



Picture: School Lake near outlet, July 30, 2007

COMFORT LAKE-FOREST LAKE WATERSHED DISTRICT 2007 WATER MONITORING REPORT

Prepared for:
Comfort Lake-Forest Lake Watershed District

Prepared By:
Washington Conservation District

May 2008

Memorandum

To: Comfort Lake-Forest Lake Watershed District Managers

From: Erik Anderson, Jessica Arendt, Wendy Griffin, Tim Sundby, and Travis Thiel --Washington Conservation District

Date: March 15, 2008

Re: CLFLWD 2007 Monitoring: Tributary to Sunrise River at Little Comfort Lake Inlet, Sunrise River at Forest Lake Outlet, Sunrise River at Comfort Lake Inlet, Sunrise River at Comfort Lake Outlet, Sunrise River at County Line Ditch, Bone Lake Subwatershed SBL05 Drainage, Bone Lake Subwatershed NBL12, Shields Lake, Moody Lake, School Lake, Birch Lake

At the request of the Comfort Lake-Forest Lake Watershed District (CLFLWD), the Washington Conservation District (WCD) conducted:

Continuous discharge and stream water quality monitoring at:

- Tributary to Sunrise River at Little Comfort Lake Inlet (Grab Samples only)
- Sunrise River at Forest Lake Outlet (Flow only)
- Sunrise River at Comfort Lake Inlet (Grab Samples only)
- Sunrise River at Comfort Lake Outlet (Flow only)
- Sunrise River at County Line Ditch (Composite and Grab Samples)

Manual flow measurements and grab sampling at:

- Bone Lake Subwatershed SBL05 Drainage
- Bone Lake Subwatershed NBL12

Water quality and water level monitoring at:

- Shields Lake
- Moody Lake (water quality only)
- School Lake (water quality only)
- Birch Lake (water quality only)

A table of the locations and monitoring types can be found in Table 1. The locations of the monitoring sites can be found in Figure 1. The following report briefly summarizes our methods and results for monitoring conducted from January 1 - December 31, 2007. A complete list of detailed Washington Conservation District water monitoring methods and standard operating procedures can be found at http://www.mnwc.org/water_monitoring_standards.php. This report and the accompanying data will also be provided in an electronic format.

Continuous Stream Monitoring Sites: Tributary to Sunrise River at Little Comfort Lake Inlet, Sunrise River at Forest Lake Outlet, Sunrise River at County Line Ditch, Sunrise River at Comfort Lake Inlet, and Sunrise River at Comfort Lake Outlet.

Continuous stage, velocity, and discharge measurements were taken every 15 minutes at the Tributary to Sunrise River at Little Comfort Lake Inlet from April 26-October 30, 2007, at Sunrise River at Forest Lake Outlet from March 26-October 29, 2007, at Sunrise River at County Line Ditch from March 27-October 30, 2007, at Sunrise River at Comfort Lake Inlet from March 26-October 30, 2007, and at Sunrise River at Comfort Lake Outlet from March 26-July 12, 2007 (rainfall only through October 29, 2007). Precipitation data was also continuously collected at each of these sites except at Sunrise River at Forest Lake Outlet.

Staff gages were installed and read at each site. Field stage measurements were taken in the stream channels. Temperature, dissolved oxygen, and transparency tube measurements were also taken. If feasible, stage-discharge relationships were developed at all stream sites. When the area-velocity probe was covered with debris, erroneous velocity readings were given and the stage to discharge relationships were used to calculate discharge or a relationship of level to velocity was used to interpolate values. Flow weighted storm event composite samples and/or storm event grab samples; baseflow composite samples and/or baseflow grab samples were collected at all continuous stream monitoring sites. In addition to these samples, *E.coli* grab samples were also taken at all eight sites. The samples were analyzed by the Metropolitan Council Environmental Services Lab.

Discontinuous Stream Monitoring Sites: Bone Lake Subwatershed SBL05 Drainage and Bone Lake Subwatershed NBL12

Periodic manual discharge measurements were taken or attempted throughout the monitoring season at each site. Grab samples were collected concurrently with the discharge measurements for discharge/nutrient correlations to be established. Bone Lake subwatershed NBL12 (northwest subwatershed to Moody Lake) and subwatershed SBL05 discharge measurements and grab sampling were attempted throughout the monitoring. Due to a dry season, a collection of samples less than that in the monitoring plan were able to be collected.

Lake Water Quality Monitoring Sites: Shields Lake, Moody Lake, School Lake, and Birch Lake.

The work plan for 2007 included monitoring of four lakes. All lakes were monitored monthly from April through October except Moody Lake (monitored biweekly from April through October). All lakes were monitored by collecting Secchi transparencies, temperature, and dissolved oxygen profiles. Secchi transparencies are used for general comparisons of water quality across the watershed and for monitoring general water quality trends in a given lake from year to year. Temperature and dissolved oxygen profiles provide information on the in-lake dynamics and how each lake may be functioning each year. All four lakes had 2-meter surface composite water quality samples taken for analysis of total phosphorus, total Kjeldahl nitrogen, and chlorophyll-a concentrations.

A summary of lake water quality monitored in 2007 is included in this report. The Metropolitan Council Environmental Services produces a lake water quality report on all lakes enrolled in the 2007 CAMP (Citizen Assisted Monitoring Program) program which will include water quality information on lakes both monitored and not monitored by the WCD in 2007. Lake elevation information that was collected in 2007 is compiled and

organized by the Minnesota DNR Division of Waters. All lake elevation information can be found at <http://www.dnr.state.mn.us/lakefind/index.html>.

ABBREVIATIONS, ACRONYMS, AND SYMBOLS

CAMP	Citizen-Assisted Lake Monitoring Program
cfs	cubic feet per second
cf	cubic feet
Cl- <i>a</i> or CLA	Chlorophyll- <i>a</i>
CLFLWD	Comfort Lake Forest Lake Watershed District
COD	Total Chemical Oxygen Demand
DO	Dissolved Oxygen
E. Coli	<i>Escherichia coli</i>
mg/L	milligram per liter
MN DNR	Minnesota Department of Natural Resources
MPCA	Minnesota Pollution Control Agency
MPN	most probable number
OHW	Ordinary High Water level
Ortho-P	Ortho-phosphate
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TP	Total Phosphorus
TSI	Trophic State Index
TSS	Total Suspended Solids
µg/L	microgram per liter
VSS	Volatile Suspended Solids
WCD	Washington Conservation District

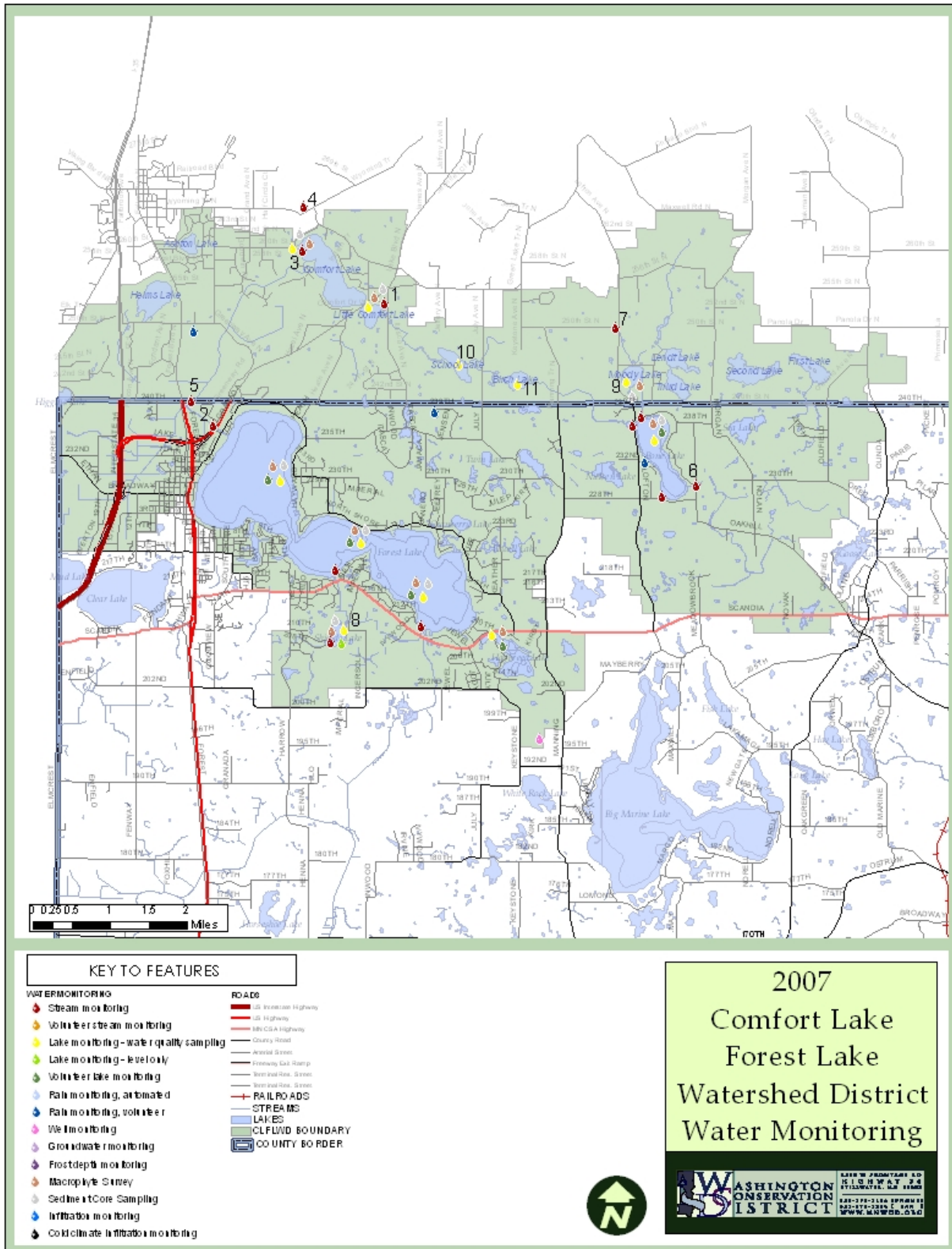


Figure 1. CLFLWD Monitoring Locations

Table 1. Monitoring Site Location and Description Summary

Site Description	Map Site ID#	Full Site Name	Summarized Site Name	General Site Location	Monitoring Site Description	Monitored Parameters
Stream Monitoring	1	Tributary to Sunrise River at Little Comfort Lake Inlet	Little Comfort Lake Inlet	Itasca Avenue	Flow Monitoring in Natural Cross-Section	Discharge and Water Quality Grab Samples*
Stream Monitoring	2	Sunrise River at Forest Lake Outlet	Forest Lake Outlet	North Shore Drive	Flow Monitoring in Natural Cross-Section	Discharge and Water Quality Grab Samples*
Stream Monitoring	3	Sunrise River at Comfort Lake Inlet	Comfort Lake Inlet	West Comfort Drive	Flow Monitoring Through Culvert	Discharge and Water Quality Grab Samples*
Stream Monitoring	4	Sunrise River at Comfort Lake Outlet	Comfort Lake Outlet	Wyoming Trail	Flow Monitoring in Natural Cross-Section	Discharge and Water Quality Grab Samples*
Stream Monitoring	5	Sunrise River at County Line Ditch	County Line Ditch	¼ Mile East of Hwy 61	Flow Monitoring in Natural Cross-Section	Discharge and Water Quality Composite Samples*
Stream Monitoring	6	Bone Lake Subwatershed SBL05 Drainage	Bone East	Meadowbrook Ave.	Flow Measurements in Natural Cross-Section	Manual Discharge Measurements and Water Quality Grab Samples**
Stream Monitoring	7	Bone Lake Subwatershed NBL12 Drainage	Moody Drainage	250 th St	Flow Measurements in Natural Cross-Section	Manual Discharge Measurements and Water Quality Grab Samples**
Monitored Parameters						
Lake Monitoring	8	Shields Lake	--	--	Deepest Point Within the Lake	Surface Water Quality Samples Elevation***
Lake Monitoring	9	Moody Lake	--	--	Deepest Point Within the Lake	Surface Water Quality Samples***
Lake Monitoring	10	School Lake	--	--	Deepest Point Within the Lake	Surface Water Quality Samples***
Lake Monitoring	11	Birch Lake	--	--	Deepest Point Within the Lake	Surface Water Quality Samples***

*Stream Monitoring Water Quality Sample Parameters Include: Total Phosphorus, Dissolved Phosphorus, Total Kjeldahl Nitrogen, Nitrate, Nitrite, Ammonia Nitrogen, Total Suspended Solids, Volatile Suspended Solids, Total Organic Carbon, E. Coli Bacteria

**Site ID# 6-7 Water Quality Sample Parameters Include: Total Phosphorus, Ortho Phosphorus, and Total Kjeldahl Nitrogen only

***Lake Water Quality Sample Parameters Include: Total Kjeldahl Nitrogen, Total Phosphorus, Chlorophyll-a, Secchi Disk Transparency, Temperature, Dissolved Oxygen

Sections Within Report

1) Summary of 2007 Lake Water Quality

2) Bone Lake Subwatershed

- Stream Monitoring
 - a. Bone Lake Subwatershed Drainage Monitoring
 - b. Moody Lake Subwatershed Drainage Monitoring
- Lake Monitoring
 - a. Moody Lake

3) Little Comfort Lake Subwatershed

- Stream Monitoring
 - a. Little Comfort Lake Inlet
- Lake Monitoring
 - a. School Lake
 - b. Birch Lake

4) Forest Lake Subwatershed

- Stream Monitoring
 - a. Forest Lake Outlet
- Lake Monitoring
 - a. Shields Lake

5) Comfort Lake Subwatershed

- Stream Monitoring
 - a. County Line Ditch
 - b. Comfort Lake Inlet
 - a. Comfort Lake Outlet

6) Historical Lake Water Quality

7) Historical Stream Loading and Discharge Summary

1) Summary of 2007 Lake Water Quality

1. TRANSPARENCY (SECCHI DISK)

The measurement of depth of light penetration using a Secchi disk gives a simple measure of water transparency, or clarity. It is a possible indication of turbidity in the water, as well as, an indication of the trophic state of the lake. A reduction in water transparency is usually the result of increased turbidity caused by suspended sediments, organic matter, and/or phytoplankton (algae). The 2007 average summer water transparency (June 1 – September 30) was calculated for each lake monitored in CLFLWD. The transparencies ranged from 2.2 feet in Moody Lake to 5.6 feet in Birch Lake. The typical range for this ecoregion, the North Central Hardwood Forests, is 4.9 - 10.5 feet (Figure 2). Of the average Secchi disk transparency values observed in 2007, only Birch Lake was better than the average range for this ecoregion. Historical transparency data for selected lakes can be found in Appendix A.

