

- Aquifers, including identifying future water sources,
- Aquifer sustainability,
- Recharge areas,
- Sensitivity to pollution,
- Flow directions,
- Connections to lakes, streams, and wetlands,
- Chemistry,
- Wellhead protection, and others...

Results are provided as GIS files and paper maps, and are especially useful to community planners.

Geologic Atlases are a partnership of the MN Geological Survey, MN DNR, and local governments. 94% of funding was secured by the MN Geological Survey (MGS) and MN Department of Natural Resources (DNR) from the Legislative-Citizen Commission for Minnesota Resources (LCCMR). A required local contribution totaling 6% of project expenses was provided by the seven Anoka County watershed organizations and the Anoka Conservation District. Completion of the project requires 4-5 years.

Purpose: To gain knowledge about groundwater and geology that enables improved management of groundwater, including availability, pollution prevention, and pollution management.

Locations: Throughout Anoka County

Results: An Anoka County Geologic Atlas began in 2009 with financial support from all seven Anoka County Watershed Management Organizations and the Anoka Conservation District. These funds were used to locate approximately 9,500 groundwater wells, with approximately an additional 500 to be located in early 2010. Boring logs from these wells and others already in the County Well Index will be used to create the geologic atlas. The MGS has already begun the process of using these wells to create the geologic atlas. Thereafter the DNR will perform a groundwater analysis for the atlas. In total, the geologic atlas is expected to be completed around 2014.

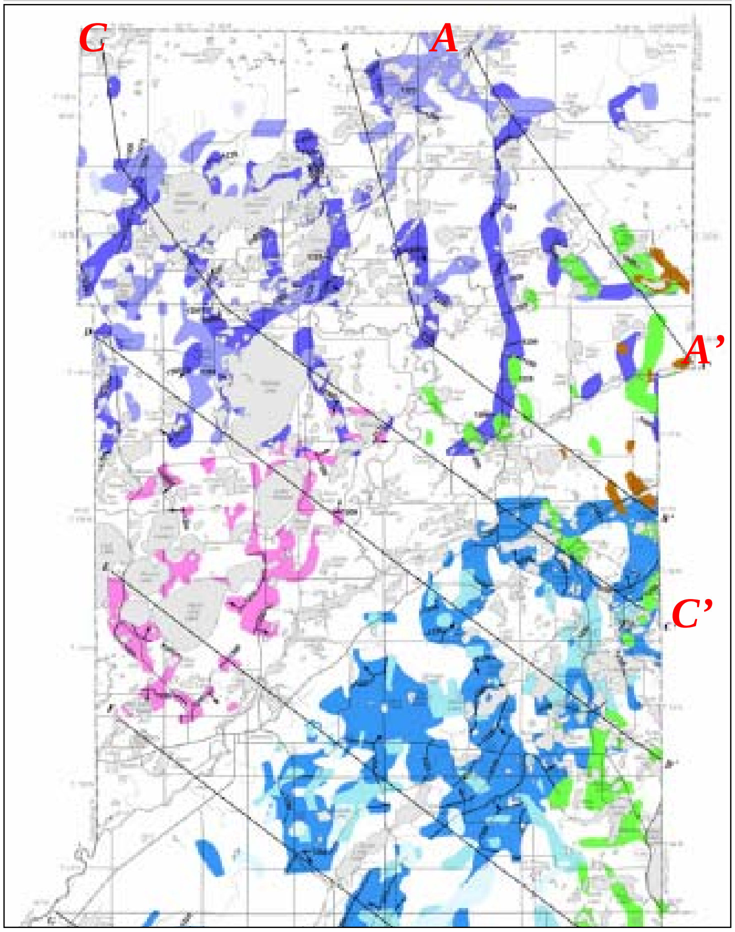
An example of portions of a geologic atlas from Crow Wing County are on the following page.

EXAMPLE GEOLOGIC ATLAS WORK PRODUCTS

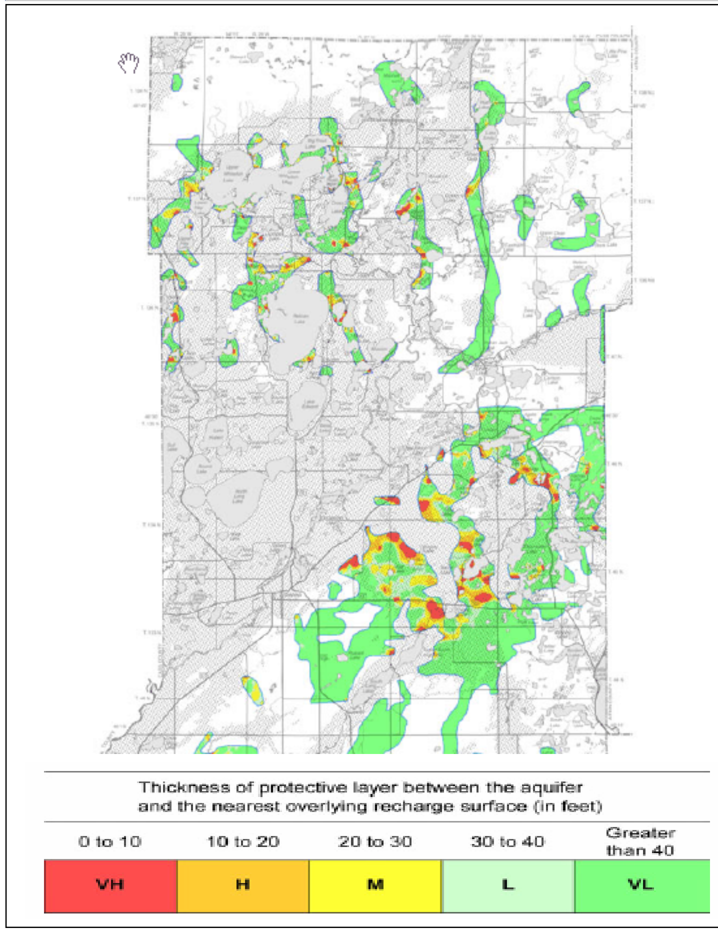
Crow Wing County Geologic Atlas

Excerpted from: Peterson, T. 2008. Hydrogeology, Pollution Sensitivity, and Lake and -Groundwater Interaction. MN Ground Water Association Newsletter 27-3.

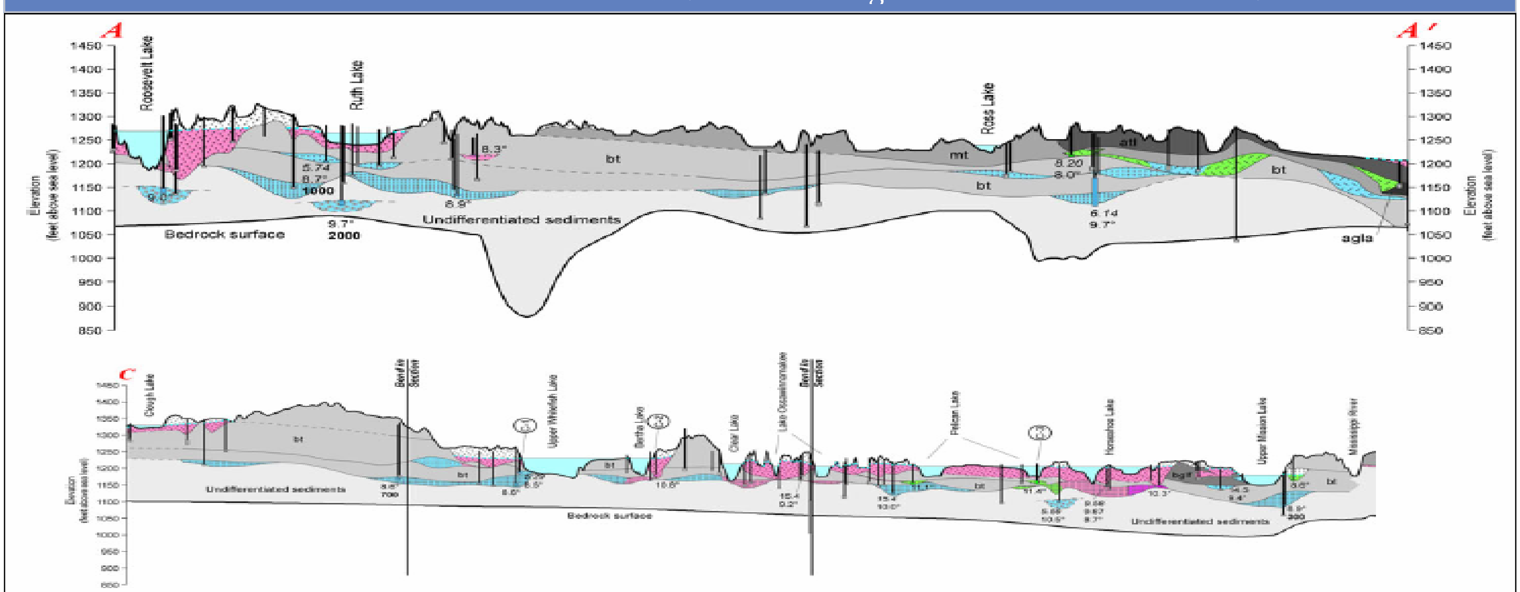
Extent and Distribution of Buried Aquifers Including Direction of Flow



Pollution Sensitivity of Buried Aquifers



Selected hydro-geologic cross sections showing groundwater residence time. Cross sections A-A' and the Northwest 2/3 of C-C' are shown. See above figure for cross section location.



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	Ob Well	Student Biom	Geologic Atlas	Project Management (detail below)	Rice Lake Assessment	Total
Revenues								
RCWD	650	900	0	2280	5000	9000	5500	23330
State	0	0	240	0	0	0	0	240
Anoka Conservation District	0	485	254	914	725	12266	10495	25139
County Ag Preserves	13	0	0	661	0	0	5000	5674
Other Service Fees	0	0	0	(0)	8	0	0	8
Local Water Planning	0	0	0	0	0	0	0	0
TOTAL	663	1385	494	3855	5734	21266	20995	54392
Expenses-								
Capital Outlay/Equip	2	3	2	10	56	150	14	237
Personnel Salaries/Benefits	563	1203	427	3299	5116	17130	19290	47028
Overhead	42	83	31	161	249	3250	699	4515
Employee Training	7	20	6	36	41	120	291	521
Vehicle/Mileage	8	18	6	48	89	166	288	623
Rent	32	56	22	116	157	450	404	1237
Program Participants	0	0	0	0	0	0	0	0
Program Supplies	8	3	1	186	25	0	9	231
Equipment Maintenance	0	0	0	0	0	0	0	0
TOTAL	663	1385	494	3855	5734	21266	20995	54392
NET	0	0	0	0	0	0	0	0

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 above.

RCWD BMP Cost Share Program	Technician Hours	Technician Cost ($55/hr)	Specialist Hours	Specialist Cost ($67/hr)	Total Hours	Total Cost
Administration	8.5	$467.50			8.50	$467.50
Anderson	21.5	$1,182.50	40.0	$2,680.00	61.50	$3,862.50
Aveda	11.0	$605.00			11.00	$605.00
Colberg	8.5	$467.50	30.0	$2,010.00	38.50	$2,477.50
Gustafson	4.0	$220.00			4.00	$220.00
Hauser	2.0	$110.00			2.00	$110.00
Hawkinson	12.5	$687.50	15.0	$1,005.00	27.50	$1,692.50
Helps	36.0	$1,980.00			36.00	$1,980.00
Hinds	2.5	$137.50			2.50	$137.50
Holien	2.5	$137.50			2.50	$137.50
Johnson	1.5	$82.50			1.50	$82.50
Leblanc	4.8	$261.25	32.0	$2,144.00	36.75	$2,405.25
Newman	6.0	$330.00	16.0	$1,072.00	22.00	$1,402.00
Ojczyk	4.0	$220.00			4.00	$220.00
Percy	7.0	$385.00	1.0	$67.00	8.00	$452.00
Peterson	3.0	$165.00			3.00	$165.00
Savre	8.0	$440.00	27.0	$1,809.00	35.00	$2,249.00
St. Josephs	1.5	$82.50			1.50	$82.50
Storlien	2.0	$110.00			2.00	$110.00
Svetin	3.3	$178.75	23.0	$1,541.00	26.25	$1,719.75
Wolf	12.5	$687.50			12.50	$687.50
TOTAL	**162.5**	**$8,937.50**	**184.0**	**$12,328.00**	**346.50**	**$21,265.50**

Recommendations

- **Install water quality improvement projects identified through the Rice Lake subwatershed assessment in 2009.**
- **Improve the ecological health of Clearwater, Hardwood, and Rice Creeks.** Hardwood and Clearwater Creeks are designated as "impaired" for aquatic life (based on fish IBI's) by the MPCA. Rice Creek does not have this designation and its fish community monitoring does not indicate problems, but its macroinvertebrate community is troubled, perhaps due to water quality degradation by storm water inputs.
- **Address water quality problems in Moore Lake**. Storm water inputs and over-abundant waterfowl are likely sources of water quality problems.
- **Expand the network of reference wetlands** to include altered and ditched sites. These aid in accurate wetland regulatory determinations.
- **Continue local support of and input into the Anoka County Geologic Atlas project.** Groundwater sustainability is an issue of concern.
- **Reduce road salt use.** Elevated chlorides are pervasive throughout shallow aquifers and the streams that feed them.

CHAPTER 6:
COON CREEK WATERSHED

Task	Partners	Page
Precipitation	CCWD, ACD, volunteers	6-144
Precipitation Analyses	CCWD, ACD	6-146
Lake Levels	CCWD, ACD, volunteers	6-148
Lake Water Quality	CCWD, ACD, ACAP	6-150
Stream Hydrology	CCWD, ACD	6-155
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Stream Water Quality - Biological (professional)	CCWD, ACD	6-183
Wetland Hydrology	CCWD, ACD, ACAP	6-197
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Anoka County Geologic Atlas	Anoka Co. WMOs and WDs, ACD, DNR, MGS	6-222
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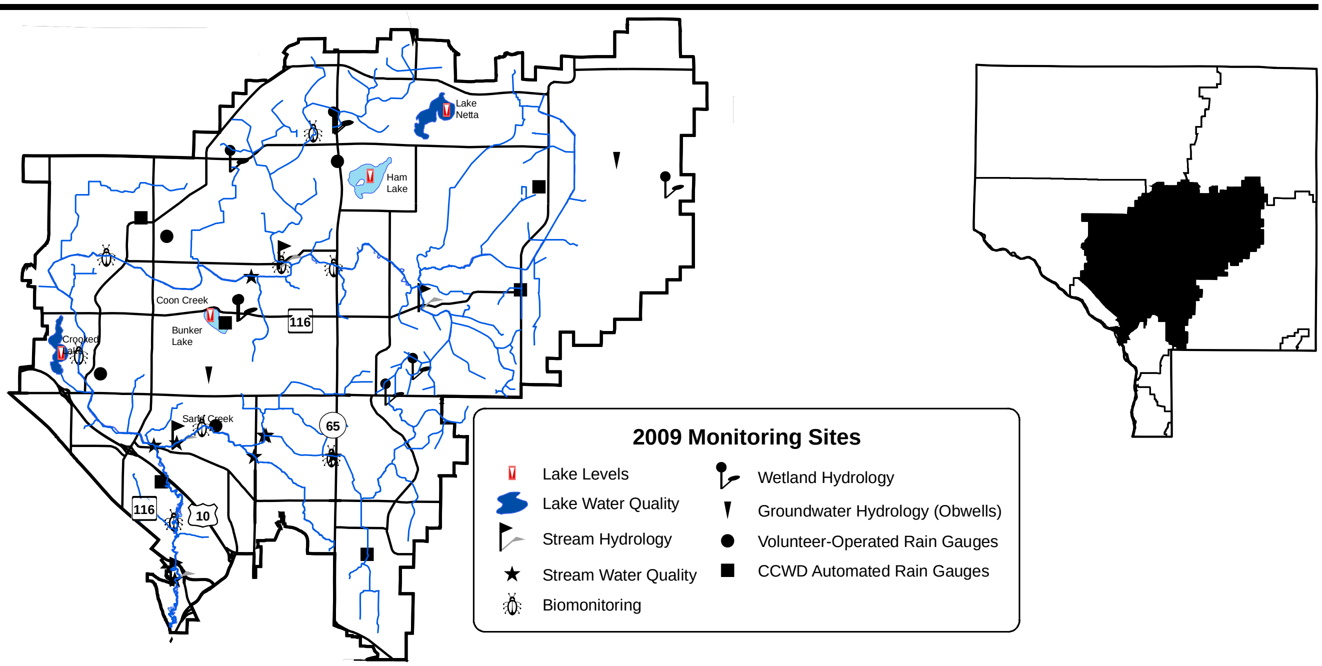
Groundwater Hydrology (obwells)	ACD, MNDNR	see Chapter 1

ACAP = Anoka County Ag Preserves, ACD = Anoka Conservation District, CCWD = Coon Creek Watershed District, MGS = MN Geological Survey, 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 vary over distance, and these differences are critical to understanding local hydrology, including predicting flooding.

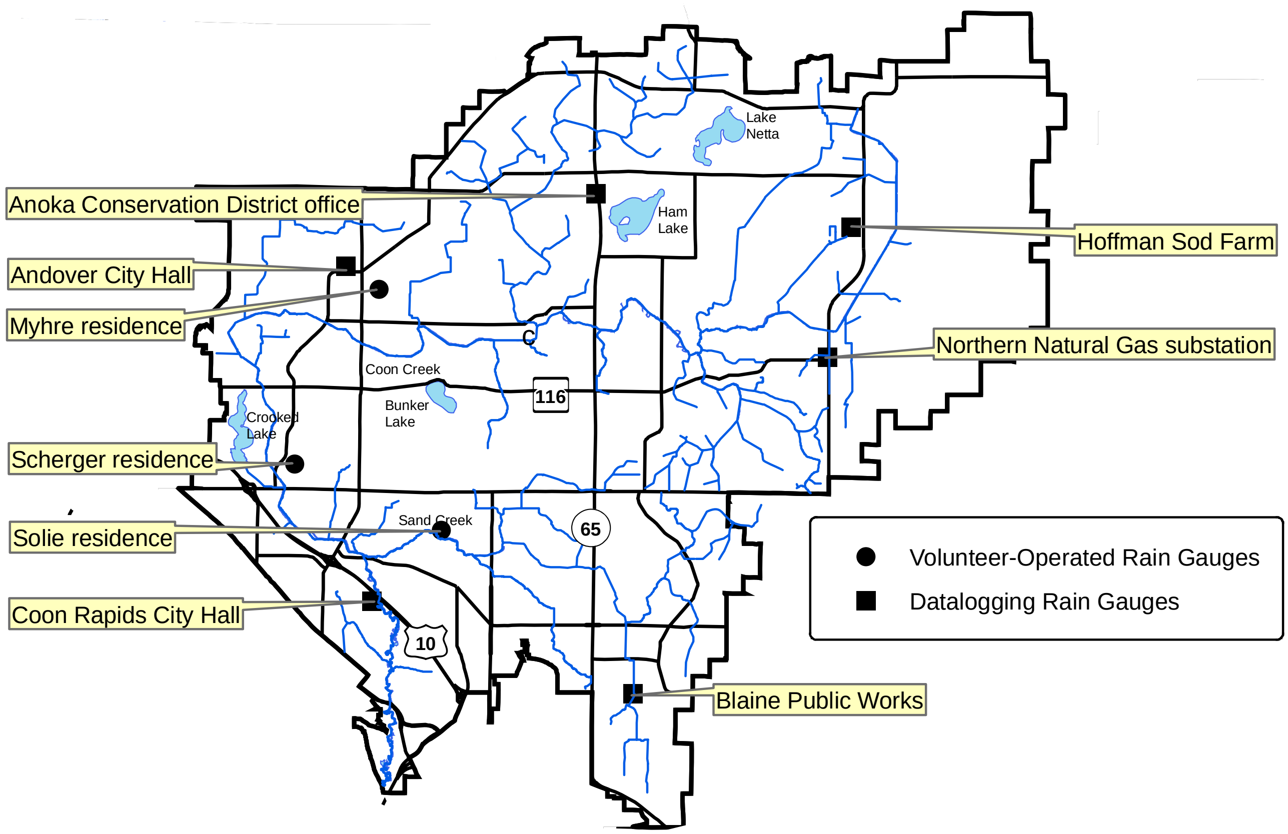
Purpose: To aid in all types of hydrologic analyses, predictions, and regulatory decisions within the watershed.

Locations:
<u>Datalogging gauges:</u>
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 at Lexington Blvd and Bunker Lake Blvd, Ham Lake
<u>Cylinder gauges read by volunteers:</u>
Myhre residence, Andover
Scherger residence, Coon Rapids
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.

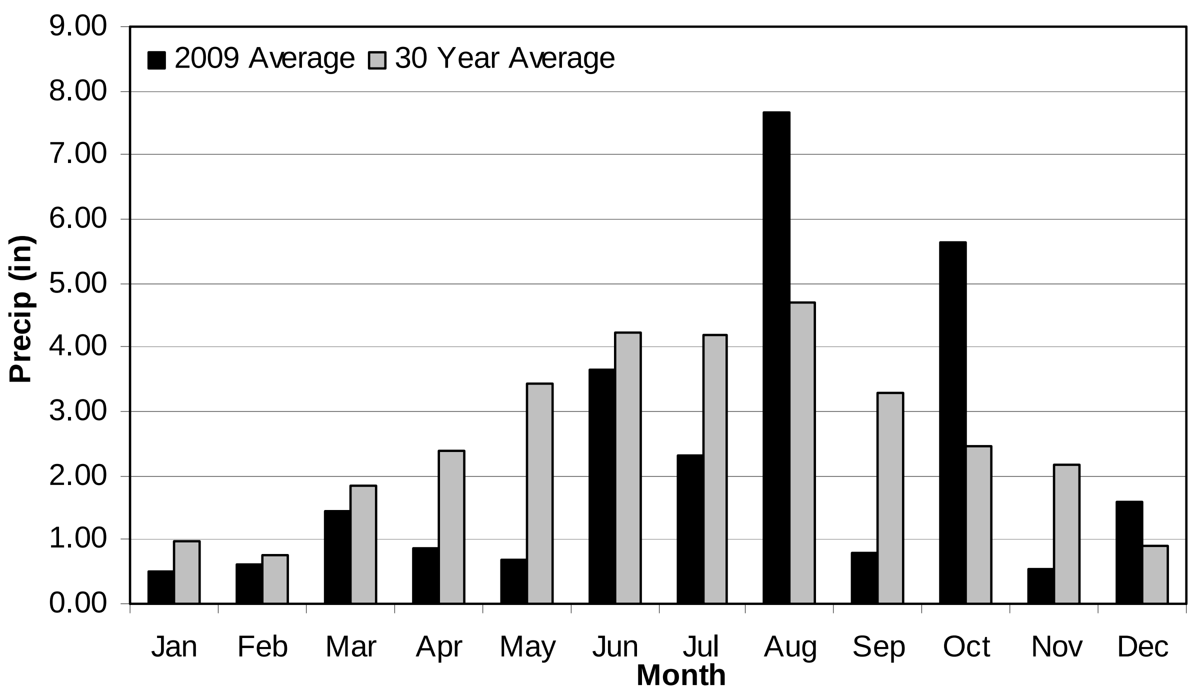
Coon Creek Watershed 2009 Precipitation Monitoring Sites



Coon Creek Watershed 2009 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)
Tipping bucket, datalogging rain gauges (Time and date of each 0.01" is recorded)															
Andover City Hall	Andover				0.83	0.81	4.05	2.67	7.12	0.68	5.44			21.60	15.33
Blaine Public Works	Blaine				0.29	0.14	2.00	1.19						3.62	3.33
Coon Rapids City Hall	Coon Rapids				0.91	0.45	3.68	1.93	6.29	0.55	5.44			19.25	12.90
Anoka Cons. District office	Ham Lake				0.97	0.93	4.18	3.47	9.41	1.04	6.41			26.41	19.03
Hoffman Sod Farm	Ham Lake				0.99	0.67	3.80	2.61			4.74			12.81	7.08
Northern Nat. Gas substation	Ham Lake				0.83			2.85	7.40	0.70	5.30			17.08	10.95
Cylinder rain gauges (read daily)															
N. Myhre	Andover	0.51	0.62	1.44	1.14	0.92	4.36	2.13	8.44	0.60	5.90	0.55	1.59	28.20	16.45
S. Scherger	Coon Rapids				0.95	0.66	4.56	1.75	7.68	1.26	6.12			22.98	15.91
S. Solie	Coon Rapids				0.90	0.77	2.63	2.35	7.38					14.03	13.13
2009 Average	County-wide	0.51	0.62	1.44	0.87	0.67	3.66	2.33	7.67	0.81	5.62	0.55	1.59	26.33	15.13
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) 2009 storms analyses and 2) long term precipitation trend analysis. The second analysis is reported below.

1.) **2009 Storms 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. For those storms 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 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 utilizing data from the National Weather Service (NWS) station closest to the middle of the Coon Creek Watershed District. Normal precipitation totals for each month are from the NWW Cedar station. Deviation from normal during the preceding 6- , 12-, and 24-month time periods were calculated and graphed.

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: Andover City Hall, Andover

Anoka Conservation District office, Ham Lake

Blaine Public Works, off 101st Ave, Blaine

Coon Rapids City Hall, Coon Rapids

Hoffman Sod Farm, Lexington Blvd near 155th Ave, Ham Lake

Northern Natural Gas Substation at Lexington Blvd and Bunker Lake Blvd, Ham Lake

Results:

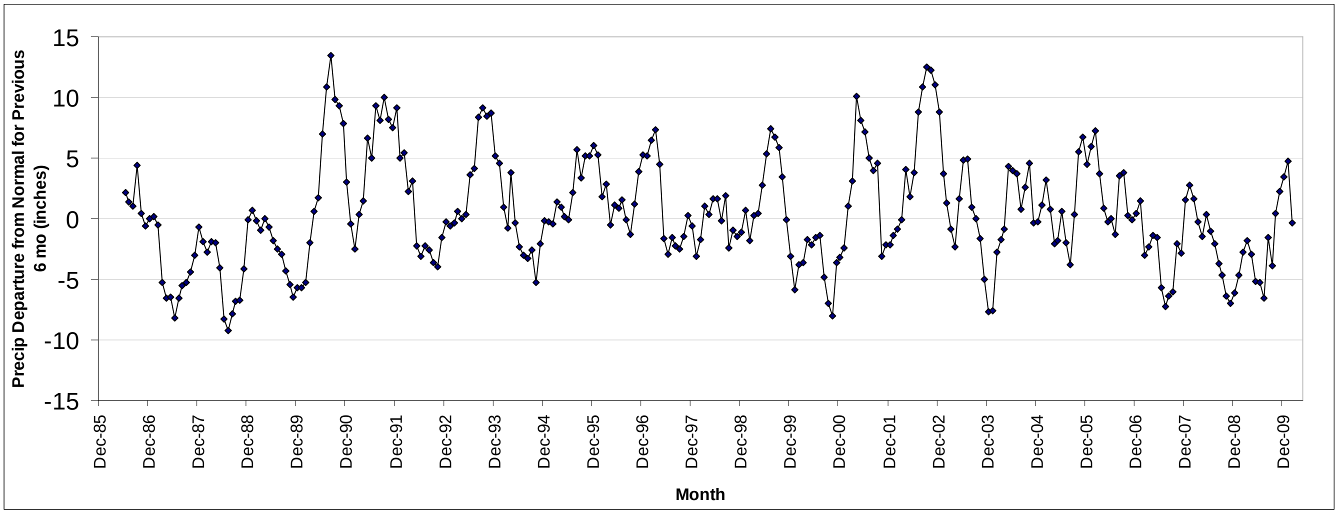
1.) **2009 Storms Analyses:** The results of these analyses were delivered to the Coon Creek Watershed District in digital form and are not reported here due to complexity and lengthiness.

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

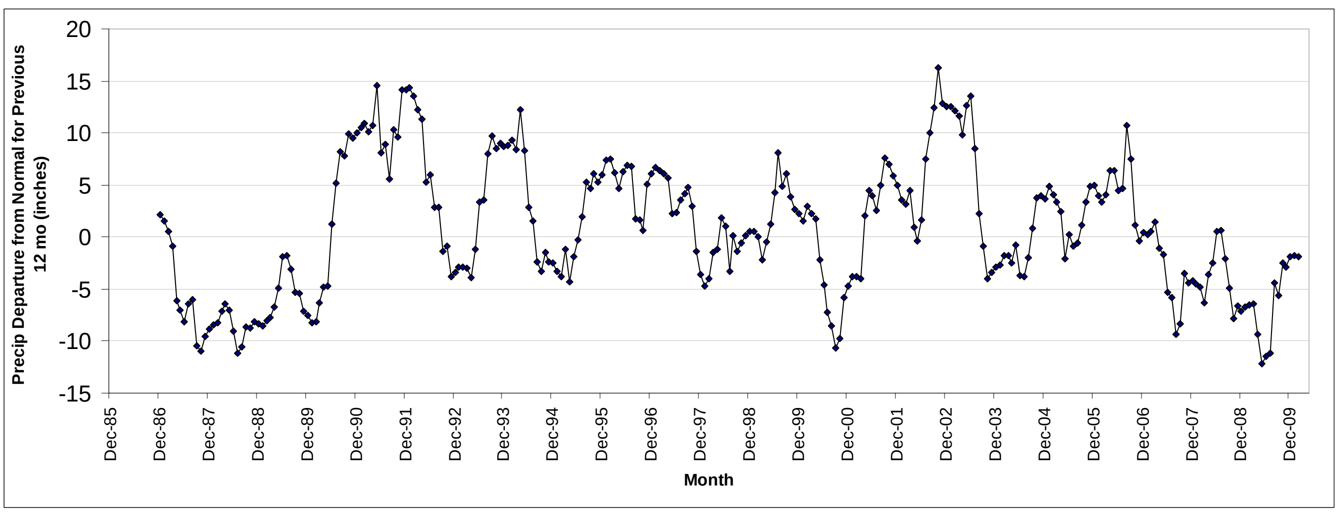
Long Term Precipitation Trends

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.

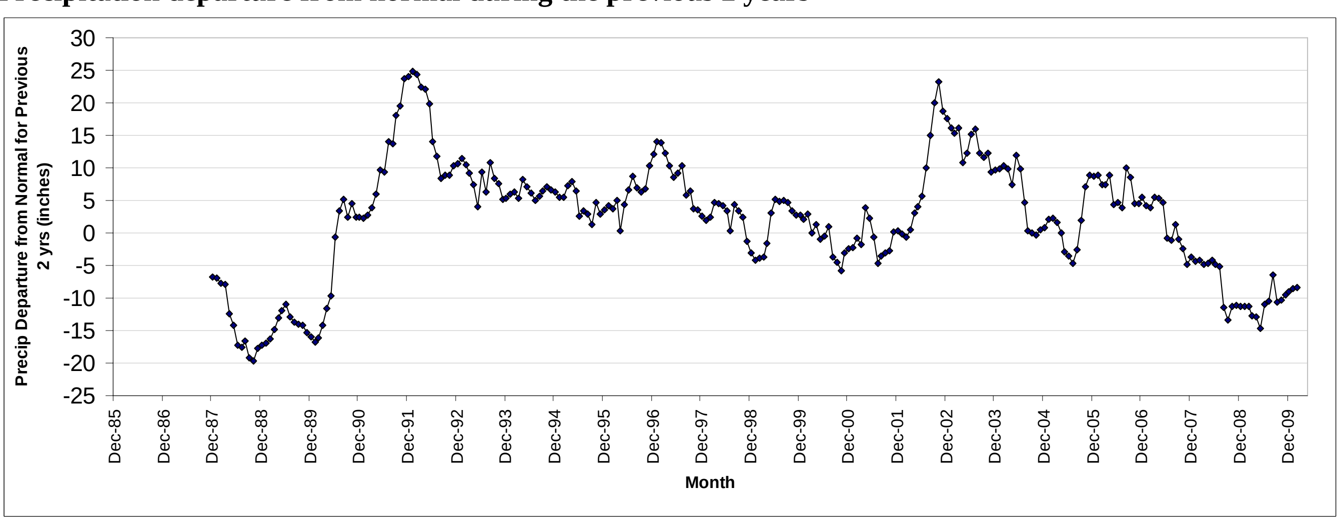
Precipitation departure from normal during the previous 6 months



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.

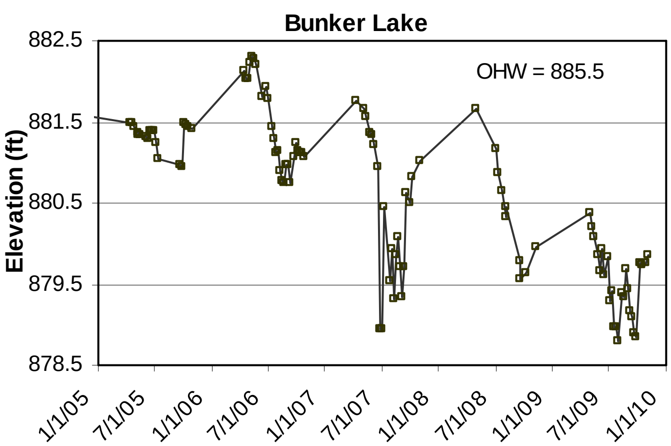
Locations: Bunker Lake, Ham Lake, Lake Netta, Crooked Lake

Results: Lake levels were measured 24 to 46 times, depending upon the lake. Water levels of these four lakes fell throughout summer 2009 in response to drought, with a small rebound when ample rain fell in August and October. This continues a period of water level decline in these lakes in recent years.

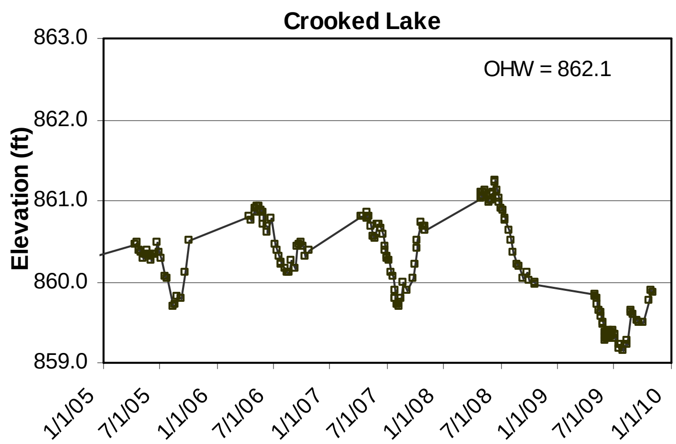
Bunker Lake was so low that open water could not be reached for placement of a gauge. Instead, a perforated 40" deep PVC well was installed in the dry lakebed area. Subsurface water level readings were taken within the well by ACD staff.

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

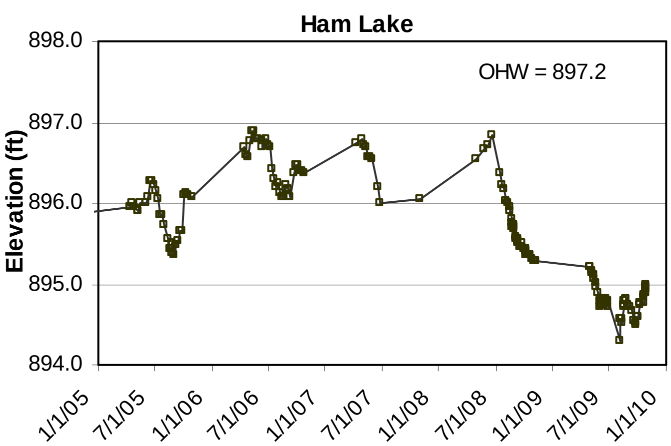
Bunker Lake Levels 2005-2009



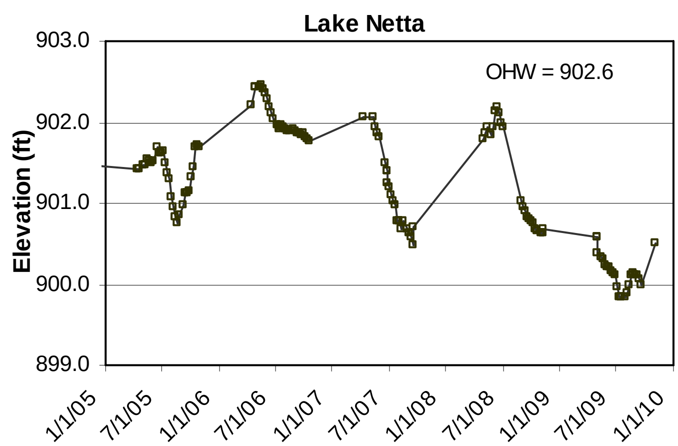
Crooked Lake Levels 2005-2009



Ham Lake Levels 2005-2009



Netta Lake Levels 2005-2009



Coon Creek Watershed Lake Levels Summary 2005-2009

Lake	Year	Average	Min	Max
Bunker	2005	881.33	880.94	881.50
	2006	881.45	880.75	882.31
	2007	880.39	878.95	881.77
	2008	880.41	879.57	881.66
	2009	879.52	878.79	880.37
Crooked	2005	860.23	859.68	860.51
	2006	860.54	860.10	860.92
	2007	860.35	859.68	860.86
	2008	860.75	859.96	861.24
	2009	859.47	859.14	859.90
Ham	2005	895.85	895.37	896.26
	2006	896.48	896.07	896.89
	2007	896.49	895.99	896.78
	2008	895.75	895.29	896.83
	2009	894.80	894.30	895.22
Netta	2005	901.36	900.76	901.72
	2006	902.05	901.76	902.46
	2007	901.17	900.49	902.07
	2008	901.32	900.63	902.19
	2009	900.15	899.84	900.58

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.

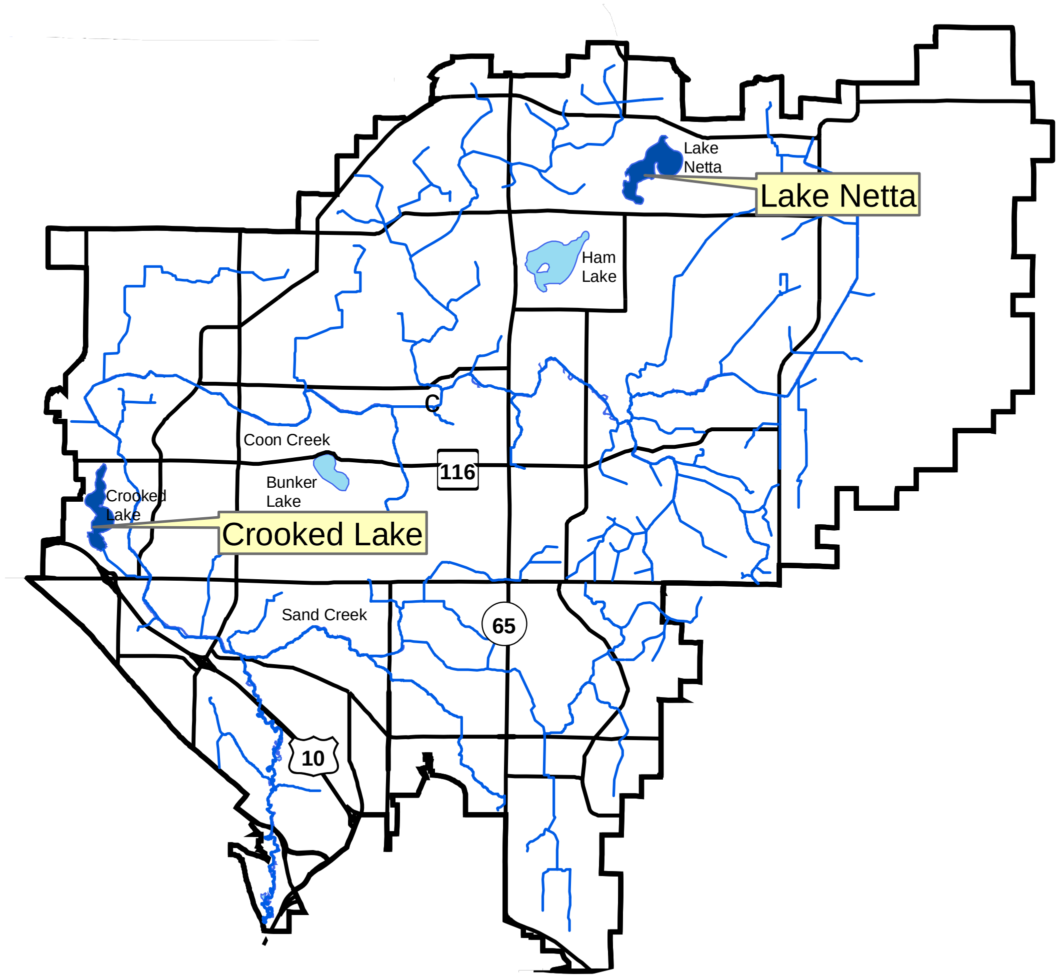
Purpose: To detect water quality trends and diagnose the cause of changes.

Locations: Crooked Lake

Lake Netta

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 2009 Lake Water Quality Monitoring Sites



Crooked Lake

CITIES OF ANDOVER AND COON RAPIDS, LAKE ID # 02-0084

Background

Crooked Lake is located in west-central Anoka County, lying half in 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. Most of the lake is surrounded by single family homes. The watershed is urban/developed.

In 1990 Eurasian Water Milfoil was discovered in the lake, followed by a whole-lake treatment with fluridone in 1992 that eradicated nearly all aquatic vegetation. Eurasian Water Milfoil was discovered again in 1996. In 2002 the DNR implemented a low dose of fluridone, which reduced the milfoil while having a lesser impact on other vegetation. The lake is still infested with Eurasian water milfoil, though the similar-looking northern milfoil is also abundant. The exotic, invasive plant curly leaf pondweed is also present, but rarely to nuisance levels.

2009 Results

In 2009 Crooked Lake had above-average water quality for this region of the state (NCHF Ecoregion), receiving an overall B grade. It had earned a B letter grade the previous nine monitored years. Overall, the lake is slightly eutrophic. In 2009 water quality was among the best of all monitored years since 1975, when monitoring began. 2008 was the best. Average total phosphorus in 2009 was 36 ug/L, which is higher than all other years since 1994 except 2006. Average chlorophyll-a tied with 2006 for the lowest recorded at this lake at 8.0 ug/L. Secchi transparency was the better than all other monitored years by 0.6 ft, at an average of 7.8 feet throughout summer.

Trend Analysis

Fifteen years of water quality data have been collected by the Metropolitan Council (between 1983 and 1998) and the Anoka Conservation District (between 2000 and 2008) with eight additional years of transparency measurements by citizens. Water quality has significantly improved from 1983 to 2009 (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,12}=21.03$, $p=0.0001$). Most improvements occurred between 1989 and 1994. If only data after 1993 are examined, Secchi transparency has an improving trend, but total phosphorus and chlorophyll-a are statistically unchanged (one-way ANOVAs).

Discussion

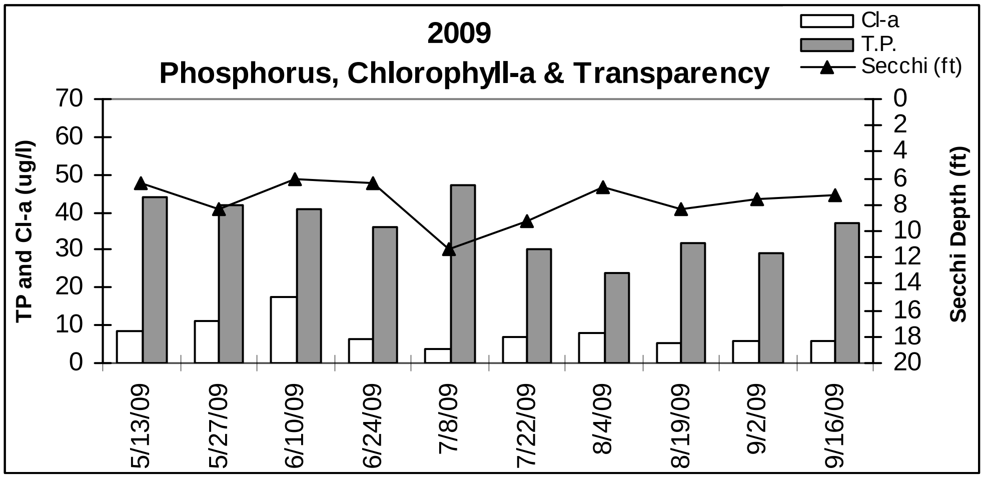
Water quality in Crooked Lake is remarkably good considering its urban watershed and intensely manicured shorelines. Continued efforts to improve stormwater draining to the lake and manage shorelines in a more lake-friendly manner are encouraged to continue the trend of imporving water quality. Invasive aquatic plants continue to be a challenge in Crooked Lake. Eurasian water milfoil and curly-leaf pondweed are both present, though their densities are at nuisance levels in few areas. The native northern milfoil is present and matted to the surface in some areas, especially the north bay, and might be mistaken for eurasian water milfoil. Caution is urged when managing non-native plants to avoid impacting native plants. The plant community is strongly contributing to good water qualiy, and improperly focused plant management will likely result in water quality declines. The 2009 lake management plan provides direction for protecting water quality and managing plants.

