MINNEHAHA CREEK WATERSHED DISTRICT

QUALITY OF WATER QUALITY OF LIFE

2013
Hydrologic, Hydraulic and Water Quality Monitoring Report

May 2014

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Hydrologic, Hydraulic and Water Quality Monitoring Report

Prepared by

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Hydrodata Program

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PREFACE

The Minnehaha Creek Watershed District (MCWD)'s annual Watershed Monitoring Program began in 1968. It was a simple program to quantify the water quality and hydrology of the watershed. The major hydrologic features of the watershed include Lake Minnetonka, Minnehaha Creek, the Minneapolis Chain of Lakes, and Minnehaha Falls. The program has expanded and continued to evolve over the years. The Hydrologic, Hydraulic, and Water Quality Monitoring Program, also known as the "Hydrodata Program", is a cooperative effort performed with the involvement of several governmental organizations including, Minneapolis Park and Recreation Board, Three Rivers Park District, Metropolitan Council Environmental Services, Minnesota Pollution Control Agency, Minnesota Department of Natural Resource, United States Geological Survey, and Lake Minnetonka Conservation District.

In 2013, the Hydrodata Program monitored the water quality of the lakes and streams throughout the 181 square miles of the watershed district. Staff monitored 27 bays on Lake Minnetonka, 11 upper watershed lakes, and 16 limited access lakes for physical parameters, nutrients, clarity, algal abundance, and water level. Staff also monitored for physical parameters, flow, nutrients, suspended solids, chloride, and *E. coli*. for 11 sites on Minnehaha Creek, and 35 sites on the streams in the upper watershed which eventually flow into Lake Minnetonka.

This report will be presented in three parts: Executive Summary, Main Report, and a Technical Appendix. The Main Report will provide information on the 11 subwatersheds that are located within the boundaries of the Minnehaha Creek Watershed District, as well as the District wide summary of the water quality. The Technical Appendix will provide detailed information about the 2013 monitoring and analysis by subwatershed.

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ACRONYMS OF WATER QUALITY TERMS

303 (d) List	Minnesota Pollution Control Agencies List of Impaired Waters under the Clean Water Act
305 (b) Report	Minnesota Pollution Control Agencies Report to US Congress on the Minnesota's water quality
BMPs	best management practices
CAMP	Citizen Assisted Monitoring Program
CFS	cubic feet per seconds
CFU/100 mL	colony forming units per 100 milliliters
CLMI	Citizen Lake Monitoring Initiative
CPR	citizen precipitation recorders
DI	deionized
DO	dissolved oxygen
Chl-a	chlorophyll-a concentration
Cl	chloride
EPA	Environmental Protection Agency
EQuIS	Environmental Quality Information System
GPS	Global Positioning System
lbs	pounds
LMCD	Lake Minnetonka Conservation District
MCES	Metropolitan Council Environmental Services
MCWD	Minnehaha Creek Watershed District
mg/L (ppm)	milligrams per liter, parts per million
µg/L (ppb)	micrograms per liter, parts per billion
µS/cm	micro Siemens per centimeter
MN 7050	Minnesota State Statutes
MnDNR	Minnesota Department of Natural Resources
MPCA	Minnesota Pollution Control Agency
MPRB	Minneapolis Park and Recreation Board
MSP	Minneapolis – St Paul International Airport
NCHF	North Central Hardwood Forest (Ecoregion)
NH_4	ammonia
NO_3/NO_2	nitrate/nitrite
NOAA	National Oceanic and Atmospheric Administration
NOHW	normal ordinary high water (level)
NWS	National Weather Service
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control

SD	Secchi depth
SOP	standard operating procedure
SRP	soluble reactive phosphorus
TMDL	Total Maximum Daily Load
TN	total nitrogen
TP	total phosphorus
TRPD	Three Rivers Park District
TSI	Trophic Status Index
TSS	total suspended solid
WQ	water quality

GLOSSARY

Chloride: Chloride (Cl^-) measurements are performed to detect the influx of road salts from winter deicing procedures.

Chlorophyll-a: Chlorophyll-*a* concentration is a proxy for phytoplankton (algae) biomass in the water.

Dissolved Oxygen: The amount of dissolved oxygen in a waterbody indicates the ability of that waterbody to support a balanced aquatic ecosystem.

Ecoregion: Natural differences in lake water quality occur across Minnesota's widely varied geographical and environmental regions. The geomorphic and chemical properties of lakes vary across these regions. These differences are accounted for by dividing the regions into seven different ecoregions. Each ecoregion contains a geographically distinct collection of plants, animals, natural communities and environmental conditions.

Epilimnion: Upper layer of more or less uniformly warm, circulating, and fairly turbulent water during summer stratification.

Escherichia coli (E. coli): *E. coli* are a member of the fecal coliform group of bacteria.

Eutrophication: In a body of water, it is characterized by an abundant accumulation of nutrients that support a dense growth of algae and other organisms, the decay of algae and organisms depletes the shallow waters of oxygen in summer.

***Hypolimnion*:** The lowest stratum during summer stratification which changes very little in temperature

Internal Loading: Release of phosphorus from lake sediments during oxygen-depleted conditions. Depending on the overall nutrient budget for a lake, internal loading can be a major source of in-lake phosphorus annually and can contribute to eutrophication.

Macrophyte: A relatively large aquatic plant. Examples include floating-leaved (e.g., water lilies), submerged (e.g., coontail), and emergent (e.g., cattail).

Metalimnion: The layer between the epilimnion and hypolimnion that exhibits a marked thermal discontinuity.

Nitrogen: Nitrogen (N) is a chemical element occurring in several forms. Algae and other plants require N as a primary nutrient. Ammonia and nitrate N are the chief forms susceptible to algal and plant uptake, but certain dissolved organic forms can also be assimilated. Measurement of N provides insight into the total potential for algal and plant growth.

Ammonia: Ammonia-N is the total of all N in the form of either dissolved gas (NH_3) or ammonium ion (NH_4^+).

Nitrate: Nitrate-N is nitrogen dissolved as nitrate ion (NO_3^-). A less abundant inorganic form is the nitrite ion (NO_2^-), which occurs in low dissolved oxygen environments). Elevated nitrate levels usually indicate bacterial nitrification, which is typical of sewage-contaminated waters.

Total Kjeldahl-Nitrogen: Total Kjeldahl-Nitrogen (TKN) measures the total of all N in the form of either organic-N or ammonia-N. Organic-N includes particulate forms (such as cell matter from algae or bacteria, and sewage solids) and dissolved forms (such as proteins and peptides).

pH: pH measures the concentration of hydrogen ion (H^+) in water. Surface waters in the metropolitan area are usually basic (pH greater than 7.0), due to plant and algal photosynthesis and geologic characteristics.

Phosphorus: Phosphorus (P) is a chemical element found in waters most commonly in one of several forms of phosphate (PO_4). Total phosphorus (TP) measures the sum of all forms. Settling of solids, algal and bacterial cell matter, as well as uptake by rooted plants, removes P from the water. TP measurements show the maximum potential for algal growth and can be used to classify the trophic status of a lake.

Soluble Reactive Phosphorus: Soluble reactive phosphorus (SRP) or orthophosphate is an essential nutrient for photosynthesis; not only do plants convert this form into organic matter, but phosphorus is also a crucial component of the energy for organisms. Orthophosphorus measurements show the amount of P immediately available for plant life.

Secchi Depth: The Secchi depth provides a physical measurement of water clarity by observation of the Secchi disc at the maximum visual depth in the water column. Secchi depth is an indicator of algal population density and turbidity, and can be utilized to classify the trophic status of the lake.

Specific Conductance: Specific conductance is a measure of the water's ability to act as a conductor. High conductivity is an indicator of low water quality and implies high concentrations of chlorides or other dissolved solids.

Subwatershed: Part of a larger watershed, a subwatershed is the land that drains to a specific waterbody.

Temperature Profile: In lakes, the temperature profile with depth determines the extent to which surface and bottom waters are mixed. A large difference (stratification) indicates little mixing, while a small difference or no difference generally shows thorough mixing throughout all depths. Water temperature also determines the DO saturation level, the concentration that would occur in the absence of all biological activity.

Trophic State: The trophic state of a lake is a *qualitative* description of biological productivity. Common terms include eutrophic mesotrophic and oligotrophic

Watershed: A watershed is the area of land that drains to a common lake, wetland, stream or river.

EXECUTIVE SUMMARY

The Minnehaha Creek Watershed District (MCWD) monitors lakes and streams within its watershed boundaries on a seasonal basis for water quality indicators linked to recreational, aesthetic, and biological conditions. There are eleven major subwatersheds within the Minnehaha Creek Watershed boundary (Figure 1). The 2013 monitoring season results are presented by subwatershed in this report. Figure 2 displays the lakes monitored within MCWD that do and do not meet the North Central Hardwood Forest (NCHF) water quality state standards.

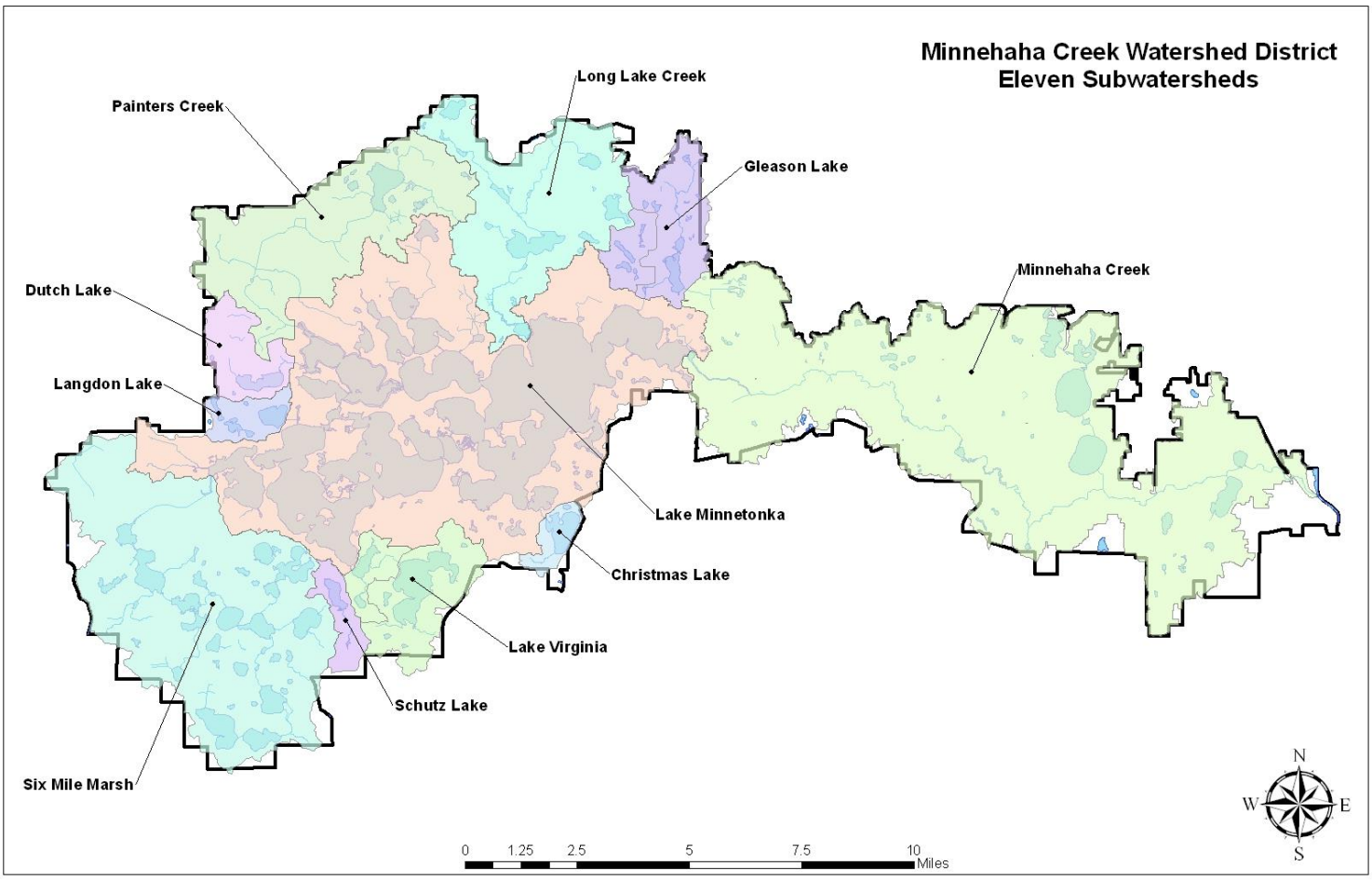

Figure 1. The Subwatersheds of Minnehaha Creek Watershed District

Christmas Lake Subwatershed: Christmas Lake and 2 stream sites on Christmas Lake Creek were the only lake and stream monitored in 2013 within the Christmas Lake Subwatershed.

Meet Ecoregion Water Quality Standards	Do Not Meet Ecoregion Water Quality Standards	Not Applicable
Christmas Lake		Christmas Lake Creek

Dutch Lake Subwatershed: Dutch Lake and 2 stream sites on Dutch Creek were monitored in the Dutch Lake Subwatershed in 2013.

Meet Ecoregion Water Quality Standards	Do Not Meet Ecoregion Water Quality Standards	Not Applicable
	Dutch Lake	Dutch Creek

Gleason Lake Subwatershed: Gleason Lake and 3 stream sites on Gleason Creek were monitored in the Gleason Lake Subwatershed in 2013.

Meet Ecoregion Water Quality Standards	Do Not Meet Ecoregion Water Quality Standards	Not Applicable
	Gleason Lake	
	Gleason Creek	

Lake Minnetonka Subwatershed: There were 4 limited access lakes, 27 bays of Lake Minnetonka, and 2 streams that were monitored within the subwatershed in 2013.

Meet Ecoregion Water Quality Standards	Do Not Meet Ecoregion Water Quality Standards	Not Applicable
Black Lake	Forest Lake	Forest Lake Creek
Carman Bay	Halsted Bay	Classen Creek
Carsons Bay	Harrisons Bay	
Cooks Bay	Jennings Bay	
Crystal Bay	Maxwell Bay	
Gideon Bay	Peavey Lake	
Grays Bay	Priests Bay	
Lafayette Bay	Stubbs Bay	
Lake William	West Arm	
Lower Lake North		
Lower Lake South		
North Arm		
Phelps Bay		
Smithtown Bay		
Spring Park Bay		
St. Albans Bay		
Wayzata Bay		
West Upper Lake		

Lake Virginia Subwatershed: In 2013, there were 4 lakes and 1 stream site monitored in the Lake Virginia Subwatershed (note: one lake has 2 monitoring sites).