2. PHOSPHORUS

Phosphorus is a major nutrient involved in eutrophication and is generally associated with the growth of aquatic weeds and algae blooms. Common sources of phosphorus include runoff from agricultural fields, livestock areas, urban areas, lakeshore lawns, and improperly operating septic systems. In most lakes in the Northern Hardwood ecoregion, phosphorous is the least available nutrient; therefore, the concentration of phosphorous controls the extent of algal growth. Algal growth in turn affects the clarity of the water and light penetration. The typical range for surface total phosphorous concentrations in the ecoregion is 0.023 - 0.050 mg/L (Figure 3). Surface total phosphorous concentrations in sampled lakes in CLFLWD range from 0.054 mg/L in School Lake to 0.206 mg/L in Shields Lake. In 2007, all lakes sampled had an average summer surface total phosphorous value greater than the ecoregion range (poorer than average).

Curly leaf pondweed is present on many lakes within the CLFLWD. Curly leaf pondweed has the ability to release significant amounts of phosphorus to the water body during the summer months because of its unique life cycle. This plant can start to grow while ice is still on lakes and in turn will displace native vegetation. It has the ability to form dense mats on the surface of lakes in the spring and will then die during the summer releasing nutrients to the water column.

Throughout this report, lake graphs containing surface total phosphorus include a nutrient impairment threshold of 0.040 mg/L or 0.060 mg/L (impairment threshold for deep and shallow lakes respectively) for this ecoregion. Shields Lake and Birch Lake are considered shallow lakes and the impairment threshold is 0.060 mg/L, while School Lake and Moody Lake are considered deep lakes and the impairment threshold is 0.040 mg/L. The Minnesota Pollution Control Agency uses this threshold as a determination of lake impairment for TP, where a minimum of four summertime measurements is collected and twelve total samples is considered ideal for impairment determination. Listing a lake as impaired, in turn, can lead to a Total Maximum Daily Load study and nutrient reducing actions and projects.

3. CHLOROPHYLL-*a*

Chlorophyll-*a* is a photosynthetic component found in algae and aquatic plants. It is also an indicator of algal productivity. The 2007 average summer chlorophyll-*a* concentrations ranged from 21 µg/L in Birch Lake to 80 µg/L in Moody Lake. The ecoregion range for chlorophyll-*a* concentration is 5-22 µg/l (Figure 4). Of the lakes sampled in 2007, all exceeded (poorer than) the ecoregion range for chlorophyll-*a* except for Birch Lake, which was within the ecoregion range.

4. NITROGEN

Nitrogen, much like phosphorus, is a nutrient found naturally in lakes and streams. Several forms of nitrogen are responsible for health problems in young children and pregnant women and increase the rate of lake eutrophication. The concentration of nitrogen (along with phosphorus) can control primary production (the rate of algal growth) and subsequently water quality. Phosphorus is usually thought to become limiting where the total nitrogen to total phosphorus (TN/TP) ratio is 10:1 (Carlson 1992). Therefore, the nutrient controlling water quality in the lakes of the CLFLWD is phosphorous and not nitrogen. In 2007, average summer surface total Kjeldahl nitrogen (TKN) concentrations ranged from 1.24 mg/L in School Lake to 3.09 mg/L in Moody Lake. The ecoregion range for surface TKN is 0.60 – 1.20 mg/L (Figure 5). Of the lakes sampled in 2007, all lakes exceeded (poorer than) the ecoregion range.

5. TEMPERATURE AND DISSOLVED OXYGEN

Temperature and dissolved oxygen profiles were measured when samples were taken. In addition to surface water measurements, temperature and dissolved oxygen was measured at one-meter intervals from the surface to the lake bottom. This data is contained in Appendix C. The data collected enables temperature and dissolved oxygen profiles to be developed. These profiles show the extent of summer stratification and are useful in identifying the thermocline (the layer of water in which the temperature rapidly declines). The thermocline is an important thermal barrier for chemical and biological activity. In lakes with no thermocline present or little stratification, the lake may mix throughout the summer making bottom nutrients available throughout the water column for use by organisms like algae.

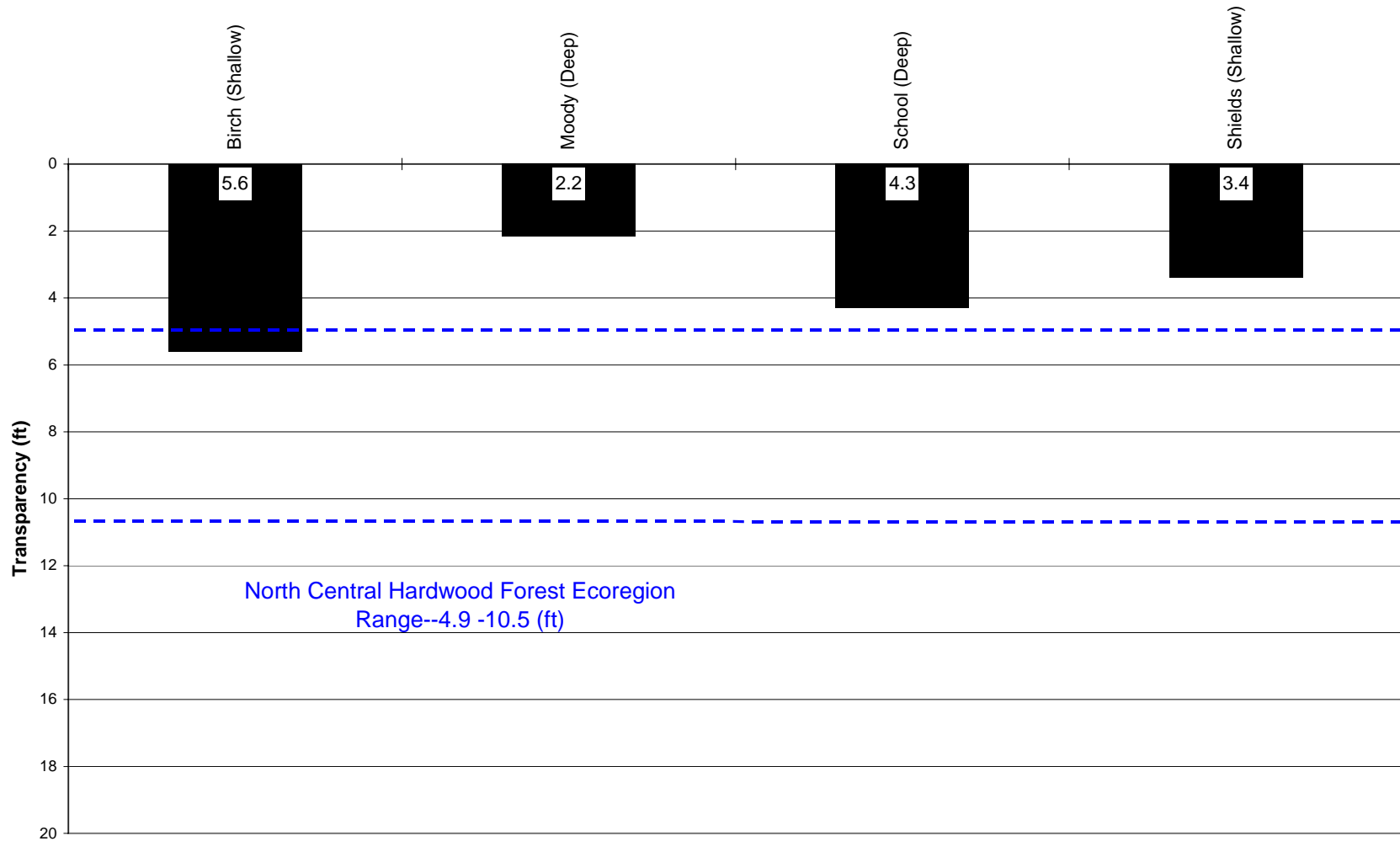


Figure 2. 2007 Average Secchi Transparencies and Ecoregion Range

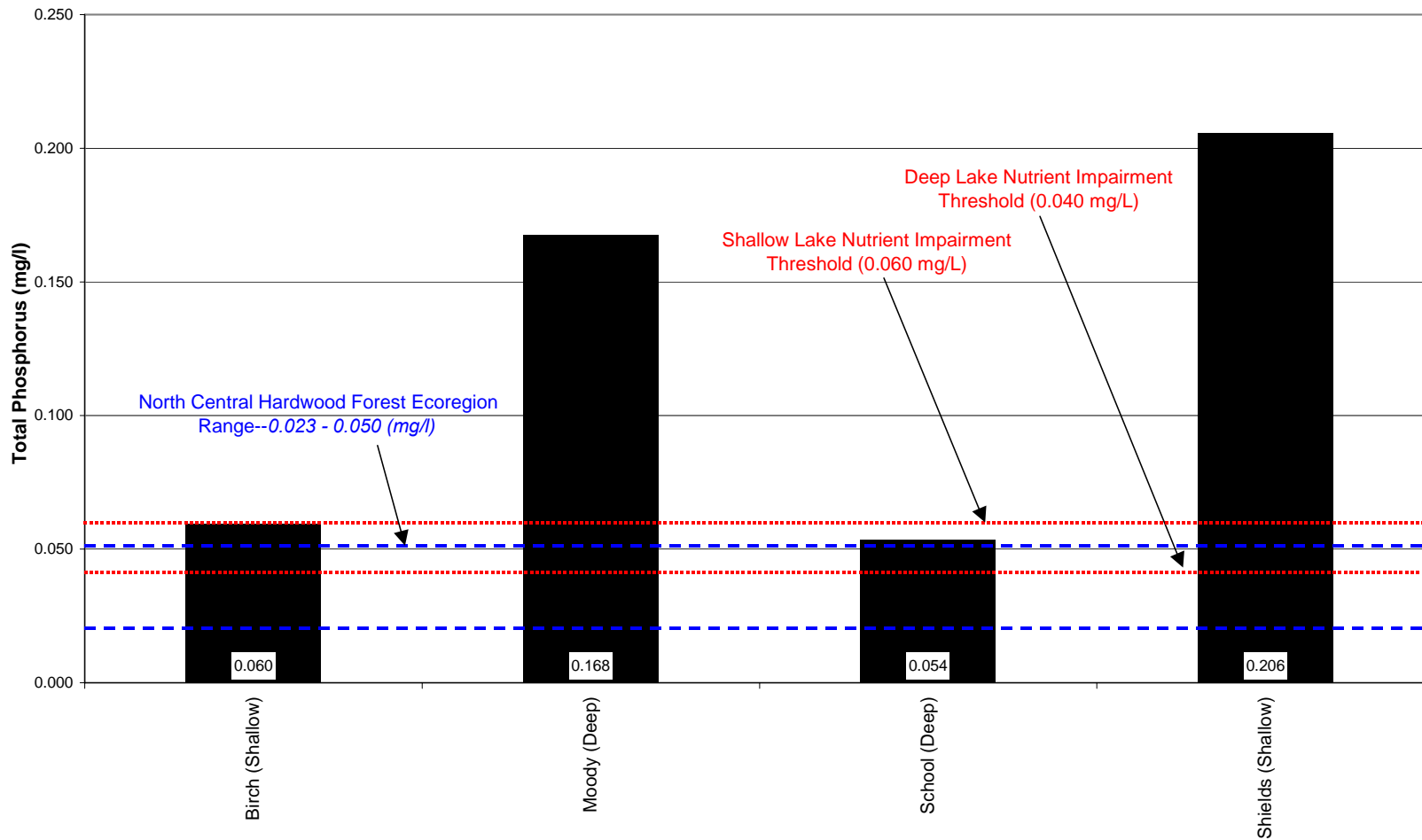


Figure 3. 2007 Average Surface Total Phosphorus, Ecoregion Range, and MPCA Nutrient Impairment Thresholds