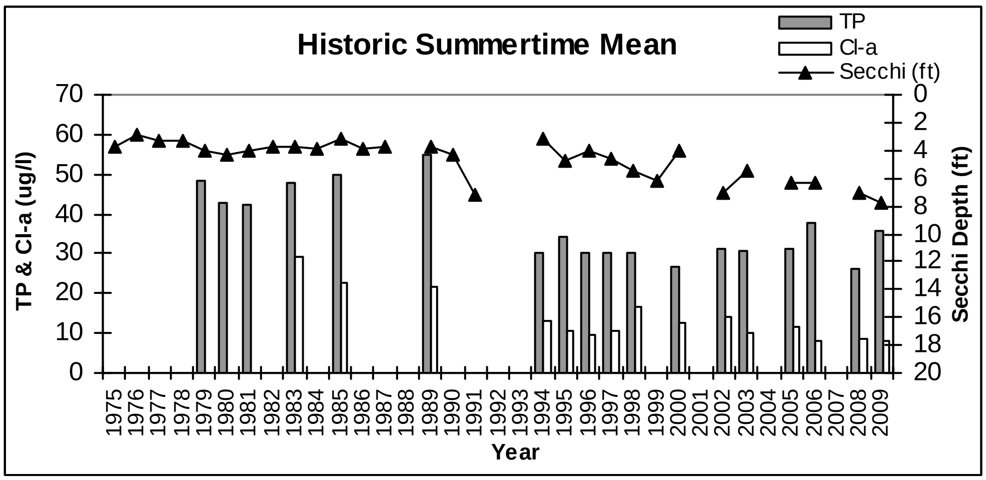
2009 Crooked Lake Water Quality Data

Crooked Lake 2009		Date	5/13/2009	5/27/2009	6/10/2009	6/24/2009	7/8/2009	7/22/2009	8/4/2009	8/19/2009	9/2/2009	9/16/2009			
		Time	9:25	9:00	8:55	9:00	9:00	9:25	9:05	8:25	8:45	8:00			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	7.93	8.09	8.23	8.18	8.05	8.14	8.16	8.17	7.92	8.54	8.14	7.92	8.54
Conductivity	mS/cm	0.01	0.500	0.534	0.496	0.509	0.494	0.501	0.459	0.494	0.485	0.476	0.495	0.459	0.534
Turbidity	FNRU	1	6	5	3	6	1	3	4	2	6	4	4	1	6
D.O.	mg/L	0.01	9.38	10.31	10.21	9.59	8.60	8.98	9.13	8.06	7.48		9.08	7.48	10.31
D.O.	%	1	93%	110%	106%	118%	102%	102%	106%	95%	84%		102%	84%	118%
Temp.	°C	0.10	15.3	18.9	17.7	25.9	24.1	22.2	23.0	23.8	21.0	23.30	21.5	15.3	25.9
Temp.	°F	0.10	59.5	66.0	63.9	78.6	75.4	72.0	73.4	74.8	69.8	73.9	70.7	59.5	78.6
Salinity	%	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.01	0.02
Cl-a	ug/L	1	8.7	11.3	17.6	6.5	4	6.9	7.7	5.5	6.0	6.0	8.0	3.6	17.6
T.P.	mg/L	0.005	0.044	0.042	0.041	0.036	0.047	0.030	0.024	0.032	0.029	0.037	0.036	0.024	0.047
T.P.	ug/L	5	44	42	41	36	47	30	24	32	29	37	36	24	47
Secchi	ft	0.1	6.4	8.3	6.0	6.4	11.4	9.3	6.6	8.4	7.6	7.3	7.8	6.0	11.4
Secchi	m	0.1	2.0	2.5	1.8	2.0	3.5	2.8	2.0	2.6	2.3	2.2	2.4	1.8	3.5
Field Observations															
Physical			2.0	2.0	2.0	3.0	2.0	2.0	2.0	1.5	2.0	2.0	2.1	1.5	3.0
Recreational			2.0	2.0	2.0	3.0	2.0	2.0	2.0	1.5	2.0	2.0	2.1	1.5	3.0

*reporting limit

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
Year	1994	1995	1996	1997	1998	1999	2000	2002	2003	2005	2006	2008	2009
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
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
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
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

Carlson's Tropic State Indices

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

Crooked Lake Water Quality Report Card

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

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.

2009 Results

In 2009 Lake Netta had good water quality for this region of the state (NCHF Ecoregion), receiving an overall B letter grade. The lake is slightly eutrophic. Total phosphorus, chlorophyll-a, and secchi depths were all similar to past years and were a testament to the clear water and healthy vegetation in the lake. Average total phosphorus was 32.2 ug/L, below the state water quality standard of 40 ug/L. Chlorophyll-a averaged 8.9 ug/L. Secchi transparency averaged 7.6 feet. The maximum transparency was 10.4 feet, the minimum as 6.0 feet. ACD staff's subjective observations of the lake's physical characteristics and recreational suitability were that there was little or "some" algae present and conditions were good or excellent for swimming and boating.

In 2009 one water sample was analyzed for lead on June 24. This was due to resident concerns about shotgun shot from a gun range on the south side of the lake. The lab found that lead levels were below their detection limit of 0.5 ug/L.

Trend Analysis

Nine years of water quality data have been collected by the Anoka Conservation District (1997-99, 2001, 2003-04, 2006, 2007, 2009), along with Secchi measurements by citizens five other years. Lake water quality has fluctuated between "A" and "B" grades. There is no significant long-term trend (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,6}=0.3$, $p=0.75$). However, this analysis excludes secchi depths taken in the early 1990's by volunteers. Some longer-term trend may be occurring; annual average secchi depth before 1998 was 1.5 to 2.4 m, but have been 2.3 to 3m since 1998 indicating better clarity in recent years.

Discussion

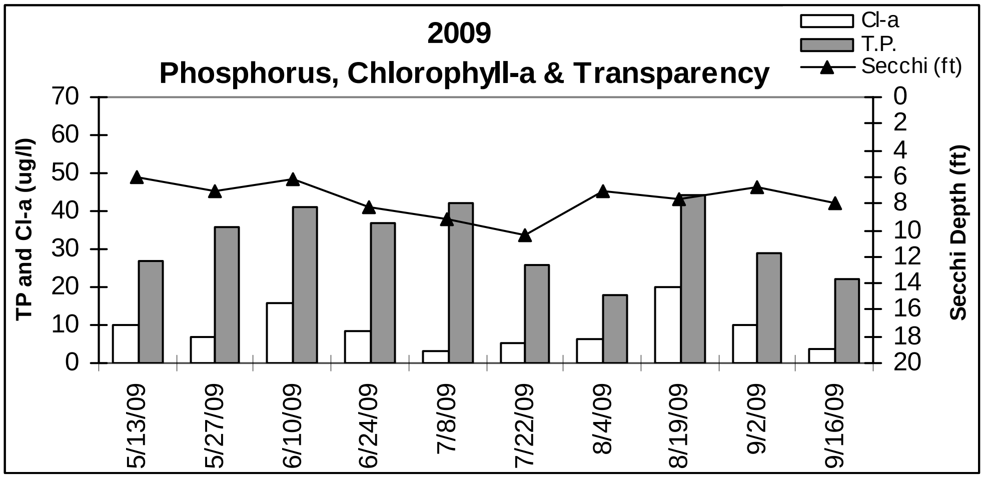
This lake has excellent water quality. It is a macrophyte (large plant) dominated lake, as opposed to algae dominated. These plants are essential to maintaining good water quality. The plants consume nutrients in the water, making them unavailable to algae. They also minimize sediment disturbance by wind or boats and provide refuges for zooplankton, which eat 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 maintenance of vegetated buffers near the water's edge by property owners.

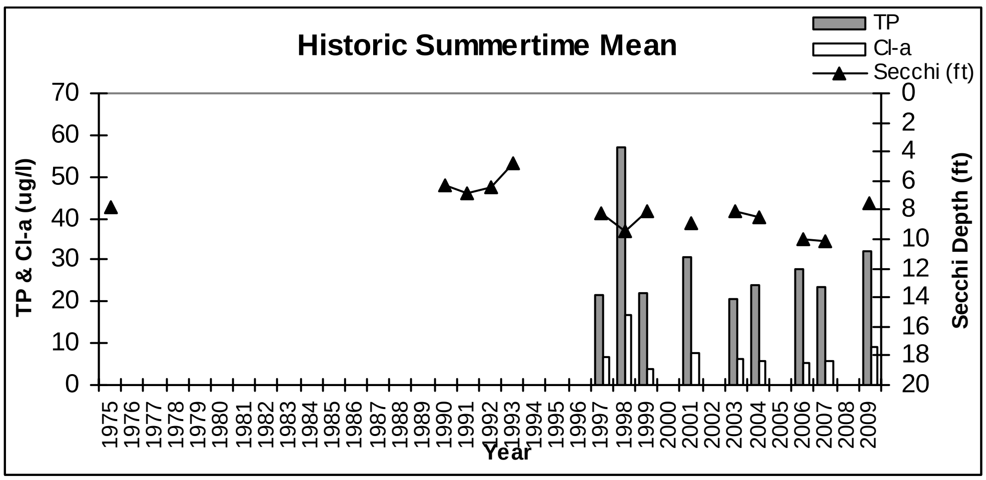
2009 Lake Netta Water Quality Data

Lake Netta 2009			5/13/2009	5/27/2009	6/10/2009	6/24/2009	7/8/2009	7/22/2009	8/4/2009	8/19/2009	9/2/2009	9/16/2009			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.100	7.40	7.23	7.46	7.90	8.04	7.77	7.94	7.24	7.70	7.69	7.64	7.23	8.04
Conductivity	mS/cm	0	0.241	0.270	0.252	0.244	0.224	0.224	0.198	0.214	0.213	0.215	0.446	0.198	2.410
Turbidity	FNRU	1.00	5.00	4.00	3.00	3.00	3.00	2.00	3.00	4.00	7.00	2.00	4	2.00	7.00
D.O.	mg/l	0	9.37	7.16	9.02	8.69	9.68	10.30	9.06	6.99	8.22	7.93	8.64	6.99	10.30
D.O.	%	1.0	94%	76%	92%	109%	115%	118%	106%	81%	92%	92%	98%	76%	118%
Temp.	°C	0.1	15.9	18.4	16.1	27.0	24.0	22.0	23.3	23.2	20.8	22.9	20.4	6.1	27.0
Temp.	°F	0.1	60.6	65.1	61.0	80.6	75.2	71.6	73.9	73.8	69.4	73.2	68.6	43.0	80.6
Salinity	%	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Cl-a	ug/l	1	9.9	6.6	15.9	8.2	3.3	5.2	6.1	20.1	9.8	3.7	8.9	3.3	20.1
T.P.	mg/l	0.005	0.027	0.036	0.041	0.037	0.042	0.026	0.018	0.044	0.029	0.022	0.032	0.018	0.044
T.P.	ug/l	5	27.0	36.0	41.0	37.0	42.0	26.0	18.0	44.0	29.0	22.0	32.2	18.0	44.0
Lead	ug/l	2.5				<.5									
Secchi	ft	0.1	6.00	7.00	6.10	8.30	9.20	10.40	7.00	7.72	6.80	7.90	7.642	6	10.4
Secchi	m	0.1	1.8	2.1	1.9	2.5	2.8	3.2	2.1	2.4	2.1	2.4	2.3	1.8	3.2
Field Observations															
Physical			1	1.5	1.5	2	1.5	1	1.5	2	1.5	1	1.5	1	2
Recreational			1	1.5	1.5	2	1.5	1	1.5	2	1.5	1	1.5	1	2

*reporting limit

Lake Netta Water Quality Results





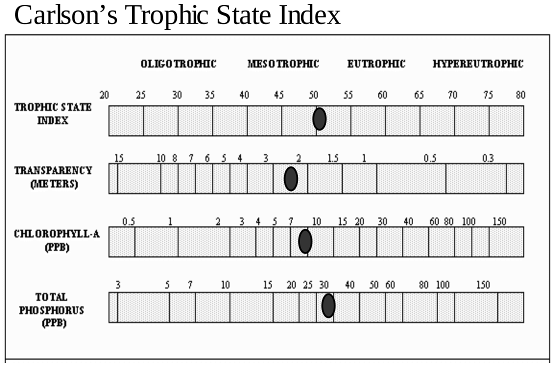
Lake Netta Historical Summertime Mean Values

Agency	CLMP	CLMP	CLMP	CLMP	CLMP	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD
Year	1975	1990	1991	1992	1993	1997	1998	1999	2001	2003	2004	2006	2007	2009
TP						21.8	56.9	22.2	30.7	20.8	23.8	28.0	23.5	32.2
Cl-a						6.7	16.6	3.8	7.7	6.2	5.7	5.5	5.6	8.9
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
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
TSIP						49	62	49	54	48	50	52	50	54
TSIC						49	58	44	51	48	48	47	48	52
TSIS	47	51	49	50	54	47	45	47	46	47	46	44	44	48
TSI						48	55	47	50	48	48	48	47	51

Lake Netta Water Quality Report Card

Year	75	90	91	92	93	97	98	99	2001	2003	2004	2006	2007	2009
TP (ug/L)						A	A	A	B	A	B+	B	B	C
Cl-a (ug/L)						A	A	A	A	A	A	A	A	A
Secchi	B	C	C	C	C	A	A	A	B	B	B	B+	B	B
Overall						**B**	**B**	**A**	**B**	**A**	**A**	**B+**	**B+**	**B**

Carlson's Trophic State Index



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 also facilitate calculation of pollutant loads, use of computer models for developing management strategies, and water appropriations permit decisions.

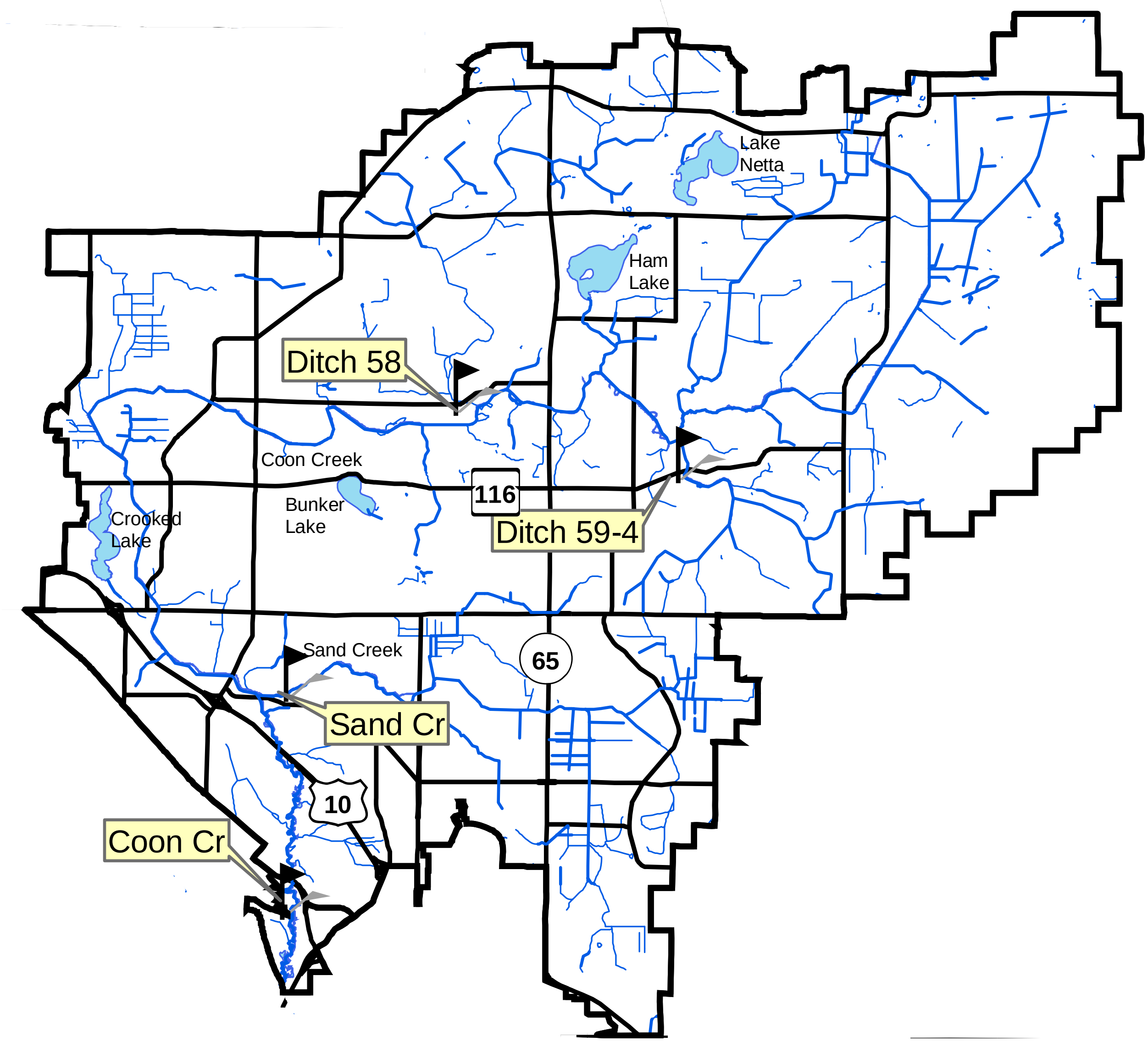
Locations: Coon Creek at Coon Hollow, Coon Rapids

Ditch 58 at Andover Blvd (Highway 16), Ham Lake

Ditch 59-4 at Bunker Lake Boulevard NE, Ham Lake

Sand Creek at Xeon Street, Coon Rapids

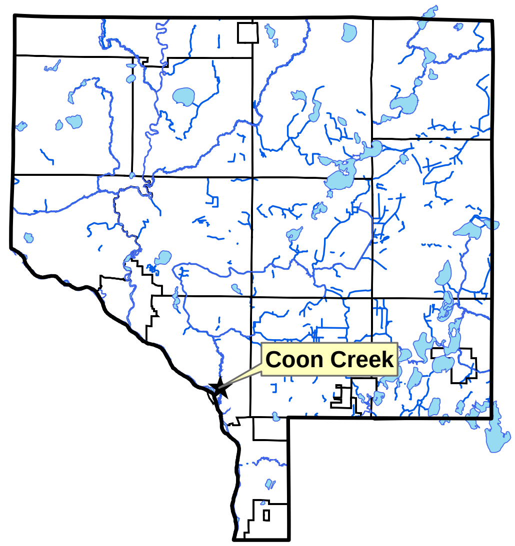
Coon Creek Watershed 2009 Stream Hydrology Monitoring Sites



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.

Coon Creek has flashy responses to storms (see hydrograph on 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 2006-2009 serve to illustrate this phenomenon. Following a 0.94-inch rainfall on August 1st, 2007 the creek rose 0.73 feet in the first two hours, and another 1.76 feet during the second two hours. Thereafter, it began receding but did not reach pre-storm levels for nine days (two rainfalls in between were 0.02 and 0.05 inches). In the few hours following larger storms, water levels can rise nearly 4 feet in a few hours. 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 it rose 2.23 feet. It took about 15 days for 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 inches during a two hour period, rising a total of 3.46 feet in response to the storm. A 1.31-inch rainfall on June 27th, 2009 caused the creek to rise 1.72 feet within the first four hours, and the creek continued to rise another 1.1 feet in the subsequent four hours, totaling a rise of 2.82 feet. Pre-storm levels were reached approximately nine days after the peak stream level was achieved, and only one 0.01-inch rainfall event occurred during those nine days. Similarly, a 2.11-inch rainfall on August 19th, 2009 caused the creek to rise 3.62 feet within 16 hours. Due to continuous significant rainfall events in the following days, pre-storm levels were not achieved.

Coon Creek's water level increases substantially per inch of rainfall. Examining 19 relatively isolated storms ranging in size from 0.72 to 2.23 inches in 2006-09, the creek rose an average of 1.95 feet per inch of rainfall. The creek increase per inch of rain ranged from 1.33 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.

A rating curve was developed in 2005 so that creek flow estimates can be calculated from the continuous water level record (see next page). A rating curve is the mathematical relationship between water level and flow. This mathematical relationship is determined by taking manual measurements of creek flow during many different water levels. Under extremely high water levels flow measurements could not be safely taken, so the rating curve is only considered accurate for water levels less than 822.0 ft msl (i.e. flows <38.19). In 2009 creek flows ranged from 6.55 cfs to over 38.06 cfs. The maximum water level observed since monitoring began in 2005 was 2.73 feet greater than the capacity of the rating curve; if the rating curve is projected forward this water level would correspond to a flow of >80 cfs.

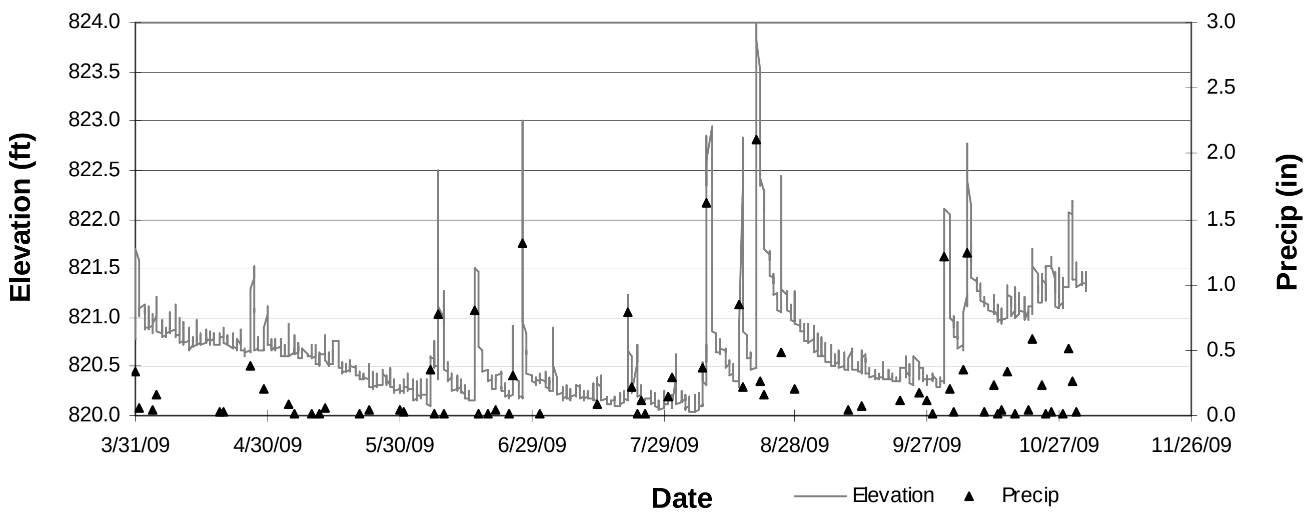
Coon Creek Hydrology (continued)

Summary of All Monitored Years

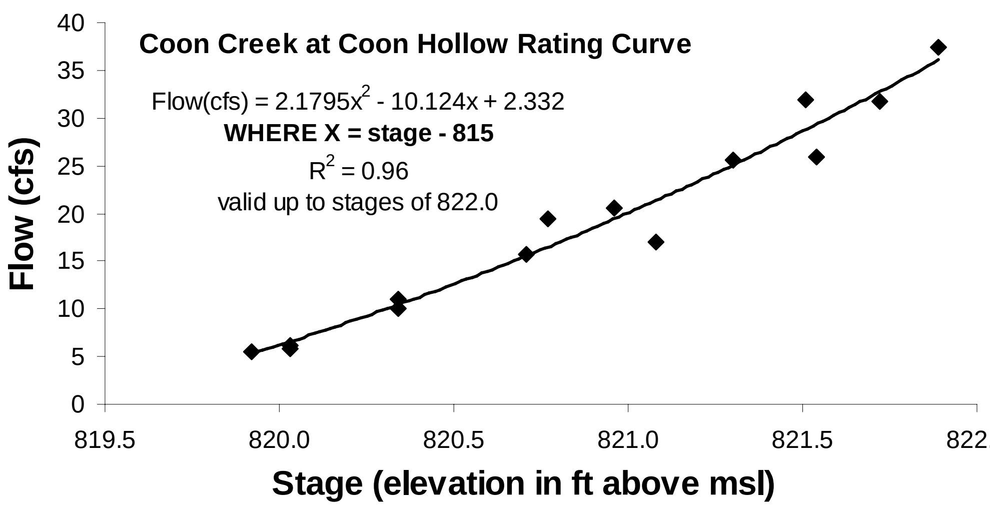
Percentiles	2005	2006	2007	2008	2009	All Years
Min	820.04	820.26	820.33	820.43	820.03	820.03
2.5%	820.06	820.42	820.40	820.52	820.12	820.15
10.0%	820.19	820.53	820.53	820.57	820.20	820.38
25.0%	820.57	820.78	820.73	820.63	820.35	820.6
Median (50%)	820.91	821.35	821.25	820.88	820.61	820.94
75.0%	821.26	821.78	821.88	821.78	820.93	820.94
90.0%	821.77	822.27	822.63	822.26	821.31	822.17
97.5%	822.92	822.76	823.21	822.79	822.05	822.86
Max	823.26	824.18	824.47	823.96	824.11	824.47

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

2009 Hydrograph



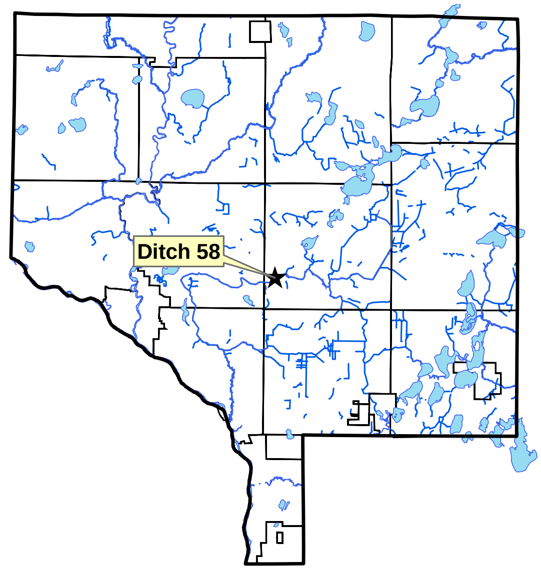
Rating Curve (2005)



DITCH 58

at Andover Boulevard, Ham Lake

Notes



Ditch 58 is a tributary to Coon Creek. Upstream of the monitoring site, Ditch 58 consists of 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 dominated by suburban residential and sod fields. The ditch is about 10 feet wide and 2 feet deep at the monitoring site during baseflow.

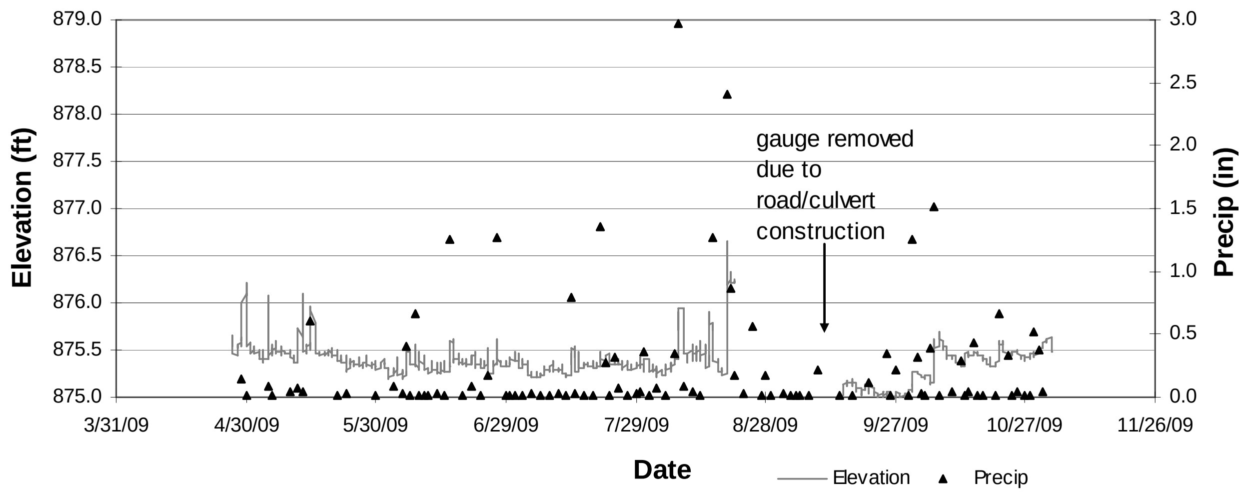
Ditch 58 water levels fluctuated 1.67 feet throughout 2009. Water levels were nearly flat throughout most of the summer. Significant rainfall events in August resulted in increased water levels, but at this same time major road construction and culvert replacement work forced the gauge to be removed.

Summary of All Monitored Years

Percentiles	2001	2002	2003	2004	2005	2006	2007	2008	2009	All Years
Min	875.29	875.81	875.28	875.23	875.05	875.31	875.24	875.29	874.98	874.69
2.5%	875.35	876.18	875.57	875.63	875.54	875.91	875.29	875.33	875.01	875.25
10.0%	875.48	876.33	875.64	875.51	875.37	875.66	875.37	875.36	875.16	875.35
25.0%	875.58	876.41	875.74	875.63	875.54	875.91	875.49	875.39	875.29	875.46
Median (50%)	875.65	876.51	876.10	875.83	875.78	876.20	875.89	875.56	875.37	875.80
75.0%	875.77	876.73	876.59	876.05	876.04	876.35	876.16	876.06	875.46	875.80
90.0%	876.23	877.42	877.01	876.45	876.22	876.47	876.40	876.28	875.54	876.55
97.5%	876.30	878.13	878.16	877.04	876.98	876.89	876.90	876.61	875.79	877.26
Max	876.48	878.13	878.19	878.03	878.12	877.75	877.64	877.63	876.65	878.19

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

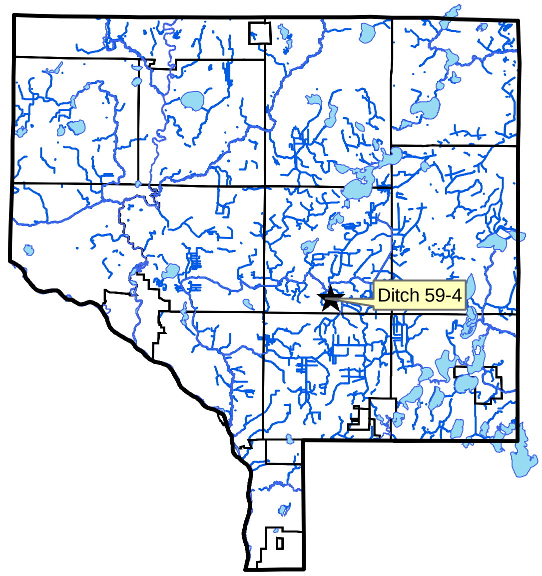
2009 Hydrograph



DITCH 59-4

at Bunker Lake Boulevard NE, Ham Lake

Notes



Ditch 59-4 originates in northeast Blaine and flows northwest to join Coon Creek approximately 0.3 miles downstream of the monitoring site. Upstream of the monitoring site, Ditch 59-4 has three main branches which have a total length exceeding 5 miles. Watershed land uses are dominated by suburban residential and sod fields. The ditch is about 7 feet wide and 1.5 feet deep at the monitoring site during baseflow.

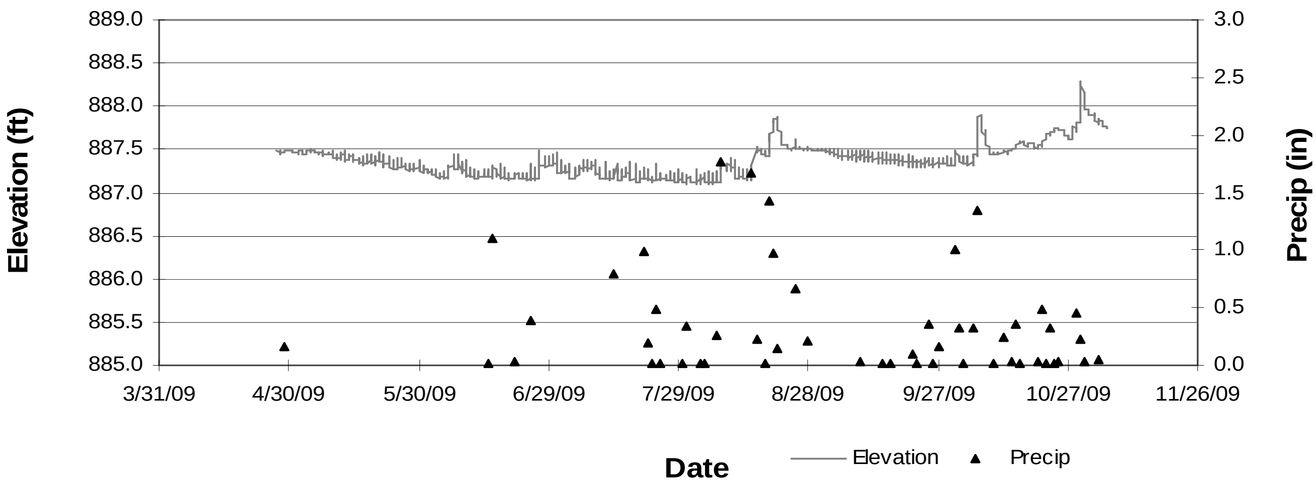
2009 was the second year that Ditch 59-4 was monitored. The total range in water levels was 1.19 feet. Water levels were approximately 0.25 ft. lower during the spring as compared to late summer and fall. Rain events during August caused an increase in water level that was sustained throughout the remainder of 2009.

Summary of All Monitored Years

Percentiles	2008	2009	All Years
Min	887.09	887.09	885.67
2.5%	887.12	887.13	887.12
10.0%	887.16	887.16	887.16
25.0%	887.21	887.24	887.22
Median (50%)	887.28	887.36	887.32
75.0%	887.74	887.48	887.32
90.0%	887.95	887.62	887.89
97.5%	888.13	887.84	888.06
Max	888.50	888.28	888.50

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

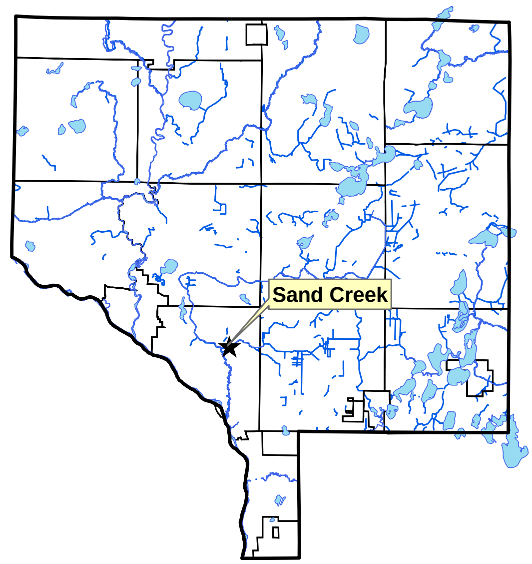
2009 Hydrograph



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 2.5-3 feet deep at the monitoring site during baseflow.

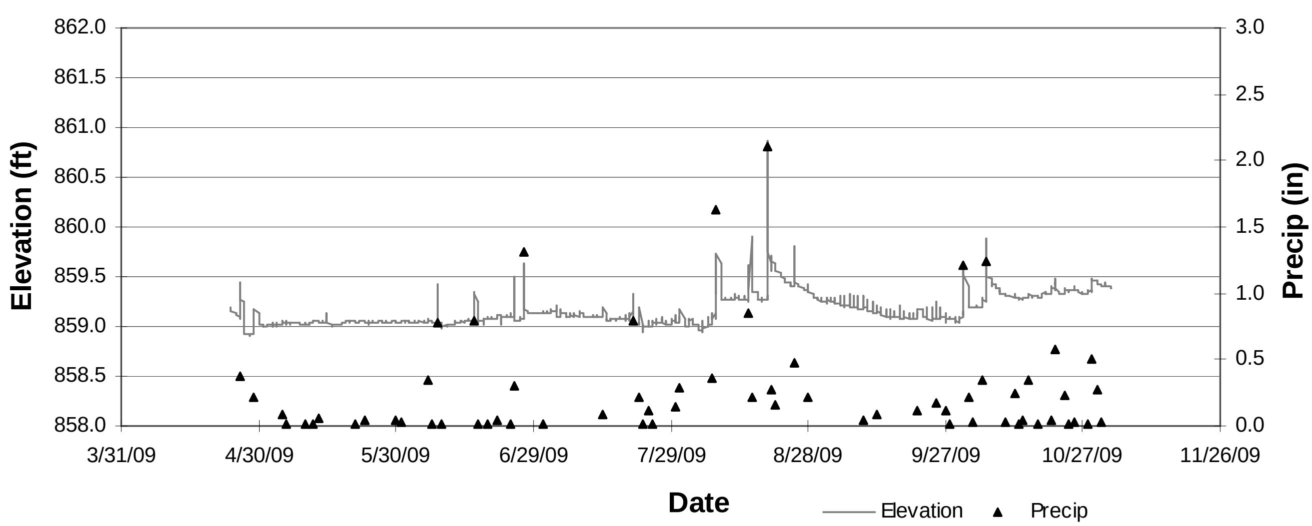
Sand Creek shows little variation in water levels, which is unusual for a stream with a suburban watershed. Sand Creek water levels fluctuated 1.96 feet in 2009. Excluding storms, the total seasonal variability in water levels was only about 1 foot. Still, the creek can have more dramatic hydrologic changes following large 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. It is typical for Sand Creek to rise and fall very quickly following rainfall, often on a time scale of only a few hours.

Summary of All Monitored Years

Percentiles	2001	2002	2003	2004	2005	2006	2007	2008	2009	All Years
Min	859.06	859.22	859.21	859.31	859.35	859.32	859.17	859.35	858.91	858.91
2.5%	859.09	859.44	859.26	859.33	859.41	859.43	859.30	859.44	858.99	859.03
10.0%	859.15	859.48	859.32	859.40	859.45	859.54	859.41	859.48	859.03	859.12
25.0%	859.23	859.61	859.41	859.46	859.55	859.70	859.47	859.53	859.05	859.39
Median (50%)	859.33	859.75	859.55	859.60	859.72	859.86	859.64	859.58	859.10	859.55
75.0%	859.49	859.93	859.75	859.80	859.97	860.01	859.81	859.78	859.29	859.55
90.0%	859.54	860.09	860.00	860.03	860.21	860.12	859.98	859.94	859.38	860.00
97.5%	859.65	860.32	860.28	860.32	860.51	860.27	860.11	860.13	859.54	860.25
Max	860.00	861.22	861.13	861.27	861.50	861.38	861.10	860.88	860.87	861.50

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

2009 Hydrograph



Stream Water Quality – Chemical Monitoring

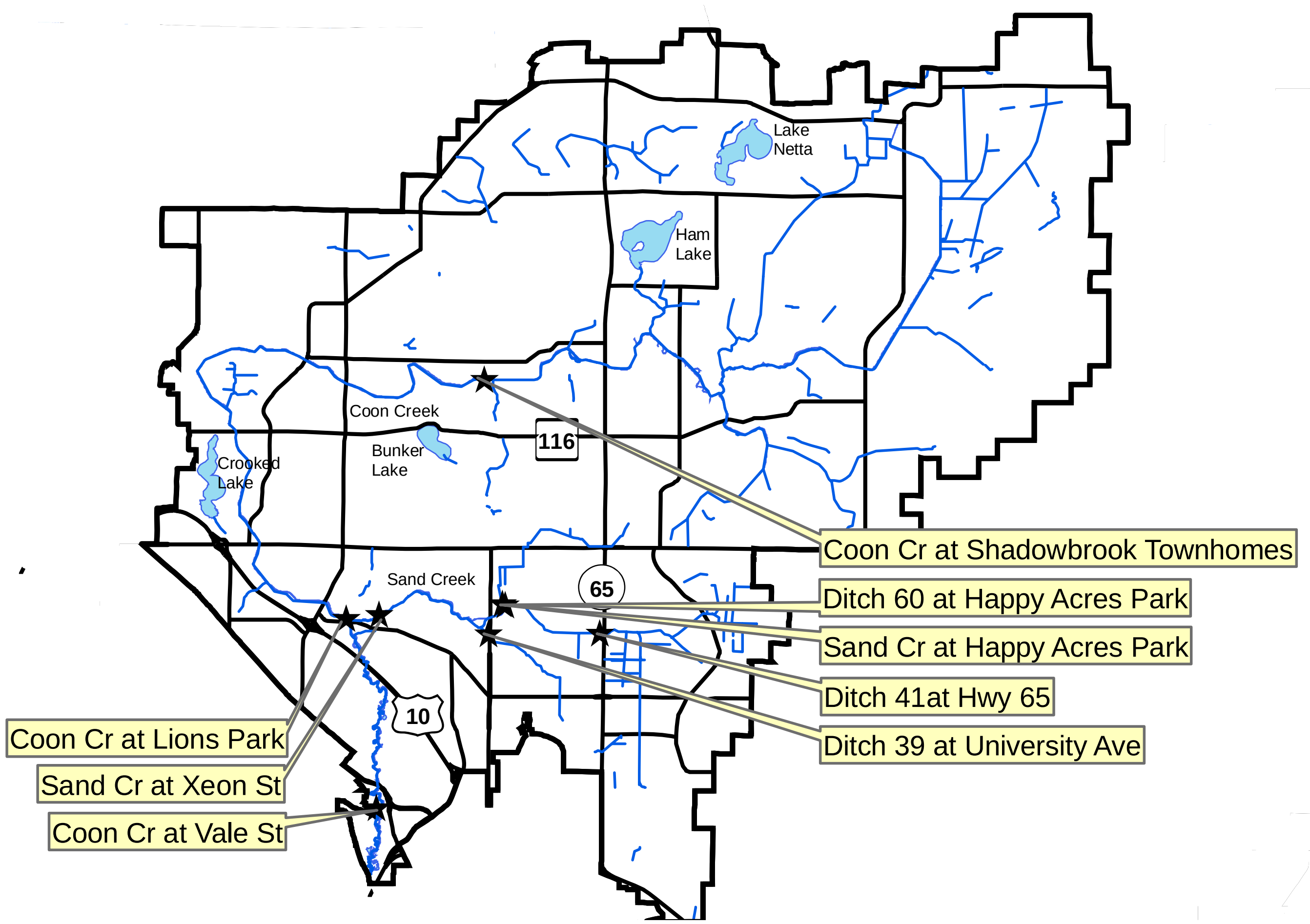
Description: Each stream was monitored eight times between April and October; four times during baseflow and four times during storm flow. Storm flow events were defined as an approximately one-inch rainfall in 24 hours, though totals vary from location to location. Each stream was tested for pH, conductivity,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

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

Locations: Coon Creek at Shadowbrook Townhomes, Andover
Coon Creek at Lions Park, Coon Rapids
Coon Creek at Vale St., Coon Rapids
Sand Creek at Highway 65, Blaine
Sand Creek at Happy Acres Park, Blaine
Ditch 60 at Happy Acres Park, Blaine
Ditch 39 at University Ave, Coon Rapids
Sand Creek at Xeon Street, Coon Rapids

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

Coon Creek Watershed Stream Water Quality Monitoring Sites

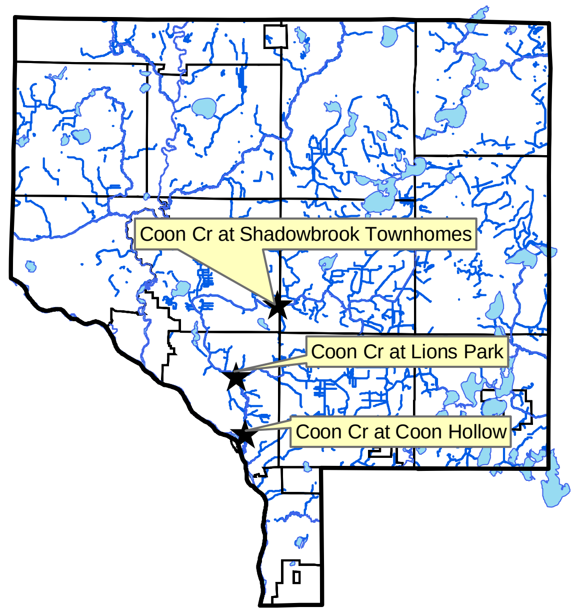


COON CREEK

Coon Creek at Shadowbrook Townhomes, Andover	STORET SiteID = S004-620
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 Creek at Vale Street - 2005, 2006, 2007, 2008, 2009
Coon Creek at Shadowbrook Townhomes – 2007, 2008, 2009
Coon Creek at Lions Park – 2007, 2008, 2009



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.

Methods

Coon Creek has been monitored for several years at Vale Street, near its outlet to the Mississippi River as well as at two upstream sites. The Lions Park site was selected because this is just before Coon Creek joins with its major tributary, Sand Creek. All Coon Creek sites, as well as Sand Creek, were monitored at synchronously to allow comparisons.

Streams 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. 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. 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, and chlorides. 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 Vale 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, as well as an overall assessment. Sand Creek monitoring is reported elsewhere, but some comparisons between Sand Creek and Coon Creek are made here.

