South Washington Watershed District

2010 Monitoring Report

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South Washington Watershed District

Contents

Acronyms and Abbreviations

CAMP……Citizen-Assisted Lake Monitoring Program
cfs……cubic feet per second
Chl *a*……Chlorophyll *a*
CS……Chronic Standard
DO……Dissolved Oxygen
E. Coli……*Escherichia coli*
FAV……Final Acute Standard
mg/L……milligram per liter
MnDNR……Minnesota Department of Natural Resources
MnPCA……Minnesota Pollution Control Agency
MS……Maximum Standard
OHW……Ordinary High Water Elevation
Ortho-P……Ortho-phosphate
RAL……Regional Assessment Location
SWWD……South Washington Watershed District
TKN……Total Kjeldahl Nitrogen
TMDL……Total Maximum Daily Load
TP……Total Phosphorus
TSI……Trophic State Index
TSS……Total Suspended Solids
µg/L……microgram per liter
VSS……Volatile Suspended Solids
WCD……Washington Conservation District
WMP……Watershed Management Plan

Executive Summary

SWWD's monitoring programs are organized based on a Regional Assessment approach. By following a regional assessment approach, monitoring is focused on key crossings and checkpoints throughout the District. Data from those monitoring locations is used to identify regional issues for further investigation. In addition to monitoring at Regional Assessment Locations, SWWD conducts subwatershed assessment monitoring, participates in the Metropolitan Council's Citizen Assisted Monitoring Program (CAMP), and limited monitoring of groundwater levels.

In 2010, SWWD operated 8 Regional Assessment Locations, 5 Subwatershed Assessment Locations, participated in the CAMP program which monitored 7 lakes, conducted additional stormwater monitoring in watersheds of 2 lakes, monitored surface elevation on 2 additional lakes, and continued long term monitoring of groundwater levels near the District's regional infiltration facilities. This executive summary provides an overview of major findings from the 2010 monitoring data. The body of the Monitoring Report summarizes and presents data collected in 2010. Year to year analysis is performed following odd monitoring years and will be performed again for the 2011 report.

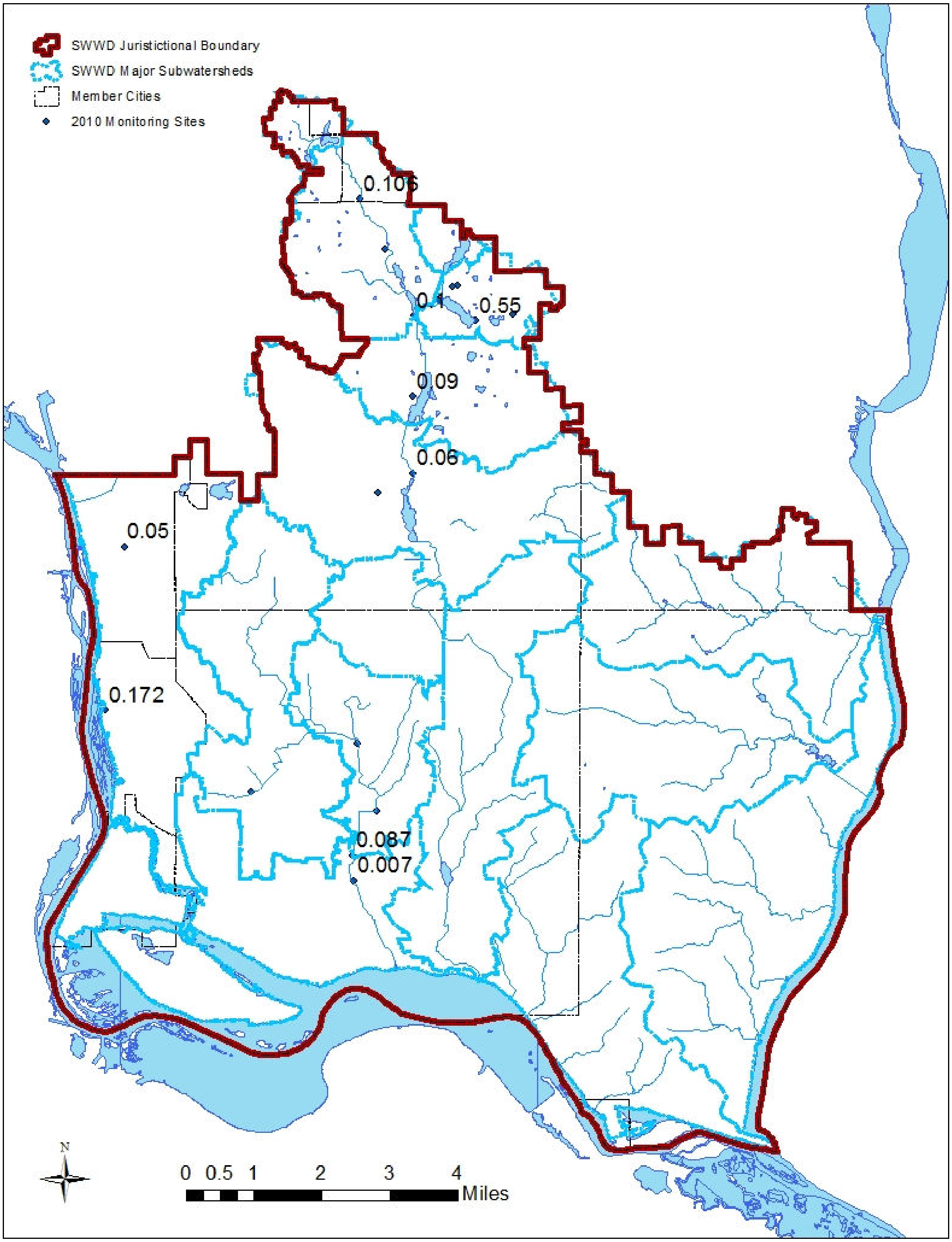
Regional Assessment Locations were generally monitored from early April through October. Some sites—MS2, 100th Street, and Wilmes Lake Outlet—display consistently good water quality. MS2 effectively serves as watershed outlet for the majority of the Northern major subwatershed of the District. Data collected at MS2 indicates that the Northern major subwatershed, though mostly developed, currently transmits relatively low runoff or pollutants. Likewise, the 100th St site effectively serves as the watershed outlet for the West Draw and Central Draw major subwatersheds and transmits low runoff and pollutants. The Wilmes Lake outlet met state water quality standards throughout the monitoring season; however, data indicates a high phosphorus load leaving the lake and flowing to Colby Lake.

Other Regional Assessment Locations—Newport, St. Paul Park, Central Ravine, and MS1—display flashy hydrographs indicating rapid transmission of even small storm events and high concentrations of pollutants. 2010 results for Newport, St. Paul Park, and Central Ravine which all drain to the Mississippi River, indicate heavy metal concentrations frequently in excess of state standards. However, all three sites did meet SWWD's total phosphorus loading standard for the Mississippi River. MS1 exceeded state water quality standards on several occasions and exceeded SWWD's total phosphorus loading standard for Wilmes Lake. 2010 total phosphorus loading rates at SWWD's regional and water body assessment locations are shown in Map ES1.

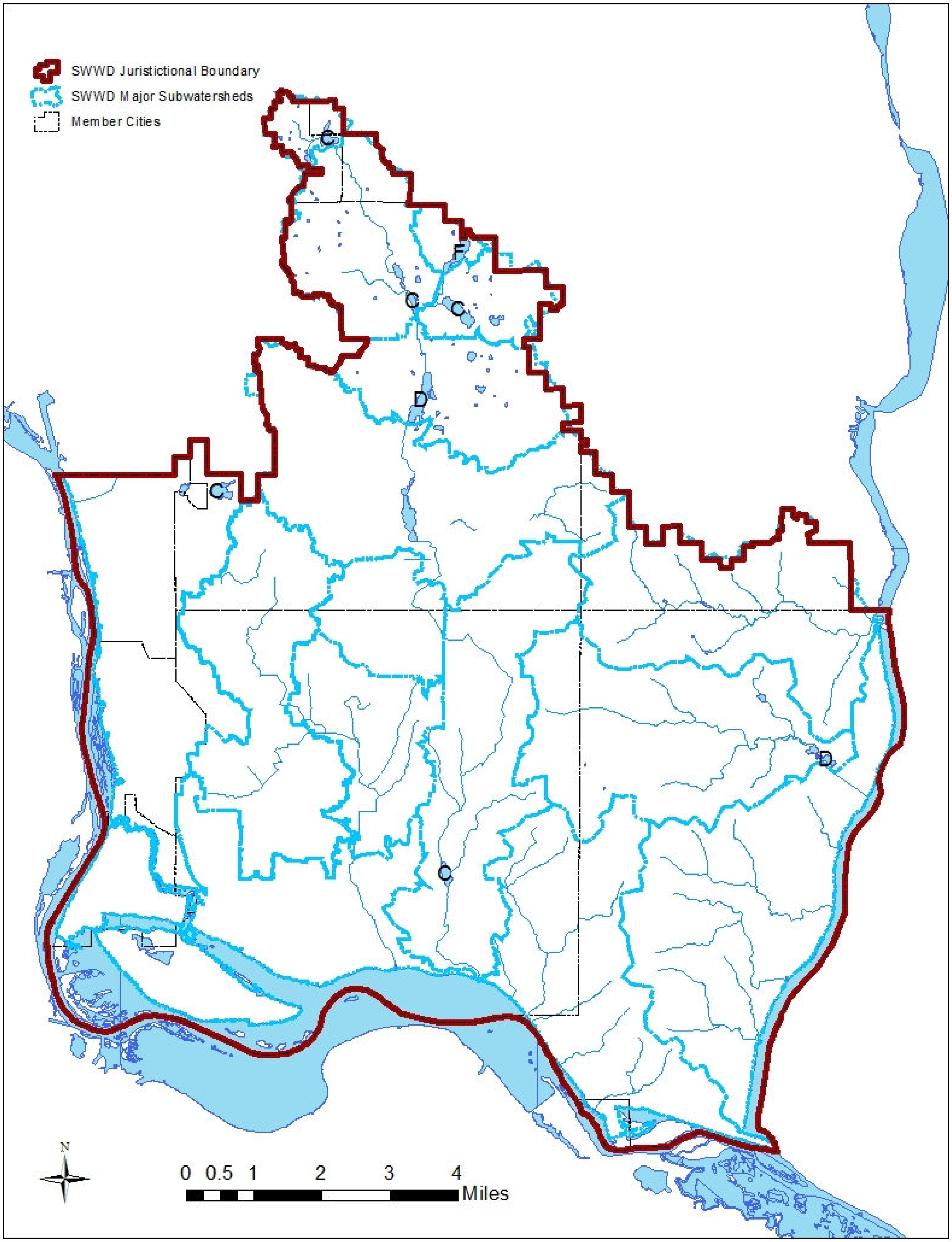
SWWD Lakes are held to two sets of standards. First, impairment status is determined based on state eutrophication standards. Second, SWWD sets interim goals for all shallow lakes in the District which are thought to be feasible for lakes in an urban environment. District rules and standards are set to achieve SWWD's interim goals while SWWD's programs and planning efforts are focused on meeting state standards. For Powers Lake, the District's only deep lake, SWWD sets goals that exceed state standards with the goal of protecting the priority water body.

All SWWD lakes are eutrophic except Markgrafs which is hyper-eutrophic. Light attenuation in most lake is dominated by algae which are nevertheless limited by some factor other than available phosphorus. Exceptions, however, include Markgrafs Lake which is dominated by non algal turbidity and Ravine Lake. Water quality in some lakes—Armstrong and Ravine—has shown improvement since monitoring began. Both lakes, while currently listed as impaired, are close to meeting state eutrophication standards. Water quality of La, Wilmes, and Colby Lakes has been consistent since monitoring began. Wilmes and Colby are both currently listed as impaired. Water quality of the remaining District Lakes—Markgrafs, O'Conner's, and Powers—appears to be declining. Markgrafs Lake exhibited continued, rapid degradation far exceeding both state eutrophication standards and SWWD water quality goals. Powers Lake, considered a priority water body by SWWD, also continued to exhibit a prolonged decline in all eutrophication. Further, stormwater monitoring within the Powers Lake watershed indicates routine phosphorus loading in excess of SWWD loading standards for the lake. Lakes grades are displayed in map ES2.

Map ES1: 2010 Total Phosphorus Loading Rates at SWWD Regional and Water Body Assessment Locations.



Map ES2: 2010 Lake Grades of Monitored SWWD Lakes



Introduction

The South Washington Watershed District (SWWD) is located entirely in Washington County and the Twin Cities metropolitan area containing portions of ten cities and townships: Afton, Cottage Grove, Denmark Township, Grey Cloud Island Township, Hastings, Lake Elmo, Newport, Oakdale, St. Paul Park and Woodbury. The jurisdictional area (i.e. legal boundary) of the District and location of member cities is shown in Map 1.

While SWWD incorporates portions of 10 municipalities each facing their own water management challenges, SWWD mission is to manage water and water resources of the South Washington Watershed District in cooperation with our citizens and communities. As such, one of SWWD's objectives is to establish a framework for characterizing and managing water resources at a regional level based on the 16 major subwatersheds making up the SWWD. SWWD's major subwatersheds are shown in Map 2.

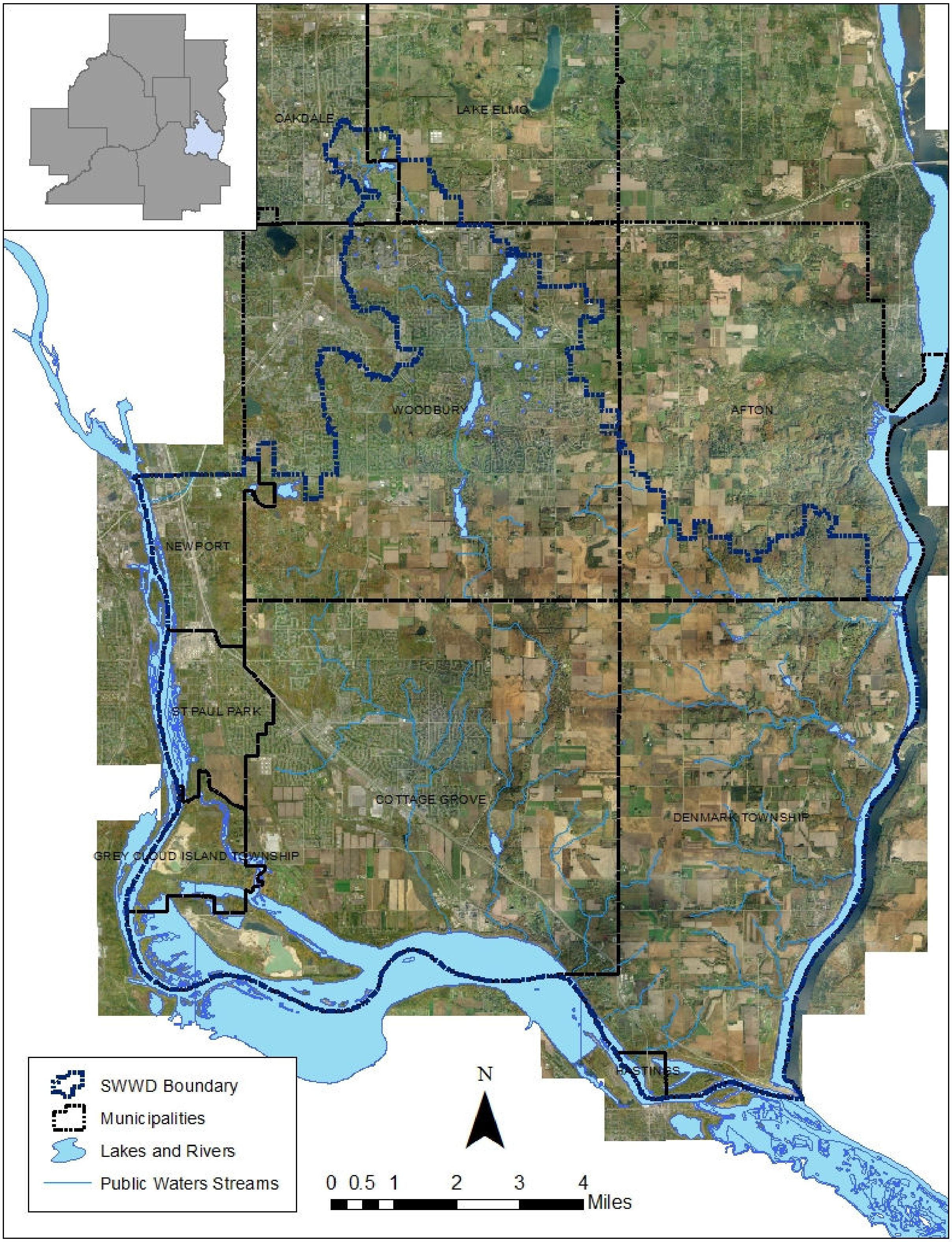
In 2009, the District adopted a formal monitoring plan to document and standardize its various monitoring programs. The plan guides long-term data collection by identifying goals and objectives for use of data and address how the data will be used to inform watershed planning and decision-making.

Reflecting SWWD's focus on managing the watershed as a whole, SWWD's monitoring programs are organized based on a Regional Assessment approach. By following a regional assessment approach, monitoring is focused on key crossings and checkpoints throughout the District. Data from those monitoring locations is used to identify regional issues for further investigation. In addition to monitoring at Regional Assessment Locations, SWWD conducts subwatershed and waterbody assessment monitoring to refine understanding of water resources of the various regions of the District.

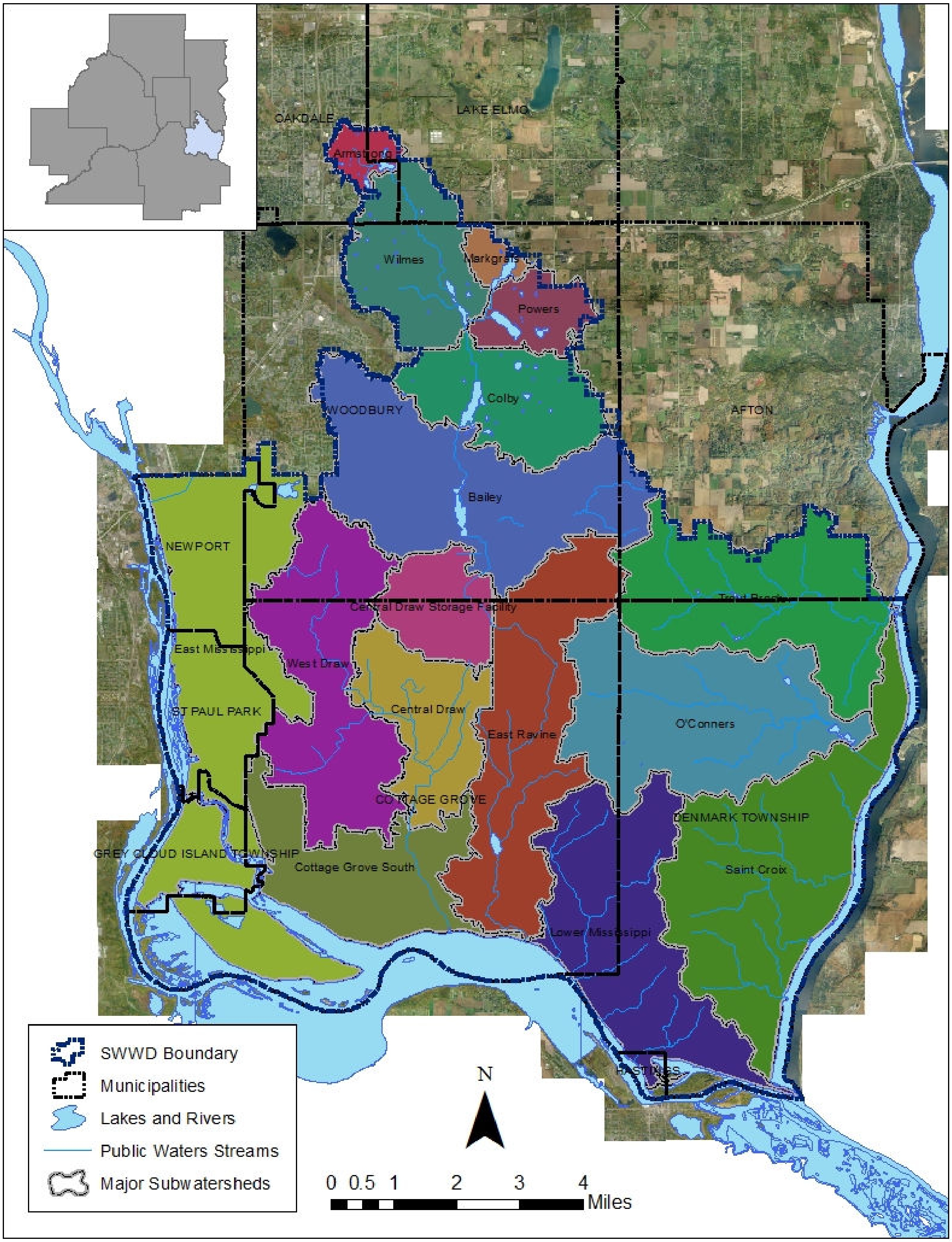
SWWD's in-lake monitoring, for waterbody assessments, is carried out as part of the Metropolitan Council's Citizen Assisted Lake Monitoring Program (CAMP). CAMP is a screening level program that is used to identify long-term water quality trends in lakes.   Additionally, SWWD routinely conducts in-depth assessments of priority waterbodies as resources allow. In depth assessments require multiple monitoring sites within a lake catchment and are used to characterize watershed loading and help identify strategies for water quality improvement.

SWWD's maintains a network of wells surrounding SWWD's regional infiltration facilities. SWWD has routinely monitored water level in the wells; and beginning in 2010 SWWD and the Minnesota Department of Health worked together to monitor groundwater quality as well. SWWD will continue to evaluate opportunities to expand the groundwater monitoring program beyond its current focus as opportunities arise and resources allow.

Map 1: Approximate Juristictional Area of the South Washington Watershed District



Map 2: Major Subwatersheds of the South Washington Watershed District



Surface Water

Introduction

SWWD drains to both the Mississippi and Lower St. Croix Rivers. SWWD's Mississippi basin generally drains from north to south. Strong changes in elevation are evident across the basin, ranging from a high of roughly 1,100 feet above mean sea level in Oakdale to 687 feet which is the normal pool elevation of the Mississippi River. Elevations of basins and lakes tend to decrease from north to south in the basin reflecting a subsurface bedrock valley.

Three major surface drainageways exist in SWWD's Mississippi basin. A central drainageway begins in Oakdale and Lake Elmo and continues south approximately 7 miles to Bailey Lake at Dale Road. The outlet for Bailey Lake is a pump station that discharges into a large infiltration basin in Woodbury, known as CD-P85. A permanent outlet to drain south to the Mississippi River from the infiltration basin is planned to accommodate severe flood conditions during ultimate development. This would utilize the existing easterly drainageway which runs south through the Cottage Grove Ravine Regional Park.

The easterly drainageway is an intermittent stream ravine which runs north to south with some minor landlocked basins and two DNR protected waters within the ravine. The downstream portion of the easterly drainageway (from 80th Avenue south to the river) is listed as a DNR protected water. A box culvert exists beneath Highway 61 to convey flow to the Mississippi River, but some obstructions between the culvert and the Regional Park pond in the past have caused flooding of the park entrance road.

The westerly drainageway runs northwest to southeast, starting in the southwestern corner of Woodbury and outlets into the Mississippi River just east of the terminus of 110th Street South in Cottage Grove in addition to some direct drainage to the river. The westerly drainageway is comprised of two escarpments: the central ravine and the west draw. Approximately 9,300 acres of land naturally drains through the westerly drainageway. This waterway must pass through three water bodies before reaching the Mississippi River. The channel and water bodies are protected by the DNR.

In addition to the three drainageways, there are three major subwatersheds that directly drain to the Mississippi River. The East Mississippi major subwatershed consists of Newport, St. Paul Park, Grey Cloud Island Township, and portions of both Woodbury and Cottage Grove. The East Mississippi subwatershed lies along the Eastern bank of the Mississippi River and Western edge of SWWD and drains to the River by several stormsewer outlets and direct overland drainage. The Cottage Grove South and Lower Mississippi major subwatersheds consists of portions of Cottage Grove, Denmark Township, and Hastings and also consists primarily of direct overland drainage to the River and a number of steep and actively eroding ravines.

Roughly, the eastern third of the District drains to the St. Croix River. Of that area, one third drains via Trout Brook, one third drains to O'Conners Lake (which does not currently outlet to the St. Croix River), and the remaining third drains to the St. Croix River via overland drainage and several ravines.

Surface waters within the District include shallow and deep lakes, ponds, wetlands, and intermittent streams. Many of these are designated as protected waters by the Minnesota DNR. These surface waters have local, and for the Mississippi and St. Croix Rivers, regional and national significance. The St. Croix River is classified as an Outstanding Resource Value Water (ORVW).

Lakes in the district are predominantly shallow (maximum depth less than 15 feet) and show wetland characteristics which affects management efforts and appropriate uses. The characteristics of surface waters are discussed individually below. SWWD surface waters are Class 2B—cool and warm water fishes, not protected for drinking water. Trout Brook historically supported trout but no longer does. None of the surface waters are used as a source of water supply. Ponds and lakes in the district are typically used for indirect contact recreation such as boating and fishing. Wetlands provide aesthetics and wildlife value but also serve stormwater management functions.

There are several waters identified by the MPCA as impaired in the District; including the Mississippi and St. Croix Rivers, the lower reach of the eastern Mississippi River drainageway through the Cottage Grove Ravine Park, and Colby, Markgrafs, Ravine, and Wilmes Lakes.

The District has been collecting data on runoff quantity and quality at intermittent stream sites, many of which are currently used as storm water drainage ways, since 1996. The data collection efforts from 1996-1999 are poorly documented and contain information of unknown reliability. Beginning in 2000, the Washington Conservation District was contracted by the District to oversee the data collection for runoff quantity and quality of stormwater. Since 2000, the program has expanded and remains a major program of the SWWD. Results of SWWD's surface water monitoring programs are presented in this section and are organized by monitoring goals; Regional Assessment, Subwatershed Assessment, Waterbody Screening, and In-Depth Waterbody Assessment. This report is meant primarily to summarize the data collected in 2010. Additional year to year trend analyses are performed for odd monitoring years.

State Water Quality Standards

7050.0222 SPECIFIC STANDARDS OF QUALITY AND PURITY FOR CLASS 2B WATERS OF THE STATE; AQUATIC LIFE AND RECREATION.

The MPCA defines standards as follows: “Chronic standard (CS) is the highest concentration of a toxicant to which aquatic organisms can be exposed indefinitely with no harmful effects, or to which humans or wildlife consumers of aquatic organisms can be exposed indefinitely with no harmful effects”. “Maximum standard (MS) is a concentration that protects aquatic organisms from potential lethal effects of a short-term “spike” in toxicant concentrations. This is always equal to one-half the final acute value”. “Final acute value (FAV) is the concentration that would kill about half of the exposed individuals of a very sensitive aquatic species”.

Cadmium, total µg/l

The CS shall not exceed: exp.(0.7852[ln(total hardness mg/l)]-3.490)
The MS shall not exceed: exp.(1.128[ln(total hardness mg/l)]-1.685)
The FAV shall not exceed: exp.(1.128[ln(total hardness mg/l)]-0.9919)
For hardness values greater than 400 mg/l, 400 mg/l shall be used to calculate the standard.

Chloride mg/l

The CS shall not exceed: 230
The MS shall not exceed: 860
The FAV shall not exceed: 1720

Chromium +3, total µg/l

The CS shall not exceed: exp.(0.819[ln(total hardness mg/l)]+1.561)
The MS shall not exceed: exp.(0.819[ln(total hardness mg/l)]+3.688)
The FAV shall not exceed: exp.(0.819[ln(total hardness mg/l)]+4.380)
For hardness values greater than 400 mg/l, 400 mg/l shall be used to calculate the standard.

Copper, total µg/l

The CS shall not exceed: exp.(0.6200[ln(total hardness mg/l)]-0.570)
The MS shall not exceed: exp.(0.9422[ln(total hardness mg/l)]-1.464)
The FAV shall not exceed: exp.(0.9422[ln(total hardness mg/l)]-0.7703)
For hardness values greater than 400 mg/l, 400 mg/l shall be used to calculate the standard.

Escherichia (E.) coli: Not to exceed 126 organisms per 100 milliliters as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than tem percent of all samples taken during any calendar month individually exceed 1,260 organisms per 100 milliliters. The standard applies only between April 1 and October 31.

Lead, total µg/l

The CS shall not exceed: exp.(1.273[ln(total hardness mg/l)]-4.705)
The MS shall not exceed: exp.(1.273[ln(total hardness mg/l)]-1.460)
The FAV shall not exceed: exp.(1.273[ln(total hardness mg/l)]-0.7643)
For hardness values greater than 400 mg/l, 400 mg/l shall be used to calculate the standard.

Nickel, total μg/l

The CS shall not exceed: exp.(0.846[ln(total hardness mg/l)]+1.1645)
The MS shall not exceed: exp.(0.846[ln(total hardness mg/l)]+3.3612)
The FAV shall not exceed: exp.(0.846[ln(total hardness mg/l)]+4.0543)
For hardness values greater than 400 mg/l, 400 mg/l shall be used to calculate the standard.

Zinc, total μg/l

The CS shall not exceed: exp.(0.8473[ln(total hardness mg/l)]+0.7615)
The MS shall not exceed: exp.(0.8473[ln(total hardness mg/l)]+0.8604)
The FAV shall not exceed: exp.(0.8473[ln(total hardness mg/l)]+1.5536)
For hardness values greater than 400 mg/l, 400 mg/l shall be used to calculate the standard.

Regional Assessment

One of the objectives of the SWWD is to establish a framework for characterizing and managing water resources at a regional level rather than solely at a site-specific level. To optimize monitoring efforts for regional assessment, the District has designated key locations at critical crossings and checkpoints throughout the watershed as regional assessment locations (Chapter 6, Section 8 of the SWWD WMP, Amended 2011). Locations were chosen to characterize water quality and quantity entering or leaving a region. Data collected at these locations through the District's surface water monitoring programs is used to identify trends in regional water quality and quantity as well as potential areas for concern, develop and verify regional models, set benchmarks for regional water quality, evaluate effectiveness of ordinances resulting from the SWWD WMP, evaluate regional affects of proposed development projects, and predict and evaluate the success of BMP and resource conservation projects. All regional assessment locations are part of the District's permanent monitoring program and will be operated until deemed unnecessary by analysis and modeling, unless otherwise noted below.

Methods

Regional assessment monitoring stations are automated to the greatest extent feasible and operated by the WCD. Regional assessment monitoring sites are equipped with an area-velocity probe (stage and flow), rain gauge (where rainfall is monitored), and an ISCO 24 bottle automated water quality sampler. Monitoring equipment is operated by a 12V deep cycle battery. Where possible, stations are also equipped with a 20 watt solar panel to keep the battery charged. Two sites, MS1 and MS2, were also equipped with backup self powered water level loggers (for flow monitoring) which allows for data collection when primary equipment is not recording or during malfunctions.

Stage, velocity, and discharge measurements are taken every 15 minutes at all regional assessment locations. Continuous rainfall is also recorded at 4 of the regional assessment locations—MS1, MS2, Bailey Lift Station, and 100th St—spaced from north to south. Field stage measurements are taken at all sites and stage to discharge or area-velocity relationships are developed. Stage to discharge relationships are used to interpolate missing data.

Additional information about specific methods or equipment can be obtained by contacting staff at SWWD or WCD, both of whom maintain a collection of the Standard Operating Procedures used in data collection.

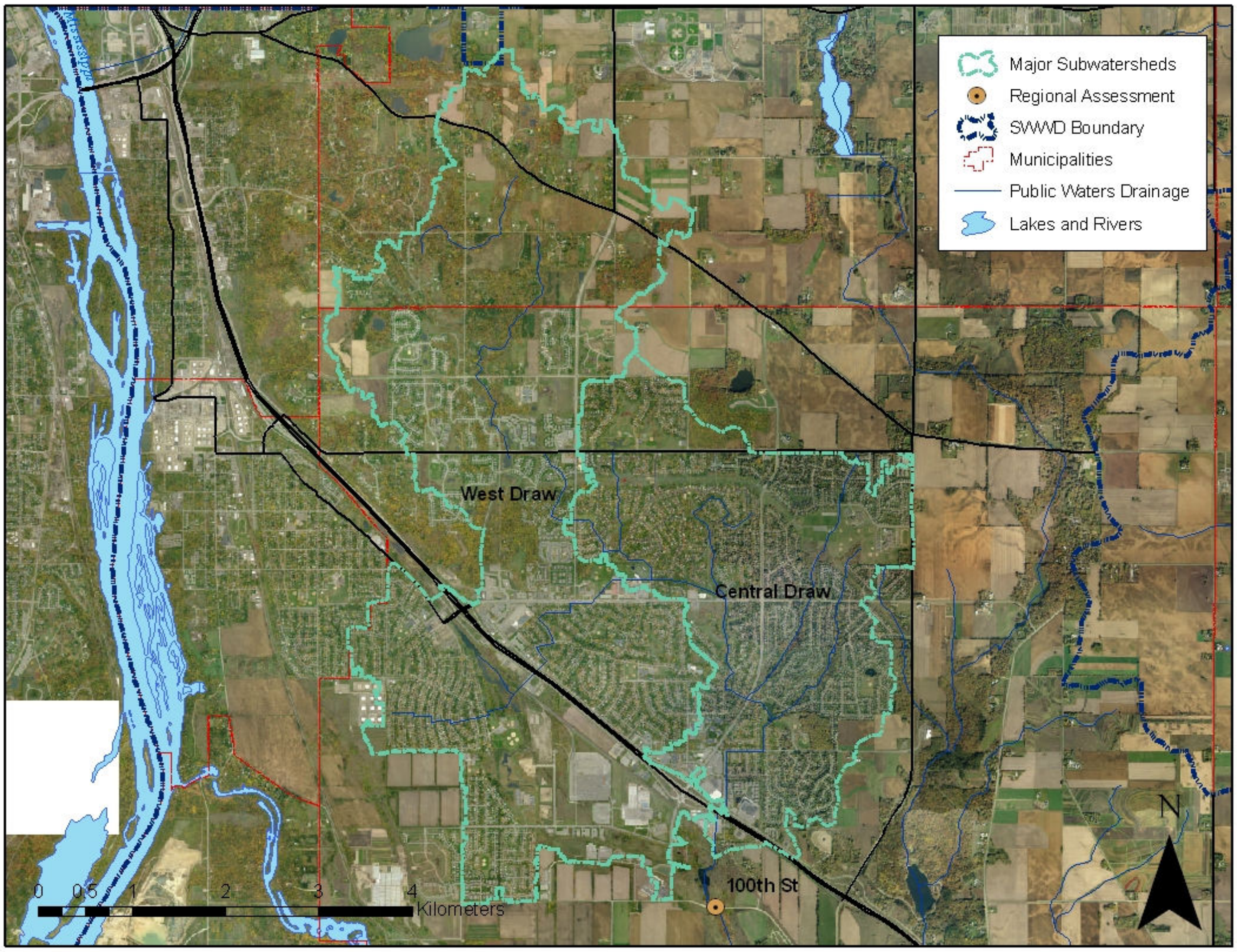
Up to seven types of samples are collected at Regional Assessment Locations; snowmelt grab, snowmelt composite, baseflow grab, baseflow composite, stormflow grab, stormflow composite, and bacteria grab. All water quality samples are analyzed at the Metropolitan Council Environmental Services Lab in St. Paul.

This report summarizes monitoring data collected in 2010 and provides growing season load estimates of total phosphorus and total suspended solids as calculated from collected data using the Army Corps of Engineers FLUX32 Load Estimating Software, 2.95 Beta. Additional trend analysis occurs in odd years. Results are discussed individually for each site.

2010 Regional Assessment Locations

100th Street (East of Jamaica Ave S)

Map 3: 100th St Location



The 100th Street site (Map 3) is key to understanding the hydrologic system of both the Central Draw and West Draw Major Subwatersheds as it is located just downstream of the outflows of both. Monitoring data collected at the 100th Street location helps illustrate any impacts of activity on the quality and quantity of water ultimately draining to the Mississippi River. The 100th Street monitoring site was established in 2000. Parameters monitored include bacteria (since 2001), stage (since 2000), flow (since 2001), heavy metals (since 2001), nutrients (since 2001), and rainfall (since 2002). The site has been operated continuously since establishment. In 2007 this site was relocated just upstream of the original location due to backwater influences from downstream. A new regional monitoring location (Central Ravine) was established at the outlet of the Central Draw watershed in 2009.