Meet Ecoregion Water Quality Standards	Do Not Meet Ecoregion Water Quality Standards	Not Applicable
Lake Minnewashta	Lake Virginia	Lake Minnewashta Creek
	Lake Minnewashta (South Bay) (CAMP)	St. Joe Lake
	Tamarack Lake	

Langdon Lake Subwatershed: There were 2 lakes and 2 stream sites monitored in the Langdon Lake Subwatershed in 2013.

Meet Ecoregion Water Quality Standards	Do Not Meet Ecoregion Water Quality Standards	Not Applicable
	Langdon Lake	Langdon Lake Creek

Long Lake Creek Subwatershed: Long Lake Creek Subwatershed had 5 lakes and 3 stream sites on Long Lake Creek monitored in 2012.

Meet Ecoregion Water Quality Standards	Do Not Meet Ecoregion Water Quality Standards	Not Applicable
Lydiard Lake	Dickey's Lake	Long Lake Creek
	Mooney Lake	
	Long Lake	
	Tanager Lake	

Minnehaha Creek Subwatershed: There were 16 lakes and 11 stream sites on Minnehaha Creek that were monitored in 2013 within the Minnehaha Creek Subwatershed.

Meet Ecoregion Water Quality Standards	Do Not Meet Ecoregion Water Quality Standards	Not Applicable
Cedar Lake	Bass Lake (NW Pond)	Hannan Lake
Lake Calhoun	Cobblecrest Lake	
Lake Harriet	Diamond Lake	
Meadowbrook Lake	Lake Hiawatha	
	Lake of the Isles	
	Lake Nokomis	
	Mother Lake	
	Pamela Pond	
	Powderhorn Lake	
	South Oak Lake	
	Twin Lake	
	Windsor Lake	
	Minnehaha Creek	

Painter Creek Subwatershed: There were 5 stream sites on Painters Creek that were monitored in the Painter Creek Subwatershed in 2013.

Meet Ecoregion Water Quality Standards	Do Not Meet Ecoregion Water Quality Standards	Not Applicable
	Painters Creek	

Schutz Lake Subwatershed: Schutz Lake and Schutz (Madeline) Creek are the only waterbodies within the Schutz Lake Subwatershed which were monitored in 2013.

Meet Ecoregion Water Quality Standards	Do Not Meet Ecoregion Water Quality Standards	Not Applicable
	Schutz Lake	Schutz (Madeline) Creek

Six Mile Marsh Subwatershed: There were 16 lakes and 12 stream sites on Six Mile Creek that were monitored in the Six Mile Marsh Subwatershed in 2013.

Meet Ecoregion Water Quality Standards	Do Not Meet Ecoregion Water Quality Standards	Not Applicable
Carl Krey Lake	Church Lake	Six Mile Creek
Kelser's Pond	East Auburn Lake	Wassermann – West Pond
Lake Zumbra	Lundsten Lake South	
Lundsten Lake North	Mud Lake	
Marsh Lake	Parley Lake	
Piersons Lake	Steiger Lake	
Stone Lake	Turbid Lake	
Sunny Lake	Wassermann Lake	
Wassermann – North Pond		
Wassermann – South Pond		
West Auburn Lake		

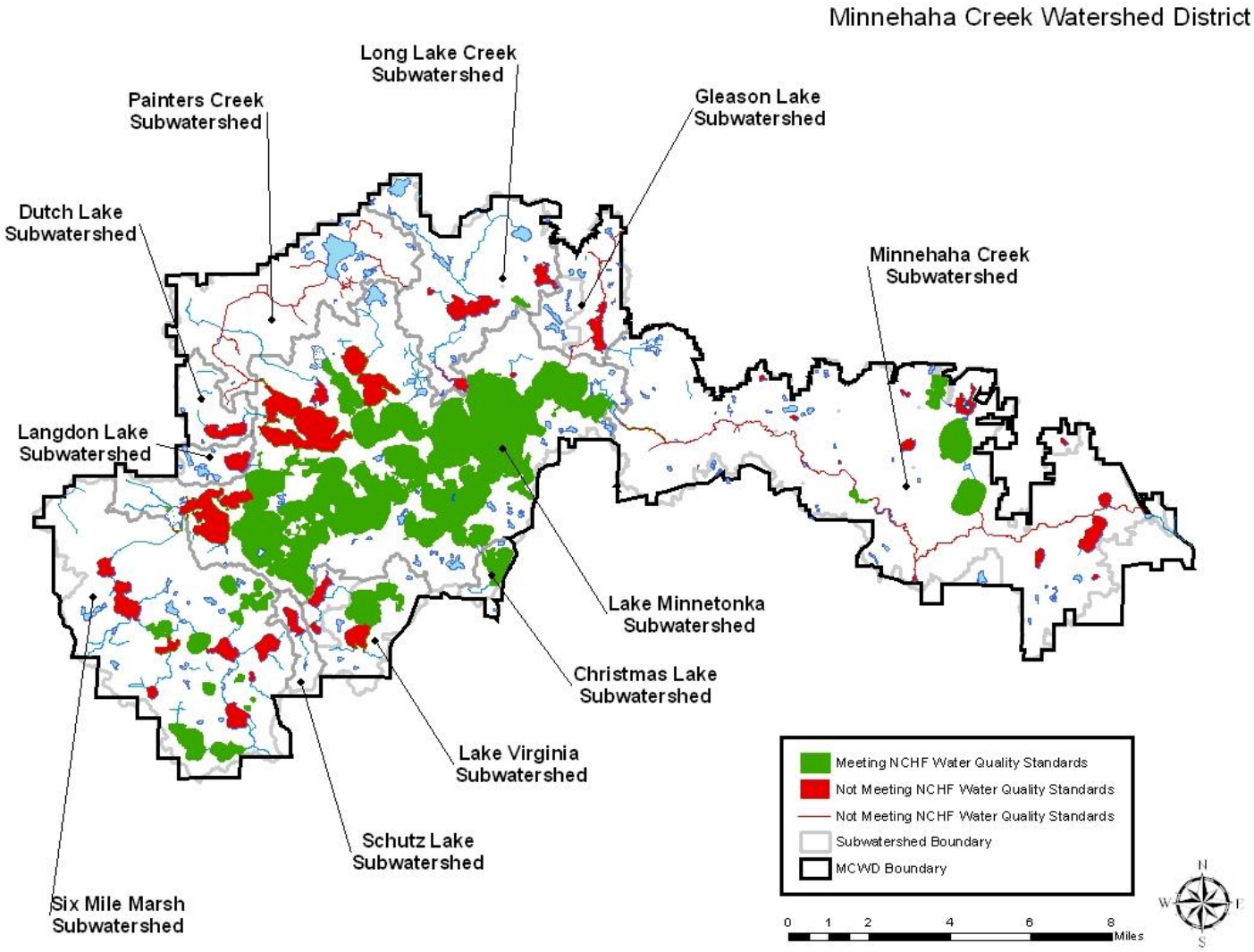

Figure 2. Lakes within MCWD that do and do not meet the North Central Hardwood Forest (NCHF) Water Quality State Standards

INTRODUCTION

1.1 Minnehaha Creek Watershed District

The Minnehaha Creek Watershed District (MCWD) was established in 1967 and is responsible for managing and protecting the water resources of the Minnehaha Creek Watershed drainage basin in parts of Minneapolis, Minnesota and its western suburbs.

The District seeks to conserve the natural resources of Minnehaha Creek watershed through public information and education, regulation of land use, regulation of the use of water bodies and their beds, and capital improvement projects. MCWD is responsible for 181 square miles that drain into the Minnehaha Creek and ultimately the Mississippi River. The watershed district includes eight major creeks, 129 lakes, and thousands of wetlands throughout all or part of 27 cities and three townships in two counties (i.e., Hennepin and Carver).

The watershed of Minnehaha Creek includes approximately 151 square miles in Hennepin County and 30 square miles in Carver County. The upper watershed, with a total area of 123 square miles, includes Lake Minnetonka (est. 14,101 acres) and the 100 square miles of land that drains into Lake Minnetonka. The lower watershed includes Minnehaha Creek (21.23 miles) and the 59 square miles of land that drains into the Minnehaha Creek below Lake Minnetonka. The Lake Minnetonka outlet is located at Gray's Bay Dam, the headwaters of Minnehaha Creek (Figure 3).

The major hydrologic features of the watershed include Lake Minnetonka, Minnehaha Creek, the Minneapolis Chain of Lakes, and Minnehaha Falls. Each watershed feature provides unique recreational opportunities and aesthetic resources. Through monitoring and analysis of its streams and lakes, the District has identified areas of water quality degradation and flooding. The District has then used this knowledge to develop and implement solutions that improve or maintain the water quality throughout the watershed.

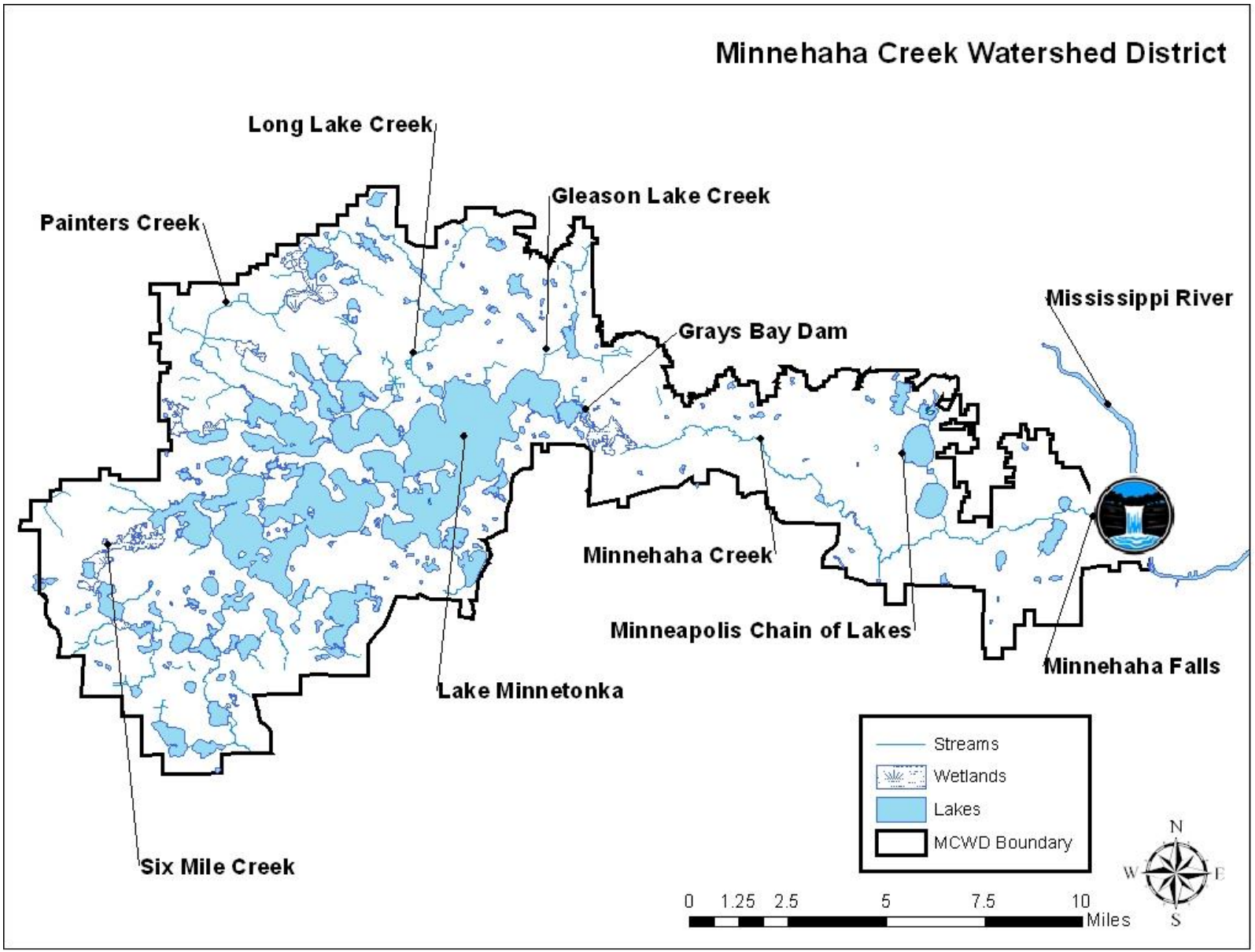

Figure 3. Map of the Minnehaha Creek Watershed District

1.2 The Hydrodata Monitoring Program

The MCWD has an extensive hydrologic data monitoring program through which it collects and analyzes precipitation, water level, discharge, water quality, stream flow, and groundwater level data. The District publishes the information in annual hydrologic monitoring reports. In addition, historical hydrologic data that the MCWD has collected since 1968 are maintained and available on the District's website (www.minnehahacreek.org), and through the MPCA's database (EQuIS).

The Hydrologic, Hydraulic, and Water Quality Monitoring Program or the Hydrodata Program is a cooperative effort by the MCWD, Minneapolis Park and Recreation Board (MPRB), Three Rivers Park District (TRPD), Lake Minnetonka Conservation District (LMCD), Metropolitan Council Environmental Services (MCES), Minnesota Pollution Control Agency (MPCA), and Minnesota Department of Natural Resources (MnDNR). The Hydrodata Program has expanded and continued to evolve over the years. In 2004, MCWD brought the program in house to conduct and manage the lake and stream water quality monitoring.

The current program is designed to provide hydrologic, hydraulic and water quality data to:

1. Run statistical analysis of the data to:
    - Identify long-term trends on the water quality parameters
    - Identify stressors/emerging issues that need to be investigated or monitored
    - Maximize efficiencies in monitoring frequencies (i.e., biweekly vs. monthly), locations and events
2. Assess designated use impairment of lakes and streams, and determine whether lakes are meeting their established water quality goals as determined by MCWD and MPCA
3. Identify opportunities to, design, maintain, and assess performance of capital improvement projects
4. Provide data to calibrate models used by MCWD and other organizations
5. Communicate the results of the monitoring report to raise awareness about the health in each subwatershed and educate the public about what they can do to improve their lakes and streams

In the following sections, terms such as water quality grades, trophic state index and eutrophication standards will be used frequently. Information describing these terms can be found in the Technical Appendix - Section 4. For the reader's benefit, the tables briefly describing the terms are presented below:

A-1. Lake Water Quality Grade Description

Grade	Relative Ranking	Description
A	90% and up	Crystal clear, beautiful. These lakes are exceptional and are enjoyed recreationally without question or hesitation.
B	70 - 90%	These lakes generally have good water quality but algae may limit swimming, particularly toward the end of summer.
C	30 -70%	Average quality. Swimming, boating and fishing may be undesirable relatively early in the season. Algae blooms occasionally.
D	10 - 30%	These lakes have severe algae problems. People are generally not interested in recreation on these lakes.
F	Lowest 10%	Not enjoyable. Such a lake would have several limitations to recreational use.
N/A		Insufficient data to calculate a lake grade (Either < 5 monitoring events and/or the Secchi disk was visible at the bottom of the lake and/or obstructed by vegetation during more than one monitoring event).