Overall, Coon Creek is moderate upstream and during baseflow, but declines downstream and during storms. Dissolved pollutants, as measured by conductivity, salinity, and chlorides, were slightly elevated in Coon Creek and showed little variability in different flow conditions and little variability from upstream to downstream. Some of these dissolved pollutants are originating from the shallow groundwater which feeds the creek during baseflow. Phosphorus was at acceptably low levels during baseflow, but was much more variable and generally higher during storms. Suspended solids and turbidity were also reasonably low at baseflow, but increased several-fold during storms and increased from upstream to downstream. Coon Creek's water is often brown and sometimes strongly brown. Other water quality measures, including pH and dissolved oxygen were with the range considered normal and healthy for streams in this area.

Different approaches will be needed to address this creek's two generalized pollution problems. Dissolved pollutants migrating from the shallow groundwater into the creek must be controlled at the source. Once on the ground, sandy soils in the watershed facilitate quick movement of dissolved materials into the groundwater. The results suggest that while road deicing salts are a large component of the dissolved pollutants, they are not the only one. Suspended materials swept into the creek during storms can be addressed with a combination of prevention and best management practices to capture them before storm water conveyances deliver them to the creek. 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. Good water quality in this stream is important for its own sake, but also because it is degrading the Mississippi River. Coon Creek empties in to the Mississippi just upstream of drinking water intakes for the Twin Cities and important recreational areas on the river.

Conductivity, Chlorides, and Salinity

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. Salinity measures dissolved salts as a percent salinity. 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. Overall, dissolved pollutants in Coon Creek are slightly high.

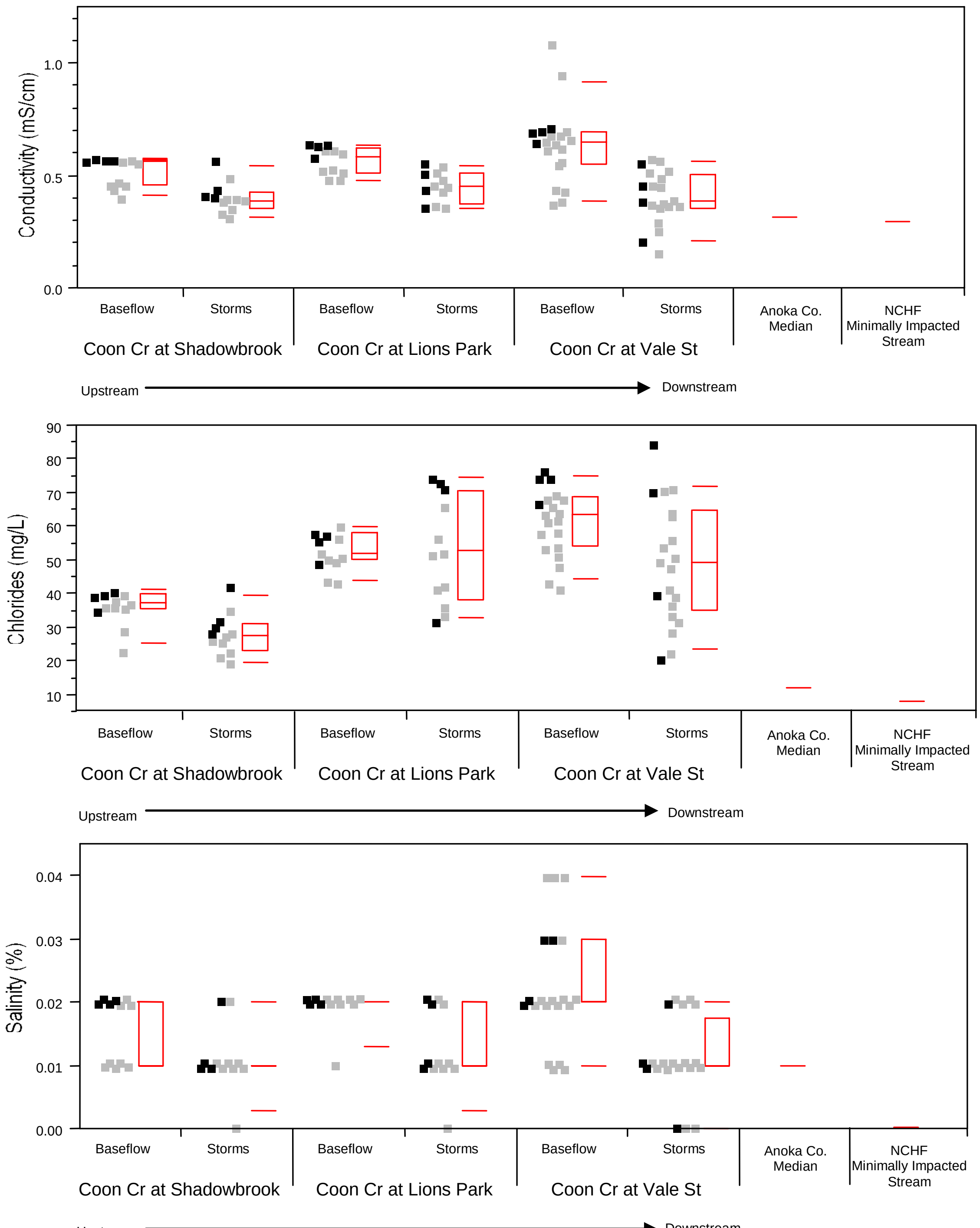
Conductivity and salinity in Coon Creek were only slightly higher than typically found in Anoka County streams, but chlorides were significantly higher and of greater concern (see figures below). Median conductivity in Coon Creek (all sites) was 0.491 mS/cm compared to the countywide median of 0.318 mS/cm. Median salinity in Coon Creek (all sites) was 0.02% compared to the countywide median of 0.01%, though salinity is not a very sensitive or useful measure. Median chlorides in Coon Creek (all sites), on the other hand, were more than four times higher than the countywide median (49 vs 12 mg/L). Elevated chlorides have been found in most urban and suburban areas of Anoka County and elsewhere due to higher road deicing salt application. Conductivity and salinity sources likely included road deicing salts as well as a broad mixture of other chemicals found on roads and other impervious surfaces.

The Minnesota Pollution Control Agency (MPCA) has a water quality standard for only one of the dissolved pollutant parameters, chlorides, but Coon Creek does not exceed this standard. The chronic water quality standard is 230 mg/L. The maximum observed in Coon Creek was 85 mg/L. It is possible that higher levels do occur at other times, such as during snowmelt, but were not captured by the monitoring.

Dissolved pollutants were higher in downstream reaches of Coon Creek, where there is more impervious area (see figures below). The increase is slight for conductivity and salinity. It is most pronounced when comparing among baseflow conditions, probably because baseflow sampling conditions were all similar, whereas storm conditions were more variable. Median baseflow conductivity increased modestly from upstream to downstream (0.568, 0.586, and 0.654 mS/cm, respectively). The difference from upstream to downstream for chlorides was much more dramatic, especially between the Shadowbrook and Lions Park monitoring sites. Median baseflow chlorides from upstream to downstream were 37, 52, 63 mg/L, respectively.

Dissolved pollutants were similar during baseflow and storm conditions. 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 as a primary contributor. In Coon Creek, we find both are similarly high. In other words, stormwater runoff is an important source, but pollutants have also built up over time in the shallow groundwater. While storms dilute some of the baseflow pollutants, they also carry additional pollutants which 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, and preventing their release into the environment and treating them before infiltration should be a high priority. Removing them once they have entered shallow groundwater is exceedingly difficult.

Conductivity, chlorides, and salinity at Coon Creek. Dots are individual readings. Black dots are 2009 readings, grey dots are 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) is a common nutrient pollutant. It is limiting for most algae growth. Total phosphorus (TP) in Coon Creek was consistently low during baseflow conditions, but more than doubled during storms (see figure below). Best management practices for this stream are needed to address stormwater phosphorus along the entire monitored stream length.

Baseflow TP was low. During baseflow the three monitoring sites had median TP of 70, 76, 77 ug/L, respectively, from upstream to downstream. This is much lower than the countywide median for streams of 126 ug/L. There was little variability among baseflow samples, with only three samples exceeding 126 ug/L. The maximum was 179 ug/L.

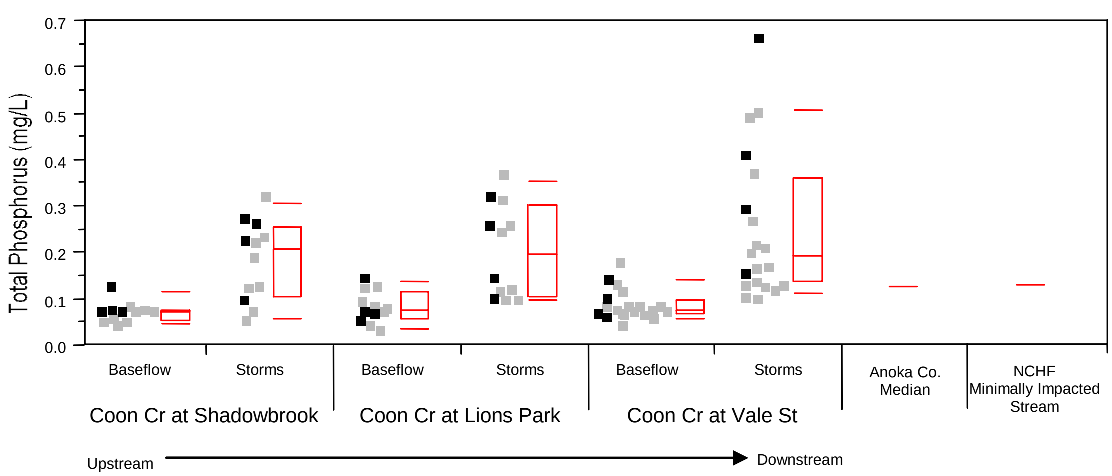
During storms TP was higher, and sometimes much higher. Median TP during storms was 2.5 times the median for baseflow at each site. Storms also had much greater variability. The standard deviation for storm readings were 99 mg/L at Shadowbrook, 102 at Lions Park, and 159 at Vale Street. By contrast, the standard deviations during baseflow were 22, 34, and 33 mg/L, respectively. 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 increased in an upstream to downstream direction during storms. While median storm TP was similar at the three sites (174, 194, and 192 ug/L, respectively, upstream to downstream), the Vale Street site had the highest individual readings and much more variability. At Vale Street there were six readings over 300 ug/L, while there were three such instances at Lions Park and only one at Shadowbrook. More sampling events at Vale Street could partially explain this.

The dominant phosphorus source is likely different in upstream and downstream stream reaches. Upstream is less densely developed and development occurred more recently with more stringent stormwater management standards. Here, mobilization of in-stream sediments and agricultural runoff may be an important phosphorus source, and stormwater runoff to a lesser degree. Downstream areas are more densely developed and were developed before modern-day stormwater standards. Here, flows are often higher and more flashy, so mobilization of in-stream sediments may continue to be important, but stormwater runoff from impervious surfaces is likely quite important.

From a management standpoint, phosphorus reduction during storms needs to occur throughout the watershed. Arguably 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, sometimes very high. 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.

Total phosphorus at Coon Creek. Dots are individual readings. Black dots are 2009 readings, grey dots are 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 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 are low upstream and during baseflow, but increase dramatically during storms and in downstream reaches (see figures below). The stream appears to exceed state water quality standards for turbidity, though it has not yet been listed as impaired by the MPCA.

During baseflow TSS and turbidity were low. Median turbidity during baseflow from upstream to downstream were 8, 4, and 9 FRNU, respectively. This is lower than the countywide median of 9 FRNU and the MPCA's water quality standard of 25. Median TSS during baseflow from upstream to downstream was 5, 9, and 8 mg/L, respectively. This is lower than the median for streams county-wide of 13.5 mg/L.

During storms TSS and turbidity are higher. Median turbidity during storms was 1.6 to 7.9 times higher than during baseflow (comparison is among site medians). Median storm turbidity was 13, 30, and 39 mg/L from upstream to downstream. The greatest increase from baseflow to storms was at the Vale Street monitoring site (farthest downstream). Median TSS during storms was 2.5 to 5.1 times higher than during baseflow. Median storm TSS was 19, 20, and 46 mg/L from upstream to downstream. Both measures were much more variable during storms too.

There is likely enough data for the MPCA to consider Coon Creek "impaired" due to violations of turbidity water quality standards. Whenever possible, MPCA prefers to use turbidity for these determinations rather than use TSS and transparency tube as surrogates. A minimum of 20 readings are required. At least three observations and 10% of all observations must exceed the water quality standard of 25 NTU to be considered impaired. At the Shadowbrook monitoring site (farthest upstream), 3 of 23 (13%) readings exceeded the standard. At the Lions Park monitoring site (middle), 9 of 25 readings (36%) exceeded the standard. At the Vale Street monitoring site (farthest downstream), 15 of 40 (38%) of readings exceeded the standard. Keep in mind that half of all readings are during storms and half during baseflow. All except three exceedences were during storms. Based on this, the MPCA is likely to list Coon Creek as impaired for high turbidity.

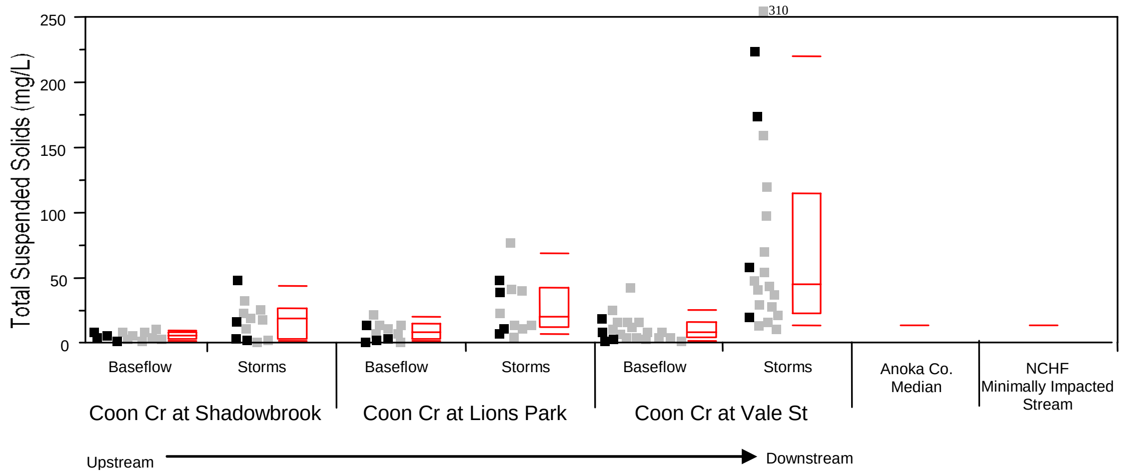
There are some questions regarding the appropriateness of such an impaired listing. First, turbidity measurements were taken using units of FNRU, not NTU. It is uncertain how these units differ, but the difference is likely small. Also, Coon Creek exceeded the surrogate standard of 100 mg/L TSS only five times. Only one of five transparency tube measurements exceeded that surrogate standard of 20 cm. However, given the preference for using turbidity directly, these points are likely irrelevant.

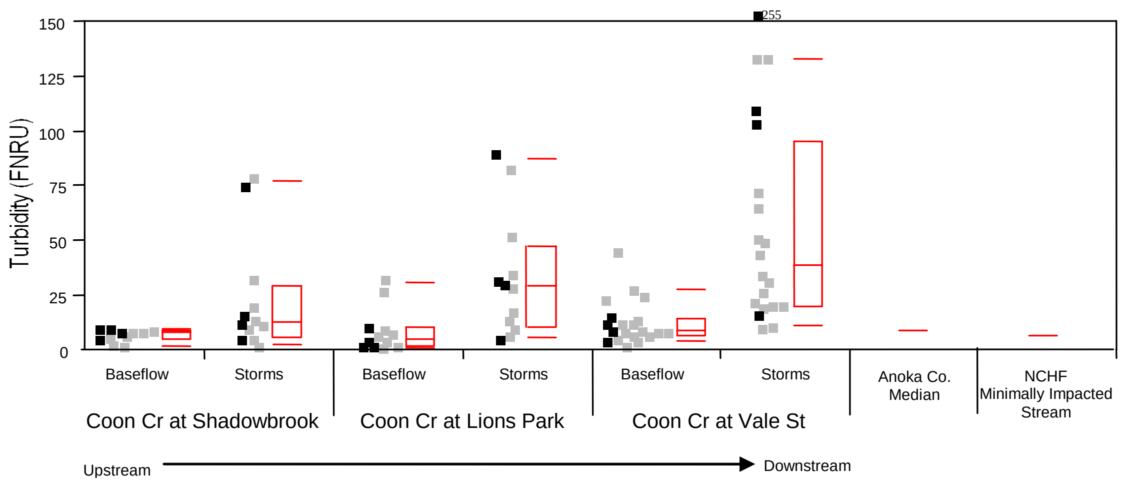
Turbidity and TSS problems are most severe in downstream reaches. Readings in downstream areas are typically two-times higher than those from upstream areas. Median storm turbidity was 13, 30, and 39 mg/L from upstream to downstream. Median storm TSS was 19, 20, and 46 mg/L from upstream to downstream. Higher flows in downstream areas probably contribute to greater bedload transport of sediment. Greater impervious area in downstream portions of the watershed results more urban stormwater runoff, which is often high in suspended materials. The lower portions of the Coon Creek watershed were mostly developed before rigorous stormwater treatment regulations were enacted.

From a management perspective, water quality improvement projects should focus upon treating stormwater, especially in the lower half of the watershed. Retrofitting the existing stormwater conveyance and treatment system will be necessary in many instances. Where redevelopment occurs, improved stormwater practices should be installed. In some areas, stabilization of the creek itself is needed; several areas of significant streambank erosion exist. This is not surprising given that upper reaches of the creek have been ditched.

In addition to the data presented above, some transparency tube data and photos are available from the Anoka Conservation District. Transparency tube readings were not included in this report because they were taken only in 2009 and because in many instances water clarity was greater than the tube's length, resulting in a reading of >100cm. Stream appearance was also photo-documented during every sampling, but is not included in this report.

Total suspended solids and turbidity at Coon Creek. Dots are individual readings. Black dots are 2009 readings, grey dots are 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).

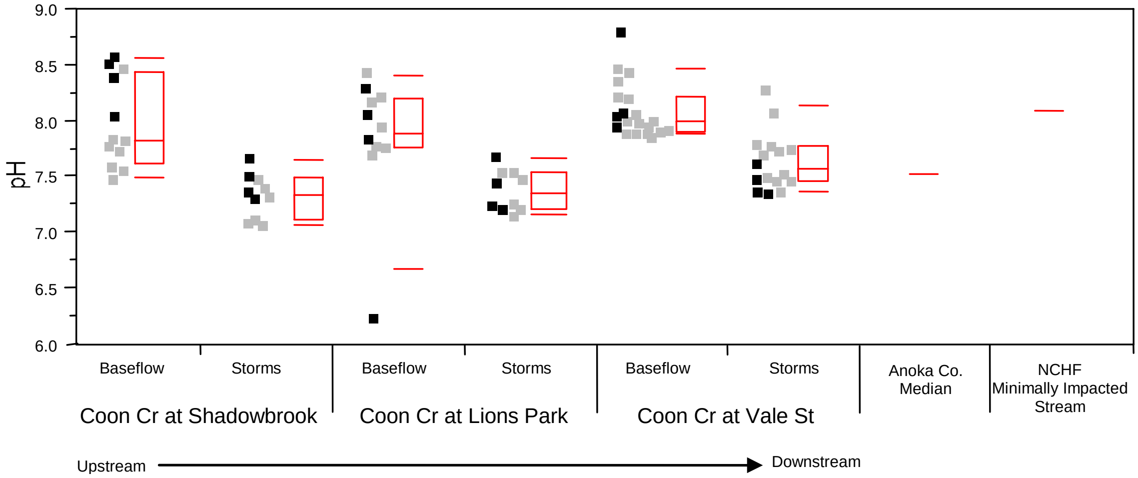




pH

pH was within the expected range at all sites, with one exception. 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 evens, but this is not surprising because rainfall has a lower pH and the creek serves as a stormwater conveyance for four cities. One unusually low pH reading of 6.24 occurred on July 20, 2009. The reason for this low reading is unknown, but it appears to be isolated.

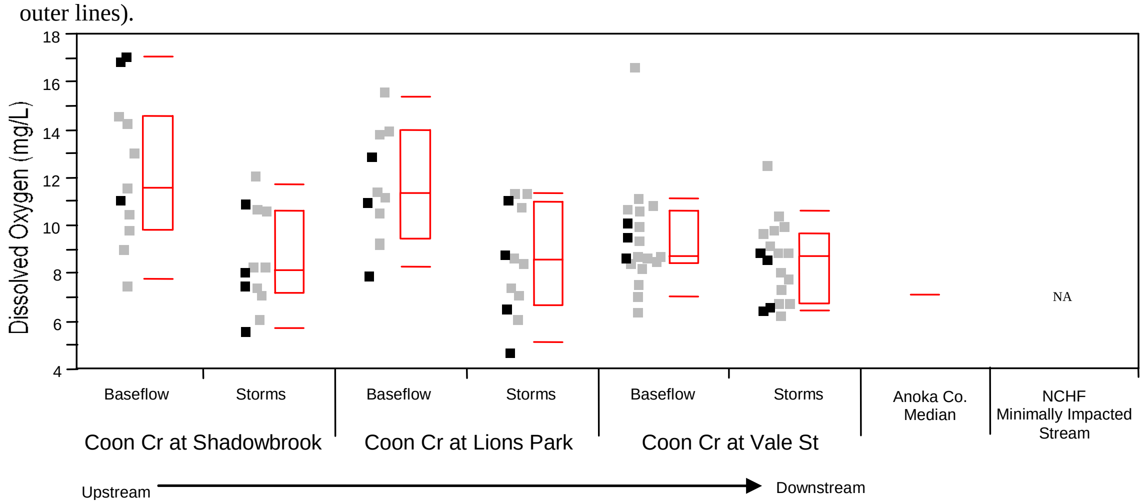
pH at Coon Creek. Dots are individual readings. Black dots are 2009 readings, grey dots are readings from previous years. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Dissolved Oxygen

Dissolved oxygen was similar at all sites, only once dropping below 5 mg/L at which point some aquatic life becomes stressed.

Dissolved Oxygen at Coon Creek. Dots are individual readings. Black dots are 2009 readings, grey dots are 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).

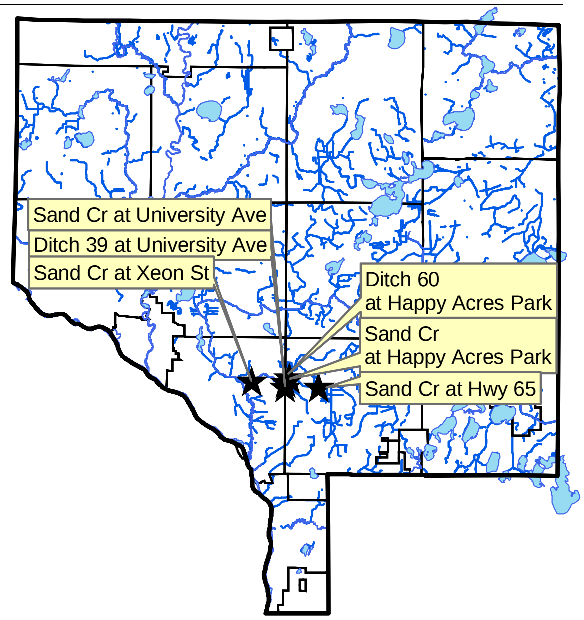


SAND CREEK SYSTEM

Sand Creek (Ditch 41) at Highway 65, Blaine	STORET SiteID = S005-639
Sand Creek at Happy Acres Park, Blaine	STORET SiteID = S005-641
Ditch 60 at Happy Acres Park, Blaine	STORET SiteID = S005-642
Sand Creek at University Avenue, Coon Rapids	STORET SiteID = S005-264
Ditch 39 at University Avenue, Coon Rapids	STORET SiteID = S005-638
Sand Creek at Xeon Street, Coon Rapids	STORET SiteID = S004-619

Years Monitored

Sand Creek (Ditch 41) at Highway 65 – 2009 only
Sand Creek at Happy Acres Park – 2009 only
Ditch 60 at Happy Acres Park – 2009 only
Sand Creek at University Avenue – 2008 only
Ditch 39 at University Avenue – 2009 only
Sand Creek at Xeon Street – 2007, 2008, and 2009



Background

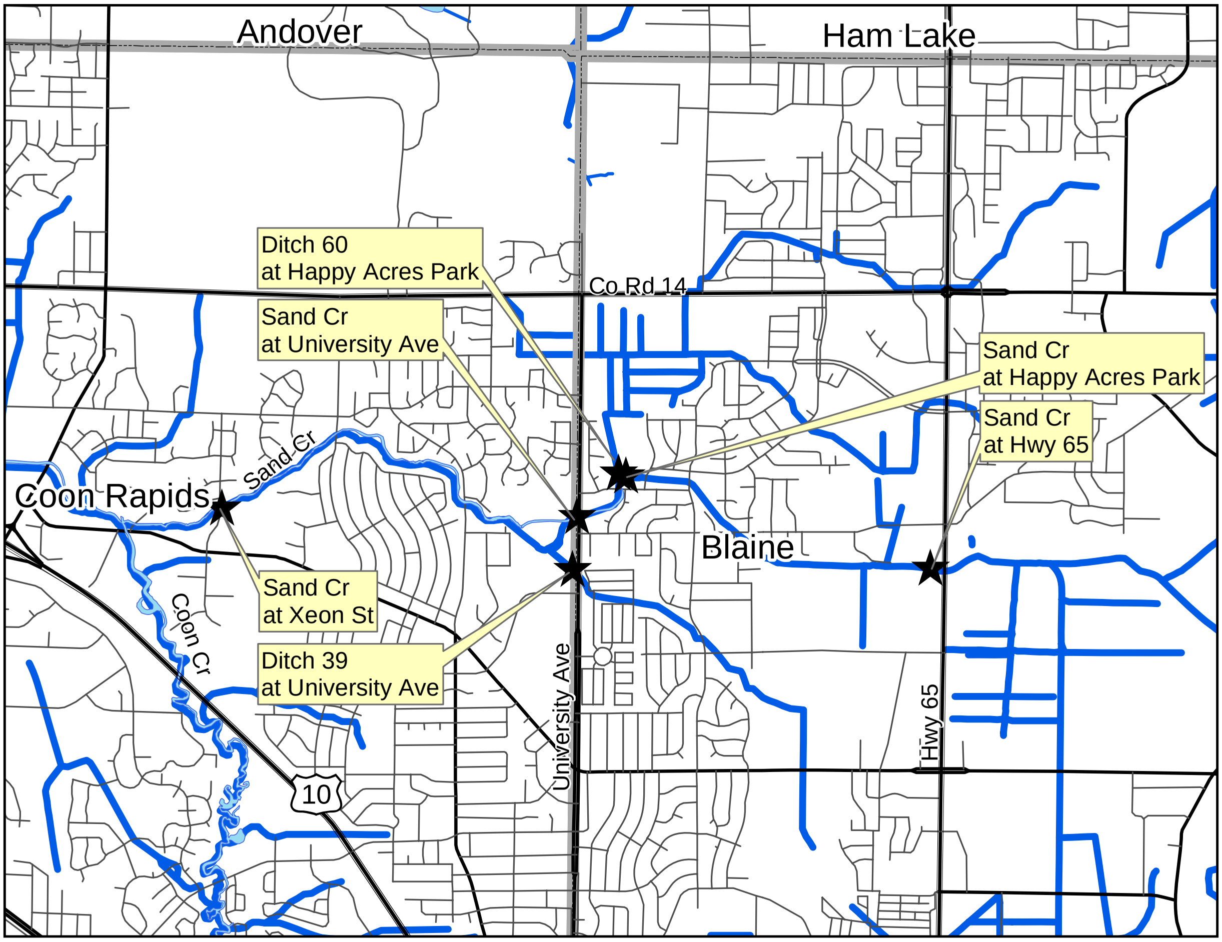
Sand Creek is the largest tributary to Coon Creek. It drains suburban residential, commercial and retail areas throughout northeastern Coon Rapids and western Blaine. A number of ditch tributaries exist. Monitored tributaries include Ditch 39 and Ditch 60. At Sand Creek's juncture with Coon Creek it is 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. 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. 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, and chlorides. 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).

The sites monitored represent both tributary ditches as well as the main stem of the creek. The farthest upstream site, Ditch 41 at Highway 65, is the main stem of Sand Creek and is the outlet of a network of stormwater ponds and stormwater lakes associated with newer (post 1995) residential developments in the City of Blaine. These developments include "The Lakes," "Club West," and others. West of Highway 65 is older residential development, with some retail and commercial. Other monitoring sites were strategically located to monitor tributaries just before they enter Sand Creek and Sand Creek just before it enters Coon Creek. A map of monitoring sites is below.

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, water quality in Sand Creek is good, especially for a creek with a suburban watershed. Phosphorus, suspended solids, and turbidity are often elevated in urban streams but in Sand Creek were generally lower than the median of other Anoka County streams (Anoka County includes a range of urban to rural). They were similar during baseflow and storms, but did increase from upstream to downstream. On the other hand, dissolved pollutants in Sand Creek (as measured by conductivity, chlorides, and salinity) were 6-8 times higher than the Anoka County median. During storms dissolved pollutant levels ranged widely, but concentrations were overall highest during baseflow. The concentration of dissolved pollutants did not increase from upstream to downstream; they actually appear to decrease slightly downstream. Detailed results are presented below for each pollutant type.

Generally, Sand Creek water does not degrade Coon Creek, into which if flows. Sand Creek phosphorus, total suspended solids, and turbidity were all lower than Coon Creek. Conductivity was the exception, which was notably higher in Sand Creek. Coon Creek has several water quality problems, including dissolved pollutants, phosphorus, and suspended solids.

Conductivity, Chlorides, and Salinity

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. Salinity measures dissolved salts as a percent salinity. 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 Sand Creek is upstream from the drinking water intakes on the Mississippi River for the Twin Cities. Overall, dissolved pollutants in Sand Creek are moderately high.

Sand Creek dissolved pollutant levels are often double the level typically found in Anoka County streams (see figures below). Considering all sites in all years, median conductivity in Sand Creek is nearly two times greater than the median for all Anoka County streams (0.711 mS/cm compared to 0.318 mS/cm). Chlorides were even higher. Sand Creek median chlorides were 6 times greater than the median of all Anoka County streams (75 mg/L vs 12 mg/L). This is still less than the Minnesota Pollution Control Agency's chronic water quality standard for chloride of 230 mg/L. Salinity is not as sensitive of a test, but salinity in Sand Creek averaged 0.03% compared to 0.01% for the county-wide median. It is possible that higher levels of conductivity, chlorides, and salinity do occur at other times, such as during snowmelt, but were not captured by the monitoring.

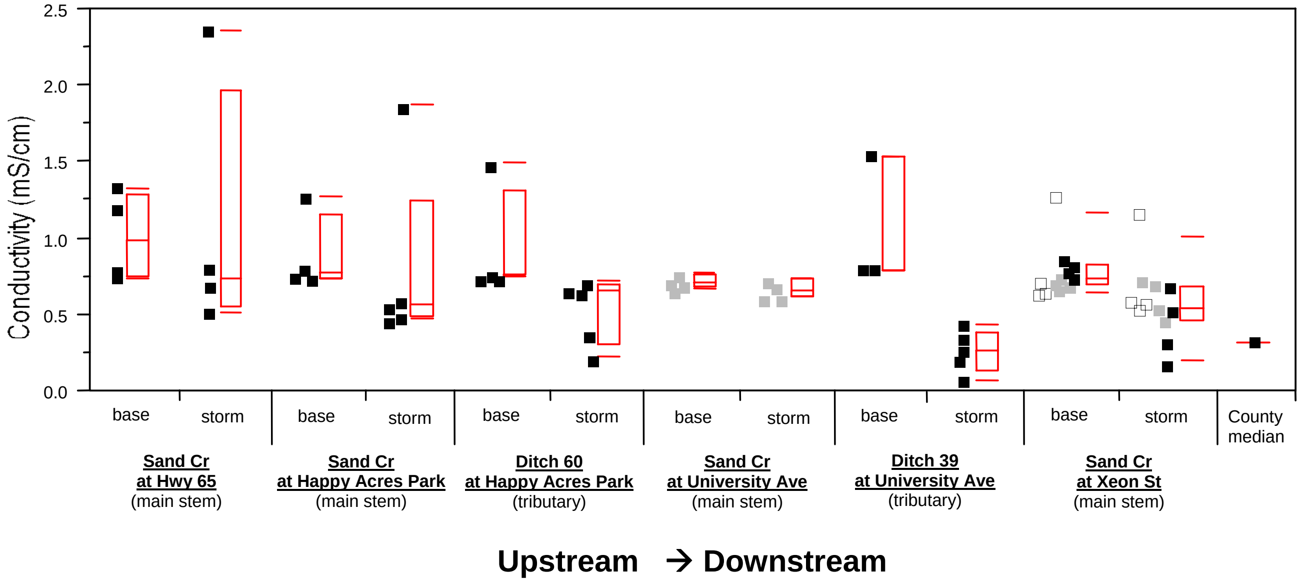
It's not surprising that Sand Creek, which lies in a suburban area, would have greater dissolved pollutants than the county-wide median. The county spans rural to urban areas. Urban stormwater runoff often contains higher dissolved pollutants than those from rural environments. Stormwater treatment practices 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.

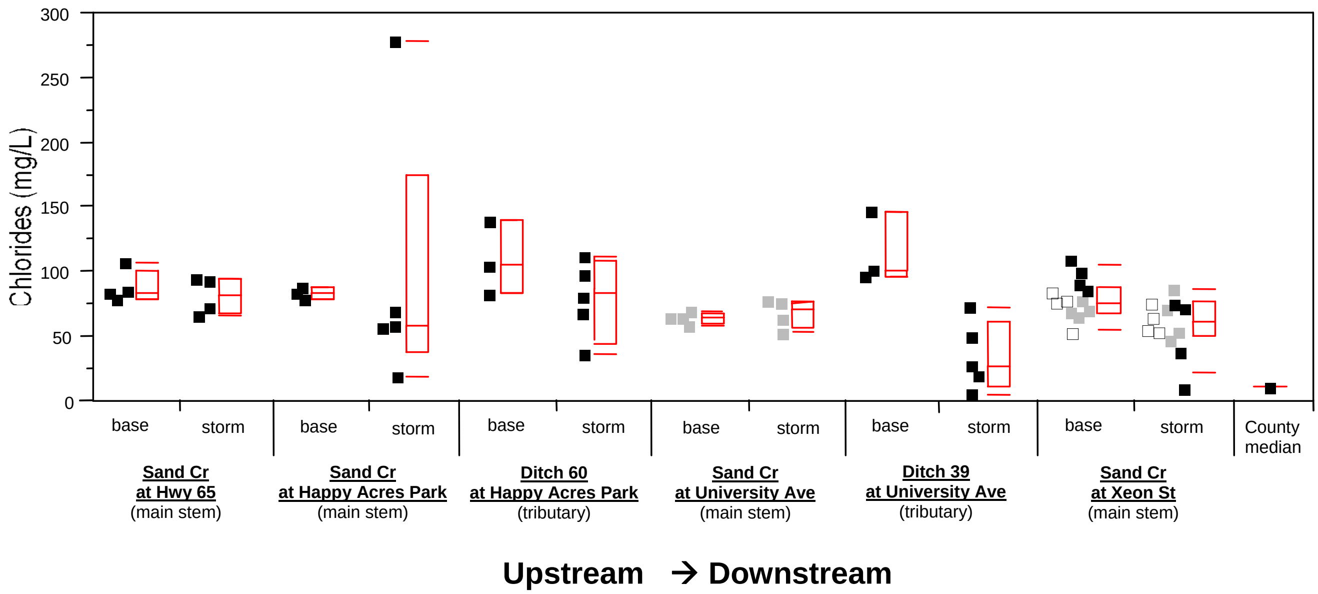
From upstream to downstream there is little change in dissolved pollutants in Sand Creek (see figures below). While upstream sites seem to have a little more variability with an occasional higher reading, all sites were similar. This suggests dissolved pollutant concentrations in all parts of the watershed are similar.

There was little difference between storm and baseflow conditions. If road runoff was the primary dissolved pollutant source, then readings would be highest during storms. Dissolved pollutants can also easily infiltrate into shallow groundwater that feed streams during baseflow. If this has occurred, dissolved pollutants will be high during baseflow. For Sand Creek at Xeon Street, the site with the most data and at the bottom of the watershed, measures of dissolved pollutants were similar during storms and baseflow. However, it is notable that baseflow readings were slightly higher overall. The two tributaries (Ditch 39 and 60) had their highest conductivity, chlorides, and salinity during baseflow too, but the difference was greater. For all other sites baseflow and storm readings were indistinguishable. In all cases, the high dissolved pollutants during baseflow is indicative of pollution of the shallow groundwater that feeds the stream during baseflow. During storms the shallow groundwater inputs are diluted, but dissolved pollutants in stormwater runoff keep overall concentrations similar. 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. Removing them once they have entered shallow groundwater is exceedingly difficult.

Sand Creek degrades Coon Creek with dissolved pollutants. Both creeks were monitored just before Sand Creek joins with Coon Creek. Across all years monitored, Sand Creek's median conductivity was 0.689 mS/cm, while Coon Creek's was 0.519. Sand Creek's median chlorides were 22 mg/L higher than Coon Creek. The two streams have similar salinity, but this measure is not very sensitive.

Conductivity, chlorides, and salinity at Sand Creek. Dots are individual readings. Open dots are 2007 readings, grey dots are 2008 readings, and black dots are 2009 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





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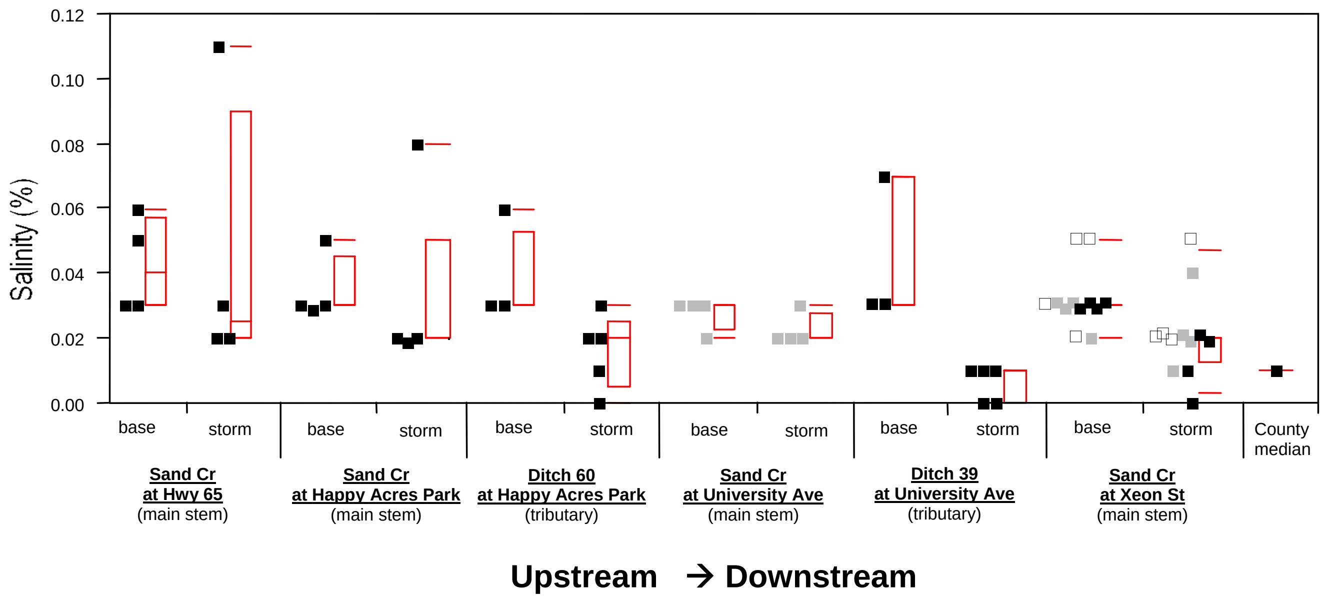


Total Suspended Solids and Turbidity

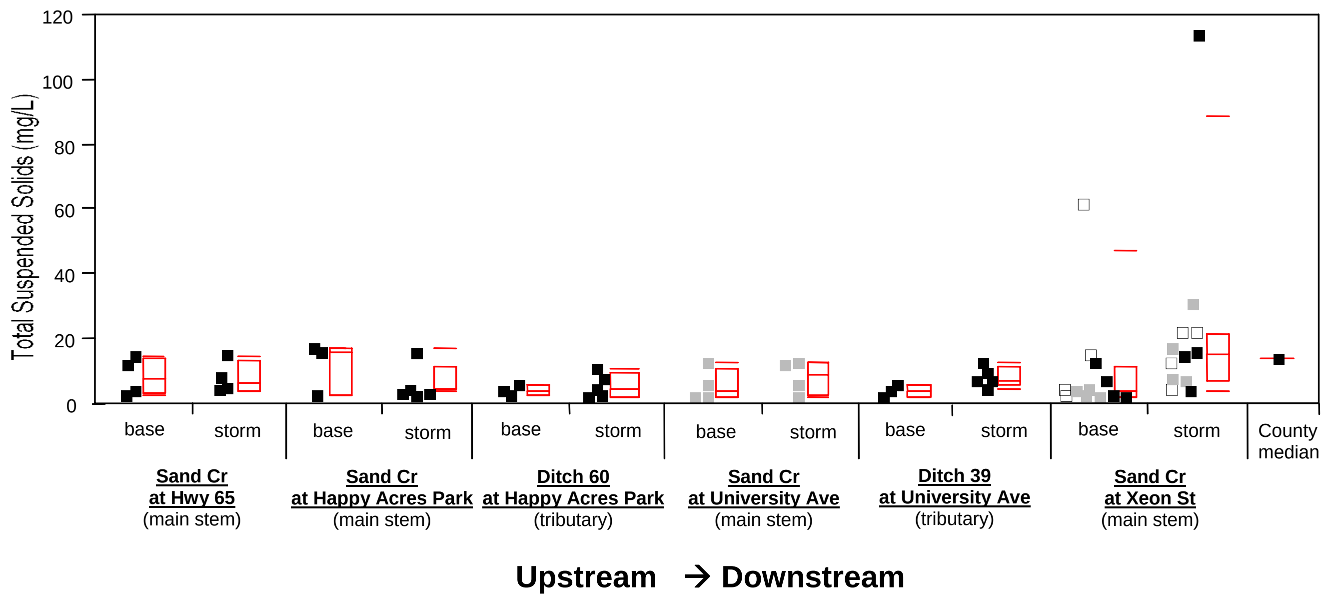
Total suspended solids (TSS) and turbidity both measure solid particles in the water. TSS measures these particles by weighing materials filtered out of the water. Turbidity measures by defraction of a beam of light sent though the water sample, and is therefore most sensitive to large particles. Both TSS and turbidity are low in the upstream reaches of Sand Creek but are higher downstream, especially during storms (see figures below).

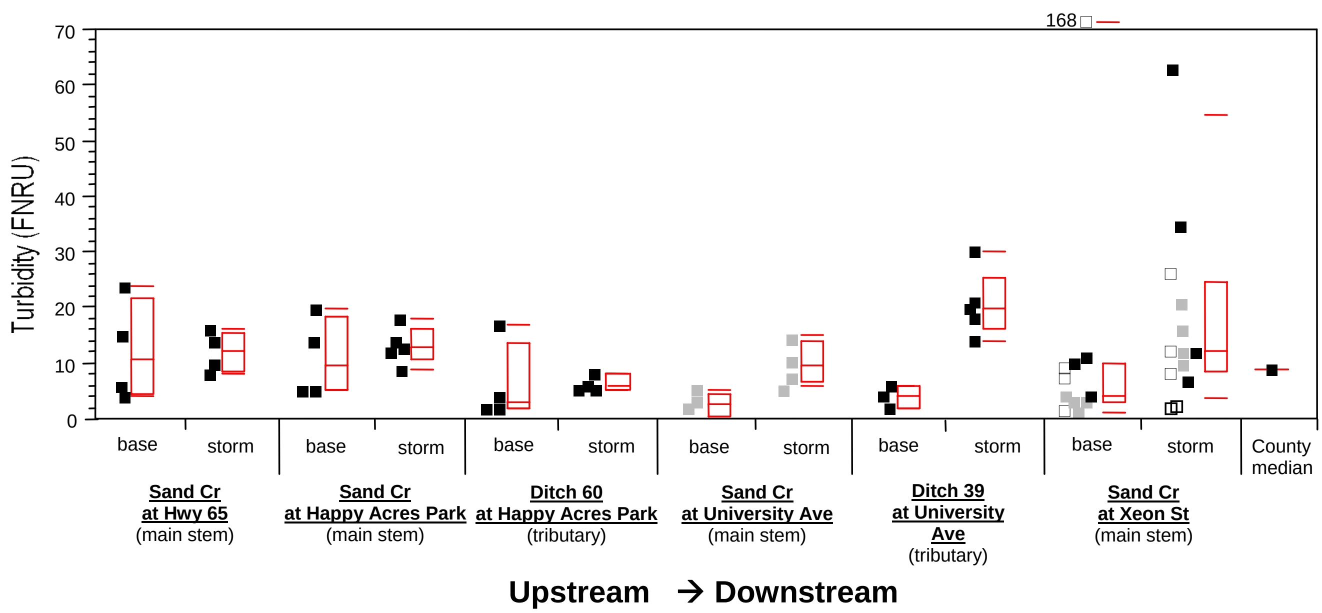
TSS is consistently low at upstream sites, but creeps upward at the farthest downstream sites. Down to and including Sand Creek at University Avenue, median TSS reading (6 mg/L) was less than half the median for Anoka County streams (median 14 mg/L) and no readings exceeded it by more than 3 mg/L. Baseflow and storm readings were similar. The Ditch 39 tributary at University Avenue was similar too, but appeared to have slightly higher TSS during storms; the difference is small and not worrisome. Farthest downstream at Xeon Street, Sand Creek had the highest TSS, especially during storms. During baseflow it was similar to upstream sites (median 4 compared to 6 mg/L), with the exception of one higher reading of 61 mg/L. But during storms at Xeon Street median TSS was 16 mg/L and readings of 114 mg/L was observed.