Results

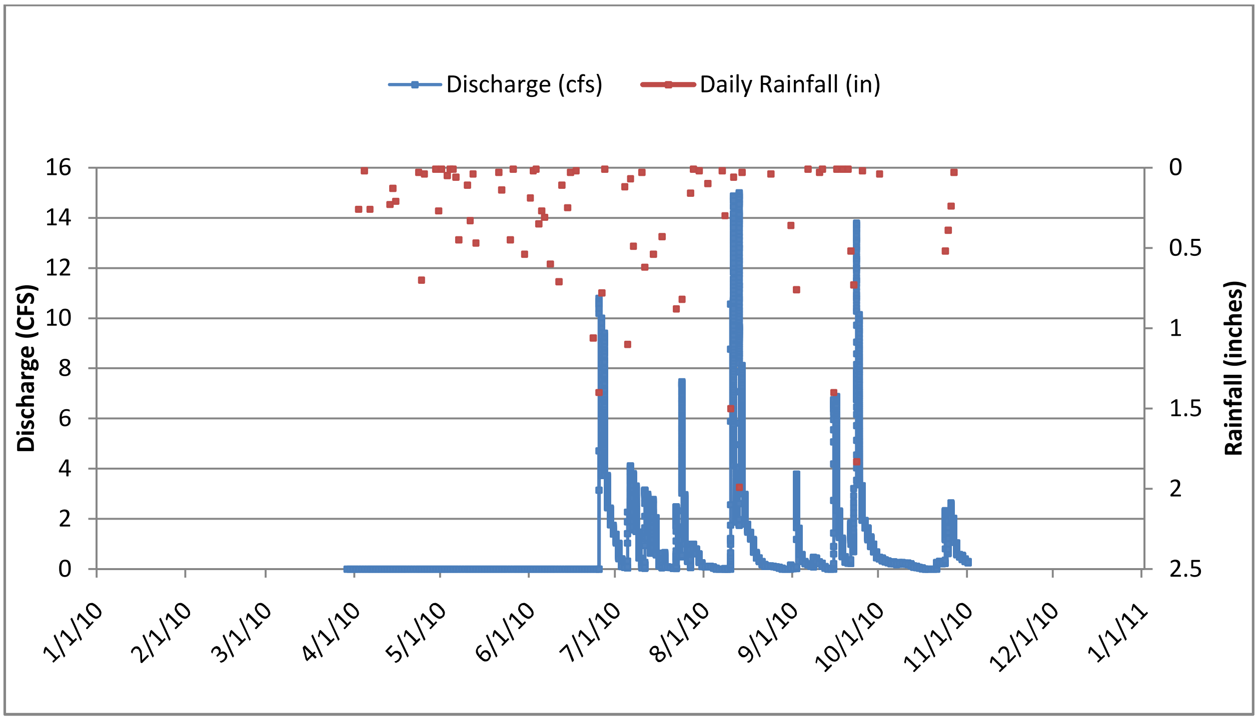
Flow measurements were collected at the 100th Street site every 15 minutes from March 29 at 11:00 am to November 1 at 9:30 am. Discharge was calculated from flow using the rating curve below.

$$y = 1.0167573400(x + 3.345)^2 – 4.5078835467(x + 3.345) + 3.34$$

A rain gauge was also installed throughout the monitoring season, although the gauge was found to be plugged on June 14 and July 7. Precipitation data during the malfunction was corrected using data from SWWD's MS2 rain gauge. Average daily discharge and daily rainfall is shown in Figure 1.

The 2010 total phosphorus and total suspended solids loading summary is presented in Table 1. Reported loads represent loading during the growing season, May 1-September 30. Year to year trend analysis is performed in odd years. In 2010, 3 baseflow grab samples, 2 bacteria Grab samples, 1 storm grab sample, and 8 storm composite samples were collected at the 100th Street site. Water quality results are reported in Table 2.

Figure 1: 100th St Average Daily Discharge and Observed Rainfall



Year	Growing Season Rainfall (inches)	Growing Season Runoff Volume (acre-feet)	Projected Annual Runoff Volume (acre-feet)	Total Phosphorus (lbs)	Total Phosphorus (lbs/ac/yr)	Total Suspended Solids (lbs)	Total Suspended Solids (lbs/ac/yr)
2010	23.86	247	272	63.6	0.007	4,392.2	0.52

[1]Loads calculated using the Army Corps of Engineers FLUX32 Load Estimating Software, 2.95 Beta.

Table 1: 100th 2010 St Growing Season Loading Summary[1]

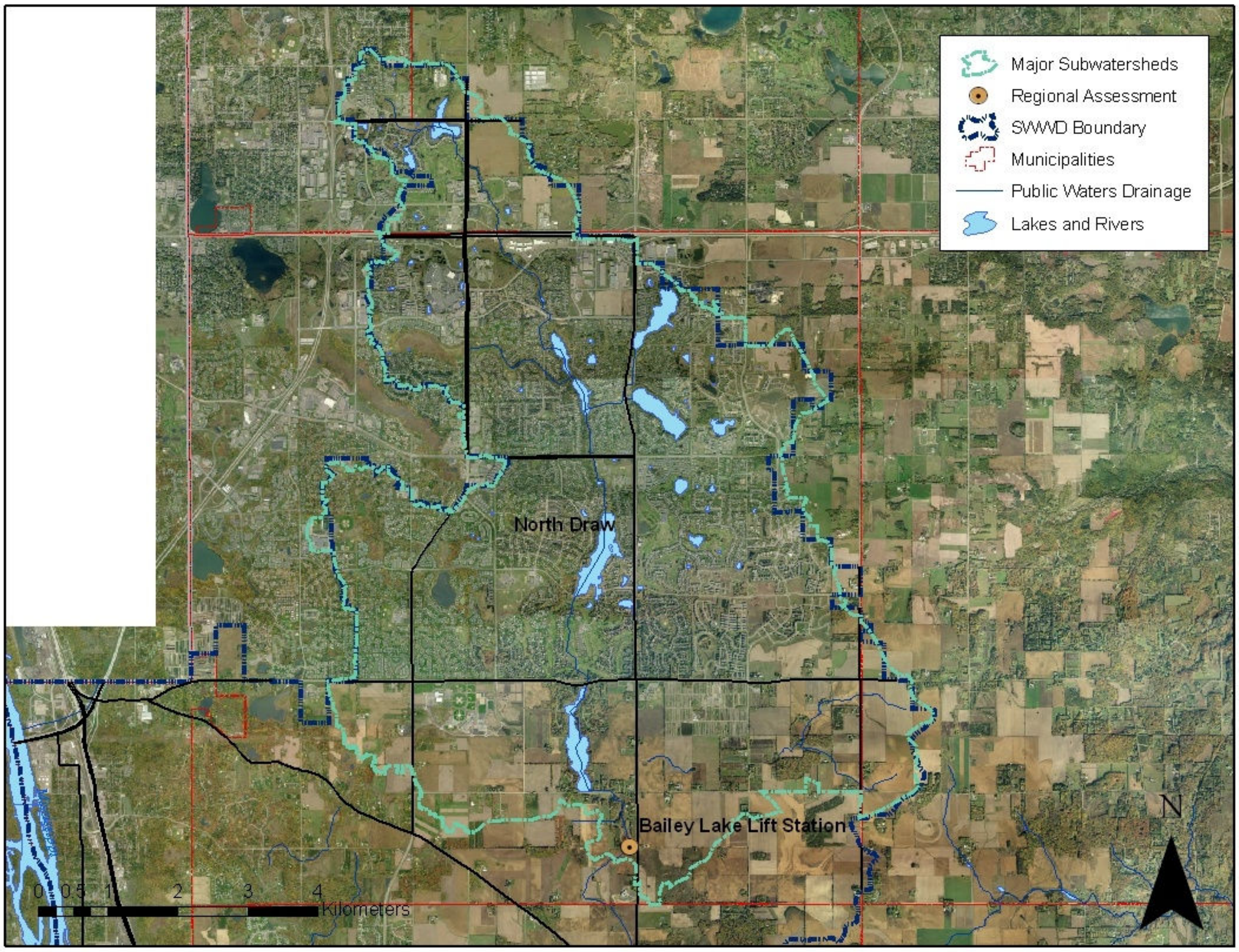
Sample Type	Start Date	End Date	Suspended solids (mg/L)	Volatile suspended solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Dissolved Phosphorus (mg/L)	E. coli (mpn/100 mL)	Chloride	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Nickel (mg/L)	Zinc (mg/L)	Hardness (mg/L_CaCO3)	Ammonia Nitrogen (mg/L)	Nitrate N (mg/L)	Nitrite N (mg/L)
Storm Composite	6/27/10 2:18	6/28/10 10:02	12	~7	0.95	0.18	<0.010		20	<0.0005	<0.005	0.0037	0.0006	0.0012	0.0062	36	~0.03	0.12	<0.03
Storm Composite	7/6/10 0:59	7/6/10 4:10	14	11	1.8	0.167	~0.023		39	<0.0005	<0.005	0.0019	0.0002	0.0017	<0.005	88	0.32	<0.05	<0.03
Storm Composite	7/7/10 18:14	7/7/10 20:19	5	~3	0.65	0.075	~0.026		18	0.0016	<0.005	0.0022	0.0003	0.0013	<0.005	64	0.18	<0.05	<0.03
Base Grab	7/20/10 14:23		4	~2	0.34	0.094	0.086		32	<0.0005	<0.005	0.0011	<0.0001	0.0025	<0.005	154	0.11	0.05	<0.03
E. Coli Grab	7/28/10 10:17		~1	~1	0.83	0.057	~0.030	461	29	<0.0005	<0.005	0.0009	<0.0001	0.0015	<0.005	92	~0.03	0.07	<0.03
Storm Grab	8/10/10 22:04	8/11/10 1:01	23	~10	1	0.1	<0.010		66	<0.0005	<0.005	0.0019	0.0005	0.0023	<0.005	152	<0.02	<0.05	<0.03
Storm Composite	8/11/10 1:06	8/11/10 11:29	8	~4	0.57	0.081	<0.010		28	<0.0005	<0.005	0.0022	0.0004	0.0014	<0.005	82	~0.03	0.14	<0.03
Storm Composite	8/13/10 4:05	8/13/10 7:02	9	7	1.1	0.1	~0.020		20	<0.0005	<0.005	0.0018	0.0002	0.0015	<0.005	72	0.1	<0.05	<0.03
Base Grab	8/23/10 12:14		~1	~1	0.5	0.104	0.089		23	<0.0005	<0.005	0.0009	<0.0001	0.0024	<0.005	144	0.21	<0.05	<0.03
Storm Composite	9/2/10 10:09	9/3/10 7:45	4	~2	0.45	0.081	<0.010		80	<0.0005	<0.005	0.0012	0.0002	0.0019	0.0054	166	<0.02	<0.05	<0.03
Storm Composite	9/15/10 21:07	9/16/10 13:35	4	~2	0.44	~0.038	~0.012		52	<0.0005	<0.005	0.0015	0.0003	0.0015	<0.01	118	<0.02	0.22	<0.03
Storm Composite	9/23/10 0:34	9/23/10 23:57	8	6	0.95	0.06	<0.010		20	<0.0010	<0.01	<0.01	<0.003	<0.02	<0.02	88	<0.02	0.12	<0.03
E. Coli Grab	9/30/10 8:23							166											
Base Grab	10/5/10 14:51		~2	~1	0.44	~0.040	~0.033		71	<0.0010	<0.01	<0.01	<0.003	<0.02	<0.02	212	~0.02	0.2	<0.03

Key: No Exceedance Determinable; Exceeds CS; Exceeds MS; Exceeds FAV; Exceeds E. Coli Standard for Individual Sample

Table 2: 100th St Water Quality Sample Results and MN Rule 7050.0222 Class 2B Water Quality Standard Exceedances

Bailey Lift station

Map 4: Bailey Lift Station Location

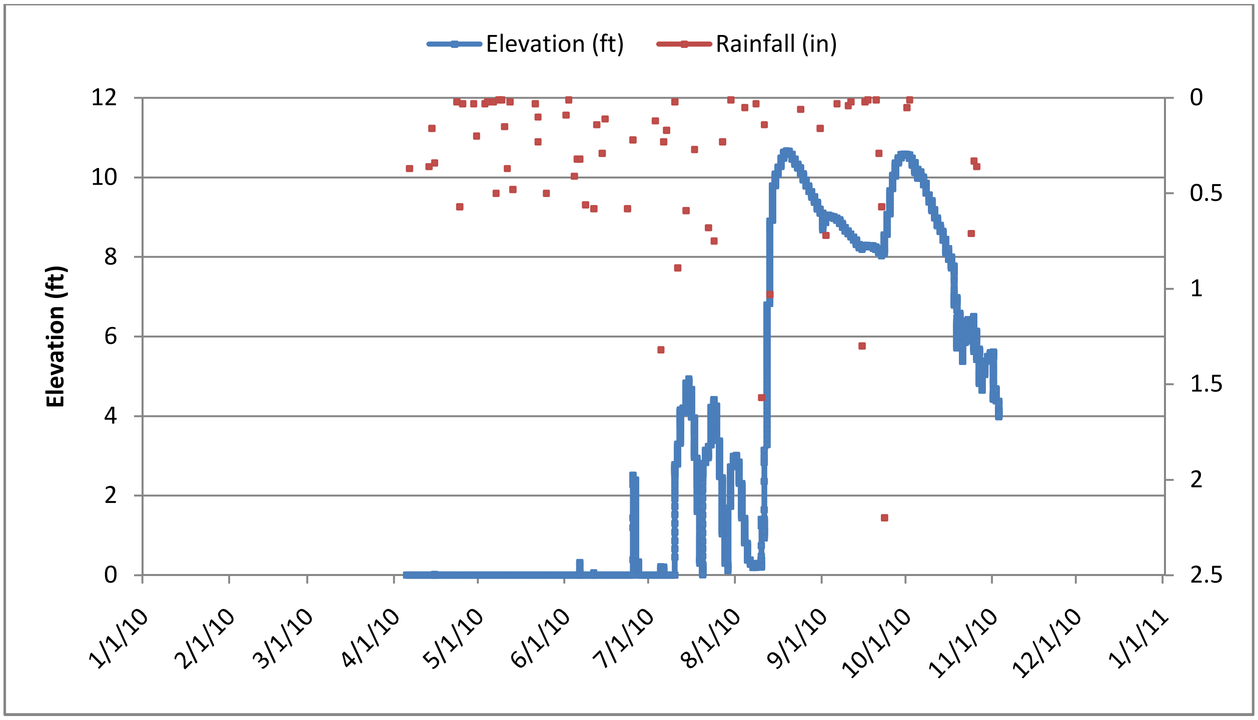


The Bailey Lift Station site (Map 4) currently consists of only a water level logger and rain gauge. The logger is installed within a stilling well attached to a concrete wall at the base of the Bailey lift station. Water quality grab samples are collected at the lift station outlet to CD-P85 during pumping events which have not been necessary since 2005. The City of Woodbury did run the pumps briefly in 2010 to test the system. The site will be completely established after Woodbury has become fully developed and pumping at the Bailey Lake Lift station becomes routine. The station will serve as a regional assessment location for the entire Northern watershed and provides water quality and quantity data for water entering the Central Draw Storage Facility watershed and Central Draw Overflow Corridor. Parameters monitored will include stage, flow, rainfall, nutrients, heavy metals and bacteria. In the interim, data collected at the lift station will help the District determine how much water is leaving the Northern watershed and assess the need for establishing a full regional assessment location.

Results

Half hourly water level measurements were collected from April 5 at 11:00 to November 3 at 10:00. A rain gauge was also installed throughout the monitoring season. Water surface elevation and daily rainfall is shown in Figure . One water sample was collected when the lift station was activated for testing. Water Quality results are shown in Table 3.

Figure 2: Bailey Lift Station Average Daily Discharge and Observed Rainfall



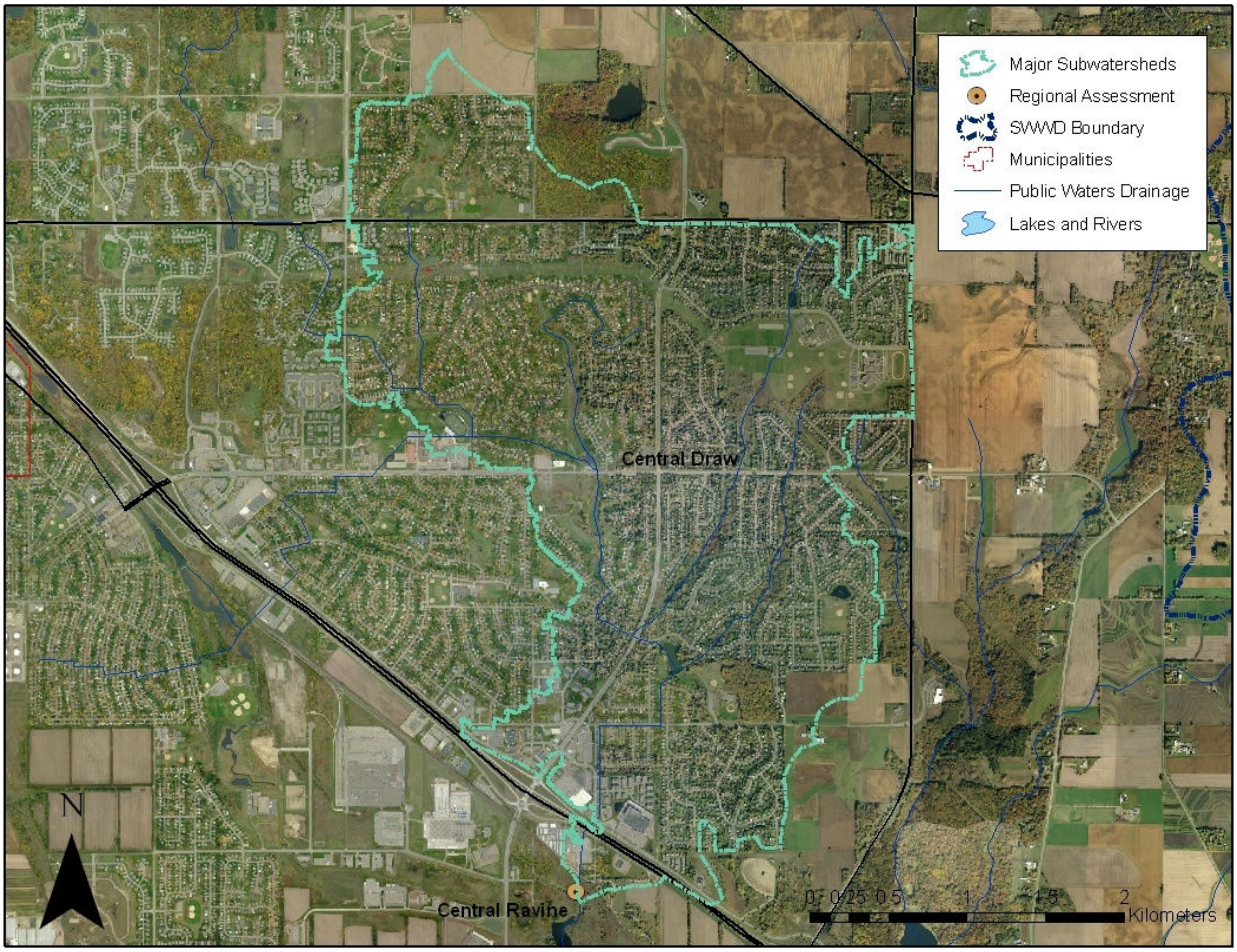
Type	Sampled date	End sampling	Suspended solids (mg/L)	Volatile suspended solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Dissolved Phosphorus (mg/L)	E coli	Chloride ion (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Nickel (mg/L)	Zinc (mg/L)	Hardness (mg/L_CaCO3)	Ammonia Nitrogen (mg/L)	Nitrate N (mg/L)	Nitrite N (mg/L)
Stormflow Grab	9/1/2010 9:10		38	14	1.6	0.223	0.015		55	<0.0005	<0.005	0.0052	0.0035	0.0035	0.0408	88	~0.05	0.12	<0.03

Key: No Exceedance Determinable; Exceeds CS; Exceeds MS; Exceeds FAV; Exceeds E. Coli Standard for Individual Sample

Table 3: 100th St Water Quality Sample Results and MN Rule 7050.0222 Class 2B Water Quality Standard Exceedances

Central Ravine

Map 5: Central Ravine Location



The Central Ravine location (Map 5) was established in 2009. Data collected from this location will give a better understanding of the quantity and quality of water leaving the Central Draw watershed and entering a large wetland complex before ultimately draining to the Mississippi River through the 100th St site. Parameters monitored include bacteria, stage, flow, heavy metals, and nutrients.

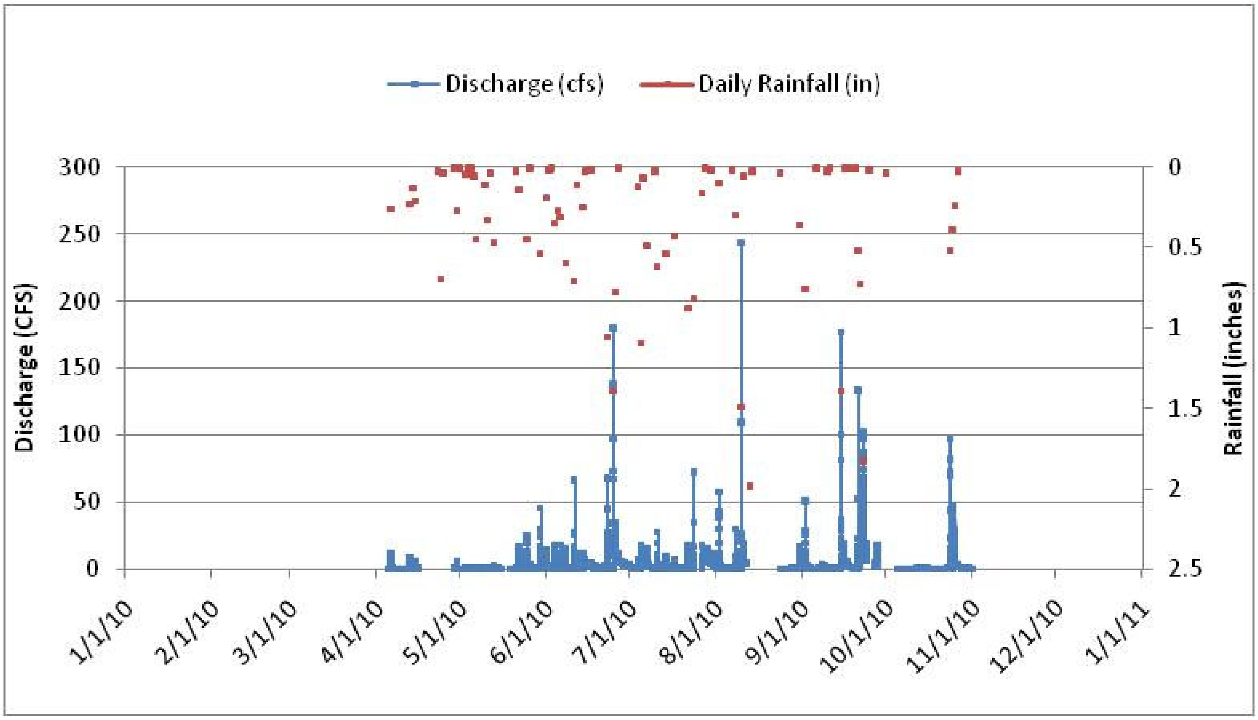
Results

Flow measurements were collected at the Central Ravine site every 15 minutes from April 5 at 11:30 to November 1 at 17:00. Discharge was calculated using an area velocity relationship, which is the cross sectional area of the water channel as determined by the water level within the pipe multiplied by the measured velocity. Average daily discharge is shown in Figure 3. The figure also displays precipitation observed at the nearby 100th St site.

The growing season loading summary is reported in Table 4 and reflects totals during the May 1 to September 30 growing season. Additional year to year trend analyses are performed in odd years. In

2010, 2 snowmelt grab samples and 20 storm composite samples were collected at the Central Ravine site. Water quality results are reported in Table 5.

Figure 3: Central Ravine Average Daily Discharge and 100th St Observed Rainfall



Year	Growing Season Observed Rainfall (in)[2]	Growing Season Runoff Volume (acre-feet)	Projected Annual Runoff Volume (acre-feet)	Total Phosphorus (lbs)	Total Phosphorus (lbs/ac/yr)	Total Suspended Solids (lbs)	Total Suspended Solids (lbs/ac/yr)
2010	23.86	516.38	547.68	235.58	0.087	196,118	72.23

[1]Loads calculated using the Army Corps of Engineers FLUX32 Load Estimating Software, 2.95 Beta.

Table 4: Central Ravine Annual Loading Summary

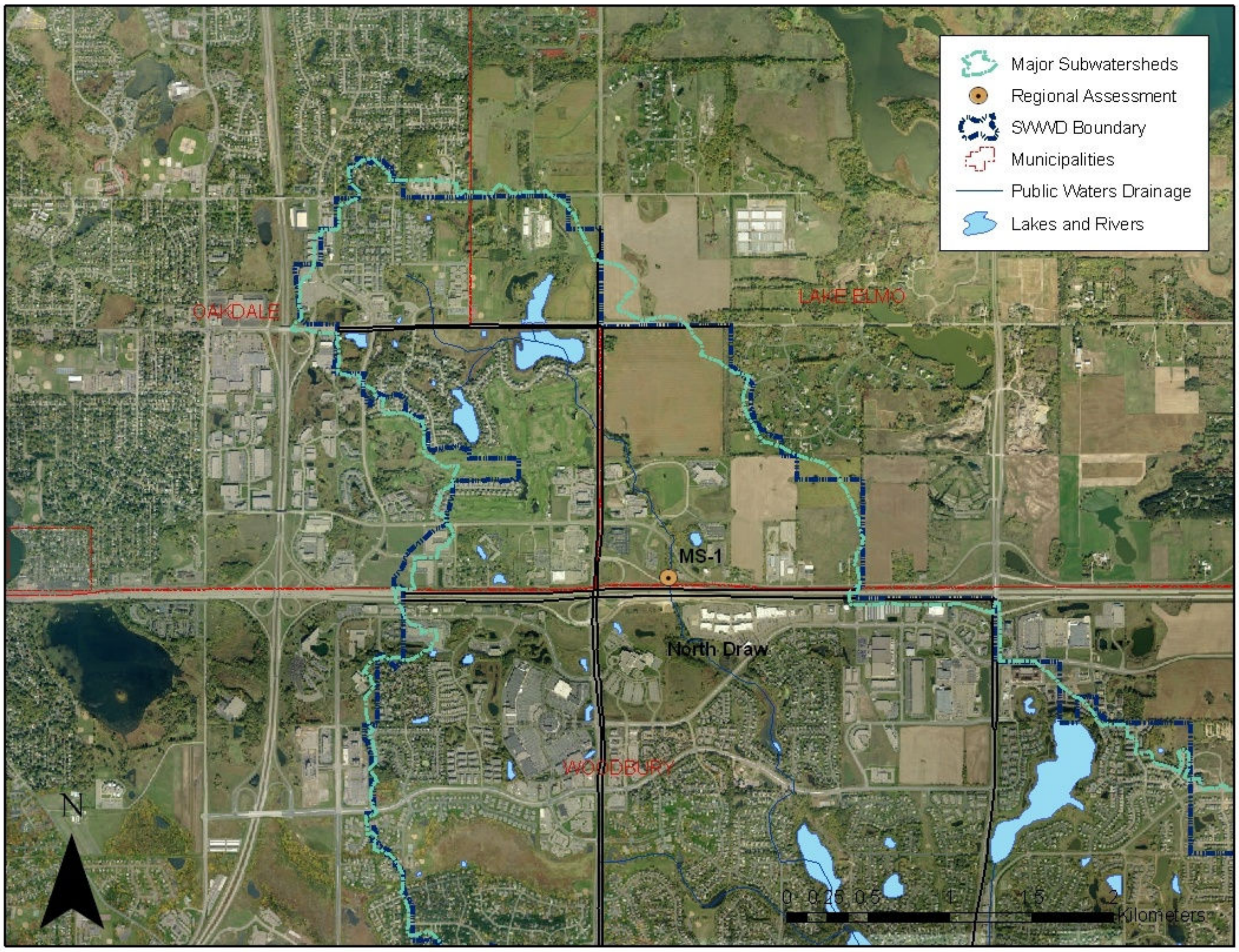
Sample Type	Sampled date	End sampling	Suspended solids (mg/L)	Volatile suspended solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Dissolved Phosphorus (mg/L)	Chloride ion (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Nickel (mg/L)	Zinc (mg/L)	Hardness (mg/L_CaCO3)	Ammonia Nitrogen (mg/L)	Nitrate N (mg/L)	Nitrite N (mg/L)
Snowmelt Grab	3/8/2010 12:00		279	41	5.6	0.761	0.094	970	<0.0005	0.0204	0.0457	0.0232	0.0322	0.158	152	0.4	0.77	0.17
Snowmelt Grab	3/11/2010 10:29		103	55	2.2	0.359	0.232	83	<0.0005	0.0092	0.0182	0.0064	0.0068	0.0989	32	0.54	0.51	0.04
Storm Composite	4/13/2010 7:13	4/15/10 3:24	864	330	1.8	0.292	0.055	14								0.86	0.72	0.04
Storm Composite	5/7/2010 10:12	5/7/10 11:11	57	30	0.78	0.086	~0.037	5	<0.0005	0.0055	0.0068	0.002	0.0029	0.0525	16	0.2	0.27	<0.03
Storm Composite	5/10/2010 19:44	5/11/10 12:47	68	35	1.3	0.121		7	<0.0005	<0.005	0.0053	0.0014	0.0019	0.0348	30	0.6	0.78	<0.03
Storm Composite	5/13/2010 2:25	5/14/10 11:02	57	26	1.9	0.151	~0.013	34	<0.0005	<0.005	0.0067	0.0023	0.0028	0.0495	34	0.31	0.25	<0.03
Storm Composite	5/25/2010 20:06	5/26/10 0:05	77	31	1.9	0.263	0.055	6	<0.0005	<0.005	0.0103	0.0026	0.0032	0.0636	32	0.17	0.52	0.07
Storm Composite	5/30/2010 18:08	5/30/10 20:29	810	192	2.8	0.433	0.064	8	<0.0005	0.0077	0.0141	0.0057	0.0058	0.115	76	0.17	0.16	0.04
Storm Composite	6/1/2010 15:45	6/1/10 16:56			1.7	0.255	0.053	9							38	0.36	0.42	0.04
Storm Composite	6/8/2010 6:06	6/8/10 16:21	40	19	0.77	0.111	~0.026	6	<0.0005	<0.005	0.0049	0.0019	0.0019	0.0396	34	0.21	0.31	0.03
Storm Composite	6/11/2010 6:43	6/11/10 8:22	173	55	1.6	0.25	<0.010	3	<0.0005	0.0081	0.014	0.0067	0.0057	0.0927	26	0.1	0.36	0.04
Storm Composite	6/14/2010 11:35	6/14/10 13:37	44	30	0.38	0.057	~0.017	4	<0.0005	<0.005	0.0038	0.0007	0.0014	0.0147	20	~0.06	0.24	<0.03
Storm Composite	6/15/2010 1:45	6/15/10 14:35	24	17	1.9	0.208	~0.013	85	<0.0005	<0.005	0.0039	<0.0005	0.0019	0.011	34	~0.03	<0.05	<0.03
Storm Composite	6/23/2010 3:20	6/23/10 6:32	306	64	1.3	0.331	0.068	5	<0.0005	<0.005	0.0112	0.0045	0.004	0.0556	24	0.1	0.4	<0.03
Storm Composite	6/25/2010 18:33	6/25/10 19:33	469	115	1.7	0.219	~0.027	5	<0.0005	0.0057	0.0106	0.0052	0.0043	0.0506	28	0.49	0.44	0.05
Storm Composite	7/27/2010 21:03	7/28/10 0:51	140	44	2.1	0.22	<0.010	7	<0.0005	<0.005	0.0084	0.0035	0.0038	0.0467	24			
Storm Composite	8/8/2010 1:43	8/8/10 2:25	212	84	3	0.469	0.199	5	<0.0005	0.0051	0.0181	0.0069	0.0057	0.125	28	0.49	0.45	0.07
Storm Composite	8/10/2010 20:13	8/11/10 8:50	46	16	1.1	0.137	<0.010	3	<0.0005	<0.005	0.0031	0.0009	0.0014	0.0134	24	<0.02	0.17	<0.03
Storm Composite	9/2/2010 4:06	9/2/10 10:34	19	7	0.62	0.091	<0.010	3	<0.0005	<0.005	0.0024	0.0008	0.0012	0.0165	22	0.08	0.17	<0.03
Storm Composite	9/15/2010 19:25	9/15/10 20:44	41	14	0.78	0.122	~0.025	3	<0.0005	<0.005	0.0053	0.0023	0.0019	0.0354	18	0.25	0.24	<0.03
Storm Composite	9/22/2010 16:25	9/23/10 0:54	30	13	0.78	0.109	~0.019	2	<0.0010	<0.010	<0.010	<0.003	<0.02	0.023	28	0.08	0.06	<0.03
Storm Composite	9/23/2010 1:25	9/23/10 7:07	16	12	1	0.121	<0.010	4	<0.0010	<0.010	<0.010	<0.003	<0.02	<0.02	32	0.09	<0.05	<0.03

Key: No Exceedance Determinable; Exceeds CS; Exceeds MS; Exceeds FAV; Exceeds E. Coli Standard for Individual Sample

Table 5: Central Ravine Water Quality Sample Results and MN Rule 7050.0222 Class 2B Water Quality Standard Exceedances

MS1 (near I94 and County 13)

Map 6: MS1 Location



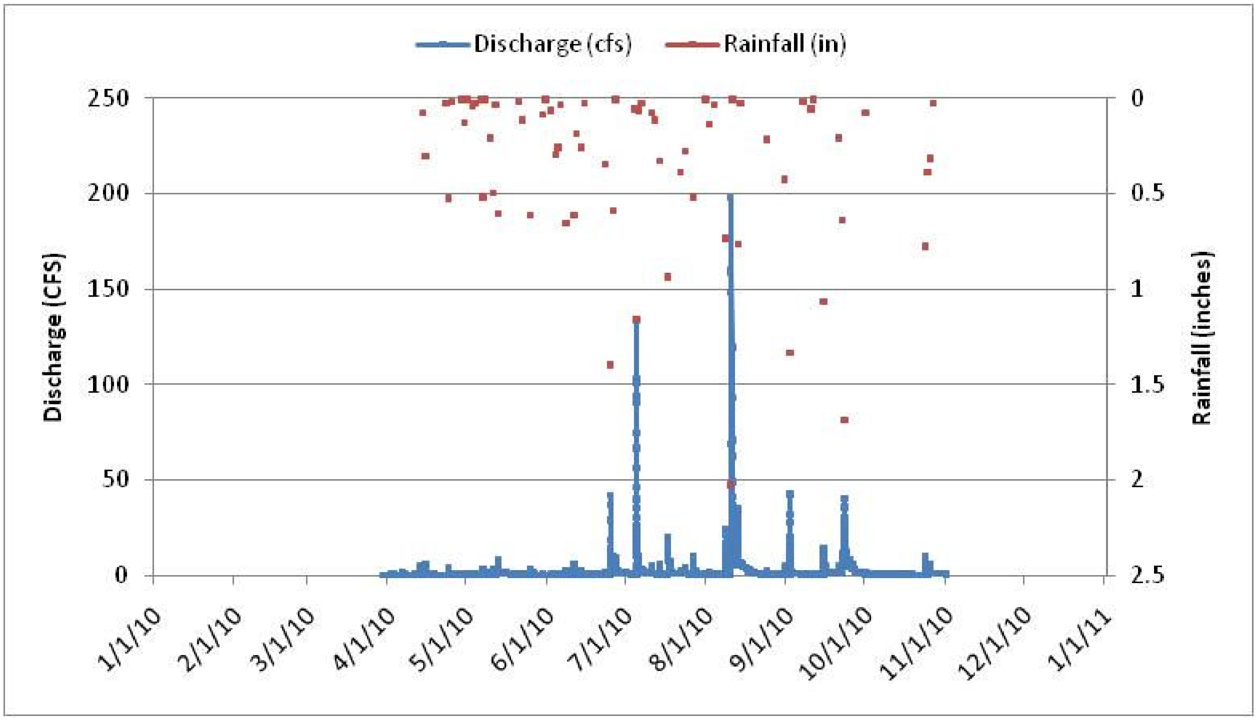
MS1 (Map 6) is a vital link in understanding the intercommunity flow from Lake Elmo and Oakdale to Woodbury. This data gives a baseline understanding of the initial surface water quality and quantity at the headwaters of the watershed. Comparative studies throughout Woodbury are possible with this key dataset. The MS1 monitoring site was established in 1996. Parameters monitored include bacteria (since 2002), stage, flow, heavy metals, nutrients, and rainfall.

Results

Flow measurements were collected at the MS1 site every 15 minutes from March 30 at 14:15 to November 1 at 15:00. Discharge was calculated using an area velocity relationship, which is the cross sectional area of the water channel as determined by the water level within the pipe multiplied by the measured velocity. A rain gauge was also installed throughout the monitoring season. Average daily discharge and daily rainfall is shown in Figure 4.

The growing season loading summary is reported in Table 6. Reported numbers reflect the growing season, May 1 to September 30. Additional year to year trend analysis is performed in odd years. One snowmelt grab, 4 baseflow grab, 13 stormflow composite, and 5 bacteria grab samples were collected at the MS1 site in 2010. The 5 bacteria samples were only tested for E. Coli. Water quality results are reported in Table 7.

Figure 4: MS1 Average Daily Discharge and Observed Rainfall



Year	Growing Season Rainfall (inches)	Growing Season Runoff Volume (acre-feet)	Projected Annual Runoff Volume (acre-feet)	Total Phosphorus (lbs)	Total Phosphorus (lbs/ac/yr)	Total Suspended Solids (lbs)	Total Suspended Solids (lbs/ac/yr)
2010	21.1	368.29	400.53	156.4	0.106	39,264	26.71

[1]Loads calculated using the Army Corps of Engineers FLUX32 Load Estimating Software, 2.95 Beta.