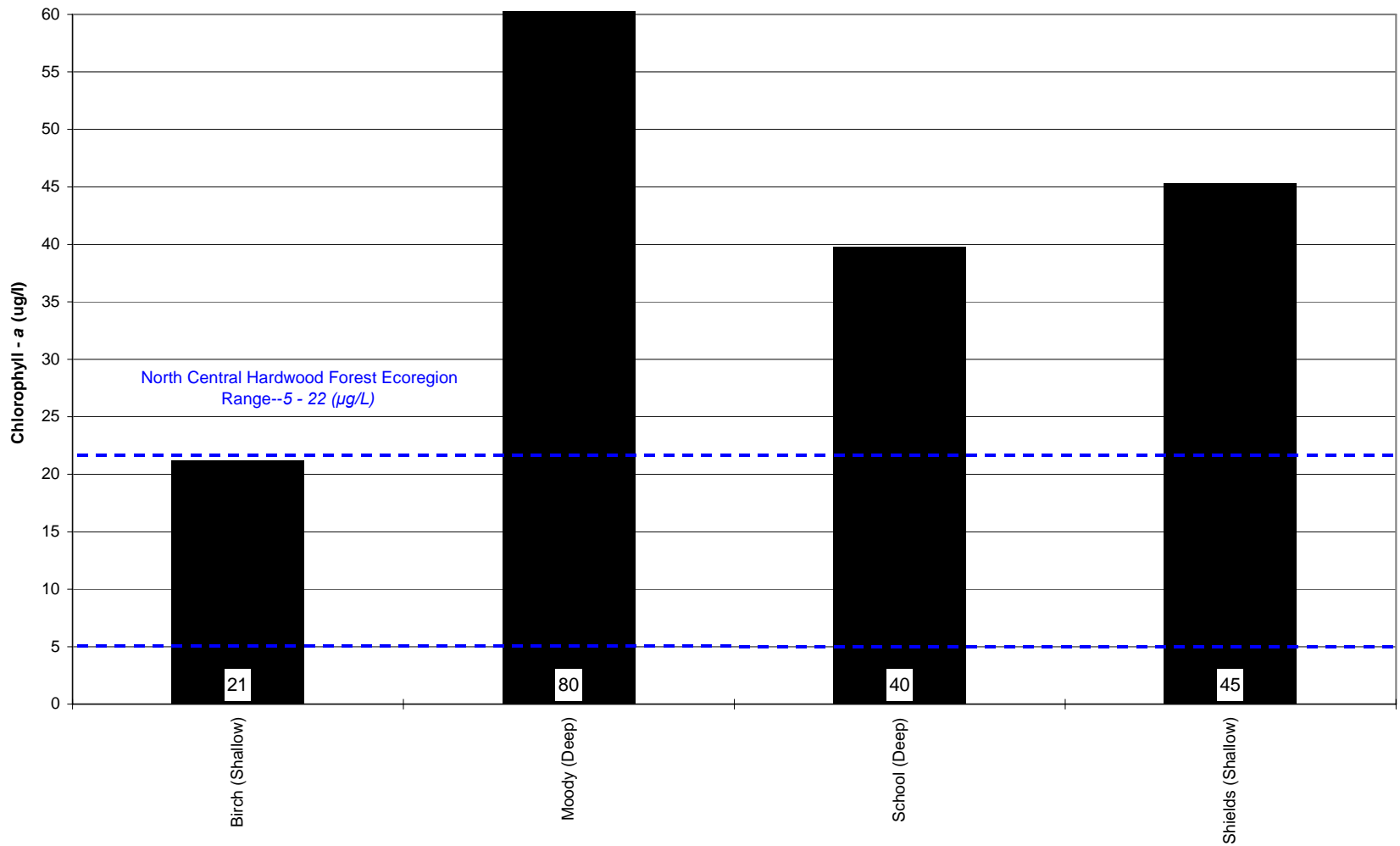


Figure 4. 2007 Average Surface Chlorophyll-*a* and Ecoregion Range

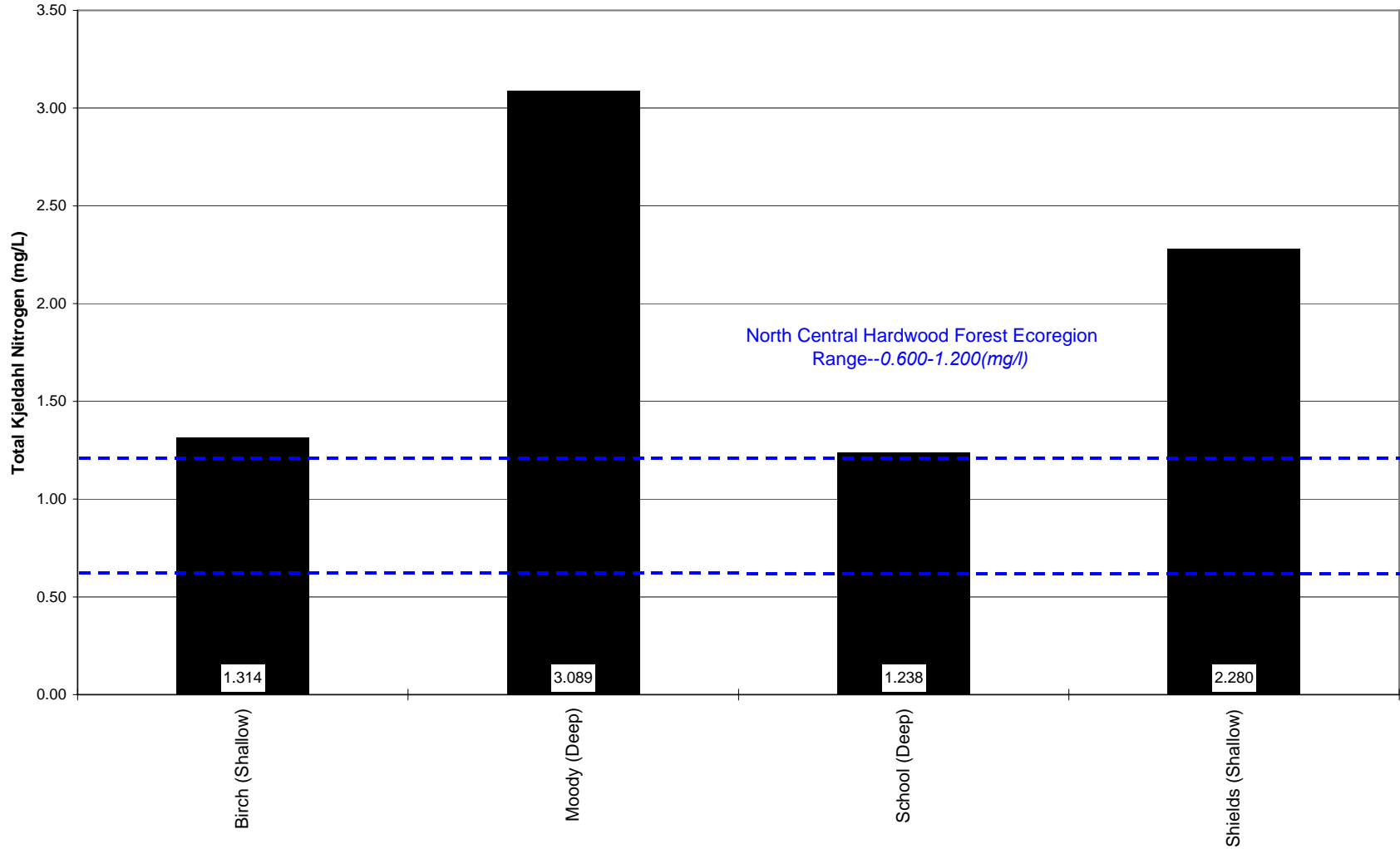


Figure 5. 2007 Average Surface Total Kjeldahl Nitrogen and Ecoregion Range

Table 2. 2007 Average Water Quality Results and Ecoregion Ranges

Lake	Surface TP (mg/l)	Chlorophyll-a (ug/l)	Surface TKN (mg/l)	Secchi Disk (feet)	Secchi Disk (meters)
<i>Eco-Region Value</i>	<i>0.023-0.050</i>	<i>5-22</i>	<i>0.600-1.200</i>	<i>4.9-10.5</i>	<i>1.50-3.20</i>
Birch (Shallow)	0.060	21	1.314	5.6	1.71
Moody (Deep)	0.168	80	3.089	2.2	0.66
School (Deep)	0.054	40	1.238	4.3	1.31
Shields (Shallow)	0.206	45	2.280	3.4	1.04

2) Bone Lake Subwatershed

Bone Lake Subwatershed Drainage Monitoring

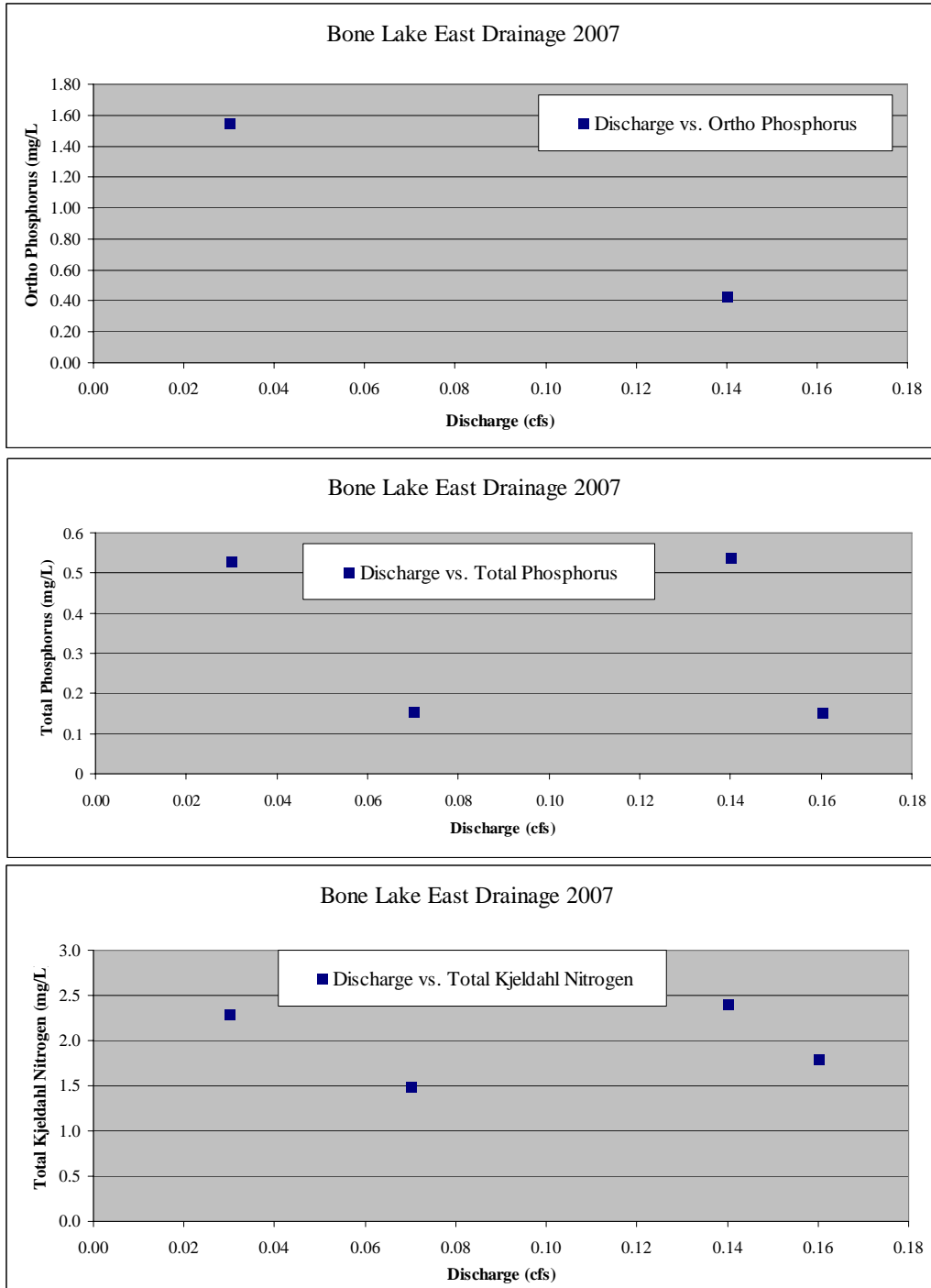
Discharge measurements and water quality grab samples were taken during the monitoring season at the Bone Lake East Drainage subwatershed SBL05. Discharge measurements were taken using a Marsh McBirney Flow-Mate Model 2000 flow meter. The channel was divided into equal widths (stations) and depth and velocity measurements were made at the midpoint of each station. Once the entire channel measurements had been recorded, depth of each location measured was multiplied by the width between stations. This calculation produces an area for each station. Once the product of each station's area and velocity are calculated, a discharge for each station is complete. Each station's discharge is then summed to determine a cumulative discharge for the site. If it was determined that the channel was not suitable to use a handheld flow meter, a portable cutthroat flume was used to determine discharge. To use the flume, the flume had to be placed in the channel and water from the channel had to be blocked and diverted into the flume. Once the setup process was complete, the water level of the channel was allowed to equalize. Upon equalization, the depth in the flume was measured. Based upon pre-calculated engineering tables, a specific depth within the upstream opening of the flume will provide a specific discharge. This discharge was recorded and the flume was left to set for a longer time to determine if there was any change in stage to determine that the channel had in fact fully equalized. If no change was apparent in depth in the flume, the discharge measurement was complete. If sites had no recordable discharge, no grab sample was taken.

Efforts to take seven samples and discharge measurements during the monitoring season were attempted. Due to a dry monitoring season, less than the planned seven samples and discharge measurements could be obtained. Figure 6 displays the associated water quality and discharge data for 2007. One note about this particular data is that the May 24, 2007 sampled TP concentrations were less than the ortho-phosphorus concentrations. This result is not possible since ortho-phosphorus is a fraction of the total phosphorus concentration. The lab was made aware of this discrepancy and had no explanation of this particular result. It would be in the best interest of the reader of this particular data to leave this data point out of any analysis or to make any conclusions from this value. A couple important items to note about these data is 1) the concentrations of phosphorus appear high indicating that although little discharge might occur

from this drainage under dry(er) conditions, the loads could be significant because the concentrations are high and 2) of the samples where the ortho-phosphorus value was obtained without possible error in concentration, it appears that a large portion of the TP concentration consists of ortho-phosphorus (~80%). Based on the results, no apparent relationship exists between discharge and nutrient concentrations in 2007. The same efforts to collect this particular data were made in 2006 and no apparent relationship was seen in 2006 either. When both data sets are combined, there is still no relationship apparent between discharge and nutrient concentrations (Figure 7). Due to an error at the laboratory, ortho-phosphorus concentrations were not processed for the two samples collected in the October 2007 samples.

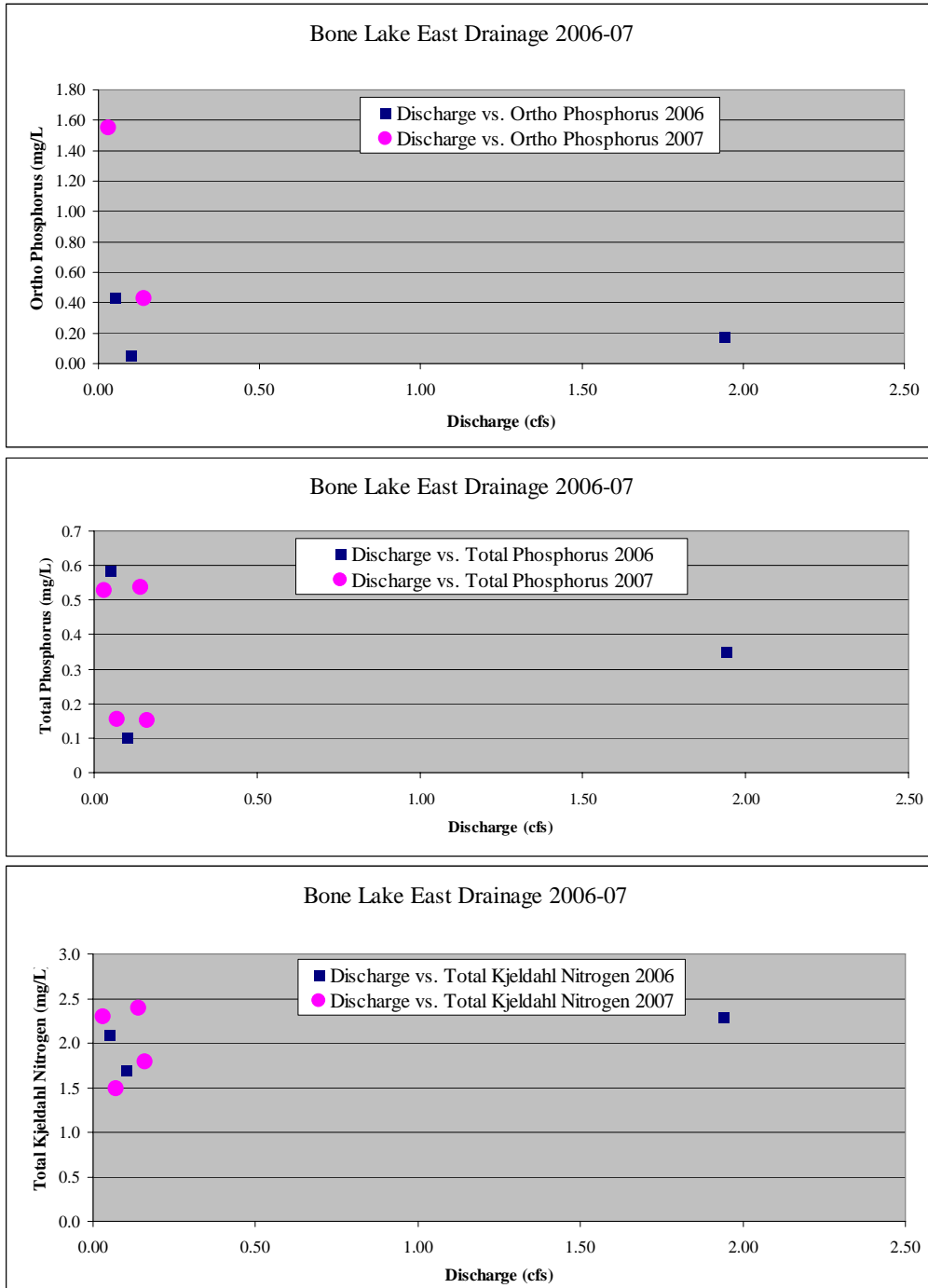
Moody Lake Subwatershed Drainage Monitoring

Discharge measurements and water quality grab samples were attempted at the Bone Lake subwatershed NBL12 that drains to Moody Lake. In 2006, attempts to sample subwatershed NLB23 were performed with no success due to lack of any measurable flow. Although little water appeared to discharge from this subwatershed to Moody Lake in 2007, the water had extremely high concentrations of nutrients contributing to potential significant loads. Ortho-phosphorus concentrations do not appear to be as significant of a percentage of the TP, but are still very high in concentration. An adjacent feedlot may be the source of these high concentrations and this should be investigated further. Based on the small amount of samples obtained from this location, it is difficult to determine any sound conclusions at this time other than highly nutrient concentrated water drains from this subwatershed. No apparent trend appears to exist at this time either.