A-2. Description of the Carlson's Trophic State Index

Trophic State	TSI	Description
Oligotrophic	< 30	Clear water, oxygen throughout the year in the hypolimnion. Salmonid fisheries in deep lakes.
	30 - 40	Deeper lakes still exhibit oligotrophic characteristics, but some shallower lakes will become anoxic in the hypolimnion during the summer
Mesotrophic	40 - 50	Water moderately clear, but increasing probability of anoxia in hypolimnion
Eutrophic	50 - 60	Decreased transparency, anoxic hypolimnia during the summer, macrophyte problems evidence, warm-water fisheries only
	60 - 70	Dominance of blue-green algae, algal scum probable, extensive macrophyte problems
Hypereutrophic	70 - 80	Heavy algal blooms possible throughout the summer, dense macrophyte beds, but extent limited by light penetration.
	> 80	Algal scum, summer fish kills, few macrophytes, dominance of rough fish

Moore, L. and K. Thronton, Ed 1998. Lake and Reservoir Restoration Guidance Manual. USEPA: EPA 440/5-88-002

A-3. North Central Hardwood Forest Ecoregion Water Quality Standards for Shallow and Deep Lakes (MPCA, 2012)

North Central Hardwood Forest Ecoregion	Water Quality State Standards (June-Sept Mean)	
	Shallow Lakes	Deep Lakes
Secchi Depth (m)	> 1.0	> 1.4
Chlorophyll-*a* (µg/L)	< 20	< 14
Total Phosphorus (µg/L)	< 60	< 40

A-4. North Central Hardwood Forest Ecoregion Chloride Standard for Lakes and Streams (MPCA, 2012)

North Central Hardwood Forest Ecoregion	Chronic	Acute
	2 or more exceedances over 3 years	1 or more exceedances over 3 years
Chloride (mg/L)	230	860

A-5. North Central Hardwood Forest Ecoregion Guidelines and Standard for Streams (MPCA, 2012)

North Central Hardwood Forest Ecoregion	Water Quality Stream Guidelines (25^{th} -75^{th} percentile)	Water Quality State Standards
		Streams
Temperature (°C)	2 - 21	
Dissolved Oxygen (mg/L)	n/a	> 5 mg/L
Total Suspended Solids (mg/L)	4.8 - 16	
Total Phosphorus (µg/L)	60 - 150	

A-6. North Central Hardwood Forest Ecoregion E. *coli* Standard for Streams (MPCA, 2012)

North Central Hardwood Forest Ecoregion	Chronic	Acute
	Geometric mean of not less than 5 samples within any calendar month	Not more than 10% of all samples taken during any calendar month individually exceed
E. *coli* (cfu/100 ml)	126	1,260

2. WATER QUALITY OF LAKES AND STREAMS

2.1 Christmas Lake Subwatershed

Lake Water Quality: Christmas Lake was the only lake monitored in the Christmas Lake subwatershed and the lake received an A water quality grade in 2013. The Carson's TSI scores for Christmas Lake characterize the lake as oligotrophic. Christmas Lake has clear water and oxygen throughout the hypolimnion. All the NCHF ecoregion water quality standards were met in Christmas Lake in 2013 (Table 1).

Table 1. 2013 Lake Grades, Mean Summer Surface Parameters and TSI Values for lakes in the Christmas Lake Subwatershed

Lake Grade	Lake	Mean SECC (m)	Mean CHLA (µg/L)	Mean TP (µg/L)	TSI
May-Sept		**June-Sept**			
A	Christmas	6.21	1.75	11.44	34

Lake Chloride: The chloride concentrations in Christmas Lake ranged between 32.6 mg/L and 39.4 mg/L throughout the open waters season in 2013. None of the concentrations exceeded the acute and chronic chloride standard.

Stream Water Quality: Water quality in Christmas Creek was generally good at the inlet of Christmas Lake (CCH02) for Temperature and TSS when compared to MPCA's ecoregion guidelines for the North Central Hardwood Forest Ecoregion. TP mean was outside of the water quality streams guidelines with a mean concentration of 237 µg/L. The Christmas Lake outlet (CCH01) to the creek was sampled only four times late June through July before lake levels dropped below the weir and the creek remained dry for the remainder of the sampling season. The mean temperature was high compared to the MPCA's stream guidelines at 23.9 °C. The mean TSS and TP met the MPCA's guidelines. Annual loading results for TSS, TP, and chloride were increased at CCH02 from the previous year. Unable to calculate annual loading at CCH01 due to lack of sufficient amount of data points.

Stream Dissolved Oxygen: Christmas Creek's dissolved oxygen (DO) concentrations were generally above the Minnesota State Standards (MN 7050) for the inlet site (CCH02) and outlet (CCH01) (Table 2).

Stream Discharge: Time-weighted flow in the Christmas Creek inlet (CCH02) was 0.28 cfs and 1.17 cfs for the outlet (CCH02) (Table 3). Drought conditions resulted in stagnant or no flow situations for both the Lake's stream inlet and outlet.

Table 2. Summer Dry-Weather DO Profiles in Christmas Lake Subwatershed Streams

	Christmas, Christmas Outlet	Christmas, Christmas Inlet
6/3/2013		6.39
6/10/2013		10.05
6/17/2013		6.15
6/24/2013	8.05	5.3
7/1/2013	7.96	5.97
7/8/2013		5.98
7/15/2013	9.52	6.15
7/22/2013	6.09	5.41
8/5/2013		5.35

Note: Blank spaces indicate no data collected and green font indicates less than 5 mg/L DO standards

Table 3. 2013 Concentration and Load for Christmas Subwatershed Stream Sites

				Flow-Weighted Mean Concentration					Load (pound)				
Station	Creek	Contributing Watershed Area (sq. mi.)	Average Flow (cfs)	TP (µg/L)	SRP (µg/L)	TN (mg/L)	TSS (mg/L)	Cl (mg/L)	TP	SRP	TN	1000 lbs TSS	1000 lbs CL
CCH01	Christmas	1.17	0.36	16.62	0.00		0.30		12	0.00		0	
CCH02	Christmas	0.28	0.22	114.8	108.6	1.0	3.9	26.5	49	46	435	2	11

2.2 Dutch Lake Subwatershed

Lake Water Quality: Dutch Lake Subwatershed has one monitored lake in 2013 – Dutch Lake. Dutch Lake received a D water quality lake grade indicating the recreational activity may be undesirable at certain times of the year (Table 4). The productivity state in Dutch Lake is eutrophic which means there is high probability in extensive algae (blue greens) and aquatic plant issues. In 2013, all three NCHF ecoregion water quality standards for deep lakes were not met in Dutch Lake (Table 4).

Table 4. 2013 Lake Grades, Mean Summer Surface Parameters and TSI Values for lakes in the Dutch Lake Subwatershed (Red indicates the parameter did not meet the Standard)

Lake Grade	Lake	Mean SECC (m)	Mean CHLA (µg/L)	Mean TP (µg/L)	TSI
May-Sept		June-Sept			
D	Dutch	0.77	62.31	81.13	68

Lake Chloride: The chloride concentrations in Dutch Lake ranged between 31.9 mg/L and 43.9 mg/L throughout the open waters season in 2013. None of the concentrations exceeded the acute and chronic chloride standard.

Stream Water Quality: Water quality in Dutch Creek inlet (CDU02) and outlet (CDU01) was generally good for Temperature and TSS when compared to MPCA's ecoregion guidelines for the North Central Hardwood Forest Ecoregion. CDU01 was below the TP guideline with a mean concentration of 106 µg/L, but CDU02 exceeded with a concentration of 413 µg/L. Annual loading results for TSS, TP, and chloride were exceeded from the previous year at CDU01. Annual loading at CDU02 was reduced for TSS and Chloride, while TP was increased from the previous year.

Stream Dissolved Oxygen: Dutch Creek's dissolved oxygen (DO) concentrations were generally below the Minnesota State Standards (MN 7050) at CDU01 and CDU02 (Table 5).

Stream Discharge: Time-weighted flow in Dutch Creek (CDU02, CDU01) was 0.99 cfs and 1.51, respectively (Table 6). CDU02 and CDU01 had flowing water throughout the season.

Table 5. Summer Dry-Weather DO Profiles in Dutch Lake Subwatershed Streams

	Dutch, Dutch Outlet	Dutch, Dutch Inlet
6/4/2013	5.56	2.84
6/11/2013	7.41	2.38
6/18/2013	4.93	1.38
6/24/2013	2.15	0.87
7/1/2013	2.78	0.82
7/8/2013	3.22	2.1
7/15/2013	3.87	1.42
7/22/2013	2.97	1.42
7/29/2013	4.57	2.82
8/5/2013	4.23	
8/12/2013	3.36	
8/19/2013	3.76	
8/27/2013	3.93	
9/4/2013	6.36	
9/10/2013	4.29	
9/25/2013	6.08	

Note: Blank spaces indicate no data collected and green font indicates less than 5 mg/L DO standards

Table 6. 2013 Concentration and Load for Dutch Lake Subwatershed Stream Sites

				Flow-Weighted Mean Concentration					Load (pound)				
Station	Creek	Contributing Watershed Area (sq. mi.)	Average Flow (cfs)	TP (µg/L)	SRP (µg/L)	TN (mg/L)	TSS (mg/L)	Cl (mg/L)	TP	SRP	TN	1000 lbs TSS	1000 lbs CL
CDU01	Dutch	2.95	1.51	66.0	28.0	0.7	7.5	28.8	197	83	2228	22	86
CDU02	Dutch	1.41	0.99	226.0	155.1	0.5	2.6	11.9	441	303	921	5	23

2.3 Gleason Lake Subwatershed

Lake Water Quality: Gleason Lake was the only lake monitored in the Gleason Lake Subwatershed in 2013 (Table 7). Gleason Lake received a C water quality grade indicating the recreational activities may be undesirable at certain times of the year due to occasional algae blooms and coontail overgrowth. Four years ago, Gleason Lake productivity was on the high end of eutrophic scale. The productivity state in 2013 is still eutrophic, but on the middle range of the scale. Eutrophic state means there is high probability in extensive algae and aquatic plant issues. Gleason Lake did not meet two of the three NCHF ecoregion water quality standards for shallow lakes in 2013 (Table 7).

Table 7. 2013 Lake Grades, Mean Summer Surface Parameters and TSI Values for lakes in the Gleason Lake Subwatershed (Red indicates the parameter did not meet the Standard)

Lake Grade	Lake	Mean SECC (m)	Mean CHLA (µg/L)	Mean TP (µg/L)	TSI
May-Sept		**June-Sept**			
C	Gleason *	1.68	24.00	**67.75**	60

* Shallow lake with a maximum depth less than 15 ft. or has a littoral area that is greater than 80 percent

Lake Chloride: The chloride concentrations in Gleason Lake ranged between 96.4 mg/L and 126 mg/L throughout the open waters season in 2013. None of the concentrations exceeded the acute and chronic chloride standard.

Stream Water Quality: Water quality in Gleason Lake Stream inlet (CGL03) was generally good for Temperature and TSS when compared to MPCA's ecoregion guidelines for the North Central Hardwood Forest Ecoregion. The TP for this location was slightly higher than the range with a mean concentration of 165 µg/L. The lake outlet (CGL01) was within the range for Temperature, TSS and TP. The stream's outlet at I-394 (CGL04) was in range for Temperature and TSS, but exceeded the TP guideline with a mean concentration of 176 µg/L. Annual loading results for TSS, TP, and chloride were increased at CGL03 and CGL01. CGL04 was increased in TP and TSS, but was decreased for Cl from the previous year.

Stream Dissolved Oxygen: Gleason Lake Creek's dissolved oxygen (DO) concentrations were generally above the Minnesota State Standards (MN 7050) at CGL03. Half of CGL01 and the majority at CGL04 were below the standard (Table 8).

Stream Discharge: Time-weighted flow in Gleason Lake Creek (CGL01, CGLO3, and CGL04) was 0.89 cfs, 1.70 cfs and 0.89 cfs, respectively (Table 9). CGL01 had flow through the end of August. CGL03 and CGL04 went dry or stagnant in August, but had flow start again in October.

Table 8. Summer Dry-Weather DO Profiles in Gleason Lake Subwatershed Streams

	Gleason, Gleason Lake Outlet	Gleason, Gleason Inlet	Gleason, Gleason Outlet 394
6/4/2013	9.4	6.52	6.81
6/12/2013	12.88	9.08	9.17
6/19/2013	10.04	6.54	4.68
6/26/2013	5.98	4.64	0.39
7/2/2013	5.05	5.51	0.82
7/9/2013	2.21	5.66	1.47
7/16/2013	3.67	7.58	0.39
7/23/2013	0.94	5.49	1.17
7/30/2013	3.52	5.58	1.77
8/6/2013	5.81	7.29	6.12
8/14/2013	4.65	6.91	2.47
8/21/2013		8.21	0.95

Note: Blank spaces indicate no data collected and green font indicates less than 5 mg/L DO standards

Table 9. 2013 Concentration and Load for Gleason Lake Subwatershed Stream Sites

				Flow-Weighted Mean Concentration					Load (pound)				
Station	Creek	Contributing Watershed Area (sq.mi.)	Average Flow (cfs)	TP (µg/L)	SRP (µg/L)	TN (mg/L)	TSS (mg/L)	Cl (mg/L)	TP	SRP	TN	1000 lbs TSS	1000 lbs CL
CGL03	Gleason	2.56	1.70	91.0	46.4	0.4	8.6	72.5	305	155	1371	29	242
CGL01	Gleason	4.07	0.89	26.0	4.1	0.2	4.8	54.6	46	7	293	9	96
CGL04	Gleason	0.52	0.89	109.4	33.8	0.3	5.3	86.4	191	59	463	9	151

2.4 Lake Minnetonka Subwatershed

Lake Water Quality: Water quality grades for the bays/lakes in the Lake Minnetonka Subwatershed are presented in Table 10. Thirteen bays on Lake Minnetonka received an A water quality lake grade (including A-) in 2013. Majority of the eastern bays on Lake Minnetonka as well as Crystal Bay, Lafayette Bay, Carman Bay, Spring Park Bay, Phelps Bay and Smithtown Bay have crystal clear water with little to no algae issues that could inhibit recreational activity. The Carson's TSI scores indicate that thirteen bays had mesotrophic characteristics in 2013 - moderately clear water, but increased chance of anoxia in the hypolimnion (Table 10). All thirteen bays met the NCHF ecoregion water quality standards for deep lakes in 2013.