Table 6: MS1 Annual Loading Summary

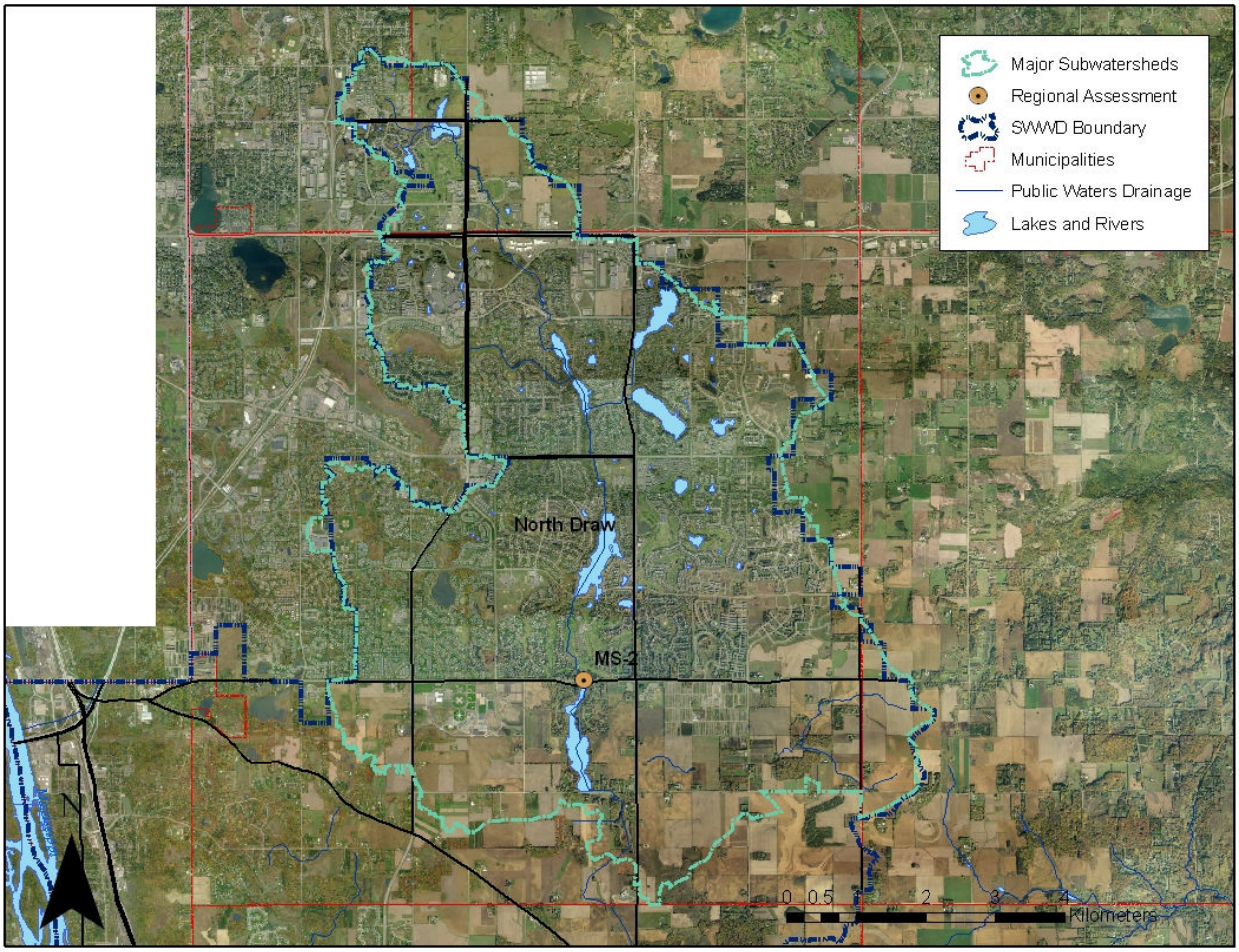
Sample Type	Sampled date	End sampling	Suspended solids (mg/L)	Volatile suspended solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Dissolved Phosphorus (mg/L)	E coli	Chloride ion (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Nickel (mg/L)	Zinc (mg/L)	Hardness (mg/L_CaCO3)	Ammonia Nitrogen (mg/L)	Nitrate N (mg/L)	Nitrite N (mg/L)
Snowmelt Grab	3/11/10 11:18		64	18	1.6	0.327	0.26		103	<0.0005	0.006	0.0132	0.003	0.0043	0.0655	68	0.28	0.37	<0.03
Storm Comp	4/13/10 5:22	4/13/10 7:05	84	~9	2.7	0.242	~0.027		142								0.62	0.67	<0.03
Base Grab	4/29/10 10:41		4	~2	1	~0.044	~0.011		615	<0.0005	<0.005	0.0069	<0.0001	0.0039	<0.005	212	~0.02	0.24	<0.03
Storm Comp	5/11/10 0:14	5/11/10 3:10	6	~2	1.2	0.092	~0.029		99	<0.0005	<0.005	0.0058	0.0006	0.0018	0.0117	80	0.16	0.88	<0.03
E. Coli Grab	5/25/10 9:26		79	~13	1.2	0.154	~0.045	162	139	<0.0005	<0.005	0.0105	0.0011	0.0037	0.051	184	~0.05	0.64	0.05
Storm Comp	6/11/10 7:28	6/11/10 10:14	30	6	0.96	0.123	0.067		56	<0.0005	<0.005	0.012	0.0009	0.0018	0.0173	64	0.18	0.36	0.04
E. Coli Grab	6/24/10 8:20							1203											
Storm Comp	6/25/2010 18:13 PM	6/25/10 19:25	195	~31	1.5	0.367	0.085		17	<0.0005	0.0074	0.0178	0.0037	0.0053	0.0639	38	0.15	0.31	0.06
Storm Comp	7/5/10 12:25	7/5/10 15:43	233	26	1.1	0.323	0.122		10	0.0005	0.0071	0.0094	0.0057	0.0053	0.0323	20	0.12	0.21	<0.03
Storm Comp	7/17/10 20:50	7/17/10 22:00	50	9	0.98	0.186	0.07		10	<0.0005	<0.005	0.0068	0.0012	0.002	0.016	34	0.09	0.23	<0.03
Base Grab	7/20/10 15:32		~2	~1	0.68	0.072	0.088		92	<0.0005	<0.005	0.004	<0.0001	0.0022	<0.005	128	<0.02	0.09	<0.03
E. Coli Grab	7/27/10 20:40	7/28/10 2:41	~10	~4	0.63	0.083	0.053		24	<0.0005	<0.005	0.0047	0.0005	0.0018	0.0072	80	0.11	0.4	<0.03
Storm Comp	7/28/10 11:00	7/28/10 11:00						365											
Storm Comp	8/8/10 1:52	8/8/10 7:40	42	~9	1.1	0.183	0.059		15	<0.0005	<0.005	0.007	0.0009	0.0022	0.0158	68	0.15	0.52	<0.03
Storm Comp	8/10/10 23:55	8/11/10 0:59	149	~14	1.2	0.367	0.165		8	<0.0005	<0.005	0.0063	0.0027	0.0049	0.0168	30	0.15	1.31	<0.03
Storm Comp	8/13/10 4:15	8/13/10 9:00	38	~5	0.79	0.161	0.09		32	<0.0005	<0.005	0.0034	0.0006	0.0021	0.0082	72	0.07	0.14	<0.03
Base Grab	8/23/10 13:26		~2	~1	0.58	0.07	~0.048		80	<0.0005	<0.005	0.0031	<0.0001	0.0025	<0.005	144	<0.02	0.12	<0.03
E. Coli Grab	8/26/10 9:04							365											
Storm Comp	9/2/10 3:57	9/2/10 13:04	23	~4	0.8	0.169			14	<0.0005	<0.005	0.0052	0.0007	0.0021	0.0115	66	~0.02	0.28	<0.03
Storm Comp	9/15/10 5:35	9/16/10 0:03	36	10	0.9	0.151	~0.045		13	<0.0005	<0.005	0.0057	0.0008	0.0024	0.0162	62	<0.02	0.45	<0.03
Storm Comp	9/22/10 22:16	9/24/10 4:25	23	~5	0.91	0.181	0.085		19	<0.001	<0.010	<0.010	<0.003	<0.020	0.025	70	0.11	0.13	<0.03
E. Coli Grab	9/30/10 9:07	9/30/10 9:07						46											
Base Grab	10/6/10 9:54		<1	~1	0.34	0.058	~0.049		62	<0.001	<0.010	<0.010	<0.003	<0.020	<0.020	146	~0.02	0.46	<0.03

Key: No Exceedance Determinable; Exceeds CS; Exceeds MS; Exceeds FAV; Exceeds E. Coli Standard for Individual Sample

Table 7: MS1 Water Quality Sample Results and MN Rule 7050.0222 Class 2B Water Quality Standard Exceedances

MS2 (N side of Bailey Lake)

Map 7: MS2 Location



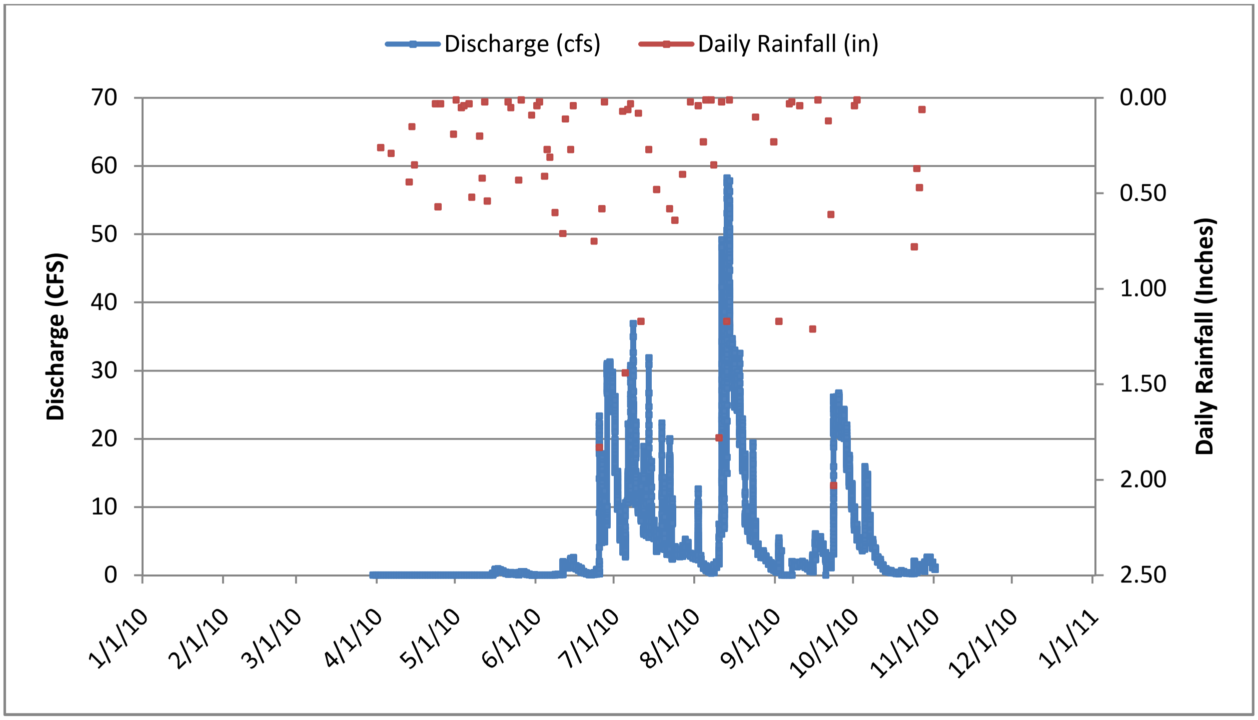
Water from a large portion of Woodbury, including outflow from Colby Lake, collects at MS2 (Map 7) before flowing into Bailey Lake. Data collected at this location will be used to assess loading rates from the portion of Woodbury that drains into Bailey Lake and develop models that will be used to evaluate effects of proposed development, BMP, and conservation projects. The MS2 monitoring site was established in 1996; however, only water quality data collected since 2000 is consistent and reliable. Parameters monitored include stage, flow, heavy metals, nutrients, and rainfall.

Results

Flow measurements were collected at the MS2 site every 15 minutes from March 30 at 10:45 to November 1 at 10:30. Discharge was calculated using an area velocity relationship, which is the cross sectional area of the water channel as determined by the water level within the pipe multiplied by the measured velocity. A rain gauge was also installed throughout the monitoring season. Average daily discharge and daily rainfall is shown in Figure 5.

The 2010 growing season loading summary is reported in Table 8 and reflects loads during the May 1 to September 30 growing season. Additional year to year analyses are performed in odd years. In 2010, 3 baseflow grab samples, 5 stormflow grab samples, 2 stormflow composite samples, and 3 bacteria grab samples were collected at the MS2 site. Water quality results are reported in Table 9. None of the samples exceeded state water quality standards.

Figure 5: MS2 Average Daily Discharge and Observed Rainfall



Year	Observed Growing Season Rainfall (inches)	Runoff Volume (acre-feet)	Projected Annual Runoff Volume (acre-feet)	Total Phosphorus (lbs)	Total Phosphorus (lbs/ac/yr)	Total Suspended Solids (lbs)	Total Suspended Solids (lbs/ac/yr)
2010	22.82	1,729	1,890	607	0.06	76,856	7.57

[1]Annual loads calculated using the Army Corps of Engineers FLUX32 Load Estimating Software, 2.95 Beta.

Table 8: MS2 Annual Loading Summary

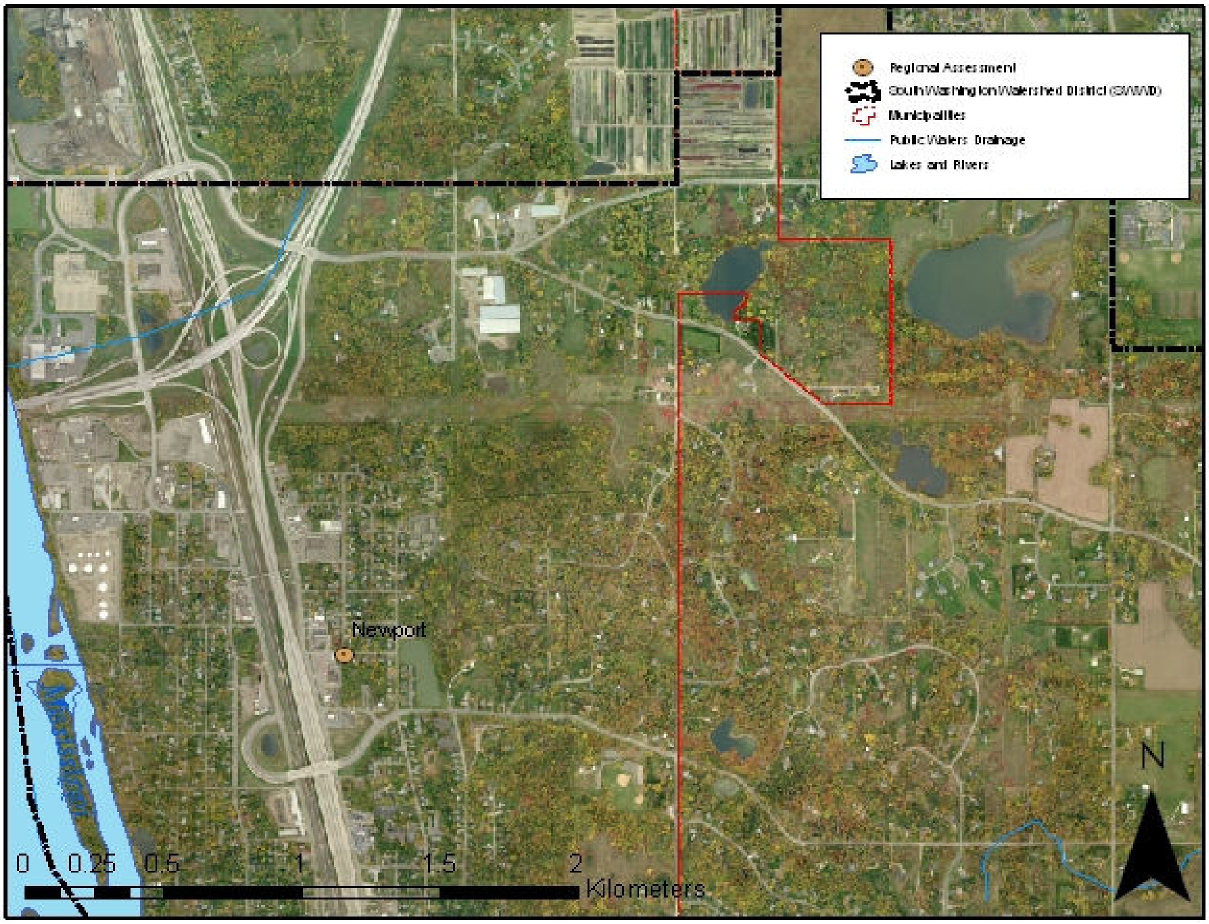
Sample Type	Sample Start	Sample End	Suspended solids (mg/L)	Volatile suspended solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Dissolved Phosphorus (mg/L)	E coli	Chloride ion (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Nickel (mg/L)	Zinc (mg/L)	Hardness (mg/L_CaCO3)	Ammonia Nitrogen (mg/L)	Nitrate N (mg/L)	Nitrite N (mg/L)
Storm Comp	6/11/10 10:53	6/12/10 19:02	13	9	1.8	0.118	~0.025		91	<0.0005	<0.005	0.0032	0.0002	0.0012	0.0053	62	~0.04	<0.05	<0.03
Storm Comp	6/25/10 22:09	6/26/10 13:35	8	4	1.1	0.092	~0.019		59	<0.0005	<0.005	0.0029	<.0005	0.0012	<0.005	54	0.1	0.06	<0.03
Storm Grab	7/7/10 12:56		22	20	2	0.115	~0.030		75	<0.0005	<0.005	0.0017	0.0006	0.0012	<0.005	52	~0.03	<0.05	<0.03
Base Grab	7/20/10 14:53		20	18	2.1	0.117	~0.044		71	<0.0005	<0.005	0.0016	0.0001	0.0012	<0.005	62	<0.02	<0.05	<0.03
E. Coli Grab	7/28/10 10:35							76											
Storm Grab	7/28/10 10:35		13	10	1.7	0.124	~0.016		66	<0.0005	<0.005	0.0017	0.0002	0.0012	<0.005	56	<0.02	<0.05	<0.03
Storm Grab	8/11/10 13:56		17	12	1.8	0.164	~0.016		50	<0.0005	<0.005	0.003	0.0002	0.0012	<0.005	54	<0.02	<0.05	<0.03
Base Grab	8/23/10 12:41		17	13	1.7	0.135	~0.027		42	<0.0005	<0.005	0.0016	0.0004	0.0013	<0.005	58	<0.02	<0.05	<0.03
E. Coli Grab	8/26/10 8:29							27											
Storm Grab	9/3/10 10:17		15	10	1.7	0.193	~0.011		36	<0.0005	<0.005	<.01	0.0004	0.0014	<0.005	68	0.17	<0.05	<0.03
Storm Grab	9/24/10 15:23		20	13	2	0.147	~0.028		41	<.001	<.01	<.01	<.0003	<.02	<.02	48	0.33	<0.05	<0.03
E. Coli Grab	9/30/10 8:40							28											
Base Grab	10/5/10 15:54		16	11	1.6	0.102	~0.034		41	<.001	<.01	<.01	<.0003	<.02	<.02	64	~0.03	0.06	<0.03

Key: No Exceedance Determinable; Exceeds CS; Exceeds MS; Exceeds FAV; Exceeds E. Coli Standard for Individual Sample

Table 9: MS2 Water Quality Sample Results and MN Rule 7050.0222 Class 2B Water Quality Standard Exceedances

Newport (Tributary to Mississippi River)

Map 8: Newport Location



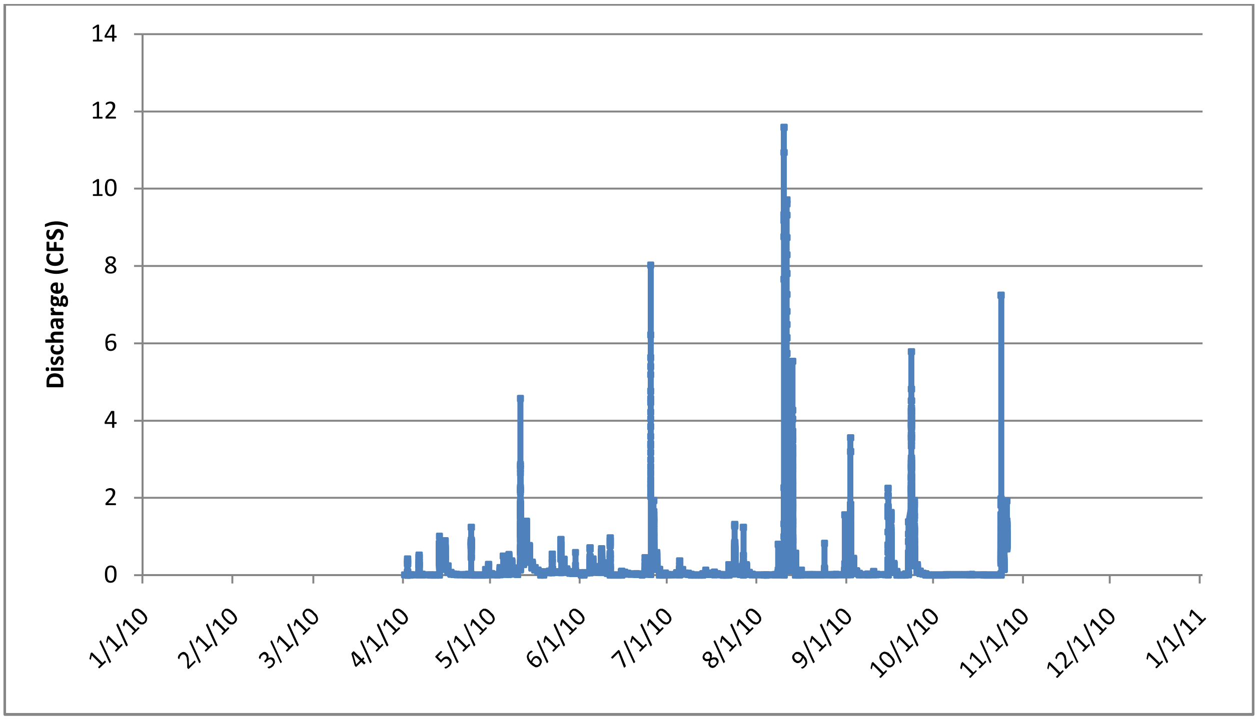
The Newport site (Map 8) is on a tributary to the Mississippi River through which stormwater runoff from the majority of the City flows. This station serves as a regional assessment location for the City of Newport and will help develop baseline water quality and quantity data for runoff flowing into the Mississippi River. The site was established in 2006. Parameters monitored include bacteria, flow, stage, nutrients, and heavy metals.

Results

Flow measurements were collected at the Newport site every 15 minutes from April 1 at 15:00 to October 26 at 21:45. Data was not collected during several short periods due to equipment malfunction. Discharge was calculated using an area velocity relationship, which is the cross sectional area of the water channel as determined by the water level within the pipe multiplied by the measured velocity. Average daily discharge is shown in Figure 6.

In 2010, 1 stormflow grab, and 10 stormflow composite samples were collected at the Newport site. All samples were analyzed at the Metropolitan Council Environmental Services Lab for nutrients and metals. Water quality results are reported in Table 11. The 2010 growing season loading summary is reported in Table 10. Reported loads represent loading during the May 1 to September 30 growing season. Additional year to year trend analyses are performed in odd years.

Figure 6: Newport Average Daily Discharge



Year	Growing Season Runoff Volume (acre-feet)	Projected Annual Runoff Volume (acre-feet)	Total Phosphorus (lbs)	Total Phosphorus (lbs/ac/yr)	Total Suspended Solids (lbs)	Total Suspended Solids (lbs/ac/yr)
2010	43	51	14.14	.05	10,693	36

[1]Annual loads calculated using the Army Corps of Engineers FLUX32 Load Estimating Software, 2.95 Beta.

Table 10: Newport Annual Loading Summary

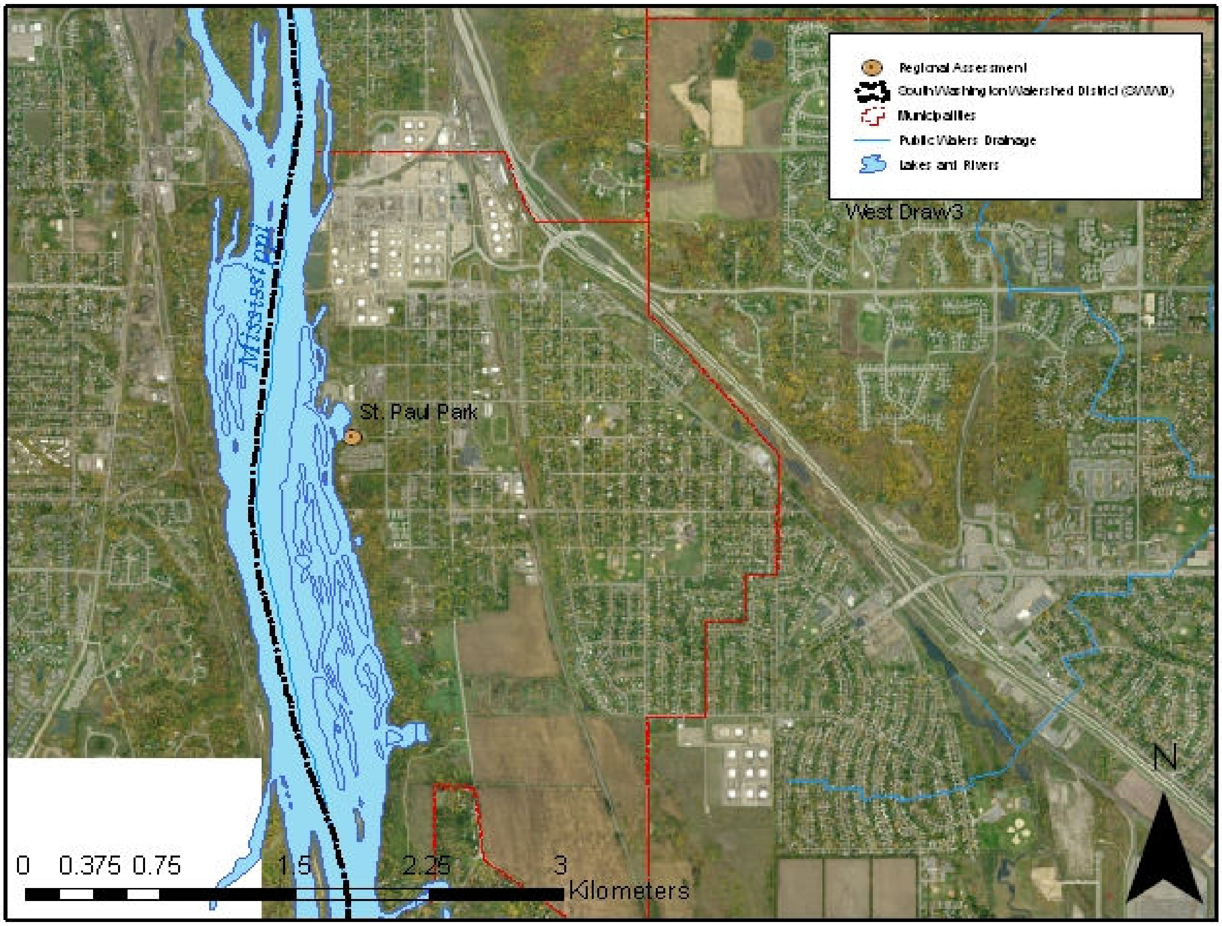
Sample Type	Sampled date	End sampling	Suspended solids (mg/L)	Volatile suspended solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Dissolved Phosphorus (mg/L)	E coli	Chloride ion (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Nickel (mg/L)	Zinc (mg/L)	Hardness (mg/L_CaCO3)	Ammonia Nitrogen (mg/L)	Nitrate N (mg/L)	Nitrite N (mg/L)
Storm Grab	4/15/10 12:17		5	~2	0.95	~0.049	0.146		149	<0.0005	<.01	0.0038	0.0005	0.0019	0.0181	88	~0.03	0.05	<0.03
Storm Comp	5/11/10 3:37	5/12/10 0:14	5	~1	0.74	0.058	~0.033		93	<0.0005	<0.005	0.0041	0.0007	0.0019	0.0079	64	~0.04	0.06	<0.03
Storm Comp	5/13/10 4:15	5/14/10 8:05	15	5	0.73	0.054	~0.016		90	<0.0005	<0.005	0.0039	0.0028	0.0019	0.0131	80	~0.04	0.06	<0.03
Storm Comp	6/8/10 10:40	6/8/10 22:54	286	57	1.3	0.198	~0.041		83	<0.0005	<0.005	0.0044	0.0021	0.0022	0.0169	34	<0.02	0.05	<0.03
Storm Comp	6/25/10 18:08	6/25/10 18:45	5430	2130	8.4	1.96	0.054		30	0.0023	0.037	0.164	0.0971	0.0341	1.09	94	0.1	0.07	<0.03
Storm Comp	8/10/10 11:47	8/11/10 8:33	21	~9	0.98	0.146	~0.036		16	<0.0005	<0.005	0.0034	0.0013	0.0016	0.0259	48	0.2	0.08	<0.03
Storm Comp	8/13/10 4:07	8/13/10 9:05	299	~18	0.92	0.139	0.051		13	<0.0005	<0.005	0.0026	0.0013	0.0014	0.0126	38	0.17	0.06	0.04
Storm Comp	9/2/10 5:08	9/2/10 16:16	7	~4	0.68	0.128	~0.021		10	<0.0005	<0.005	0.0018	0.0004	0.0012	0.009	50	0.08	0.08	<0.03
Storm Comp	9/15/10 11:30	9/16/10 16:48	32	7	0.6	0.134	~0.026		11	<0.0005	<0.005	0.0023	0.001	0.0028	0.0212	64	<0.02	0.06	<0.03
Storm Comp	9/23/10 12:39	9/23/10 23:18	10	3	0.28	0.05	~0.032		5	<.001	<.01	<.01	<.003	<.02	<.02	38	~0.04	0.11	<0.03

Key: No Exceedance Determinable; Exceeds CS; Exceeds MS; Exceeds FAV; Exceeds E. Coli Standard for Individual Sample

Table 11: Newport Water Quality Sample Results and MN Rule 7050.0222 Class 2B Water Quality Standard Exceedances

Saint Paul Park (Tributary to Mississippi River)

Map 9: Saint Paul Park Location



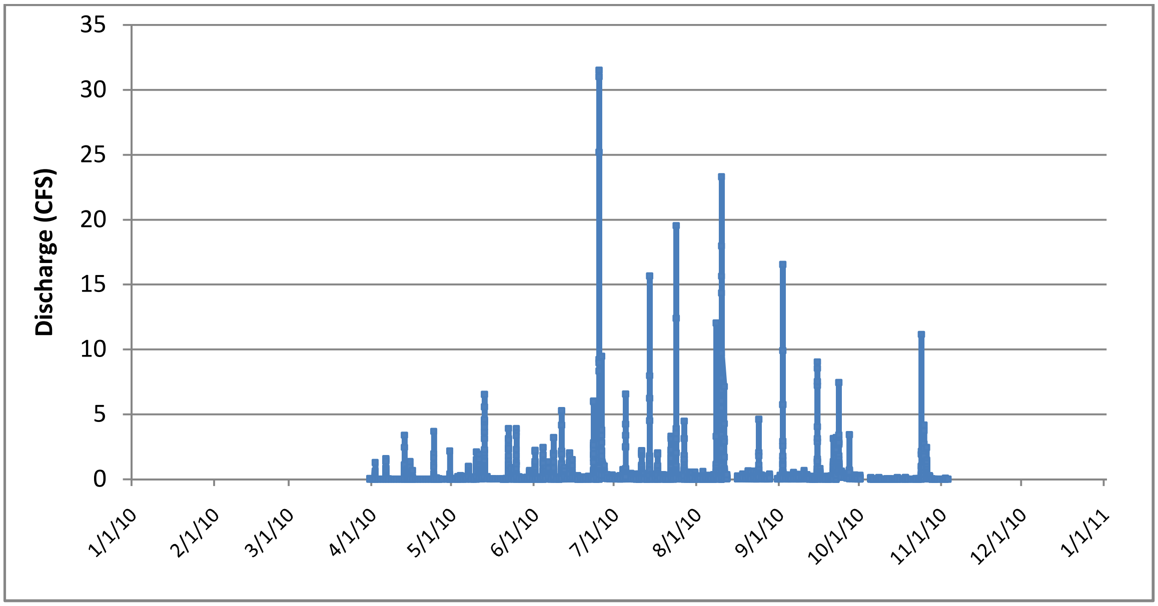
The St. Paul Park site (Map 9) monitors stormwater that discharges directly from the city stormsewer system to the Mississippi River by pipe. This regional assessment location will be used to characterize baseline water quality and quantity data for stormwater generated in St. Paul Park and direct loading to the River. The site was established in 2006. Parameters monitored include bacteria, flow, stage, nutrients, and heavy metals.

Results

Flow measurements were collected at the St. Paul Park site every 15 minutes from March 31 at 15:15 to November 3 at 10:30. Discharge was calculated using an area velocity relationship, which is the cross sectional area of the water channel as determined by the water level within the pipe multiplied by the measured velocity. Average daily discharge is shown in Figure 7.

The 2010 growing season loading summary is reported in Table 12. Amounts reported reflect loading during the May 1 to September 30 growing season. Additional year to year trend analyses are performed in odd years. In 2010, 2 snowmelt grab and 13 stormflow composite samples were collected at the St. Paul Park site. Water quality results are presented in Table 13.

Figure 7: St. Paul Park Average Daily Discharge



Year	Growing Season Runoff Volume (acre-feet)	Projected Annual Runoff Volume (acre-feet)	Total Phosphorus (lbs)	Total Phosphorus (lbs/ac/yr)	Total Suspended Solids (lbs)	Total Suspended Solids (lbs/ac/yr)
2010	40	45	12.9	0.172	4,740	63

[1]Annual loads were calculated using the Army Corps of Engineers FLUX32 Load Estimating Software, 2.95 Beta.