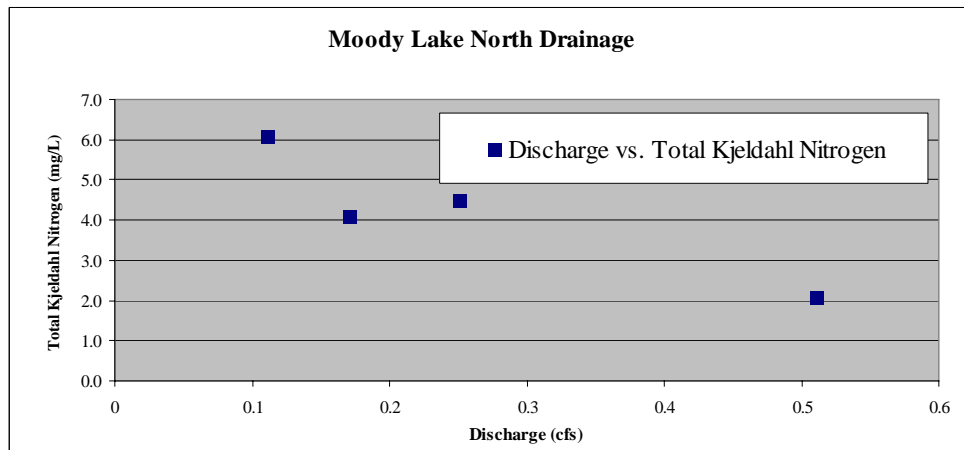
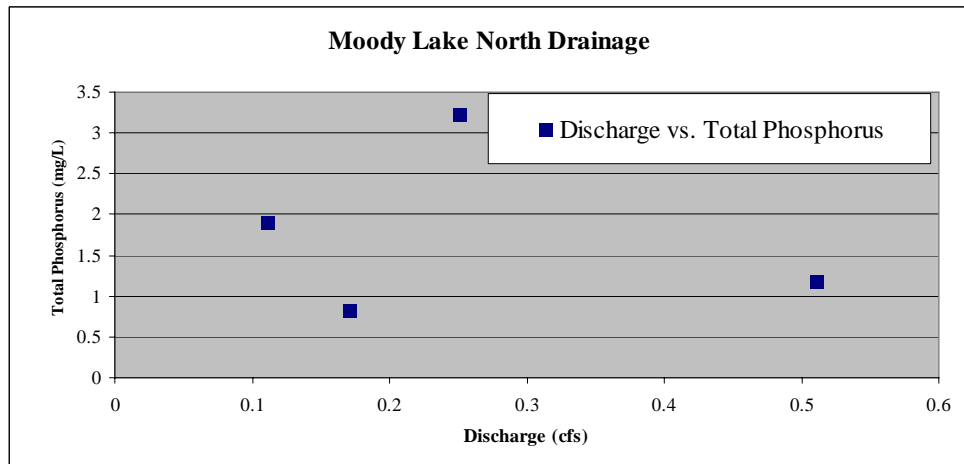
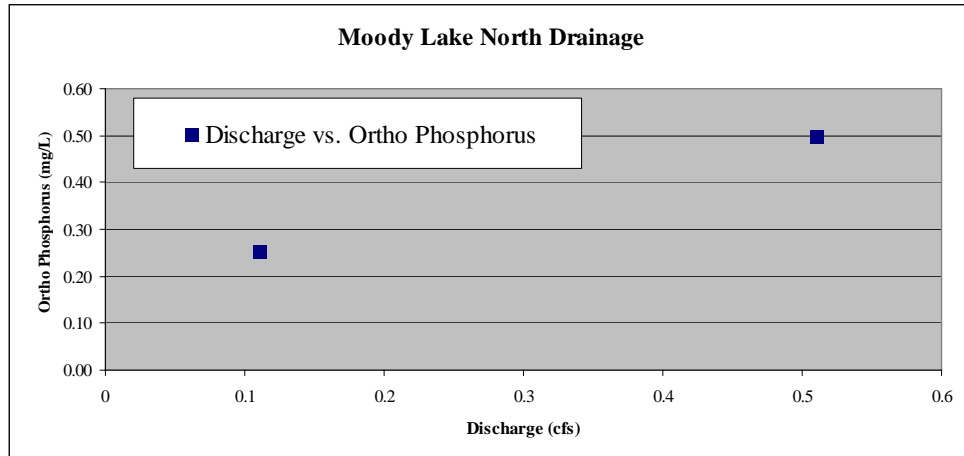
	Discharge (cfs)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphorus (mg/L)
5/24/07 8:15	0.03	2.30	0.530	1.550
10/5/07 9:30	0.14	2.40	0.539	0.433
10/16/07 14:00	0.07	1.50	0.156	
10/18/07 0:00	0.16	1.80	0.152	

Figure 6. Bone Lake East Drainage Subwatershed SBL05 2007 Discharge and Water Quality Data



	Discharge (cfs)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphorus (mg/L)
5/9/06 9:00	0.10	1.70	0.102	0.058
6/6/06 9:45	1.94	2.30	0.353	0.175
8/2/06 9:40	0.05	2.10	0.586	0.435
5/24/07 8:15	0.03	2.30	0.530	1.550
10/5/07 9:30	0.14	2.40	0.539	0.433
10/16/07 14:00	0.07	1.50	0.156	
10/18/07 0:00	0.16	1.80	0.152	

Figure 7. Bone Lake East Drainage Subwatershed SBL05 2006-07 Discharge and Water Quality Data



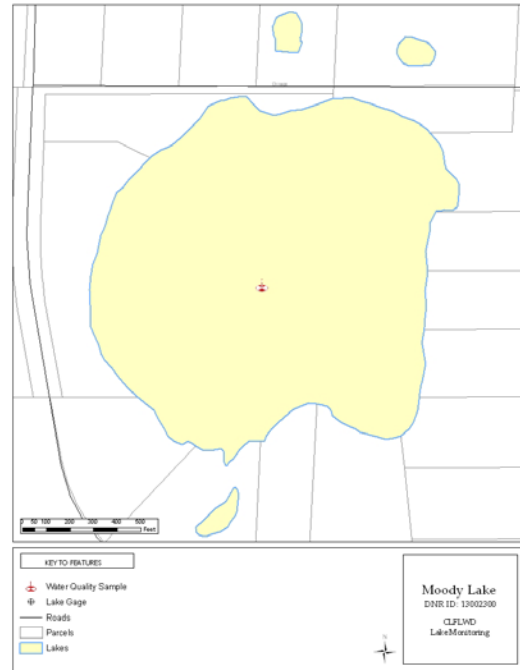
	Discharge (cfs)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphorus (mg/L)
5/24/07 8:45	0.11	6.1	1.910	0.253
10/5/07 9:45	0.51	2.1	1.190	>0.500
10/16/2007	0.17	4.1	0.832	
10/18/07 9:20	0.25	4.5	3.240	

Figure 8. Moody Lake Northwest Drainage Subwatershed NBL19 2007 Discharge and Water Quality Data

Moody Lake

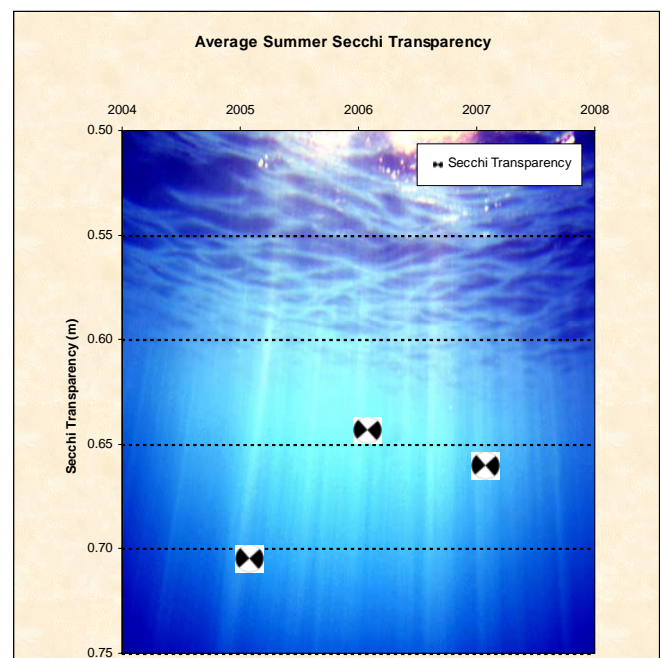
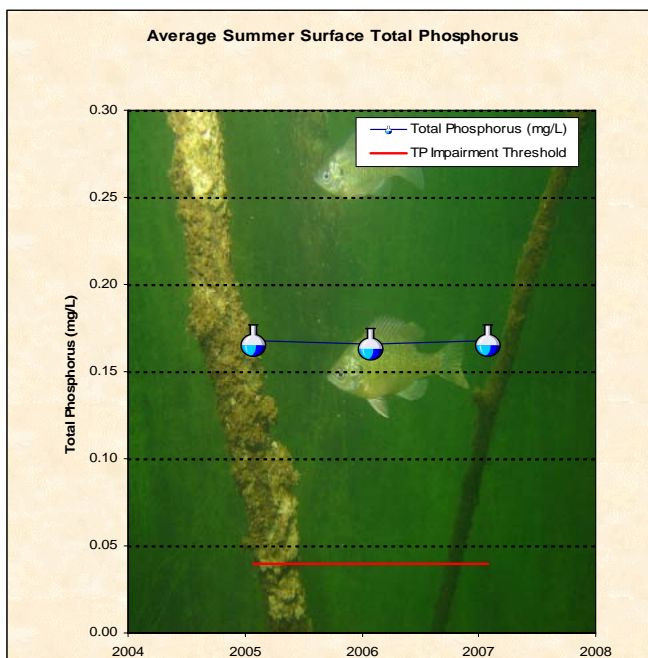
2007 Lake Grade: F

- DNR ID #: 130023
 - Municipality: Chisago Lakes S. Township
 - Location: S ½ Sect. 32 T33 – R20
 - Lake Size: 35 Acres
 - Maximum Depth: 48 ft
 - Ordinary High Water Mark: N/A
 - 61% Littoral
- Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Moody Lake was considered a hypereutrophic lake in 2007, based on the Carlson Trophic State Index.
- Moody Lake is listed as impaired on the MPCA's Impaired Water's List
- At this time, there are not enough years of data to determine a statistically significant trend in overall water quality.
- The major land use is rural/agricultural.
- **Curly Leaf Pondweed (an invasive aquatic plant) is present.**
- The lake did stratify and a thermocline was present at an average depth of 3 meters.
- Moody Lake is listed as impaired on the Minnesota Pollution Control Agency's Impaired Waters List.



Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depth (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celcius)
4/13/2007	0.095	60	1.20	1.83	8.90	13.10
4/30/2007	0.081	18	1.40	1.68	10.01	14.50
5/8/2007	0.083	24	1.40	1.52	5.39	24.80
5/21/2007	0.100	28	1.40	1.37	13.29	21.20
6/4/2007	0.160	90	2.20	0.76	10.05	23.40
6/18/2007	0.217	18	2.70	1.37	10.17	26.50
7/2/2007	0.160	110	3.80	0.61	8.75	26.80
7/16/2007	0.186	130	4.50	0.46	8.50	26.20
7/30/2007	0.223	75	3.30	0.30	11.21	23.80
8/14/2007	0.196	50	2.90	0.30	9.29	22.00
8/28/2007	0.167	84	2.80	0.61	10.34	18.40
9/10/2007	0.128	120	3.70	0.46	8.18	15.30
9/24/2007	0.072	43	1.90	1.07	10.56	15.80
10/11/2007	0.109	29	2.90	1.52	9.34	8.60
2007 Average	0.141	63	2.58	0.99	9.57	20.0
2007 Summer Average	0.168	80	3.09	0.66	9.67	22.0

Water Quality threshold is 0.04 mg/L TP or higher*

Shallow Lake water quality threshold is 0.06 mg/L or higher*

	High	High Date	Low	Low Date	Average
2007 Elevation (ft)	NA	NA	NA	NA	NA

*MPCA description of Impaired Lake's Listing criteria: "At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. Data requirements for 303(d) listing consist of 12 or more TP measurements collected from June through September over the most recent 10-year period. Ideally this should represent 12 separate visits to the lake over the course of two summers; however it might also reflect four monthly samples over the course of three years (a typical sampling regimen for many lake monitoring programs). In addition to exceeding the TP guideline thresholds, lakes to be considered for 303(d) listing should have at least 12 Secchi measurements and 12 chlorophyll-a measurements. This amount of data will allow for at least one season (preferably more) of paired TP, chlorophyll-a, and Secchi disk data and provide a basis for evaluating their interrelationships and hence the trophic status of the lake."

Lake Water Quality Summary

Trophic Status

Lake Grades

	2007	2007	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Hypereutrophic	F	F	D-					
Chlorophyll-a (ug/l)	Hypereutrophic	F	C	C-					
Secchi depth (ft)	Hypereutrophic	F	D	D					
Overall	Hypereutrophic	F	D	D					

3) Little Comfort Lake Subwatershed

Little Comfort Lake Inlet

The station for the Little Comfort Lake Inlet site recorded flow between April 26-October 30, 2007 (Figure 9). Total discharge during this period was 129,682,053 cf or 2,979 acre-ft. Total rainfall recorded during the monitoring season was 23.65 inches. Peak discharge of 90.72 cfs occurred on June 8th. The high flows were caused by a probable beaver dam or stream channel blockage removal upstream on June 8th.