Four bays on Lake Minnetonka received a B water quality grade (including B+ to B-) in 2013. Black Lake, Cooks Bay, and West Upper Lake are located in Mound, Minnetrista and Spring Park. North Arm is located in Orono. These bays/lakes usually have clear water except near the end of the summer when algae may limit recreational activities. Cooks and West Upper bays had mesotrophic characteristics in 2013, according to the TSI scores (Table 10), where Black Lake and North Arm had eutrophic characteristics indicating decreased water clarity and anoxia in the hypolimnia throughout the summer, and evident aquatic plant issues (Table 10). All four waterbodies met all three NCHF ecoregion water quality standards in 2013.

Peavey Lake was the only monitored eastern bay on Lake Minnetonka to receive a C water quality grade which indicates recreational activity may not be desirable. Peavey is considered eutrophic with a TSI score of 60. This lake has extensive algae and aquatic plants problems (Table 10). In 2013, the mean total phosphorus concentrations in Peavey Lake did not meet the NCHF ecoregion water quality standard (Table 10).

Harrisons Bay, Maxwell Bay, Priests Bay, and West Arm on Lake Minnetonka are located in the west and northwest area of the lake also received a C (including C+ and C-) water quality lake grade in 2013. A C water quality grade indicates that recreational activity may not be desirable. Based on the TSI scores, these four bays are eutrophic (Table 10). Eutrophic lakes are considered

productive which often leads to high algal biomass, decreased water clarity, problems with aquatic plants and anoxia hypolimnia during the summer. Blue green algae may be dominant in these bays. The mean chlorophyll-*a* concentrations in Maxwell Bay did not meet the NCHF ecoregion standard in 2013 (Table 10). Priest Bay did not meet two of the three NCHF ecoregion water quality standards and Harrisons Bay and West Arm did not meet all three in 2013.

Forest Lake, Halsted Bay, Jennings Bay, and Stubbs Bay on Lake Minnetonka are located in the west and northwest area of the lake and received a D (including D+) water quality lake grade. These bays are classified as having severe algae problems that inhibit recreational activity. Based on the TSI scores, these 4 bays are considered eutrophic (Table 10). Eutrophic waterbodies have large algal blooms, mostly blue greens, which lead to light limitations and reduce aquatic plant growth. All 4 bays did not meet any of the three NCHF ecoregion water quality standards in 2013 (Table 10).

Lake William did not receive a water quality grade in 2013, because during one or more of the monitoring events the Secchi disk was visible at the bottom of the lake and/or obstructed by vegetation. These lakes are eutrophic with TSI score of 53. Eutrophic lakes are considered productive which often leads to high algal biomass, decreased transparency, issues with aquatic plants and low dissolved oxygen in the hypolimnion. Lake William met 2 of the three NCHF ecoregion water quality standards for shallow lakes in 2013 (Table 11).

Table 10. 2013 Lake Grades, Mean Summer Surface Parameters and TSI Values for the lakes in the Lake Minnetonka Subwatershed (Red indicates the parameter did not meet the Standard)

Lake Grade	Lake/Bay	Mean SECC (m)	Mean CHLA (µg/L)	Mean TP (µg/L)	TSI
May-Sept		**June-Sept**			
A	Grays	4.56	2.88	15.38	41
A	Carman	4.32	3.06	14.81	41
A	Lower Lake South	5.20	3.75	15.00	41
A	Lafayette	4.65	3.44	14.88	41
A	Lower Lake North	4.98	3.38	16.88	41
A	St. Albans	4.31	2.94	16.13	41
A	Gideon	5.04	4.06	15.31	42
A	Wayzata	4.77	3.50	16.88	42
A	Spring Park	4.03	3.25	16.25	42
A	Crystal	3.91	4.06	18.06	44
A	Phelps	3.77	3.75	20.50	44
A	Carsons	4.04	4.50	20.75	44
A	Smithtown	3.43	4.29	18.50	44
B+	West Upper	2.70	5.13	17.75	46
B+	Cooks	2.16	8.57	19.63	49
B+	North Arm	2.66	7.88	30.25	50
B-	Black	2.14	9.75	27.75	51
C+	Maxwell	1.65	14.69	37.69	55
C	Priests	1.31	23.25	30.31	57
C	Peavey	1.78	9.75	129.38	60
C	Harrisons	1.14	34.13	42.50	61
C-	West Arm	1.36	51.13	76.13	64
D+	Forest	1.06	44.94	61.00	63
D+	Jennings	1.04	58.00	140.19	68
D	Stubbs	0.96	56.38	80.25	66
D	Halsted	0.90	62.88	108.38	68

Table 11. Shallow lakes in Minnetonka Subwatershed: (maximum depth less than 15 ft. or that have a littoral area is greater than 80 percent)

Lake Grade	Lake	Mean Secchi Depth (m)	Mean Chlorophyll (µg/L)	Mean Total Phosphorus (µg/L)	TSI
May-Sept		**June-Sept**			
N/A	**William Lake****	*	5.25	43.38	53

* = There was insufficient data to calculate a mean; ** = Volunteer Lake Monitor;
N/A = insufficient data to calculate the Lake Grade

Lake Chloride: All the lakes and bays in the Lake Minnetonka Subwatershed except for Peavey Lake have chloride concentrations that range between 30 mg/L and 65 mg/L. The chloride levels in Peavey Lake exceeded the chloride chronic standard in June 2013 with concentrations at 256 mg/L.

Stream Water Quality: Water quality in Classen Creek is generally good at the four monitoring sites (CCL04, CCL01, CFO01 & CST01) for Temperature and TSS when compared to MPCA's ecoregion guidelines for the North Central Hardwood Forest Ecoregion. TP mean was outside of the water quality streams guidelines for all of the sites with the highest mean being shared by CFO01 and CST01 at 366 μg/L. Annual loading results for TSS, TP, and chloride were increased at all locations from the previous year.

Stream Dissolved Oxygen: The dissolved oxygen (DO) concentrations at CCL01 was above the Minnesota State Standards (MN 7050). Half of the concentrations at CCL04 were above the standard and the majority of the concentrations at CFO01 and CST01 were below. (Table 12).

Stream Discharge: Time-weighted flow in Classen Creek (CCL01, CCL04 & CST01) was 0.63 cfs, 0.87 cfs, and 031 cfs, respectively, and flow from Forest Lake inlet was 0.39 cfs (Table 13). Stagnant or no flow situations for CCL01, CCL04 and CFO01 began in mid-August and CST01 was stagnant end of June.

Table 12. Summer Dry-Weather DO Profiles in Minnetonka Subwatershed Streams

	Minnetonka, Classen: Watertown Rd	Minnetonka, Classen: Bayside	Minnetonka, Stubbs Bay	Minnetonka, Forest Lk Creek
6/4/2013	5.8	8.01	1.87	3.74
6/12/2013	6.83	11.11	3.01	3.85
6/18/2013				3.29
6/19/2013	5.37	8.33	1.45	
6/26/2013	3.04	7.07	0.28	1.75
7/1/2013				2.56
7/2/2013	3.98	7.75		
7/9/2013	4.68	7.19		
7/15/2013				3.28
7/16/2013	5.13	8.82		
7/22/2013				2.51
7/23/2013	4.54	7.18		
7/30/2013	4.51	8.99		
8/6/2013	6.16	9.37		8.64
8/13/2013	5	12.17		6

Note: Blank spaces indicate no data collected and green font indicates less than 5 mg/L DO standards

Table 13. 2013 Concentration and Load for Minnetonka Subwatershed Stream Sites

				Flow-Weighted Mean Concentration					Load (pound)				
Station	Creek	Contributing Watershed Area (sq. mi.)	Average Flow (cfs)	TP (µg/L)	SRP (µg/L)	TN (mg/L)	TSS (mg/L)	Cl (mg/L)	TP	SRP	TN	1000 lbs TSS	1000 lbs CL
CFO01	Forest	1.00	0.39	209.1	151.9	1.1	2.6	37.9	161	117	825	2	29
CCL04	Classen	1.24	0.87	150.6	97.0	1.3	3.0	38.4	257	165	2224	5	65
CCL01	Classen	1.55	0.63	148.3	95.0	1.6	14.7	36.8	183	117	1922	18	45
CST01	Stubbs Inlet	0.79	0.31	139.0	121.0	1.1	1.8	20.8	86	75	661	1	13

Grays Bay Dam: Lake Minnetonka Elevation and Discharge: MCWD's policy is to operate the Grays Bay Dam to reduce flooding both on Minnehaha Creek and Lake Minnetonka. This is accomplished by controlling the discharge from Lake Minnetonka to Minnehaha Creek. Normally the dam is not operated until all ice is off the lake and the lake's water level is above 928.6 feet above mean sea level (FAMSL). MCWD staff began operation of the Grays Bay Dam on May 6, 2013 with an elevation of 928.81 FAMSL and discharging water at 12 cfs. The lake elevation at ice-out on May 2, 2012 was 928.74 FAMSL and the dam was releasing 0 cfs at this

date. Grays Bay Dam was discharging 12 cfs to 75 cfs May 6, 2013 until June 21, 2013. The discharge was then increased with the Dam releasing water at a range of 150 cfs to 300 cfs through the first week of August. Discharge was lowered to 100 cfs on August 9, 2013 and continued to be gradually reduced until the Dam was closed on October 28, 2013. The latest lake elevation reading was taken on November 18, 2013 at 928.54 FAMSL (Figure 4).

During the 2013 period of record, the average lake elevation was 929.26 FAMSL with an overall fluctuation of 1.6 feet. Annual lake evaporation in the vicinity is normally about 31 inches.

The calculated discharge (time weighted flow) over the Grays Bay dam was 39.1 cfs over the entire open water season, which is equivalent to 4.31 inches of runoff from the 123-square mile area of upper watershed (23 year average = 4.47 inches) (Figure 5). Comparatively, the calculated flow at Browndale Dam in Edina, 11 miles downstream from Grays Bay Dam was 45.95 cfs (Figure 6).

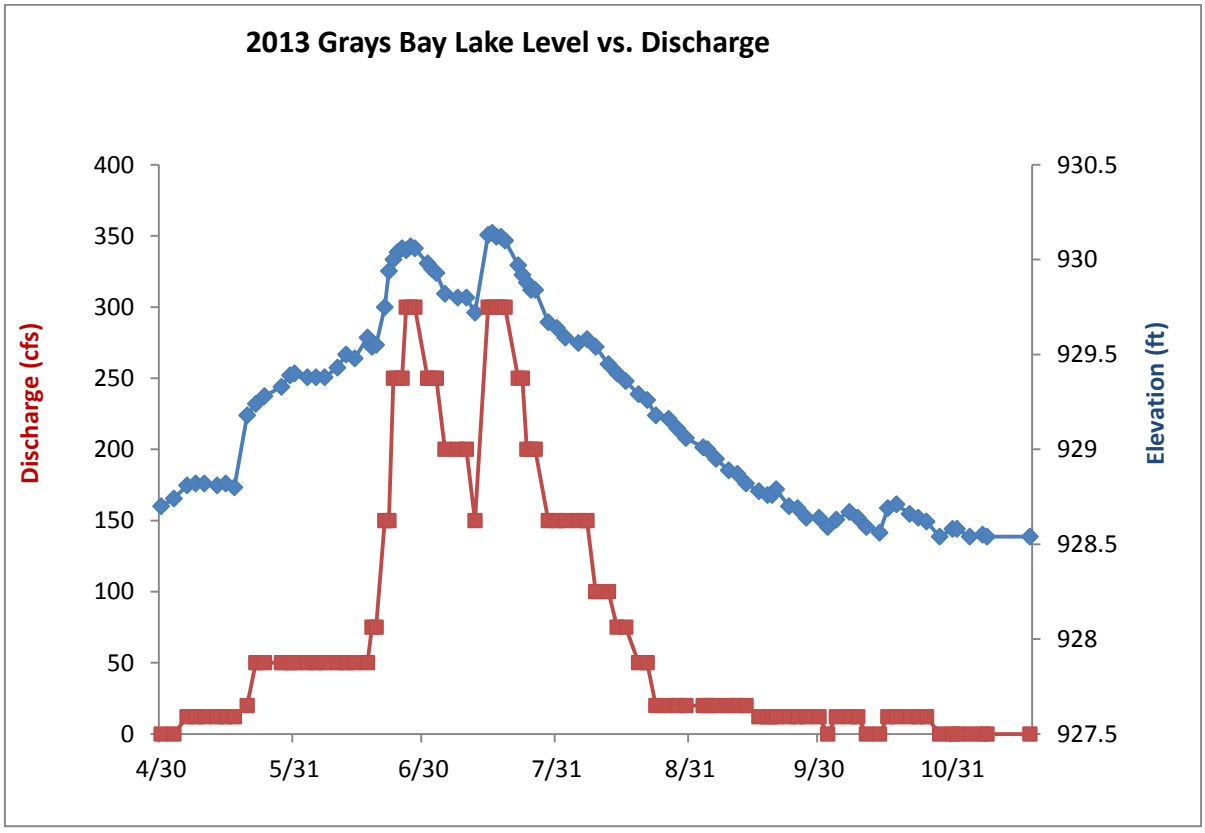

Figure 4. Lake Minnetonka Elevation (above mean sea level) and Grays Bay Dam Discharge During 2013 Open-Water Conditions Lake Elevation (diamonds) and Discharge (squares).
Note: Run Out Elevation is 929.75 feet; 100-year flood elevation is 931.5 feet