Table 12: St. Paul Park Annual Loading Summary

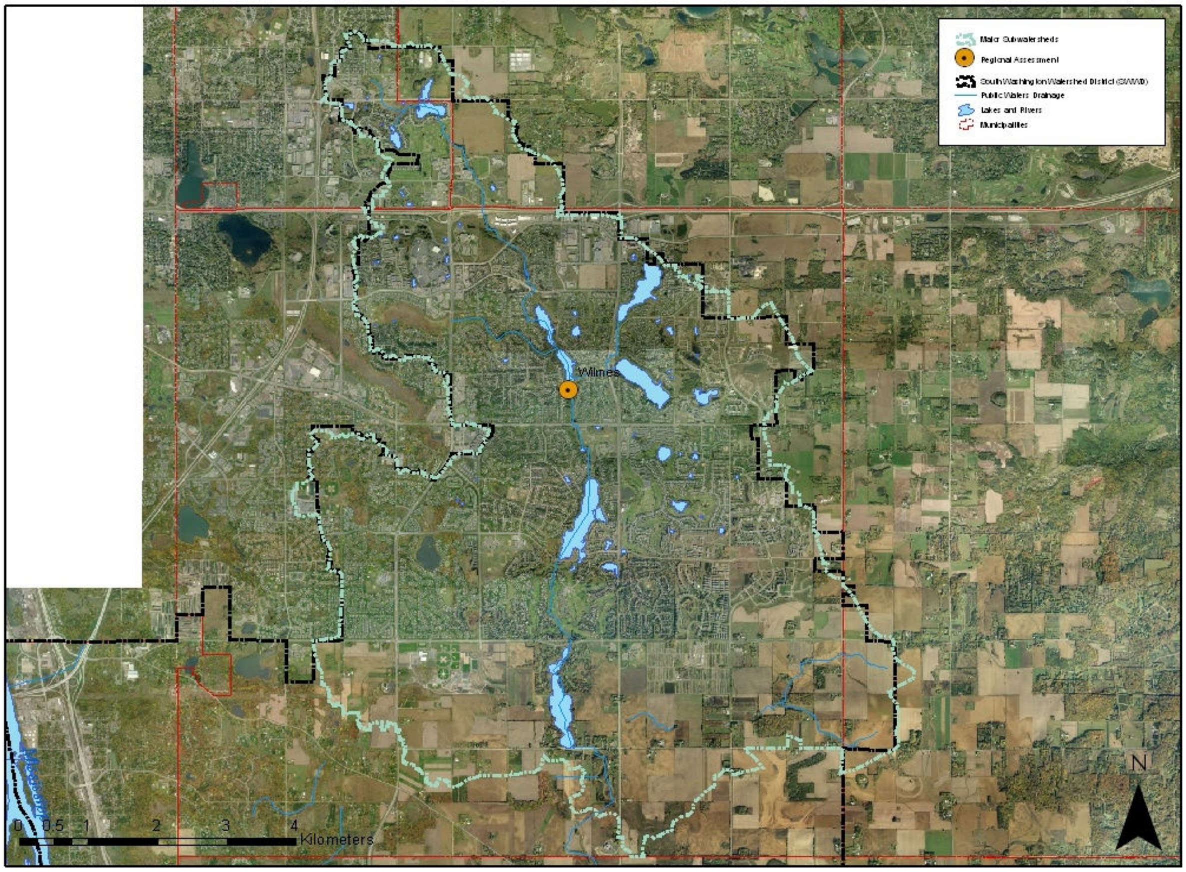
Sample Type	Sampled date	End sampling	Suspended solids (mg/L)	Volatile suspended solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Dissolved Phosphorus (mg/L)	Chloride ion (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Nickel (mg/L)	Zinc (mg/L)	Hardness (mg/L_CaCO3)	Ammonia Nitrogen (mg/L)	Nitrate N (mg/L)	Nitrite N (mg/L)
Snowmelt Grab	3/8/10 11:30		293	31	1.4	0.254	~0.049	20	<0.0005	0.0055	0.0117	0.0074	0.0055	0.0649	72	0.24	0.77	0.06
Snowmelt Grab	3/11/10 9:50		85	27	1	0.183	0.052	51	<0.0005	0.0092	0.0165	0.0148	0.0072	0.0871	80	0.25	0.89	0.05
Storm Comp	5/25/10 20:21	5/25/10 22:20	82	25	1.3	0.189	~0.028	2	<0.0005	<0.005	0.0108	0.0061	0.0035	0.087	32	0.16	0.49	0.04
Storm Comp	6/8/10 5:54	6/8/10 6:20			1	0.151	~0.016	<2								0.31	0.23	<0.03
Storm Comp	6/11/10 6:57	6/11/10 7:52	154	30	1.1	0.191	~0.014	<2	<0.0005	0.0055	0.0109	0.014	0.0046	0.0574	26	0.24	0.53	0.05
Storm Comp	6/23/10 3:13	6/23/10 4:15	39	12	1.3	0.188	0.076	2	<0.0005	<0.005	0.0108	0.004	0.0037	0.067		0.24	0.63	0.16
Storm Comp	6/25/10 18:22	6/25/10 19:28	622	88	1.9	0.282	0.067	<2	<0.0005	0.0087	0.0163	0.0204	0.0059	0.0656	42	0.52	0.37	<0.03
Storm Comp	7/5/10 21:52	7/5/10 22:41			0.81	0.103	~0.020	<2	<0.0005	<0.005	0.0087	0.0058	0.003	0.0465	22	0.13	0.28	<0.03
Storm Comp	7/27/10 21:01	7/27/10 21:23	104	19	1.1	0.112	~0.039	3	<0.0005	<0.005	0.0091	0.0066	0.0028	0.0612	32			
Storm Comp	8/8/10 1:37	8/8/10 2:01	382	82	2.5	0.449	0.165	3	<0.0005	0.0059	0.0184	0.0193	0.007	0.105	44	0.26	0.41	0.04
Storm Comp	8/10/10 10:14	8/10/10 11:22	927	31	0.6	0.143	0.098	3	<0.0005	0.006	0.0067	0.0038	0.0022	0.0334	26			
Storm Comp	8/10/10 19:55	8/10/10 23:57	68	10	0.68	0.122	~0.049	<2	<0.0005	<0.005	0.0044	0.0025	0.0019	0.0277	56	0.11	0.38	<0.03
Storm Comp	9/2/10 3:50	9/2/10 7:17	57	15	0.51	0.129	0.057	3	<0.0005	<0.005	0.0042	0.0035	0.0018	0.0198	28	0.06	0.38	<0.03
Storm Comp	9/15/10 12:06	9/15/10 20:57	56	16	1.5	0.19	~0.036	<2	<0.0005	<0.005	0.0083	0.0049	0.0027	0.0376	28	0.14	0.2	<0.03
Storm Comp	9/22/10 21:57	9/23/10 7:58	21	6	0.26	0.059	~0.021	<2	<.001	<.01	<.01	<.03	<.02	<.02	64	<0.02	0.19	<0.03

Key: No Exceedance Determinable; Exceeds CS; Exceeds MS; Exceeds FAV; Exceeds E. Coli Standard for Individual Sample

Table 13: St. Paul Park Water Quality Sample Results and MN Rule 7050.0222 Class 2B Water Quality Standard Exceedances

Wilmes Lake Outlet

Map 10: Wilmes Lake Outlet Location



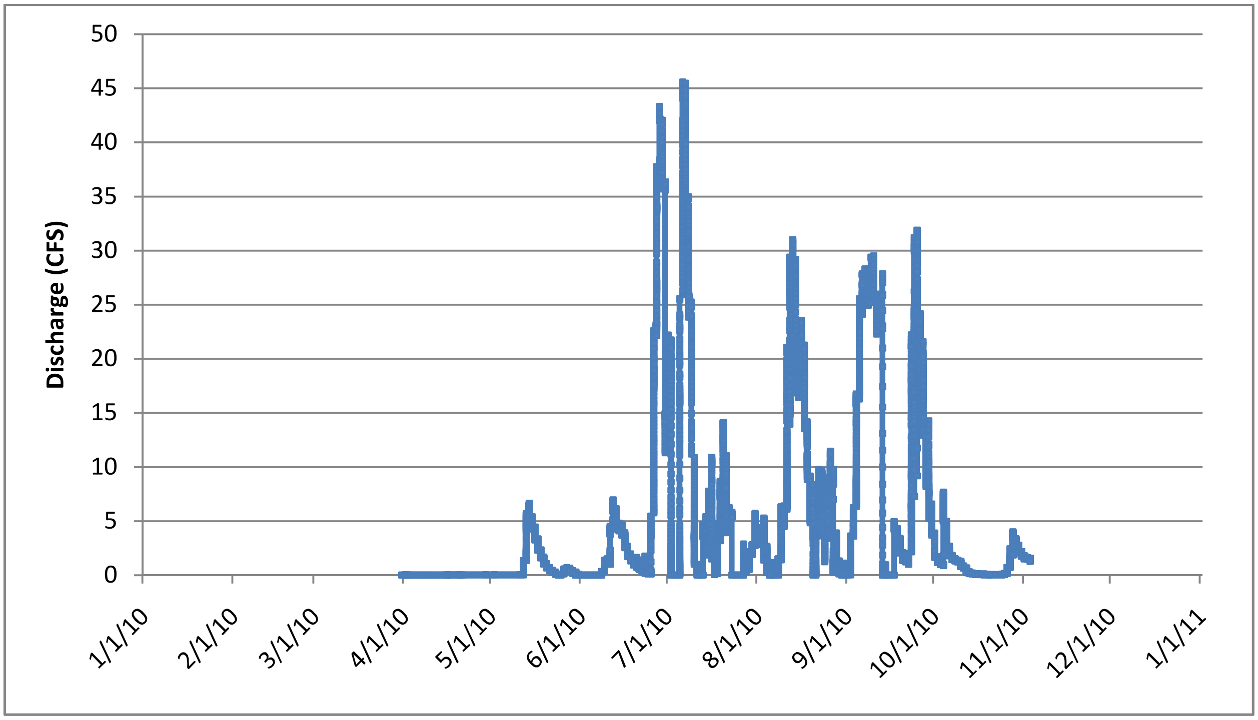
The Wilmes Lake Outlet location (Map 10) was established in 2009. Data collected from this location will give a better understanding of the quantity and quality of water leaving the upper half of the Northern watershed and flowing toward Colby Lake. Parameters monitored include bacteria, stage, flow, heavy metals, and nutrients.

Results

Flow measurements were collected at the Wilmes Lake Outlet site every 15 minutes from March 31 at 12:00 to November 3 at 14:15. Due to equipment malfunction, no data was collected April 5 at 11:45 to April 14 at 15:00 and July 23 at 6:15 to July 27 at 13:15. Discharge was calculated using an area velocity relationship, which is the cross sectional area of the water channel as determined by the water level within the pipe multiplied by the measured velocity. Average daily discharge is shown in Figure 8.

The 2010 loading summary is provided in Table 14. Reported values reflect loading during the May 1 to September 30 growing season. Additional year to year trend analyses are performed in odd years. In 2010, 3 baseflow grab samples, 9 storm composite samples, and 1 bacteria grab sample were collected at the Wilmes outlet. The bacteria sample was analyzed only for E. coli. Water quality results are reported in Table 1515. None of the water quality parameters exceeded state water quality standards.

Figure 8: Wilmes Lake Outlet Average Daily Discharge



Year	Growing Season Runoff Volume (acre-feet)	Projected Annual Runoff Volume (acre-feet)	Total Phosphorus (lbs)	Total Phosphorus (lbs/ac/yr)	Total Suspended Solids (lbs)	Total Suspended Solids (lbs/ac/yr)
2010	2,062	2,143	522.23	0.10	51,374	9.97

[1]Annual loads calculated using the Army Corps of Engineers FLUX32 Load Estimating Software, 2.95 Beta.

Table 14: Wilmes Lake Outlet Annual Loading Summary

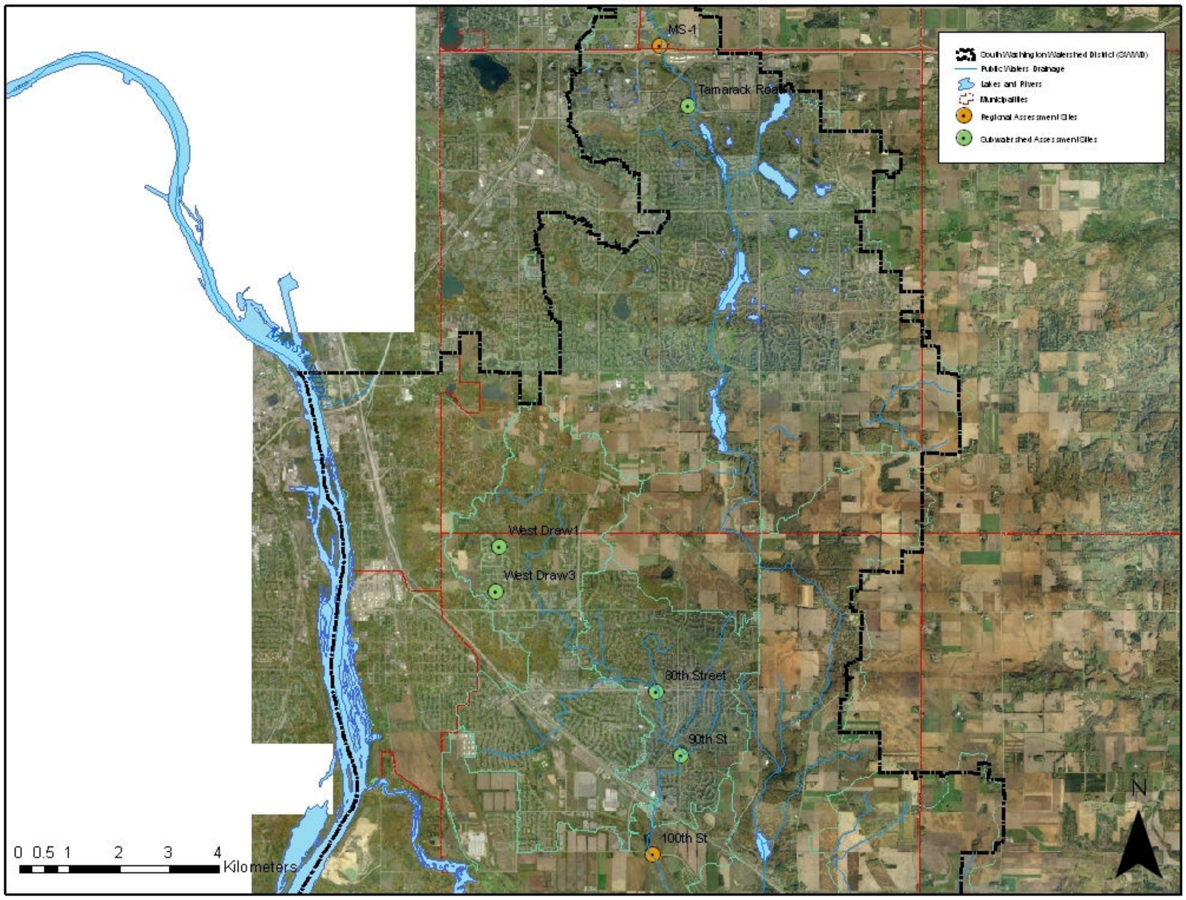
Sample Type	Sampled date	End sampling	Suspended solids (mg/L)	Volatile suspended solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Dissolved Phosphorus (mg/L)	E coli	Chloride ion (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Nickel (mg/L)	Zinc (mg/L)	Hardness (mg/L_CaCO3)	Ammonia Nitrogen (mg/L)	Nitrate N (mg/L)	Nitrite N (mg/L)
Storm Comp	5/12/10 17:27	5/17/10 7:16	4	3	1.1	0.068	~0.020		90	<0.0005	<0.005	0.0039	0.0001	0.001	0.01	88	0.09	<0.05	<0.03
Storm Comp	6/11/10 10:40	6/15/10 12:08	5	4	1.2	0.061	<0.010		98	<0.0005	<0.005	0.0034	<.0005	0.002	<0.005	72	0.1	0.06	<0.03
Storm Comp	6/25/10 23:29	6/27/10 5:04	6	3	1.2	0.068	~0.012		104	<0.0005	<0.005	0.003	<.0005	0.001	<0.005	76	0.09	0.05	<0.03
Storm Comp	7/5/10 23:32	7/6/10 14:03	8	4	1.1	0.073	~0.037		79	<0.0005	<0.005	0.0031	0.0003	0.001	<0.005	60	0.08	0.15	0.04
Base Grab	8/4/10 11:02		3	3	1.1	~0.048	~0.021		65	<0.0005	<0.005	0.0015	0.0001	0.001	<0.005	100		<0.05	<0.03
Storm Comp	8/11/10 2:44	8/12/10 19:15	10	7	1.1	0.09	~0.046		50	<0.0005	<0.005	0.0023	0.0003	0.001	<0.005	60	0.12	0.16	0.06
Base Grab	8/24/10 10:04		5	4	1	0.07	0.089		44	<0.0005	<0.005	0.0017	0.0002	0.001	<0.005	88	<0.02	<0.05	<0.03
E. Coli Grab	8/26/10 8:16							4											
Storm Comp	9/2/10 7:34	9/3/10 10:44	11	7	1.4	0.128	~0.011		49	<0.0005	<0.005	0.0018	0.0002	0.001	0.01	104	~0.03	<0.05	<0.03
Storm Comp	9/23/10 11:06	9/23/10 20:35	14	9	1.2	0.112	~0.031		44	<.001	<.01	<.01	<.003	<.02	<.02	68	0.06	0.23	<0.03
Storm Comp	9/23/10 21:03	9/25/10 9:05	13	9	1.4	0.128	~0.046		49	<.001	<.01	<.01	<.003	<.02	<.02	312	0.19	0.13	<0.03
Storm Comp	9/25/10 9:23	9/25/10 11:58	12	8	1.3	0.117	~0.028		47	<.001	<.01	<.01	<.003	<.02	<.02	68	0.16	0.09	0.04
Base Grab	10/6/10 9:38		7	5	1	0.073	~0.037		39	<.001	<.01	<.01	<.003	<.02	<.02	88	0.07	<0.05	<0.03

Key: No Exceedance Determinable; Exceeds CS; Exceeds MS; Exceeds FAV; Exceeds E. Coli Standard for Individual Sample

Table 15: Wilmes Lake Outlet Water Quality Sample Results and MN Rule 7050.0222 Class 2B Water Quality Standard Exceedances

Subwatershed Assessment

Map 11: Subwatershed Assessment Locations



To enhance the SWWD regional assessment framework, the District operates subwatershed assessment sites on a rotating basis. Subwatershed assessment locations are chosen in order to further define and manage water resources within the major regions of the watershed. Data collected at these locations will be used to identify priority subwatersheds within the larger watershed regions of the District as well as to help calibrate regional models and update maximum allowable load levels corresponding to the contributing areas for each location. Subwatershed assessment sites, once established, will generally be operated for a period of 3-10 years depending on District goals, range of data being collected, and changes in the watershed.

Current subwatershed assessment locations are shown in Map 11. The purpose of all existing subwatershed assessment monitoring sites is to calibrate SWWD's District wide hydrology model. Flows resulting from a wide range of storm events are needed for model calibration and monitoring will continue until an adequate range of storms have been captured. SWWD will continue to consult with District Engineers regarding data needs for model calibration at each site.

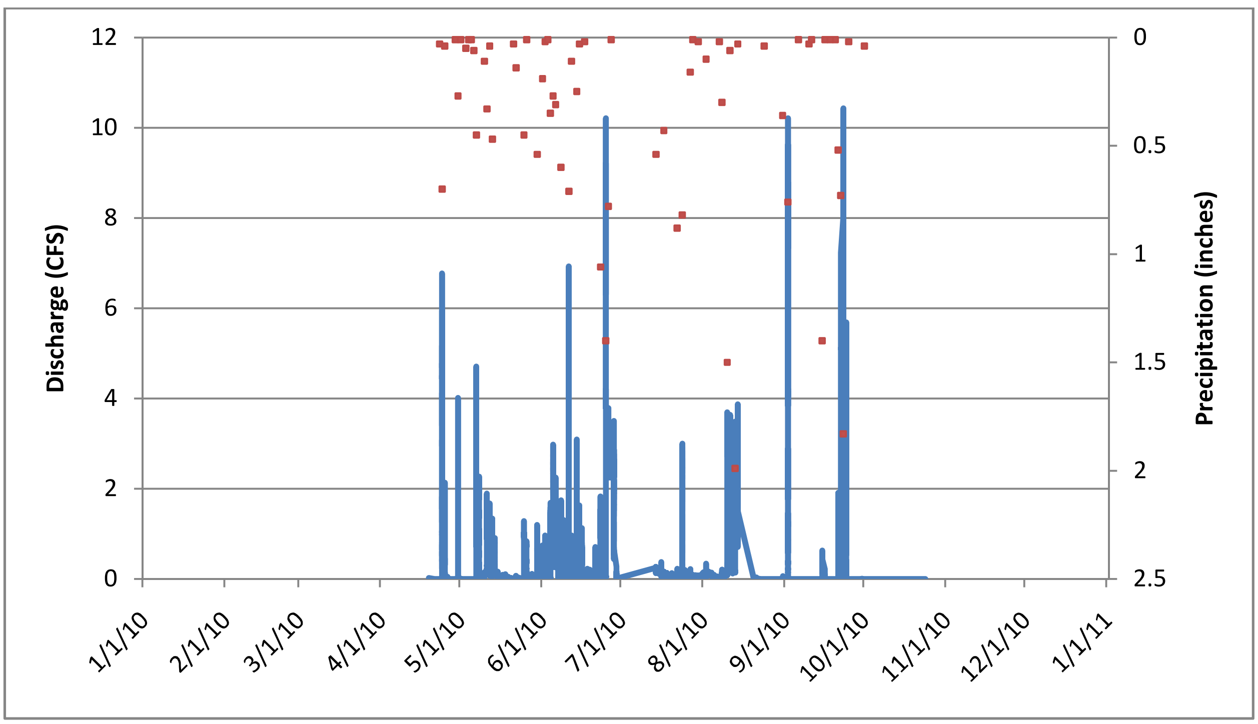
All existing subwatershed assessment sites are monitored for flow using a self-powered water level logger. Stage measurements are taken every 15 minutes. Field stage measurements are taken at all sites and stage to discharge rating curves are developed, if possible. Rating curves are used to calculate discharge at the subwatershed assessment locations. Rainfall measurements from the closest SWWD Regional Assessment Location are paired with the collected flow data. Runoff and rainfall data for each site is presented below. Observed runoff resulting from measured rainfall is compared to modeled peak flows resulting from 24 hour events of 1", 2.75", and 6.3". 2.75" and 6.3" approximate the 2 and 100 year events, respectively.

Results

80th St

The 80th Street site is in the Central Draw Subwatershed. The existing Central Draw model is 10 years old and in need of updating. Therefore, modeled flows are considered obsolete. Continued data collection during a wide variety of storm events at 80th Street will be used to update the existing model. Average daily discharge recorded at 80th Street and rainfall observed at the 100th Street RAL is presented in Figure 9.

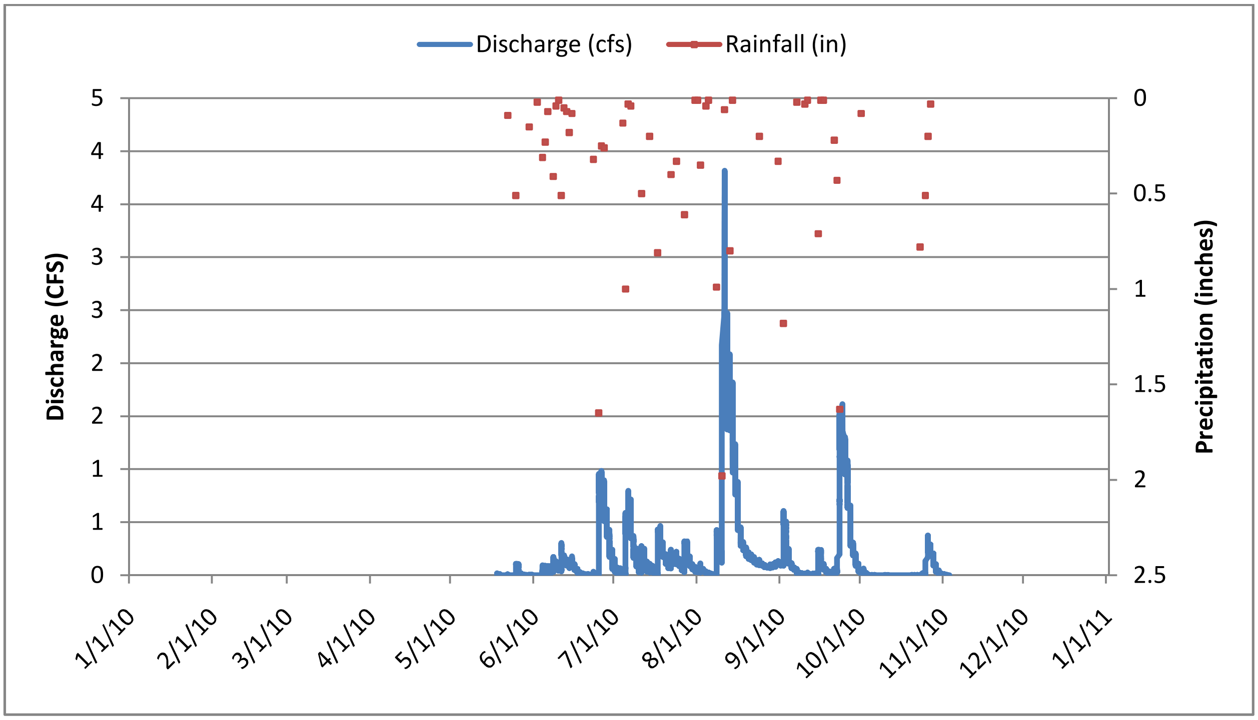
Figure 9: 80th St Average Daily Discharge and 100th St Observed Rainfall



CD-P27/Dancing Waters

The 80th Street site is in the Powers Lake watershed (SWWD northern watershed). The existing NWS model is up to date. However, additional data in the area is needed to verify the model as many of the basins have only recently developed, including Dancing Waters. This site is intended to monitor the outflow of CD-P27 which was originally designed to operate as an infiltration basin. Following development of a sinkhole during the October 2005 100 yr rain event, this basin was sealed and now operates as a pond. Continued monitoring of the CD-P27 outflow will give us a better idea of what is actually leaving a large portion of the Powers Lake watershed. Average daily discharge recorded at the CD-P27/Dancing Waters site and rainfall observed at the Powers East site is presented in Figure 10.

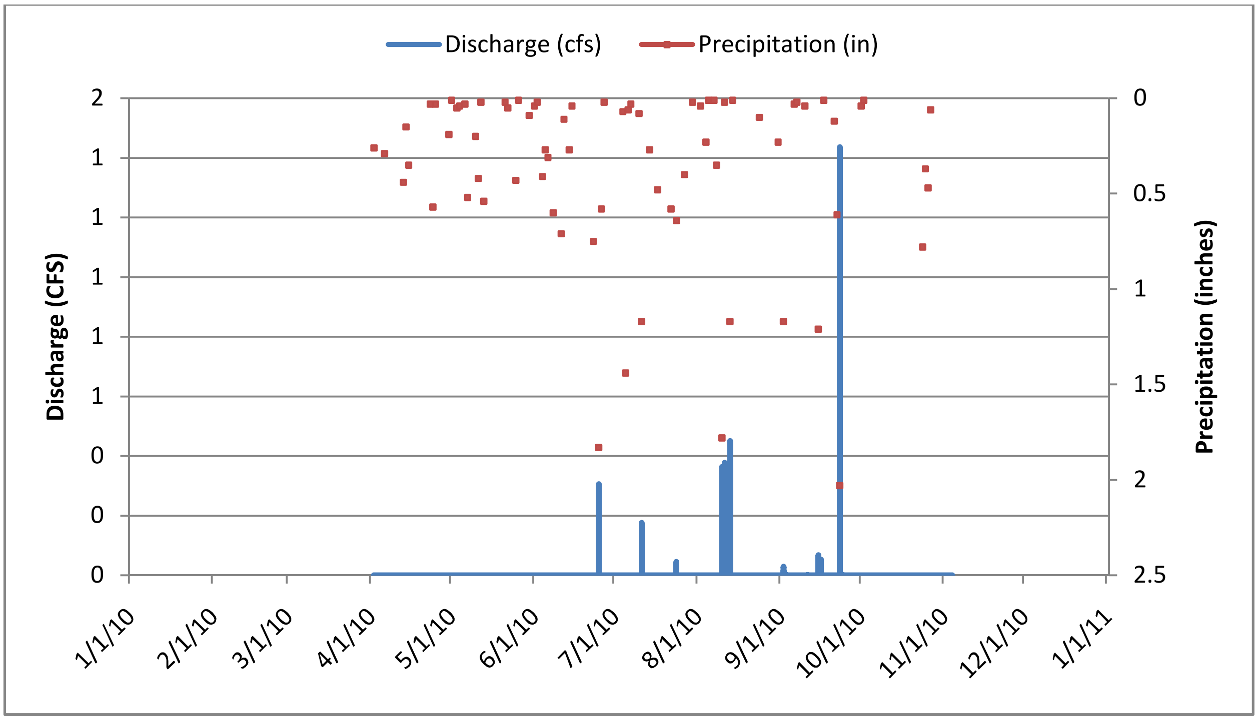
Figure 10: CD-P87/Dancing Waters Average Daily Discharge and Powers East Observed Rainfall



East Ridge

The East Ridge site is in the Bailey Lake catchment of SWWD's Northern Watershed and monitors flow out of the East Ridge detention pond flowing into Bailey Lake. The East Ridge pond provides rate and volume control for a large portion of the Bailey Lake catchment and is integral in maintaining allowable inflows at Bailey Lake and the regional infiltration facilities (CD-P85/CD-P86) downstream. Monitoring began in 2010. Data from this site will be used to verify modeled flows coming out of the pond. Observed flows are displayed in Figure 11 along with daily precipitation observed at the MS2 Regional Assessment Location.

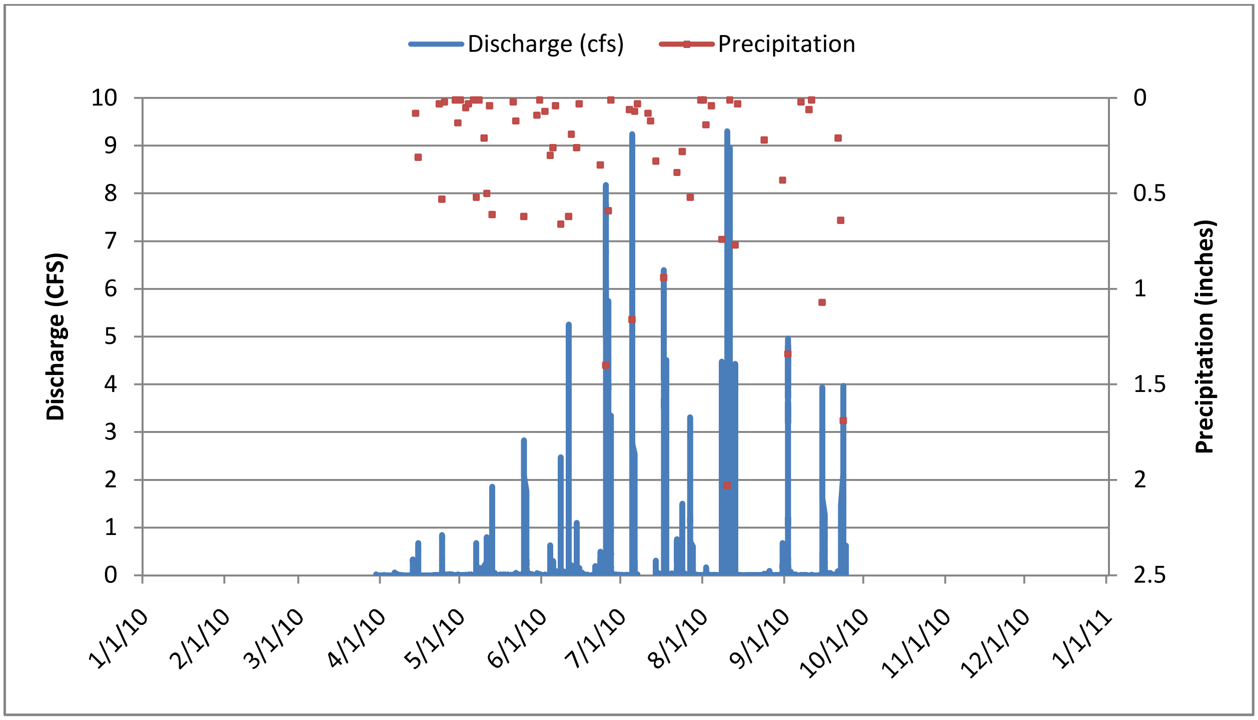
Figure 11: East Ridge Discharge and MS2 Observed Daily Rainfall



Tamarack

Tamarack is in the Northern subwatershed and has been monitored now for 10 years, and the model for the Northern subwatershed has been recently updated. However, the site continues to be monitored as development and redevelopment continues. Recorded discharge at Tamarack and daily rainfall observed at the MS1 Regional Assessment Location is presented in Figure 12.

Figure 12: Tamarack Recorded Discharge and MS1 Observed Daily Rainfall



Waterbody Assessment

Screening Programs

Long-term records of lake water quality are critical for assessing trends or changes in the integrity of a lake system. The Metropolitan Council's Citizen Assisted Monitoring Program (CAMP) has been utilizing volunteers to help obtain information on the health of Twin Cities lakes since 1993. Volunteers collect water samples for analysis and record observational information.

As of 2010, there are currently 7 lakes in the District that are actively monitored as part of the CAMP. In addition to the CAMP, the District has utilized the Washington Conservation District (WCD) to annually collect more detailed water quality data on Powers Lake and Armstrong Lake. The WCD also currently collects water level information on 8 lakes.

Citizen-Assisted Lake Monitoring Program

The SWWD participates in the Metropolitan Council's Citizen-Assisted Lake Monitoring Program (CAMP). Lakes within the District are monitored on an annually rotating basis with the goal of maintaining long-term data records for all lakes in the District. Lakes chosen for monitoring are monitored biweekly from April to October. Monitoring is conducted at the deepest point of each lake and consists of water sample collection and in-field measurements of surface temperature, dissolved oxygen, and transparency. Samples are analyzed for nitrogen, phosphorous, and chlorophyll-a. Hypolimnion water quality samples are collected where appropriate. Using water quality results, grades are assigned to lakes based on the guidelines below. If possible, volunteers are recruited to conduct monitoring. Lakes without volunteers are monitored by the WCD. Data from the CAMP program is used to detect long-term trends in lake water quality.

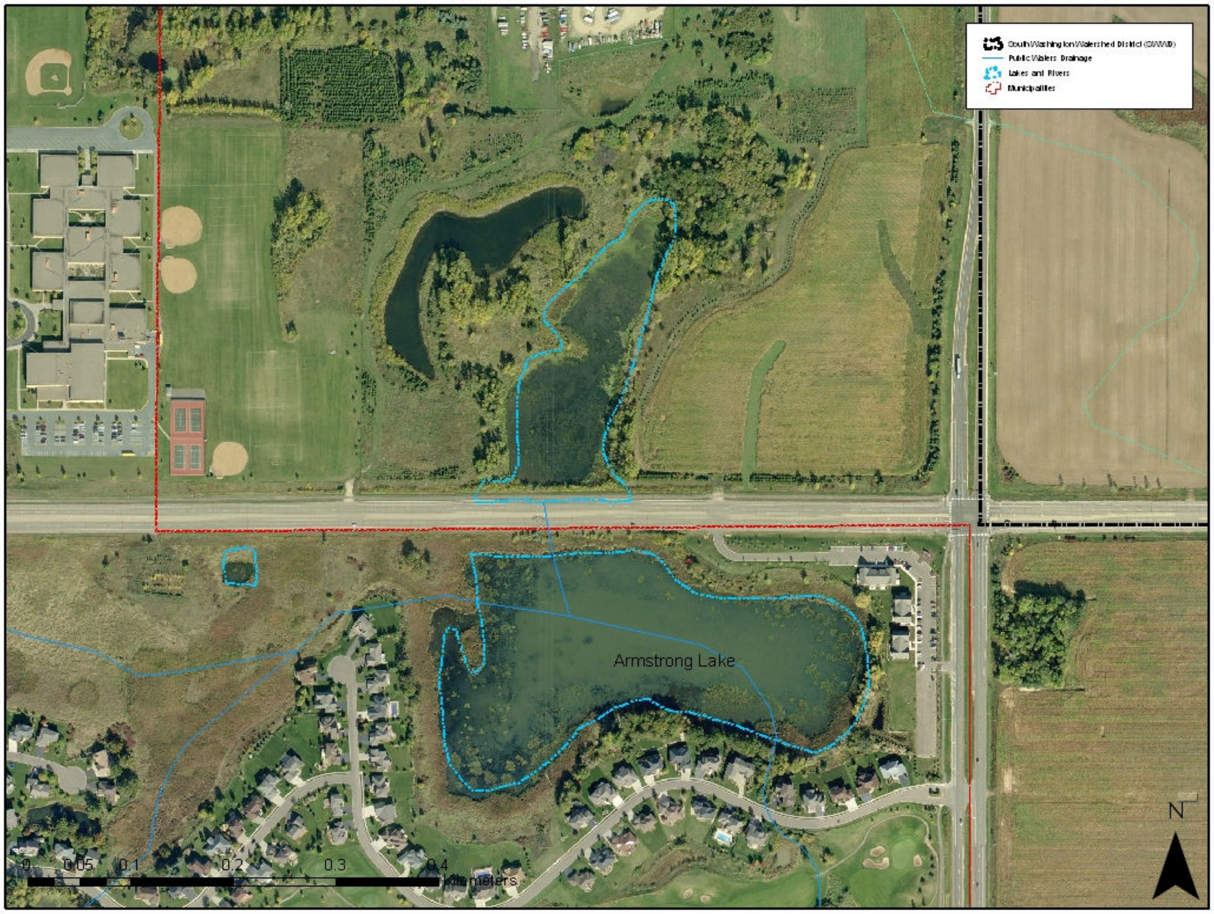
Grade	Total Phosphorus (µg/L)	Chlorophyll-a (µg/L)	Secchi Depth (m)
A	< 23	< 10	> 3.0
B	23-32	10-20	3.0-2.2
C	32-68	20-48	2.2-1.2
D	68-152	48-77	1.2-0.7
F	> 152	> 77	< 0.7

Citizen Assisted Monitoring Program (CAMP) Grading Criteria

Armstrong Lake

DNR ID #82-0116 Municipality: Lake Elmo/Oakdale
Surface Area: 39 Acres Watershed Area: 566 Acres
Mean Depth: 3-5 feet Maximum Depth: 5 feet
SWWD Maximum Allowable Phosphorus Load: 0.18 lbs/ac/yr
SWWD Trophic State Index (TSI) goal: 63-66

Map 12: Armstrong Lake



Armstrong Lake (Map 12) is approximately 39 acres in size and has a contributing watershed of 487 acres. This very shallow and flat lake is located in the headwaters of the Northern subwatershed. A majority of the drainage area to the lake is from Oakdale and is comprised mostly of low density residential land use with some farm areas; few undeveloped parcels remain. The lake is used for wildlife viewing and aesthetics. Non-motorized boating is possible.

The lake is divided in two by County Road 10 with a culvert under the road connecting the north and south basins. The northern portion of the lake is in Lake Elmo and has a maximum depth of 3 feet. The southern portion of the lake is in Oakdale and has a maximum depth of 5 feet. Water quality samples are taken in the southern basin because of its greater depth.

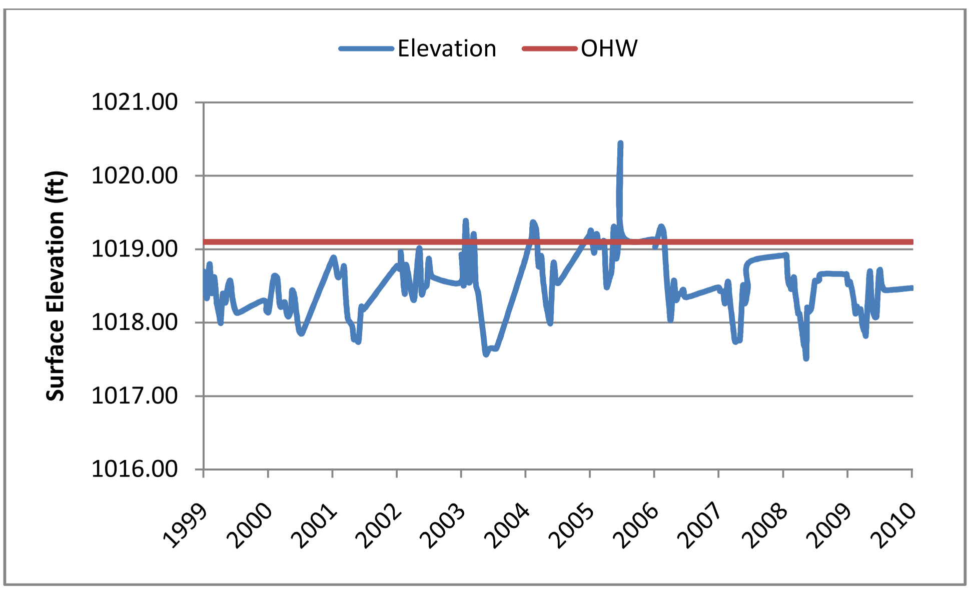
SWWD sets an interim TSI goal of 63-66 for Armstrong Lake, corresponding to an allowable watershed TP loading rate of 0.18 lbs/ac/yr. SWWD's interim goal exceeds MnPCA eutrophication standards. Upon meeting SWWD's interim goal, loading rates will be reevaluated and modified to work toward meeting state eutrophication standards.