The results for turbidity were similar, however the stream more often had turbidity that exceeded the county median. Down to and including Sand Creek at University Avenue, median turbidity was 8 FRNU compared to the county-wide median of 9. This is lower than the Minnesota Pollution Control Agency's water quality standard of 25 NTU. Storm flows and base flows had similar turbidity. The Ditch 39 tributary had over double the turbidity (20 FRNU), but this was only during storms. Furthest downstream at Xeon Street, baseflow turbidity was similar to all other sites, but storm turbidity was higher. During storms, turbidity at Xeon Street ranged from 4 to 114 FNRU, with a median of 15.5 FNRU.

During every water quality sampling in 2009, transparency tube measurements of water clarity were taken and staff photo-documented the appearance of the water at every monitoring site. A transparency tube is a tube filled with water containing a black and white disk at the bottom of the tube. Water is released from the tube until the disk can be seek. The water level in the tube is then recorded. Higher transparency tube readings indicate better water clarity. Transparency tube readings are not included in this analysis because in many instances the bottom of the tube could be seen when the tube was full of water (i.e. reading was >100cm). Photos of water conditions are numerous and are available from the Anoka Conservation District.

Total suspended solids and turbidity at Sand Creek. Dots are individual readings. Open dots are 2007 readings, grey dots are 2008 readings, and black dots are 2009 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



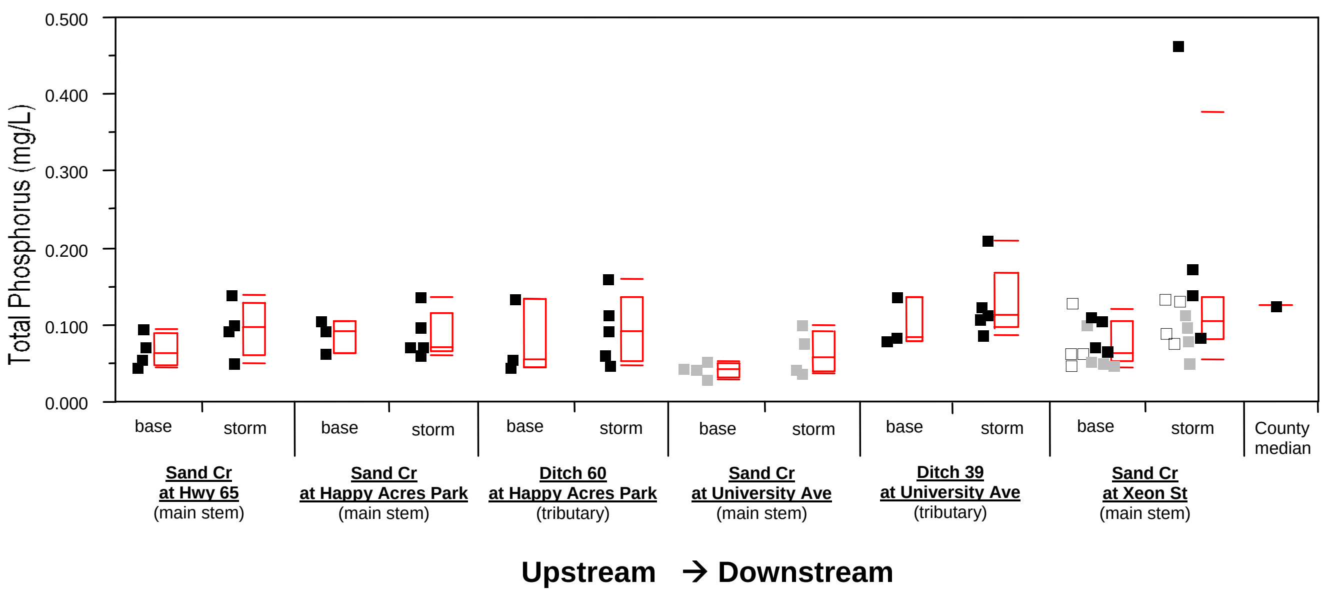


Total Phosphorus

Total phosphorus (TP) is a common nutrient pollutant. It is limiting for most algae growth. TP was low in Sand Creek (see figure below). Median Sand Creek TP for all sites in all years during baseflow (0.063 mg/L) and storms (0.094 mg/L) were below the median for Anoka County streams (0.126 mg/L) and below the published value for minimally impacted streams in this ecoregion (0.130 mg/L). While TP is slightly higher at most sites during storms compared to baseflow, this difference is minor. No apparent TP increase occurs from upstream to downstream; all sites are similar, including the tributary ditches.

These low phosphorus levels, even during storms, is surprising in a suburban setting. The fact that the watershed is mostly residential probably helps to keep phosphorus inputs relatively low. Additionally, storm flushing into Sand Creek is light; the hydrograph (earlier in this report) is relatively flat, even in response to moderate storms.

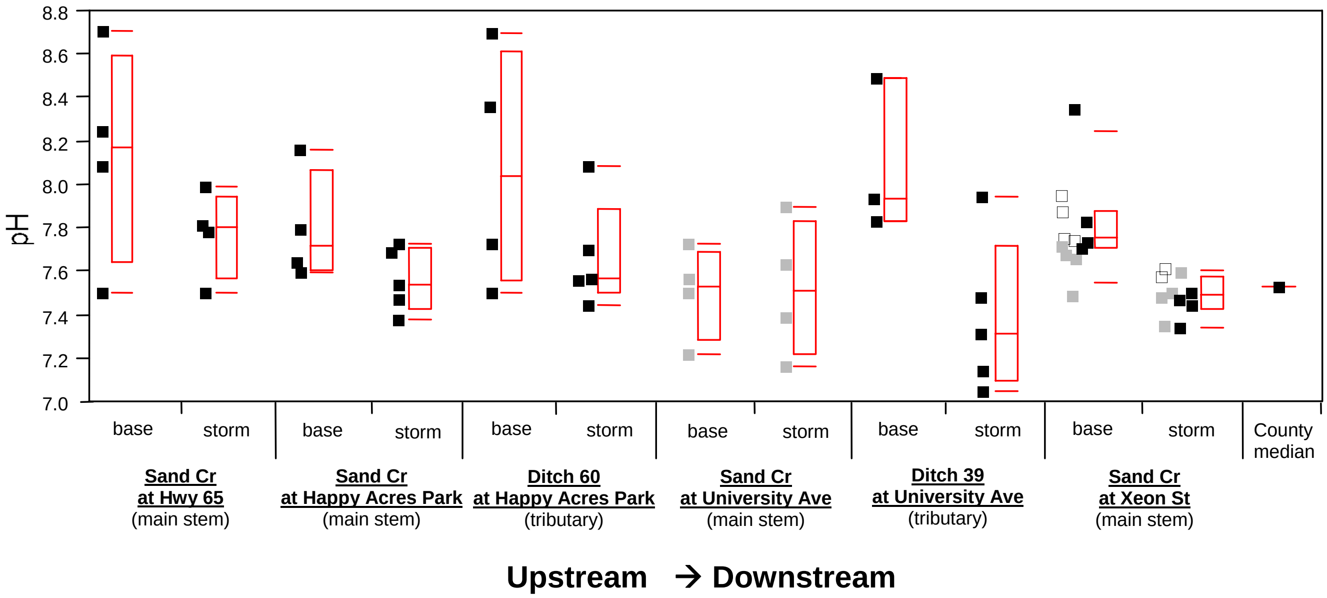
Total phosphorus at Sand Creek. Dots are individual readings. Open dots are 2007 readings, grey dots are 2008 readings, and black dots are 2009 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



pH

Sand Creek pH was within the expected range at all sites and during all conditions (see figure below), ranging from 7.05 to 8.71. The median was 7.65. The Minnesota Pollution Control Agency water quality standards set an expectation for pH between 6.5 and 8.5. At the farthest downstream sites (Ditch 39 at University Ave and Sand Cr at Xeon), storm pH was noticeably lower than baseflow, but this is likely because of higher percentage by volume of rain downstream. Rainwater has a lower pH.

pH at Sand Creek. Dots are individual readings. Open dots are 2007 readings, grey dots are 2008 readings, and black dots are 2009 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

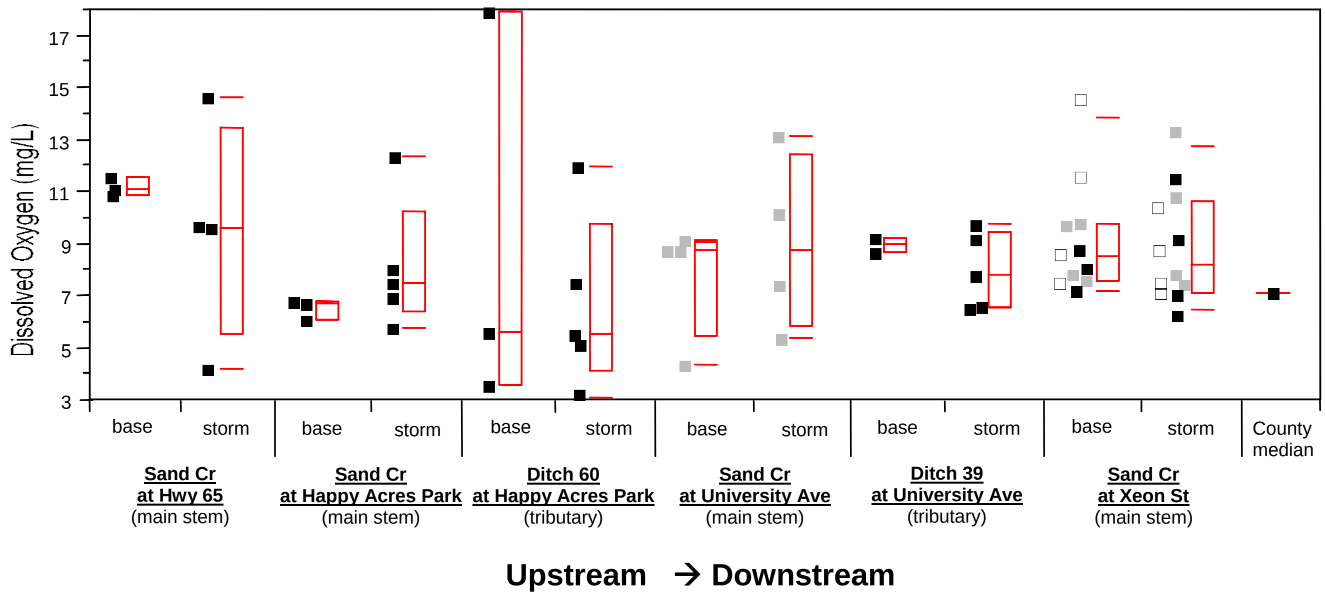


Dissolved Oxygen

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 on 95% of the site visits (see figure below). On four occasions it dropped below 5 mg/L. These four readings occurred at three different sites; two during storms and two during baseflow. Three occurred in 2009, which was a severe drought year. Stagnant conditions are probably responsible for these low oxygen conditions, and are likely natural.

Dissolved Oxygen at Sand Creek. Dots are individual readings. Open dots are 2007 readings, grey dots are 2008 readings, and black dots are 2009 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Stream Water Quality – 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.

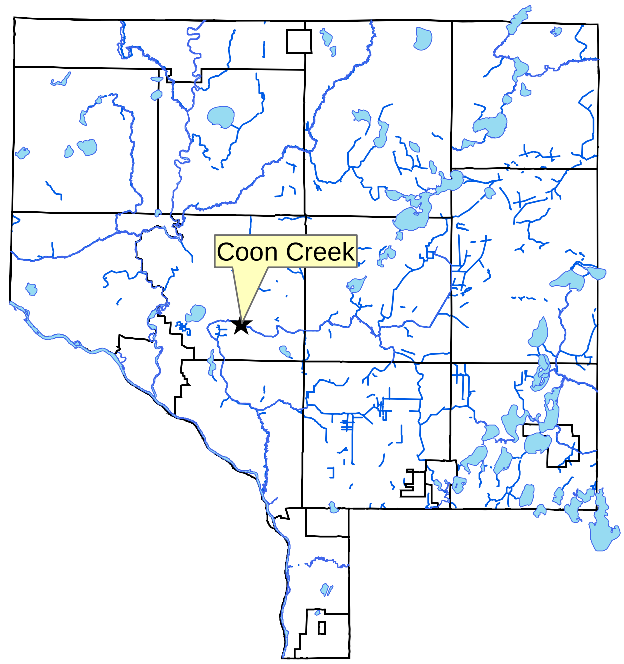
Family Biotic Index (FBI) — An index that utilizes known pollution tolerances for each family. Lower numbers indicate better stream quality.

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 Crosstown Blvd near Andover High School, Andover



Last Monitored

By Andover High School in 2009

Monitored Since

Fall 2003

Student Involvement

168 students in 2009, approx 651 since 2003

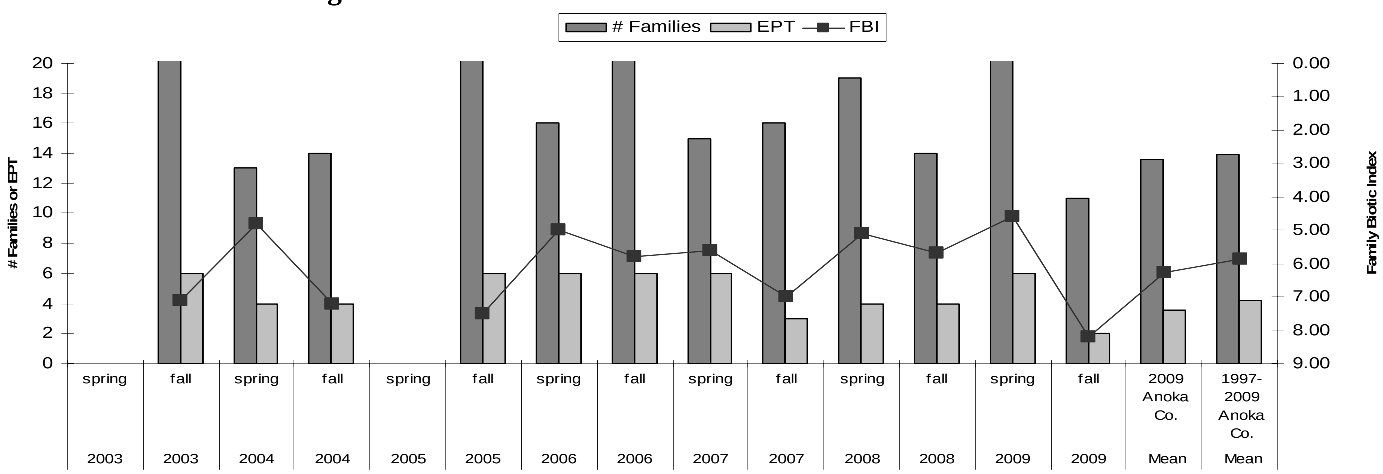
Background

Coon Creek originates in the southern part of the Carlos Avery Wildlife Management Area in western Columbus Township. 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. 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 residential on the south side of the creek and the high school campus on the north side. A vegetated buffer 20-100 feet wide is present at the sampling site, and is typical elsewhere. The banks are steep with moderate to heavy erosion in spots. The streambed is composed of sand and silt. The stream is 1 to 2.5 feet deep at baseflow and approximately 10-15 feet wide.

Results

Two Andover High School classes monitored this stream in spring 2009, while one class monitored it during the fall. There was a marked decrease in all biotic indices when comparing the spring and fall data for 2009. This is potentially due to the decreased sampling effort associated with fewer students sampling during the fall. When comparing these data with Anoka County averages, all spring biotic indices were higher while all fall biotic indices were lower. Such variation is also seen across other years, and this variability is likely due to different sampling intensities, and different climate and stream flow conditions. Overall, the multi-year dataset suggests health of Coon Creek at this location is similar to the average of other Anoka County streams.

Summarized Biomonitoring Results for Coon Creek in Andover



Biomonitoring Data for Coon Creek in Andover

Year	2003	2004	2004	2005	2005	2006	2006	2007	2007
Season	fall	spring	fall	spring	fall	spring	fall	spring	fall
FBI	7.10	4.80	7.20		7.50	5.00	5.80	5.60	7.00
# Families	21	13	14		22	16	23	15	16
EPT	6	4	4		6	6	6	6	3
Date	21-Oct	10-May	19-Oct	2-May	17-Oct	24-May	6-Oct	1-May	3-Oct
sampling by	AHS	AHS	AHS	AHS	AHS	AHS	AHS	AHS	AHS
sampling method	MH	MH	MH	MH	MH	MH	MH	MH	MH
# individuals	267	89	130	inadequate	301	141	415	317	176
# replicates	2	1	1	sample	1	1	2	2	1
Dominant Family	corixidae	baetidae	corixidae		corixidae	calopterygidae	calopterygidae	calopterygidae	corixidae
% Dominant Family	46.4	48.3	50		53.5	29.1	49.6	31.9	36.4
% Ephemeroptera	6.0	51.7	4.6		9.0	29.8	3.4	13.9	1.7
% Trichoptera	16.5	11.2	22.3		5.0	14.9	6.7	6.0	4.5
% Plecoptera	0.0	0.0	0.0		0	0.7	0.0	0.0	0.0

Year	2008	2008	2009	2009	Mean	Mean
Season	spring	fall	spring	fall	2009 Anoka Co.	1997-2009 Anoka Co.
FBI	5.10	5.70	4.60	8.20	6.3	5.9
# Families	19	14	21	11	13.6	13.9
EPT	4	4	6	2	3.6	4.2
Date	30-May	2-Oct	15-May	29-Sep		
sampling by	AHS	AHS	AHS	AHS		
sampling method	MH	MH	MH	MH		
# individuals	90.7	195	679	203		
# replicates	3	1	1	1		
Dominant Family	Baetidae	Calopterygidae	Baetidae	Corixidae		
% Dominant Family	38.2	25.6	68.9	51.2		
% Ephemeroptera	40.4	23.1	70.3	1.5		
% Trichoptera	12.5	2.6	3.2	2.0		
% Plecoptera	0.0	0.0	0.0	0.0		

Supplemental Stream Chemistry Readings

Parameter	10/21/03	5/10/04	10/19/04	5/2/05	10/16/05	5/24/06	10/6/06	5/01/07	10/03/07	5/30/08	10/02/08	5/15/09	9/29/09
pH	8.66	9.25	9.45	8.72	7.75	7.77	7.62	8.50	7.62	7.41	7.66	7.65	7.79
Conductivity (mS/cm)	0.662	0.496	0.379	0.357	0.310	0.508	0.559	0.454	0.417	0.458	0.609	0.582	0.640
Turbidity (NTU)	10	12	22	11	15	15	16	11	14	12	4	15	5
Dissolved Oxygen (mg/L)	7.71	na	9.83	na	10.07 (93%)	6.70 (70%)	9.46 (82%)	11.19 (106%)	8.93 (88%)	8.79 (83%)	9.52 (81%)	8.40 (78%)	8.60 (76%)
Salinity (%)	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.02
Temperature (C)	10.8	14.5	7.9	5.9	10.9	16.8	9.6	13.3	15.1	13.0	8.2	13	10

Discussion

The invertebrate community suggests Coon Creek's health is average compared to other nearby streams. The stream's habitat is relatively sparse, mostly due to past excavations aimed at making the creek perform like a ditch. The supplemental stream water chemistry readings taken during biomonitoring indicate a higher than expected level of dissolved pollutants, as measured by conductivity. Conductivity and salinity were similar to, though not as extreme as, some urbanized streams at the same time of year. The source could be road salts, failing septic systems, and/or chemical wastes. Turbidity was also high. These factors, as well as the general lack of habitat in this ditched stream, probably limit the invertebrate community.

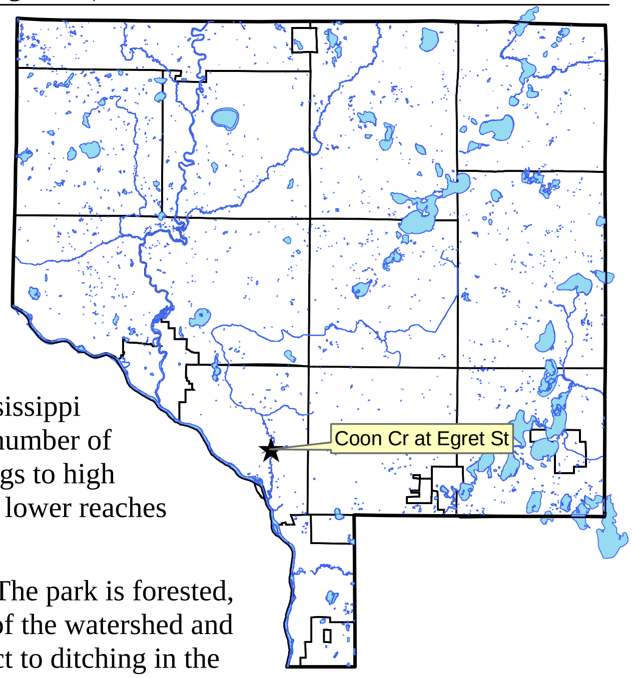
Andover High School Students at Coon Creek in 2009.

Andover High school Students at Coon Creek in 2008.

Biomonitoring

COON CREEK

at Erlandson Park (Egret St.)



Last Monitored

By Blaine High School in 2009

Monitored Since

Fall 2009

Student Involvement

32 students in 2009

Background

Coon Creek originates in the southern part of the Carlos Avery Wildlife Management Area in western Columbus Township. 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 with lower reaches have not.

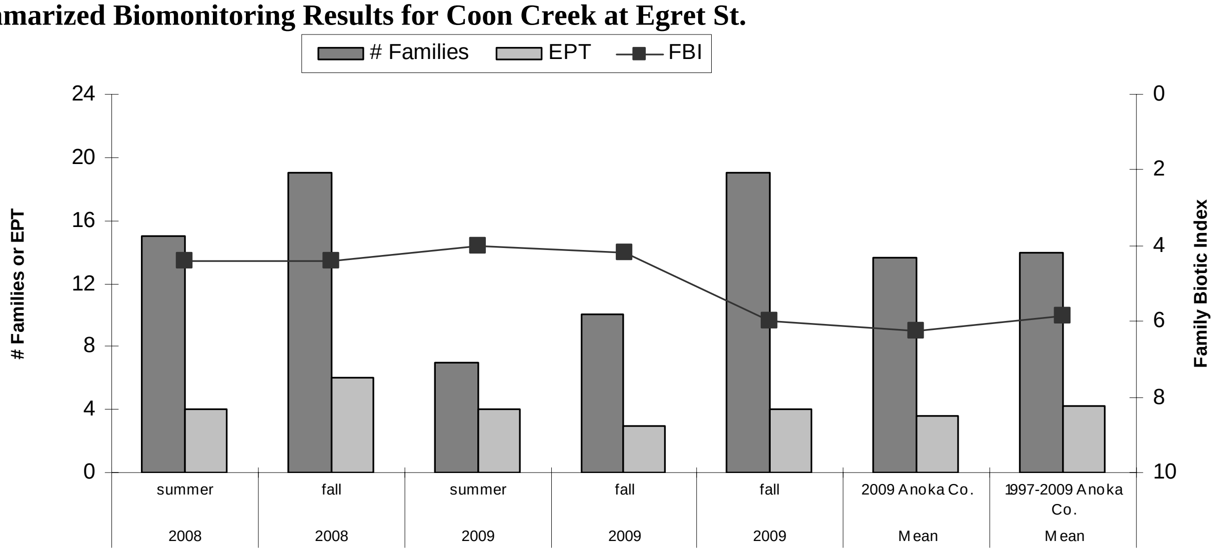
The Egret Street sampling site is within Erlandson City Park. The park is forested, but surrounding areas are urban. This site is in the lower part of the watershed and therefore carries relatively larger flows and has not been subject to ditching in the past. This site has rock riffles, deep pools, and quiet runs.

Results

This site has only been monitored in 2008 and 2009. Most monitoring was done by Anoka Conservation District (ACD) staff as part of a professional biomonitoring study. In fall 2009 Blaine High School also monitored. The groups sampled adjacent stream reaches within Erlandson Park.

The biomonitoring suggests that stream health is similar to the average for Anoka County streams, despite the good quality habitat. Family Biotic Index (FBI) has been consistently higher than the county average, but the number of families and number of pollution sensitive families (EPT) has been similar to county averages. It is interesting to compare the two fall 2009 samplings. ACD staff found fewer families (on left in graph below) than students (on right in graph), likely because 32 students were involved so sampling effort was greater. Only one of these additional families was a pollution sensitive (EPT), so the student FBI indicated poorer stream health.

Summarized Biomonitoring Results for Coon Creek at Egret St.



Biomonitoring Data for Coon Creek at Egret Street

Year	2008	2008	2009	2009	Mean	Mean
Season	spring	fall	spring	fall	2009 Anoka Co.	1997-2009 Anoka Co.
FBI	5.10	5.70	4.60	8.20	6.3	5.9
# Families	19	14	21	11	13.6	13.9
EPT	4	4	6	2	3.6	4.2
Date	30-May	2-Oct	15-May	29-Sep		
sampling by	AHS	AHS	AHS	AHS		
sampling method	MH	MH	MH	MH		
# individuals	90.7	195	679	203		
# replicates	3	1	1	1		
Dominant Family	Baetidae	Calopterygidae	Baetidae	Corixidae		
% Dominant Family	38.2	25.6	68.9	51.2		
% Ephemeroptera	40.4	23.1	70.3	1.5		
% Trichoptera	12.5	2.6	3.2	2.0		
% Plecoptera	0.0	0.0	0.0	0.0		

Supplemental Stream Chemistry Readings

Parameter	8/27/2008	10/9/2008	8/24/2009	10/5/2009	10/7/2009
pH	7.79	7.78	7.73	7.89	7.55
Conductivity (mS/cm)	0.614	0.654	0.613	0.660	0.570
Turbidity (NTU)	5	3	11	6	15
Dissolved Oxygen (mg/L)	8.50	10.26	7.96	10.27	10.82
Salinity (%)	0.02	0.02	0.02	0.02	0.02
Temperature (C)	18.4	10.2	18.7	9.1	9.7
Total Suspended Solids (mg/L)	3	4	16	2	na

Discussion

The invertebrate community suggests Coon Creek's health is average compared to other nearby streams. This is similar to what students at Andover High School have found when sampling Coon Creek near Crosstown Boulevard. This is unexpected because habitat at the Egret Street site is much better, including riffles, pools, snags, and forested areas around the stream. At Crosstown Boulevard the creek has been ditched so there are no riffles or pools, there is no rocky habitat, few snags, and adjacent habitat is grassy. One possible explanation is that the biotic community at Egret Street is limited by poorer water quality despite the better habitat. Chemical monitoring has found that Coon Creek's water quality declines from upstream to downstream. This corresponds with an increase in urbanization. Future monitoring will provide insight.

Stream Water Quality – Biological Monitoring (Professional)

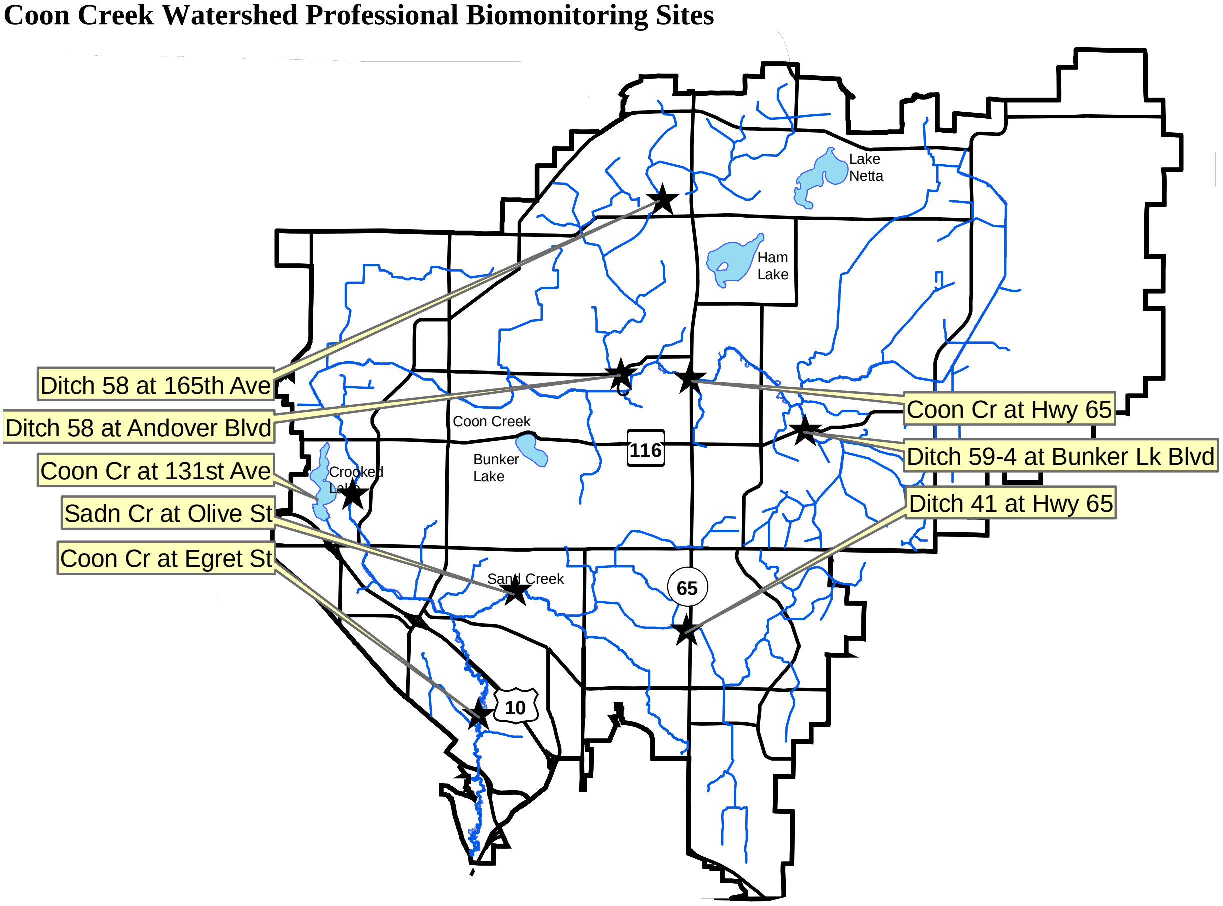
Description: The professional biological monitoring program is more comprehensive than student biomonitoring. All field work, identifications, and analyses are completed by professional aquatic ecologists. Sampling and habitat assessment methods are taken from the U.S. EPA or MPCA. Interpretation of results is based on invertebrate communities sampled and is 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 Cr at 131st St
Coon Cr at Hwy 65
Coon Cr at Egret Blvd
Ditch 58 at 165th St
Ditch 41 at Ulysses St (W side of Lowes)
Ditch 59-4 at Bunker Lake Blvd

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

Coon Creek Watershed Professional Biomonitoring Sites

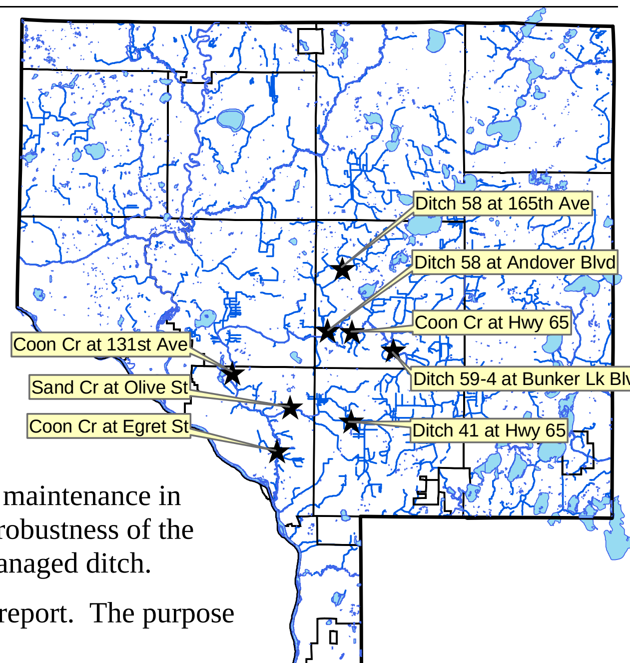


COON CREEK SYSTEM

		Monitored by		
Maintenance Regime	**Site**	**2000**	**2008**	**2009**
Unmaintained	Ditch 58 at 165th Ave.		ACD	ACD
Not ditched or cleaned	Ditch 58 at Andover Blvd.			ACD
in last 10 years	Sand Creek at Olive St.			ACD
	Coon Creek at Egret St.	MPCA	ACD	ACD
Maintained	Ditch 59-4 at Bunker Lake Blvd.		ACD	
Ditched or cleaned	Ditch 41 at Highway 65		ACD	ACD
in last 10 years	Coon Creek at Highway 65	MPCA	ACD	ACD
	Coon Creek at 131st Ave.		ACD	ACD
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 been subject to 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. One of these reaches is an actively maintained ditch that had been cleaned recently to sustain desired flow and the other has 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,
- compare the biological integrity of the Coon Creek system with similar nearby streams,
- examine the effect of total suspended solids on invertebrate communities, and
- corroborate the MPCA's findings.

Professional biomonitoring was conducted for this study within the stream and ditch reaches identified in the table above during 2008 and 2009. 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. In this case, both staff possess Master's degrees in aquatic ecology and combined have over 10 years of biological monitoring experience. The sampling methods used were the same as those used by the MPCA, the US EPA's multihabitat 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 was chosen as a parameter 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. After identification of macroinvertebrates 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 at a given location. 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 FBI ranges from 0-10 (see table below), with 0 being best because it represents a macroinvertebrate community with the lowest tolerance for pollution.

Qualitative water quality ratings corresponding to quantitative FBI scores.

FBI Score	Corresponding Water Quality Rating
0-3.75	Excellent
3.76-4.25	Very Good
4.26-5	Good
5.01-5.75	Fair
5.76-6.5	Fairly Poor
6.51-7.25	Poor
7.26-10	Very Poor

Results and Discussion

Summary

The data used in this study are limited in several ways and therefore the results should be interpreted with caution. Limitations include the length of the study (2 years), the 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, both 2008 and 2009 data support of the following general conclusions:

- Total number of families, FBI, and EPT indices of stream health are not different among unmaintained reaches of stream and those that have been maintained (ditched or cleaned) in the last 10 years.
- Coon Creek sites monitored by the MPCA and used to designate the creek as "biologically impaired" ahave biological indices of stream health that are in the middle of the range of the seven other streams that were monitored throughout Anoka County in 2009 and other years (includes student-monitored sites).
- There does not appear to be any strong correlations between TSS and any of the invertebrate indices, suggesting that TSS is not a strong predictor of macroinvertebrate community health in these systems.
- Unmaintained sites have slightly higher values of overall MSHA score, land use, substrate, and channel morphology scores, and lower turbidity values. All of these observations are consistent with better stream conditions, but the differences are not dramatic and there is inconsistency among years.
- The relationships between overall MSHA score and the three biotic indices suggested that only FBI was correlated with overall MSHA score.

- In 2008 and 2009 poorer invertebrate communities were found than by the MPCA in 2000 at the two Coon Creek sites designated as impaired (Highway 65 and Egret St.). The Highway 65 site (maintained) had poorer biotic indices of stream health than the Egret Street site (not maintained).
- There is notable variability in biological survey results among samplings. This has been observed by both professional and student long-term biomonitoring.

These results point to a number of problems with the current system of identifying biological impairments and correcting them. First, MPCA's use of single samples to determine impaired conditions does not take into account the variability in natural environments and is therefore prone to erroneous results. In the case of Coon Creek, it appears that they may have overestimated long-term stream health. Secondly, there are questions about the appropriateness of state biological standards for streams being applied to ditches. The MPCA has recognized this and begun developing tiered biotic standards for different types of waterways, but until those are completed the current "impaired" designations have not been rescinded. The fact that Coon Creek's biota is typical among the Anoka County streams monitored provides some evidence that either many streams are biologically impaired or the standards are inappropriate. Third, a single biotic impairment designation for all of Coon Creek is inappropriate because of the great variability throughout this watershed. Two sampling sites is not sufficient to understand the entire creek length, especially in such a diverse watershed; the MPCA plans to monitor more sites in 2010. Any total maximum daily load study for Coon Creek will likely identify different stressors in different areas. In upstream areas, which have experienced greater disturbance through ditching, habitat is likely most limiting to stream life. Farther downstream, habitat is better but water quality is poorer. Many of the stressors will be related to factors that are difficult to change, such as the effect of 100 years of ditching activity or urban development. More realistic protocols are needed that allow managers to focus on realistic ways to improve stream health.

A final concern is the use of biological stream standards in the total maximum daily load (TMDL) framework. This framework originated from the Federal Clean Water Act and was used to address industrial, point source pollutants. The process is based upon determining the maximum amount of pollutant that can be discharged while still meeting water quality standards. Biological standards do not fit this approach. Biota are not a stressor or pollutant. A TMDL for impaired biota begins with a stressor identification process. This process focuses on water quality. In many waterways, but most obviously ditches, habitat may be the problem, not water quality. In other cases, the stressors identified (usually TSS or DO) may only be partial or intermittent factors. Efforts to address any one factor may be beneficial, but not result in the biotic community outcomes that are sought.

Effect of Management Activity on Invertebrate Indices

The table at the beginning of this section provides detailed information regarding site location and the organization responsible for sampling. Four of the six sites examined by ACD during 2008 are channelized and actively maintained with either a backhoe or similar equipment to sustain drainage capacity. The remaining two sites had not been maintained for at least 10 years. The sites examined in 2009 consisted of three maintained and four unmaintained sites. 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 do not appear to differ between unmaintained and maintained sites in the compiled 2008 and 2009 data set (Figure 1). In addition, there did not appear to be any differences between the maintained and unmaintained sites within the individual years, justifying the presentation of compiled data. These data suggest the disturbances created by stream and ditch maintenance (i.e. manual removal of accumulated sedimentation) is only one of several factors affecting invertebrate communities. These conclusions should be taken cautiously because of the limited data set, but the congruence between the 2008 and 2009 data provide increasing support for this conclusion.

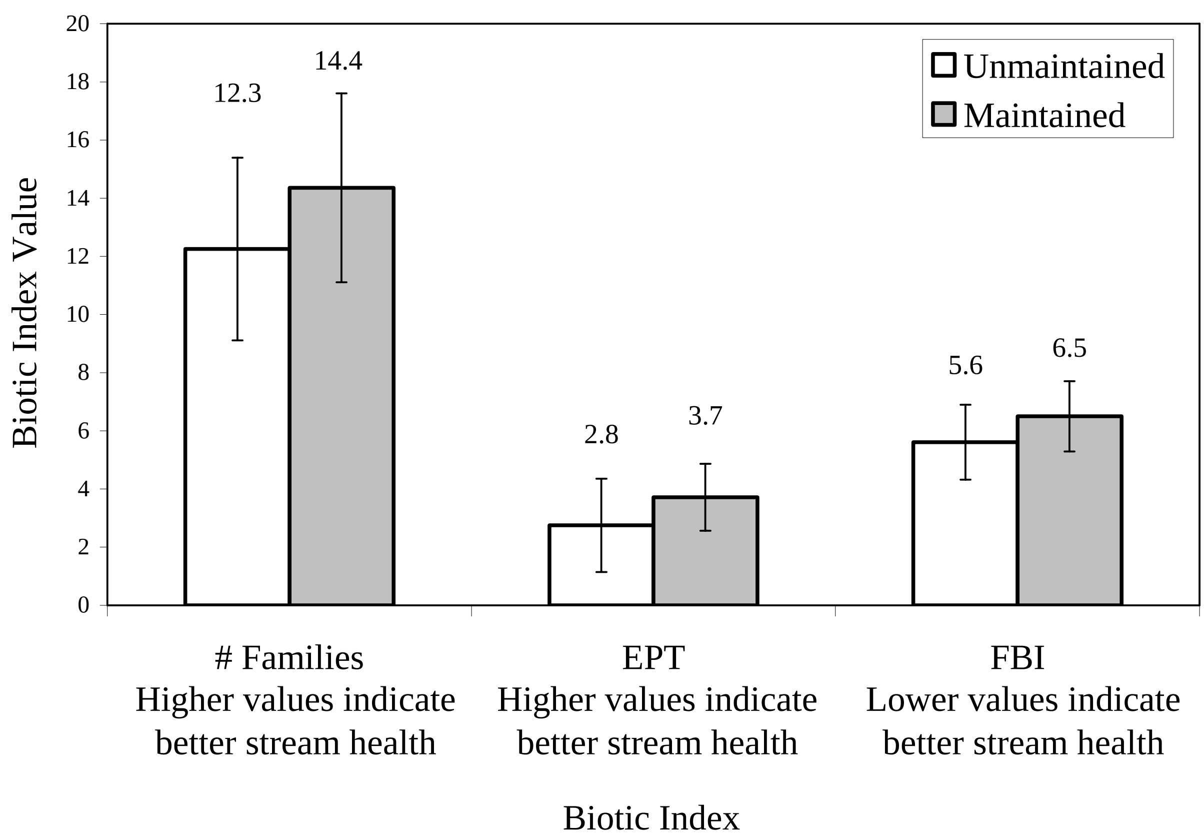


Figure 1. Average biotic index scores (± 1 standard deviation) for compiled data from 2008 and 2009 in unmaintained and maintained sites. Note that higher values for number of families and the EPT index indicate better stream health, while lower FBI values indicate better stream health.

Comparison between Coon Creek and other local streams

Comparison of the biotic indices of stream health between the sites identified as impaired by the MPCA (Coon Creek at Egret Street and Coon Creek at Highway 65) and other sites across Anoka County provides perspective for the overall stream health and "impaired" designation at each location. Overall, the MPCA sites monitored and designated as impaired by the MPCA in 2000 have typical invertebrate communities for Anoka County streams. Conclusions are somewhat dependent on individual years and indices, but the Coon Creek sites were routinely in the middle of the distribution.

Students biomonitored five streams during 2008 and seven streams during 2009 and we compared the results to Coon Creek. In the student biomonitoring program students, under the supervision of Anoka Conservation District (ACD) staff and teachers, conducted field sampling and initial invertebrate identifications. ACD staff checked and verified all identifications. The same indices of stream health as those used for the professional biomonitoring were calculated. Data from 2008 and 2009 are presented separately because of the discrepancies in sampling locations between years (Table 1). A historical average was calculated across all sites and sampling years and included within each of the figures below.

2008 biomonitoring indices of stream health are compared across all professional and student biomonitored sites in figures 2, 3, and 4. Total number of families present, EPT and FBI scores are ranked from best ecological health to worst (Figures 2, 3, and 4 respectively). The total number of families present and the number of EPT families present at each location were similar between Egret Street and Highway 65, and were slightly higher than the historical average (Figures 2 and 3). The Coon Creek site at Egret Street had better stream health than the site at Highway 65 when using the FBI as a predictor (Figure 4). The qualitative guidelines for the FBI suggest the corresponding water quality rating at the Egret Street location is good, while the Highway 65 location has a water quality rating of fairly poor.

Table 1. List of streams that were biomonitored and years sampled for comparison with Coon Creek sites of interest.

	Sampled	
Stream	2008	2009
Pleasure Creek	X	
Clearwater Creek	X	X
Ditch 41		X
Ditch 58		X
Hardwood Creek	X	X
Rice Creek	X	X
Rum River	X	X
Sand Creek		X

2009 biomonitoring indices of stream health are compared across all professional and student biomonitored sites in figures 5, 6, and 7. Again, the sites are ranked from best ecological health to worst based upon total number of families present, EPT, and FBI (Figures 5, 6, and 7 respectively). The total number of families found at the Highway 65 site (13.0) is an intermediate value and relatively similar to the historical average (13.9; Figure 5). However, the total number of families found at Egret Street is 8.5, which is closer to the lowest value in the data set (7.0; Figure 5). The number of EPT families did not differ between the two sites in 2009 (3.5), and was an intermediate value close to the historical average (4.2; Figure 6). The FBI indicates an opposite pattern of stream health when comparing the two sites relative to the total number of families present (Figure 7). Egret Street has the lowest FBI in the data set (4.1), which is indicative of the best stream health, while Highway 65 has an FBI of 6.9, indicative of poor stream health. Using the qualitative FBI guidelines, the Coon Creek sites designated as impaired by the MPCA in 2000 are classified as very good (Coon Creek at Egret Street) and poor (Coon Creek at Highway 65) according to the 2009 data. When comparing with the 2008 data, 2009 FBI results at both Highway 65 and Egret Street are similar. However, the small dataset used to generate these conclusions should be taken into consideration and conclusions should be interpreted cautiously.