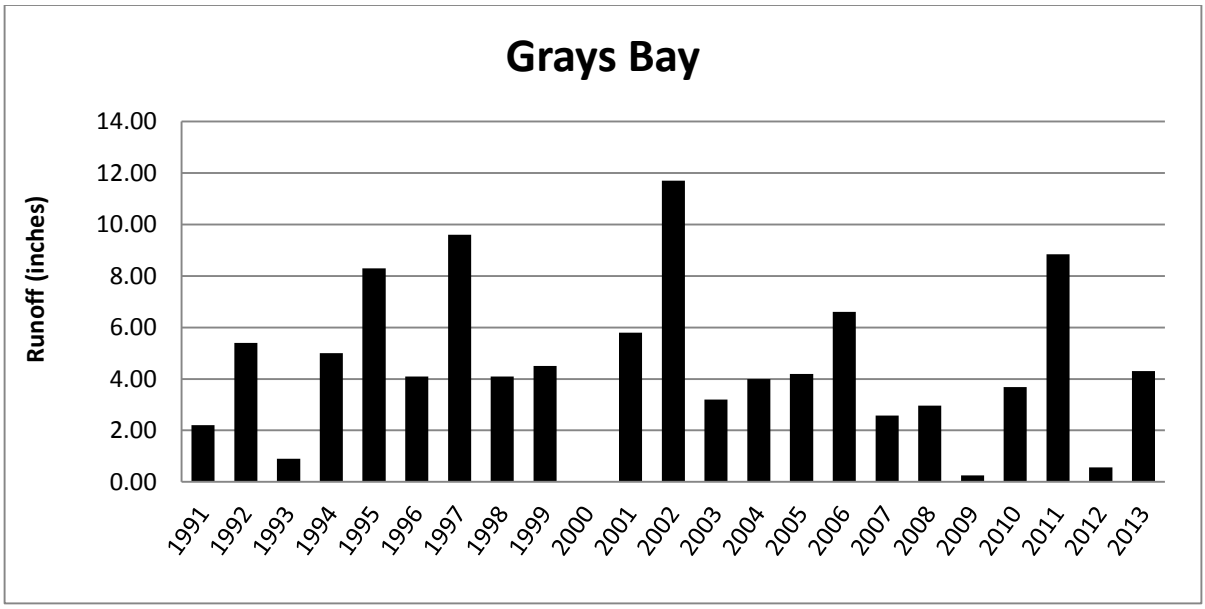

Figure 5. Upper Watershed Runoff Calculated from Grays Bay Dam Discharge Setting, 1991 to 2013 (average = 4.31 inches)

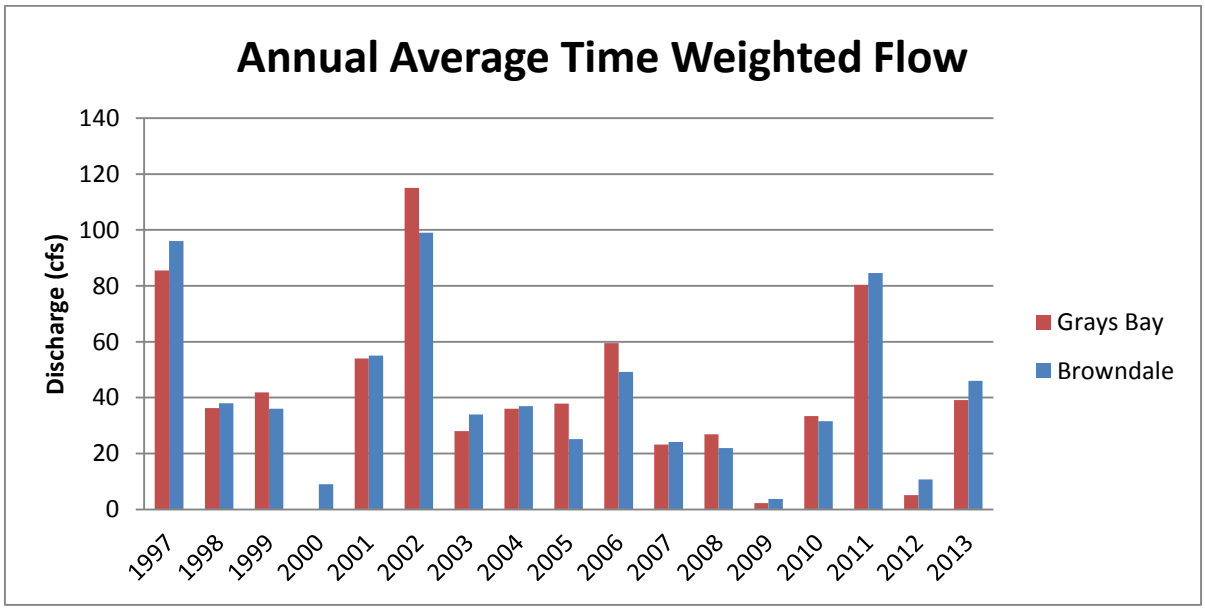

Figure 6. Annual Average Time Weighted Flow at Grays Bay Dam and Browndale Dam

2.5 Lake Virginia Subwatershed

Lake Water Quality: Water quality grades for the water bodies in the Lake Virginia Subwatershed are presented in Table 14. Lake Minnewashta as well as the South Bay site on Lake Minnewashta (monitored by CAMP) received a B water quality grade in 2013. The South Bay site is not at the deepest location on the lake. Lake Minnewashta and the South Bay site both received a TSI score of 51. Both monitoring locations indicate that Lake Minnewashta is on the low end of the scale for the eutrophic state meaning that there is decreased transparency and potential for anoxic hypolimnia during the summer. Macrophyte problems are also evident. Lake Minnewashta meet all three NCHF ecoregion standards in 2013 where the Lake Minnewashta, South Bay, did not meet the NCHF ecoregion chlorophyll-a standard (Table 14).

Tamarack Lake received a B- water quality lake grade in 2013. A B- water quality lake grade indicates the lake has decent water quality until the end of the summer when algae blooms may inhibit recreational activity. The TSI score for Tamarack Lake characterizes the lake as in a eutrophic state meaning there may be decreased clarity in the epilimnion and anoxic conditions in the hypolimnion during the summer. Tamarack Lake did not meet the NCHF ecoregion chlorophyll-a standard for deep lakes in 2013.

Lake Virginia received a C- water quality grade indicating the recreational activity maybe undesirable at certain times of the year. The productivity state in Lake Virginia is eutrophic which means there is a high probability of extensive algae and aquatic plant issues. In 2013, all three NCHF ecoregion water quality standards for deep lakes were not met in Lake Virginia (Table 14).

Lake St. Joes did not receive a water quality lake grade and TSI score due to insufficient data collected in 2013.

Table 14. 2013 Lake Grades, Mean Summer Surface Parameters and TSI Values for lakes in the Lake Virginia Subwatershed (Red indicates the parameter did not meet the Standard)

Lake Grade	Lake	Mean SECC (m)	Mean CHLA (µg/L)	Mean TP (µg/L)	TSI
May-Sept		June-Sept			
B	Minnewashta	1.81	10.38	22.63	51
B	Minnewashta, South Bay	2.50	24.24	17.05	51
N/A	St. Joe				N/A
B-	Tamarack	2.10	17.00	39.00	55
C-	Virginia	1.19	51.25	60.75	63

Lake Chloride: Chloride was not monitored in St. Joe Lake in 2013. The chloride concentrations in the lakes of the Lake Virginia Subwatershed did not exceed the chloride standard in 2013. The chloride concentrations ranged between 32 mg/L and 61 mg/L.

Stream Water Quality: Water quality in Minnewashta Creek was generally good at the outlet of Lake Minnewashta (CMW02) for Temperature, TSS, and TP when compared to MPCA's ecoregion guidelines for the North Central Hardwood Forest Ecoregion. Annual loading results for TSS, TP, and chloride were increased at CMW02 from the previous year.

Stream Dissolved Oxygen: Minnewashta Creek's dissolved oxygen (DO) concentrations were above the Minnesota State Standards (MN 7050) (Table 15).

Stream Discharge: Time-weighted flow in the Minnewashta Creek outlet (CMW02) was 1.34 cfs (Table 16). Drought conditions resulted in stagnant or no flow situations the end of August and remained this way for the remainder of the season.

Table 15. Summer Dry-Weather DO Profiles in Lake Virginia Subwatershed Stream

	Virginia, Minnewashta Outlet
6/3/2013	10.08
6/10/2013	12.27
6/17/2013	11.4
6/24/2013	8.48
7/1/2013	7.27
7/8/2013	7.24
7/15/2013	9.16
7/22/2013	6.8
7/29/2013	7.08
8/5/2013	8.2
8/12/2013	7.99
8/19/2013	8.89

Note: Blank spaces indicate no data collected and green font indicates less than 5 mg/L DO standards

Table 16. 2013 Concentration and Load for Lake Virginia Subwatershed Stream Sites

				Flow-Weighted Mean Concentration					Load (pound)				
Station	Creek	Contributing Watershed Area (sq. mi.)	Average Flow (cfs)	TP (µg/L)	SRP (µg/L)	TN (mg/L)	TSS (mg/L)	Cl (mg/L)	TP	SRP	TN	1000 lbs TSS	1000 lbs CL
CMW02	Minnewashta	4.81	1.34	12.4	0.0	0.4	4.4	42.4	33	0.0	1093	12	112

2.6 Langdon Lake Subwatershed

Lake Water Quality: Langdon Lake Subwatershed had only one lake monitored in 2013 – Langdon Lake. Langdon Lake received a D- water quality lake grade in 2013. D water quality lake grade indicates the recreational activity may be undesirable at certain times of the year due to algae blooms (Table 17). The productivity state in Langdon Lake was hypereutrophic in 2013. Frequent, large algae blooms (blue greens) and dense aquatic plant beds that lead to severe light limitations are common in hypereutrophic lakes. In 2013, all three NCHF ecoregion water quality standards for deep lakes were not met in Langdon Lake (Table 17).

Table 17. 2013 Lake Grades, Mean Summer Surface Parameters and TSI Values for lakes in the Langdon Lake Subwatershed (Red indicates the parameter did not meet the Standard)

Lake Grade	Lake	Mean SECC (m)	Mean CHLA (µg/L)	Mean TP (µg/L)	TSI
May-Sept		June-Sept			
D-	Langdon	0.50	87.11	122.38	73

Lake Chloride: The chloride concentrations in Langdon Lake ranged between 55.30 mg/L and 63.90 mg/L throughout the open waters season in 2013. None of the concentrations exceeded the acute and chronic chloride standard.

Stream Water Quality: Water quality in Langdon Creek inlet (CLA02) and outlet (CLA01) was generally good for Temperature and TP when compared to MPCA's ecoregion guidelines for the North Central Hardwood Forest Ecoregion. TSS was high at CLA01 with a means of 20.8 mg/L, but CLA02 was within the guidelines. Annual loading results for CLA01 for TP and TSS were increased when compared to the previous year. CLA02 TP was also increased from the previous year. Comparisons could not be made from the previous year for CLA02 for TSS and chloride and CLA01 for chloride due to insufficient data in 2012.

Stream Dissolved Oxygen: Langdon Creek's dissolved oxygen (DO) concentrations were generally above the Minnesota State Standards (MN 7050). Both the inlet and outlet were dry or stagnant by August (Table 18).

Stream Discharge: Time-weighted flow in Langdon Creek (CLA02, CLA01) was 0.36 cfs and 1.65 cfs, respectively (Table 19).

Table 18. Summer Dry-Weather DO Profiles in Langdon Lake Subwatershed Streams

	Langdon, Langdon Inlet	Langdon, Hwy 110
6/3/2013	5.71	
6/4/2013		6.38
6/11/2013		11.43
6/18/2013		9.03
6/24/2013	6.95	7.62
7/1/2013	4.65	11.02
7/8/2013		9.67
7/15/2013	8.45	13.46
7/22/2013	5.88	9.77
7/29/2013		10.22
8/5/2013	10.55	8.16
8/12/2013		5.78
8/19/2013		2.02

Note: Blank spaces indicate no data collected and green font indicates less than 5 mg/L DO standards

Table 19. 2013 Concentration and Load for Langdon Lake Subwatershed Stream Sites

				Flow-Weighted Mean Concentration					Load (pound)				
Station	Creek	Contributing Watershed Area (sq. mi.)	Average Flow (cfs)	TP (µg/L)	SRP (µg/L)	TN (mg/L)	TSS (mg/L)	Cl (mg/L)	TP	SRP	TN	1000 lbs TSS	1000 lbs CL
CLA02	Langdon	0.92	0.36	20.0	9.9	0.0	0.1	0.4	14	7	4	0	0
CLA01	Langdon	1.65	0.63	83.2	0.8	0.9	19.3	81.8	103	1.0	1148	24	101

2.7 Long Lake Creek Subwatershed

Lake Water Quality: The water quality grades for Long Lake Subwatershed in 2013 are presented in Table 20. Lydiard Lake received an A- water quality grade. This lake is crystal clear throughout the season, although lily pads and a fringe wetland have been encroaching on the open water. The TSI score for Lydiard Lake is 47 classifying the lake as mesotrophic. All three NCHF ecoregion water quality standards were met in Lydiard Lake in 2013 (Table 20).

Dickey's, Long and Mooney Lakes received a C (including C-) water quality lake grade. Lakes that receive a C indicate the recreational activity may be undesirable at certain times of the year (Table 20). The productivity state in these three lakes was eutrophic which means there is a high probability of extensive algae and aquatic plant issues. Dickey's Lake did not meet the NCHF ecoregion chlorophyll-*a* and total phosphorus standards in 2013. Long Lake did not meet any of the three NCHF ecoregion water quality standards in 2013. Mooney Lake did not meet the NCHF ecoregion Secchi depth and chlorophyll-*a* standards in 2013 (Table 20).

Tanager Lake received a D water quality lake grade in 2013. Tanager Lake is the last lake in the Long Lake Subwatershed before flowing into Lake Minnetonka. This lake has severe algae problems which limits recreational activities. The productivity state for Tanager Lake was eutrophic in 2013, which means there is high probability for extensive algae and aquatic plant issues. Extensive blue green algae and macrophyte problems may exist. Tanager Lake did not meet any of the three NCHF ecoregion water quality standards in 2013 (Table 20).

Table 20. 2013 Lake Grades, Mean Summer Surface Parameters and TSI Values for lakes in the Long Lake Creek Subwatershed (Red indicates the parameter did not meet the Standard)

Lake Grade	Lake	Mean SECC (m)	Mean CHLA (µg/L)	Mean TP (µg/L)	TSI
May-Sept		June-Sept			
A-	Lydiard*	2.73	10	13.88	47
C	Dickey's*	2.13	14.25	48	55
C	Long	1.38	37.50	64.00	62
C-	Mooney *(**)	0.88	25.5	57.75	62
D	Tanager	1.08	69.57	102.25	67

* Volunteer Lake Monitor;

**Shallow lake with a maximum depth less than 15 ft. or has a littoral area that is greater than 80 percent;

Lake Chloride: The chloride concentrations in the lakes of the Long Lake Subwatershed did not exceed the chloride standard in 2013. The chloride concentrations ranged between 29 mg/L and 66 mg/L.