Results

Lake level has been recorded by volunteers at Armstrong Lake since 1999. Armstrong Lake fluctuates quickly, but only within a small range of elevations. The surface elevation of Armstrong Lake has not exceeded the ordinary high water elevation since 2006. Recorded surface elevations are presented in Figure 13.

Lake water quality was monitored monthly through the growing season. Water Quality results are below in Table . Annual growing season averages of total phosphorus, chlorophyll a, and secchi transparency are shown graphically in Figures 14-16. Armstrong Lake's 2010 trophic status and historical lake grades are presented in Table 16.

Figure 13: Armstrong Lake Surface Elevation, 1999-2010



Date	Secchi Depth (m)	Water Temperature C	Surface Elevation	Pheophytin-a corrected Chlorophyll-a (ug/L)	Trichromatic Chlorophyll-a (ug/L)	TKN (mg/L)	TP (mg/L)
5/2/2010	1.1	12.6	1018.37	2.3	2.3	0.84	0.032
5/30/2010	1.1	27	1018.41	3.8	5.9	0.81	0.076
6/27/2010	1.2	27	1018.75	2.3	3.2	0.82	0.03
7/25/2010	0.08	27.4	1018.47	11	14	0.55	0.051
8/17/2010	1.2	23.3	1018.77	5.2	5.9	0.84	0.104
9/19/2010	1.1	13.4	1018.57	9.6	11	0.84	0.038
10/15/2010	1	14.6	1018.49	13	15	0.99	0.079

Table 16: Armstrong Lake 2010 Water Quality Results From the Met Council Citizen Assisted Monitoring Program (CAMP)

Figure 14: Armstrong Lake Historical Mean Growing Season Total Phosphorus Concentrations

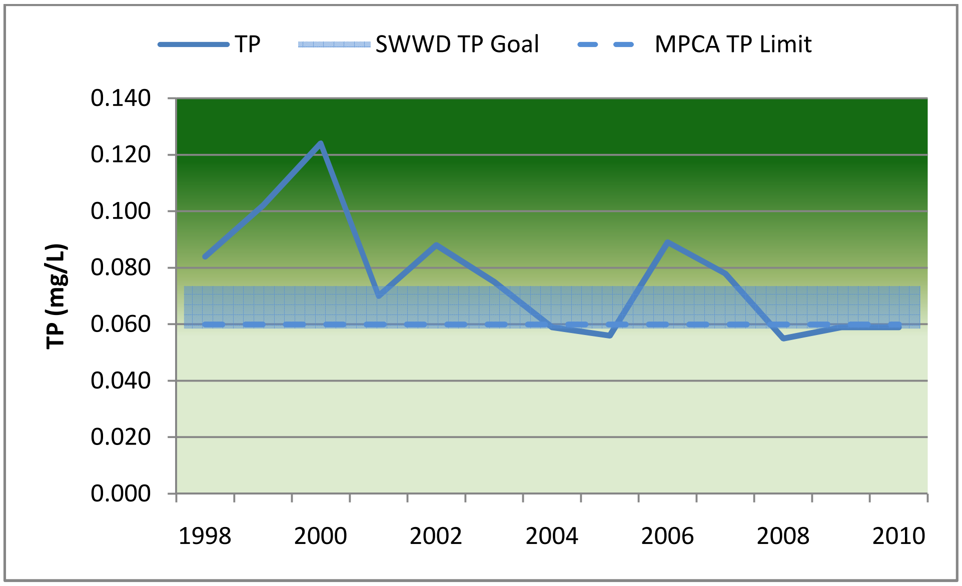
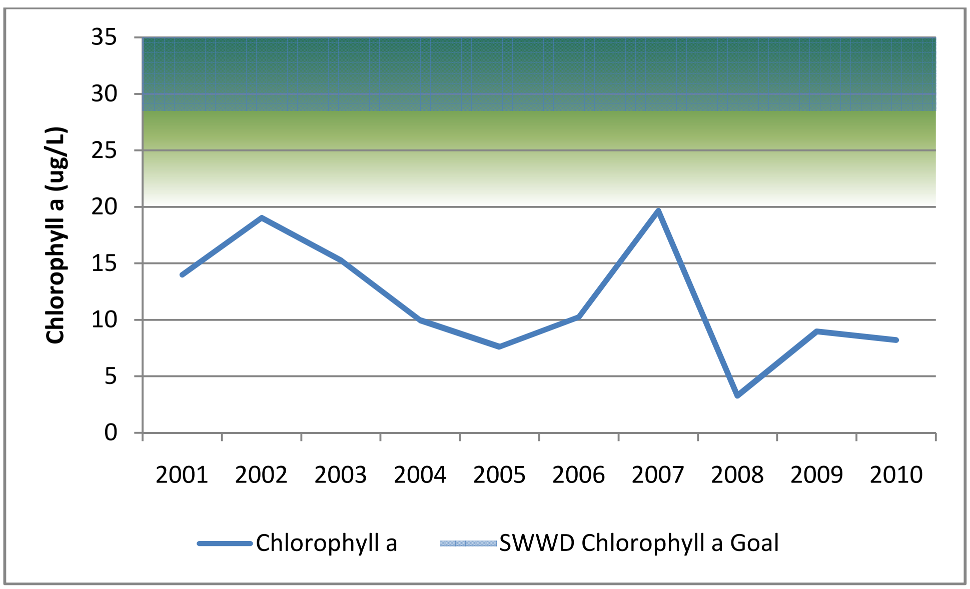
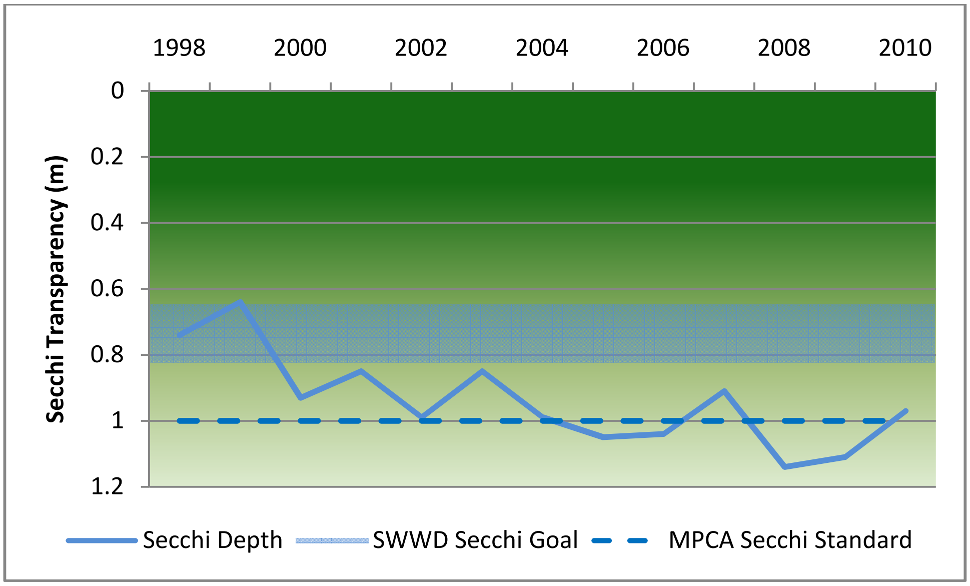


Figure 15: Armstrong Lake Historical Mean Growing Season Chlorophyll a[1] Concentrations



[1]Uncorrected trichromatic chlorophyll a concentrations are displayed in this figure and are the basis of the Met Council lake grading system. MnPCA standards apply to Pheophytin a corrected chlorophyll a concentrations.

Figure 16: Armstrong Lake Historical Mean Growing Season Secchi Transparency



Parameter	Trophic Status	Lake Grades												
		98	99	00	01	02	03	04	05	06	07	08	09	10
Total Phosphorus	63; Eutrophic	D	D	D	D	D	D	C	C	D	D	C	C	C
Chlorophyll a	51; Eutrophic				B	B	B	A	A	B	B	A	A	A
Secchi Transparency	60; Eutrophic	D	F	D	D	D	D	D	D	D	D	D	D	D
Overall	Eutrophic	D	D	D	D	D	D	C	C	D	D	C	C	C

Table 17: Armstrong Lake 2010 Trophic Status and Historical Lake Grades

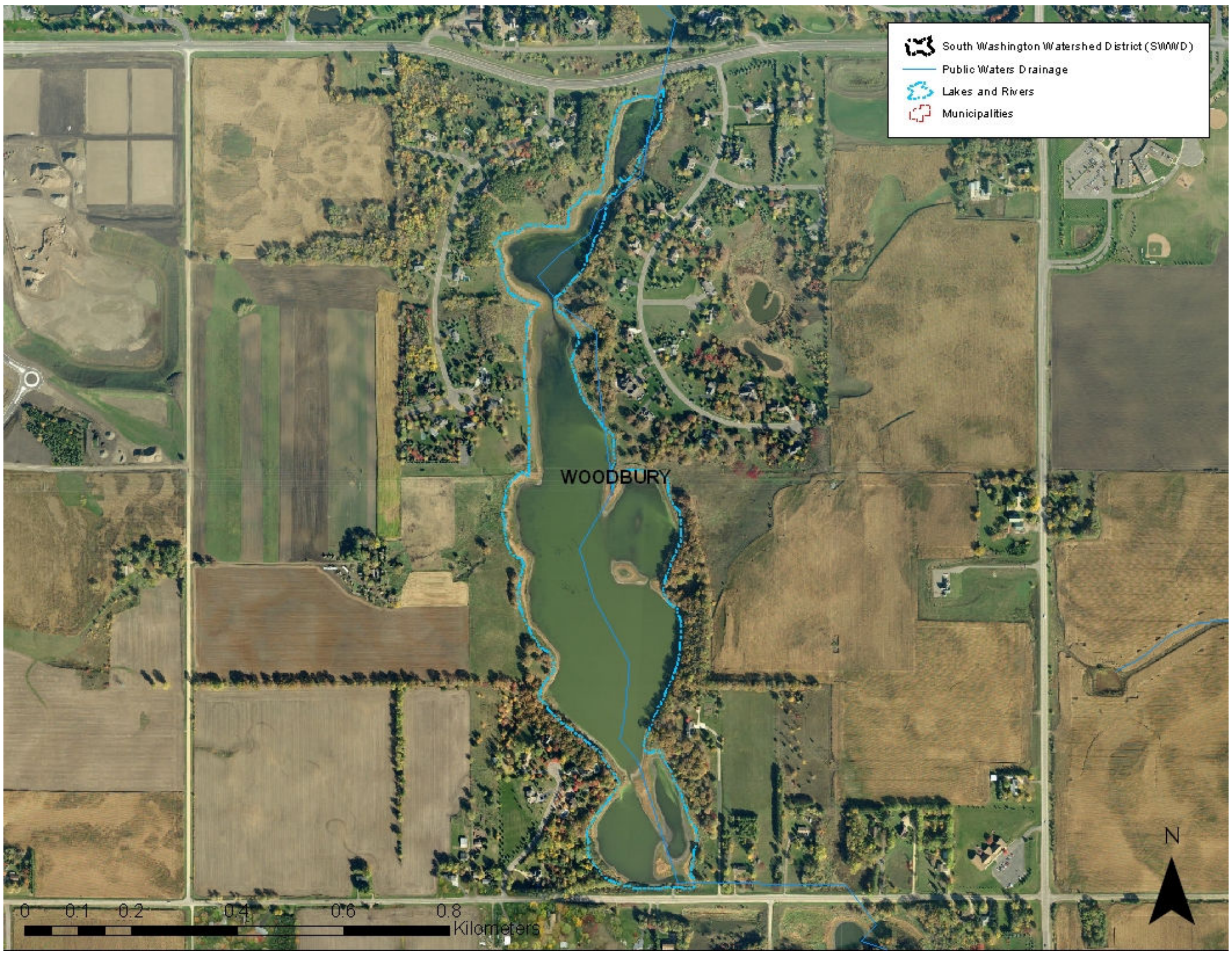
Discussion

Armstrong Lake is characterized by a steady surface elevation showing little fluctuation. Armstrong has been and continues to be a eutrophic lake, however, year to year water quality is consistently improving. While graded C in 2010, Armstrong Lake meets, or nearly meets MnPCA shallow lake water quality standards while exceeding SWWD TSI goals. Historically, chlorophyll a concentrations are lower than expected considering total phosphorus and secchi transparency measurements. The disparity is indicative of a higher proportion of non-algal turbidity. It is possible that algae growth is limited by light, however there may also be a high proportion of TP in forms unavailable to algae. High non-algal turbidity is likely due to high rates of mixing in the shallow lake and accompanying suspension of sediments from the lake bottom. Chloride has historically been high in Armstrong Lake, likely due to de-icing materials used on County Road 10.

Bailey Lake

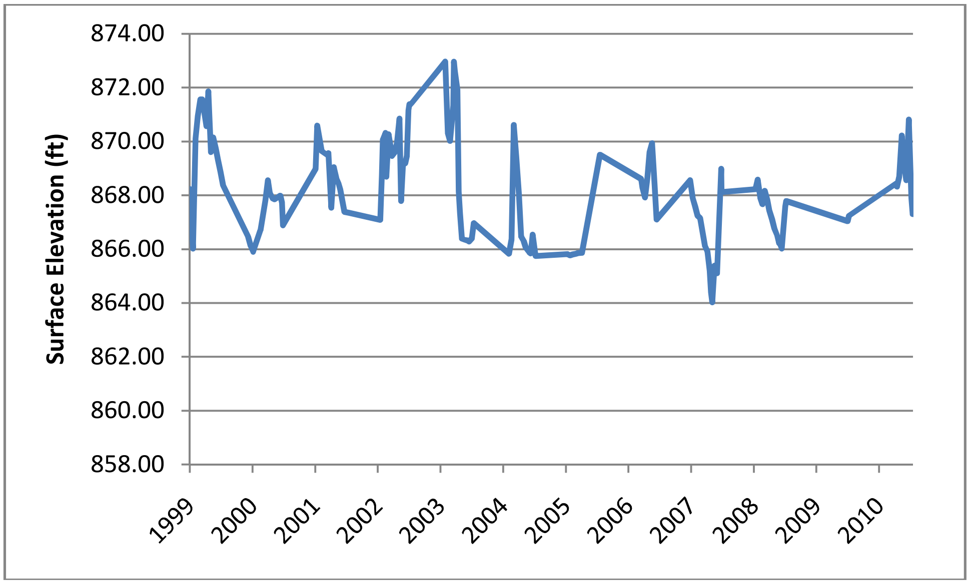
DNR ID #82-0097	Municipality: Woodbury
Surface Area: 61 Acres	Watershed Area:
Mean Depth:	Maximum Depth:
SWWD Maximum Allowable Phosphorus Load: maintain existing	
SWWD Trophic State Index (TSI) Goal:	

Map 13: Bailey Lake



Bailey Lake (Map 13Map 13) is transitioning from wetland to lake and is an integral part of the drainage network in the District. Water quality data is not currently collected at Bailey Lake through the CAMP program; however, water level has been monitored since 1999 and periodic water quality samples were collected at Bailey Lake in 2010 as part of a collaborative effort between SWWD and MDH to assess impacts of infiltration on groundwater. Results from those efforts are presented in the Groundwater section. Historical surface elevation is shown in Figure 17. Historically, the elevation is low and many parts are dry except during wet periods when runoff from the Northern subwatershed collects in the basin. The lake itself is a product of development in the Northern subwatershed. Much of the existing basin was historically farmland.

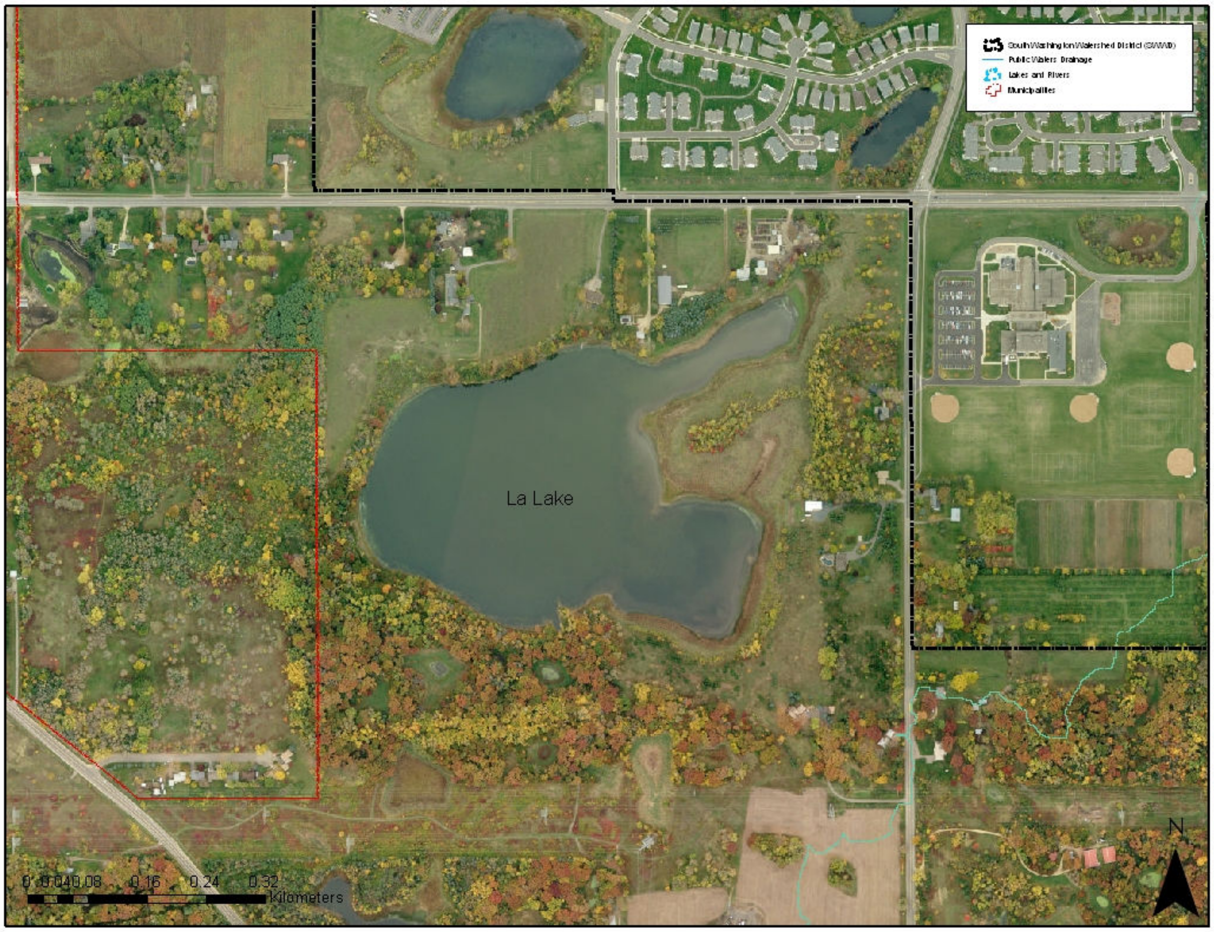
Figure 17: Bailey Lake Surface Elevation; 1999-2010



La Lake

DNR ID #82-0097 Municipality: Woodbury
Surface Area: 45 Acres Watershed Area: 81 Acres
Mean Depth: 6 feet Maximum Depth: 10 feet
SWWD Maximum Allowable Phosphorus Load: 1.65 lbs/ac/yr
SWWD Trophic State Index (TSI) Goal: 60-65

Map 14: La Lake



La Lake (Map 14) is a landlocked shallow basin within the East Mississippi subwatershed (Map 4.8). The less than 2-to-1 ratio of drainage area to lake surface area implies that inputs to the lake will be relatively straightforward to manage. The lake's drainage area is predominantly undeveloped with a mix of natural habitat areas and some agricultural land use. The watershed is privately owned and a portion of it is being considered for development. Currently, however, no storm sewer outfalls discharge to the lake and previous existence of septic systems for the few residences around the lake is likely of little concern to the lake. This lake is classified as a wetland by the Minnesota DNR, and has been used in the past by MnDNR Fisheries as a walleye rearing pond.

SWWD sets a TSI goal of 60-65 for La Lake, corresponding to an allowable watershed TP loading rate of 1.65 lbs/ac/yr. SWWD's goal encompasses MnPCA water quality standards for shallow lakes in the region.

Results

Lake level has been recorded at La Lake since 2004. While, lake level was monitored all season in 2010, the surface elevation was consistently below the existing lake gauge. Subsequently, only one reading was taken in 2010—at the end of the season when the surface elevation was surveyed.   La Lake surface elevation readings since 2004 are shown in Figure 18.

Lake water quality was monitored once in April and twice in each of May through October. Water Quality results are below in Table 18.

Annual growing season averages of total phosphorus, chlorophyll a, and secchi transparency are shown graphically in Figures 19-21. La Lake's 2010 trophic status and historical lake grades are presented in Table 19.

Figure 18: La Lake Surface Elevation 2004-2010

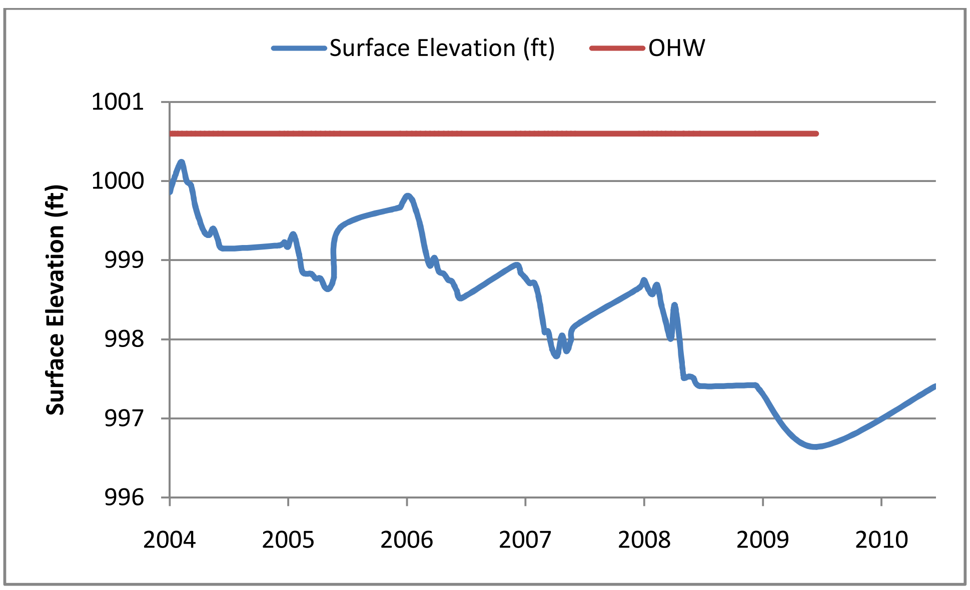


Figure 19: La Lake Historical Mean Growing Season Total Phosphorus Concentration

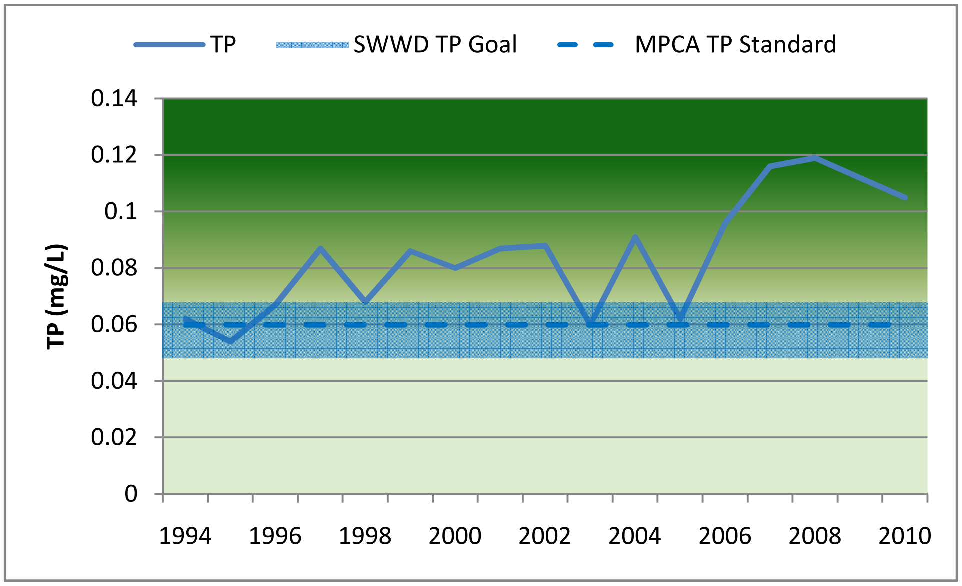
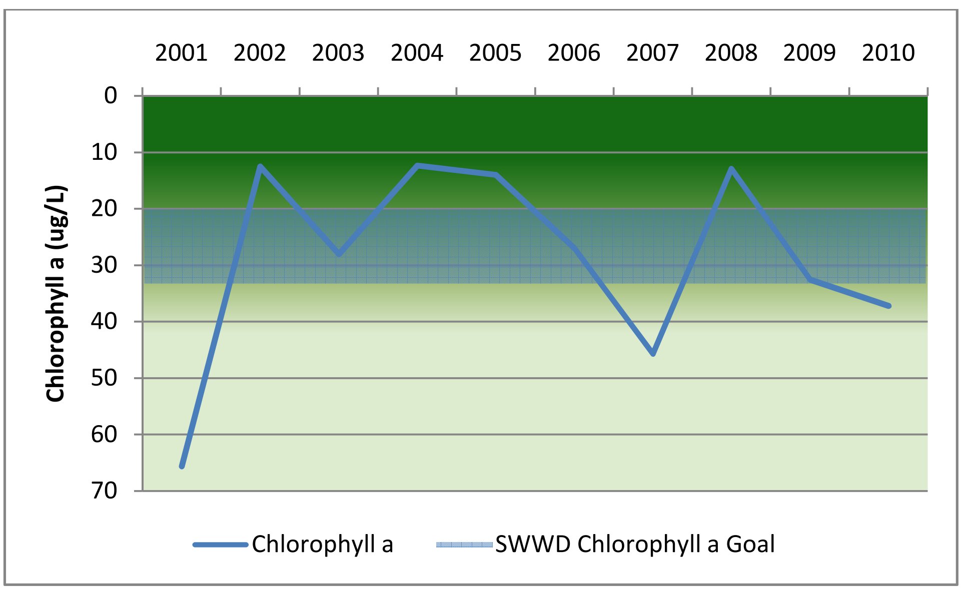
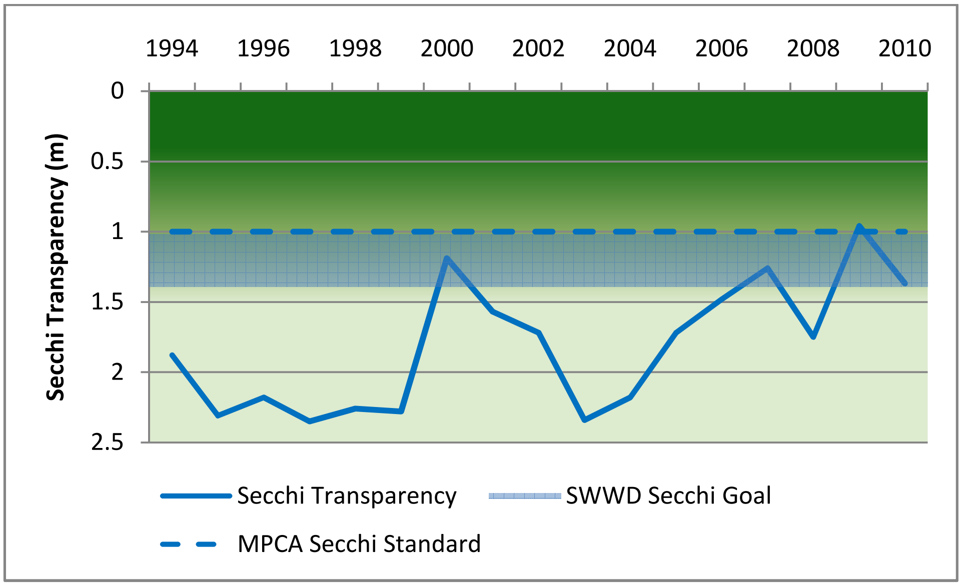


Figure 20: La Lake Historical Mean Growing Season Chlorophyll a[1] Concentration



[1]Uncorrected trichromatic chlorophyll a concentrations are displayed in this figure and are the basis of the Met Council lake grading system. MnPCA standards apply to Pheophytin a corrected chlorophyll a concentrations.

Figure 21: La Lake Historical Mean Growing Season Secchi Transparency


1994
1996
1998
2000
2002
2004
2006
2008
2010
0
0.5
1
1.5
2
2.5
Secchi Transparency (m)
Secchi Transparency
SWWD Secchi Goal
MPCA Secchi Standard

Date	Secchi Depth (m)	Water Temperature (°C)	Pheophytin a Corrected Chlorophyll a (ug/L)	Trichromatic Uncorrected Chlorophyll a (ug/L)	TKN (mg/L)	TP (mg/L)
04/28/10	2.5	15.9	1	1.8	0.88	0.062
05/16/10	2.5	20	13	14	0.87	0.035
05/30/10	2.5	27.2	1	1.6	0.95	0.107
06/16/10	2.5	26.4	4.9	5.7	0.89	0.129
06/27/10	0.8	28.5	140	140	1.9	0.164
07/30/10	0.5	28.3	70	71	2.4	0.146
08/22/10	0.5	28.7	57	58	1.1	0.077
09/19/10	0.5	17.4	28	32	1.4	0.105
10/03/10	0.7	19.5	33	38	1.3	0.114
10/17/10	0.7	14	6.4	10	1.1	0.115

Table 18: La Lake 2010 Lake Water Quality Results

Parameter	**Trophic Status**	**Lake Grades**																
		94	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**
Total Phosphorus	71;Hyper-eutrophic	C	C	C	D	D	D	D	D	D	C	D	C	D	D	D	D	D
Chlorophyll a	66; Eutrophic								D	B	C	B	B	C	C	B	C	C
Secchi Transparency	55; Eutrophic	C	B	C	B	B	B	D	C	C	B	C	C	C	C	C	C	C
Overall	Eutrophic	C	B	C	C	C	C	D	D	C	C	C	C	C	C	C	C	C

Table 19: La Lake 2010 Trophic Status and Historical Lake Grades

Discussion

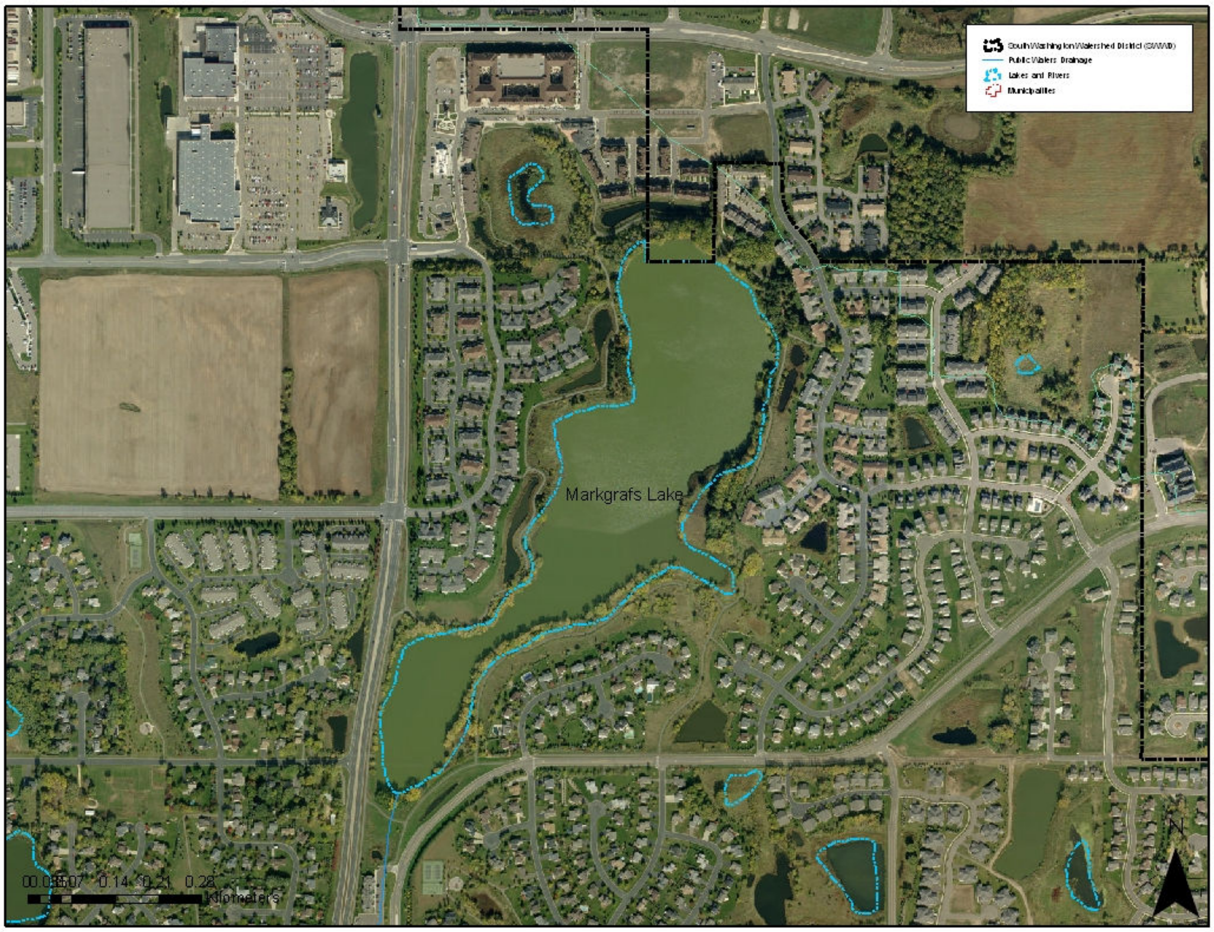
La Lake displays surface elevation trends typical for land locked basins. With no outlet, the surface elevation rises during years of high precipitation and slowly falls during years with less precipitation. La Lake's surface elevation has been steadily dropping since monitoring began in the years following high precipitation year of 2002. Accompanying the decreasing surface elevation in recent years has been a spike in total phosphorus concentration and rapid decrease in secchi transparency. Given the small size of the lake's watershed and absence of development activity, the drastic changes in TP and transparency are likely due to lake dynamics and decreased lake volume.

In 2010, mean growing season total phosphorus concentration exceeded both SWWD goals and MnPCA shallow lake water quality standards. Chlorophyll a and secchi transparency both met SWWD goals. Historically, and in 2010, total phosphorus was higher than expected based on chlorophyll a and secchi transparency measurements. That dynamic is indicative of a system where algae dominate light attenuation but are nevertheless limited by some factor other than TP (i.e. nitrogen or grazing).

Markgrafs Lake

DNR ID #82-0089	Municipality: Woodbury
Surface Area: 46 Acres	Watershed Area: 436 Acres
Mean Depth: 5 feet	Maximum Depth: 8 feet
SWWD Maximum Allowable Phosphorus Load: 0.61 lbs/ac/yr	
SWWD Trophic State Index (TSI) Goal: 66-70	

Map 15: Markgrafs Lake



Markgrafs Lake (Map 15) is approximately 46 acres in surface area and has a contributing watershed of 413 acres. The lake is situated at the east boundary divide of the Northern subwatershed. The watershed is almost fully developed. Commercial land use dominates the upper part of the watershed. Dense residential units surround the lake but the shoreline remains wooded. Stormwater treatment ponds receive runoff from the developments prior to flowing into Markgrafs.

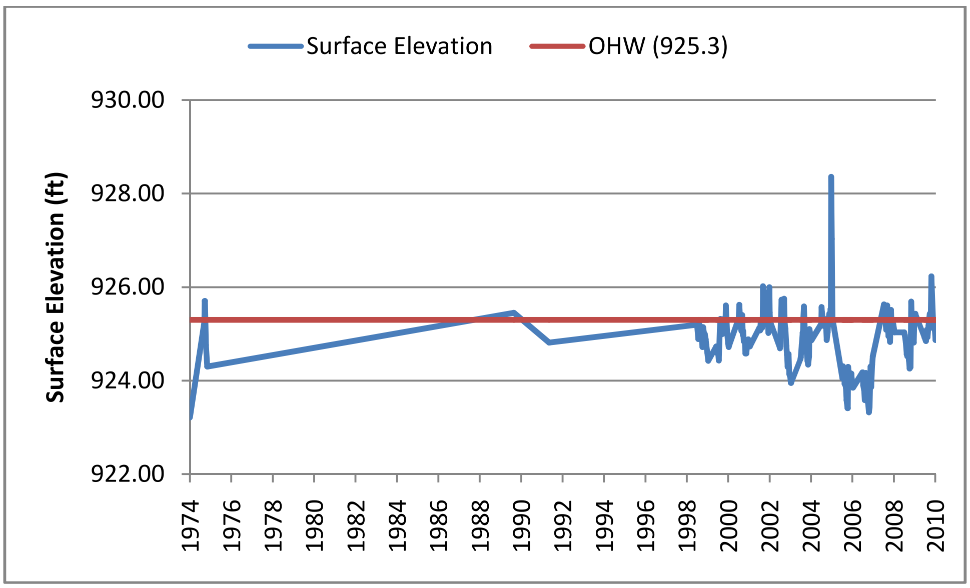
SWWD sets a TSI goal of 66-70 for Markgrafs Lake corresponding to an allowable watershed TP loading rate of 0.61 lbs/ac/yr. SWWD considers its goal to be an interim goal as it exceeds MnPCA eutrophication standards. When water quality consistently meets SWWD's interim goal, loading standards will be reexamined and modified to work toward meeting MnPCA's eutrophication standards.