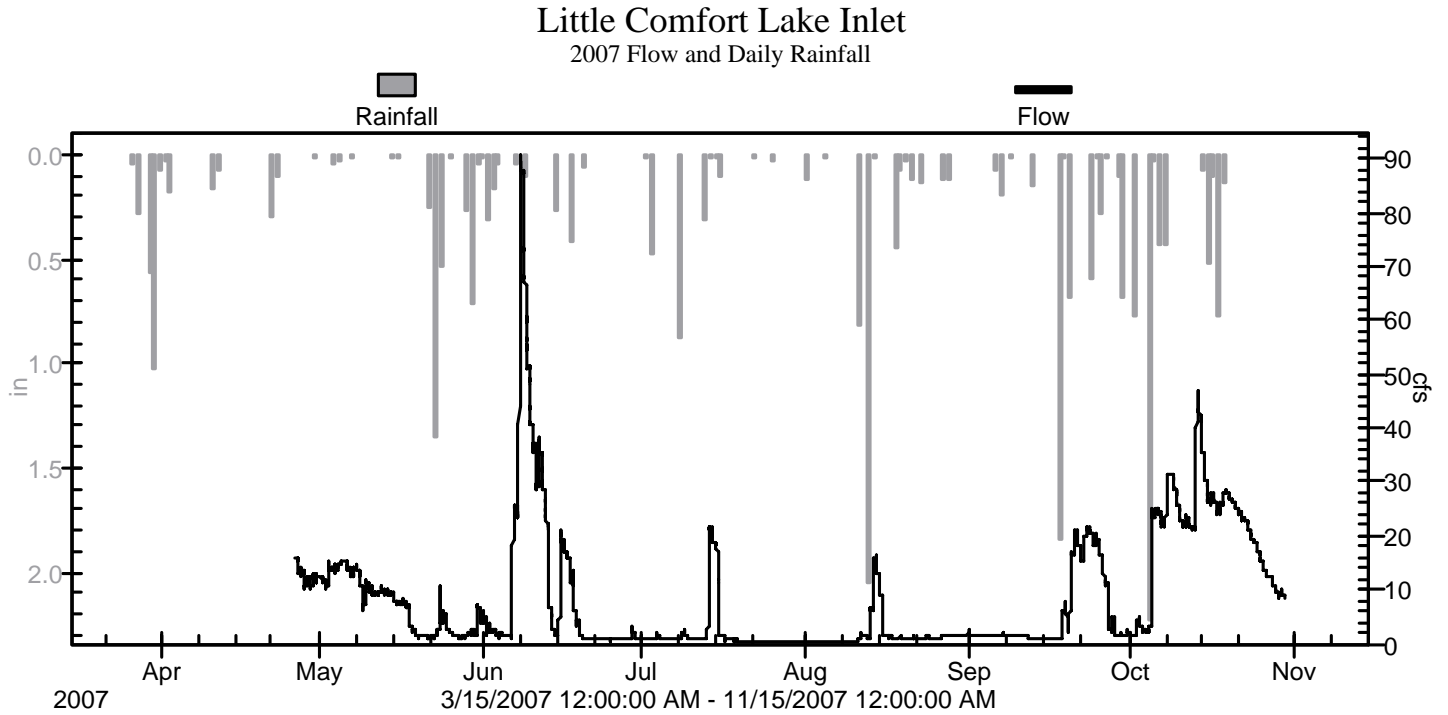


Figure 9. Little Comfort Lake Inlet 2007 Flow and Daily Rainfall

Grab samples were collected at the Little Comfort Lake Inlet site in 2007. The TSS, TKN, TP, VSS, Nitrate, Nitrite, Dissolved Phosphorus, Total Organic Carbon, and *E. coli* results from all collected samples are listed in Table 3 and field water quality measurements are listed in Table 4. The highest concentrations of TKN and TP were 1.40 mg/L (April 2 storm grab, May 24 storm grab, and October 5 storm grab) and 0.165 mg/L (October 5 storm grab) respectively. The TSS maximum concentration of 15 mg/L was from the October 5 storm grab sample. One thing to note is that nutrient concentrations at this site in 2007 from samples collected were significantly lower than in 2006. This may be due to the low precipitation year, but it is most likely due to only grab samples being collected versus having composite samples collected. Composite sampling has the ability to take samples based on flow-weighting, or in other words will take samples based on a specified quantity of water discharged through the site allowing you to capture samples from the entire event and tend to be more representative.

Table 3. Little Comfort Lake Inlet 2007 Sample Chemistry Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved TP (mg/L)	TOC (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)	E. Coli (mpn/100ml)
Storm Grab	4/2/07 9:55	4/2/07 9:55	6	4	1.40	0.080	-0.019	8.8	<0.03	0.24	0.74	
Base Grab	4/23/07 14:51	4/23/07 14:51	3	-2	0.96	-0.049	<0.010		<0.03	0.08		
E. coli Grab	5/2/07 11:10	5/2/07 11:10										30
Base Grab	5/21/07 8:23	5/21/07 8:23	3	-1	0.68	0.054	<0.010	8.9	<0.03	0.09	0.17	
Storm Grab	5/24/07 9:06	5/24/07 9:06	3	-2	1.40	0.070	-0.031	12.8	<0.03	0.06	0.51	
E. coli Grab	6/13/07 9:28	6/13/07 9:28										109
Base Grab	6/28/07 10:45	6/28/07 10:45	4	-2	0.68	0.081	-0.016	10.2	<0.03	<0.05	-0.04	
E. coli Grab	7/16/07 10:10	7/16/07 10:10										147
Storm Grab	8/13/07 9:35	8/13/07 9:35	3	-2	0.95	0.109	-0.037	11.2	<0.03	<0.05	-0.05	
Storm Grab	8/14/07 9:04	8/14/07 9:04	7	-4	0.90	0.092	-0.040	11.9	<0.03	0.05	-0.03	
Base Grab	9/12/07 10:03	9/12/07 10:03	-1	-1	0.31	-0.029	-0.022	4.8	<0.03	<0.05	<0.02	
Storm Grab	9/19/07 13:31	9/19/07 13:31	8	3	0.71	0.065	-0.028	10.4	<0.03	<0.05	-0.03	
Storm Grab	10/5/07 10:30	10/5/07 10:30	15	7	1.40	0.165	0.061	17.6	<0.03	0.22	0.08	
Storm Grab	10/18/07 9:32	10/18/07 9:32	-2	-2	1.10	-0.032	-0.036	12.2	0.06	0.26	0.39	
E. coli Grab	10/18/07 9:32	10/18/07 9:32										41

Table 4. Little Comfort Lake Inlet 2007 Field Water Quality Measurements

Date/Time	Transparency (cm)	Water Temperature (C)	Dissolved Oxygen (mg/L)
4/2/07 10:55		5.1	5.74
4/23/07 14:50	>100	18.5	9.50
5/21/07 8:23	>120	12.1	9.54
5/24/07 9:06	>120	13.9	5.96
6/19/07 9:40		18.3	5.66
6/28/07 10:41		19.8	7.80
7/10/07 9:00	>120	21.2	5.63
9/12/07 10:03	>120	10.2	8.12

Table 5. Little Comfort Lake Inlet 2007 Total Phosphorus and Total Suspended Solids Loading

Sample Type	Sample Collection Time		Loading Interval		Interval Volume (cf)	Interval Volume (ac-ft)	Interval TSS (lb)	Interval TP (lb)		
	Start	End	TSS (mg/L)	TP (mg/L)					Start	End
<i>Base**</i>			3	0.055	1/1/07 0:00	4/1/2007 15:00	11,745,000	269.77	1,955	40.1
Storm Grab	4/2/07 9:55	4/2/07 9:55	6	0.080	4/1/07 15:00	4/2/2007 15:00	604,800	13.89	227	3.0
<i>Base</i>			3	0.055	4/2/07 15:00	4/23/07 0:00	3,520,800	80.87	586	12.0
Base Grab	4/23/07 14:51	4/23/07 14:51	3	0.049	4/23/07 0:00	4/25/07 0:00	345,600	7.94	65	1.1
<i>Base</i>			3	0.055	4/25/07 0:00	4/26/07 15:30	284,400	6.53	47	1.0
Base Grab	5/21/07 8:23	5/21/07 8:23	3	0.054	4/26/07 15:30	5/23/07 8:30	21,678,080	497.92	4,060	73.1
Storm Grab	5/24/07 9:06	5/24/07 9:06	3	0.070	5/23/07 8:30	5/25/07 14:30	853,661	19.61	160	3.7
<i>Base</i>			3	0.055	5/25/07 14:30	5/29/07 17:30	522,670	12.01	87	1.8
Storm			6	0.088	5/29/07 17:30	6/1/07 12:30	935,832	21.49	367	5.1
<i>Base</i>			3	0.055	6/1/07 12:30	6/6/07 8:30	775,857	17.82	129	2.6
<i>Base</i>			3	0.055	6/6/07 8:30	6/19/07 7:30	29,574,620	679.29	4,923	100.9
Base Grab	6/28/07 10:45	6/28/07 10:45	4	0.081	6/19/07 7:30	7/3/07 12:30	1,134,762	26.06	283	5.7
Storm			6	0.088	7/3/07 12:30	7/4/07 15:30	137,835	3.17	54	0.8
<i>Base</i>			3	0.055	7/4/07 15:30	7/8/07 12:30	278,018	6.39	46	0.9
Storm			6	0.088	7/8/07 12:30	7/9/07 13:30	153,673	3.53	60	0.8
<i>Base</i>			3	0.055	7/9/07 13:30	7/13/07 8:30	272,662	6.26	45	0.9
<i>Base</i>			3	0.055	7/13/07 8:30	7/15/07 23:30	3,164,945	72.70	527	10.8
<i>Base</i>			3	0.055	7/15/07 23:30	8/11/07 2:30	914,003	20.99	152	3.1
Storm Grab	8/13/07 9:35	8/13/07 9:35	3	0.109	8/11/07 2:30	8/13/07 19:30	648,687	14.90	121	4.4
Storm Grab	8/14/07 9:04	8/14/07 9:04	7	0.092	8/13/07 19:30	8/15/07 13:30	1,693,230	38.89	740	9.7
Base Grab	9/12/07 10:03	9/12/07 10:03	1	0.029	8/15/07 13:30	9/18/07 6:30	3,517,649	80.80	220	6.4
Storm Grab	9/19/07 13:31	9/19/07 13:31	8	0.065	9/18/07 6:30	9/27/07 11:30	11,662,680	267.88	5,824	47.3
<i>Base</i>			3	0.055	9/27/07 11:30	10/2/07 10:30	758,858	17.43	126	2.6
Storm			6	0.088	10/2/07 10:30	10/3/07 9:30	302,462	6.95	119	1.7
<i>Base</i>			3	0.055	10/3/07 9:30	10/5/07 0:30	323,638	7.43	54	1.1
Storm Grab	10/5/07 10:30	10/5/07 10:30	15	0.165	10/5/07 0:30	10/10/07 19:30	12,588,820	289.15	11,788	129.7
<i>Base</i>			3	0.055	10/10/07 19:30	10/16/07 12:30	14,014,620	321.90	2,333	47.8
Storm Grab	10/18/07 9:32	10/18/07 9:32	2	0.032	10/16/07 12:30	10/21/07 4:30	10,704,130	245.86	1,336	21.4
<i>Base</i>			3	0.055	10/21/07 4:30	10/30/07 10:00	13,070,660	300.22	2,176	44.6
<i>Base**</i>			3	0.055	10/30/07 10:00	1/1/08 0:00	27,036,000	620.99	4,501	92.3
Storm Average			6	0.088						
Base Average			3	0.055						
All Average			5	0.075						
Total							173,218,653	3,979	43,113	676
CLFLWD Major Subwatershed Total Acres										
Total Load							10,513			
Total TP/TSS (lb/ac/yr)									4.10	0.06
Total TP/TSS (kg/ha/yr)									4.60	0.07

*Italics indicate estimated concentrations based on average base and storm flow concentrations

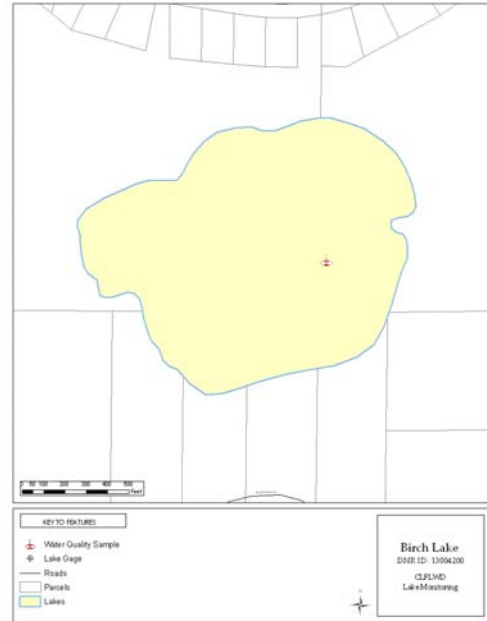
** Interval volumes from 1/1/07 to 4/26/07 and 10/30/07 to 1/1/08 where estimated based upon base flow

Total phosphorus loading for Little Comfort Lake Inlet for 2007 was estimated at 0.06 lb/ac (676 lbs.) (Table 5). Monitoring between Little Comfort Inlet and Bone Lake Outlet helps to explain loading differences between the two sites. One important note is that loading to Little Comfort Lake was significantly less in 2007 than in 2006. This may be due to the low precipitation year, but it is most likely due to only grab samples being collected versus having composite samples collected. Composite sampling has the ability to take samples based on flow-weighting, or in other words will take samples based on a specified quantity of water discharged through the site allowing you to capture samples from the entire event and tend to be more representative.

Birch Lake

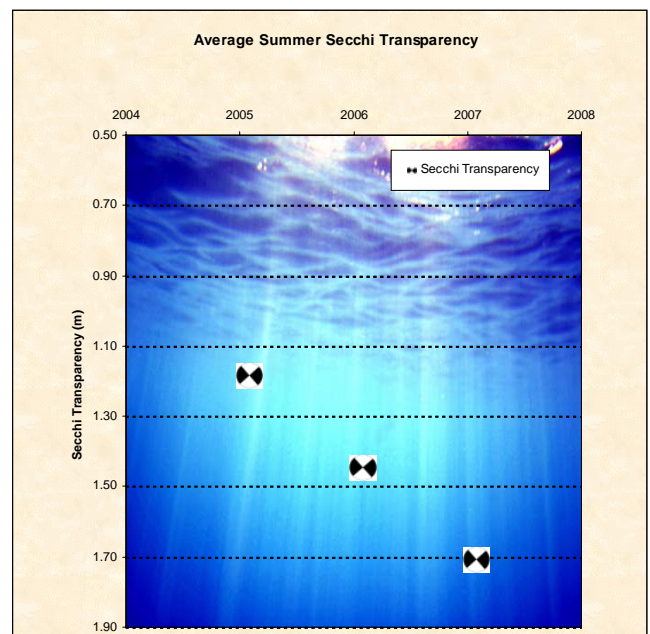
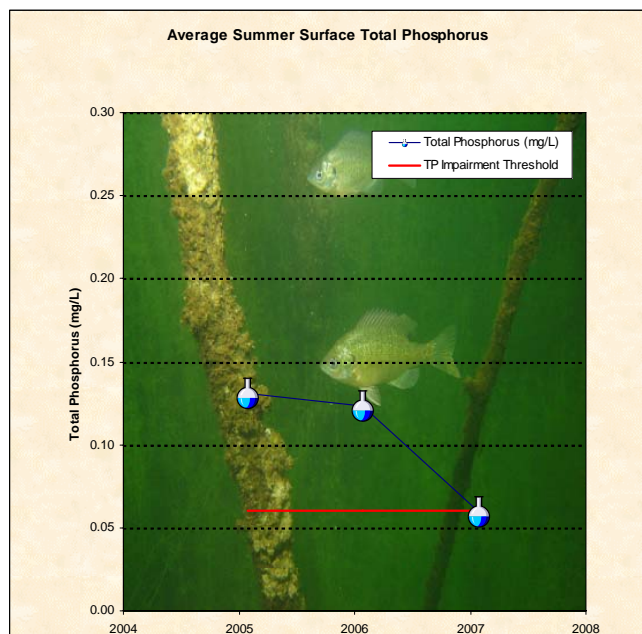
2007 Lake Grade: C

- DNR ID #: 130042
 - Municipality: Wyoming Township
 - Location: SE^{1/4} Section 36 T33N-R21W
 - Lake Size: 33 Acres
 - Maximum Depth: 11 ft
 - Ordinary High Water Mark: N/A
 - 100% Littoral
- Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Birch Lake was considered a eutrophic lake in 2007, based on the Carlson Trophic State Index.
- **Limited amount of Curly Leaf Pondweed (An invasive aquatic plant) is present.**
- At this time, there are not enough years of data to determine a statistically significant trend in overall water quality but the water quality generally appears to be improving.
- The major land use is rural/agricultural.
- The lake did stratify and a thermocline was present for intermittent periods during the monitoring season.



Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depth (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celcius)
4/13/2007	0.036	8	0.99	2.74	6.42	12.5
5/8/2007	0.035	6	1.10	3.20	4.86	27.0
6/4/2007	0.038	12	0.67	2.13	6.30	23.2
7/2/2007	0.070	16	1.10	1.83	4.56	25.9
7/30/2007	0.065	11	1.60	0.91	2.20	22.1
8/28/2007	0.083	41	1.80	1.37	10.51	13.4
9/24/2007	0.042	26	1.40	2.29	8.89	12.2
2007 Average	0.053	17	1.24	2.07	6.25	19.5
2007 Summer Average	0.060	21	1.31	1.71	6.49	19.4

Water Quality threshold is 0.04 mg/L TP or higher*

Shallow Lake water quality threshold is 0.06 mg/L or higher*

	High	High Date	Low	Low Date	Average
2007 Elevation (ft)	NA	NA	NA	NA	NA

*MPCA description of Impaired Lake's Listing criteria: "At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. Data requirements for 303(d) listing consist of 12 or more TP measurements collected from June through September over the most recent 10-year period. Ideally this should represent 12 separate visits to the lake over the course of two summers; however it might also reflect four monthly samples over the course of three years (a typical sampling regimen for many lake monitoring programs). In addition to exceeding the TP guideline thresholds, lakes to be considered for 303(d) listing should have at least 12 Secchi measurements and 12 chlorophyll-a measurements. This amount of data will allow for at least one season (preferably more) of paired TP, chlorophyll-a, and Secchi disk data and provide a basis for evaluating their interrelationships and hence the trophic status of the lake."

Lake Water Quality Summary

Trophic Status

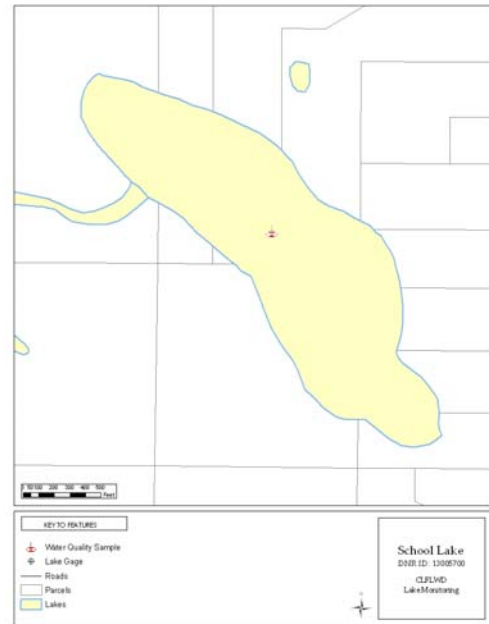
Lake Grades

	2007	2007	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Eutrophic	C	D	D					
Chlorophyll-a (ug/l)	Eutrophic	C	B	D+					
Secchi depth (ft)	Eutrophic	C	C	C-					
Overall	Eutrophic	C	C	D+					

School Lake

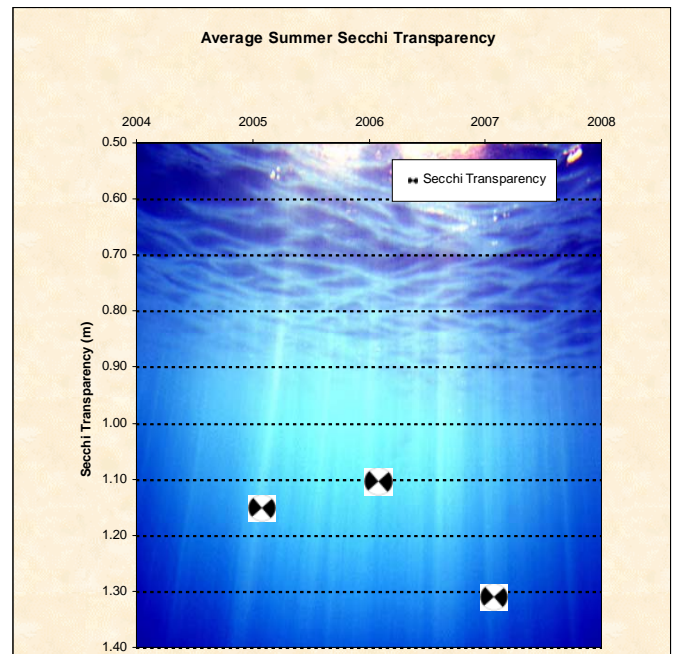
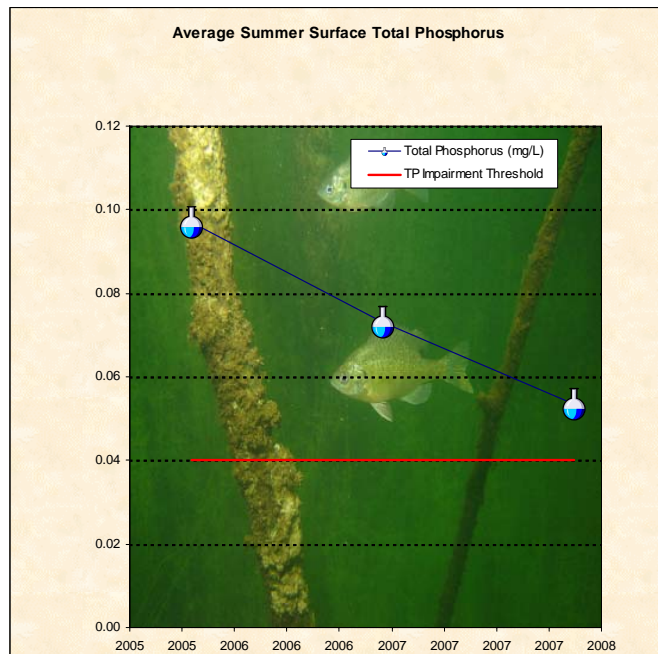
2007 Lake Grade: C

- DNR ID #: 130057
- Municipality: Wyoming Township
- Location: SE^{1/4} Section 36 T33N-R21W
- Lake Size: 47 Acres
- Maximum Depth: 26 ft
- Ordinary High Water Mark: N/A
- 66% Littoral
Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- School Lake was considered a eutrophic lake in 2007, based on the Carlson Trophic State Index.
- **A limited amount of Curly Leaf Pondweed (An invasive aquatic plant) is present**
- At this time, there are not enough years of data to determine a statistically significant trend in overall water quality but the water quality appears to be improving slightly.
- The major land use is rural/agricultural.
- The lake did stratify and a thermocline was present at between a depth of 3 and 4 meters.



Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depth (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celcius)
4/13/2007	0.058	25	1.10	1.52	8.80	14.50
5/8/2007	0.037	33	1.10	1.98	6.44	26.40
6/5/2007	0.041	23	0.70	1.83	9.57	23.70
7/2/2007	0.045	26	0.99	1.07	10.20	27.80
7/30/2007	0.033	18	1.20	1.22	7.14	23.10
8/28/2007	0.065	74	1.50	1.07	5.37	15.90
9/24/2007	0.084	58	1.80	1.37	6.76	13.70
2007 Average	0.052	37	1.20	1.44	7.75	20.73
2007 Summer Average	0.054	40	1.24	1.31	7.81	20.84

Water Quality threshold is 0.04 mg/L TP or higher*

Shallow Lake water quality threshold is 0.06 mg/L or higher*

	High	High Date	Low	Low Date	Average
2007 Elevation (ft)	NA	NA	NA	NA	NA

*MPCA description of Impaired Lake's Listing criteria: "At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. Data requirements for 303(d) listing consist of 12 or more TP measurements collected from June through September over the most recent 10-year period. Ideally this should represent 12 separate visits to the lake over the course of two summers; however it might also reflect four monthly samples over the course of three years (a typical sampling regimen for many lake monitoring programs). In addition to exceeding the TP guideline thresholds, lakes to be considered for 303(d) listing should have at least 12 Secchi measurements and 12 chlorophyll-a measurements. This amount of data will allow for at least one season (preferably more) of paired TP, chlorophyll-a, and Secchi disk data and provide a basis for evaluating their interrelationships and hence the trophic status of the lake."

Lake Water Quality Summary

Trophic Status

Lake Grades

	2007	2007	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Eutrophic	C	C	D					
Chlorophyll-a (ug/l)	Hypereutrophic	C	C	C					
Secchi depth (ft)	Eutrophic	C	C	C-					
Overall	Eutrophic	C	C	C-					

4) Forest Lake Subwatershed

Forest Lake Outlet

The station at the Forest Lake Outlet site recorded stage, velocity, and flow from March 26 to October 29, 2007 (Figure 10). Total discharge during this period was 95,341,217 cf or 2,190 acre-ft. No automated rain gage is installed at this site to determine total seasonal rainfall. The highest discharge recorded of 30.92 cfs occurred on April 1, 2007. This peak is a result of an intense storm event recorded in the general area of this site. The Big Comfort Inlet site received 1.66 inches of rain over a three-day period contributing to this peak discharge event.

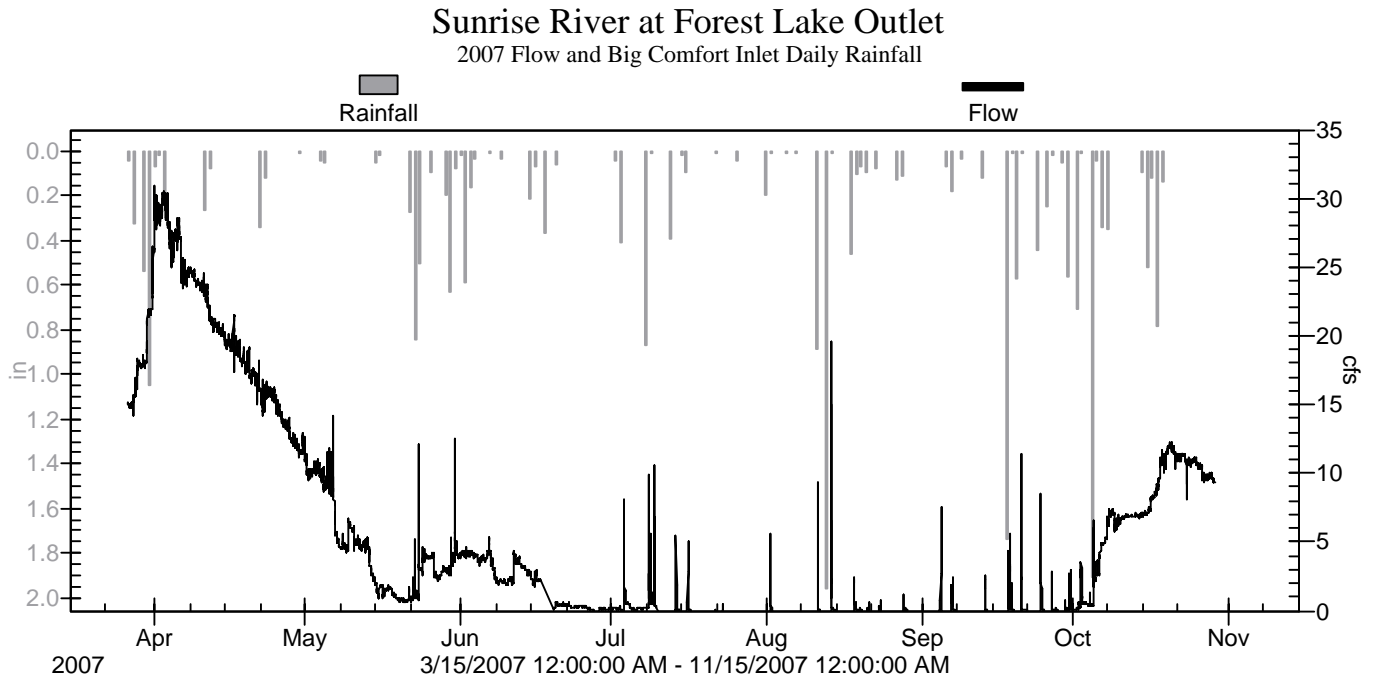


Figure 10. Forest Lake Outlet 2007 Flow and Daily Rainfall

Table 6. Forest Lake Outlet 2007 Total Phosphorus and Total Suspended Solids Loading