2008 Data

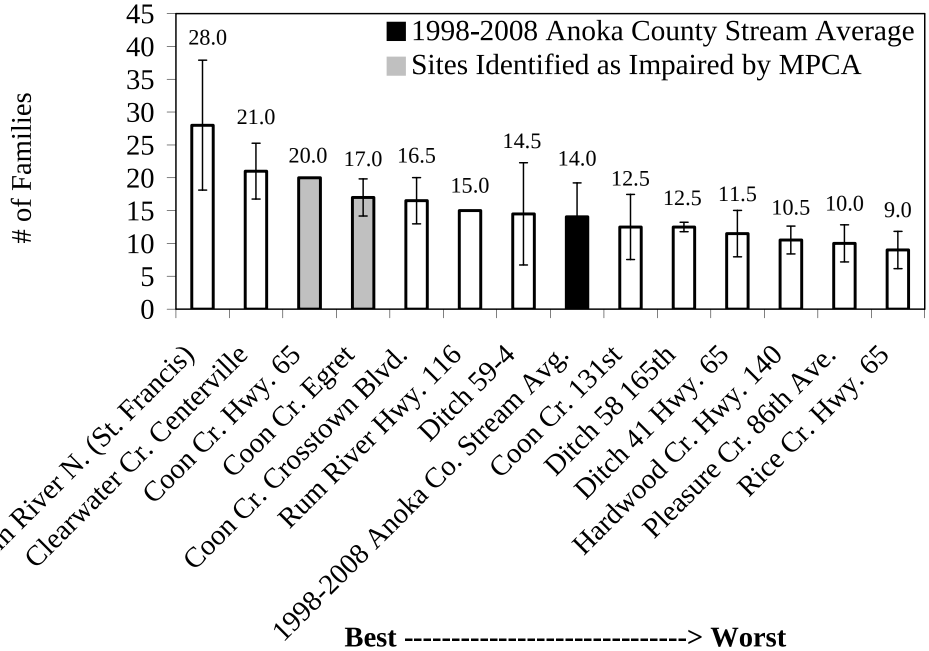


Figure 2. Total number of families (± 1 standard deviation) present across sites sampled for macroinvertebrates in 2008. Gray bars represent the two sites identified as impaired by the MPCA. Black bar represents the historical average calculated across all sampling sites and dates (1998-2008).

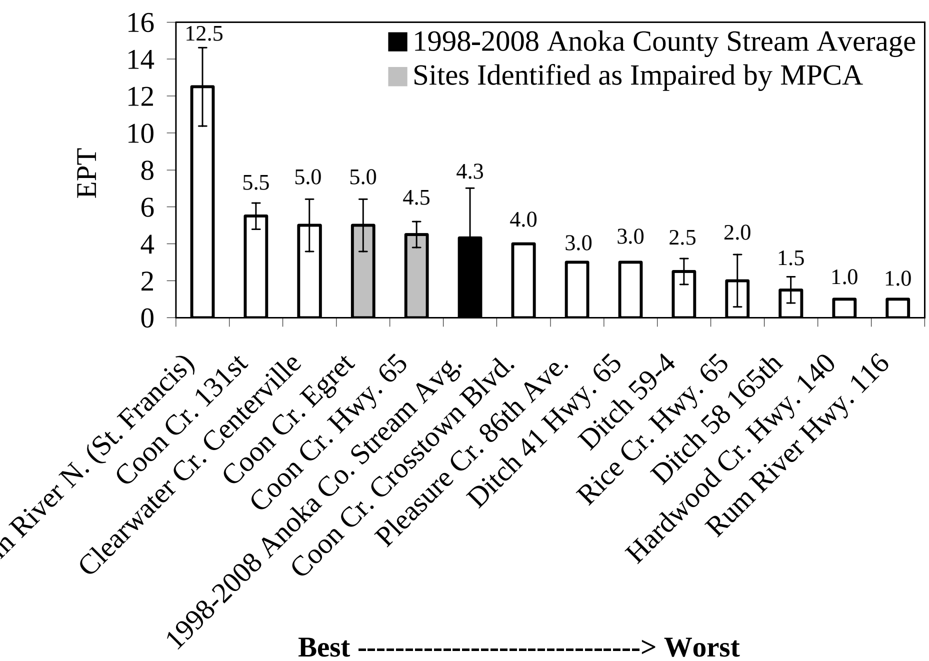


Figure 3. EPT index (± 1 standard deviation) across sites sampled for macroinvertebrates in 2008. Gray bars represent the two sites identified as impaired by the MPCA. Black bar represents the historical average calculated across all sampling sites and dates (1998-2008).

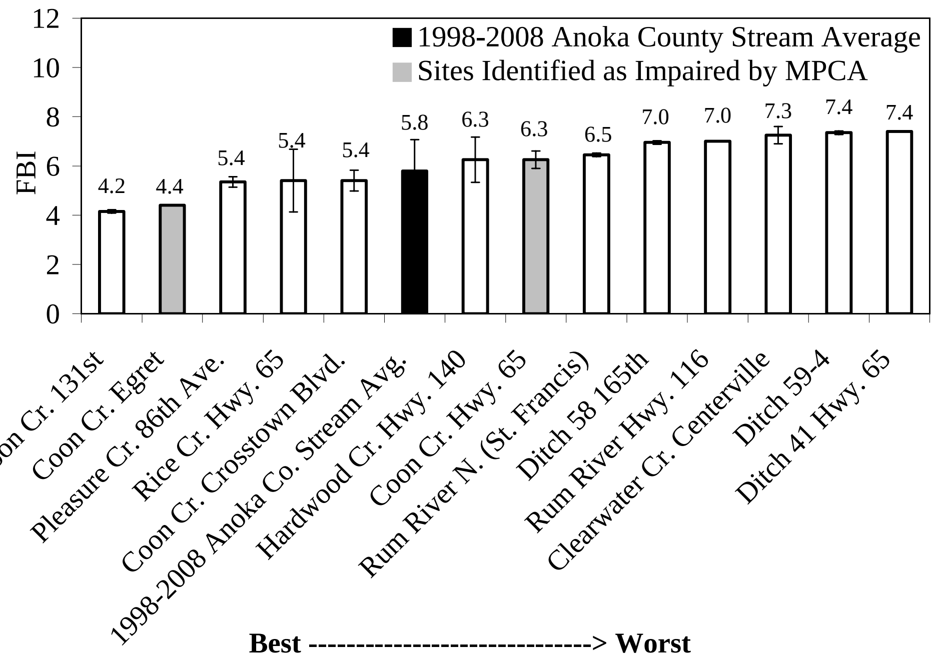


Figure 4. FBI (± 1 standard deviation) across sites sampled for macroinvertebrates in 2008. Gray bars represent the two sites identified as impaired by the MPCA. Black bar represents the historical average calculated across all sampling sites and dates (1998-2008). Note that lower FBI values indicate better stream health.

2009 Data

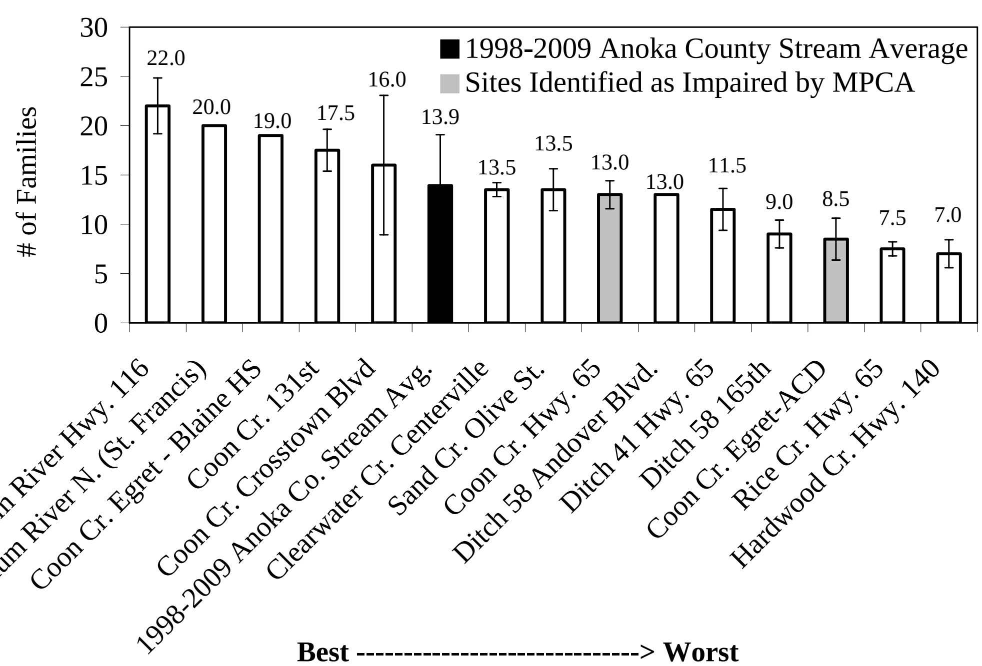


Figure 5. Total number of families (± 1 standard deviation) present across sites sampled for macroinvertebrates in 2009. Gray bars represent the two sites identified as impaired by the MPCA. Black bar represents the historical average calculated across all sampling sites and dates (1998-2009).

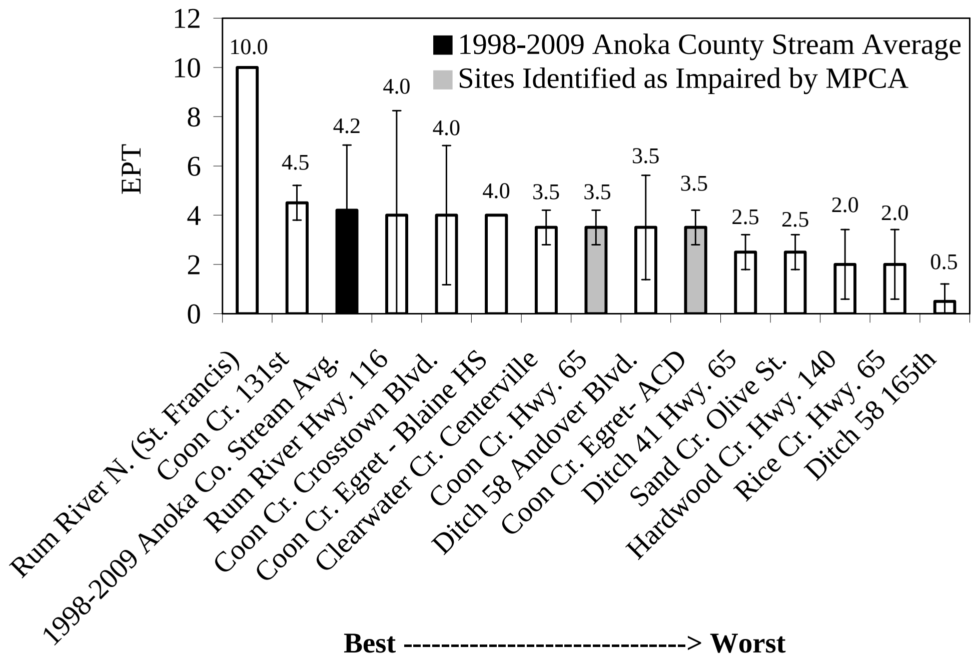


Figure 6. EPT index (± 1 standard deviation) across sites sampled for macroinvertebrates in 2009. Gray bars represent the two sites identified as impaired by the MPCA. Black bar represents the historical average calculated across all sampling sites and dates (1998-2009).

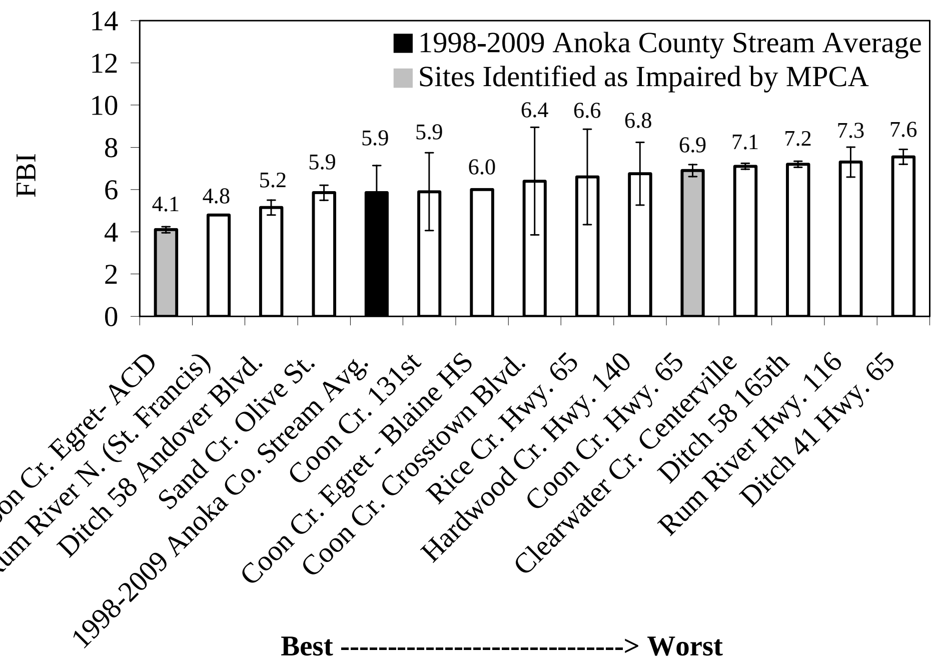


Figure 7. FBI (± 1 standard deviation) across sites sampled for macroinvertebrates in 2009. Gray bars represent the two sites identified as impaired by the MPCA. Black bar represents the historical average calculated across all sampling sites and dates (1998-2009). Note that lower FBI values indicate better stream health.

Effect of Total 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 can provide some important information for determining the causes of the impaired biota status. Figures 8 and 9 display the relationships between the three invertebrate indices and TSS from the two sampling efforts in 2009 (August and October, respectively). There does not appear to be any strong correlations between TSS and any of the invertebrate indices, suggesting that TSS is not a strong predictor of these invertebrate indices within these systems. It should also be noted that data from the October 2009 sampling effort experienced TSS levels below the level of detection by the equipment used (2 mg/L). Therefore, any conclusions drawn from this analysis should be interpreted with caution because of the single sampling date from which meaningful TSS measurements were obtained (August 2009).

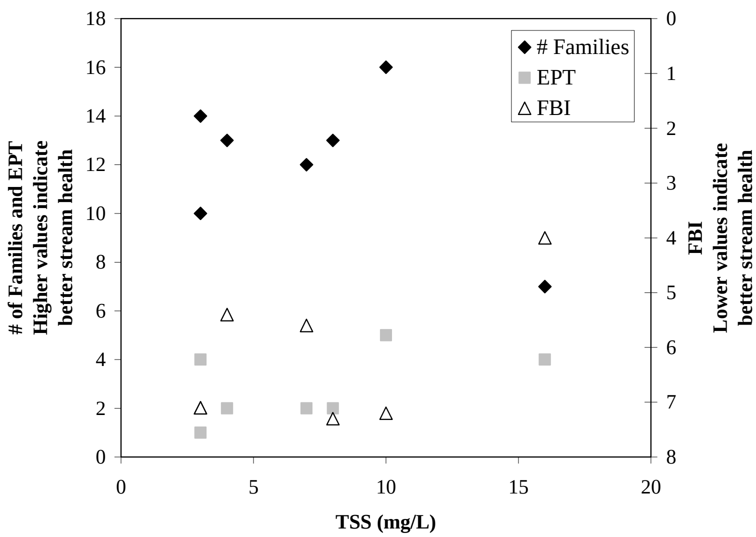


Figure 8. Relationships between total number of families, EPT, and FBI macroinvertebrate indices and TSS (mg/L) from the August 2009 sampling effort.

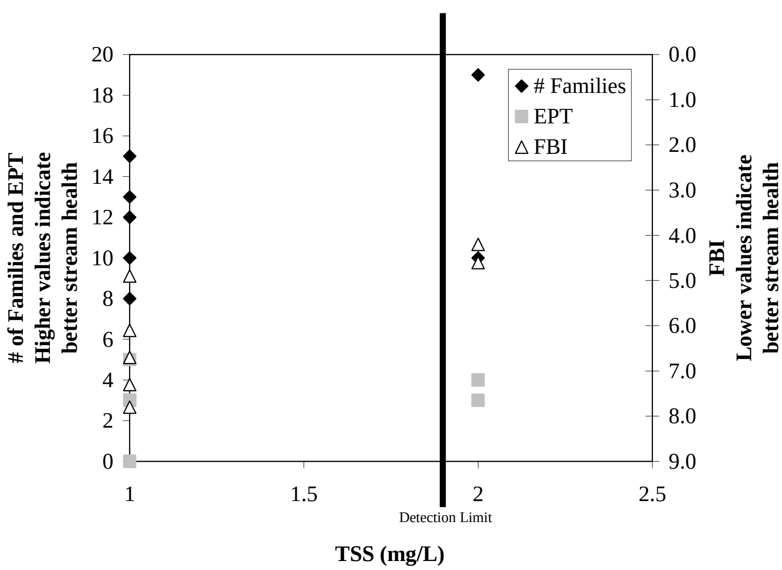


Figure 9. Relationships between total number of families, EPT, and FBI macroinvertebrate indices and TSS (mg/L) from the October 2009 sampling effort. It should be noted that many of the measurements were below the level of detection of the equipment used (2 mg/L).

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 Protocol (MSHA). MSHA scores, TSS levels, and turbidity levels were compared between maintained and unmaintained sites to examine the effect of management type. Overall, the 2009 data suggest unmaintained sites have higher values of overall MSHA score, land use, substrate, and channel morphology scores, and lower turbidity values. All of these observations are consistent with better stream conditions, but the differences are not dramatic and there is inconsistency between years. For example, in 2008 only land use score appeared to be higher in unmaintained sites. The results obtained in 2009 are intriguing and provide some evidence of the negative effects associated with stream maintenance, but definitive conclusions should be withheld until more data have been collected.

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 and 2009 were averaged because no significant landscape modifications had occurred around any of the sampling locations. In addition, water quality measurements were taken at each site and water samples were collected and analyzed for total suspended solids (TSS). Temperature, dissolved oxygen, conductivity, salinity, flow rates, and pH were not compared across maintained and unmaintained sites as 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 data are included only from the August 24, 2009 sampling effort because of values below the detection limit obtained during the October 5, 2009 sampling.

The effects of stream and ditch maintenance on the MSHA habitat scores and common water quality parameters of turbidity and TSS are inconsistent across years and the differences are not dramatic. The unmaintained sites appear to have slightly higher MSHA scores, indicating better overall stream condition (Figure 10). However, the large standard deviations, uneven sample sizes, and limited sampling duration warrant caution when drawing definitive conclusions. Comparisons of the individual MSHA category scores suggest that land use, substrate, and channel morphology have slightly higher values in unmaintained sites (Figure 11). However, similar caution should be applied to these results given the previously mentioned limitations of this data set. Turbidity is slightly higher within the maintained sites, but this difference is not observed with TSS (Figure 12).

The results of this analysis indicate there are no striking differences between maintained and unmaintained sites with respect to MSHA scores, turbidity, or TSS. Although maintenance regime does not appear to affect these measures of stream health, the limited sample size warrants further research. In addition, other landscape scale drivers such as surrounding land use and hydrologic connectivity could be important factors to consider in future analyses.

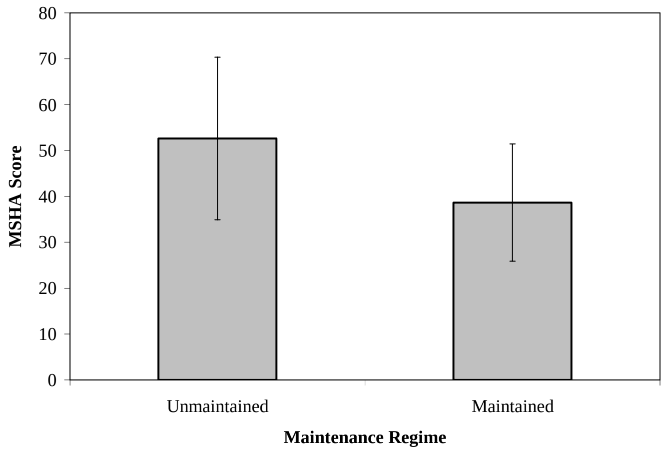


Figure 10. Comparison of the averaged MSHA score (± 1 standard deviation) from 2008 and 2009 samplings between maintained sites and those unmaintained within the last 10 years.

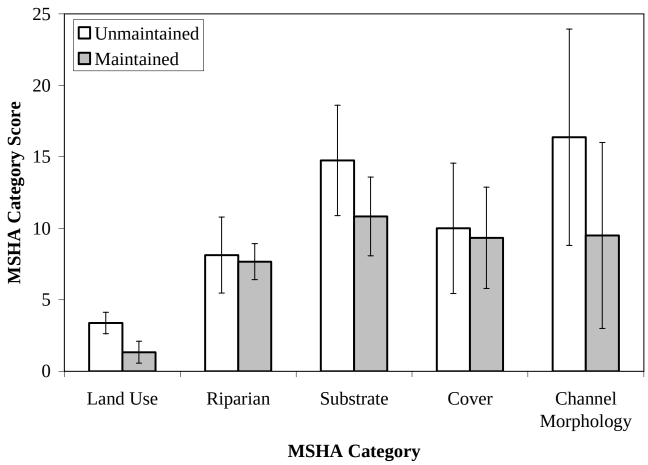


Figure 11. Comparison of land use, riparian, substrate, cover, and channel morphology MSHA category scores (± 1 standard deviation) averaged from 2008 and 2009 between maintained and unmaintained sites within the last 10 years.

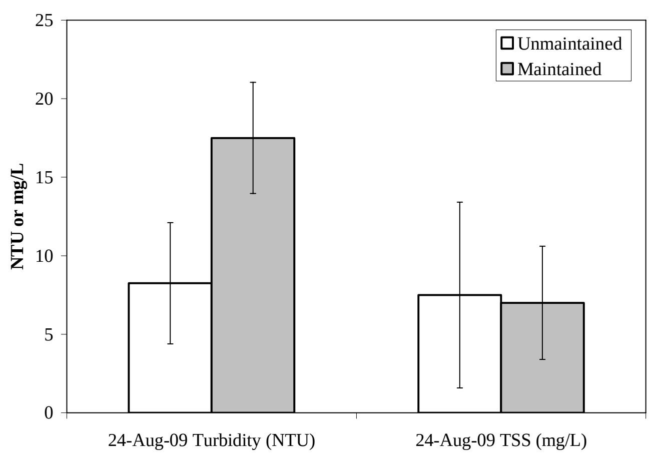


Figure 12. Comparisons of turbidity and TSS (± 1 standard deviation) from the August 24, 2009 sampling effort between unmaintained and maintained sites within the last 10 years.

Relationship between MSHA score and biotic indices

MSHA score provides a quantitative estimate of overall stream habitat by assessing in-stream and near-stream habitat parameters. These habitat parameters have previously been shown to influence biotic communities, and therefore their relationships with the biotic indices used in this study were assessed. The relationships between overall MSHA score and the three biotic indices suggested that only FBI was correlated with overall MSHA score (Figure 13). Specifically, lower values of FBI (indicative of a less pollution tolerant invertebrate community) corresponded to higher overall MSHA scores (indicative of better stream habitat).

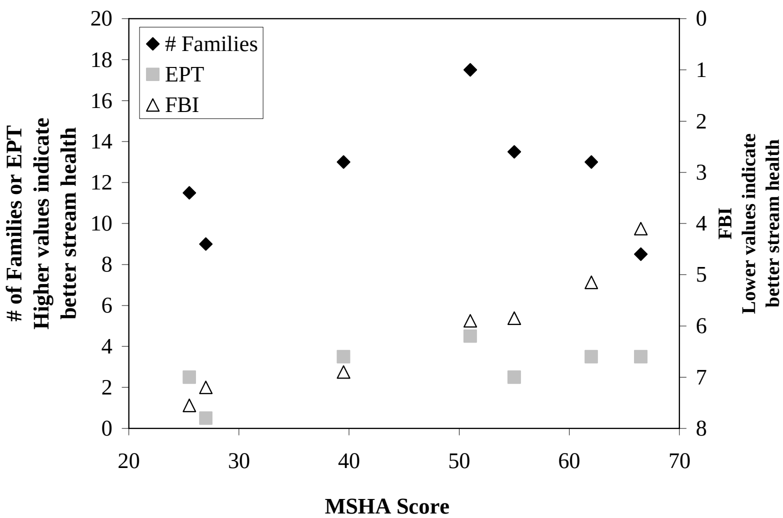


Figure 13. Biotic indices of stream health did not consistently increase with MSHA score, except for a slight improvement in FBI.

Comparison with results obtained by the Minnesota Pollution Control Agency

One goal of this study was to compare MPCA's invertebrate data from Coon Creek in 2000 with 2008 and 2009 data collected by ACD at the same sites. This comparison serves to check the accuracy of the impaired designation that was made based upon a single sampling date. Analysis of family level data from all sites within this study generally found a poorer invertebrate community than found by MPCA staff. Overall, MPCA biotic sampling in 2000 indicates better stream health than 2008 and 2009 samplings. Therefore, it appears MPCA's stream health assessment is not erroneously poor. Yet, questions remain about appropriate biological expectations for ditches. The MPCA has begun developing tiered standards for ditches, and this should prove beneficial for proper characterization of these systems.

Comparison across time at the Coon Creek at Highway 65 site indicates the MPCA found a rich biota in 2000 with respect to the total number of families, but successive samplings found fewer (Figure 14). The number of EPT families and the FBI were also poorer with successive samplings, yet the differences were less pronounced (Figure 14). The comparison across time at the Coon Creek at Egret Street site also displays the high total number of families found by the MPCA in 2000 and fewer in successive samplings (Figure 15). A similar trend was observed with respect to the number of sensitive EPT families. However, FBI values were slightly higher in 2008 and 2009 than in 2000 (Figure 15).

MPCA identifies all of their invertebrate samples to the genus level, which is more specific than the family-level identifications done for this study. We converted genus level data to family level for the purpose of making direct comparisons. It is worthwhile to look at just the year 2000 genus level data alone, too. Genus level identifications allow sorting the sometimes markedly different tolerances of the different genus within each family, and is therefore better. MPCA found a rich invertebrate biota at Egret Street (Erlandson Park), but the Hilsenhoff Biotic Index (HBI) indicated poorer stream health than at Highway 65. At Egret Street 57 different genus were found. MPCA staff indicated that this total is notably higher than most sites in the metro, but 28 of these were listed as pollution tolerant. By comparison, 36 genus were found at Highway 65 (29 in a later replicate), of which 22 were listed as pollution tolerant. The HBI, which has a scale of 0 to 10 with lower numbers indicating better stream health, was 6.05 at Egret Street, which corresponds to a water quality assessment of "fair." At Highway 65 the HBI was 5.67, which corresponds to a water quality assessment of "good." There are marked habitat differences between these two sites – at Highway 65 the stream is ditched whereas at Egret Street the creek is not ditched an flows as riffles, pools, and runs through a nature park preserve.

Drawing definitive conclusions about the validity of the MPCA's designation of Coon Creek as impaired based on this small data set should be performed with caution. However, as data are collected in progressive years and the body of evidence increases, determinations of support or rejection of the MPCA's finding will be possible. The incorporation of MPCA's tiered standards for ditches will also elucidate the most appropriate biological expectations for these systems. Likewise, the increase in number of sampling locations along Coon Creek will result in more appropriate designations for each stream reach.

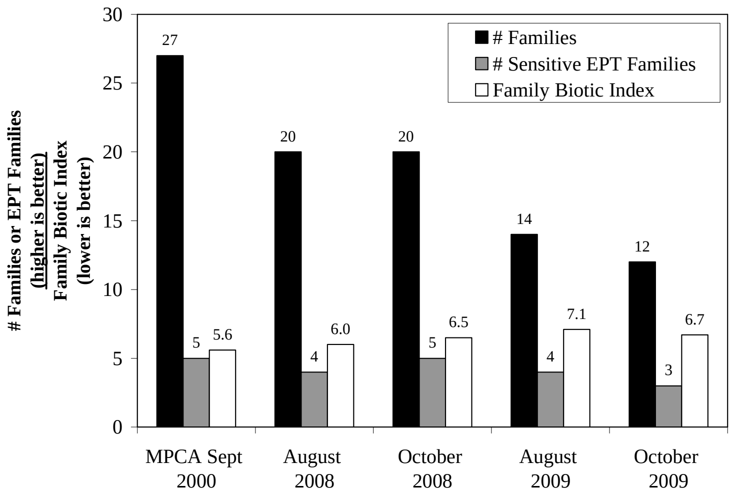


Figure 14. Comparison of family-level invertebrate indices of stream health from 2008 and 2009 samplings with original sampling effort by the MPCA in 2000 at Coon Creek at Highway 65.

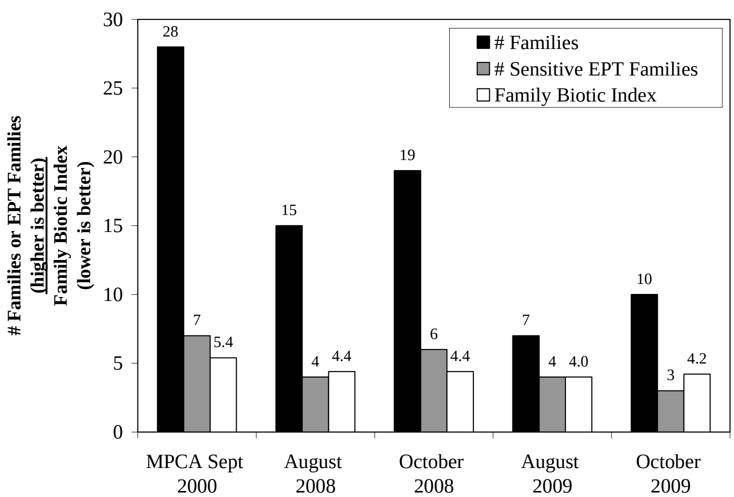


Figure 15. Comparison of family-level invertebrate indices of stream health from 2008 and 2009 samplings with original sampling effort by the MPCA in 2000 at Coon Creek at Egret Street.

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)

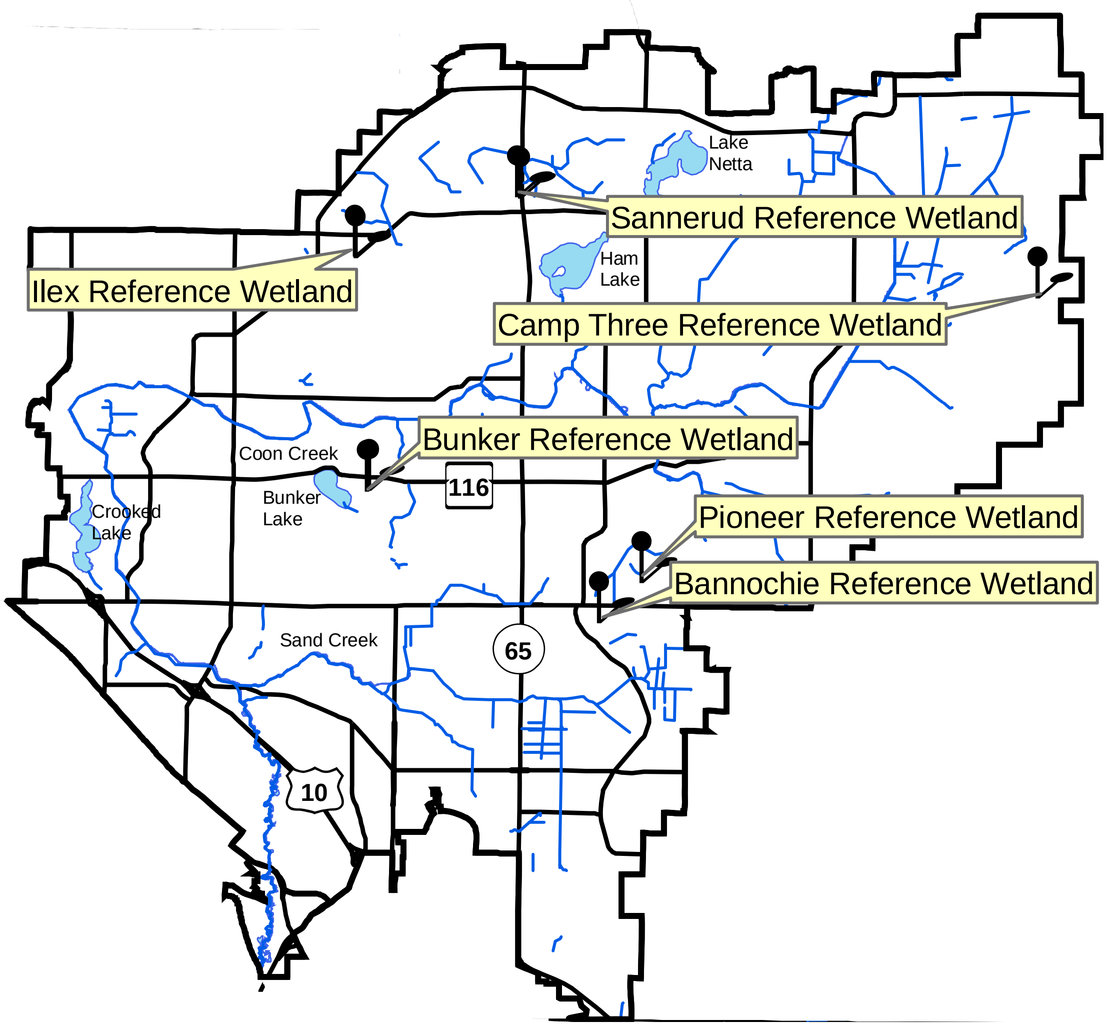
Pioneer Park Wetland, Pioneer Park off Main St., Blaine

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.

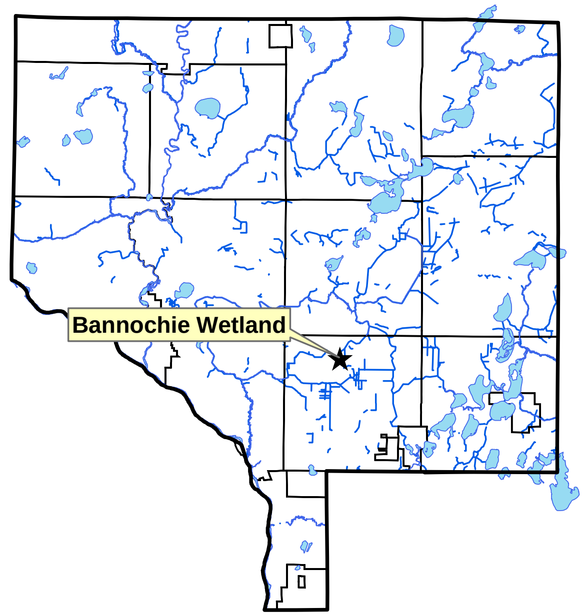
Coon Creek Watershed 2009 Wetland Hydrology Monitoring Sites



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	-

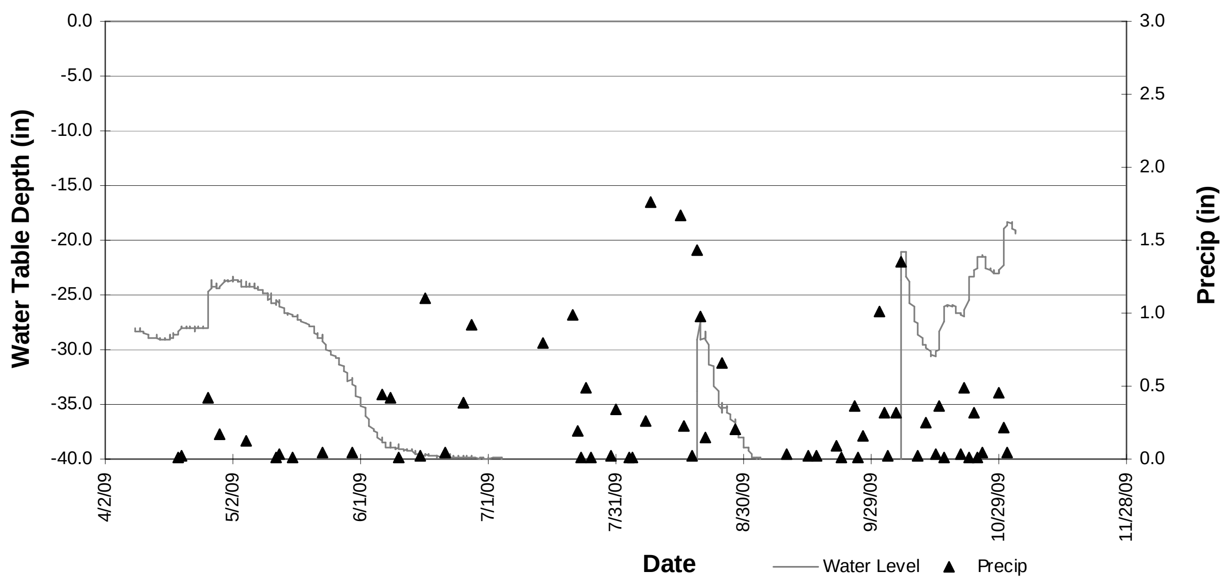
Surrounding Soils: Rifle and some Zimmerman fine sand

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.

2009 Hydrograph



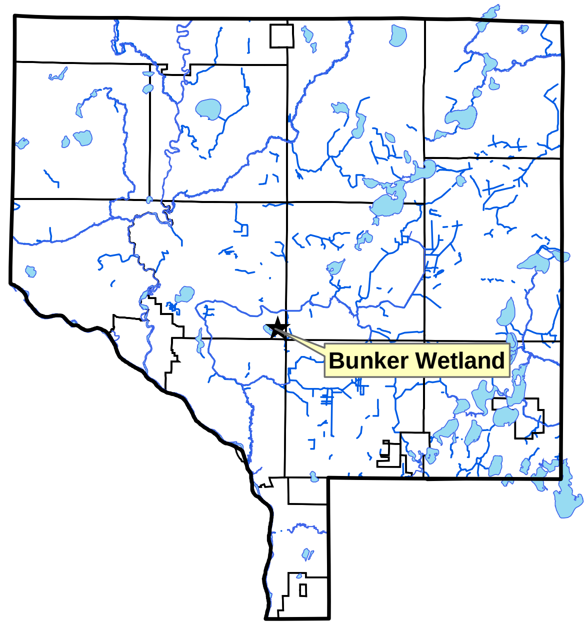
Well depth was 40 inches, so a reading of–40 or less indicates water levels were at an unknown depth greater than or equal to 40 inches.

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	-

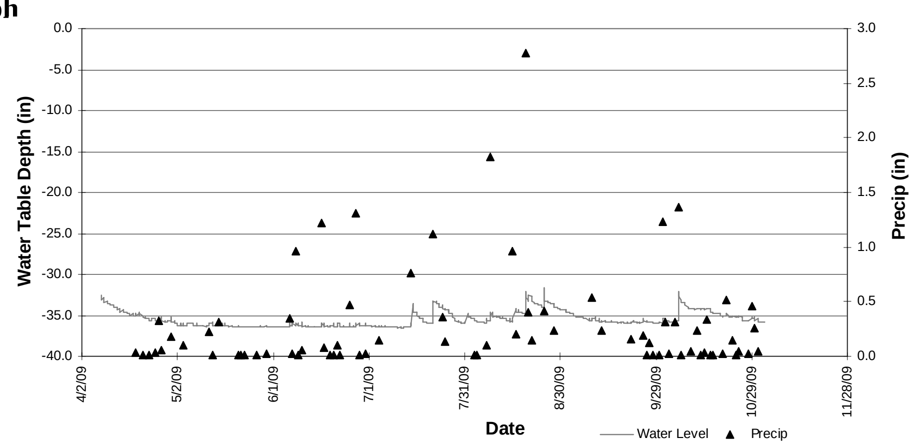
Surrounding Soils: Zimmerman fine sand

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.

2009 Hydrograph

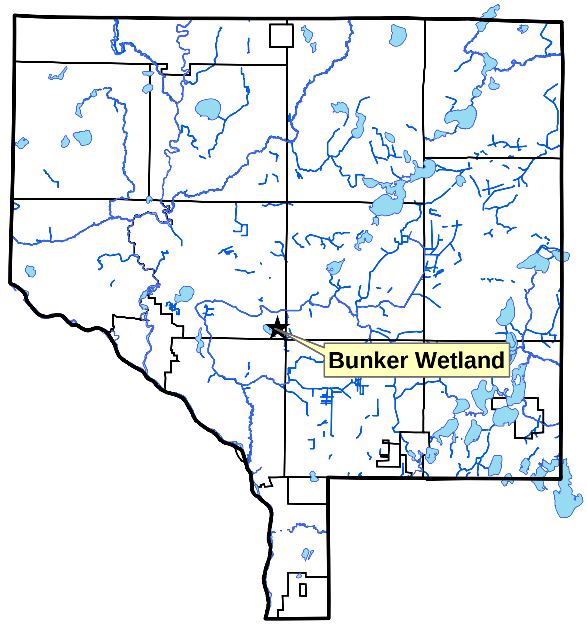


Well depth was 36 inches, so a reading of–36 indicates water levels were at an unknown depth greater than or equal to 36 inches.

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	-

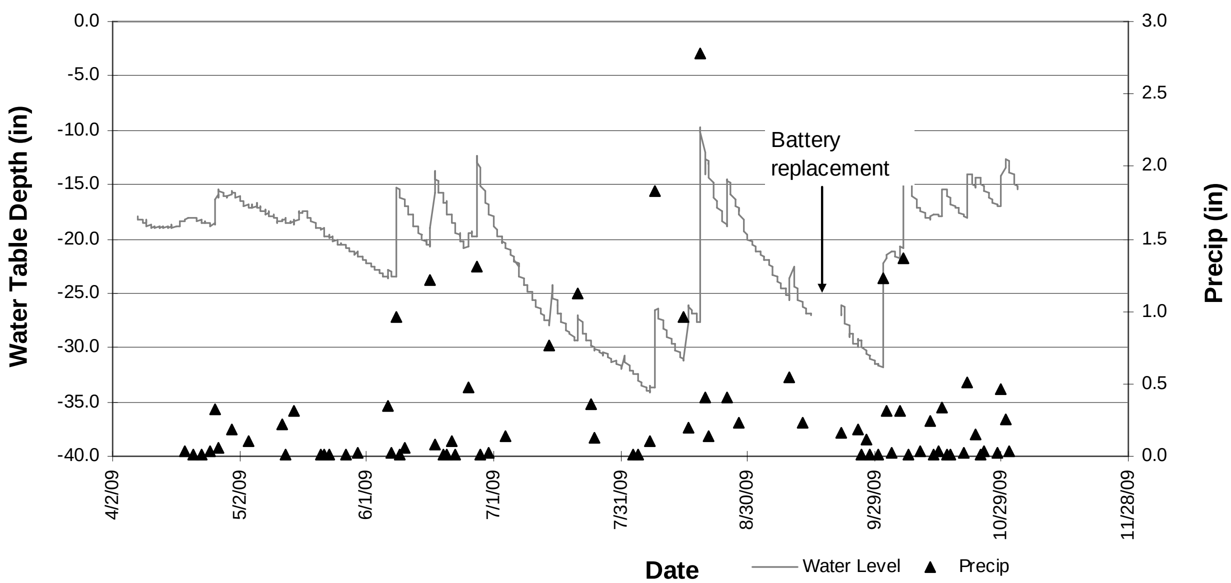
Surrounding Soils: Zimmerman fine sand

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 was installed at the end of 2005 and first monitored in 2006.

2009 Hydrograph

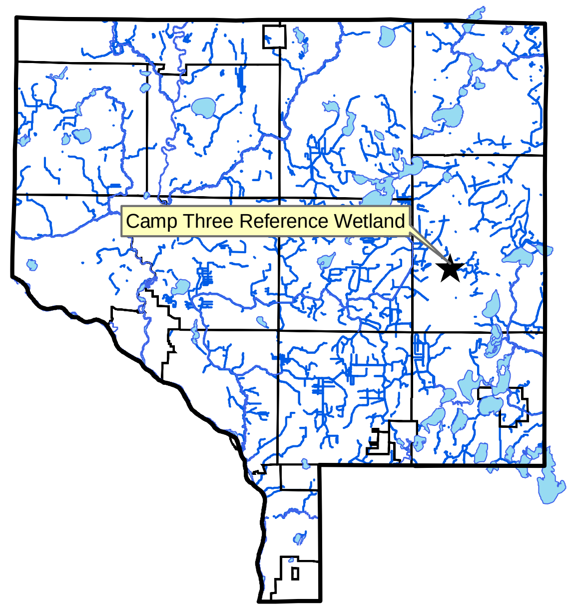


Well depth was 40 inches, so a reading of–40 indicates water levels were at an unknown depth greater than or equal to 40 inches.