Results

Lake level has been recorded at Markgrafs Lake since 1974. Lake level was recorded twice monthly during 2010. Historical lake surface elevations are shown in Figure 22.

Lake water quality was monitored twice in April and June through October and once in May. Water Quality results are below in Table 20. Annual growing season averages of total phosphorus, chlorophyll a, and secchi transparency are shown graphically in Figures 23-25. Markgrafs Lake's 2009 trophic status and historical lake grades are presented in Table 21.

Figure 22: Markgrafs Lake Surface Elevation, 1974 to 2010



Date	Secchi Transparency (m)	Water Temperature (°C)	Pheophytin a Corrected Chlorophyll a (ug/L)	Trichromatic Uncorrected Chlorophyll a (ug/L)	TKN (mg/L)	TP (mg/L)
04/18/10	0.3	17.8	86	87	3.3	0.189
05/02/10	0.3	17.7	64	67	3.3	0.147
05/16/10	0.3	17.7	41	42	2.7	0.166
05/27/10	0.41	27.1	46	47	3.6	0.19
06/07/10	0.41	17.9	49	51	3.5	0.232
06/27/10	0.25	26.7	580	590	3.5	0.2
07/10/10	0.25	27.8	140	140	3.5	0.19
07/23/10	0.25	26.4	170	160	3.6	0.227
08/08/10	0.25	27	160	150	3.7	0.266
08/20/10	0.25	27.1	81	84	2.7	0.138
09/05/10	0.25	27	88	91	3	0.152
09/16/10	0.25	17.3	100	110	5.3	0.316
09/28/10	0.25	17	170	180	5.2	0.287
10/20/10	0.25	13.5	23	30	3	0.18

Table 20: Markgrafs Lake 2010 water quality results from the Met Council Citizen Assisted Monitoring Program (CAMP)

Figure 23: Markgrafs Lake Historical Mean Growing Season Total Phosphorus Concentrations

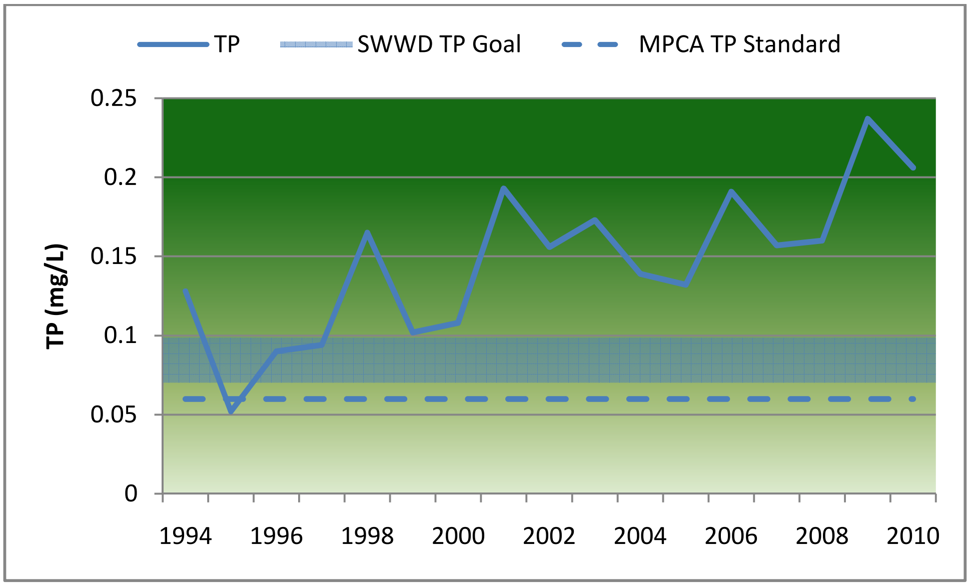
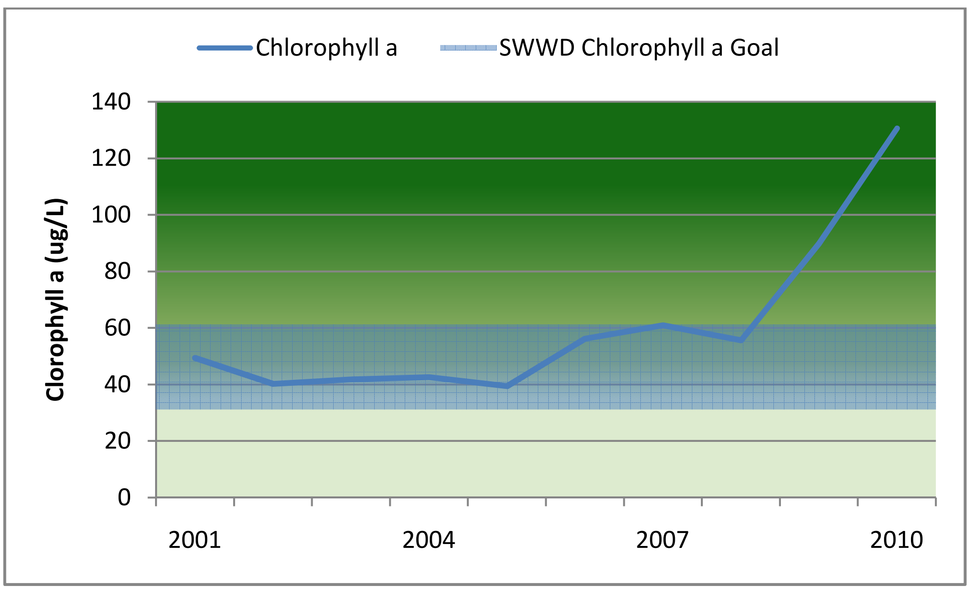
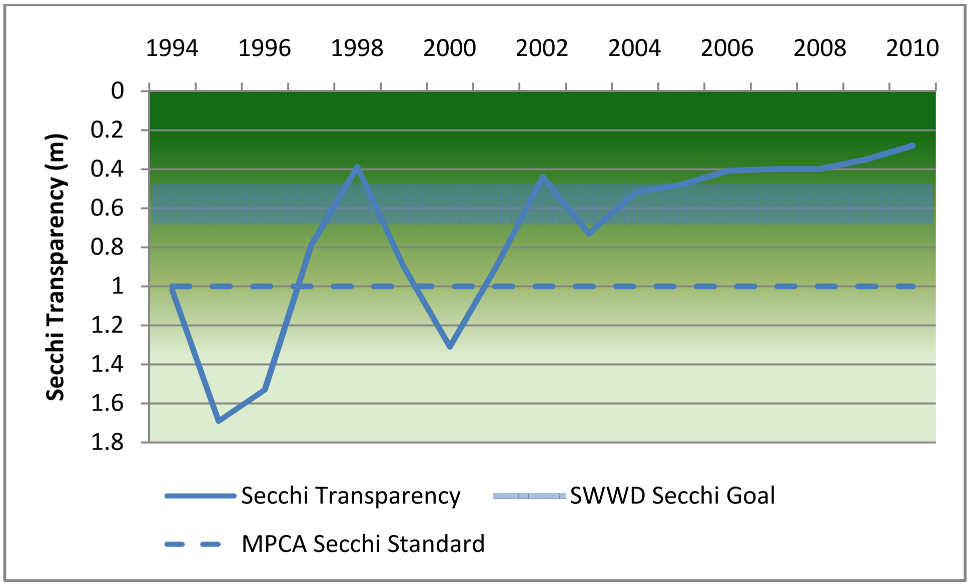


Figure 24: Markgrafs Lake Historical Mean Growing Season Chlorophyll a[1] Concentrations



[1]Uncorrected trichromatic chlorophyll a concentrations are displayed in this figure and are the basis of the Met Council lake grading system. MnPCA standards apply to Pheophytin a corrected chlorophyll a concentrations.

Figure 25: Markgrafs Lake Historical Mean Growing Season Secchi Transparency



Parameter	Trophic Status	Lake Grades 94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Total Phosphorus	81;Hyper-eutrophic	D	C	D	D	F	D	D	F	F	F	D	D	F	F	F	F	F
Chlorophyll a	78;Hyper-eutrophic								D	C	C	C	C	D	D	D	F	F
Secchi Transparency	78;Hyper-eutrophic	F	D	D	F	F	F	D	F	F	F	F	F	F	F	F	F	F
Overall	Hyper-eutrophic	D	D	D	D	F	D	D	F	D	D	D	D	F	F	F	F	F

Table 21: Markgrafs Lake 2010 Trophic Status and Historical Lake Grades

Discussion

The surface elevation of Markgrafs Lake has historically fluctuated rapidly, but within a small range. That dynamic is representative of its relatively small watershed and outlet at 924.94, just below the OHW.

Water quality has always rated fairly poor at Markgrafs Lake based on the Met Council CAMP grading system with long term trends showing continued declines. In 2010, all indicators remained high. Secchi transparency is likely at or near its lower limit. None of the water quality parameters meet SWWD's TSI goal for the Lake and all far exceed MnPCA eutrophication standards. Additional study is necessary to determine the historical background condition of the lake. Dramatic action will be needed to achieve even modest gains in water quality.

O'Conners Lake

DNR ID #82-0200	Municipality: Denmark Township
Surface Area: 23 Acres	Watershed Area: 6,018 Acres
Mean Depth:	Maximum Depth: 11 feet
SWWD Maximum Allowable Phosphorus Load: Pending	
SWWD Trophic State Index (TSI) Goal: Pending	

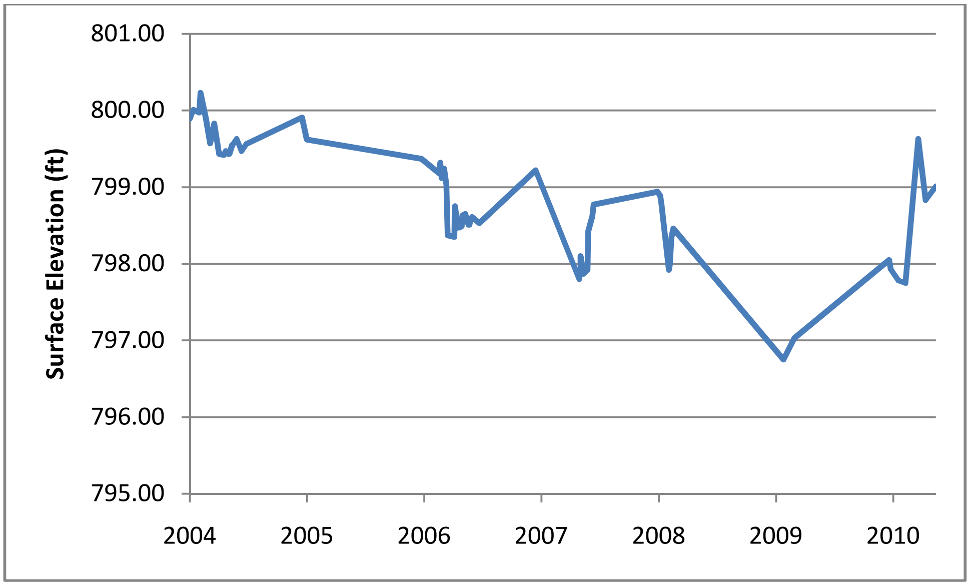
Map 16: O'Conners Lake

O'Conners Lake sits at the terminus of O'Conners Creek in a closed basin. The lake collects drainage from approximately 6,000 acres of agricultural and rural residential lands and drains into bedrock. O'Conners Lake and Creek were added to SWWD jurisdiction in 2010; however, monitoring through the CAMP program began in 2005.

Results

Lake level has been recorded at O'Conners Lake since 2004. Lake levels from 2004 through 2010 are displayed in Figure 26. Lake water quality was monitored 9 times during the 2010 season. Water Quality results are below in Table 22. Annual growing season averages of total phosphorus, chlorophyll a, and secchi transparency are shown graphically in Figures 27-29. O'Conners Lake's 2010 trophic status and historical lake grades are summarized in Table 23.

Figure 26: O'Conner's Lake Surface Elevation, 2004 to 2010



Date	Secchi Depth (m)	Water Temperature °C	Surface Elevation (ft)	Chloride (mg/L)	Pheophytin a Corrected Chlorophyll a (ug/L)	Trichromatic Uncorrected Chlorophyll a (ug/L)	TKN (mg/L)	TP (mg/L)
04/15/10	1.2	19	798.05		21	25	0.97	0.072
05/14/10	1.3	13.7	797.78		7.1	7.9	0.81	0.05
06/05/10	1.9	22.7	797.75		7.4	7.5	0.77	0.03
06/26/10	0.2	24.3			5.4	6.5	0.8	0.14
07/15/10	0.7	25.5	799.63		20	23	1.2	0.213
07/25/10	0.8	26.7			26	27	2.5	0.14
08/07/10	0.9	29.6	798.83		19	22	0.99	0.099
08/28/10	0.6	23.7			31	35	1.3	0.145
09/08/10	0.3	20.3	799.01		130	140	1.9	0.151

Table 22: O'Conner's Lake 2010 Water Quality Data Collected for Met Council's Citizen Assisted Monitoring Program (CAMP)

Figure 27: O'Conner's Lake Historical Mean Growing Season Total Phosphorus Concentrations

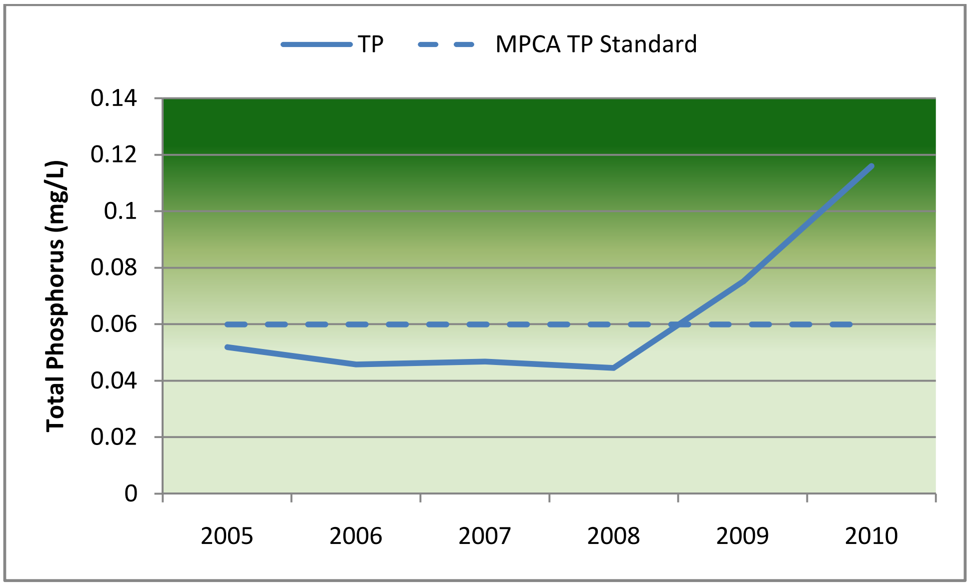
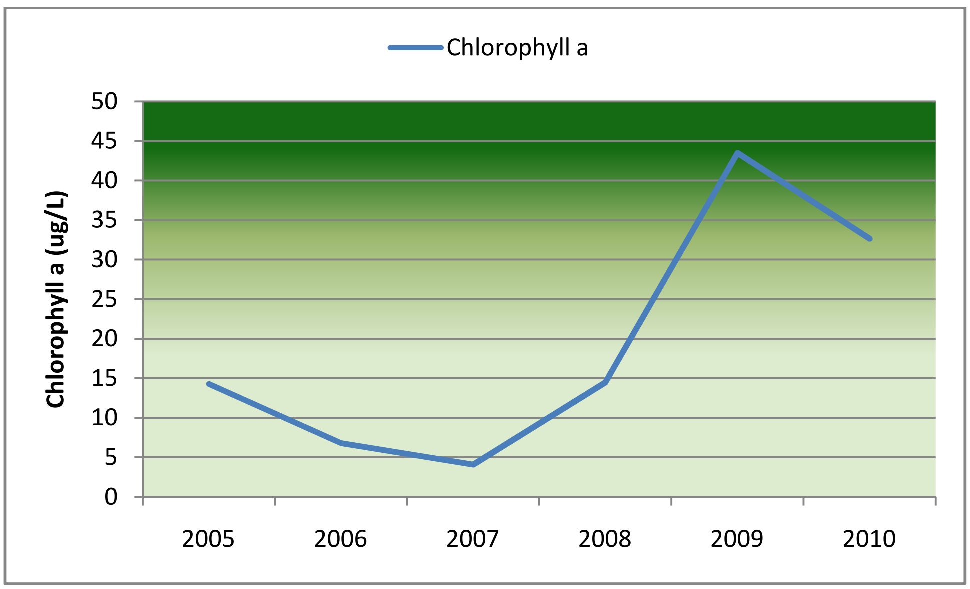
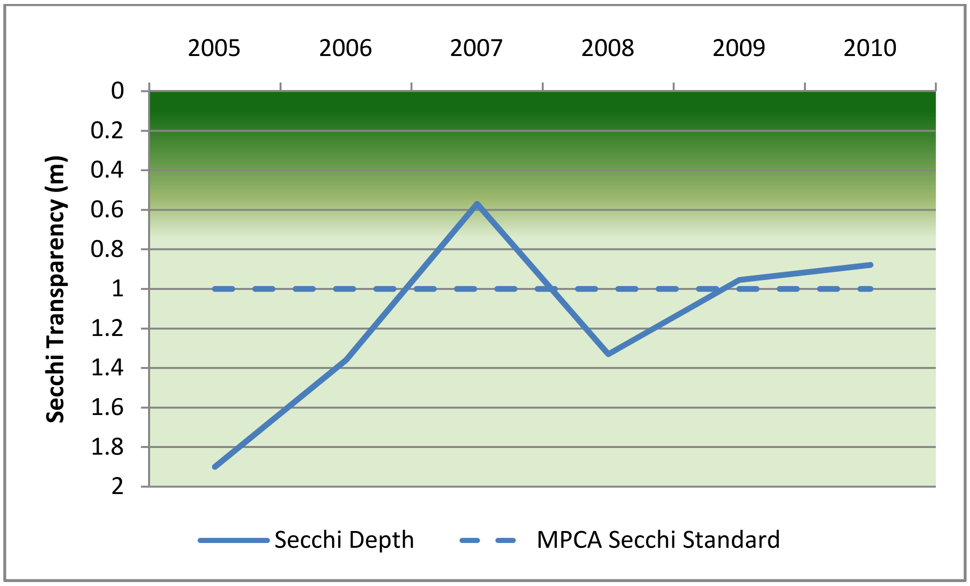


Figure 28: O'Conner's Lake Historical Mean Growing Season Chlorophyll a[1] Concentrations



[1]Uncorrected trichromatic chlorophyll a concentrations are displayed in this figure and are the basis of the Met Council lake grading system. MnPCA standards apply to Pheophytin a corrected chlorophyll a concentrations.

Figure 29: O'Conner's Lake Historical Mean Growing Season Secchi Transparency



Parameter	Trophic Status	Lake Grades 05	06	07	08	09	10
Total Phosphorus	Eutrophic	C	C	C	C	D	D
Chlorophyll a	Eutrophic	B	A	A	B	C	C
Secchi Transparency	Meso-trophic	C	C	F	C	D	D
Overall	Eutrophic	C	B	C	C	D	D

Table 23: O'Conner's Lake 2010 Trophic Status and Historical Lake Grades

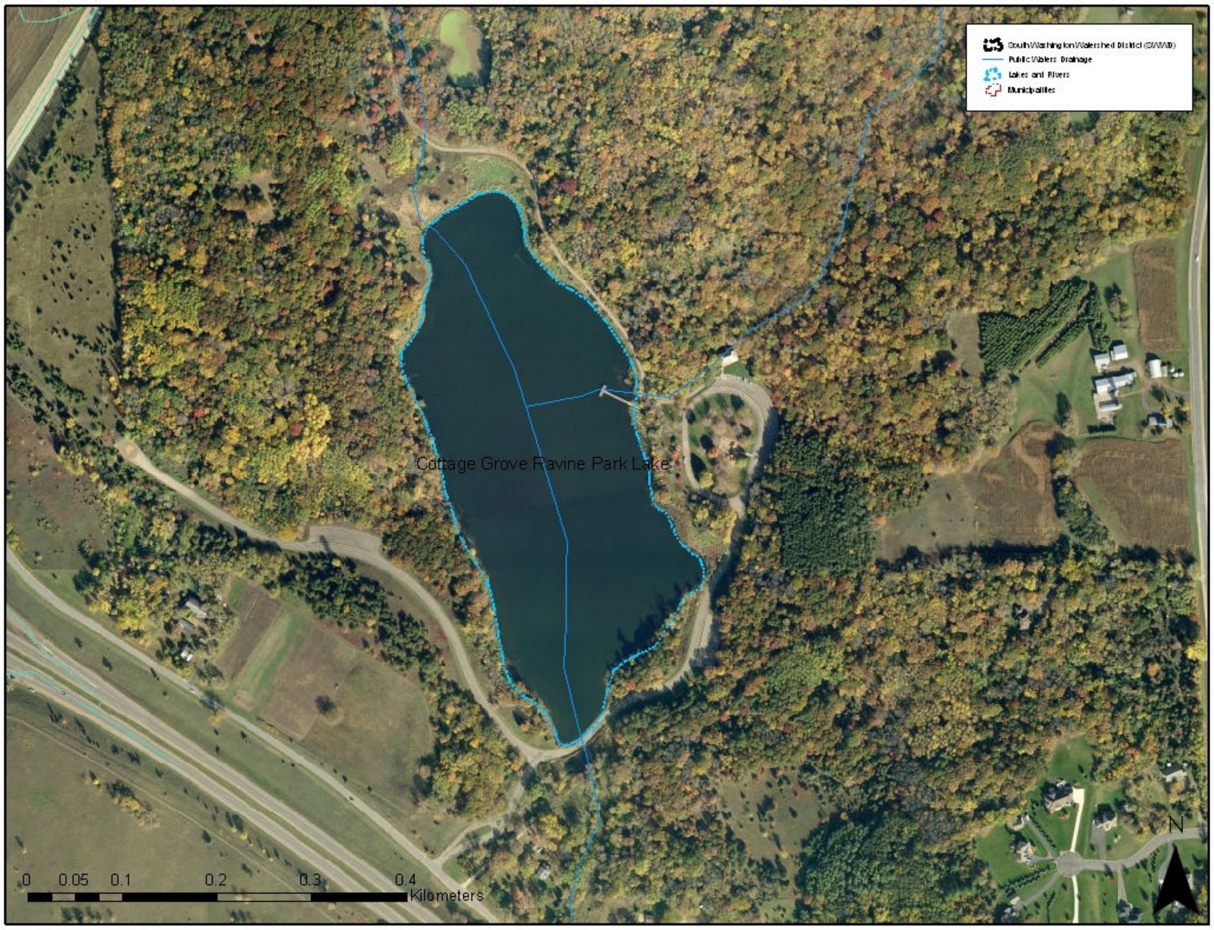
Discussion

O'Conner's Lake exhibits characteristics similar to other closed basin systems. Historically, water levels drop slowly during prolonged dry stretches and rise rapidly during wet years (2005, 2010). Water quality however, is a concern at O'Conner's Lake. Total phosphorus, while steady from 2005-2007, has increased rapidly beginning in 2008. While not has clear, chlorophyll a and transparency (as measured by secchi depth) have also followed a general decline since monitoring began. These trends are especially concerning in a closed basin lake as nutrients will continue to cycle within the system.

Ravine Lake

DNR ID #82-0087	Municipality: Cottage Grove
Surface Area: 25 Acres	Watershed Area: 802 Acres
Mean Depth: 7 feet	Maximum Depth: 16 feet
SWWD Maximum Allowable Phosphorus Load: 0.04 lbs/ac/yr	
SWWD Trophic State Index (TSI) Goal: 63-66	

Map 17: Ravine Lake



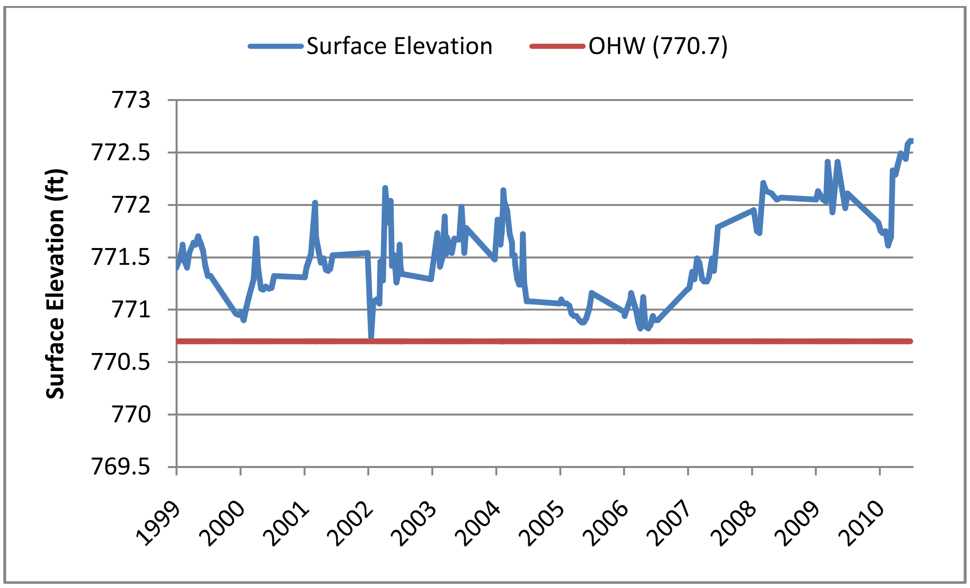
Ravine Lake (Map 17) is located in the East Ravine subwatershed and is situated in the Cottage Grove Regional Park. A lake management plan was completed for this lake in 2003. The watershed is predominantly wooded / park or agricultural land. As noted in the management plan, the lake has a contributing watershed of about 800 acres but planned urbanization will increase this watershed to about 3,400 total acres (Map 4.9). Further, the SWWD is pursuing a watershed overflow conveyance which will route through this system. The lake has a strong groundwater influx in addition to surface inputs. SWWD set a TSI goal of 63-66 for Ravine Lake, corresponding to a watershed TP loading rate of 0.04 lbs/ac/yr based on 3,400 acres. SWWD considers its goal an interim one as it does not meet MnPCA standards.

Results

Lake level has been recorded at Ravine Lake since 1999. Lake levels from 1999 through 2010 are displayed in Figure 30.

Lake water quality was monitored monthly during the 2010 growing season. Water Quality results are below in Table 24. Annual growing season averages of total phosphorus, chlorophyll a, and secchi transparency are shown graphically in Figures 31-33. Ravine Lake's 2010 trophic status and historical lake grades are summarized in Table 25.

Figure 30: Ravine Lake Surface Elevation, 1999 to 2010



Date	Secchi Depth (m)	Water Temperature °C	Surface Elevation (ft)	Chloride (mg/L)	Pheophytin a Corrected Chlorophyll a (ug/L)	Trichromatic Uncorrected Chlorophyll a (ug/L)	TKN (mg/L)	TP (mg/L)
5/3/2010	1.52	15.2	6.06		24	26	0.84	0.048
5/19/2010	3.35	20.4	6.08	20	4.6	5.8	0.83	0.045
6/28/2010	0.76	24.9	6.66		67	68	1.1	0.103
7/26/2010	2.59	28	6.7	17	7.4	8.4	0.88	0.049
8/23/2010	1.52	27.3	6.8	17	23	25	1.3	0.063
9/20/2010	0.98	16.4	6.91	19	16	17	1.5	0.074
10/18/2010	2.9	14	6.94	18	7	7.7	2	0.076

Table 24: Ravine Lake 2010 Water Quality Data Collected for Met Council's Citizen Assisted Monitoring Program (CAMP)

Figure 31: Ravine Lake Historical Mean Growing Season Total Phosphorus Concentrations

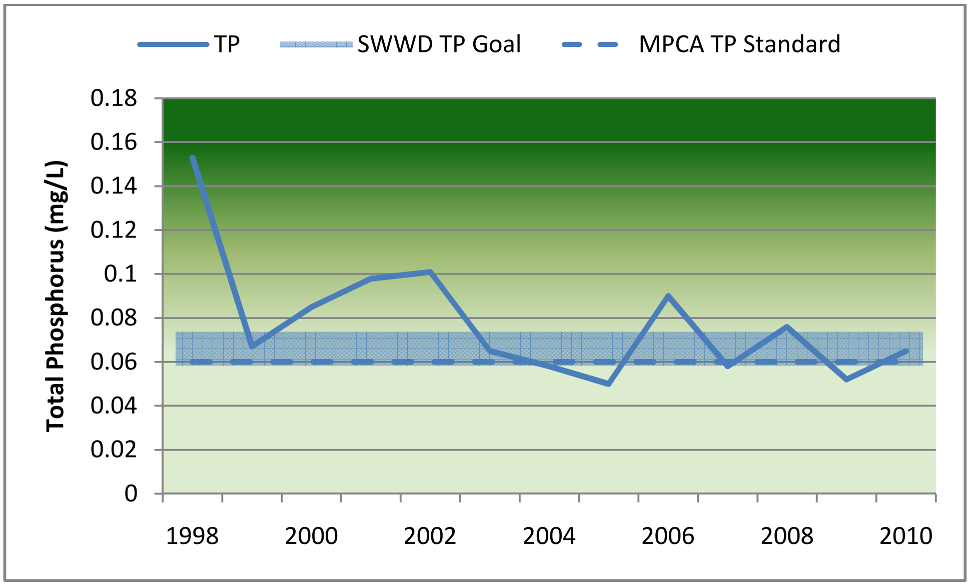
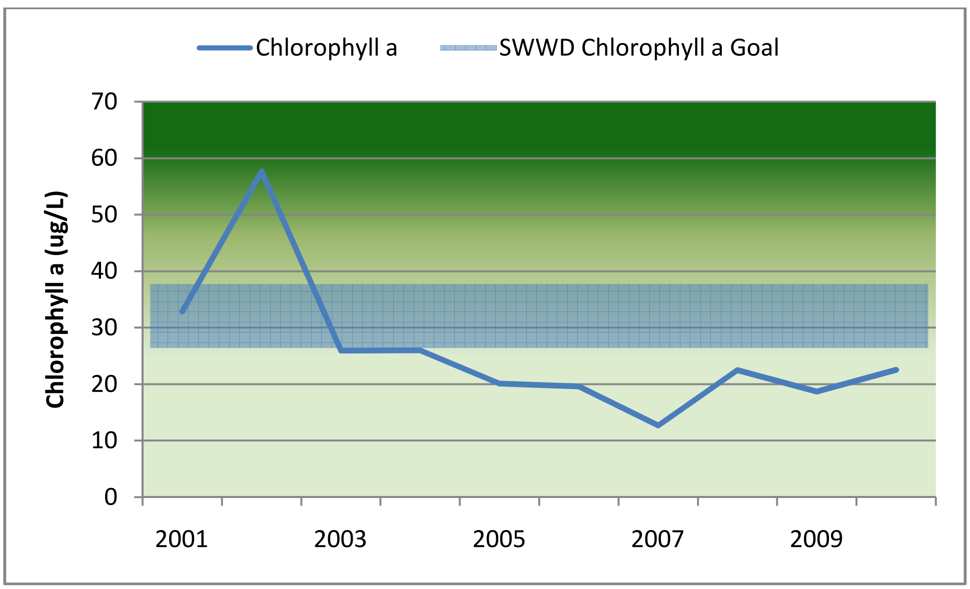
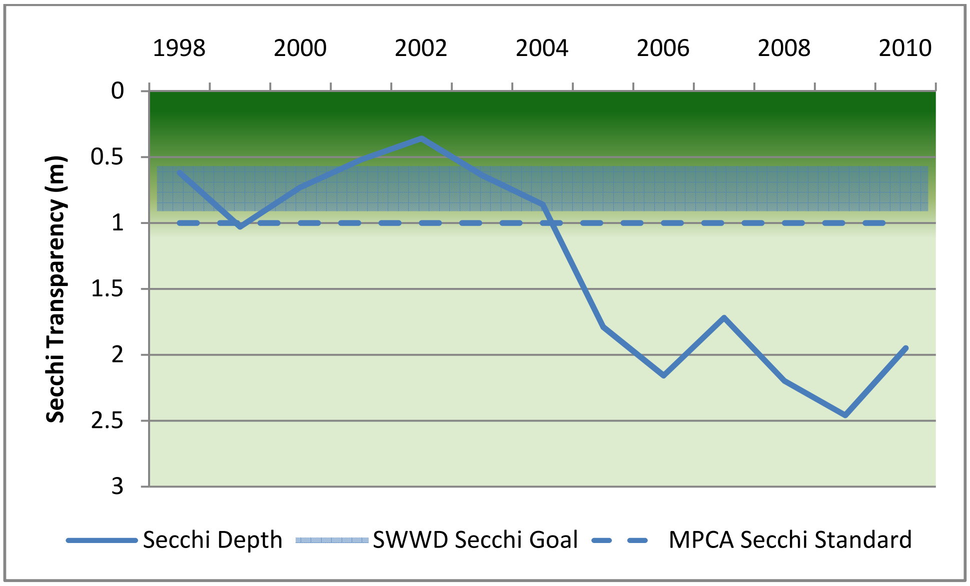


Figure 32: Ravine Lake Historical Mean Growing Season Chlorophyll a[1] Concentrations



[1]Uncorrected trichromatic chlorophyll a concentrations are displayed in this figure and are the basis of the Met Council lake grading system. MnPCA standards apply to Pheophytin a corrected chlorophyll a concentrations.

Figure 33: Ravine Lake Historical Mean Growing Season Secchi Transparency



Parameter	Trophic Status	Lake Grades 98	99	00	01	02	03	04	05	06	07	08	09	10
Total Phosphorus	Eutrophic	F	D	D	D	D	C	C	C	D	C	D	C	C
Chlorophyll a	Eutrophic				C	D	C	C	C	B	B	C	B	C
Secchi Transparency	Meso-trophic	F	D	D	F	F	F	D	C	C	C	B	B	C
Overall	Eutrophic	F	D	D	D	D	D	C	C	C	C	C	B	C

Table 25: Ravine Lake 2010 Trophic Status and Historical Lake Grades

Discussion

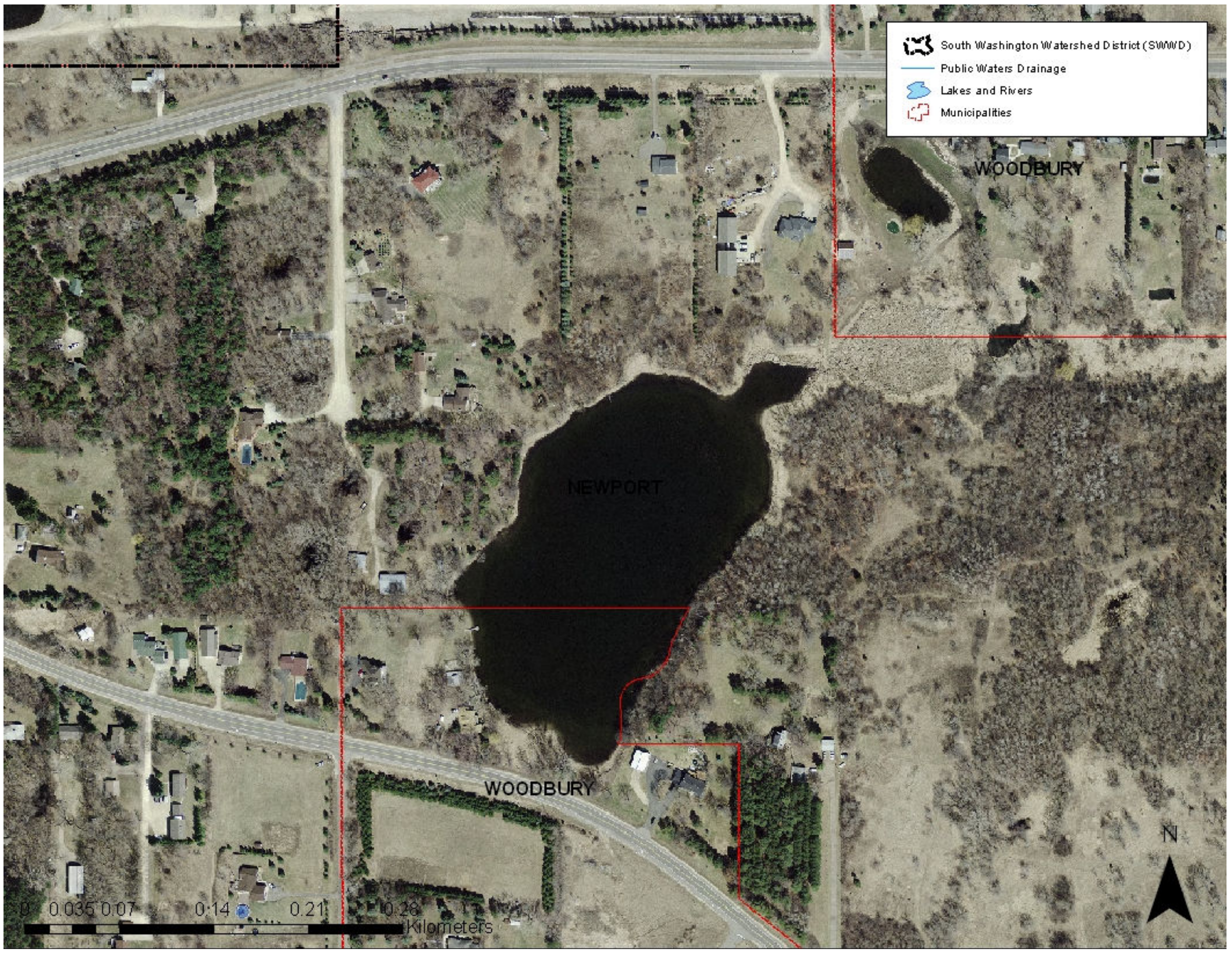
Historically, water levels in the Regional Park water body (Ravine Lake) have risen, changing the system from a wetland-like system to more of a lake system. That trend continued in 2010 with the lake reaching some of its highest recorded levels, partially due to a crushed culvert at the lake outlet. The lake outlet was temporarily repaired in the fall of 2010, and will be addressed again during construction of SWWD's Central Draw Overflow.