Sample Type	Sample Collection Time		Loading Interval		Interval Volume (cf)	Interval Volume (ac-ft)	Interval TSS (lb)	Interval TP (lb)		
	Start	End	TSS (mg/L)	TP (mg/L)					Start	End
Base**			NA	0.035	1/1/07 0:00	3/1/07 0:30	7,649,100	175.69	NA	16.77
Base**			NA	0.035	3/1/07 0:30	3/26/07 15:30	17,712,000	406.82	NA	38.70
Base			NA	0.035	3/26/07 15:30	3/29/07 5:30	3,606,008	82.83	NA	7.88
Storm			NA	0.032	3/29/07 5:30	4/5/07 1:30	15,078,360	346.33	NA	30.12
Base			NA	0.035	4/5/07 1:30	4/22/07 14:30	31,839,180	731.31	NA	69.57
Storm	4/22/2007	4/22/2007	NA	0.017	4/22/07 14:30	4/27/07 12:30	6,355,819	145.99	NA	6.75
Base	5/10/2007	5/10/2007	NA	0.018	4/27/07 12:30	5/18/07 0:30	12,374,640	284.23	NA	13.91
Base	5/19/2007	5/19/2007	NA	0.021	5/18/07 0:30	5/22/07 18:30	402,695	9.25	NA	0.53
Storm			NA	0.032	5/22/07 18:30	5/22/07 19:30	8,281	0.19	NA	0.02
Base			NA	0.035	5/22/07 19:30	5/23/07 14:30	72,863	1.67	NA	0.16
Storm			NA	0.032	5/23/07 14:30	5/26/07 15:30	980,196	22.51	NA	1.96
Base			NA	0.035	5/26/07 15:30	5/30/07 18:30	1,036,811	23.81	NA	2.27
Storm			NA	0.032	5/30/07 18:30	5/31/07 8:30	239,564	5.50	NA	0.48
Base/Intermittent Flow	6/2/07	6/2/2007	NA	0.014	5/31/07 8:30	6/16/07 21:00	4,583,137	105.27	NA	4.01
	NO DATA		NA	0.023	6/16/07 21:00	6/19/07 15:15	0	0.00	NA	0.00
Base/Intermittent Flow	6/28/2007	6/28/2007	NA	0.033	6/19/07 15:15	7/3/07 13:30	268,113	6.16	NA	0.55
Storm			NA	0.032	7/3/07 13:30	7/5/07 19:30	93,608	2.15	NA	0.19
Base/Intermittent Flow			NA	0.035	7/5/07 19:30	7/8/07 13:30	37,872	0.87	NA	0.08
Storm			NA	0.032	7/8/07 13:30	7/8/07 21:30	55,030	1.26	NA	0.11
Base/Intermittent Flow			NA	0.035	7/8/07 21:30	7/13/07 22:30	78,381	1.80	NA	0.17
Storm			NA	0.032	7/13/07 22:30	7/14/07 0:30	9,557	0.22	NA	0.02
Base/Intermittent Flow	7/15/2007	7/15/2007	NA	0.045	7/14/07 0:30	7/16/07 5:30	2,678	0.06	NA	0.01
Storm			NA	0.032	7/16/07 5:30	7/16/07 7:30	11,818	0.27	NA	0.02
Base/Intermittent Flow	7/28/07 0:00	7/28/07 0:00	NA	0.035	7/16/07 7:30	8/1/07 19:30	3,386	0.08	NA	0.01
Storm			NA	0.032	8/1/07 19:30	8/1/07 21:30	14,642	0.34	NA	0.03
Base/Intermittent Flow			NA	0.035	8/1/07 21:30	8/11/07 3:30	3,173	0.07	NA	0.01
Storm			NA	0.032	8/11/07 3:30	8/11/07 4:30	20,911	0.48	NA	0.04
Base/Intermittent Flow	8/12/07	8/12/2007	NA	0.037	8/11/07 4:30	8/13/07 20:30	3,392	0.08	NA	0.01
Storm			NA	0.032	8/13/07 20:30	8/14/07 0:30	68,408	1.57	NA	0.14
Base/Intermittent Flow			NA	0.035	8/14/07 0:30	8/18/07 10:30	4,092	0.09	NA	0.01
Storm			NA	0.032	8/18/07 10:30	8/18/07 13:30	16,740	0.38	NA	0.03
Base/Intermittent Flow	8/23/2007	8/23/2007	NA	0.049	8/18/07 13:30	9/6/07 21:30	55,005	1.26	NA	0.17
Storm			NA	0.032	9/6/07 21:30	9/7/07 6:30	30,372	0.70	NA	0.06
Base/Intermittent Flow	9/9/2007	9/9/2007	NA	0.051	9/7/07 6:30	9/13/07 10:30	2,107	0.05	NA	0.01
Storm			NA	0.032	9/13/07 10:30	9/13/07 12:30	8,590	0.20	NA	0.02
Base/Intermittent Flow	9/17/2007	9/17/2007	NA	0.047	9/13/07 12:30	9/18/07 4:30	3,091	0.07	NA	0.01
Storm			NA	0.032	9/18/07 4:30	9/18/07 21:30	81,042	1.86	NA	0.16
Base/Intermittent Flow			NA	0.035	9/18/07 21:30	9/20/07 17:30	2,615	0.06	NA	0.01
Storm			NA	0.032	9/20/07 17:30	9/20/07 20:30	32,954	0.76	NA	0.07
Base/Intermittent Flow			NA	0.035	9/20/07 20:30	9/24/07 17:30	5,083	0.12	NA	0.01
Storm			NA	0.032	9/24/07 17:30	9/24/07 20:30	17,852	0.41	NA	0.04
Base/Intermittent Flow			NA	0.035	9/24/07 20:30	9/26/07 19:30	1,239	0.03	NA	0.00
Storm			NA	0.032	9/26/07 19:30	9/26/07 21:30	7,958	0.18	NA	0.02
Base/Intermittent Flow			NA	0.035	9/26/07 21:30	9/30/07 4:30	6,647	0.15	NA	0.01
Storm			NA	0.032	9/30/07 4:30	9/30/07 17:30	37,239	0.86	NA	0.07
Base/Intermittent Flow			NA	0.035	9/30/07 17:30	10/2/07 15:30	23,970	0.55	NA	0.05
Storm			NA	0.032	10/2/07 15:30	10/2/07 20:30	28,966	0.67	NA	0.06
Base/Intermittent Flow			NA	0.035	10/2/07 20:30	10/5/07 3:30	97,305	2.23	NA	0.21
Storm	10/5/07	10/5/2007	NA	0.042	10/5/07 3:30	10/6/07 7:30	307,996	7.07	NA	0.81
Base			NA	0.035	10/6/07 7:30	10/7/07 23:30	698,079	16.03	NA	1.53
Storm			NA	0.032	10/7/07 23:30	10/9/07 9:30	846,835	19.45	NA	1.69
Base			NA	0.035	10/9/07 9:30	10/16/07 13:30	4,236,289	97.30	NA	9.26
Storm	10/20/07	10/20/2007	NA	0.037	10/16/07 13:30	10/22/07 22:30	5,810,897	133.47	NA	13.42
Base			NA	0.035	10/22/07 22:30	10/29/07 8:30	5,729,730	131.61	NA	12.52
Base**			NA	0.035	10/29/07 8:30	1/1/08 0:00	8,248,500	189.46	NA	18.02
Storm Average			NA	0.032						
Base Average			NA	0.035						
All Average			NA	0.034						
Total							128,950,817	2,962	NA	253
CLFLWD Major Subwatershed Total Acres							8,719			
Total Load										
Total TP/TSS (lb/ac/yr)									NA	0.03
Total TP/TSS (kg/ha/yr)									NA	0.03

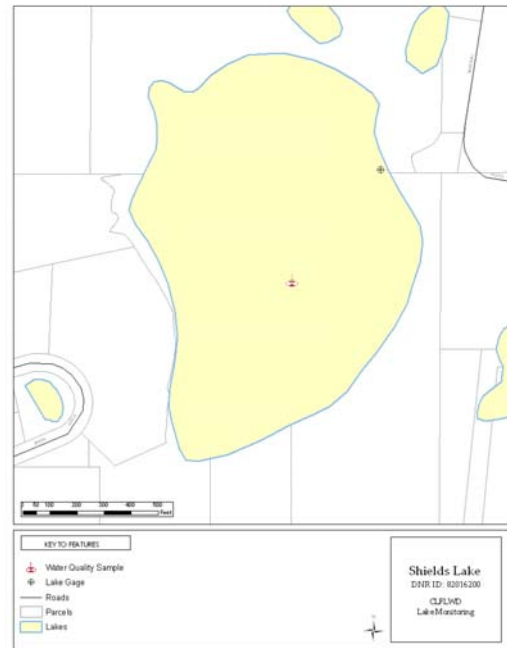
*Italics indicate estimated concentrations based on average base and storm flow concentrations
 ** Interval volumes from 1/1/07 to 3/26/07 and 10/29/07 to 1/1/08 where estimated based upon base flow

Although no samples were collected at the Forest Lake Outlet site in 2007, the WCD used in-lake concentrations to estimate a total phosphorus load at this location. Total phosphorus loading for Forest Lake Outlet for 2007 was estimated at 0.03 lb/ac (253 lbs.) (Table 6). Utilizing this data and the loading data from the County Line Ditch location will allow the CLFLWD to quantify the load originating from the City of Forest Lake that drains through the Bixby Park area.

Shields Lake

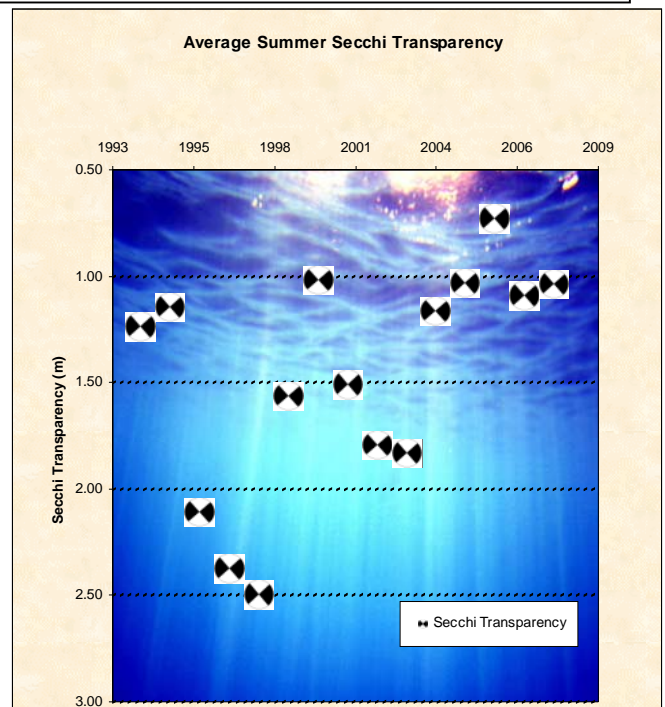
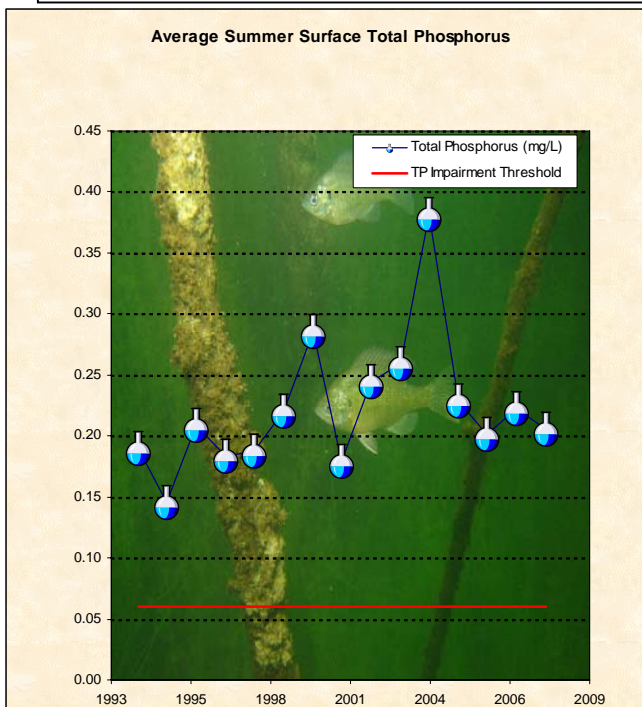
2007 Lake Grade: D

- DNR ID #: 820162
 - Municipality: City of Forest Lake
 - Location: NE^{1/4} Section 22 T32N-R21W
 - Lake Size: 26 Acres
 - Maximum Depth: 27 ft
 - Ordinary High Water Mark: 902.5 ft
 - 87% Littoral
- Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Shields Lake was considered a hypereutrophic lake in 2007, based on the Carlson Trophic State Index.
- Shields Lake is listed on the MPCA's Impaired Waters List
- **There is an overall decreasing statistically significant trend in Secchi transparency and a statistically significant increasing trend in total phosphorus, both indicating decreasing water quality.**
- **Curly leaf pondweed (an invasive aquatic plant) is extensive in this lake.**
- The major land use is a mix of semi-urban, rural, and agricultural.
- The lake did stratify and a thermocline was present at an average depth of 3 meters.



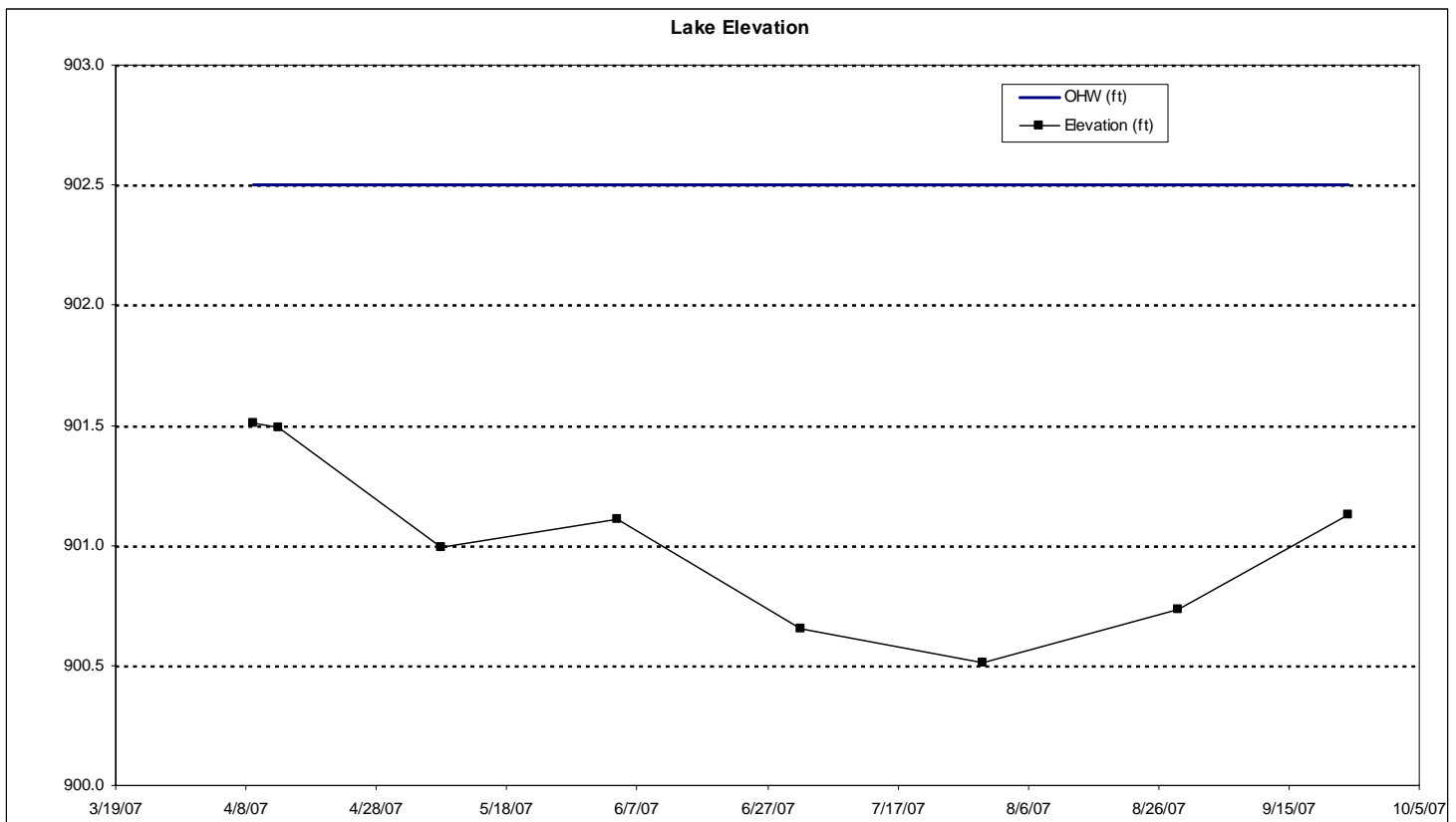
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depth (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celcius)
4/13/2007	0.311	100	2.10	0.91	19.96	5.50
5/8/2007	0.166	12	1.70	2.90	11.16	18.10
6/4/2007	0.347	7	1.50	2.29	3.17	22.10
7/2/2007	0.236	67	2.60	0.61	5.19	27.00
7/30/2007	0.099	38	2.50	0.91	10.25	32.40
8/29/2007	0.157	62	2.30	0.61	5.37	24.10
9/24/2007	0.189	53	2.50	0.76	8.63	21.90
2007 Average	0.215	48	2.17	1.28	9.10	21.59
2007 Summer Average	0.206	45	2.28	1.04	6.52	25.50

Water Quality threshold is 0.04 mg/L TP or higher*

Shallow Lake water quality threshold is 0.06 mg/L or higher*

	High	High Date	Low	Low Date	Average
2007 Elevation (ft)	901.51	4/9/2007	900.51	7/30/2007	901.02

*MPCA description of Impaired Lake's Listing criteria: "At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. Data requirements for 303(d) listing consist of 12 or more TP measurements collected from June through September over the most recent 10-year period. Ideally this should represent 12 separate visits to the lake over the course of two summers; however it might also reflect four monthly samples over the course of three years (a typical sampling regimen for many lake monitoring programs). In addition to exceeding the TP guideline thresholds, lakes to be considered for 303(d) listing should have at least 12 Secchi measurements and 12 chlorophyll-a measurements. This amount of data will allow for at least one season (preferably more) of paired TP, chlorophyll-a, and Secchi disk data and provide a basis for evaluating their interrelationships and hence the trophic status of the lake."