Stream Water Quality: Water quality in Long Lake Creek Subwatershed at the Long Lake outlet (CLO01) and at Brown Rd (CLO03) was generally good for Temperature, TSS, and TP when compared to MPCA's ecoregion guidelines for the North Central Hardwood Forest Ecoregion. A third locations at Co. Rd 6 (CLO05) was also in range for Temperature and TSS, but exceeded the TP guideline with a mean concentration of 254 µg/L. Annual loading results for TSS, TP, and chloride were increased at CLO01 and CLO05 from the previous year. Loading results for TP and chloride were increased at CLO03, but TSS was reduced from the previous year.

Stream Dissolved Oxygen: Long Lake Creek's dissolved oxygen (DO) concentrations were generally above the Minnesota State Standards (MN 7050) for CLO05 and CLO01 (Table 21). CLO03 was below the concentration for the majority of the collections.

Stream Discharge: Time-weighted flow in Long Lake Creek (CLO03, CLO05, and CLO01) was 7.16 cfs, 3.92 cfs and 5.29 cfs, respectively (Table 22). All locations became stagnant or dry late August.

Table 21. Summer Dry-Weather DO Profiles in Long Lake Subwatershed Streams

	Long, Long Lake, Brown Rd	Long, Long Lake Inlet at CR6	Long, Long Lake Outlet
6/4/2013	4.86	6.53	9.18
6/12/2013	5.52	8.95	10.89
6/19/2013	3.84	6.33	13.01
6/26/2013	0.89	3.98	13.97
7/2/2013	0.82	5.52	13.95
7/9/2013	0.3	5.67	10.22
7/16/2013	0.41	6.75	12.72
7/23/2013	0.52	5.4	6.35
7/30/2013	0.58	6.79	8.99
8/6/2013	3.16	6.99	7.24
8/14/2013	3.07	7.59	8.62
8/21/2013			7.37
8/27/2013			6.63

Note: Blank spaces indicate no data collected and green font indicates less than 5 mg/L DO standards

Table 22. 2013 Concentration and Load for Long Lake Subwatershed Stream Sites

				Flow-Weighted Mean Concentration					Load (pound)				
Station	Creek	Contributing Watershed Area (sq. mi.)	Average Flow (cfs)	TP (µg/L)	SRP (µg/L)	TN (mg/L)	TSS (mg/L)	Cl (mg/L)	TP	SRP	TN	1000 lbs TSS	1000 lbs CL
CLO03	Long	6.06	7.16	77.0	37.4	0.7	5.1	41.6	1086	527	9377	71	586
CLO05	Long	11.40	3.92	141.0	94.0	0.8	6.0	24.5	1086	722	6203	47	189
CLO01	Long	10.70	5.29	40.1	4.0	0.8	7.0	44.0	418	41	8825	73	459

2.8 Minnehaha Creek Subwatershed

Lake Water Quality: Water quality grades for the lakes in the Minnehaha Creek Subwatershed are presented in Table 23. Lake Calhoun and Lake Harriet received an A water quality grade (including A-) in 2013. These deep lakes have crystal clear water with little to no algae issues that could inhibit recreational activity. The Carson's TSI scores for these two lakes indicate that the lakes have mesotrophic characteristics – moderately clear water and oxygen depletion in the hypolimnion later in the summer. Lake Calhoun and Lake Harriet met the NCHF ecoregion water quality standards for deep lakes in 2013 (Table 23).

Lake Hiawatha received a B- water quality grade. The water quality is generally clear, but algae can limit swimming activities towards the end of summer. The trophic state index for Hiawatha is on the border between mesotrophic and eutrophic, but the water quality means indicate the lake is more mesotrophic. Lakes in a mesotrophic state have moderately clear water with increasing probability of oxygen depletion occurring in the hypolimnion. Meadowbrook Lake did not receive a lake water quality grade in 2013, because during one or more of the monitoring events the Secchi disk was visible at the bottem of the lake. However, the TSI score for Meadowbrook Lake is within the range of TSI scores calculated for lakes that received a B lake water quality grade. The trophic state for Meadowbrook Lake is eutrophic. Lake Hiawatha did not meet the ecoregion total phosphorus standard for deep lakes in 2013. Meadowbrook Lake met the ecoregion chlorophyll-*a* and total phosphorus standards for shallow lakes in 2013 (Table 23).

Cedar Lake, Lake of the Isles, and Lake Nokomis received a C water quality grade (including C+). The water quality lake grade indicates that these lakes have average water quality. Recreational activities (i.e., swimming, boating, fishing, and etc) are usually not desirable in the early season and algae blooms are common. These three lakes are in a eutrophic state with TSI scores ranging from 54-59. Blue-green algae blooms are common and macrophytes are extensive in the littoral area. Cedar Lake met all three NCHF ecoregion water quality standards for deep lakes in 2013. Lake of the Isles did not meet the ecoregion standards for Secchi depth and

chlorophyll-*a*. Lake Nokomis did meet the ecoregion standards for Secchi depth and total phosphorus in 2013 (Table 23).

Cobblecrest Pond, Pamela, Powderhorn, South Oak, Twin and Windsor lakes received a D (including D+ and D-) water quality grades. These lakes usually have severe algae blooms throughout the open water season. Mother and Windsor lakes did not receive a lake water quality grade, because during one or more of the monitoring events the Secchi disk was visible at the bottle of the lake and/or obstructed by vegetation. However, the TSI score for both lakes are within the range of TSI scores calculated for lakes that received a D lake water quality grade. The trophic state for Mother and Windsor lakes is eutrophic. Cobblecrest, Pamela, South Oak and Windsor lakes are also considered eutrophic based on their TSI scores. Eutrophic lakes are considered productive which often leads to high algal biomass, decreased water clarity, problems with aquatic plants and anoxia hypolimnia during the summer. Powderhorn and Twin lakes are considered hypereutrophic based on the TSI score. Hypereutrophic lakes have extensive algal blooms and dense macrophyte beds. Cobblecrest Pond did not meet the NCHF ecoregion Secchi depth and chlorophyll-*a* standards for shallow lakes in 2013. Pamela Lake did not meet the NCHF ecoregion Secchi depth and total phosphorus standards for shallow lakes. Mother and Windsor lakes did not meet the NCHF ecoregion chlorophyll-*a* and total phosphorus standards for shallow lakes. South Oak, Powderhorn and Twin lakes did not meet all three NCHF ecoregion water quality standards for shallow lakes in 2013 (Table 23).

Diamond Lake and Bass Lake (northwest pond) did not receive a water quality grade in 2013, because during one or more of the monitoring events the Secchi disk was visible at the bottom of the lake and/or obstructed by vegetation. Hannan Lake also did not receive a lake water quality grade in 2013 due to insufficient number of monitoring events. Diamond Lake and Bass Lake (northwest pond) are considered hypereutrophic with a TSI score of 72. Diamond and Bass lakes did not meet the NCHF ecoregion total phosphorus and chlorophyll-*a* standards in 2013 for shallow lakes (Table 23).

Table 23. 2013 Lake Grades, Mean Summer Surface Parameters and TSI Values for the lakes in the Minnehaha Creek Subwatershed (Red indicates the parameter did not meet the Standard)

Lake Grade	Lake	Mean SECC (m)	Mean CHLA (µg/L)	Mean TP (µg/L)	TSI
May-Sept		June-Sept			
A	Calhoun	3.94	3.62	16.75	43
A-	Harriet	3.64	3.56	23.38	45
N/A	Meadowbrook**		3.75	46.00	51
B-	Hiawatha	1.99	8.69	60.14	55
C+	Cedar	1.99	11.15	35.10	54
C+	Isles	1.23	23.49	39.25	59
C+	Nokomis	1.33	18.18	53.00	59
D+	Cobblecrest **	0.64	27.40	55.00	64
D+	Pamela**	0.83	14.50	126.50	65
D	South Oak **	0.70	38.01	76.14	66
N/A	Mother **		43.50	92.25	69
N/A	Windsor **		25.50	147.25	69
D-	Powderhorn **	0.55	47.43	159.88	71
D-	Twin **	0.65	82.12	149.78	72
N/A	Bass (NW pond)**		26.50	213.75	72
N/A	Diamond **		50.04	136.43	72
N/A	Hannan**				

** Shallow lake with a maximum depth less than 15 ft or has a littoral zone that is greater than 80 percent

Lake Chloride: Chloride was not monitored in Cobblecrest, South Oak and Twin lakes in 2013. Bass (northwest pond), Diamond, Isles, Pamela and Powderhorn lakes exceeded the chloride chronic standard in 2013. The exceedances in all five lakes occurred early in the open water season. The rest of the lakes in the Minnehaha Creek Subwatershed had chloride concentrations that ranged between 62 mg/L and 210 mg/L.

Stream Water Quality: Water quality in Minnehaha Creek is generally good when compared to MPCA's ecoregion guidelines for the North Central Hardwood Forest Ecoregion, in which Minnehaha Creek is located. Annual loading results for TP, TSS, and chloride were increased at all locations from the previous year except at site CMH11 where the TSS loading was reduced from the previous year.

Stream Chloride: Chloride levels in Minnehaha Creek are measured to detect the influx of road salts from winter deicing procedures. Levels peaked during the winter and early spring months

in 2013 coinciding with road salt application on surrounding streets. Levels were decreased during the remaining seasons.

Stream Dissolved Oxygen: Dissolved oxygen (DO) concentrations in Minnehaha Creek were generally above the Minnesota State Standards (MN 7050) for most locations except for CMH25, CMH19, CMH02, and CMH11 during the mid to late summer months. (Table 24).

Stream Discharge: Time-weighted flow in Minnehaha Creek ranged from 34.03 cfs (CMH25) to 46.11 cfs (CMH24) (Table 25).

Stream *E. coli*: Data collected for *E. coli* indicates that 7 out of 10 locations on Minnehaha Creek met the requirement of 10% of the values not to exceed 1,260 cfu/100 ml. Exceedances occurred at 21st Ave (CMH24), 28th Ave (CMH18), and Hiawatha Ave. (CMH06) sites (Table 26).

Stream Stormwater Monitoring: Stormwater monitoring equipment was operational at 1 site on Minnehaha Creek. Samples were collected for 1 storm event at the I-494 location. The Browndale Dam site had multiple mechanical errors and was not functioning properly in 2013.

Table 24. Summer Dry-Weather DO Profiles in Minnehaha Creek

	Grays	Mntka Ice Arena	I-494	W 34th	Excelsior	Browndale	W 56th	Xerxes	21st Ave	28th Ave	Hiawatha Ave
6/3/2013	9	7.76	7.48	7.21	8.74	8.86	9.31	8.85	8.63	8.95	8.95
6/10/2013	9.94	7.5	7.13	7.68	8.68	9.01	9.63	9.1	8.85	7.01	8.67
6/17/2013	10.73	7.3	6.68	6.45	7.12	8.22	8.93	8.6	8.42	8.08	9.05
6/25/2013	10.16	6.5	5.1	3.94	4.47	8.78	7.33	7.3	7.43	5.72	7.43
7/1/2013	8.6	5.18	4.47	7.25	4.38	6.1	6.75	6.71	6.88	5.07	6.56
7/10/2013	7.52	3.8	4.02	3.29	3.85	5.4	6.27	6.35	6.34	5.45	6.62
7/16/2013	9.96	8.14	7.19	4.97	5.03	6.6	6.98	7.12	7	6.48	7.3
7/24/2013	7.71	3.6	4.1	2.67	3.5	5.84	6.21	6.36	6.83	6.23	6.71
7/31/2013	8.35	4.51	4.51	4.01	4.65	6.5	6.99	7.25	7.76	7.47	7.78
8/7/2013	8.65	4.57	4.55	3.66	4.5	6.43	7.17	7.29	7.28	6.62	7.65
8/13/2013	10.27	7.36	4.59	4.01	5.22	6.86	7.32	8.1	7.8	9.02	8.26
8/20/2013	8.78	5.23	4.48	4.12	5.37	6.53	7.63	7.21	7.37	7.89	8.19
8/26/2013	7.18	3.45	4.42	3.37	4.29	6.59	6.48	6.32	6.92	7.44	7.24
9/3/2013	8.81	5.1	5.5	6.28	8.49	8.67	9.34	9.22	10.06	7.25	8.45
9/9/2013	7.9	3.74	3.53	3.77	5.73	6.74	6.93	6.63	7.38	6.6	6.54
9/16/2013	8.88	6.71	5.82	6.54	8.06	8.22	8.88	9.17	9.12	7.77	8.65
9/24/2013	9.87	5.96	5.45	7.02	8.11	8.98	9.46	9.53	9.35	10.5	8.85
9/30/2013	9.49	6.39	5.85	8.66	8.51	8.46	8.68	9.04	9.33	9.47	8.35

Note: Blank spaces indicate no data collected and green font indicates less than 5 mg/L DO standards

Table 25. 2013 Concentration and Load for Minnehaha Creek Subwatershed Stream Sites

				Flow-Weighted Mean Concentration					Load (pound)				
Station	Minnehaha Creek Site	Contributing Watershed Area (sq. mi.)	Average Flow (cfs)	TP (µg/L)	SRP (µg/L)	TN (mg/L)	TSS (mg/L)	CL (mg/L)	TP	SRP	TN	1000 lbs TSS	1000 lbs CL
CMH07	Grays Bay Dam	123.23	39.10	9.0	0.0	0.27	1.4	50.5	656	0	21041	105	3892
CMH25	Mntka Ice Arena		34.03	19.7	3.8	0.31	3.2	55.7	1322	255	20967	215	3733
CMH19	I-494	128.69	37.50	24.0	5.0	0.34	6.0	58.0	1763	402	25201	440	4284
CMH02	W 34th St.	136.70	40.88	14.1	32.3	0.43	4.5	57.5	1133	2600	33787	365	4630
CMH11	Excelsior Blvd	139.82	44.93	31.0	13.1	0.39	4.9	71.4	2715	1156	34929	435	6321
CMH03	Browndale Dam	142.05	45.95	35.0	16.0	0.37	3.0	74.5	3197	1479	33817	286	6742
CMH04	W 56th St.	142.85	34.48	36.0	16.0	0.40	4.5	68.0	2415	1074	27100	308	4617
CMH15	Xerxes Ave.		43.01	39.0	18.0	0.48	6.5	85.5	3251	1532	40964	550	7238
CMH24	21st Ave.		46.11	40.0	15.0	0.52	11.3	77.3	3609	1394	47337	1030	7016
CMH18	28th Ave.		41.21	40.0	14.0	0.51	5.2	88.4	3242	1108	40991	424	7172
CMH06	Hiawatha Ave.	170.49	41.18	42.0	14.0	0.63	10.0	86.8	3376	1129	50699	814	7036