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

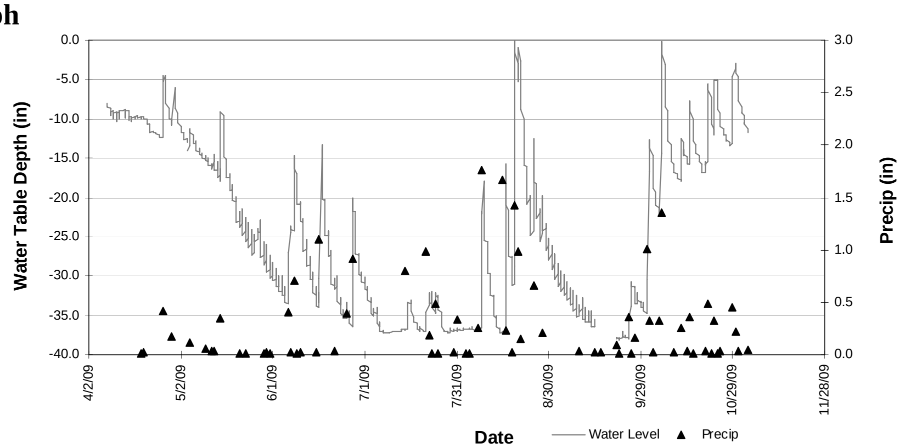
Surrounding Soils: Zimmerman Fine Sand

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.

2009 Hydrograph

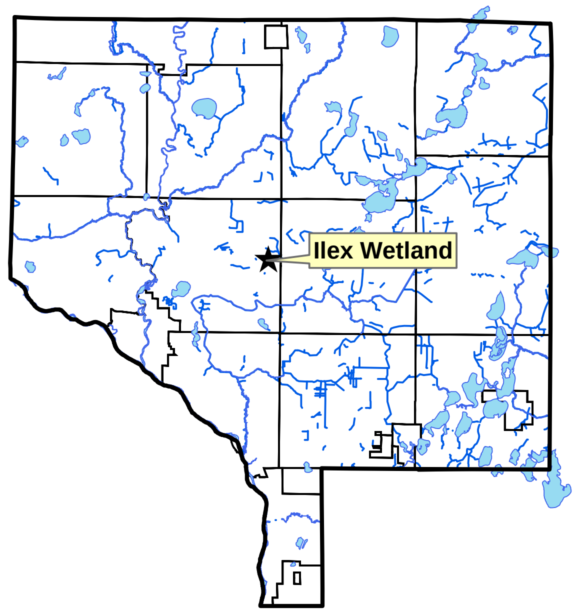


Well depth was 40 inches, so a reading of–40.0 indicates water levels at an unknown depth greater than or equal to 40.0 inches.

Wetland Hydrology Monitoring

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	-

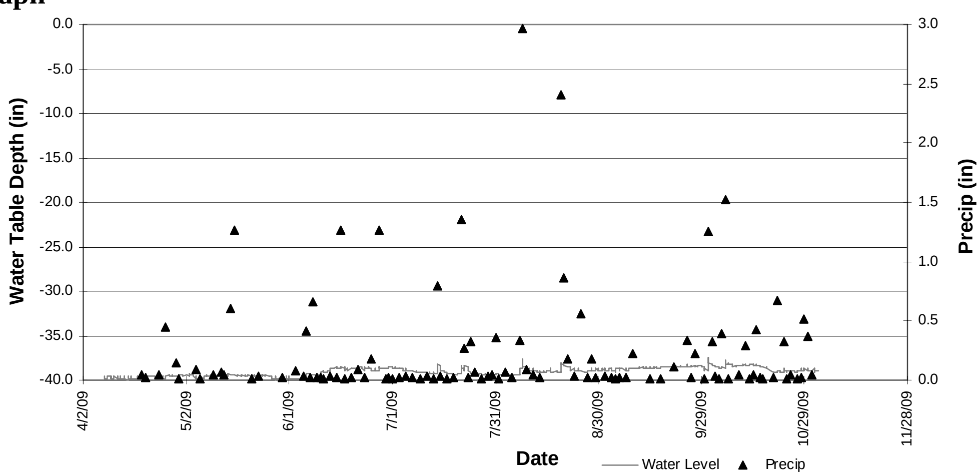
Surrounding Soils: Loamy wet sand and Zimmerman fine sand

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.

2009 Hydrograph



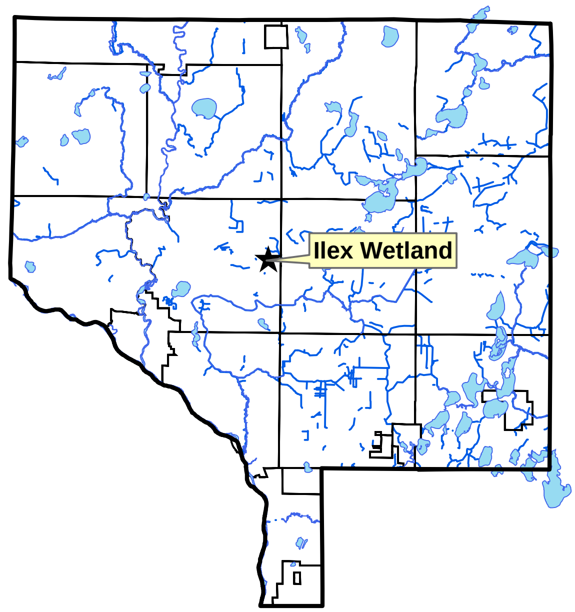
Well depth was 40 inches, so a reading of–40 indicates water levels were at an unknown depth greater than or equal to 40 inches.

Wetland Hydrology Monitoring

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	-

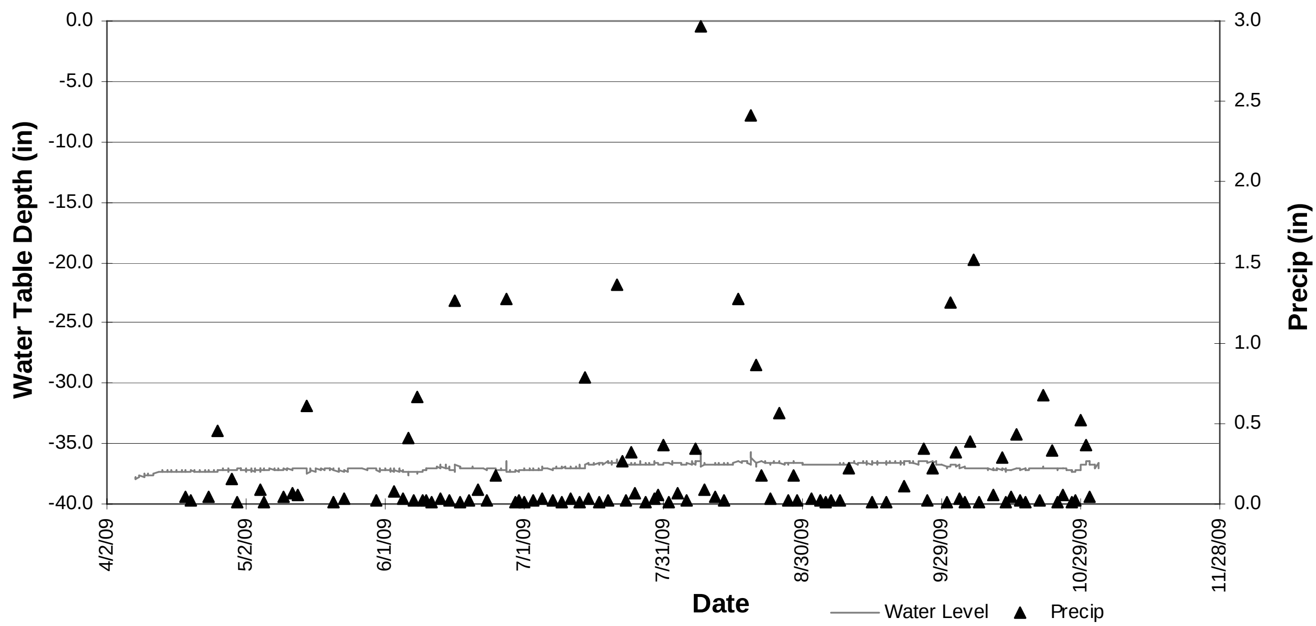
Surrounding Soils: Loamy wet sand and Zimmerman fine sand

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.

2009 Hydrograph

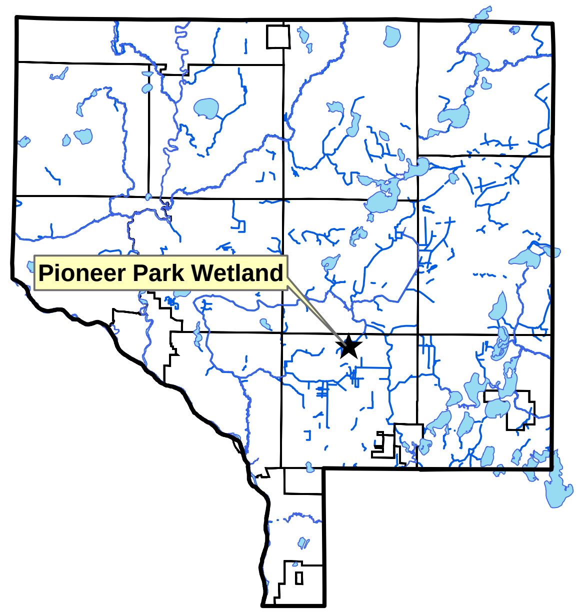


Well depth was 40 inches, so a reading of–40 indicates water levels were at an unknown depth greater than or equal to 40 inches.

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	-

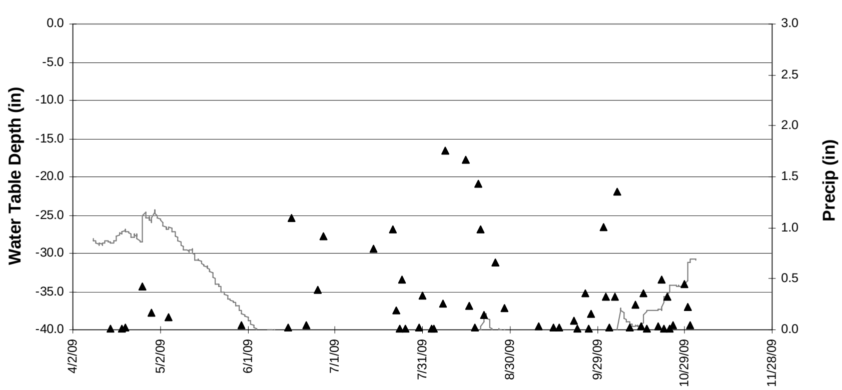
Surrounding Soils: Rifle and loamy wet sand.

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.

2009 Hydrograph

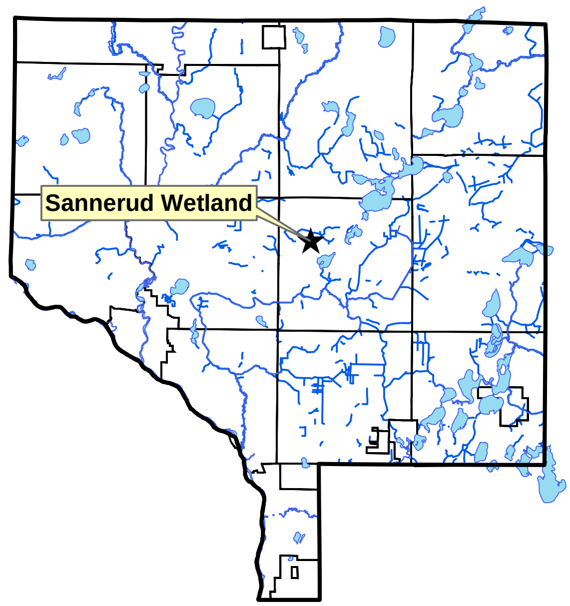


Well depth was 40 inches, so a reading of–40 indicates water levels were at an unknown depth greater than or equal to 40 inches.

Wetland Hydrology Monitoring

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	-

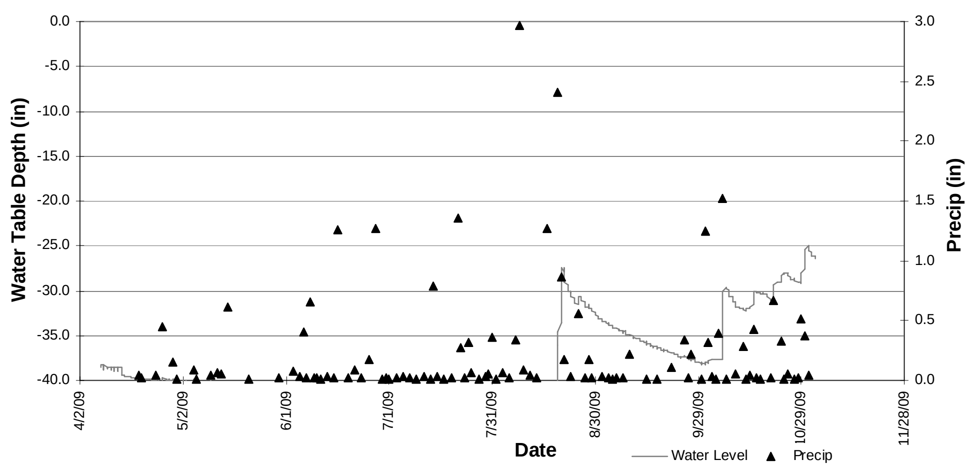
Surrounding Soils: Zimmerman and Lino.

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.

2009 Hydrograph

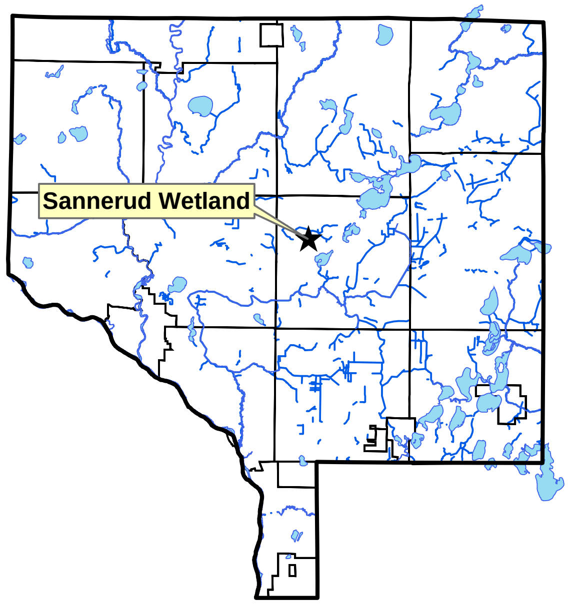


Well depth was 43.5 inches, so a reading of–43.5 indicates water levels were at an unknown depth greater than or equal to 43.5 inches.

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	-

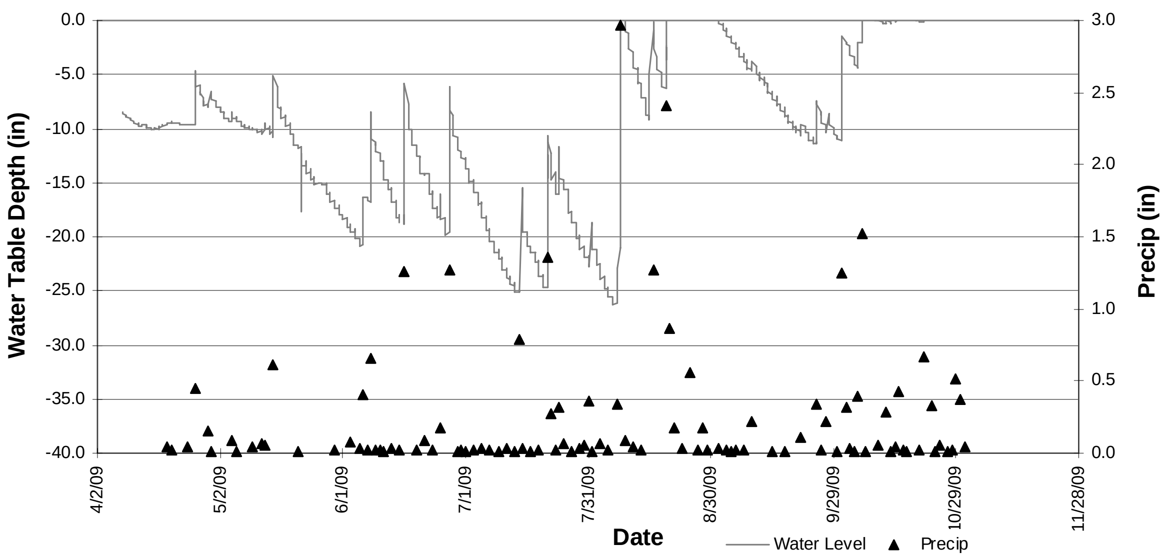
Surrounding Soils: Zimmerman and Lino.

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.

2009 Hydrograph



Well depths were 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

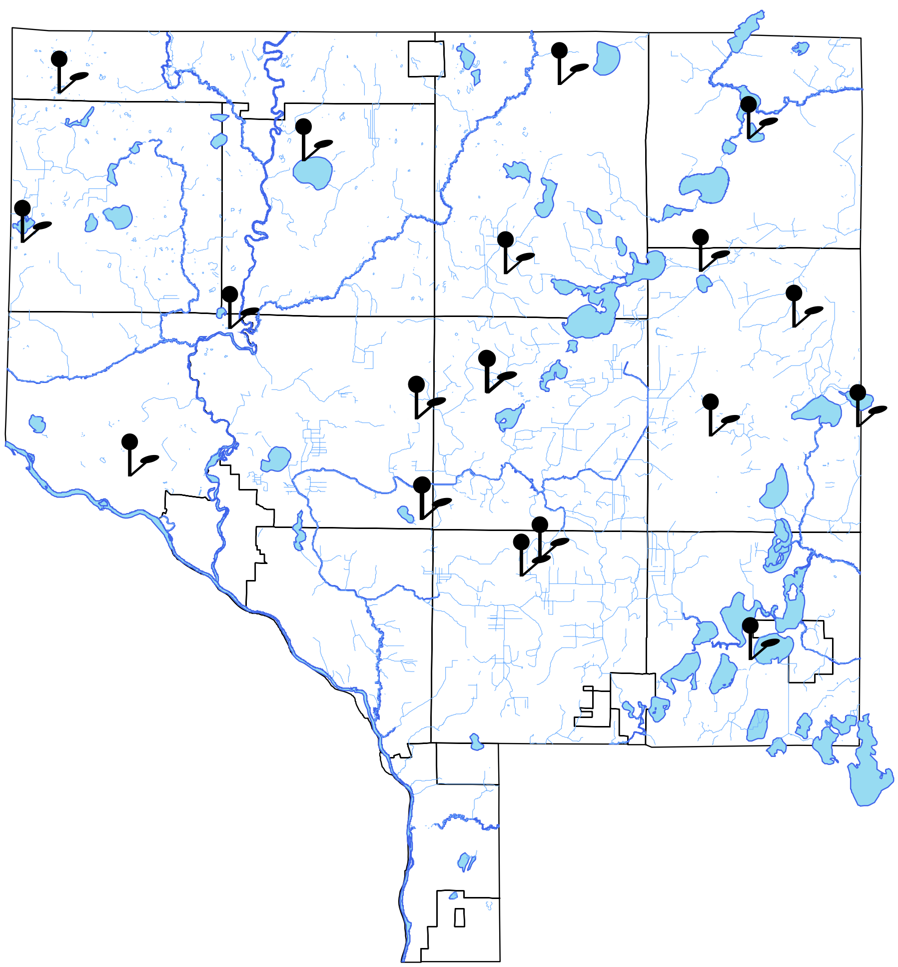
Description: This section includes analyses of wetland hydrology data that has been collected at 18 reference wetland sites. Shallow groundwater levels at the edge of these wetlands are recorded every four hours. Many have been monitored since 1996. These analyses summarize this enormous multi-year, 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.

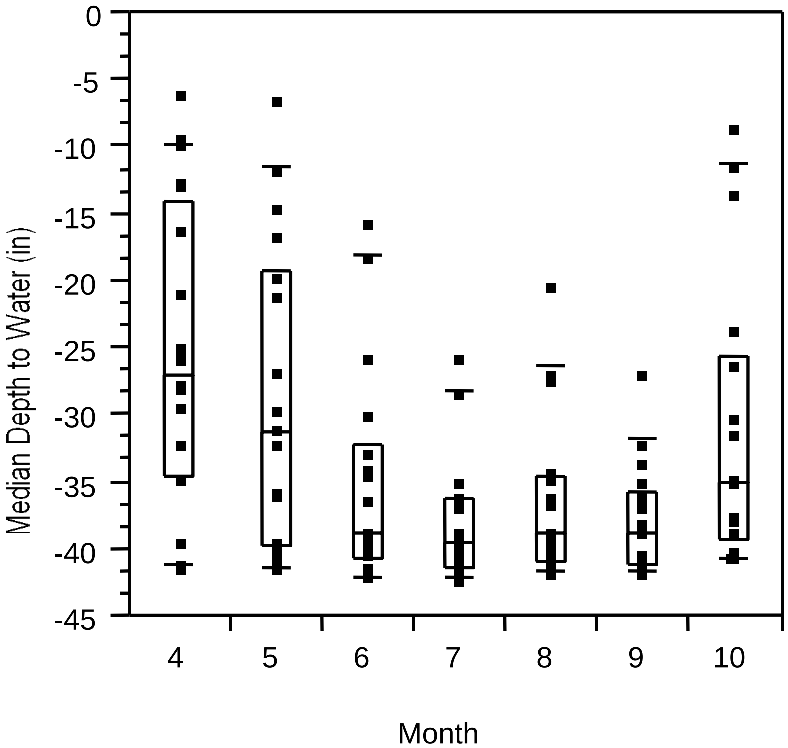
Locations: All 18 reference wetland hydrology monitoring sites in Anoka County.

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



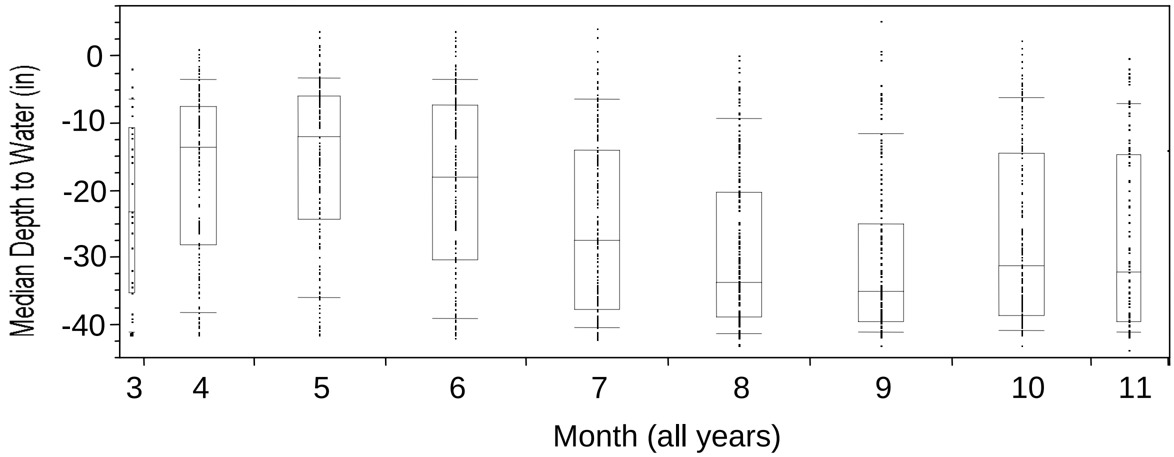
2009 Reference Wetland Water Levels Summary: Each dot represents the median depth to the water table at the edge of one reference wetland for a given month in 2009. The quantile boxes show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentile (floating horizontal lines).



Quantiles

Month	minimum	10.0%	25.0%	median	75.0%	90.0%	maximum
4	-41.6	-41.05	-34.35	-26.85	-13.8	-9.54	-6.2
5	-41.6	-41.33	-39.725	-31.15	-19.1	-11.28	-6.6
6	-42	-42	-40.525	-38.7	-32.15	-17.85	-15.6
7	-42.2	-41.93	-41.25	-39.4	-36.075	-28.04	-25.7
8	-41.7	-41.43	-40.8	-38.8	-34.5	-26.14	-20.2
9	-41.8	-41.53	-41.1	-38.65	-35.55	-31.49	-26.9
10	-40.8	-40.53	-39.05	-34.8	-25.55	-11.11	-8.5

1996-2009 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 2009. The quantile boxes show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentile (floating horizontal lines).



Quantiles

Level	minimum	10.0%	25.0%	median	75.0%	90.0%	maximum
3	-41.6	-41.08	-35.2	-23.2	-10.5	-6.3	-1.9
4	-41.6	-38.2	-28	-13.5	-7.4	-3.3	1.2
5	-41.6	-35.83	-24.2	-11.8	-5.875	-3.24	3.8
6	-42	-38.99	-30.275	-18.05	-7.125	-3.34	3.8
7	-42.2	-40.5	-37.8	-27.4	-14	-6.3	4.3
8	-43	-41.3	-38.9	-33.6	-20.2	-9.1	0.3
9	-43	-41.1	-39.5	-35	-25	-11.5	5.3
10	-43.1	-40.84	-38.7	-31.1	-14.4	-6.16	2.4
11	-43.8	-41.1	-39.5	-32	-14.65	-6.88	-0.2

Discussion:

The purpose of reference wetland data is to help assure that wetlands are accurately identified by regulatory personnel. 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 area to known wetlands, thereby helping assure accurate regulatory decisions. The analysis of reference wetland data provided above is a quantitative, non-subjective tool.

The simplest use of the reference wetland data 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.

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 every couple of years 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 unknown factors, and the presence (and possible expansion) of invasive reed canary grass. Of particular interest is how wetland hydrology will affect invasive species expansion.

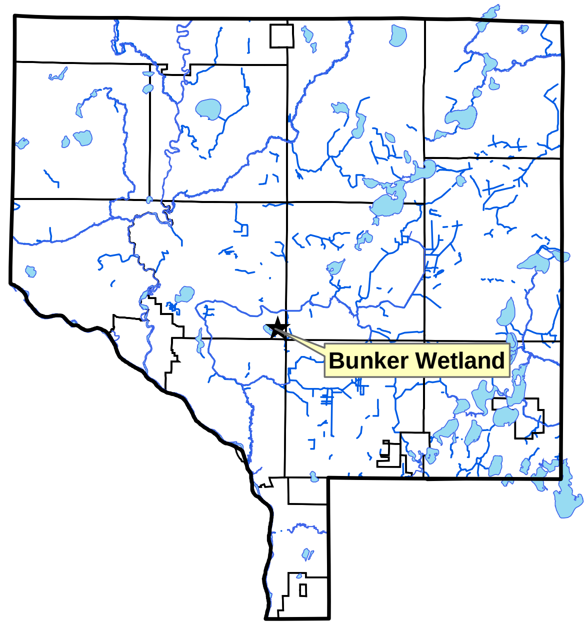
Locations: Bunker Reference Wetland, City of Andover

Results: On the following pages

BUNKER REFERENCE WETLAND

Bunker Hills Regional Park, Andover

Wetland Description



Bunker wetland is one of 18 wetlands in the Anoka Conservation District's reference wetland network. It is located within Bunker Hills Regional Park. It 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 is located to the west, while a second, much larger wetland, is located to the south.

Bunker wetland is a classified as a Circular 39 Type 2 inland fresh sedge meadow covering about 1 acre. During the early and late growing season the water table is at the ground surface. However, during summer months or periods of drought the water table recedes to depths of 35 inches below the surface. The dominate plants within this wetland are short grasses. Within the basin *Poa paulustris* (Fowl Bluegrass), *Poylgonum sagitatum* (Arrowleaf Tearthumb), and asters are dominant. These species are native to Minnesota and are indicative of a high quality wetland habitat. The edge of the wetland is predominately *Phalaris arundinacea* (Reed Canary Grass) and *Populus tremueloides* (Quaking Aspen). The soils in the Bunker Hills wetland comprise of organic material over sand. The depth of the organic material varies from a few inches to over four feet, with the organic deposits deepening towards the center of the basin.

Photo of Bunker Wetland in April

Introduction

Study of Bunker wetland is two-fold. First, the wetland hydrology (water level) is monitored continuously with automated equipment as part of the ACD's network of reference wetlands. This hydrology monitoring is performed at all reference wetlands are hydrologically monitored to provide a reference for the current state of wetlands. Most prominently, this data is used to ensure accurate wetland regulatory determinations. Secondly, at the request of the Coon Creek Watershed District, the Anoka Conservation District (ACD) has begun to study the vegetation community of the Bunkers Hills Reference Wetland. The purpose of vegetation surveys is to document vegetation changes associated with hydrological changes, invasive species, and other disturbance.

This wetland has had dramatic hydrological change during the 13 years it has been monitored. From 1996 to 2005 a monitoring well was placed what was considered to be the wetland edge. During this ten year monitoring period it was discovered the water level was decreasing. Our goal, using the jurisdictional wetland hydrology standard, was to keep this, and all of our monitoring sites on the wetland edge. With exception of the first two years of monitoring, 1996, 1997, and, a higher than normal precipitation year in 2003, the water level was below the threshold of twelve inches to be considered a jurisdictional wetland. Seven out of ten years failed to meet wetland hydrology standards. Additionally, the water levels had dropped to a level that the monitoring well was no longer considered to be within an acceptable distance of the wetland edge. In 2006 it was decided to move the well down slope in order to capture the full range of hydrology reading throughout the year.

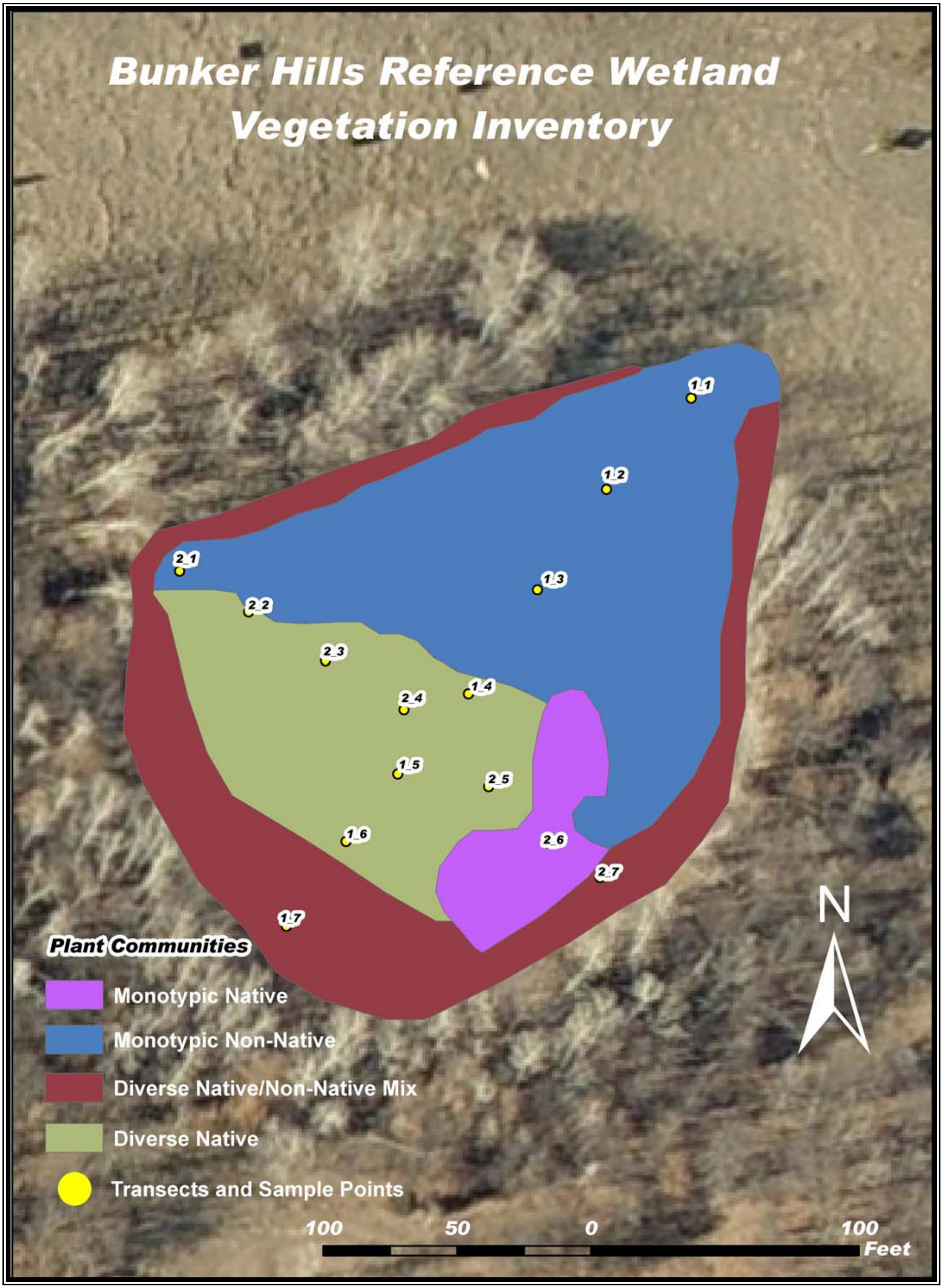
In 2006 the ACD installed a second hydrology monitoring well. This well is located in the middle of the wetland within the most diverse vegetative community. The water level has been at or near the surface in spring and following predictable summer draw downs and fall recharge patterns. As the area around the wetland is developed, our particular focus will be how wetland hydrology correlates to invasive species expansion into native vegetative communities.

2009 Data Collection Methods

A central goal of this study is to monitor the expansion of invasive species. The primary work products is a plant community map. Maps will be compiled in different years and compared. The wetland boundary location was determined by the Anoka Conservation District wetland specialist using state-approved wetland delineation methods. The wetland boundary was documented with a hand held Lowrance GPS unit and uploaded into Arc Map 9.1. Two perpendicular transects were established for systematically documenting vegetation within the wetland. Along each transect vegetation was documented at seven equally-spaced points. At each point herbaceous vegetation within a one meter quadrat was inventoried, 15-foot radius for the shrub layer, and 30-foot radius for the tree layer. Plants were characterized by percent cover. 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.

Results

A map of vegetation communities is on the following page. Brief narratives of each plant community and a plant species table are on subsequent pages. 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 figure.


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
Plant Communities
Monotypic Native
Monotypic Non-Native
Diverse Native/Non-Native Mix
Diverse Native
Transects and Sample Points
N
100
50
0
100
Feet

1. Monotypic Native

This plant community is comprised of Lake Sedge *(Carex lacustris),* with a smaller percent cover of Stinging Nettle *(Urtic dioca).* The presence of Urtica among the Carex may be indicating a drier hydrology regime has taken place, as we often see Urtica in areas that have been drained. This plant community is located on the southeast corner, and has abrupt boundaries.

Sample 2-6

Scientific Name	Common Name	%Cover	Native/Invasive	Indicator
Carex lacustris	Lake Sedge	70	Native	Obl
Urtica dioca	Stinging Nettle	30	Native	Fac

2. Monotypic Non-Native

This plant community while having a few sparsely placed native species, has a greater than 100 percent aerial coverage of Reed Canary Grass *(Phalaris arundinacea).* This boundary will continue to be monitored for encroachment into the adjacent native communities.   Additional location data points were used, to obtain an accurate plant community boundary. This wetland boundary is diffuse leading us to believe it is creeping towards the native plant 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	15	Native	Facu

3. Diverse Native/Non- Native Mix

This plant community is located on the wetland edges. It is comprised of Red Raspberry *(Rubus strigosis),* Quaking Aspen *(Populas tremulas),* and Reed Canary Grass *(Phalaris arundinacea).* These are typical plant species found on wetland edges. However the high percentage of Reed Canary Grass may at some time overwhelm the natives and encroach into the surrounding native communities. The boundaries on this plant community are fairly clear, this is most likely due to the hydrology of the site since the plant species are known to exist on wetland edges.

Sample 1-7

Scientific Name	Common Name	%Cover	Native/Invasive	Indicator
Rubus strigosis	Raspberry	70	Native	Facw
Phalaris arundinacea	Reed Canary Grass	50	Invasive	Facw
Populus trembulas	Quacking Aspen	10	Native	Fac

Sample 2-7

Scientific Name	Common Name	%Cover	Native/Invasive	Indicator
Rubus strigosis	Raspberry	70	Native	Facw
Phalaris arundinacea	Reed Canary Grass	50	Invasive	Facw
Populus trembulas	Quacking Aspen	30	Native	Fac
Urtica Dioca	Stinging Nettle	20	Native	Fac

Diverse Native

The center of this wetland is the most diverse of all the plant communities. Overtime the hydrology data suggests this wetland is becoming drier. It is likely the center is staying in its native form because the hydrology has been less affected in this area. This plant community has a clear boundary with invasive species on the perimeters. These are the areas where invasive species encroachment will be closely monitored.

There will additions to this plant community list in subsequent years. Some of the cool season grasses were not identifiable. These will be sampled further in the early to mid growing season of 2010.

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
Rubus flagellaris	Dewberry	10	Native	Facu
Thelypteris thelypteroides	Marsh Fern	10	Native	Facw
Solidago gigantia	Giant Goldenrod	5	Native	Facw
Cirsium arvense	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

Sample 1-6

Scientific Name	Common Name	%Cover	Native/Invasive	Indicator
Lycopus uniflorus	Northern Bugleweed	30	Native	Obl
Carex lacustris	Lake Sedge	30	Native	Obl
Rubus strigosis	Raspberry	30	Native	Facu
Polygonum sagittatum	Tear thumb	30	Native	Obl
Polygonum scandens	False Buckwheat	20	Native	Fac

Sample 2-2

Scientific Name	Common Name	%Cover	Native/Invasive	Indicator
Phalaris arundinacea	Reed Canary Grass	50	Invasive	Facw
Urtica Dioca	Stinging Nettle	10	Native	Fac
Carex lacustris	Lake Sedge	5	Native	Obl
Cirsium arvense	Canada Thistle	5	Invasive	Facu

Sample 2-3

Scientific Name	Common Name	%Cover	Native/Invasive	Indicator
Carex lacustris	Lake Sedge	80	Native	Obl
Polygonum scandens	False Buckwheat	20	Native	Fac
Cirsium arvense	Canada Thistle	5	Invasive	Facu

Sample 2-4

Scientific Name	Common Name	%Cover	Native/Invasive	Indicator
Carex lacustris	Lake Sedge	40	Native	Obl
Polygonum scandens	False Buckwheat	40	Native	Fac
Rubus strigosis	Raspberry	30	Native	Facw
Polygonum sagittatum	Tear thumb	30	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	10	Native	Obl
Cirsium arvense	Canada Thistle	10	Invasive	Facu

Conclusion

In subsequent years we will compare vegetative data and maps. This was the first year of inventorying Bunker wetland. It is notable that we have seen the water table decrease over the last thirteen years. If this continues it is likely to have some impact on the vegetative communities. If the water table trends downward there could be a shift to drier plant species and an increase in invasive species percent cover.

Stormwater Retrofit Assessment – Sand 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. Sand Creek was chosen because it is a high priority to the Coon Creek Watershed District. Certain subwatersheds to Sand Creek were chosen for assessment because water monitoring found water quality degradation in these areas and these areas had older development and infrastructure. The focus area included portions of the Cities of Blaine and Coon Rapids.

Purpose: To improve stormwater quality and reduce the volume of runoff entering the stormwater system from neighborhoods that most greatly contribute to the degradation of Sand Creek.

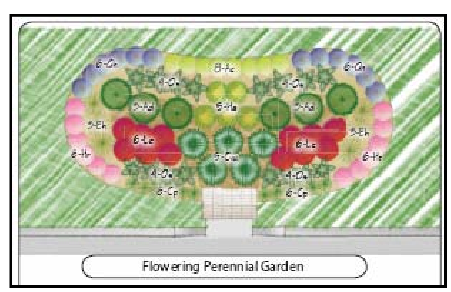
Results: Seven catchments were identified for retrofit projects within the focus area using GIS software and field inspections. In three of the catchments, pond retrofits were determined to be the best retrofit option. The other four catchments were assessed for rain garden retrofits to achieve multiple pollutant reduction levels. Cost effectiveness of each project was analyzed, and projects were listed by cost per pound of phosphorus treated to facilitate project ranking. The Coon Creek Watershed District and Anoka Conservation District plan to begin installing the most beneficial projects in 2010. The full report is available on the Coon Creek Watershed District website.

Table of potential projects identified in the assessment process

Catchment	Retrofit Project	Number of BMPs	% TP Reduction	TP Reduction (lb/yr)	Estimated Installation Cost	Cost/lb TP Reduction	O&M Term (years)	Annual O&M Cost per BMP	Estimated Term Cost/lb/yr (includes O&M)
SC-R1	New Pond	1	49%	9.3	$109,460	$11,770	30	$253	$420
SC-R2*	Neighborhood Retrofit	10	30%	4.9	$41,385	$8,446	10	$75	$998
SC-R3	Neighborhood Retrofit	19	10%	12.1	$77,493	$6,404	10	$75	$758
SC-R4*	Neighborhood Retrofit	11	30%	5.7	$45,397	$7,964	10	$75	$941
SC-R5*	Neighborhood Retrofit	10	30%	4.9	$41,385	$8,446	10	$75	$998
SC-R6	Pond Modification	1	11%	13.3	$7,104	$534	10	$3,340	$305
SC-R7	Pond Modification	1	35%	16	$14,400	$900	30	$453	$58

Pond Retrofit Concept

Neighborhood Rain Garden Retrofit



Rain Garden Concept

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, and sometimes with grant funding from the watershed organization or the Anoka Conservation District.

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: **Lakeshore Restoration Design –** Nereson Property, Crooked Lake

Description: The design for the Nereson lakeshore consists of erosion control blanket and a variety of grasses, sedges and wildflowers. Aquatic emergent plants were also included. The planting cover a majority of the shoreline to provide habitat, water quality improvement and bank stabilization. A portion of the shoreline is open for active use and dock access.

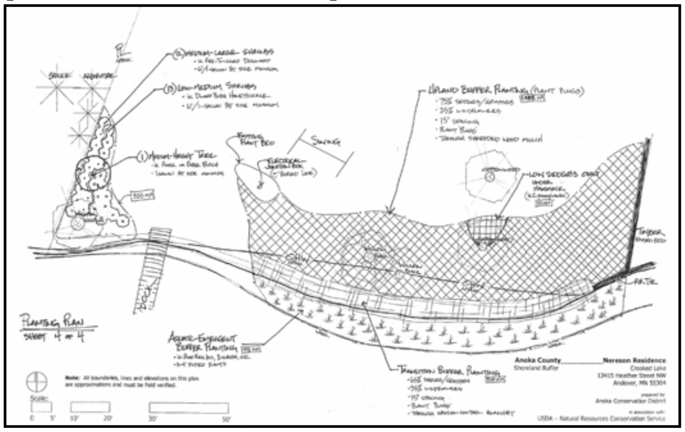


Photo: Nereson Lakeshore Design

Crooked Lake Rain Garden Design – City of Andover and several landowners around Crooked Lake

Description: The Anoka Conservation District was contracted by the City of Andover to design several curb-cut style rain gardens for a demonstration grant project through the Coon Creek Watershed District. The gardens will capture stormwater runoff from the streets, rooftops and driveways and infiltrate it into the ground. This process allows the water to be filtered naturally before entering the lake as groundwater.

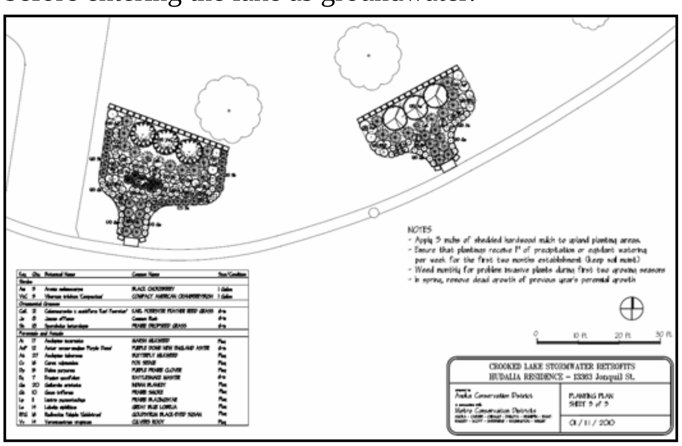


Photo: Planting plan for two curb-cut style rain gardens surrounding a catch basin that discharges to Crooked Lake

Residential Rain Garden Design – Ricci Property, Sand Creek

Description: Landscape Restoration Specialists completed a design for a curb-cut rain garden on a property adjacent to Sand Creek in Coon Rapids. A unique feature of the design is the dual curb-cuts; one on each side of a stormwater catch basin that discharges to the creek. The curb-cuts will divert water from the street into the garden and allow it to infiltrate.