Accompanying the increase in water level has been an increase in water quality. Ravine Lake has shown steady water quality improvement since monitoring began and is close to meeting MPCA eutrophication standards for shallow lakes in the North Central Hardwood Forest. The Lake does meet standards for shallow lakes in the Cornbelt Plains which encompasses a portion of the Ravine Lake watershed. While all eutrophication measures have improved, secchi depth is consistently better than expected based on TP and chlorophyll levels. That relationship combined with a periodic musty odor of the lake may indicate a dominance of blue green algae that should be watched in the future.

Ria Lake

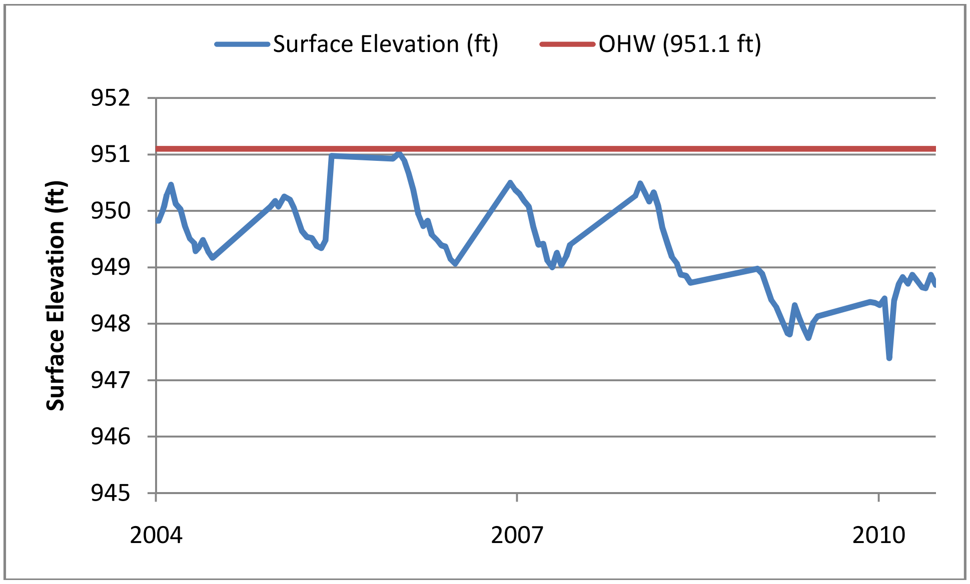
DNR ID #82-0098	Municipality: Woodbury/Newport
Surface Area: 11 Acres	Watershed Area:
Mean Depth:	Maximum Depth:
SWWD Maximum Allowable Phosphorus Load: maintain existing	
SWWD Trophic State Index (TSI) Goal:	

Map 18: Ria Lake



Ria Lake was formerly part of the Ramsey Washington Metro Watershed District. SWWD has done little work with the lake; however, water level has been consistently monitored since 2004. Historical surface elevation is shown in Figure 34Figure . The surface elevation has remained relatively steady (only seasonal fluctuations) with the exception of the 2008-2009 dry years. Water level began to recover, however, in 2010.

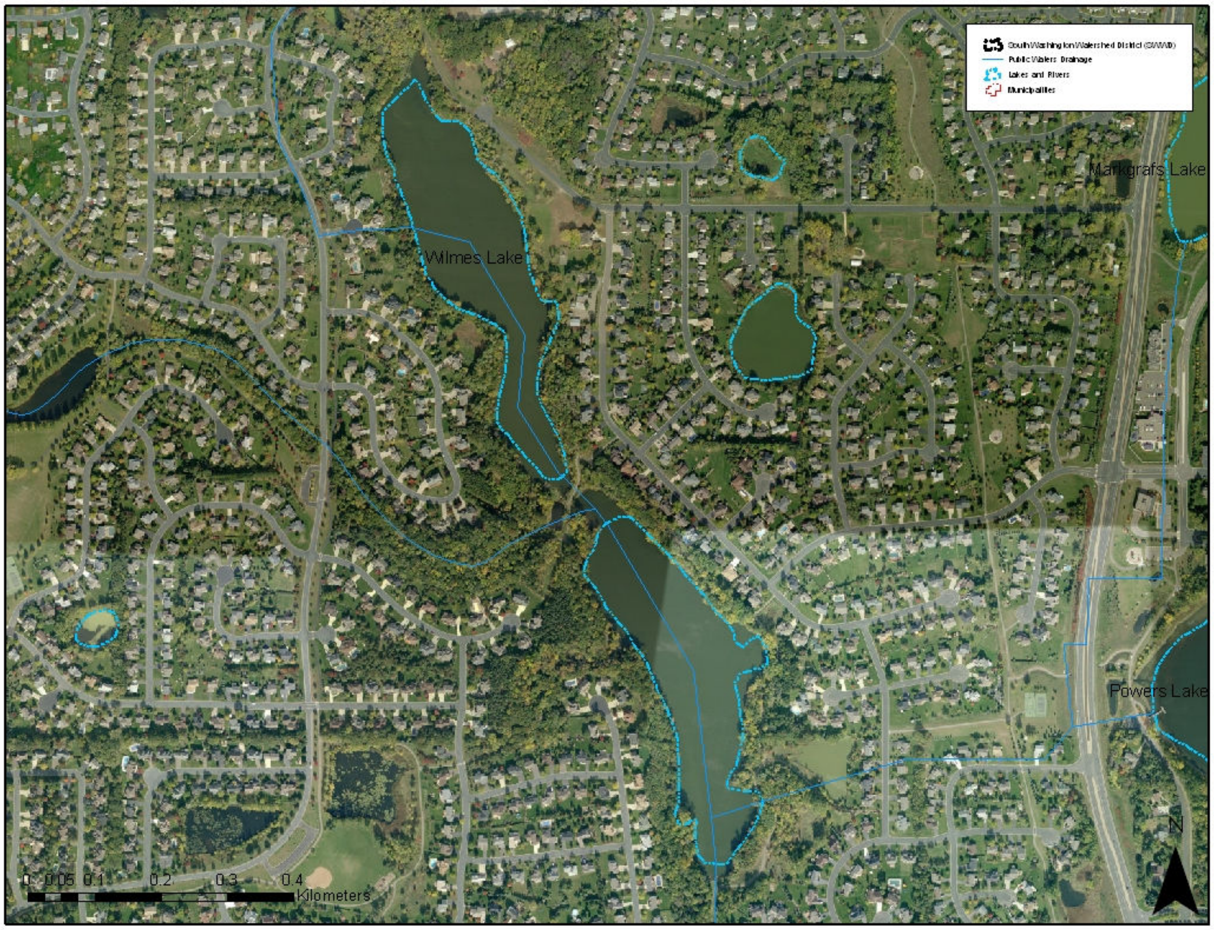
Figure 34: Ria Lake Surface Elevation; 2004-2010



Wilmes Lake

DNR ID #82-0090 Municipality: Woodbury
Surface Area: 30 Acres Watershed Area: 3,242 Acres
Mean Depth: 3-5 feet Maximum Depth: 7-18 feet
SWWD Maximum Allowable Phosphorus Load: 0.10 lbs/ac/yr
SWWD Trophic State Index (TSI) Goal: 60-63

Map 19: Wilmes Lake

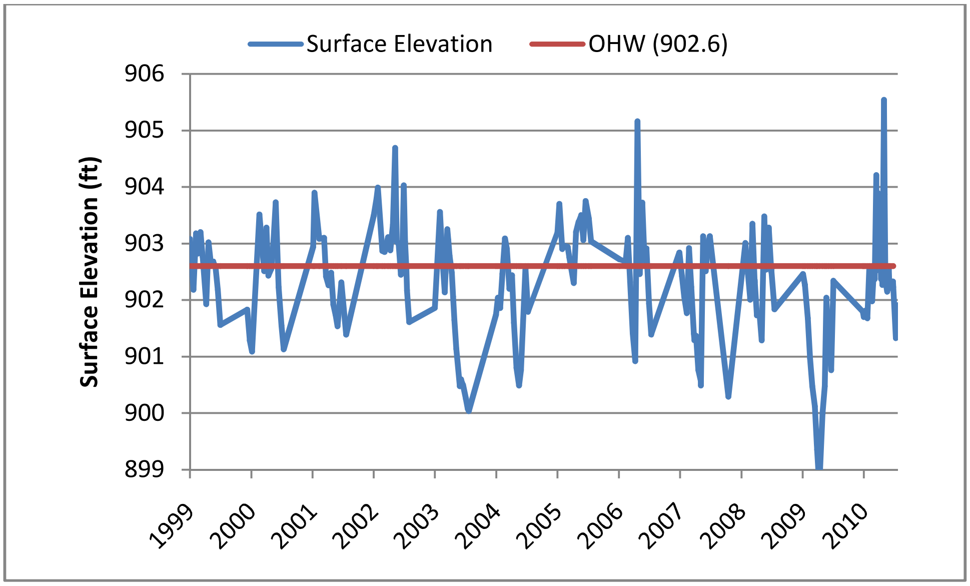


Wilmes Lake (Map 19) is situated in the Northern subwatershed. Similar to Armstrong Lake, Wilmes lake is divided into two basins by a berm with a culvert connecting the north and south basins. The southern portion of the lake has a maximum depth of 7 feet while the northern portion has a maximum depth of 18 feet. Wilmes Lake receives flows from Armstrong Lake and Markgrafs Lake, together adding approximately 1,000 acres of drainage. There is also a lift station at Powers Lake that would allow for water to be pumped from Powers to Wilmes. However, that pump station is not routinely used.

Results

Lake level has been recorded at Wilmes Lake since 1999 and are shown in Figure 35. Lake water quality was monitored 12 times April through October in 2010. Water Quality results are below in Table 26. Annual growing season averages of total phosphorus, chlorophyll a, and secchi transparency are shown graphically in Figures 36-38. Wilmes Lake's 2010 trophic status and historical lake grades are presented in Table 27.

Figure 35: Wilmes Lake Surface Elevation, 1999-2010



Date	Secchi Depth (m)	Water Temperature (°C)	Pheophytin a Corrected Chlorophyll a (ug/L)	Trichromatic Uncorrected Chlorophyll a (ug/L)	TKN (mg/L)	TP (mg/L)
04/20/10	1.3	19.1	10	11	0.91	0.056
05/15/10	2.1	16.4	6.1	7	1	0.072
05/26/10	3.2	26	2.2	2.9	0.84	0.035
06/29/10	2.2	24.1				
07/16/10	0.9	27.1	53	52	1.7	0.108
07/29/10			14	15	1.1	0.079
08/08/10	2	27.4	15	17	1.4	0.051
08/27/10	1.4	24.4	26	29	1.1	0.108
09/06/10	1	20.4	93	100	1.4	0.107
09/26/10	1.1	17.8	23	25	1.1	0.12
10/03/10	1.2	15.6	32	37	1.2	0.116
10/16/10	1	14.4	35	40	1.3	0.127

Table 26: Wilmes Lake 2010 Water Quality Data Collected Through the Met Council Citizen Assisted Monitoring Program (CAMP)

Figure 36: Wilmes Lake Historical Mean Growing Season Total Phosphorus Concentrations

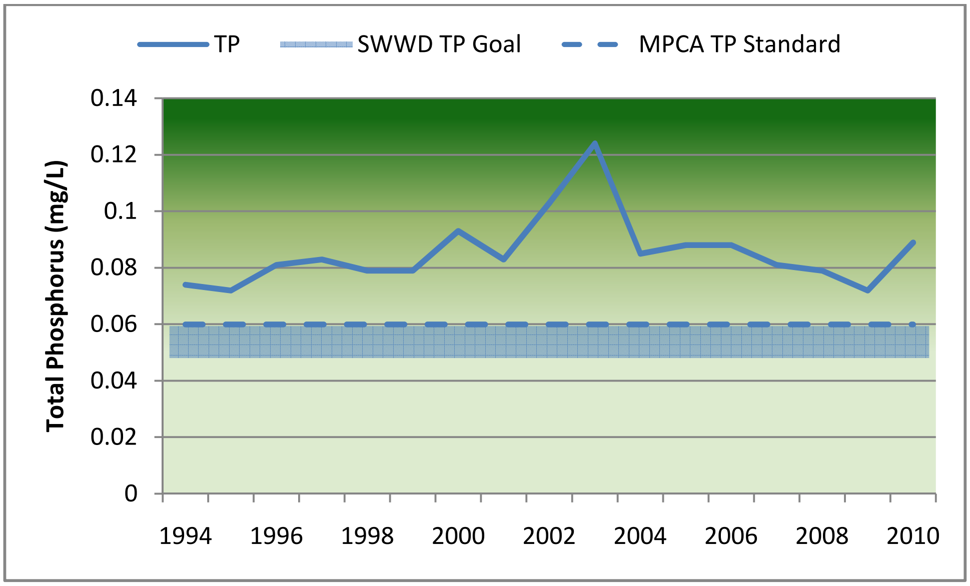


Figure 37: Wilmes Lake Historical Mean Growing Season Chlorophyll a[1] Concentrations

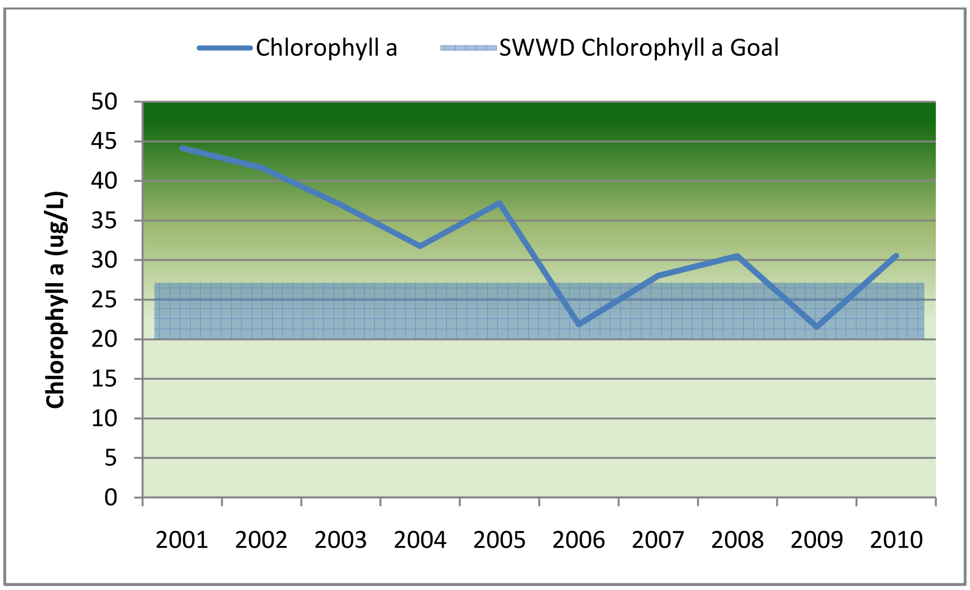
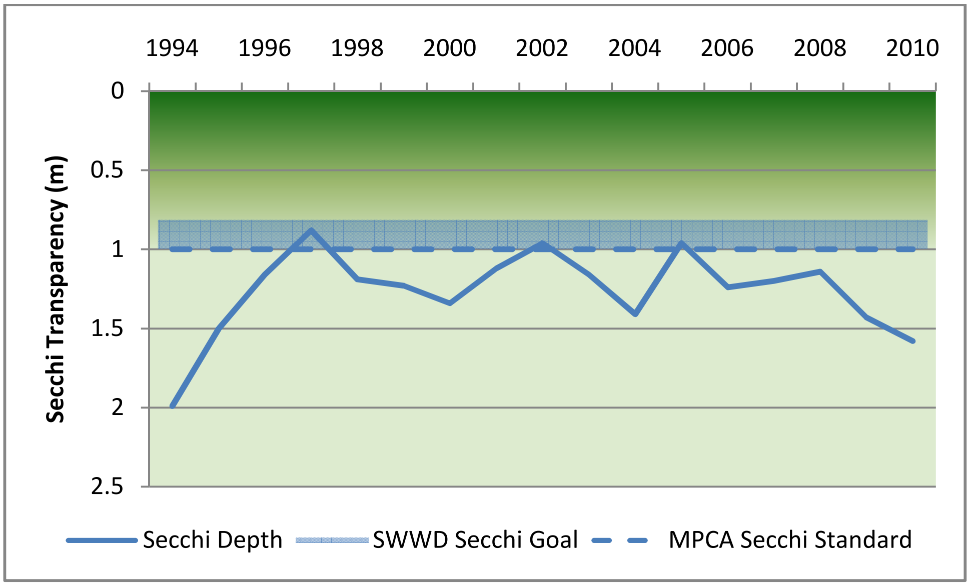


Figure 38: Wilmes Lake Historical Mean Growing Season Secchi Transparency



Parameter	Trophic Status	Lake Grades																
		94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Total Phosphorus	69; Eutrophic	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Chlorophyll a	64; Eutrophic								C	C	C	C	C	C	C	C	C	C
Secchi Transparency	53; Eutrophic	C	C	C	D	D	C	C	D	D	D	C	D	C	C	D	C	C
Overall	Eutrophic	C	C	C	D	D	C	C	D	D	D	C	D	C	C	D	C	C

Table 27: Wilmes Lake 2010 Trophic Status and Historical Lake Grades

Discussion

Historically, Wilmes surface elevation has displayed high fluctuation which continued in 2010. Wilmes discharged regularly throughout 2010 as the surface elevation overtopped the weir outlet set at the OHW.

Mean growing season total phosphorus concentration exceeded both SWWD's TSI goal for the Lake and MnPCA's shallow lake standard. Mean growing season chlorophyll a also exceeded SWWD and MnPCA standards although there is a long-term trend indicating improving chlorophyll a concentrations. Secchi transparency exceeds SWWD's goal and MnPCA's standard as it generally has in the past. The disparities in TSI scores for the three parameters indicate a system where algae dominates light attenuation in the water column, but is somehow limited—likely by zooplankton grazing.

In-Depth Assessments

Individual Waterbody Assessment

In-depth assessment of individual waterbodies becomes necessary when data from screening level monitoring programs indicates impairment or nutrient loading in excess of SWWD or MN standards. Assessments will generally last 3-5 years and consist of CAMP monitoring (Section 2.3.2.1), and a network of automated water quality and quantity monitoring sites at the waterbody's inlets. Automated stations will be operated using the same equipment and procedures used for regional assessment monitoring locations (Section 2.1.2). Data will be used to identify portions of the watershed leading to the impairment or nutrient loading. After subwatershed loading is characterized and mitigation actions taken, CAMP monitoring will continue and automated monitoring sites will be rotated amongst the lake's inlets so that each is monitored at least once every five years. Inlets will be monitored more frequently if poor water quality or high year to year variability in data persists.

Powers Lake

DNR ID #82-0092	Municipality: Woodbury
Surface Area: 56 Acres	Watershed Area: 1,384 Acres
Mean Depth: 16 feet	Maximum Depth: 41 feet
SWWD Maximum Allowable Phosphorus Load: 0.06	
SWWD Trophic State Index (TSI) Goal: 50-55	

Map 20: Powers Lake

Powers Lake (Map 20) is a 56 acre lake in SWWD's Northern watershed. SWWD completed a lake management plan (LMP) for Powers Lake in 2000 (Bonestroo, Rosene, Anderlik, & Associates). The City of Woodbury completed a LMP for Powers Lake in 2008. This historically high quality lake lies in a naturally land-locked basin with several inlets that receive runoff from developed areas (Map 1). A lift station was installed in 1995 and serves as an emergency outflow.

The natural watershed draining to Powers Lake has been significantly expanded at the same time that historical hydrological connections with Wilmes Lake have been severed. In 1999, the contributing watershed was 430 acres. Due to urbanization and expansion of the storm sewer network, the Powers Lake drainage is expected to ultimately reach approximately 1200 acres. Excluding the direct drainage immediately surrounding the lake, SWWD divides the Powers Lake drainage into 4 watersheds—Fox Run, Powers North, Powers East, and Powers West—for management purposes.

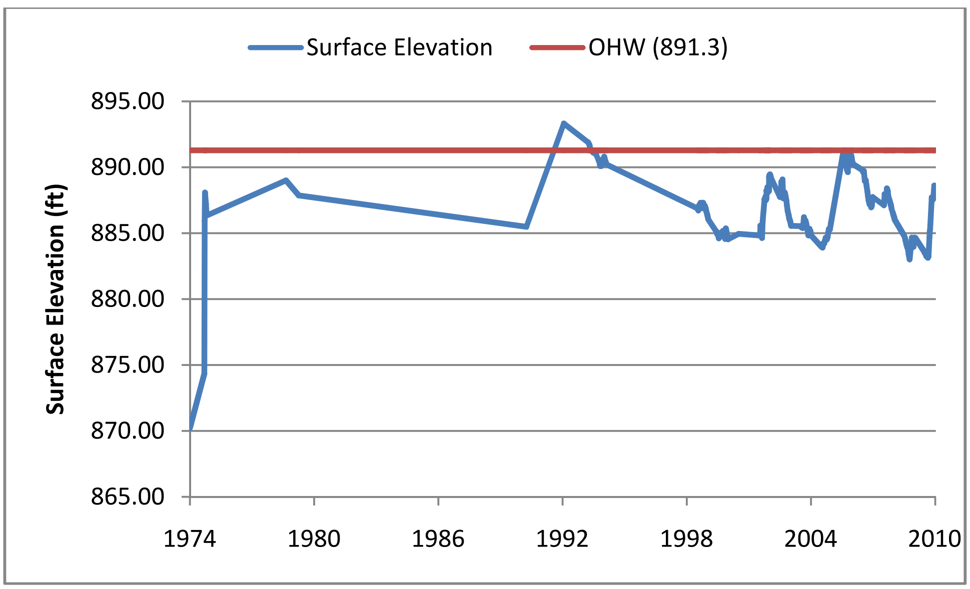
Powers Lake has a maximum depth of 41 feet and a littoral zone covering about 48 percent of its surface. Eurasian water milfoil and curly-leaf pondweed, invasive aquatic plants, dominate the aquatic plant community. The City of Woodbury has established a shore line preservation zone for the lake to ensure the lake has sufficient natural buffer around the perimeter. DNR fishery surveys were conducted in 1977, 1984, 1992, and 2007. Historically, the DNR has not conducted stocking due to a lack of public access. A public access fishing pier was added in 2004 just east of County Road 19 and the Woodbury Rotary Club purchased and stocked 2000 walleye yearling in 2007.

Results

In Lake Water Quality

Lake level has been recorded at Powers Lake since 1974 and are shown in Figure 39. Lake water quality was generally monitored twice monthly April through October in 2010. Water Quality results are below in Table 28. Annual growing season averages of total phosphorus, chlorophyll a, and secchi transparency are shown graphically in Figures 40-42. Powers Lake's 2010 trophic status and historical lake grades are presented in Table 29Table .

Figure 39: Powers Lake Surface Elevation, 1974-2010



Date	Secchi Depth (m)	Surface Temperature (°C)	Pheophytin a Corrected Chlorophyll a (ug/L)	Trichromatic Uncorrected Chlorophyll a (ug/L)	TKN (mg/L)	Hypolimnetic TKN (mg/L)	TP (mg/L)	Hypolimnionetic TP (mg/L)	Hypolimnetic Orthophosphorus (mg/L)
***04/13/10**	2.59	12	17	19	0.98	1.5	0.042	0.12	0.005
***04/28/10**	7.16	14.6	4.3	4.7	1.3	1.5	0.032	0.077	0.005
05/10/10	4.88	13.5	9.8	11	0.85	2	0.024	0.242	0.157
05/24/10	4.27	20.8	12	13	0.81		0.022		0.015
06/07/10	2.9	21.8	13	14	0.87	2.1	0.025	0.321	0.015
06/21/10	1.22	23.6	30	31	1.1	8.3	0.022	0.451	0.39
07/06/10	0.91	26.1	47	49	1.2	3.4	0.038	0.492	0.037
07/19/10	1.07	26	41	43	3.3	1.4	0.408	0.042	0.028
08/02/10	0.91	26.7	50	50	1.7	3	0.035	0.454	0.039
08/16/10	0.91	25.1	27	28	1.4	4.6	0.05	0.482	0.036
08/30/10	0.76	24.8	49	49	7.3	1.7	0.579	0.036	0.229
09/13/10	1.52	19.3	15	17	1.8	4.9	0.072	0.507	0.437
09/27/10	2.44	16.6	22	24	1.9	2.8	0.074	0.387	0.306
***10/11/10**	2.9	17.4	15	16	3.9	5.9	0.169	1.26	

***Sample was taken outside of growing season and not included when computing growing season average.**

Table 28: Powers Lake 2010 Water Quality Results From the Met Council Citizen Assisted Monitoring Program (CAMP)

Figure 40: Powers Lake Historical Mean Growing Season Total Phosphorus Concentration

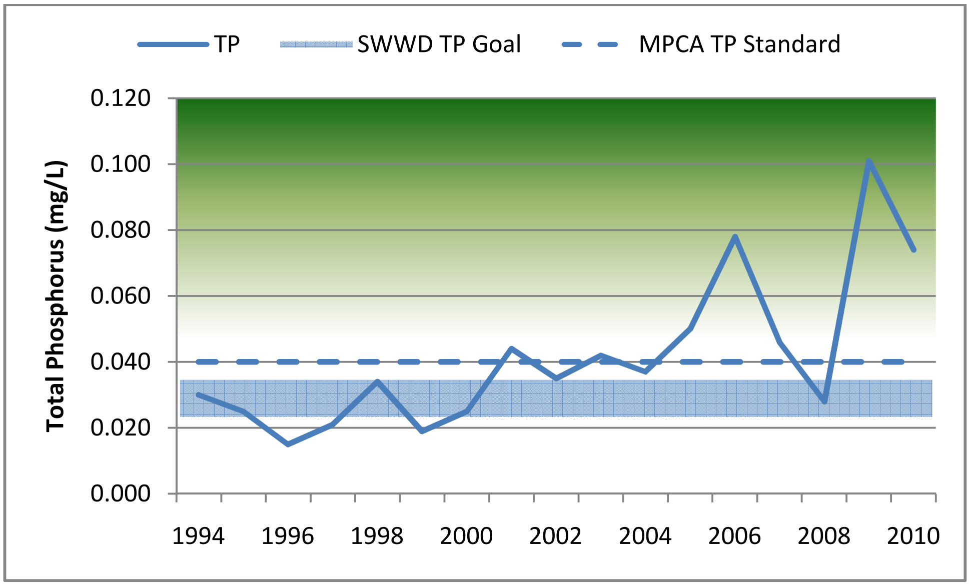


Figure 41: Powers Lake Historical Mean Growing Season Chlorophyll a[1] Concentration

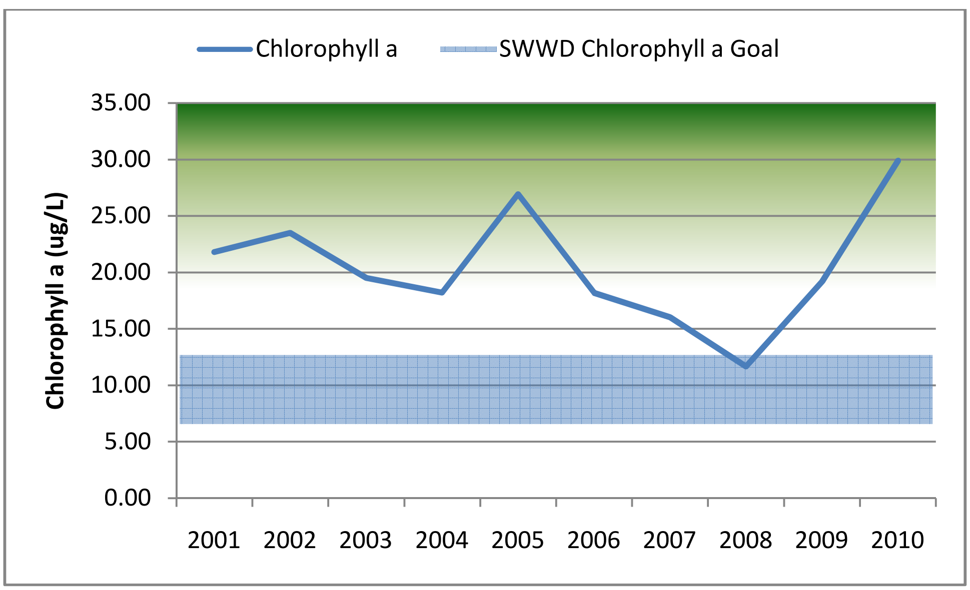
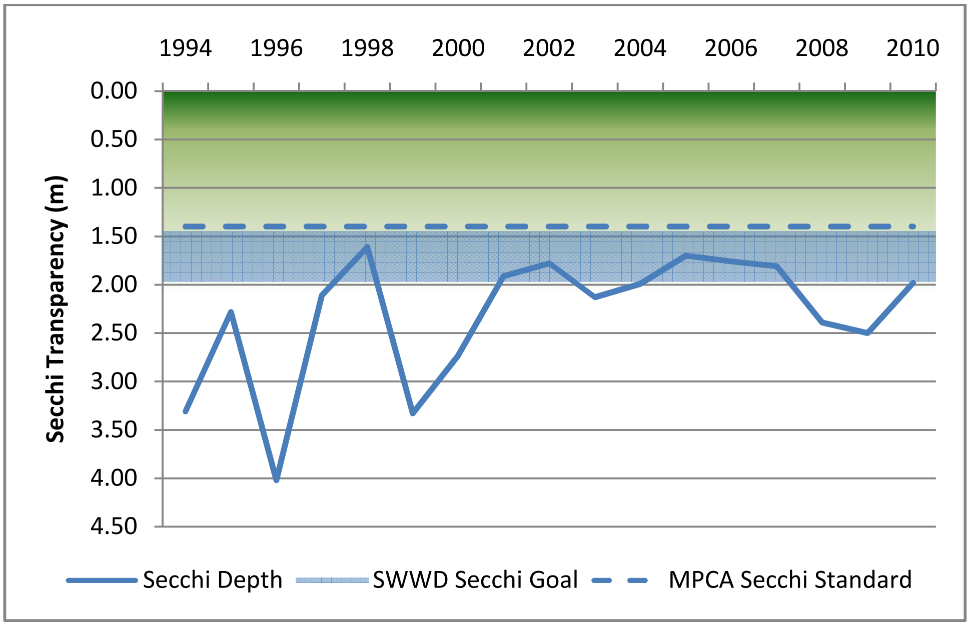


Figure 42: Powers Lake Historical Mean Growing Season Secchi Transparency



Parameter	Trophic Status	Lake Grades 94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Total Phosphorus	Eutrophic	B	B	A	A	B	A	B	C	C	C	C	C	D	C	B	D	D
Chlorophyll a	Eutrophic								C	C	B	B	C	B	B	B	B	C
Secchi Transparency	Eutrophic	A	B	A	C	C	A	B	C	C	C	C	C	C	C	B	B	C
Overall	Eutrophic	A	B	A	B	B	A	B	C	C	C	C	C	C	C	B	C	C

Table 29: Powers Lake 2010 Trophic Status and Historical Lake Grades

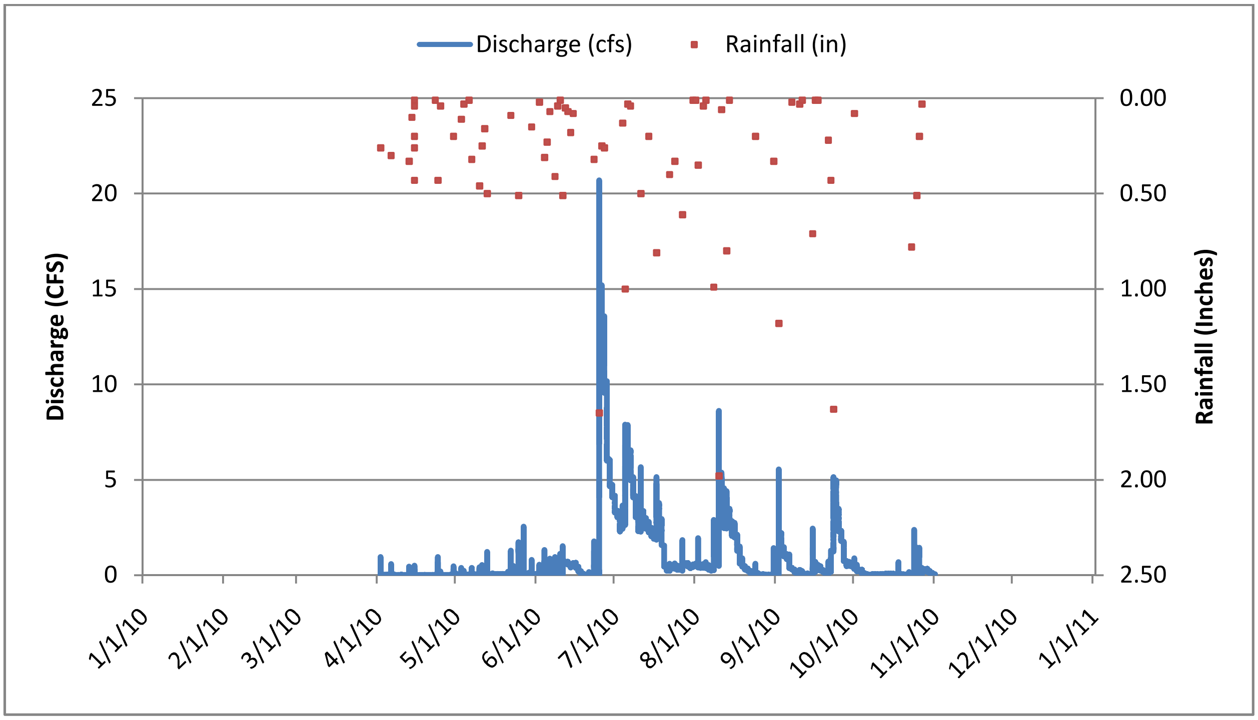
Powers Lake East

Flow measurements were collected at the Powers East site every 15 minutes from March 30 at 10:00 to November 1 at 11:45. Discharge was calculated using an area velocity relationship, which is the cross sectional area of the water channel as determined by the water level within the pipe multiplied by the measured velocity. A rain gauge was also installed throughout the monitoring season. Average daily discharge and daily rainfall is shown in Figure 43.

Up to seven types of samples are collected at Regional Assessment Locations; snowmelt grab, snowmelt composite, baseflow grab, baseflow composite, stormflow grab, stormflow composite, and bacteria grab. In 2010, 1 snowmelt grab sample, 2 baseflow grab samples, 8 stormflow composite samples, and 2 bacteria grab sample were collected at the Powers East site. All samples were analyzed at the Metropolitan Council Environmental Services Lab. Water quality results are reported in Table 32.

The 2010 growing season loading summary is reported in Table 30. Reported values reflect loading during the May 1 to September 30 growing season. Additional year to year analyses are performed for odd monitoring years.