Table 26. 2013 Minnehaha Creek *E. coli* (CFU/100ml)

Date	CSI02	CMH07	CMH19	CMH02	CMH11	CMH03	CMH04	CMH15	CMH24	CMH18	CMH06
4/18/2013	23.2		24	30	30	18	18*	31	96	116	68
4/25/2013	1		17	16	16	4	4*	9	28	20	22
5/2/2013	5		40	82	44	52	32	43*	68	110	20
5/9/2013	10	6	55	60	62	32	75	196	146*	40	65
5/16/2013	14	1	104	49	33	6	104	179	67	28*	81
5/23/2013	11	1	33	99	88	69	126	102	192	105	141*
5/30/2013	8	2*	25	125	435	2420	1733	1300	1203	1046	1300
6/6/2013	41	3	18	119	105	172	146	152	205	86	156
6/13/2013		10	26	172	99	687	727	687	1120	548	517
6/20/2013	29	4	16	122	102	64	99	88	125	40	82
6/27/2013	21	8	126	76	99	58	66	91	181*	55	238
7/11/2013	13*	1	17	72	84	125	160	291	488	1733	980
7/18/2013	13	5	70*	99	124	83	127	156	199	74	105
7/25/2013	11	2	36	62*	51	56	114	0	150	34	76
8/1/2013	15	1	40	57	62*	80	131	109	152	47	91
8/8/2013	10	<1.00	167	63	142	142*	248	313	326	488	461
8/15/2013	5	2	86	57	57	91	100*	119	150	40	62
8/22/2013	6	2	78	147	83	75	178	152*	122	33	56
8/29/2013	7	1	82	52	111	161	137	210	2420*	2420	2420
9/5/2013	29	3	91	138	210	114	214	201	2420	246*	291
9/12/2013	16	6	102	142	67	44	135	126	1046	69	154*
9/19/2013	101	11*	108	158	162	62	140	162		816	548
9/26/2013	34	5	238	214	261	46	261	140	387	91	374*
10/3/2013			225	1553	2420	2420	980	1203	2420	2420	2420
10/10/2013		2	139*	248	291	55	96	122	517	102	416
10/17/2013	23	2	158	317*	770	326	461	435	461	687	1046
10/24/2013	6	8	49	59*	110	41	47	219	69	37	184
10/31/2013	2		29	54	503*	921	488	291	770	47	2420

*Duplicate samples that have been averaged

Note: Blank spaces indicate no data collected and red font indicates exceedances greater than 1260 cfu/100 ml. 2420 cfu/100 ml is the highest reporting level obtainable by the method of testing used by TRPD Laboratory. Results reported at 2420 cfu/100 ml may be higher.

2.9 Painter Creek Subwatershed

Lake Water Quality: No lakes were monitored in the Painter Creek Subwatershed throughout 2013.

Stream Water Quality: Water quality in Painters Creek is generally good at the creek intersection with Deborah Dr. & Co. Rd. 6 (CPA03), Co Rd. 26 (CPA04), Painter Dr. (CPA06), West Branch Rd. (CPA01), and Co. Rd. 110 (CPA05) for Temperature and TSS when compared to MPCA's ecoregion guidelines for the North Central Hardwood Forest Ecoregion. Though, all of the five sites exceeded the TP with mean concentrations of 219 µg/L (CPA03), 385 µg/L (CPA04), 390 µg/L (CPA06), 373 µg/L (CPA01), and 355 µg/L (CPA05). Annual loading results for TSS, TP, and chloride were increased at all locations from the previous year.

Stream Dissolved Oxygen: Painters Creek's dissolved oxygen (DO) concentrations were generally below the Minnesota State Standards (MN 7050) for the five locations monitored (Table 27).

Stream Discharge: Time-weighted flow in Painters Creek ranged from 3.86 cfs (CPA03) to 8.35 cfs (CPA01) (Table 28). Flow was decreased by the end of the sampling season, though many of the sites still had minimal flow into October.

Stream *E. coli*: Data is collected for *E. coli* at three of the five Painter Creek monitoring sites (CPA04, CPA01, and CPA05). All three locations met the requirement of 10% of the values not to exceed 1,260 cfu/100 ml. (Table 29).

Table 27. Summer Dry-Weather DO Profiles in Painters Creek Subwatershed Streams

	Painter, CR110	Painter, W Branch	Painter, Painter Creek Dr	Painter, CR26	Painter, Deborah Dr
6/4/2013	4.2	3.08	1.07	0.66	1.59
6/12/2013	6.45	4.48	2.4	1.36	3.07
6/18/2013	3.17	2.29	1.07		
6/19/2013				0.18	1.19
6/24/2013	1.94				
6/26/2013		1.1	0.1	0.35	0.61
7/1/2013	2	1.72	0.64		
7/2/2013				0.22	0.5
7/8/2013	2.37	2.19	1.26		0.85
7/9/2013				0.13	
7/15/2013	2.35	1.93	2.63		0.93
7/16/2013				0.24	
7/22/2013	2.07	1.71			
7/23/2013			0.41	0.28	0.5
7/29/2013			0.54		
7/30/2013	2.82	2.2		0.19	0.68
8/6/2013	3.47	2.69	1.12	0.56	1.64
8/13/2013	4.23	3.02	1.65	0.4	2.34
8/20/2013	3.81	3.07	0.79	0.38	
8/21/2013					1.46
8/27/2013	3.09	2.32	0.24	0.2	1.23
9/4/2013	7.19	6.46	0.29	0.16	3.58
9/10/2013		3.22	0.58		1.81
9/17/2013	5.03	6.01			4.07
9/25/2013		4.2			3.89

Note: Blank spaces indicate no data collected and green font indicates less than 5 mg/L DO standards

Table 28. 2013 Concentration and Load for Painters Creek Subwatershed Stream Sites

				Flow-Weighted Mean Concentration					Load (pound)				
Station	Creek	Contributing Watershed Area (sq. mi.)	Average Flow (cfs)	TP (µg/L)	SRP (µg/L)	TN (mg/L)	TSS (mg/L)	Cl (mg/L)	TP	SRP	TN	1000 lbs TSS	1000 lbs CL
CPA05	Painter	13.52	6.43	215.0	141.0	0.9	14.0	39.4	2721	1783	10796	177	499
CPA01	Painter	13.03	8.35	219.6	145.0	0.9	8.2	47.1	3609	2384	15168	134	774
CPA06	Painter	12.75	7.34	217.0	148.0	0.9	2.4	44.6	3143	2137.5	13162	34	644
CPA04	Painter	12.40	7.27	215.0	161.0	0.8	2.7	41.6	3081	2307	11110	38	596
CPA03	Painter	4.99	3.86	116.0	83.0	0.7	1.5	46.2	879	628	5037	11	351

Table 29. 2013 Painter Creek Subwatershed *E. coli* (CFU/100ml)

Date	CPA01	CPA04	CPA05
4/18/2013	9	4	5
4/25/2013	9	8	13
5/2/2013	9	10	9
5/9/2013	8	12	9
5/16/2013	13	5	13
5/23/2013	30	76	25
5/30/2013	52	53	82
6/6/2013	13	28	50
6/13/2013	85	461*	93
6/20/2013	37	52	34*
6/27/2013	276	770	365
7/11/2013	108	108	78
7/18/2013	261	613	260
7/25/2013	54	102	41
8/1/2013	43	80	37
8/8/2013	102	197	118
8/15/2013	40	70	38
8/22/2013	114	50	131
8/29/2013	98	90	43
9/5/2013	135	24	125
9/12/2013		93	130
9/19/2013	365	18	178
9/26/2013	236		
10/3/2013	574*		
10/10/2013	50		
10/17/2013	96		66
10/24/2013	15		14
10/31/2013	34		17

*Duplicate samples that have been averaged

Note: Blank spaces indicate no data collected and red font indicates exceedances greater than 1260 cfu/100 ml. 2420 cfu/100 ml is the highest reporting level obtainable by the method of testing used by TRPD Laboratory. Results reported at 2420 cfu/100 ml may be higher.

2.10 Schutz Lake Subwatershed

Lake Water Quality: Schutz Lake Subwatershed only has one lake – Schutz Lake. Schutz Lake received a C water quality grade indicating the recreational activity may be undesirable at certain times of the year. The productivity state in Schutz Lake is eutrophic which means there is a high probability of extensive algae and aquatic plant issues. The mean chlorophyll-a concentrations in Schutz Lake did not meet the NCHF ecoregion water quality standard in 2013 (Table 30).

Table 30. 2013 Lake Grades, Mean Summer Surface Parameters and TSI Values for lakes in the Schutz Lake Subwatershed (Red indicates the parameter did not meet the Standard)

Lake Grade	Lake	Mean SECC (m)	Mean CHLA (µg/L)	Mean TP (µg/L)	TSI
C	Schutz	1.67	26.50	34.81	57

Lake Chloride: The chloride concentrations in Schutz Lake ranged between 56.5 mg/L and 65.1 mg/L throughout the open waters season in 2013. None of the concentrations exceeded the acute and chronic chloride standard.

Stream Water Quality: Water quality in Schutz Creek (CSC01) was generally good for Temperature and TSS when compared to MPCA's ecoregion guidelines for the North Central Hardwood Forest Ecoregion. TP was higher than the guidelines at 160 µg/L. Annual loading results for TP, TSS, and chloride were increased at CSC01 from the previous year.

Stream Dissolved Oxygen: The dissolved oxygen (DO) concentrations in Schutz Creek were generally above the Minnesota State Standards (MN 7050) for the entire season (Table 31).

Stream Discharge: Time-weighted flow in the Schutz Creek (CSC01) was 0.81 cfs (Table 32).

Table 31. Summer Dry-Weather DO Profiles in Schutz Lake Subwatershed Stream

	Schutz, Schutz Creek
6/3/2013	7.98
6/4/2013	
6/10/2013	11.4
6/11/2013	
6/17/2013	7.26
6/18/2013	
6/24/2013	6.22
7/1/2013	7.54
7/8/2013	6.86
7/15/2013	7.43
7/22/2013	6.08
7/29/2013	7.22
8/5/2013	6.84
8/12/2013	7.47
8/19/2013	6.87
8/26/2013	5.15
8/27/2013	
9/3/2013	10.92
9/4/2013	
9/9/2013	6.67
9/10/2013	
9/16/2013	8.26
9/17/2013	
9/25/2013	8.64

Note: Blank spaces indicate no data collected and green font indicates less than 5 mg/L DO standards

Table 32. 2013 Concentration and Load for Schutz Subwatershed Stream Sites

				Flow-Weighted Mean Concentration					Load (pound)				
Station	Creek	Contributing Watershed Area (sq. mi.)	Average Flow (cfs)	TP (µg/L)	SRP (µg/L)	TN (mg/L)	TSS (mg/L)	Cl (mg/L)	TP	SRP	TN	1000 lbs TSS	1000 lbs CL
CSC01	Schutz	0.72	0.81	103.0	58.0	1.5	10.2	56.4	165	93	2439	16	90

2.11 Six Mile Marsh Subwatershed

Lake Water Quality: The water quality grades for the lakes in the Six Mile Marsh Subwatershed are presented in Table 33. Zumbra and Stone lakes received an A- water quality grade in 2013. Lakes with an A water quality grade are crystal clear and can be used all season for recreational activities. The TSI score classifies Stone and Zumbra lakes as mesotrophic which means the lake is moderately clear, but there is a greater chance of anoxia in the hypolimnion. In 2013, all three NCHF ecoregion water quality standards for deep lakes were met in Stone and Zumbra lakes (Table 33).

There are seven lakes in the Six Mile Marsh Subwatershed that received a B (including B+ and B-) water quality grade. Lakes that receive a B water quality grade usually have clear water, but in the late summer algae can limit recreation. The TSI score indicates that Wasserman South pond and Piersons Lake are mesotrophic (Table 33). Lakes in a mesotrophic state have moderately clear water with increasing probability of oxygen depletion occurring in the hypolimnion. Steiger, Kelsers, West Auburn and Church lakes have TSI scores that indicate that they are in a eutrophic state. Carl Krey, a shallow lake, is also is in a eutrophic state. Shallow lakes may mix more often providing more nutrients into the water column for the algae, while deep lakes might only mix twice a year. Marsh Lake did not receive a lake water quality grade, because during one or more of the monitoring events the Secchi disk was visible at the bottom of the lake. However, the TSI score for Marsh Lake is within the range of TSI scores calculated for lakes that received a B lake water quality grade. Marsh Lake, another shallow lake, is in a eutrophic state according to the TSI score. Wassermann South pond, Piersons, Carl Krey, Kelsers, and West Auburn lakes met all three NCHF ecoregion water quality standards for deep and shallow lakes in 2013. Marsh Lake met the two of the three NCHF ecoregion water quality standards, and did not have sufficient data to calculate a mean for the secchi depth standard. Steiger Lake did not meet the NCHF ecoregion chlorophyll-*a* standard for deep lakes in 2013. Church Lake did not meet the ecoregion total phosphorus standard for deep lakes (Table 33).

Wassermann North pond, East Auburn and Turbid lakes received a C (including C+ and C-) water quality grade in 2013. The water quality in these lakes may make recreational activity

undesirable at certain times of the year. The TSI score ranges are 53 - 63 indicating that these waterbodies are in a eutrophic state. Waterbodies that are eutrophic have high probability of extensive algae and aquatic plant issues. Lundsten North and Sunny lakes did not receive a lake water quality grade, because during one or more of the monitoring events the Secchi disk was visible at the bottom of the lake and/or obstructed by vegetation. However, the TSI score for both these lakes are within the range of TSI scores calculated for lakes that received a C lake water quality grade. Wassermann North pond met all three NCHF ecoregion water quality standards in 2013. Sunny and Lundsten North lakes met two of the three NCHF ecoregion water quality standards for deep and shallow lakes, and did not have sufficient data to calculate a mean for the secchi depth standard. East Auburn Lake did not meet the ecoregion chlorophyll-*a* and total phosphorus standards. Turbid Lake did not meet all three NCHF ecoregion water quality standards for deep lakes in 2013 (Table 33).