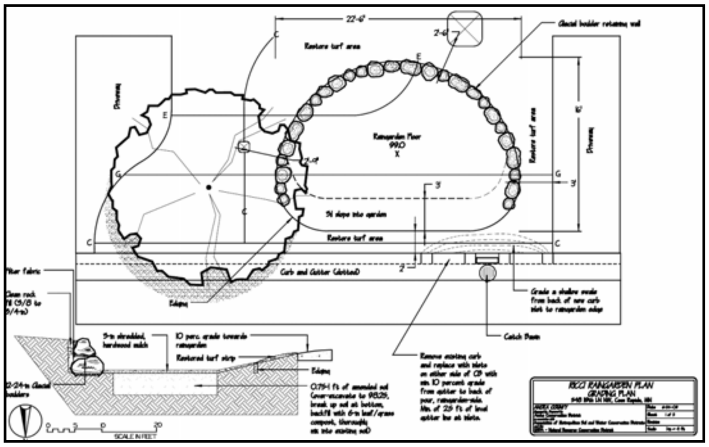


Photo: Grading plan for the Ricci rain garden

Conservation Workshops

Description: The Anoka Conservation District, with assistance from participating cities, hosted conservation workshops for the public. Three workshops were offered, including rain gardens, watersmart, and shoreland management. Workshops were two hours in length, except for the rain garden workshop. The rain garden workshop was four hours and included hands-on rain garden construction outdoors. Cities provided promotion of the workshops and facilities. ACD staff taught the workshops.

Purpose: To assist and encourage landowners to install water quality improvement projects. To encourage water conservation.

Results: The Anoka Conservation District partnered with the Cities of Blaine and Lino Lakes to host workshops in spring 2009. Workshops included shoreland management, watersmart landscaping, and a two-part rain garden workshop that included a demonstration. Participation at each workshop ranged from 10 to 30.

Participants at the Blaine rain garden workshop learn construction steps.

Anoka County Geologic Atlas

Description: A map-based report of groundwater and geology to be used for community planning and groundwater management. The Atlas provides detailed information about groundwater:

- Aquifers, including identifying future water sources,
- Aquifer sustainability,
- Recharge areas,
- Sensitivity to pollution,
- Flow directions,
- Connections to lakes, streams, and wetlands,
- Chemistry,
- Wellhead protection, and others...

Results are provided as GIS files and paper maps, and are especially useful to community planners.

Geologic Atlases are a partnership of the MN Geological Survey, MN DNR, and local governments. 94% of funding was secured by the MN Geological Survey (MGS) and MN Department of Natural Resources (DNR) from the Legislative-Citizen Commission for Minnesota Resources (LCCMR). A required local contribution totaling 6% of project expenses was provided by the seven Anoka County watershed organizations and the Anoka Conservation District. Completion of the project requires 4-5 years.

Purpose: To gain knowledge about groundwater and geology that enables improved management of groundwater, including availability, pollution prevention, and pollution management.

Locations: Throughout Anoka County

Results: An Anoka County Geologic Atlas began in 2009 with financial support from all seven Anoka County Watershed Management Organizations and the Anoka Conservation District. These funds were used to locate approximately 9,500 groundwater wells, with approximately an additional 500 to be located in early 2010. Boring logs from these wells and others already in the County Well Index will be used to create the geologic atlas. The MGS has already begun the process of using these wells to create the geologic atlas. Thereafter the DNR will perform a groundwater analysis for the atlas. In total, the geologic atlas is expected to be completed around 2014.

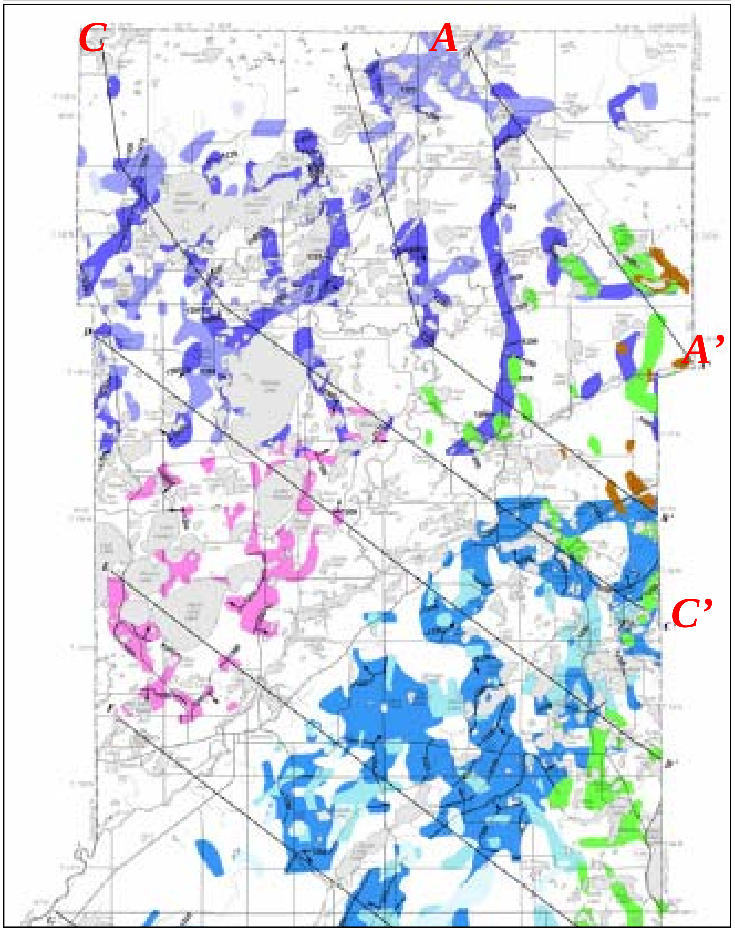
An example of portions of a geologic atlas from Crow Wing County are on the following page.

Example Geologic Atlas Work Products

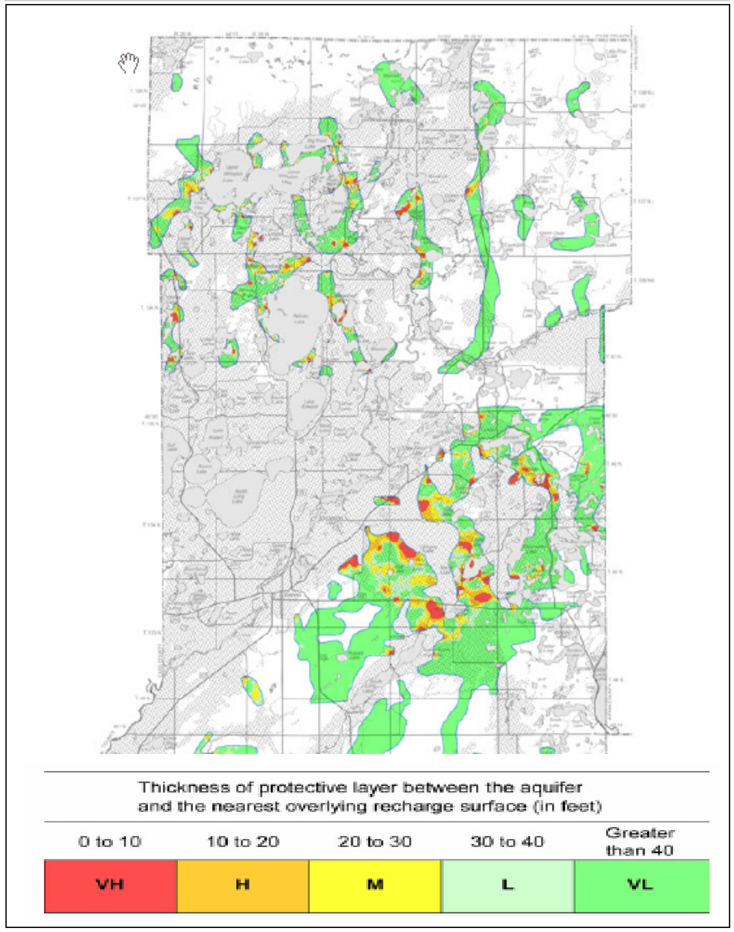
Crow Wing County Geologic Atlas

Excerpted from: Peterson, T. 2008. Hydrogeology, Pollution Sensitivity, and Lake and -Groundwater Interaction. MN Ground Water Association Newsletter 27-3.

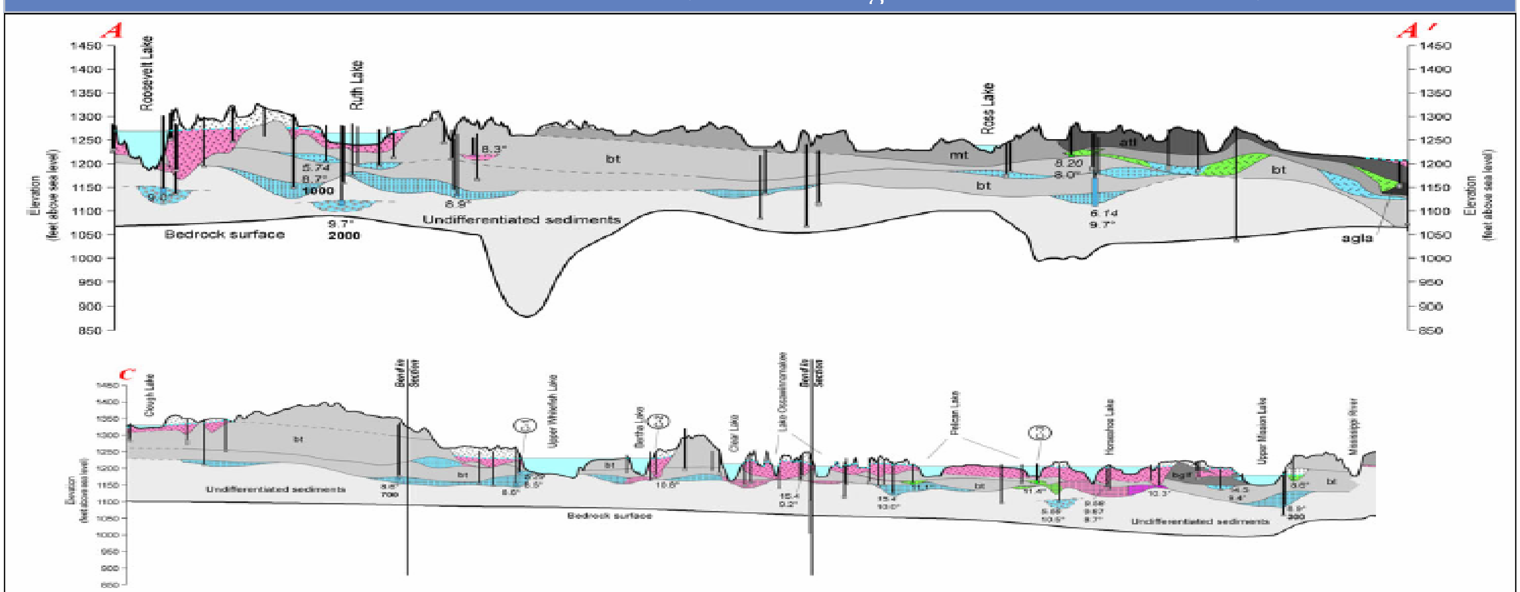
Extent and Distribution of Buried Aquifers Including Direction of Flow



Pollution Sensitivity of Buried Aquifers



Selected hydro-geologic cross sections showing groundwater residence time. Cross sections A-A' and the Northwest 2/3 of C-C' are shown. See above figure for cross section location.



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	Lake Lvl	Ob Well	Stream Level	Lake WQ	Stream WQ	Student Biom	Prof Biom	Geologic Atlas	Sandcreek Retrofit	Total
Revenues												
CCWD	3150	3450	480	0	2100	1988	7560	760	8750	5000	13802	47040
State	0	0	0	240	0	0	0	0	0	0	0	240
Anoka Conservation District	0	0	628	254	749	493	4512	1050	0	2340	2568	12593
County Ag Preserves	0	0	0	0	0	707	0	760	0	0	0	1467
Other Service Fees	0	0	0	0	0	0	0	0	0	27	0	27
Local Water Planning	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	3150	3450	1108	494	2849	3187	12072	2570	8750	7367	16370	61367
Expenses-												
Capital Outlay/Equip	18	7	2	2	22	18	18	7	21	72	71	256
Personnel Salaries/Benefits	1984	1690	962	427	2382	2083	8217	2199	4507	6574	13827	44852
Overhead	192	126	66	31	188	136	538	107	252	321	1190	3147
Employee Training	32	20	16	6	26	16	145	24	70	53	280	687
Vehicle/Mileage	33	24	14	6	39	32	125	32	73	114	228	719
Rent	130	96	45	22	133	102	347	77	152	202	749	2056
Program Participants	0	0	0	0	0	0	0	0	0	0	0	0
Program Supplies	6	25	2	1	60	800	2682	124	151	32	25	3908
Equipment Maintenance	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	2394	1988	1108	494	2849	3187	12072	2570	5225	7367	16370	55624
NET	756	1462	0	0	0	0	0	0	3525	0	0	5743

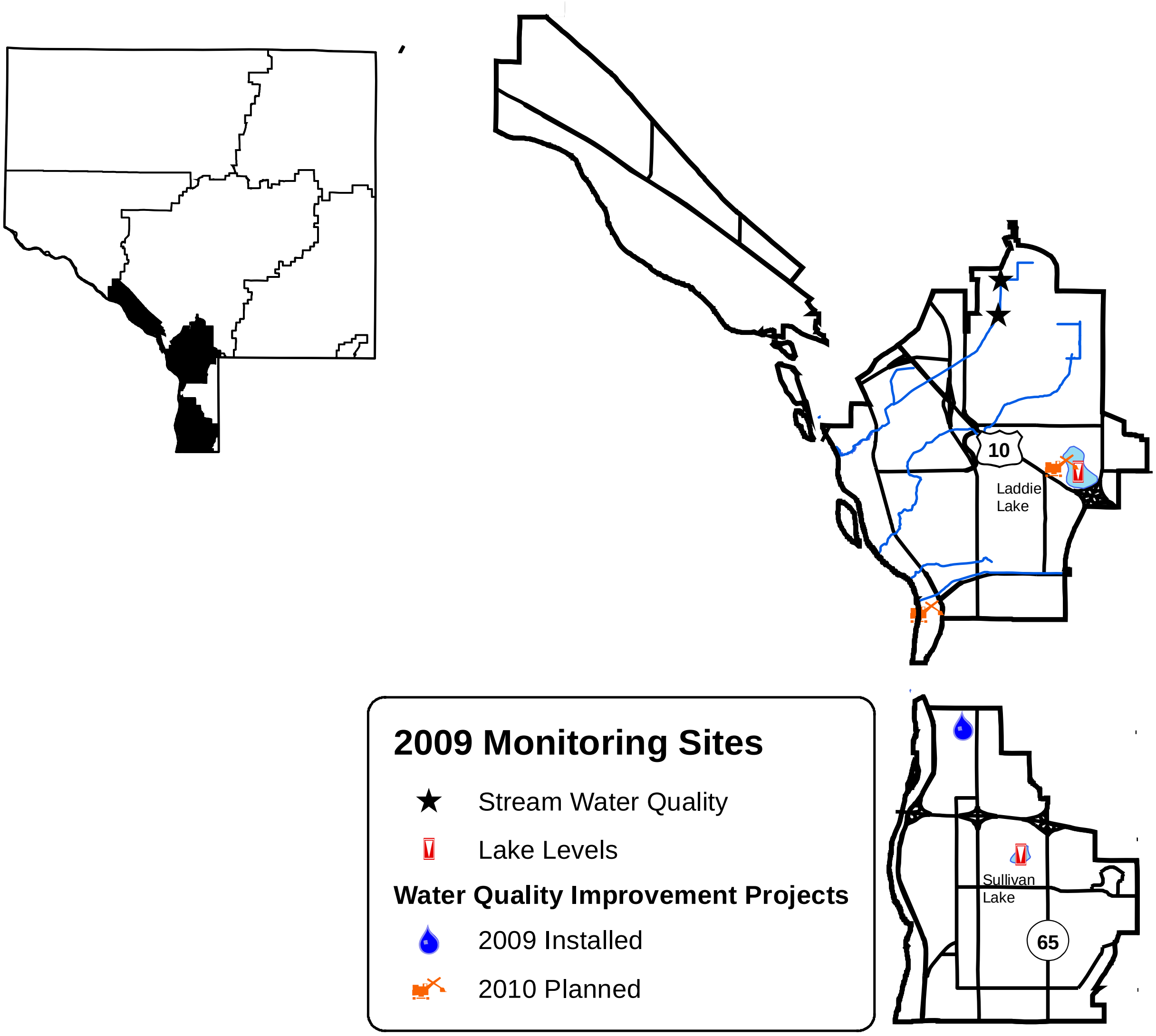
Recommendations

- **Install water quality improvement projects identified in the 2009 Sand Creek subwatershed assessment.** Potential projects have been ranked by cost effectiveness; most cost effective projects should be done first.
- **Conduct subwatershed assessments for Coon Creek that locate water quality improvement opportunities and ranks their cost effectiveness.** The Anoka Conservation District and Coon Creek Watershed District are planning an assessment for lower Coon Creek in 2010. Based on monitoring data, areas of focus should be total phosphorus, total suspended solids, and storms >1-inch.
- **Continue local support of and input into the Anoka County Geologic Atlas project.**
- **Coordinate 2010 biomonitoring of Coon Creek with the MN Pollution Control Agency (MPCA).** MPCA is planning intensive biomonitoring of Coon Creek in 2010 and will monitor some of CCWD's professional biomonitoring sites. ACD will monitor the others. ACD staff plan to also accompany MPCA monitoring.
- **Ensure that future stream monitoring is done in such a way that it can be incorporated into future total maximum daily load (TMDL) studies.** Coon Creek is presently listed as impaired for biota, but may also be failing to meet turbidity standards.
- **Reduce road salt use.** Elevated chlorides are pervasive throughout shallow aquifers and the streams that feed them.
- **Increase the usage of reference wetland data** among wetland regulatory personnel as a means for efficient, accurate wetland determinations.
- **Secure funding for Blaine High School biomonitoring** of Coon Creek.
- **Provide educational opportunities for shoreland property owners** on septic system care, low impact lawn care practices, and restoring their shoreline with native plants.
- **Integrate stream hydrology, precipitation, and water quality data into watershed-wide computer models.**

CHAPTER 7:
SIX CITIES WATERSHED

Task	Partners	Page
Lake Levels	SCWMO, ACD, MNDNR, volunteers	7-228
Stream Water Quality – Chemical	SCWMO, ACD	7-229
Public Education – Pleasure Creek E. coli	SCWMO, ACD	7-243
Water Quality Improvement Projects	ACD, ACAP, landowners	7-244
Anoka County Geologic Atlas	All Anoka Co. watershed organizations, ACD, MN Geologic Survey, MN DNR	7-247
SCWMO Website	SCWMO, ACD	7-249
Financial Summary		7-251
Recommendations		7-251
Precipitation	ACD, volunteers	Chapter 1
Ground Water Hydrology (obwells)	ACD, MNDNR	Chapter 1

ACD = Anoka Conservation District, MNDNR = Minnesota Department of Natural Resources,
SCWMO = Six Cities Watershed Management Organization, ACAP = Anoka County Ag Preserves



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

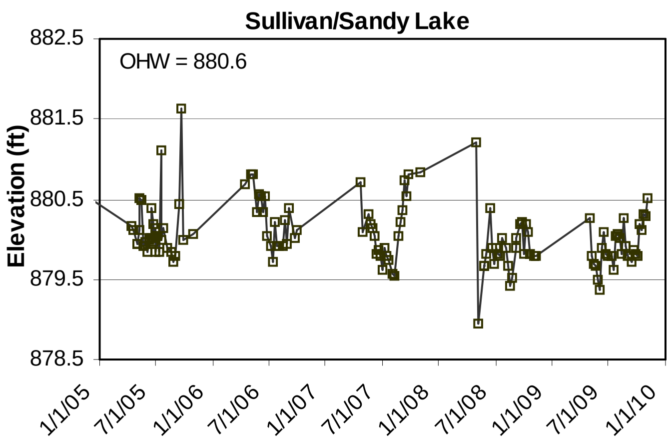
Locations: Laddie Lake

Sullivan/Sandy Lake

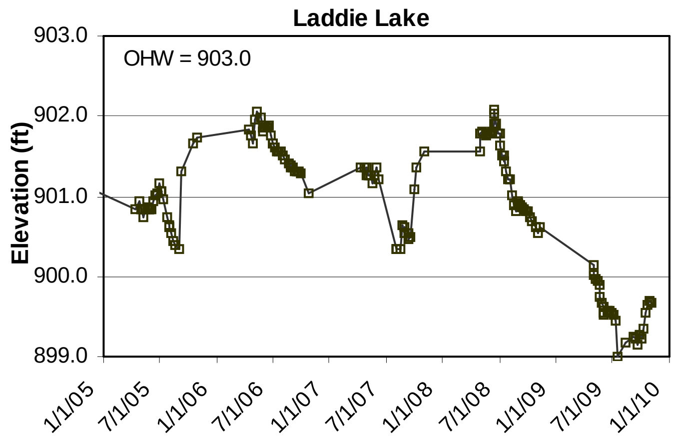
Results: Water levels were recorded 28 times at Sullivan Lake and 27 times at Laddie Lake. Sullivan Lake levels were variable, and fluctuated roughly at total of one foot. Rapid variation, which is different from most other lakes, occurs because Sullivan serves as a storm water retention basin for urbanized areas. The outlet prevents large sustained declines or increases in water level. Laddie Lake also receives storm water inputs, but to a lesser degree, and was therefore more greatly affected by drought conditions in 2008-09. Laddie Lake's water levels declined throughout 2008 and continued the decline until late July. At that point it was lower than ever previously recorded (data collection began in earnest in 1992). From August to November water levels rose 0.67 ft.

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

Sullivan/Sandy Lake Levels 2005-2009



Laddie Lake Levels 2005-2009



Six Cities Watershed Lake Levels Summary

Lake	Year	Average	Min	Max
Sullivan	2005	880.14	879.72	881.63
	2006	880.32	879.52	881.92
	2007	880.12	879.54	880.83
	2008	880.22	879.42	881.24
	2009	879.92	879.36	880.52

Lake	Year	Average	Min	Max
Laddie	2005	900.89	900.35	901.74
	2006	901.60	901.04	902.05
	2007	900.96	900.33	901.55
	2008	901.28	900.53	902.09
	2009	899.55	898.99	900.14

Stream Water Quality – Chemical Monitoring

Description: Streams were monitored eight times between April and October; four times during baseflow and four times during storm flow. Storm flow events were defined as an approximately one-inch rainfall in 24 hours. Each stream was tested for pH, conductivity, turbidity, dissolved oxygen, temperature, salinity, total suspended solids, chlorides, total phosphorus, and in some cases other tests.

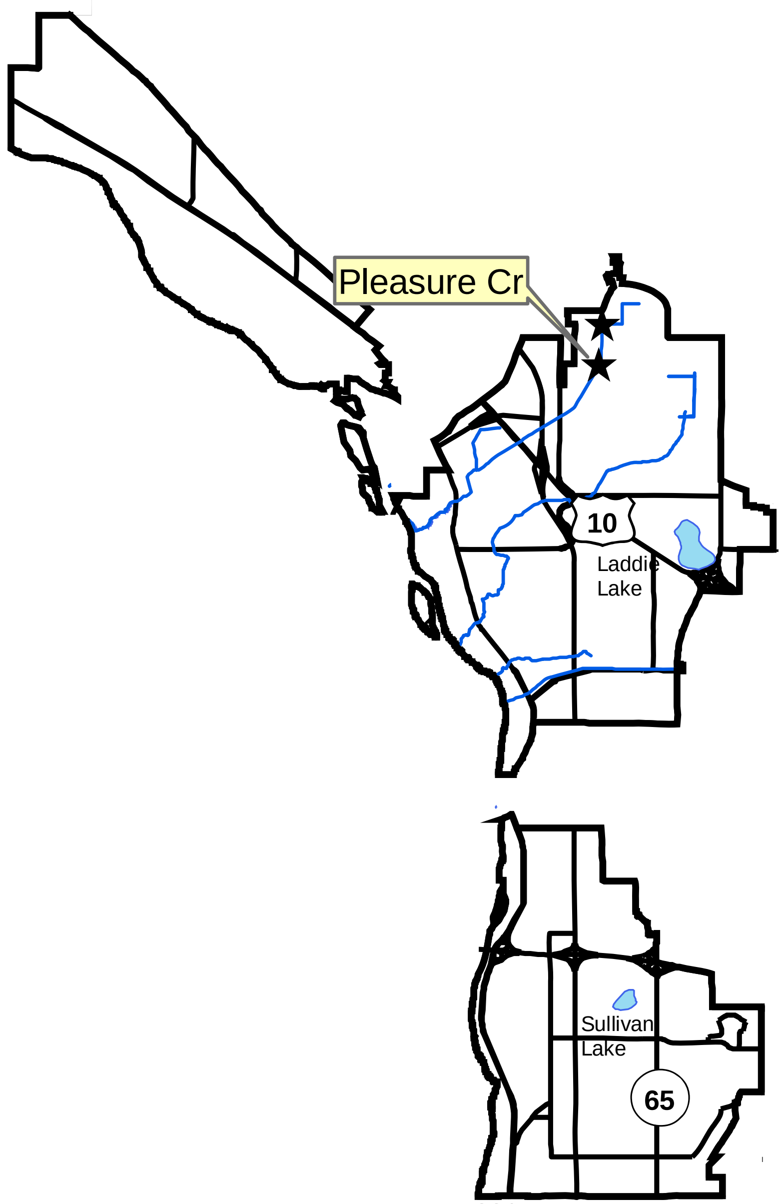
Purpose: To detect water quality trends and problems, and diagnose the source of problems.

Locations: Pleasure Creek at 99th Avenue NE, Blaine

Pleasure Creek at Pleasure Creek Parkway West, Baine

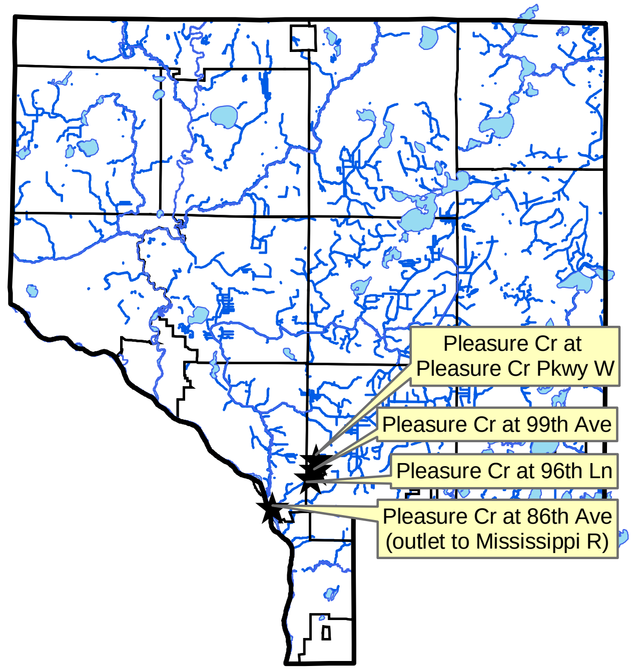
Results: Results for each stream are presented on the following pages.

Six Cities Watershed Stream Chemical Water Quality Monitoring Sites



PLEASURE CREEK

at Pleasure Creek Parkway West, north side of loop, Blaine	STORET SiteID – S005-636
at 99th Ave NE, Blaine	STORET SiteID – S005-637
at 96th Lane NE, approximately the Blaine-Coon Rapids boundary	STORET SiteID – S005-263
at 86th Ave NW, South end of Coon Rapids Dam Park, Coon Rapids	STORET SiteID – S003-995



Years Monitored (from up to downstream)

At Pleasure Creek Parkway West - 2009
At 99th Ave NE - 2009
At 96th Ln NE (Blaine-Coon Rapids city boundary) – 2008
At 86th Ave (outlet to Mississippi) - 2006 and 2007

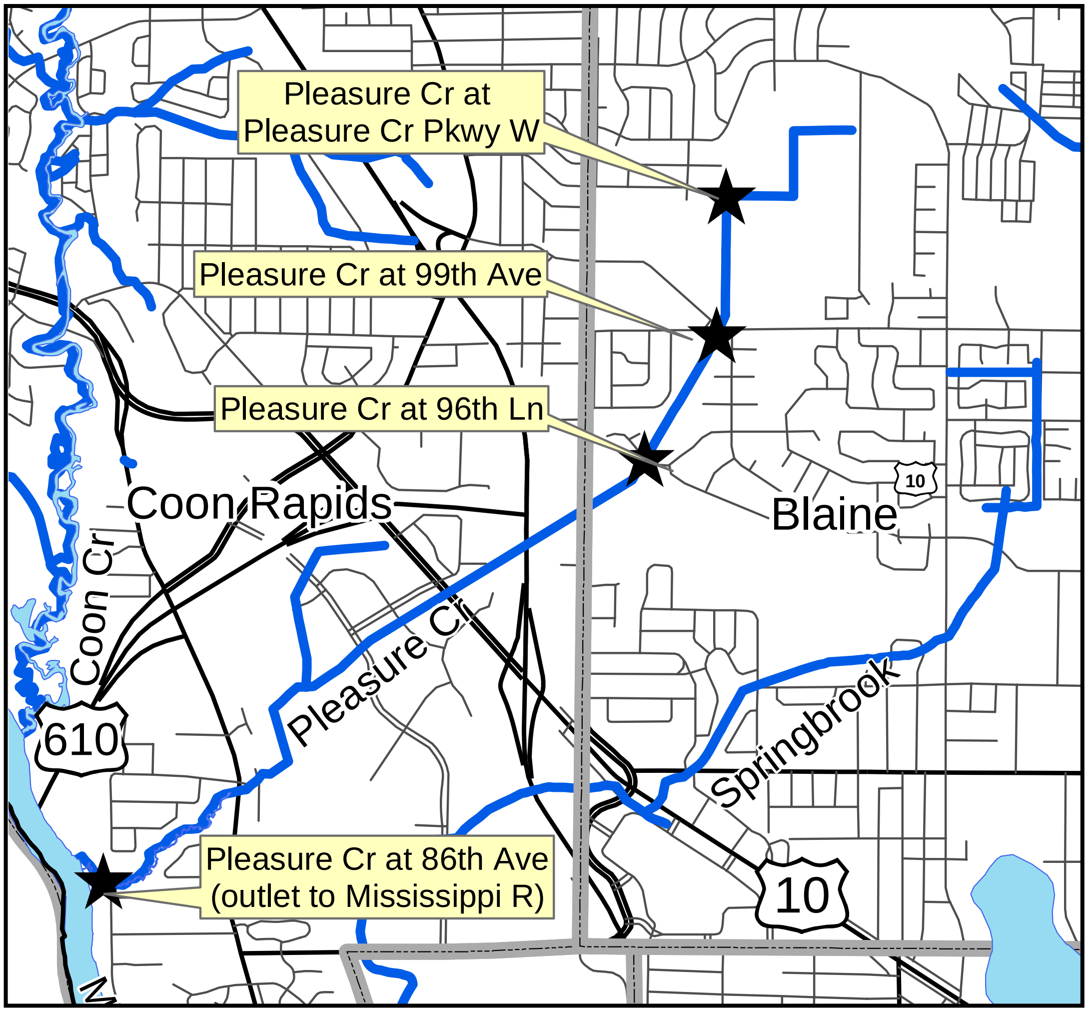
Background

Pleasure Creek flows through the southwestern portion of Blaine and southern Coon Rapids. The watershed is highly urbanized. The creek is about 8-10 feet wide and 0.5 to 1 foot deep during baseflow. The creek flows through an interconnected network of stormwater ponds in the upper part of the watershed. Past monitoring near the creek's outlet to the Mississippi River has 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. 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.

Methods

Water quality problems in Pleasure Creek were first noticed by students from Blaine High school involved in invertebrate biomonitoring of the stream. Chemical monitoring of the creek began in 2006 and 2007 at the outlet to the Mississippi River. Poor water quality was found, including high dissolved pollutants, suspended solids, and E. coli. Upstream monitoring was conducted in 2008 and 2009 to diagnose the problems. The 2008 monitoring site at 96th Lane was chosen because it is roughly mid-way between the headwaters and outlet to the Mississippi River, and because it is approximately at the boundary between the Cities of Blaine and Coon Rapids (see maps on following pages). In 2009 monitoring moved farther upstream and included two sites (see maps on following pages). The 99th Avenue stream crossing was monitored because it is the outlet of a network of stormwater ponds at Pleasure Creek's headwaters. The second site at Pleasure Creek Parkway West was selected because it split the stormwater ponds into two subwatersheds, allowing us to further localize any problems. This report incorporates the results of monitoring from all years and all sites.

Pleasure Creek Monitoring Sites



2009 Monitoring Locations Map. The upstream (northern) site splits the network of stormwater ponds, providing data for drainage from the first three northernmost stormwater ponds and their attached stormwater conveyances. The downstream site at 99th Avenue monitors the output of all stormwater ponds and their attached stormwater conveyances. Map source: City of Blaine

In each year Pleasure Creek was visited 8-9 times for water quality monitoring. Prior to 2009, half of these events were immediately after a storm (generally more than 1-inch of precipitation in 24 hours), while half were during baseflow conditions. In 2009 six of eight samples occurred during or after storms because problems were found to be more prevalent during storms and because of intermittent flows. Many storms sampled in 2009 were less than 1-inch but greater than 0.4-inches, in part because few large storms occurred in that year. Parameters measured on-site with hand-held electronic meters included pH, conductivity, turbidity, dissolved oxygen, temperature, and salinity. Water samples were sent to a state-certified lab for measurement of total phosphorus, chlorides, total suspended solids, and E. coli bacteria. E. coli samples were sent by courier to an analytical laboratory generally within 2-3 hours of sampling, but nonetheless most samples slightly exceeded the 6 hour holding for this test before analysis began. This minor exceedance of the holding time likely had minimal affect on the results, but does invalidate their use for certain uses such as impaired waters determinations by state agencies.

Results and Discussion

Despite the fact that upstream and downstream monitoring occurred in different years, some data comparison is possible and provides insight into problems. For that reason, results of all years are presented together. Each pollutant type is discussed separately below. The nature of the problem is different for each.

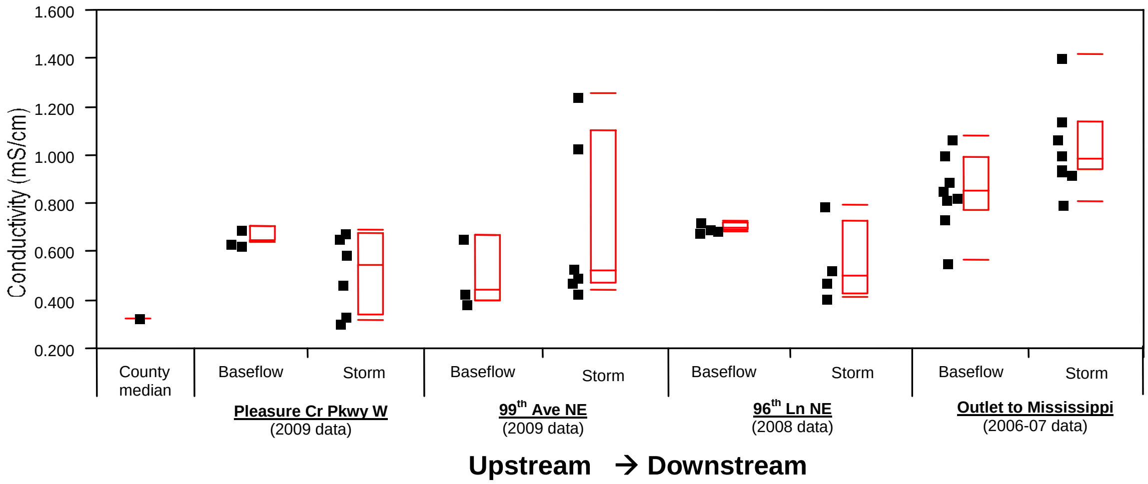
Dissolved Pollutants – conductivity, chlorides, and salinity

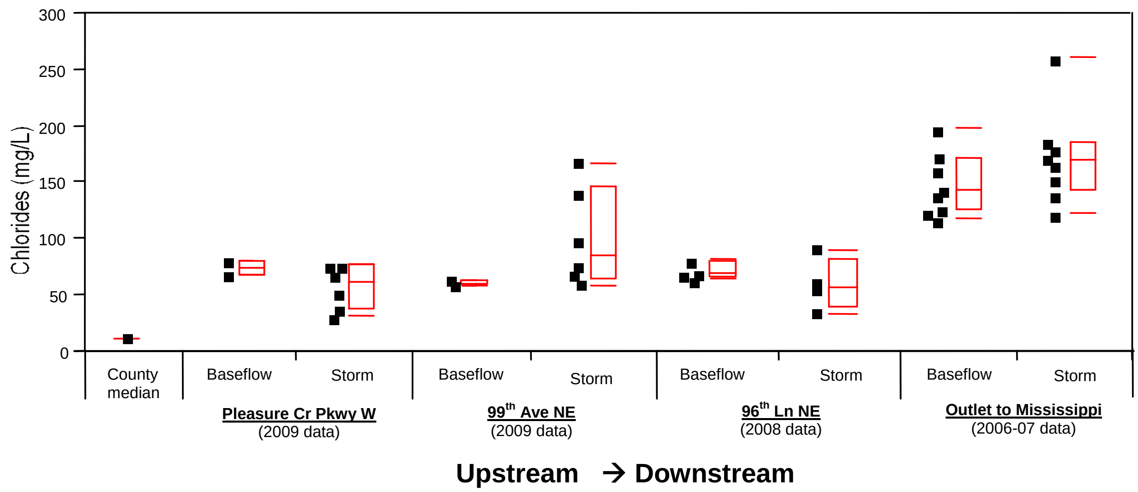
Dissolved pollutants include road salts, metals, hydrocarbons, and many others. Three of the parameters tested (conductivity, chlorides, and salinity) measure dissolved pollutants (see figures below). Conductivity is a general measure of dissolved pollutants, salinity measures salts, and chlorides are most often associated with road salts but are also present elsewhere, such as in wastewater. None measures a single pollutant. All three were high and increased from upstream to downstream. The increase between the uppermost three monitoring sites (i.e. in the City of Blaine) was small, likely because these sites are in close proximity to eachother. Greater increases were observed between the two downstream monitoring sites in the City of Coon Rapids but this is not surprising because these monitoring sites are farther apart and a larger portion of the watershed is between them.

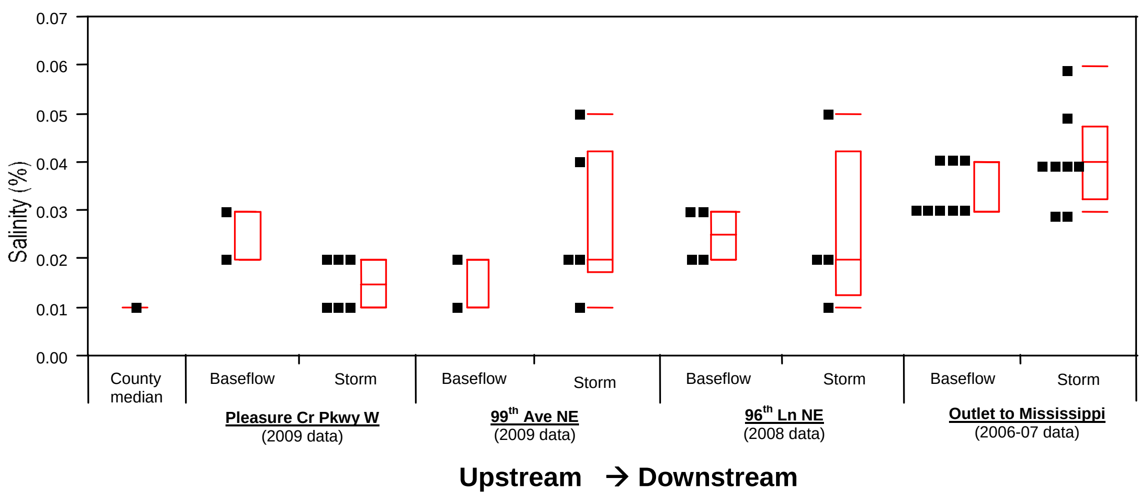
At the outlet to the Mississippi River dissolved pollutants in Pleasure Creek were among the highest observed in Anoka County, but similar to other streams in urban settings. Median conductivity was 0.945 mS/cm or three times higher than the county-wide median and the third highest among 41 Anoka County streams that have been tested (nearby Springbrook was second highest). Median chlorides at the outlet to the Mississippi was 159 mg/L, which is the second-highest of any Anoka County stream (Springbrook was highest). Chloride levels occasionally approached the Minnesota Pollution Control Agency's (MPCA) chronic standard for aquatic life of 230 mg/L, and in some cases exceed it (maximum observed was 262 mg/L). Salinity averaged about four times higher than other Anoka County streams.

At the upstream monitoring sites dissolved pollutants were lower, but were still substantially higher than other streams in the county. At the Blaine-Coon Rapids City boundary (96th Lane) conductivity averaged 0.643 mS/cm, or two times higher than the median of other Anoka County streams. At 99th Avenue and Pleasure Creek Parkway West (near the stormwater ponds at the headwaters of Pleasure Creek) median conductivity was 0.509 and 0.643 mS/cm, respectively, compared to the county-wide median of 0.318 mS/cm. Chlorides at those same locations had medians of 71 and 70 mg/L, respectively, which is more than five times higher than the county-wide median of 12 mg/L.

Dissolved Pollutant 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).







Urban stormwater is likely the most important source of dissolved pollution. No one neighborhood or city seems to contribute disproportionately to the problem; the source is diffuse. Urban storm water is known to generally carry high levels of dissolved pollutants. The Pleasure Creek watershed is densely populated and has a high percentage of impervious surfaces. In the older areas, the stormwater treatment measures in place are much less than would be required of a similar development built today. While up-to-date stormwater treatment such as settling ponds, street sweeping and catch basins do exist in part of the watershed, these practices are designed to remove particulate pollutants, and do not effectively remove dissolved pollutants. The fact that other nearby streams, such as Springbrook, have similar dissolved pollutant levels further suggests that urban stormwater is an important source. The low phosphorus in Pleasure Creek suggests that high dissolved pollutants are likely due to inorganic chemical inputs, not organic nutrient-rich inputs like those found in wastewater (see phosphorus section later in this report).

Given that dissolved pollutant concentrations are similar during baseflow and stormflow, urban stormwater is not likely the only contributor. Dissolved pollutants during baseflow are from one or more of the following:

a. Dissolved pollutants that have permeated into the shallow groundwater that feeds the stream during baseflow.
b. Continuous discharges to the creek, such as industrial wastes or illicit discharges through the stormwater conveyance system.
c. Storm water ponds upstream which may retain pollutants from storms and release them to the creek continuously.

In any case, there are multiple sources of dissolved pollutants to Pleasure Creek. Given that removal of these once they enter the environment is difficult, every effort to prevent them should be made.

Turbidity and Suspended Solids

Turbidity and total suspended solids 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. The types of stormwater treatment practices used most in the Pleasure Creek watershed, such as street sweeping, sumps, and stormwater settling ponds are most effective at removing sediment and attached pollutants. Suspended solids in Pleasure Creek are low, except in downstream reaches during storms.

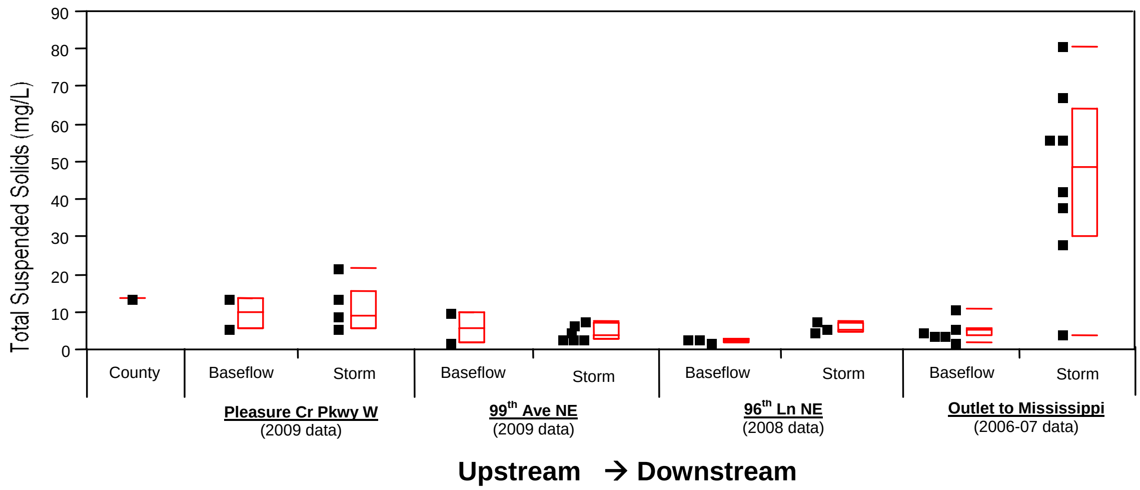
Upstream portions of Pleasure Creek have low turbidity and suspended solids (see figures on following page). Total suspended solids (TSS) is nearly always lower than the county-wide average at all monitoring sites except the outlet to the Mississippi River. At these same sites, turbidity occasionally exceeded the county-wide median, but only 2 of 26 (7.7%) turbidity readings exceeded the state's impairment threshold of 25 NTU. While turbidity and suspended solids are at good (low) levels throughout the upper reaches of Pleasure Creek, high levels regularly occur in the lower portions of the creek.