Figure 43: Powers Lake East Average Daily Discharge and Recorded Rainfall



Year	Growing Season Observed Rainfall (inches)	Growing Season Observed Runoff Volume (acre-feet)	Projected Annual Runoff Volume (acre-feet)	Total Phosphorus (lbs)	Total Phosphorus (lbs/ac/yr)	Total Suspended Solids (lbs)	Total Suspended Solids (lbs/ac/yr)
2010	20.14	348	357	281	0.55	Not Enough Data	

Table 30: Powers East Annual Loading Summary

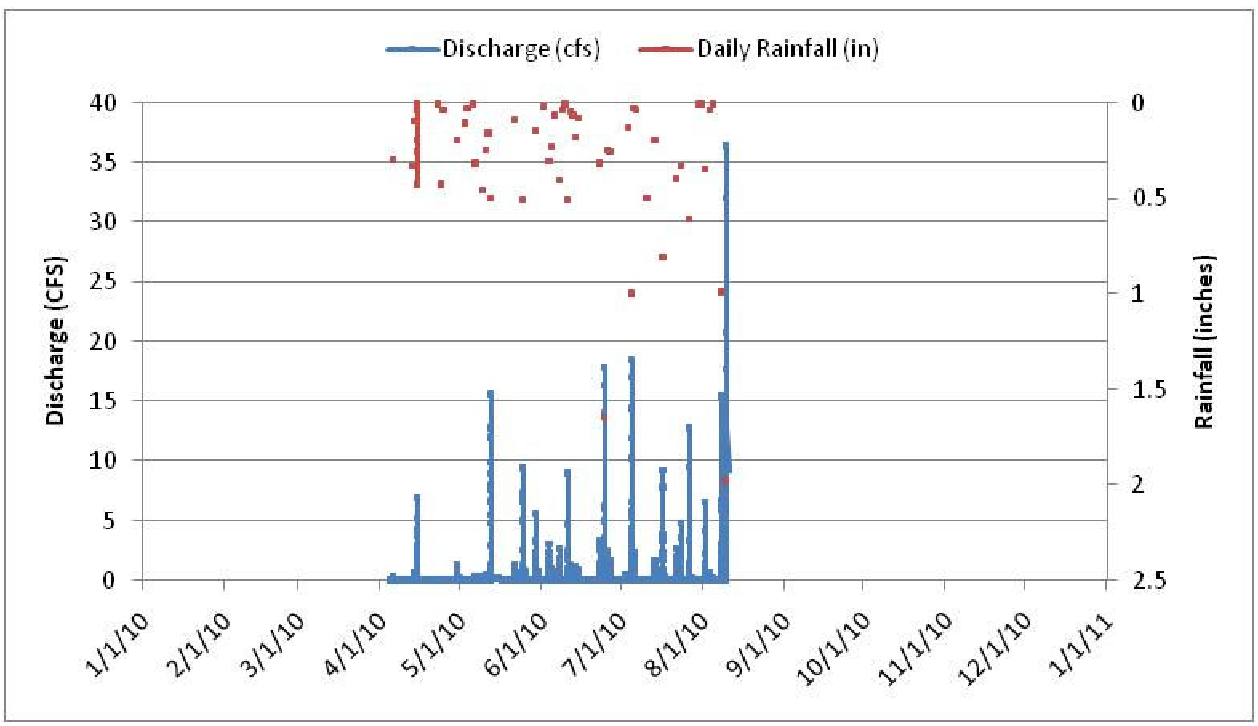
Powers Lake West

Flow measurements were collected at the Powers West site every 15 minutes from April 5 at 10:00 to August 12 at 10:30. Discharge was calculated using an area velocity relationship, which is the cross sectional area of the water channel as determined by the water level within the culvert at Powers West multiplied by the measured velocity. Measured discharge and daily rainfall (as measured at Powers East) is shown in Figure 44.

Up to seven types of samples are collected at Regional Assessment Locations; snowmelt grab, snowmelt composite, baseflow grab, baseflow composite, stormflow grab, stormflow composite, and bacteria grab. In 2009, 3 baseflow grab samples, 1 storm flow grab sample, 2 stormflow composite samples, and 3 bacteria grab sample were collected at the Powers North site. All samples were analyzed at the Metropolitan Council Environmental Services Lab for nutrients and metals. Water quality results are reported in Table 33. One early season storm flow grab sample exceeded state water quality standards for cadmium, chromium, copper, lead, nickel, and zinc. One bacteria grab sample exceeded state water quality standards for E. coli. No other samples exceeded water quality standards.

Loading was not modeled for the Powers Lake site. Due to the increased surface elevation at Powers Lake, the pond monitored at Powers West became fully connected with the lake on or near August 11.

Figure 44: Powers West Average Daily Discharge and Powers East Observed Rainfall



Type	Sampled date	End sampling	Suspended solids (mg/L)	Volatile suspended solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Dissolved Phosphorus (mg/L)	E coli	Chloride ion (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Nickel (mg/L)	Zinc (mg/L)	Hardness (mg/L_CaCO3)	Ammonia Nitrogen (mg/L)	Nitrate N (mg/L)	Nitrite N (mg/L)
Snowmelt Grab	3/11/10 8:51	3/11/10 8:51	496	144	3.2	0.807	0.116		13	<0.0005	0.0233	0.0426	0.014	0.0206	0.197	52	0.37	0.63	<0.03
Storm Comp	6/11/10 7:26	6/11/10 7:26			3.4	2.76	0.112		10								<0.02	<0.05	0.21
Storm Comp	6/25/10 18:26	6/26/10 2:53	249	~25	2	0.472	0.052		41	<0.0005	0.0072	0.0097	0.0045	0.008	0.0245	56	0.16	<0.05	<0.03
Storm Comp	6/26/10 3:07	6/26/10 23:10	24	9	1.4	0.153	~0.030		47	<0.0005	<0.005	0.003	<0.0005	0.0017	<0.005	58	0.08	<0.05	<0.03
Storm Comp	7/5/10 16:03	7/6/10 22:03			1.9	0.365	~0.031		24	<0.0005	0.0071	0.0092	0.0037	0.0073	0.0197		<0.02	<0.05	<0.03
Storm Comp	7/17/10 21:08	7/17/10 22:09			1.9	0.683	0.057		11	<0.0005	0.0143	0.021	0.0103	0.0156	0.0459		<0.02	0.06	<0.03
Storm Comp	7/20/10 15:15	7/20/10 15:15			1.1	0.08	0.061		41	<0.0005	<0.005	0.0012	<0.0001	0.0014	<0.005	124	~0.06	0.05	<0.03
Base Grab	8/8/10 1:58	8/8/10 2:29			2.4	0.999	0.105		4								<0.02	0.13	<0.03
Storm Grab	8/9/10 9:22	8/9/10 9:22			1.5	0.118	~0.046		34	<0.0005	<0.005	0.0008	<0.0001	0.0012	<0.005	80	<0.02	<0.05	<0.03
Storm Comp	8/11/10 2:30	8/11/10 18:39			1.3	0.123	~0.028		21	<0.0005	<0.005	0.0019	0.0002	0.0014	<0.005	48	~0.05	<0.05	<0.03
Base Grab	8/23/10 13:03	8/23/10 13:03			1	0.1	0.05		27	<0.0005	<0.005	0.0018	0.0003	0.0017	0.0078	74	0.06	0.2	<0.03
E. Coli Grab	8/26/10 8:49	8/26/10 8:49						93											
Storm Comp	9/23/10 10:54	9/24/10 3:26			1	0.153	0.054		18	<0.001	<0.010	<0.010	<0.003	<0.020	<0.020	148	~0.03	<0.05	<0.03
E. Coli Grab	9/30/10 8:55	9/30/10 8:55						649											

Key: No Exceedance Determinable; Exceeds CS; Exceeds MS; Exceeds FAV; Exceeds E. Coli Standard for Individual Sample

Table 32: Powers East Water Quality Sample Results and MN Rule 7050.0222 Class 2B Water Quality Standard Exceedances

Type	Sampled date	End sampling	Suspended solids (mg/L)	Volatile suspended solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Dissolved Phosphorus (mg/L)	E coli	Chloride ion (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Nickel (mg/L)	Zinc (mg/L)	Hardness (mg/L_CaCO3)	Ammonia Nitrogen (mg/L)	Nitrate N (mg/L)	Nitrite N (mg/L)
Snowmelt Grab	3/11/10 11:08	3/11/10 11:08	127	43	1	0.299	0.135		90	<0.0005	0.0219	0.0478	0.0104	0.0116	0.203	52	0.35	0.5	<0.03
Storm Grab	6/8/10 10:29	6/8/10 10:29	6	3	1.1	0.041	<0.010		145	<0.0005	<0.005	0.0068	<0.0005	0.0017	0.0099	32	0.12	0.06	<0.03
Storm Comp	6/11/10 7:22	6/11/10 7:22			2.5	0.408	0.168		97								0.14	0.18	<0.03
Storm Comp	6/25/10 18:23	6/25/10 19:48	75	14	1.1	0.195	0.054		27	<0.0005	0.0084	0.0136	0.0037	0.0034	0.0451	22	0.24	0.16	<0.03
Storm Comp	7/5/10 15:06	7/5/10 16:28	21	7	1.4	0.137	0.064		14	<0.0005	0.0074	0.0097	0.001	0.0015	0.0238	20	0.58	0.12	<0.03
Storm Comp	8/8/10 1:54	8/8/10 2:31	13	6	0.76	0.074	0.024		14	<0.0005	<0.005	0.0042	0.0006	0.0012	0.0107	48	0.16	0.17	<0.03
Storm Comp	8/10/10 20:51	8/10/10 23:03	64	15	0.99	0.24	0.105		5	<0.0005	0.0052	0.0089	0.003	0.0025	0.0328	28	0.16	0.18	<0.03
Storm Comp	8/10/10 23:06	8/10/10 23:35	34	8	0.75	0.22	0.136		3	<0.0005	<0.005	0.0055	0.0028	0.002	0.0179	24			

Key: No Exceedance Determinable; Exceeds CS; Exceeds MS; Exceeds FAV; Exceeds E. Coli Standard for Individual Sample

Table 33: Powers West Water Quality Sample Results and MN Rule 7050.0222 Class 2B Water Quality Standard Exceedances

Discussion

Powers Lake behaves as expected for a closed basin system. Following wet years and extreme rain events (1991, 1993, 2002, Oct. 2005) the lake is at its highest levels (around 890 ft). Between wet years/extreme events surface elevations recede (to around 885 ft). In 2009, the lowest surface elevation since the mid-1970s was observed and in 2010, surface elevation rebounded dramatically. What isn't clear, though, is the importance of groundwater in maintaining elevations between wet years/extreme events, or how development and increased use of groundwater has impacted groundwater inflows.

Since Powers Lake lies in a closed basin, quality of inflows is especially important due to the increased nutrient/contaminant residence time. In its WMP, SWWD identified Powers Lake as a significant regional resource. With the goal of maintaining an in-lake trophic state index (TSI) of 50-55, the District has adopted a maximum allowable phosphorus load of 88 lbs/yr or 0.06 lbs/ac/yr throughout the Powers Lake watershed which corresponds to theoretical loading level based on original drainage area (430 acres) under natural conditions. TP concentration of Powers Lake is steadily rising and the highest ever recorded mean growing season concentration was observed in 2009, exceeding SWWD goals and state eutrophication standards. Similarly, chlorophyll a concentrations exceeded SWWD goals and state standards, reaching its highest recorded level in 2010. Secchi transparency of Powers Lake, however, continued to meet both SWWD goals and state eutrophication standards in 2010. Inconsistencies in the three eutrophication measures indicate a system where algae dominate light attenuation, but are otherwise limited in some way (i.e. zooplankton grazing or nitrogen limitation). Overall, it is clear that phosphorus inputs to the lake need to be addressed in order to maintain SWWD water quality goals.

Runoff from the Powers Lake watershed is generally fairly clean. However, in 2010 several samples from both the Powers East and West sites exceeded state standards for metals. 2010 was the first year of sampling at the Powers West site. Sampling was ended early due to the pond being incorporated with the lake with rising surface elevation. Loads were not modeled due to the eventual hydrologic connection between the pond and lake. While water quality at Powers West is a concern, the issue was at least partially addressed by the City in 2010. The pond had been the only source of treatment for runoff from CSAH 19. Now, runoff from the highway drains through a vegetated swale and additional detention pond prior to emptying into the Powers West pond. Despite the high metal concentrations sampled in 2010, phosphorus remains the primary concern for Powers Lake. Phosphorus loading from the Dancing Waters development was 0.55 lbs/ac/yr in 2010 and was the highest since major excavation ended in 2005. In order to meet SWWD loading standards and water quality goals for the lake, efforts need to be taken to decrease phosphorus loading throughout the Powers Lake watershed. SWWD in cooperation with the Washington Conservation District and City of Woodbury have completed a Subwatershed Retrofit Analysis that identifies the most cost-effective projects for reducing phosphorus loading to Powers Lake. Implementation of the identified projects is underway.

Colby Lake

DNR ID #82-0094	Municipality: Woodbury
Surface Area: 68 Acres	Watershed Area: 2,839 Acres
Mean Depth: 7 feet	Maximum Depth: 11 feet
SWWD Maximum Allowable Phosphorus Load: 0.34 lbs/ac/yr	
SWWD Trophic State Index (TSI) Goal: 70-73	

Map 21: Colby Lake

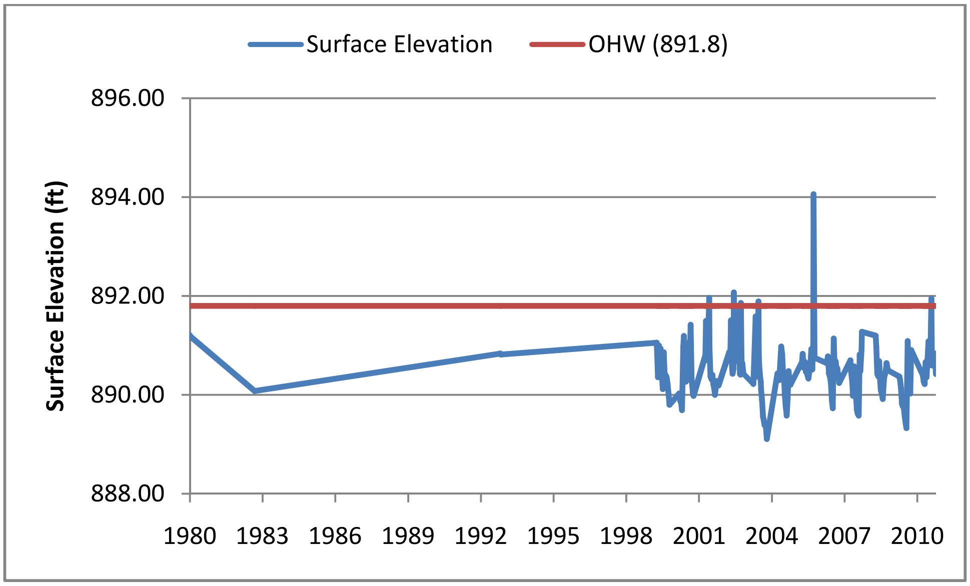
Colby Lake (Map 21) is located in the south-central portion of the Northern subwatershed. It receives flows from Wilmes Lake, so Colby Lake receives approximately 4,240 acres of additional upstream drainage. Almost the entire shoreline is owned by the City of Woodbury. A park is located at the south end of the lake. Although there is no fishing pier, the lake is actively stocked by the DNR.

Results

In Lake

Colby Lake surface elevation has been monitored since 1980 and is shown in Figure 45. Nine water quality samples were collected during the 2010 growing season at Colby Lake. Water quality results are shown in Table 34. Average annual growing season TP, chlorophyll a, and secchi transparency are shown in Figures 46-48. 2010 trophic status and historical lake grades are summarized in Table 33.

Figure 45: Colby Lake Surface Elevation, 1980-2010



Date	Secchi Depth (m)	Water Temperature (°C)	Pheopytin a Corrected Chlorophyll a (ug/L)	Trichromatic Uncorrected Chlorophyll a (ug/L)	TKN (mg/L)	TP (mg/L)
05/02/10	1.5	19.5	11	12	1.3	0.038
05/19/10	1.82	19.7	12	12	1.4	0.034
05/31/10	1.2	19.8	16	17	1.8	0.064
06/16/10	1	21	36	39	1.9	0.069
06/30/10	0.71	26	54	56	1.4	0.098
07/29/10	0.71	29.6	61	61	1.8	0.124
08/15/10	0.91	26.3	49	47	1.3	0.112
08/22/10	0.65	28.2	41	42	1.2	0.089
09/08/10	0.41		61	67	1.8	0.129

Table 34: Colby Lake 2010 Water Quality Results From the Met Council Citizen Assisted Monitoring Program (CAMP)

Figure 46: Colby Lake Historical Mean Growing Season Total Phosphorus Concentration

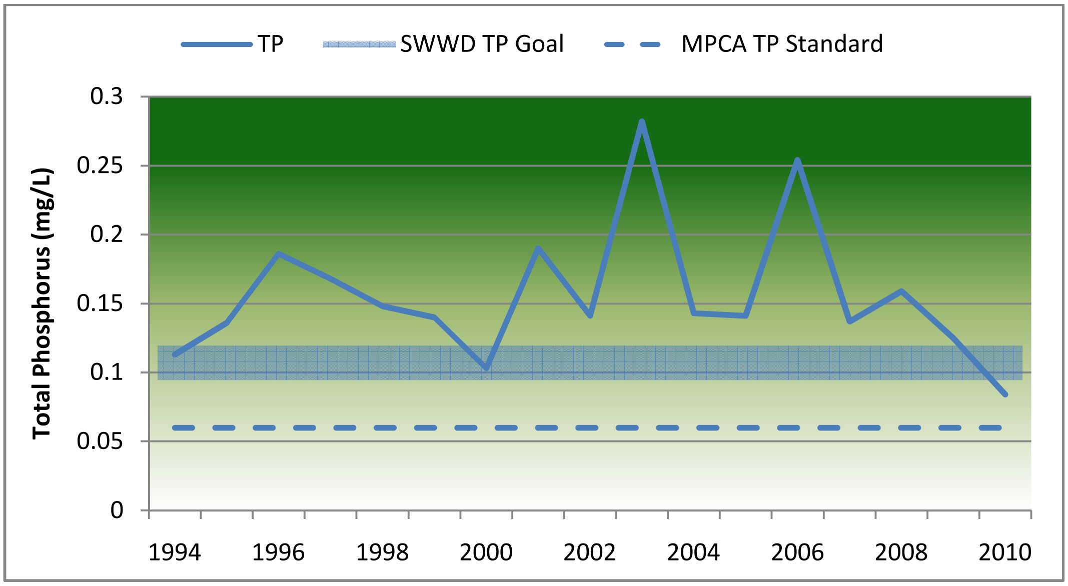


Figure 47: Colby Lake Historical Mean Growing Season Chlorophyll a[1] Concentration

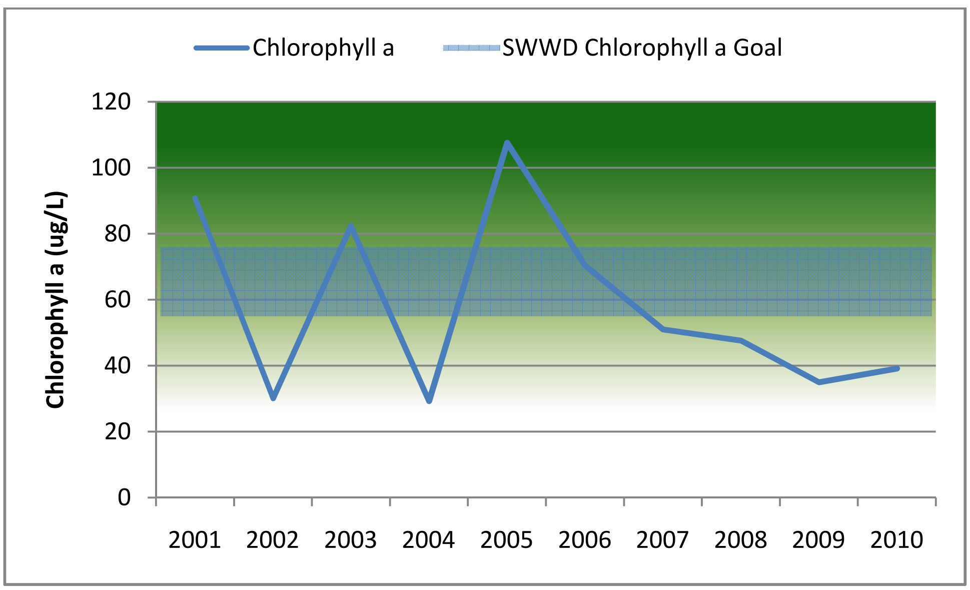
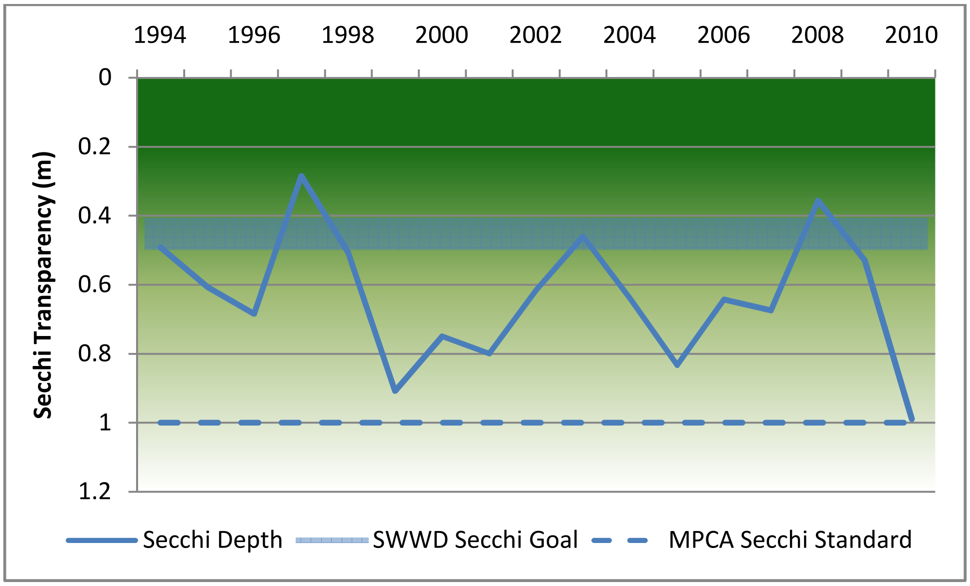


Figure 48: Colby Lake Historical Mean Growing Season Secchi Transparency



Parameter	Trophic Status	Lake Grades 94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Total Phosphorus	Eutrophic	D	D	F	F	D	D	D	F	D	F	D	D	F	D	F	D	D
Chlorophyll a	Eutrophic								F	C	F	C	F	D	D	C	C	C
Secchi Transparency	Eutrophic	F	F	F	F	F	D	D	D	F	F	F	D	F	F	F	F	D
Overall	Eutrophic	D	D	F	F	D	D	D	F	D	F	D	D	F	D	F	D	D

Table 35: Colby Lake 2010 Trohic Status and Historical Lake Grades

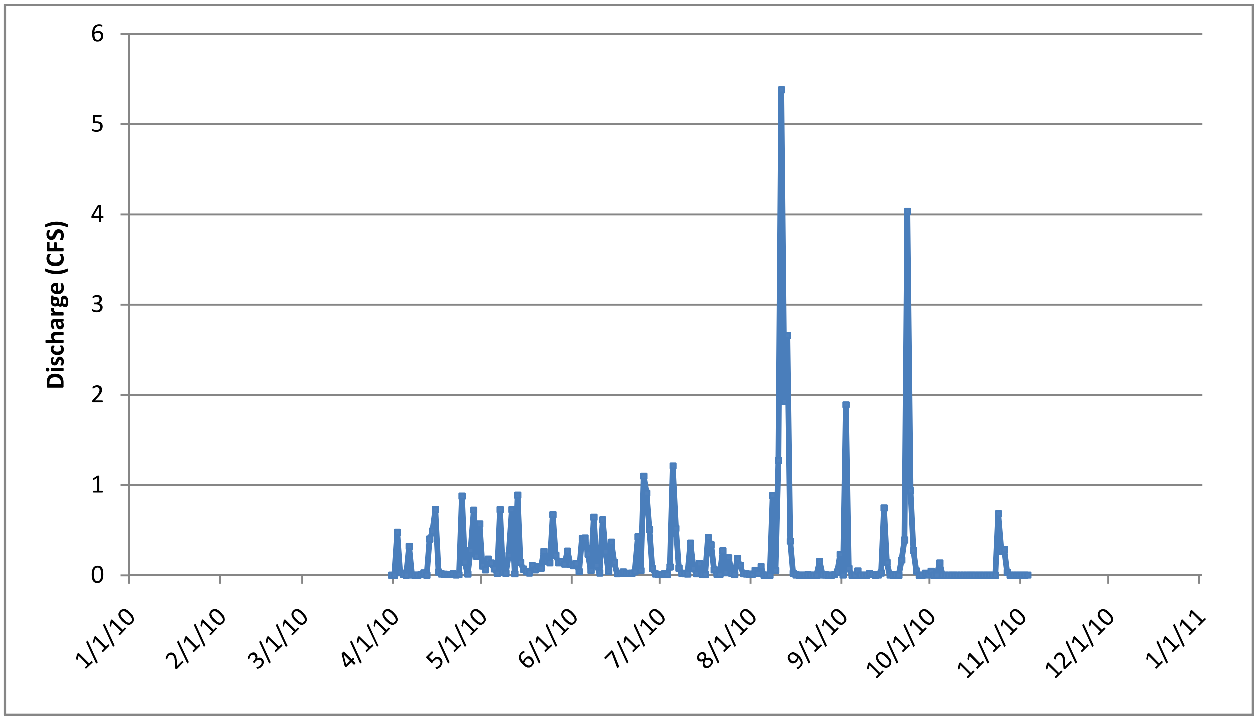
Colby West Inlet

Flow measurements were collected at the Colby West Inlet every 15 minutes from March 31 at 13:45 to November 3 at 10:15. Discharge was calculated using an area velocity relationship, which is the cross sectional area of the water channel as determined by the water level within the pipe multiplied by the measured velocity. Average daily discharge is shown in Figure .

Up to seven types of samples are collected at Regional Assessment Locations; snowmelt grab, snowmelt composite, baseflow grab, baseflow composite, stormflow grab, stormflow composite, and bacteria grab. In 2010, 1 snowmelt grab and 19 stormflow composite samples were collected at the Colby West Inlet. All samples were analyzed at the Metropolitan Council Environmental Services Lab for nutrients and metals. Water quality results are reported in Table 37.

The growing season loading summary is provided in Table 36. Reported values reflect the May 1-September 30 growing season. Additional year to year analyses are performed in odd monitoring years.

Figure 49: Colby West Inlet Average Daily Discharge



Year	Rainfall (inches)	Growing Season Runoff Volume (acre-feet)	Projected Annual Runoff Volume (acre-feet)	Total Phosphorus (lbs)	Total Phosphorus (lbs/ac/yr)	Total Suspended Solids (lbs)	Total Suspended Solids (lbs/ac/yr)
2010		77.56	91.16	34.6	0.09	24595	64

Table 36: Colby West Inlet Growing Season Loading Summary

Discussion

Colby Lake has been a poor water quality lake since CAMP monitoring began in 1994, exceeding state eutrophication standards and grading at a D or F in every year, including 2010. However, Colby Lake has at times met SWWD goals. That was the case in 2010, when all three eutropication measures met SWWD interim goals for Colby Lake.

Monitoring at the Colby Lake west tributary indicates high concentrations of metals, possibly due to the flashy nature of the subwatershed and overall lack of detention. However, phosphorus loading at the Colby west tributary was well below SWWD's current loading standard of 0.34 lbs/ac/yr.

In depth monitoring of Colby Lake will continue moving forward, including additional sites. Data will be used to refine ongoing SWWD planning efforts and document improvements following implementation of various SWWD water quality improvement programs including the Subwatershed Retrofit Analysis scheduled for the summer of 2011.

Sample Type	Sampled date	End sampling	Suspended solids (mg/L)	Volatile suspended solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Dissolved Phosphorus (mg/L)	Chloride ion (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Nickel (mg/L)	Zinc (mg/L)	Hardness (mg/L_CaCO3)	Ammonia Nitrogen (mg/L)	Nitrate N (mg/L)	Nitrite N (mg/L)
Snowmelt Grab	3/11/10 9:32		110	34	1.7	0.324	0.231	33	<.0005	0.0057	0.0112	0.0035	0.0045	0.0422	32	0.53	0.79	0.015
Storm Composite	4/13/10 5:58	4/13/10 8:12	458	138	4.6	0.532	0.032	7								1.2	0.77	0.015
Storm Composite	4/24/10 8:10	4/24/10 10:10	169	55	1.2	0.247	0.067	3	<.0005	<.005	0.009	0.0019	0.0024	0.0283	32	0.09	0.22	0.015
Storm Composite	5/7/10 10:12	5/7/10 15:27	111	42	0.95	0.12	0.041	3	<.0005	<.005	0.0064	0.0012	0.0021	0.0257	20	0.21	0.2	0.015
Storm Composite	5/10/10 19:39	5/11/10 12:37	33	14	0.97	0.095	0.166	2	<.0005	<.005	0.0051	0.0009	0.0014	0.0143	26	0.52	0.46	0.015
Storm Composite	5/13/10 10:14	5/13/10 13:13	20	6	0.98	0.134	0.024	2	0.0006	<.005	0.007	0.0029	0.0034	0.0387	18	0.18	0.2	0.015
Storm Composite	5/25/10 20:16	5/25/10 23:18	145	54	1.4	0.272	0.06	3	<.0005	<.005	0.0089	0.0025	0.0034	0.0591	30	0.17	0.31	0.09
Storm Composite	5/30/10 19:07	5/30/10 20:14	474	141	3.9	0.498	0.137	9	<.0005	<.005	0.0222	0.0037	0.0063	0.0637	88	0.62	0.32	0.12
Storm Composite	6/8/10 6:27	6/8/10 9:29	23	9	0.66	0.052	0.029	1	<.0005	<.005	0.004	0.0003	0.0011	0.012	20	0.36	0.3	0.015
Storm Composite	6/11/10 6:04	6/12/10 13:42	393	59	1.6	0.157	0.034	1	<.0005	<.005	0.0083	0.0035	0.0028	0.0401	12	0.18	0.28	0.17
Storm Composite	7/5/10 15:32	7/5/10 18:15	24	9	1.9	0.309	0.199	7	<.0005	<.005	0.0059	0.0007	0.0023	0.0135	24	0.35	0.37	0.015
Storm Composite	7/11/10 16:09	7/11/10 16:52	51	13	0.8	0.144	0.088	1	<.0005	<.005	0.0051	0.0015	0.002	0.0176	14	0.18	0.24	0.015
Storm Composite	7/17/10 20:50	7/17/10 23:01	35	10	1.4	0.257	0.132	2	<.0005	<.005	0.004	0.0009	0.0017	0.0107	22	0.38	0.33	0.04
Storm Composite	7/27/10 20:26	7/27/10 20:57	56	12	1.3	0.259	0.15	1	<.0005	<.005	0.0034	0.0006	0.0013	0.0091	20			
Storm Composite	8/10/10 20:40	8/11/10 5:27	20	10	1.5	0.235	0.096	3	<.0005	<.005	0.0029	0.0006	0.0015	0.0076	22	0.12	0.26	0.015
Storm Composite	8/13/10 3:26	8/13/10 5:41	53	12	1.1	0.224	0.162	1	<.0005	<.005	0.0042	0.0011	0.0019	0.0127	28	0.2	0.29	0.04
Storm Composite	9/2/10 3:26	9/2/10 4:11	47	10	0.59	0.2	0.126	1	<.0005	<.005	0.0031	0.001	0.0013	0.0106	2.5	0.15	0.26	0.015
Storm Composite	9/15/10 19:18	9/15/10 20:37	113	49	1.2	0.16	0.045	1	<.0005	<.005	0.0045	0.0014	0.0018	0.0204	12	0.23	0.21	0.015
Storm Composite	9/22/10 21:42	9/23/10 1:37	27	10	0.98	0.151	0.079	1	<0.001	<0.010	<0.010	<0.003	<0.020	<0.020	26	0.06	0.12	0.015
Storm Composite	9/23/10 10:17	9/23/10 23:04	31	10	1.1	0.25	0.138	2	<0.001	<0.010	<0.010	<0.003	<0.020	<0.020	28	0.07	0.21	0.015

Key: No Exceedance Determinable; Exceeds CS; Exceeds MS; Exceeds FAV; Exceeds E. Coli Standard for Individual Sample

Table 37: Colby Inlet Water Quality Sample Results and MN Rule 7050.0222 Class 2B Water Quality Standard Exceedances

Groundwater

Soils within the South Washington Watershed are generally characterized by moderate to high permeability. Hydrologic soil groups established by the Natural Resources Conservation Services (NRCS) provide a classification for the behavior of soils when thoroughly wet. This classification system is useful because there are numerous distinct soil types found within the District yet many of them respond similarly to infiltrating precipitation.

There are four major aquifers available for use in the watershed. The water table aquifer is generally unconfined and recharged through direct infiltration from precipitation and leakage from surface water bodies. The water table aquifer has not been a major source for groundwater development, although the capability of the unit to produce water is high, particularly in the major and minor buried bedrock valleys. Water quality, as suggested by previous studies, is generally very good, with the exception of locally impacted areas.

The Prairie du Chien-Jordan aquifer is the source for all high capacity wells in the watershed The Franconia-Ironton-Galesville aquifer is not used in the SWWD, primarily because of the availability of the Prairie du Chien-Jordan aquifer. Currently, the Mount Simon aquifer is not an important water source for the watershed, although it could be in the future if water quality impacts or excessive head loss becomes a problem with the Prairie du Chien-Jordan aquifer.

In most areas in the District, the sensitivity to groundwater impacts is high or very high. This indicates that the residence time of groundwater in this system is on the order of weeks to years. This means that water infiltrating in the watershed will reach the water table system in a very short period of time, leaving little opportunity for attenuation of compounds through degradation.

Currently, SWWD monitors water level in 6 wells near the District's regional infiltration facilities. Results are shown in Table 38 and Figure 50. Two of the wells were dry throughout the year. Three of the wells showed an increase in recharge during the relatively wet 2010. The remaining well held steady throughout 2010.

Beginning in 2010 SWWD, in cooperation with the Minnesota Department of Health, collected water quality samples from the existing wells and Bailey Lake, which is believed to be the primary source of recharge for the sampled wells. Wells and Bailey Lake were sampled 3 times in 2010. Water quality results for the sampled wells and Bailey Lake are shown in Table 39. Continued monitoring will help provide a baseline against which SWWD can identify potential impacts from urbanization and increased use of SWWD's regional infiltration facilities.

Well ID	Monitored	Readings	TOC Elevation (ft)	Lowest Elevation (ft)	Lowest Elevation Date	Highest Elevation (ft)	Highest Elevation Date	Range (ft)	Average Elevation(ft)
616497	1/13/2010 to 1/4/2011	10	913.53	861.90	3/17/2010 and 5/27/2010	861.85	2/26/2010	0.05	861.88
616493	1/13/2010 to 1/4/2011	10	916.75	Dry		Dry			Dry
616494	1/13/2010 to 1/4/2011	10	916.95	Dry		Dry			Dry
545603	1/6/2010 to 11/18/2011	10	909.15	861.23	9/30/2010	840.18	6/24/2010	21.05	848.03
545604	1/6/2010 to 1/4/2011	11	906.70	874.16	9/30/2010	853.51	6/24/2010	20.65	861.69
545602	1/6/2010 to 11/18/2011	10	889.25	818.80	8/24/2010	809.50	2/26/2010	9.30	812.47

Table 38: 2010 Observation Well Measurements

Well	Date	Total N (mg/L)	Total P (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Aluminum (ug/L)	Arsenic (ug/L)	Barium (ug/L)	Beryllium (ug/L)	Boron (ug/L)	Cadmium (ug/L)	Chromium (ug/L)	Cobalt (ug/L)	Copper (ug/L)	Lead (ug/L)	Lithium (ug/L)	Manganese (ug/L)	Molybdenum (ug/L)	Nickel (ug/L)	Silver (ug/L)	Strontium (ug/L)	Titanium (ug/L)	Vanadium (ug/L)	Zinc (ug/L)
545602	1/14/2010	15	0.124	19.1	46.1	919	1.5	118	<.3	18	0.18	9.19	2.49	6.57	7.55	<5	659	<.5	13.9	<.2	120	35.6	3.3	6.41
545602	4/15/2010	13	0.115	0.101	64.6	747	1.05	115	<.3	34	0.15	8.31	1.84	4.65	4.8	<5	419	0.64	9.55	<.2	159	31.2	2.77	4.99
545602	7/21/2010	11	0.029	0.1	72.4	179	<.8	73	<.3		<.1	2.79	<.5	1.09	0.83	<5	78.1	<.5	4.61	<.2	148	4.4	<1	<1
545603	1/14/2010	1.8	0.091	0.0097	26.8	566	<.8	16.1	<.3	17	0.28	55.9	7.42	4.39	8.82	<5	223	1.14	114	<.2	79.1	28.9	2.74	4.72
545603	4/15/2010	1.8	0.046	0.0174	25.9	169	<.8	13.3	<.3	19	0.14	13.3	2.35	1.57	3.17	<5	76.1	<.5	40.1	<.2	83.4	9.35	1.44	3.07
545603	7/21/2010	2.2	0.049	0.0152	19.9	491	<.8	13.9	<.3		<.1	18.7	3.25	2.44	4.45	<5	116	<.5	49.4	<.2	81.3	17.5	2.07	2.35
545604	1/13/2010	0.6	0.032	0.0388	70.1	53.2	<.8	44.9	<.3	18	<.1	56.4	1.87	2.29	0.65	<5	329	1.18	7.39	<.2	75.8	3.37	<1	1.65
545604	4/15/2010	0.4	0.035	0.0396	73.3	47.2	<.8	55.3	<.3	14	0.11	30.7	2.67	2.81	0.85	<5	421	0.59	12.5	<.2	84.7	3.51	<1	3.21
545604	7/21/2010	1	0.027	0.0375	60	77.8	<.8	48.8	<.3		<.1	17.7	1.44	2.06	0.81	<5	268	<.5	5.68	<.2	79.8	3.48	<1	1.02
Bailey Lake	1/14/2010	<.05	0.092	0.0392	78.6	37.6	0.88	47.2	<.3	20	0.16	<.3	<.5	6	0.85	<5	315	0.52	2.69	<.2	58	1.75	<1	36.7
Bailey Lake	4/15/2010	<.05	0.082	0.0362	65.3	41.9	<.8	42.9	<.3	18	<.1	<.3	<.5	3.68	1.35	<5	88	0.64	3.53	<.2	57	1.51	<1	26.7
Bailey Lake	7/21/2010	<.05	0.534	0.0363	71.8	17.7	1.52	71.3	<.3		<.1	<.3	<.5	2.56	0.67	<5	904	<.5	2.4	<.2	67.7	3.42	2.06	18.7

Table 39: Groundwater Water Quality Results

Figure 50: 2010 Observation Well Water Levels