Parley, Mud and Wassermann lakes received a D (including D+ and D-) water quality grade. Severe algae issues dominate lakes that receive a D water quality grade. The TSI scores for Parley and Wassermann lakes fall on the high end of the eutrophic scale which means there is a high probability of extensive algae, like blue-green algae, and aquatic plant issues. In 2013, Mud Lake has a TSI score that indicates it is in a hypereutrophic state. Heavy algal blooms and dense aquatic plant beds are prevalent throughout the summer. Water clarity is severely limited. All three lakes did not meet all three NCHF ecoregion water quality standards for deep lakes and shallow lakes in 2013 (Table 33).

Lundsten Lake South received an F water quality grade in 2013. Recreational activity is severely limited in lakes that receive an F water quality grade. Lundsten Lake South has TSI scores that classify the lakes as hypereutrophic. Light limitations dominate these lakes due to heavy algal blooms. In 2013, Lundsten Lake South did not meet all three NCHF ecoregion water quality standards for shallow lakes (Table 33).

Table 33. 2013 Lake Grades, Mean Summer Surface Parameters and TSI Values for lakes in the Six Mile Marsh Subwatershed (Red indicates the parameter did not meet the Standard)

Lake Grade	Lake	Mean SECC (m)	Mean CHLA (µg/L)	Mean TP (µg/L)	TSI
May-Sept		June-Sept			
A-	Zumbra	5.08	5.70	18.78	44
A-	Stone	3.54	2.77	28.18	45
B+	Wassermann S	2.53	3.00	23.75	46
B	Piersons	2.91	5.13	26.88	48
B	Carl Krey**	2.18	9.00	29.25	51
B	Steiger	2.71	16.53	27.50	52
B-	Kelser's	2.18	10.75	26.25	51
N/A	Marsh**		6.44	32.44	52
B-	West Auburn	3.00	16.28	32.45	52
B-	Church	2.60	14.00	48.50	54
C+	Wassermann N	1.98	8.25	39.75	53
N/A	Lundsten N**		8.29	46.57	55
N/A	Sunny	1.45	13.50		55
C	East Auburn	1.48	28.38	53.00	60
C-	Turbid	1.35	36.13	84.75	63
D+	Parley	1.05	40.88	83.00	65
D	Wassermann	0.89	53.88	82.75	66
D-	Mud**	0.38	66.81	141.06	74
F	Lundsten S**	1.08	123.57	223.57	80

** Shallow lake with a maximum depth less than 15 ft. or has a littoral area that is greater than 80 percent

Lake Chloride: West Auburn, Steiger, Stone, Sunny, Wassermann North and South ponds, and Zumbra lakes were not monitored for chloride in 2013. The remaining lakes in the Six Mile Marsh Subwatershed did not exceed the chloride standard in 2013. The chloride concentrations ranged between 6 mg/L and 93 mg/L.

Stream Water Quality: Water quality in Six Mile Creek is generally good at Wassermann inlet (CSI11), Wassermann outlet (CSI12), Auburn inlet (CSI05), Lundsten inlet (CSI09) Piersons Lake outlet (CSI14) and Lundsten outlet (CSI01) for Temperature, TSS, and TP when compared to MPCA's ecoregion guidelines for the North Central Hardwood Forest Ecoregion. Turbid Lake outlet (CSI13) was also in range for Temperature and TSS, but exceeded the TP with a mean concentration of 160 µg/L. Highland Rd. (CSI02) only met the Temperature ecoregion guidelines. TSS and TP both exceeded the range at 29.5 mg/L and 182 µg/L, respectively. MCWD staff monitored three new locations in 2013, Mud Lake Inlet (CSI15), Parley Lake Inlet

at Crown College (CSI16), and Halsted Bay Inlet (CSI17). CSI15 met the Temperature and TSS guidelines, but was high for TP with a concentration of 537 µg/L. CSI16 met the Temperature guidelines, but was high for TSS and TP with a concentrations of 31.1 mg/L and 522 µg/L, respectively. CSI17 did not meet any of the parameters with Temperature at 29.3º C, TSS at 19.3 mg/L and TP at 212 µg/L.

Annual loading results for TP, TSS, and Cl were reduced at CSI12 from the previous year. TSS were reduced at CSI11, CSI09, CSI01, and CSI14 from the previous year. Loading results for TSS and chloride were reduced at CSI13, and Cl was reduced at CSI02. CSI05 was increased for TP, TSS, and CL from the previous year.

Stream Dissolved Oxygen: Six Mile Creek's dissolved oxygen (DO) concentrations were generally above the Minnesota State Standards (MN 7050) for about half of the locations (CSI14, CSI13, CSI01, CSI09, CSI02, and CSI08) (Table 34).

Stream Discharge: Time-weighted flow in Six Mile Creek ranged from 0.45 cfs (CSI13) to 8.90 cfs (CSI02) (Table 35). Flow began to decrease in many of these locations in mid- to late August.

Stream *E. coli*: Data was collected for *E. coli* on one location on Six Mile Creek at Highland Rd. (CSI02). This location met the requirement of 10% of the values not to exceed 1,260 cfu/100 ml (Table 36).

Table 34. Summer Dry-Weather DO Profiles in Six Mile Creek Subwatershed Streams

	Six Mile, Wasserman Outlet	Six Mile, Wasserman Inlet	Six Mile, Turbid Outlet	Six Mile, Pierson Outlet	Six Mile, Hwy 5	Six Mile, Lunsten Inlet	Six Mile, Lunsten Outlet	Six Mile, Parley Lk Creek S	Six Mile, Parley Lk Inlet Crown	Six Mile, Mud Lk Inlet	Six Mile, Kings Pt Rd	Six Mile, Hwy 7 Highland
6/3/2013	4.87	3.71	6.74	8.8	4.06	10.03	8.65	7.83	2.48	2.78	6.87	
6/4/2013												7.25
6/11/2013	8.23	4.55	7.87	11.1	5.32	9.68	9.52	9.01	2.74	3.3	4.32	5.69
6/17/2013	10.84	2.94		5.62								
6/18/2013			6.43		3.52	9.63	8.11	9.46	1.89	2.71	4.71	8.36
6/24/2013	5.9	2.88	6.88	9.12	1.33	11.25	8.03	5.2	2.47	1.81	3.44	7.49
7/1/2013	6.31	4.87	5.9	9.86	1.26	9.37	7.26	12.53	5.41	1.65	2.57	5.89
7/8/2013	2.44	2.58	4.51	8.55	2.54	7.65	5.04	6.22	4.63	0.96	1.95	3.99
7/15/2013	3.52	3.91	7.55	10.5	3.63	10.9	4.97	8.83	4.79	2.66	0.43	7.22
7/22/2013	3.37	2.57	6.15	7.46	1.68	5.81	2.78	4.51	6.12	0.65	0.39	6.28
7/29/2013	3.28	3.7	6.92	8.52	2.36		4.55	4.88	7.61	1.27	1.83	8.39
8/5/2013	6.52	3.16	6.23	9.52	1.36	8.09	4.71	5.52	7.11	1.71	1.97	6.91
8/12/2013	3.93	3.19	6.33	8.61	1.51	10.44	3.18	5.68				
8/19/2013	1.99	3.64		8.34	2.04	6.62	2.52				2.18	4.1
8/26/2013	1.25	2.85		9.47								
8/27/2013						1.82	1.09					
9/4/2013	1.24	6.64				1.03	2.26					5.23
9/9/2013	3.19	2.06										
9/10/2013						1.23					2.08	2.14
9/17/2013							4.83				4.87	7.44
9/25/2013		4.49					4.81					3.62

Note: Blank spaces indicate no data collected and green font indicates less than 5 mg/L DO standards

Table 35. 2013 Concentration and Load for Six Mile Creek Subwatershed Stream Sites

				Flow-Weighted Mean Concentration					Load (pound)				
Station	Creek	Contributing Watershed Area (sq. mi.)	Average Flow (cfs)	TP (µg/L)	SRP (µg/L)	TN (mg/L)	TSS (mg/L)	Cl (mg/L)	TP	SRP	TN	1000 lbs TSS	1000 lbs CL
CSI12	Six Mile	4.52	1.81	42.8	0.7	0.8	8.4	23.3	153	2	3029	30	83
CSI11	Six Mile	3.01	0.72	42.0	13.0	0.5	5.3	23.6	59	19	763	7	33
CSI14	Six Mile		0.56	15.0	0.0	0.5	3.4	26.3	16	0	579	4	29
CSI13	Six Mile		0.45	83.0	22.0	1.1	8.1	15.0	74	19	999	7	13
CSI05	Six Mile	6.29	1.75	70.0	28.0	0.7	7.0	30.1	241	96	2472	24	103
CSI09	Six Mile	12.74	2.60	16.4	0.1	1.3	2.0	36.8	84	1	6528	10	188
CSI01	Six Mile	15.53	5.13	33.0	6.0	1.0	2.6	33.8	336	65	10017	26	341
CSI02	Six Mile	23.93	8.90	111.0	19.0	0.9	32.0	21.5	1943	326	15968	561	377
CSI15	Six Mile		1.62	245.1	178.9	0.7	3.1	17.1	783	571	2328	10	55
CSI16	Six Mile		0.52	300.8	176.4	1.0	17.7	16.7	308	180	1011	18	17
CSI08	Six Mile		0.70	97.8	52.9	0.7	11.1	8.4	134	72	917	15	12
CSI17	Six Mile		8.80	128.1	39.7	0.7	16.7	20.2	2218	687	12510	289	350

Table 36. 2013 Six Mile Creek Subwatershed *E. coli* (CFU/100ml)

Date	CSI02
4/18/2013	23.2
4/25/2013	1
5/2/2013	5
5/9/2013	10
5/16/2013	14
5/23/2013	11
5/30/2013	8
6/6/2013	41
6/13/2013	
6/20/2013	29
6/27/2013	21
7/11/2013	13*
7/18/2013	13
7/25/2013	11
8/1/2013	15
8/8/2013	10
8/15/2013	5
8/22/2013	6
8/29/2013	7
9/5/2013	29
9/12/2013	16
9/19/2013	101
9/26/2013	34
10/3/2013	
10/10/2013	
10/17/2013	23
10/24/2013	6
10/31/2013	2

*Duplicate samples that have been averaged

Note: Blank spaces indicate no data collected and red font indicates exceedances greater than 1260 cfu/100 ml. 2420 cfu/100 ml is the highest reporting level obtainable by the method of testing used by TRPD Laboratory. Results reported at 2420 cfu/100 ml may be higher.

3. DISTRICT WIDE WATER QUALITY SUMMARY

In order to better summarize the District's water quality in 2013, this section will be divided into upper and lower watersheds. The upper watershed of the District west of the Grays Bay Dam contains Lake Minnetonka, Christmas Lake, Lake Virginia, Schutz Lake, Six Mile Marsh, Langdon Lake, Dutch Lake, Painters Creek, Long Lake Creek, and Gleason Lake subwatersheds. The lower watershed of the District east of Grays Bay Dam is the Minnehaha Creek subwatershed.

The upper watershed land use and land cover within the Lake Minnetonka subwatershed consists mainly of single family homes adjacent to Lake Minnetonka. The land use and land cover in the remaining upper watershed has historically been undeveloped or in agricultural use; though growth of single family developments in the upper watershed has been on the rise. Several large parks are prominent throughout and the undeveloped areas are a mix of forest, woodland, grasslands, and wetlands. There is a lower percent of impervious surface area compared to the lower watershed (MCWD, 2007).

In the upper watersheds, the Christmas Lake subwatershed is the only subwatershed that has all lakes we currently monitor meeting the NCHF water quality standards. The remaining subwatersheds have at least one lake or creek that are not meeting the NCHF water quality standards. Much of the pollutant (nutrient) loading of many of these monitored locations showed an increase from the previous years. This may be due to the increased rain events that occurred in late spring and summer months of 2013; however, these water bodies that are not meeting the water quality standards may still be impacted from the previous years' loading. The watershed area to lake area ratio is also a factor. The larger the watershed area is to lake area the greater the external loading is to the lake. Several of the lakes in the upper watershed that are not meeting the NCHF water quality standards have large watershed area to lake area ratios (examples: Parley Lake, Halsted Bay and Jennings Bay). There may be other potential explanations for the impairments, including internal loading. Some remnants of inactive sewage treatment plants and other nutrient rich deposits into the lakes are a source of phosphorus for the internal loading.

Historically, some of the upper watershed lakes' sediment records have indicated that they were eutrophic even in pre-European times (Edlund et. al, 2009).

The lower watershed land use and land cover is almost completely developed. The single family residents dominate the subwatershed with scattered industrial and commercial zones. Parks and open space are distributed throughout the cities' neighborhoods. The lower watershed has a high percentage of impervious surface areas due to this increased amount of development (MCWD, 2007).

In the lower watershed, more than half of the lakes do not meet the NCHF water quality standards. The pollutant (nutrient) loading at the majority of the stream sites on Minnehaha Creek showed an increase from the previous years. The increased rain events that impacted the upper watershed also impacted the lower watershed in 2013. The previous years' loading may still be impacting the lakes and stream that are not meeting the water quality standards. Stormwater runoff from the high number of impervious surfaces and internal loading may be potential explanations for the impairments.

The MCWD's Hydrodata department is meeting its goals by working closely with the Planning department to identify impaired waters within each of the subwatersheds. The water quality data that is collected on these water bodies will be used to assist in the development of projects to reduce the pollutants within the District's lakes and streams. The Hydrodata department is also coordinating with the Communication and Education departments to convey the monitoring results to the public to raise awareness about the health of the watershed and engage and empower the community to improve their lakes and streams.

4. FUTURE INITIATIVES

2014

- Expand the Volunteer Monitoring Program (formerly known as the Citizen Lake Monitoring Initiative) to monitor additional lakes throughout the Watershed District
- Research and continue to upgrade monitoring equipment
- Continue to focus increased monitoring of streams within the Six Mile Marsh Subwatershed as part of the Six Mile Creek Diagnostic project
- Continue to focus the biological monitoring in the Six Mile Marsh, Schutz Lake and Minnehaha Creek subwatersheds
- Officially launch the MCWD's water quality database on our District's website
- Initiate the Ecosystem Evaluation program (formally the Subwatershed Health Assessment Report program). This program will develop a scientifically defensible watershed wide ecosystem evaluation/grading tool that can be used to assess watershed condition, identify target areas that need improvement, and develop management strategies to protect and improve water resources.

2015

- Work with consultant(s) and partners in the process, design, and implementation of the Links Program

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