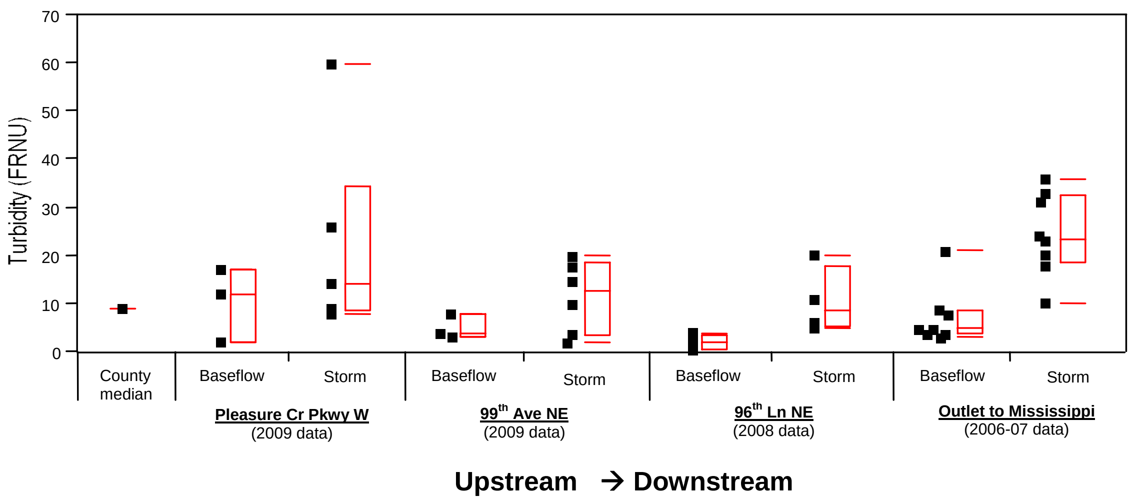
Suspended solids were high, but only during storms, at the creek's outlet to the Mississippi River. Eight storm events have been monitored at that location. Seven had TSS above the median of Anoka County streams, and ranged from 28 to 81 mg/L. Turbidity was higher too, ranging from 18 to 36 FNRU during the same seven storms. Non-storm suspended solids at this site were acceptably low.

Because of the positioning of monitoring sites, we can confidently say that high suspended solids during storms originate within the City of Coon Rapids. This is the oldest developed portion of the watershed and has fewer stormwater treatment facilities. The source of suspended solids is likely materials swept into the creek through storm water conveyances, but may also include spot erosion of the stream bank. Corrective actions should include:

- Heightened best management practices that keep suspended materials from reaching stormwater conveyances, such as street sweeping, settling ponds, swales, and others.
- Reduction of storm flow velocities in the creek by improving storm water detention or infiltration throughout the watershed. This will reduce the size of particles that can be carried and reduce streambank erosion.

Total Suspended Solids and Turbidity 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).





E. coli Bacteria

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 because of confusion about whether the analytical methods used for testing were state-approved, 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 site 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.

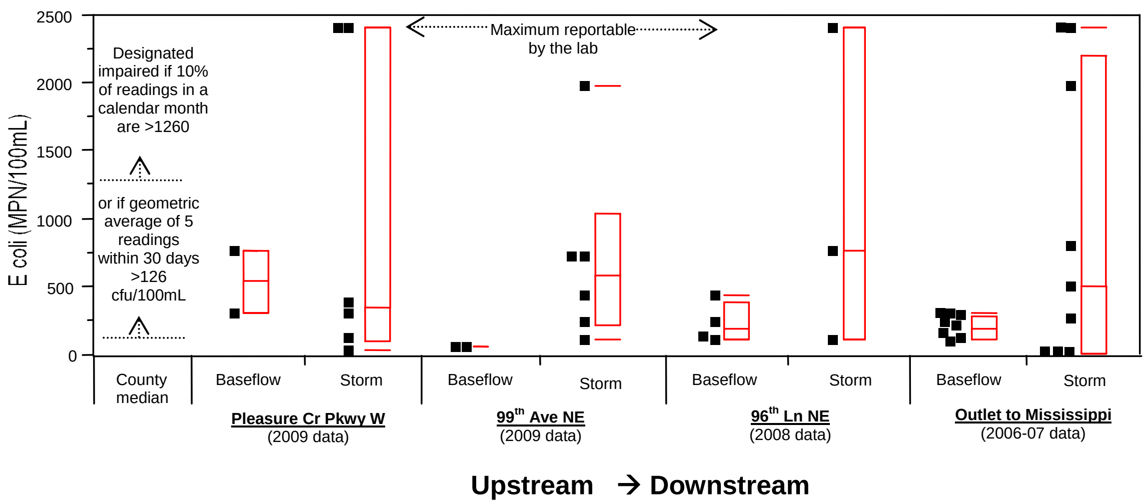
The monitoring site mid-way through the pond network (Pleasure Cr Parkway W) did have elevated E. coli during baseflow and storms, which suggests that the small drainage area upstream of this site contributes E. coli to the creek. Only two baseflow samples were taken and little flow was moving; E. coli levels were 307 and 770 MPN/100mL, which is moderately high. This would seem to suggest that bacteria levels my 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). Again, 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
Human	4.4
Duck	0.6
Sheep	0.4
Chicken	0.4
Pig	0.4
Cow	0.2
Turkey	0.1

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).

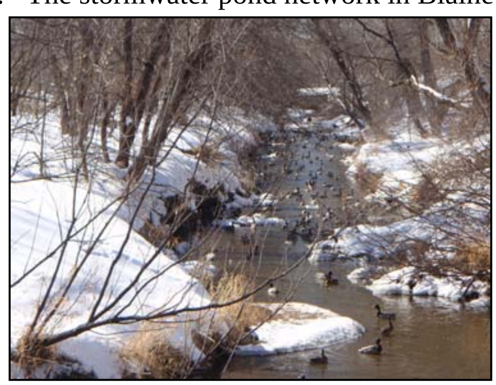
Likely bacterial sources include:

- **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 it's 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 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 congregating on Pleasure Creek near Evergreen Blvd in Coon Rapids, February 2010. 250+ ducks were present in about 350 meters of creek.

- **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.

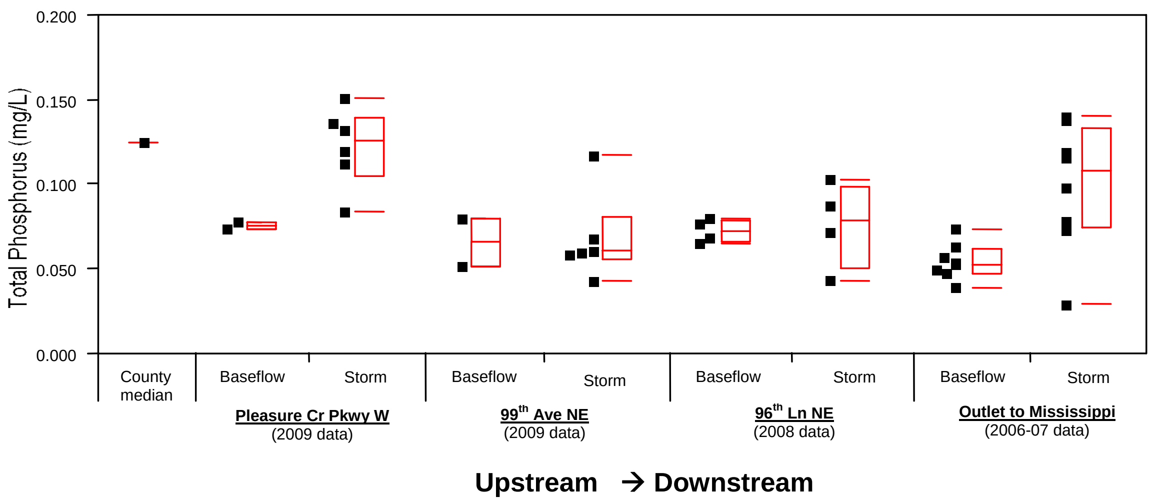
It is worth noting that understanding of E. coli impairments and tools to effectively address them are lacking. Historically, E. coli was viewed as an indicator of sewage pollution. In some cases it is. Today we know E. coli levels are elevated in virtually every urban environment, most animal agriculture 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.

Phosphorus

Phosphorus in Pleasure Creek is low. This nutrient is one of the most common pollutants in our region, and can be associated with urban runoff, agricultural runoff, wastewater, and many other sources. In Pleasure Creek total phosphorus was consistently lower than the median for Anoka County streams at both the upstream and downstream monitoring sites. It was highest at Pleasure Creek Parkway West, but this is not surprising given that this site is within a network of stormwater ponds designed to capture these pollutants. At the downstream end of the stormwater ponds phosphorus was lower. This is evidence that the ponds are effectively removing that pollutant.

The lack of nutrient inputs despite high levels of other dissolved pollutants and E. coli lends some insight into the source of the pollutants. High dissolved pollutants are likely due to inorganic chemical inputs, not organic nutrient-rich inputs like those found in wastewater. Likewise, it indicates that the source of E. coli is not likely to be active inputs of wastewater.

Phosphorus 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).



Other Parameters

Dissolved oxygen and pH were at acceptable levels commonly found in the area.

Raw Data

Raw data from all Pleasure Creek monitoring sites can be obtained online or by contacting the Anoka Conservation District. All data was submitted to the US Environmental Protection Agency's STORET database and can be downloaded from the MN Pollution Control website at http://www.pca.state.mn.us/data/edaWater/index.cfm. The Anoka Conservation District phone is 763-434-2030.

Pleasure Creek Recommendations

Pleasure Creek has water quality problems that affect aquatic life, recreation, and pose a health threat to humans that contact the water. Because Pleasure Creek is a tributary to the Mississippi River, there are also concerns about the creek's effect on the river. While the volume of water contributed to the Mississippi is relatively small, its effects could be greater due to the poor water quality. The river is an important ecosystem and serves as a drinking water source for many downstream communities, including the Cities of St. Paul and Minneapolis who have their drinking water intakes just downstream of the confluence of Pleasure Creek and the Mississippi. This drinking water is treated before consumption but it is highly desirable to avoid pollutants rather than try to remove them later. Because of the magnitude and chronic nature of water quality problems in Pleasure Creek, and because of the effects on ecosystems and humans, improving Pleasure Creek water quality should be a high priority for the Six Cities Watershed Management Organization, Cities of Blaine and Coon Rapids, Anoka Conservation District, MN Pollution Control Agency, and others.

Work done to date provides sufficient understanding to take action. Recommended actions include:

a. Action: Clean stormwater ponds frequently
Target: E. coli
Description: The network of stormwater ponds that the creek flows through in Blaine should receive regular removal of accumulated sediments and trash. The shallower, smaller ponds should be of highest priority for more frequent cleaning. The goal should be to remove organic materials and sediment that provide a substrate for bacterial growth. While the ponds are effectively removing suspended solids and phosphorus, maintaining the ponds will improve their effectiveness.

b. Action: Catch basin testing, increased cleaning
Target: E. coli
Description: By testing water and sediment from catch basins during dry weather conditions it can be determined if they are acting as reservoirs for bacterial survival. If E. coli concentrations are high, more frequent cleaning should be considered. This activity should be targeted in the Blaine neighborhoods draining to stormwater ponds first because of the known issues in that area. If problems are found there, similar work in Coon Rapids should occur.

c. Action: Targeted public education
Target: Dissolved pollutants, E. coli, and suspended solids
Description: Given that the likelihood of contact with water is low, especially during storms when E. coli is highest but flows are most hazardous, the focus of public education need not be water contact advisories. Instead, a blended public education messages that states the risks and problems but focuses on changing behaviors that will alleviate the problem should be undertaken.

d. Action: Stormwater Audit
Target: Dissolved pollutants, E. coli, and suspended solids
Description: A comprehensive assessment of the watershed for opportunities to improve stormwater treatment and ranking of those opportunities by cost-effectiveness should be undertaken. A focus should be practices that most effectively address bacteria, dissolved pollutants, and reducing storm flow rate and volume. Project and practices identified through this process should be installed. The Anoka Conservation District has staff specialized in this process and can assist.

e. Action: Consider cooperating with the Upper Mississippi River bacteria TMDL study.
Target: E. coli
Description: Another action that should be considered is joining the Upper Mississippi Bacteria TMDL Study. The Minnesota Pollution Control Agency will begin this study in 2010. They are seeking partners for monitoring, and will at least partially fund it. Their monitoring will be more intense, but less diagnostic. More may be learned through this monitoring, but the more substantial benefit of joining this project would be access to funds for correcting the problem after the study is done.

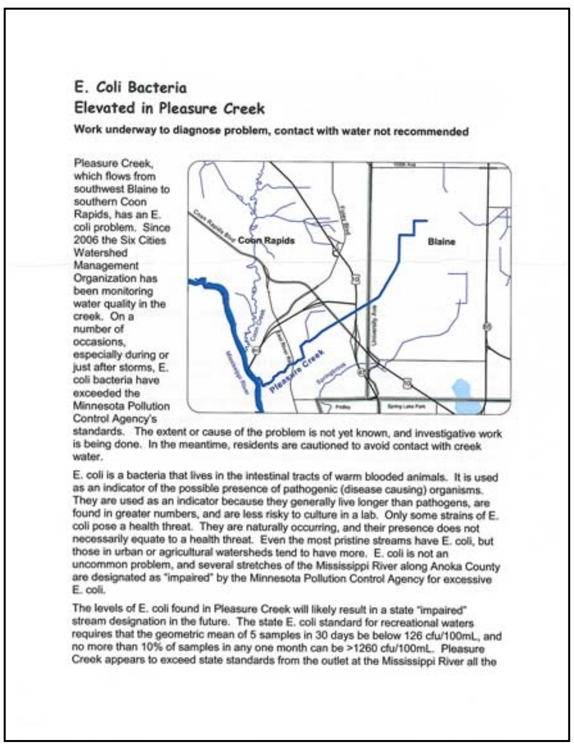
Public Education – Pleasure Creek E. coli Impairment

Description: Pleasure Creek has been monitored for E. coli in several recent years and elevated E. coli levels have been found, especially after storms. While the MN Pollution Control Agency has not yet designated the creek as "impaired" for E. coli, it will likely receive that designation in the near future. Given that a detailed understanding of the problem was not immediately available and therefore corrective actions were not imminent, the SCWMO educated the public about the problem, potential health threats, and actions they can take to minimize health threats.

E. coli is a bacteria that resides in the intestinal tracts of warm blooded animals. It is used as an indicator of the possible presence of a wide variety of pathogenic organisms. They are used as an indicator because they generally live longer than pathogens, are found in greater numbers, and are less risky to culture in a lab. Only some strains of E. coli pose a health threat. They are naturally occurring and their presence does not necessarily equate to a health threat. Even the most pristine streams have E. coli.

Purpose: To educate the public about E. coli water quality standard violations in Pleasure Creek.

Results: An educational campaign was initiated to notify the residents in the communities of Blaine and Coon Rapids via city newsletters. In June 2009 the Anoka Conservation District drafted a newsletter article on behalf of the SCWMO. The article included background on E. coli, a summary of data collected on Pleasure Creek, and cautionary actions that residents can take. The article also contained statements that E. coli is present in all streams, but the US EPA determines what levels pose an unacceptable risk. This article was emailed to the cities of Blaine and Coon Rapids for inclusion in their city newsletters.



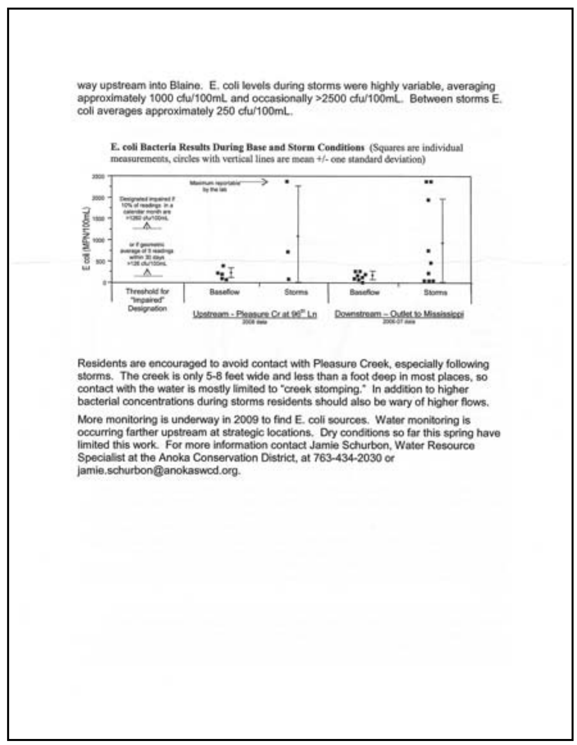
E. Coli Bacteria
Elevated in Pleasure Creek

Work underway to diagnose problem, contact with water not recommended

Pleasure Creek, which flows from southwest Blaine to southern Coon Rapids, has an E. coli problem. Since 2006 the Six Cities Watershed Management Organization has been monitoring water quality in the creek. On a number of occasions, especially during or just after storms, E. coli bacteria have exceeded the Minnesota Pollution Control Agency's standards. The extent or cause of the problem is not yet known, and investigative work is being done. In the meantime, residents are cautioned to avoid contact with creek water.

E. coli is a bacteria that lives in the intestinal tracts of warm blooded animals. It is used as an indicator of the possible presence of pathogenic (disease causing) organisms. They are used as an indicator because they generally live longer than pathogens, are found in greater numbers, and are less risky to culture in a lab. Only some strains of E. coli pose a health threat. They are naturally occurring, and their presence does not necessarily equate to a health threat. Even the most pristine streams have E. coli, but those in urban or agricultural watersheds tend to have more. E. coli is not an uncommon problem, and several stretches of the Mississippi River along Anoka County are designated as "impaired" by the Minnesota Pollution Control Agency for excessive E. coli.

The levels of E. coli found in Pleasure Creek will likely result in a state "impaired" stream designation in the future. The state E. coli standard for recreational waters requires that the geometric mean of 5 samples in 30 days be below 126 cfu/100mL, and no more than 10% of samples in any one month can be >1260 cfu/100mL. Pleasure Creek appears to exceed state standards from the outlet at the Mississippi River all the



way upstream into Blaine. E. coli levels during storms were highly variable, averaging approximately 1000 cfu/100mL and occasionally >2500 cfu/100mL. Between storms E. coli averages approximately 250 cfu/100mL.

E. coli Bacteria Results During Base and Storm Conditions (Squares are individual measurements, circles with vertical lines are mean +/- one standard deviation)

Residents are encouraged to avoid contact with Pleasure Creek, especially following storms. The creek is only 5-8 feet wide and less than a foot deep in most places, so contact with the water is mostly limited to "creek stomping." In addition to higher bacterial concentrations during storms residents should also be wary of higher flows.

More monitoring is underway in 2009 to find E. coli sources. Water monitoring is occurring farther upstream at strategic locations. Dry conditions so far this spring have limited this work. For more information contact Jamie Schurbon, Water Resource Specialist at the Anoka Conservation District, at 763-434-2030 or jamie.schurbon@anokaswcd.org.

Article submitted to the cities of Blaine and Coon Rapids for inclusion in city newsletters.

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, and sometimes with grant funding from the watershed organization or the Anoka Conservation District.

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 are described individually below.

Hogetvedt Rain Garden – completed 2009

The Hogetvedt's installed a rain garden at their residence at the corner of Sylvan Lane and Rainbow Street. The rain garden captures and treats street runoff in the Oak Glen Creek watershed. Oak Glen Creek suffers from serious erosion problems because of excessive volumes and rates of stormwater. This rain garden is ideally situated at the bottom of a slope and just upstream of a gutter. It is a curb-cut style rain garden which treats water that would otherwise enter the curbside gutter. The garden includes an approximately 27 ft x 6 ft planting area and a boulder retaining wall which helps provide additional storage volume and is aesthetically pleasing. The garden is functioning well by trapping sediment and infiltrating water.

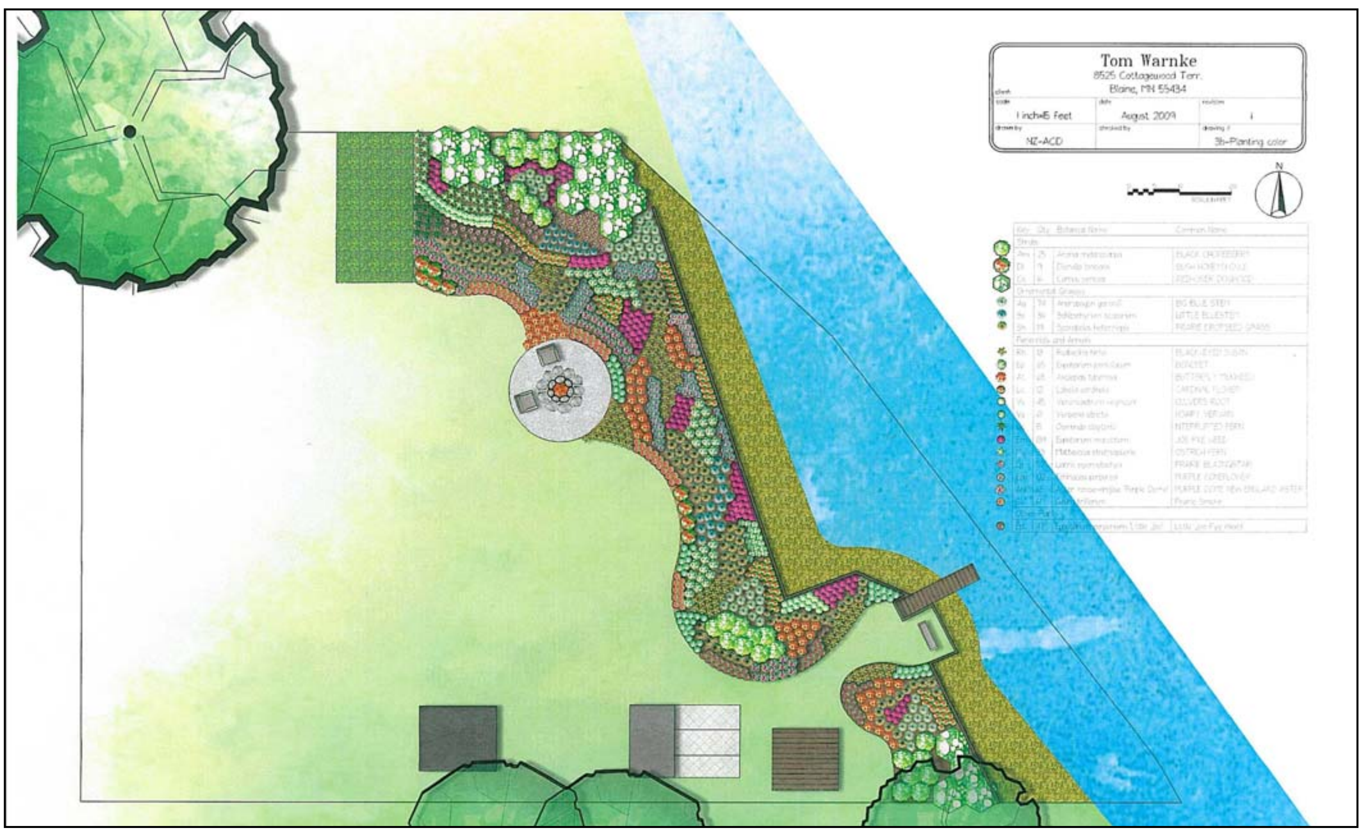
This rain garden was a partnership of the Hogetvedt's, the City of Fridley, and the Anoka Conservation District. The Hogetvedt's provided labor and some materials. The City of Fridley performed the curb cut and excavation. The Anoka Conservation District provided a grant for certain materials expenses and advised the design and construction. Ongoing maintenance will be the landowner's responsibility.

Warnke Lakeshore Restoration – planned for 2010

Laddie Lake

The Warnke property is on the West side of Laddie Lake in the City of Blaine. Currently there is very little lakeshore vegetation other than turf grass and some shrubs planted by the landowners. The owners would like to improve their shoreline and protect water quality by planting a buffer. Native plugs will be used to establish a buffer above the existing timber wall. A transitional/wet soil seed mix will be raked into the soil below the wall and above the normal water level. Wildlife exclusion fencing will be used to protect the shoreline and seeding from geese. Ultimately, this buffer will filter and infiltrate surface runoff from the property as well as provide shoreline stabilization and habitat.

The Anoka Conservation District is coordinating this project. The ACD has approved a grant to the landowners for a portion of the materials costs for this project, created the project design (below) and will advise installation. Installation is planned for 2010.



Hanley Streambank Stabilization –2008-2010

Oak Glen Creek

The Hanley property lies along Glen Creek where it flows into the Mississippi River. The site consists of a steep slope from the top of the property to the creek 30 feet below. Active erosion and bank undercutting has led to severe bank failure that will threaten the Hanley residence in the future. To correct this situation, large-scale re-grading and slope protection are needed. Stormwater rate and volume reductions throughout the watershed will provide long-term prevention of future problems here and elsewhere.

In 2008 a cedar tree revetment was installed to slow erosion and buy time for a larger scale project to take shape. Cedar tree revetments involve anchoring cut cedar trees to the bank. Benefits include improved fish and wildlife habitat, repair of bank undercutting and erosion, and prevention of future erosion.

In 2008, the Anoka Conservation District received a grant to hire an engineering firm to create a stabilization plan for the entire Glen Creek Corridor. The plan has been under development and should be completed in early 2010. At that point, it will be presented to landowners for feedback. ACD will continue to work with landowners and the City of Fridley to address project funding issues and to facilitate implementation should landowners want to move forward with the project.

A stormwater assessment for the Glen Creek watershed is also planned to identify opportunities to reduce stormwater rate and volume, as well as improve water quality. This effort is being coordinated by the Anoka Conservation District and the City of Fridley.

Anoka County Geologic Atlas

Description: A map-based report of groundwater and geology to be used for community planning and groundwater management. The Atlas provides detailed information about groundwater:

- Aquifers, including identifying future water sources,
- Aquifer sustainability,
- Recharge areas,
- Sensitivity to pollution,
- Flow directions,
- Connections to lakes, streams, and wetlands,
- Chemistry,
- Wellhead protection, and others...

Results are provided as GIS files and paper maps, and are especially useful to community planners.

Geologic Atlases are a partnership of the MN Geological Survey, MN DNR, and local governments. 94% of funding was secured by the MN Geological Survey (MGS) and MN Department of Natural Resources (DNR) from the Legislative-Citizen Commission for Minnesota Resources (LCCMR). A required local contribution totaling 6% of project expenses was provided by the seven Anoka County watershed organizations and the Anoka Conservation District. Completion of the project requires 4-5 years.

Purpose: To gain knowledge about groundwater and geology that enables improved management of groundwater, including availability, pollution prevention, and pollution management.

Locations: Throughout Anoka County

Results: An Anoka County Geologic Atlas began in 2009 with financial support from all seven Anoka County Watershed Management Organizations and the Anoka Conservation District. These funds were used to locate approximately 9,500 groundwater wells, with approximately an additional 500 to be located in early 2010. Boring logs from these wells and others already in the County Well Index will be used to create the geologic atlas. The MGS has already begun the process of using these wells to create the geologic atlas. Thereafter the DNR will perform a groundwater analysis for the atlas. In total, the geologic atlas is expected to be completed around 2014.

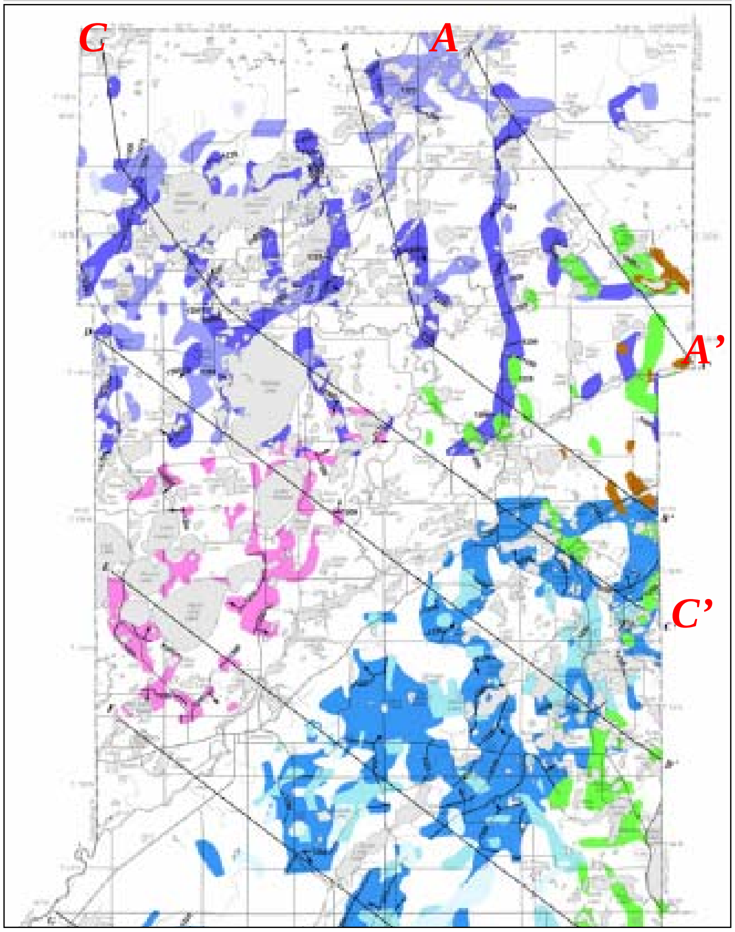
An example of portions of a geologic atlas from Crow Wing County are on the following page.

Example Geologic Atlas Work Products

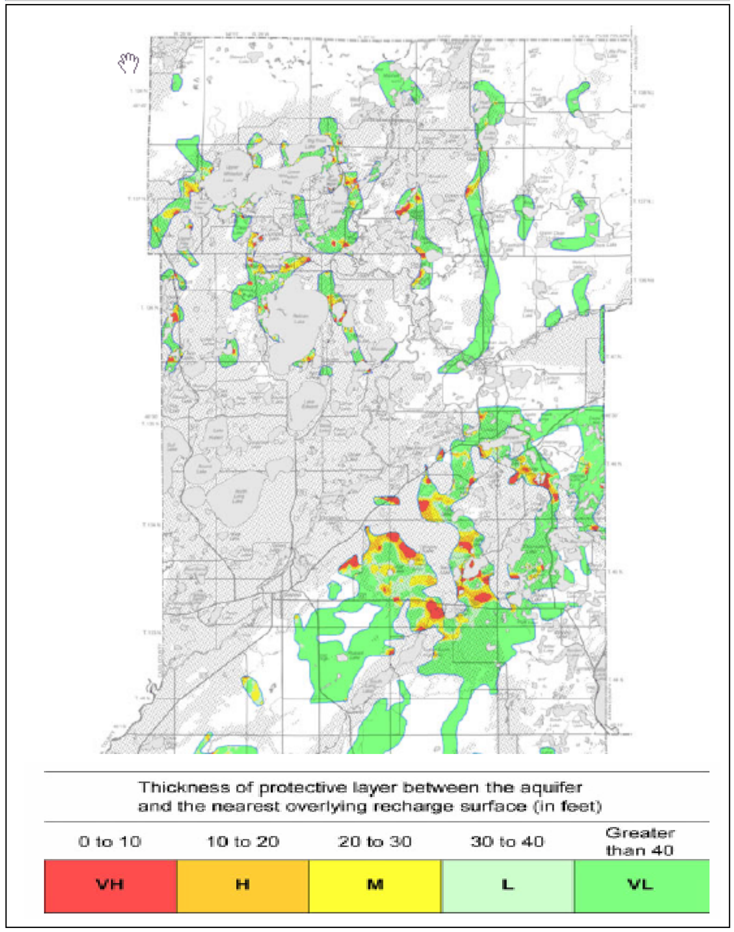
Crow Wing County Geologic Atlas

Excerpted from: Peterson, T. 2008. Hydrogeology, Pollution Sensitivity, and Lake and -Groundwater Interaction. MN Ground Water Association Newsletter 27-3.

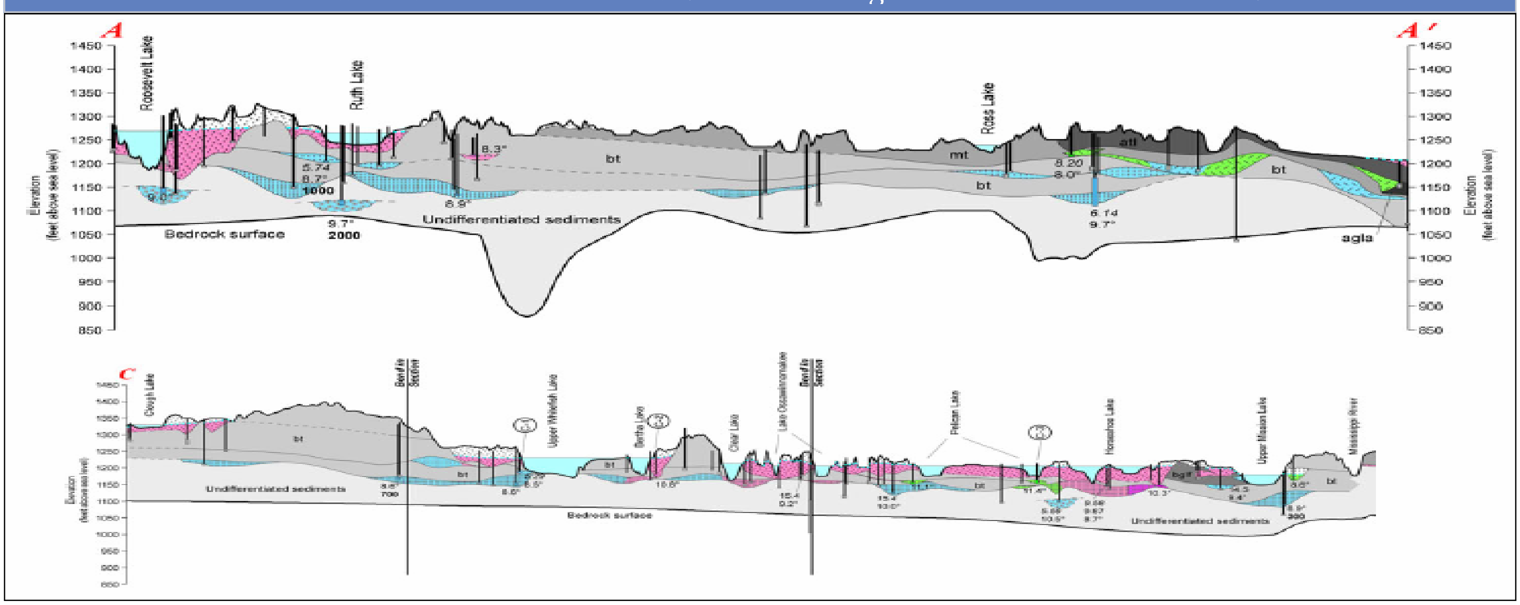
Extent and Distribution of Buried Aquifers Including Direction of Flow



Pollution Sensitivity of Buried Aquifers



Selected hydro-geologic cross sections showing groundwater residence time. Cross sections A-A' and the Northwest 2/3 of C-C' are shown. See above figure for cross section location.



SCWMO Website

Description: The Six Cities Watershed Management Organization (SCWMO) contracted the Anoka Conservation District (ACD) to design and maintain a website about the SCWMO and the Six Cities watershed. The website has been in operation since 2003. The SCWMO pays the ACD annual fees for maintenance and update of the website.

Purpose: To increase awareness of the SCWMO 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 SCWMO's alternative to a state-mandated newsletter.

Location: www.AnokaNaturalResources.com/SCWMO

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

Information about the SCWMO includes:

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

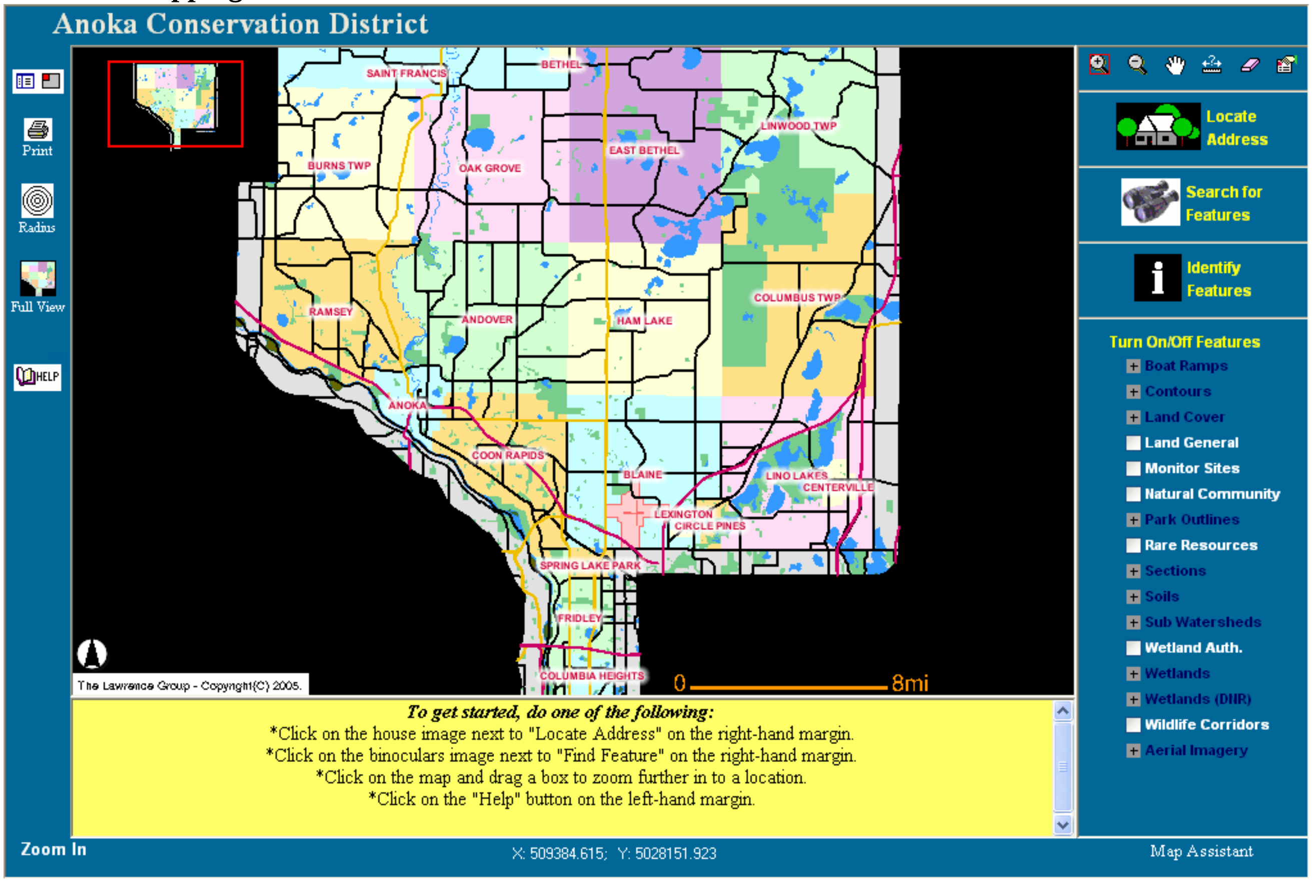
Other tools on the website include:

- 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

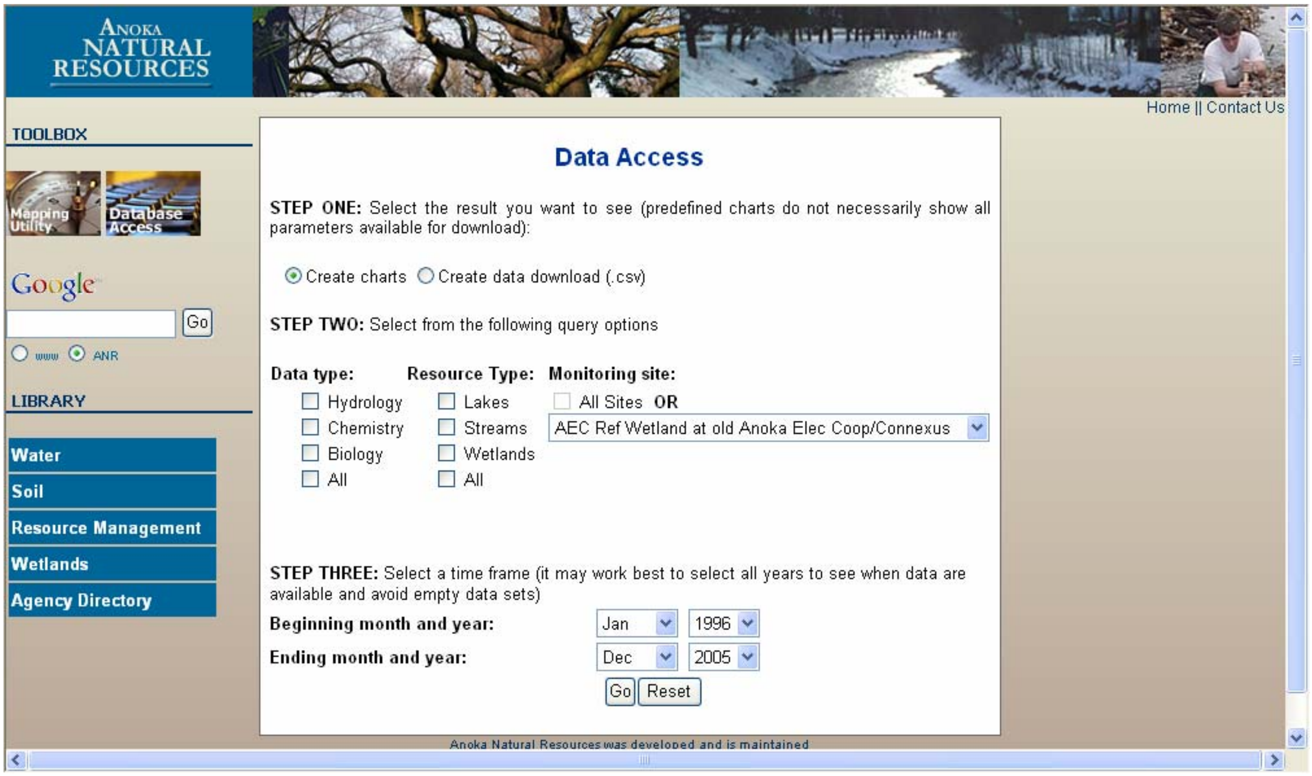
SCWMO Website Homepage - www.AnokaNaturalResources.com/SCWMO

more on next page

Interactive Mapping Tool



Interactive Data Access Tool



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.

Six Cities Watershed Financial Summary

Six Cities Watershed	Website	Lake Lvl	Stream WQ	Geologic Atlas	E. Coli Educ	Total
Revenues						
SCWMO	370	240	2439	1310	268	4627
State	0	0	0	0	0	0
Anoka Conservation District	1523	37	579	354	107	2599
County Ag Preserves	0	0	0	0	0	0
Other Service Fees	0	0	0	4	0	4
Local Water Planning	0	0	0	0	0	0
TOTAL	1893	277	3018	1668	375	7230
Expenses-						
Capital Outlay/Equip	4	1	5	16	0	26
Personnel Salaries/Benefits	1061	241	2054	1488	339	5183
Overhead	71	17	134	73	15	310
Employee Training	12	4	36	12	1	66
Vehicle/Mileage	15	4	31	26	4	80
Rent	52	11	87	46	15	211
Program Participants	0	0	0	0	0	0
Program Supplies	676	1	671	7	0	1354
Equipment Maintenance	0	0	0	0	0	0
TOTAL	1893	277	3018	1668	375	7230
NET	0	0	0	0	0	0

Recommendations

- **The SCWMO Watershed Plan, currently under revision, should provide plans to address multiple water quality problems.** Within the watershed there are two impaired lakes (Sullivan and Highland), two impaired streams (Pleasure and Springbrook) and one lake with declining water quality (Laddie).
- **Perform E. coli reduction strategies in Pleasure Creek**, including cleaning stormwater facilities more frequently, targeted public education, and an assessment of the entire watershed to determine opportunities to improve water quality by retrofitting the stormwater system. Install these practices.
- **Conduct an assessment of the Oak Glen Creek watershed** to identify opportunities to reduce stormwater rates and volumes, as well as water quality. Install these practices.
- **Structure all investigative work to fit into future TMDL studies.**
- **Reduce the frequency of lake and stream water quality monitoring**. An adequate baseline of data currently exists, so future monitoring should be focused upon detecting changes, especially changes resulting from land use and management change