Lake Water Quality Summary

	Trophic Status		Lake Grades							
	2007		2007	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Hypereutrophic		F	F	F	F	F	F	F	F
Chlorophyll-a (ug/l)	Hypereutrophic		C	D	D+	C	C	C	C	C
Secchi depth (ft)	Eutrophic		D	D	D+	C	C	C	C	C
Overall	Hypereutrophic		D	D-	D-	D+	D+	D	D	D

5) Comfort Lake Subwatershed

County Line Ditch

The County Line Ditch site was a new site added to the CLFLWD monitoring network in 2007. The primary purpose of this site was to isolate loads coming from the City of Forest Lake, Forest Lake, and quantify the load previous to discharging to Shallow Pond for determination of phosphorus release or capture between this location and Comfort Lake. The station at the County Line Ditch recorded flow from March 27, 2007 to October 29, 2007. Total discharge during this period was 132,890,500 cf or 3,052 acre-ft. Total rainfall for the monitoring season was 20.65 inches. A peak flow of 46.89 cfs occurred on October 19 from a cumulative rainfall of 1.19 inches that fell from October 15-19. One note about this location is that due to the heavy sedimentation present within the channel, difficulty arose when flow was at a minimum and the deepest point within the channel where the sensor would ideally be located would change frequently and either bury the sensor or re-route the deepest point in the channel around the sensor.

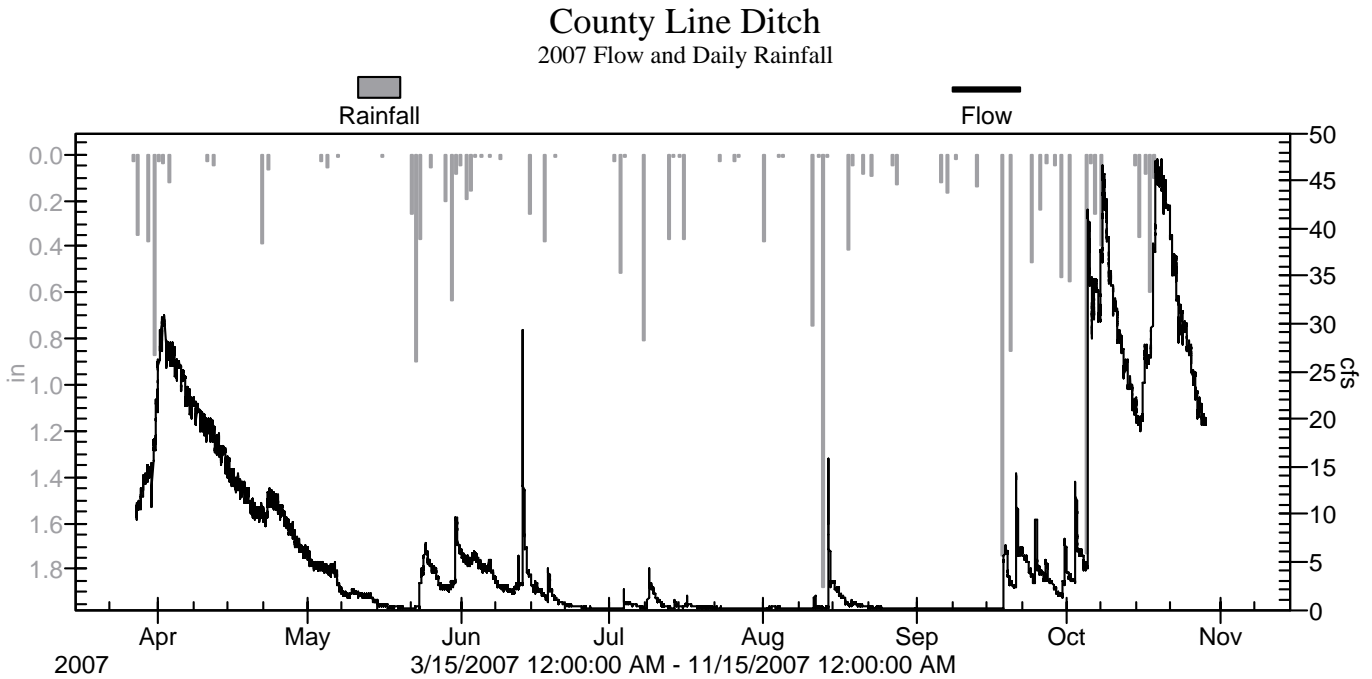


Figure 11. County Line Ditch 2007 Flow and Daily Rainfall

Grab samples and flow weighted composite samples were taken at the County Line Ditch site. The TSS, TKN, TP, VSS, Nitrate, Nitrite, Dissolved Phosphorus, Total Organic Carbon, and *E. Coli* results from all collected samples are listed in Table 7 and field water quality measurements are listed in Table 8. The highest TSS concentration of 64 mg/L was collected in a storm composite sample between August 13 and August 14, 2007. The highest TKN concentration of 6.40 mg/L was collected in a June 28, 2007 base grab sample. The highest TP concentration of 0.302 mg/L was collected in an August 11, 2007 storm composite sample. These results show that even during base flow sample collection, concentrations are still high during the summer months. This leads to a conclusion that phosphorus is leaving upstream locations due to both anoxic conditions in shallow, warm water areas, allowing the phosphorus to mobilize and also leaving wetland/peat areas that dry out and allowing the phosphorus to mobilize during storm events when inundation occurs again.

Table 7. County Line Ditch 2007 Sample Chemistry Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved TP (mg/L)	TOC (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)	E. Coli (mpn/100ml)
Snowmelt Grab	3/12/2007 11:00	3/12/2007 11:00	~2	~1	2.90	-0.049	-0.037	7.2	<0.03	0.25	0.24	
Storm Composite	3/30/2007 12:41	3/31/2007 22:15	6	~2	1.40	0.050	<0.010	7.2	<0.03	0.20	0.37	
Base Composite	4/19/2007 22:07	4/22/2007 14:06	4	3	1.00	-0.041	<0.010		<0.03	0.07	0.08	
E. Coli Grab	5/2/2007 10:45	5/2/2007 10:45										22
Base Grab	5/21/2007 9:03	5/21/2007 9:03	15	~7	3.40	0.179	-0.011	14.6	<0.03	0.09	0.50	
Storm Composite	5/25/2007 6:23	5/25/2007 19:55	5	3	2.20	0.087	-0.026	15.4	<0.03	0.08	0.07	
Storm Composite	5/30/2007 22:59	5/31/2007 12:51	12	7	1.80	0.123	-0.031		<0.03	<0.05	-0.03	
E. Coli Grab	6/13/2007 10:02	6/13/2007 10:02										186
Storm Grab	6/18/2007 14:59	6/18/2007 14:59	15	~8	3.10	0.252	-0.028	12.4	0.04	0.23	0.54	
Base Grab	6/28/2007 8:44	6/28/2007 8:44	14	~5	6.40	0.263	-0.017	16.6	<0.03	<0.05	2.70	
Base Grab	7/10/2007 9:51	7/10/2007 9:51	12	7	3.80	0.280	0.144	12.2	<0.03	<0.05	0.37	
E. Coli Grab	7/16/2007 10:37	7/16/2007 10:37										>2420
Base Grab	7/19/2007 9:17	7/19/2007 9:17	7	~5	3.20	0.228	0.085	16.4	<0.03	<0.05	0.42	
Storm Composite	8/11/2007 5:18	8/11/2007 9:48	52	19	1.90	0.302	0.115		<0.03	0.64	0.17	
Storm Composite	8/13/2007 21:59	8/14/2007 9:07	64	21	2.10	0.230	0.074		<0.03	0.58	0.18	
Base Grab	9/12/2007 12:03	9/12/2007 12:03	6	3	2.10	-0.048	-0.017	11.3	0.05	<0.05	0.09	
Storm Composite	9/18/2007 9:29	9/19/2007 3:27	17	~5	1.30	0.188	0.100		<0.03	0.32	-0.06	
Storm Composite	9/20/2007 20:42	9/22/2007 8:51	12	~4	1.40	-0.096	0.055		<0.03	0.30	0.08	
Storm Composite	9/30/2007 18:48	9/30/2007 22:40	9	~3	2.40	0.126	-0.047		<0.03	0.09	-0.02	
Storm Composite	10/5/2007 6:44	10/6/2007 0:57	27	~7	1.30	0.109	0.054		<0.03	0.37	-0.06	
E. Coli Grab	10/18/2007 10:23	10/18/2007 10:23										328

Table 8. County Line Ditch 2007 Field Water Quality Measurements

Date/Time	Transparency (cm)	Water Temperature (C)	Dissolved Oxygen (mg/L)
4/2/07 11:47		5.2	8.10
4/23/07 14:17	>100	15.8	8.98
5/21/07 9:02	55	13.1	1.67
5/25/07 9:13		13.5	3.69
5/29/07 9:15		19.1	2.68
6/1/07 9:23	90	20.7	1.58
6/5/07 9:42	>120	18.0	3.46
6/28/07 8:44		17.4	1.01
7/10/07 9:51	105	22.7	1.70
7/19/07 9:17		22.2	2.59
8/14/07 9:30	42		
9/12/07 12:03	>120	11.0	8.68
10/2/07 10:19	94	15.4	2.64
10/9/07 9:01	63	15.8	3.67
Exceeds Water Quality Standard			

Table 9. County Line Ditch 2007 Total Phosphorus and Total Suspended Solids Loading

Sample Type	Sample Collection Time		Loading Interval		Interval Volume (cf)	Interval Volume (ac ft)	Interval TSS (lb)	Interval TP (lb)		
	Start	End	TSS (mg/L)	TP (mg/L)					Start	End
<i>Base</i>			<i>10.4</i>	<i>0.198</i>	<i>1/1/06 0:00</i>	<i>3/12/07 11:00</i>	<i>5,643,540</i>	<i>129.6</i>	<i>3,664</i>	<i>69.8</i>
Snowmelt Grab	3/12/2007 11:00	3/12/2007 11:00	2.0	0.049	3/12/07 11:00	3/15/07 11:00	2,788,992	64.1	348	8.5
<i>Base</i>			<i>10.4</i>	<i>0.198</i>	<i>3/15/07 11:00</i>	<i>3/27/07 13:30</i>	<i>156,870</i>	<i>3.6</i>	<i>102</i>	<i>1.9</i>
<i>Base</i>			<i>10.4</i>	<i>0.198</i>	<i>3/27/07 13:30</i>	<i>3/30/07 12:30</i>	<i>3,322,808</i>	<i>76.3</i>	<i>2,157</i>	<i>41.1</i>
Storm Composite	3/30/2007 12:41	3/31/2007 22:15	6.0	0.050	3/30/07 12:30	4/5/07 10:30	10,730,036	246.5	4,019	33.5
Base Composite	4/19/2007 22:07	4/22/2007 14:06	4.0	0.041	4/5/07 10:30	4/22/07 14:30	24,062,660	552.7	6,009	61.6
<i>Storm</i>			<i>21.9</i>	<i>0.156</i>	<i>4/22/07 14:30</i>	<i>4/26/07 13:30</i>	<i>371,845</i>	<i>85.3</i>	<i>5,077</i>	<i>36.2</i>
Base Grab	5/21/2007 9:03	5/21/2007 9:03	15.0	0.179	4/26/07 13:30	5/23/07 15:30	6,454,246	148.2	6,044	72.1
Storm Composite	5/25/2007 6:23	5/25/2007 19:55	5.0	0.087	5/23/07 15:30	5/26/07 6:30	10,785,566	24.8	337	5.9
<i>Base</i>			<i>10.4</i>	<i>0.198</i>	<i>5/26/07 6:30</i>	<i>5/30/07 18:30</i>	<i>1,080,862</i>	<i>24.8</i>	<i>702</i>	<i>13.4</i>
Storm Composite	5/30/2007 22:59	5/31/2007 12:51	12.0	0.123	5/30/07 18:30	5/31/07 14:30	543,157	12.5	407	4.2
<i>Base</i>			<i>10.4</i>	<i>0.198</i>	<i>5/31/07 14:30</i>	<i>6/18/07 12:30</i>	<i>5,899,758</i>	<i>135.5</i>	<i>3,830</i>	<i>73.0</i>
Storm Grab	6/18/2007 14:59	6/18/2007 14:59	15.0	0.252	6/18/07 12:30	6/19/07 2:30	136,912	3.1	128	2.2
Base Grab	6/28/2007 8:44	6/28/2007 8:44	14.0	0.263	6/19/07 2:30	7/3/07 14:30	458,813	10.5	401	7.5
<i>Storm</i>			<i>21.9</i>	<i>0.156</i>	<i>7/3/07 14:30</i>	<i>7/4/07 1:30</i>	<i>46,726</i>	<i>1.1</i>	<i>64</i>	<i>0.5</i>
<i>Base</i>			<i>10.4</i>	<i>0.198</i>	<i>7/4/07 1:30</i>	<i>7/8/07 15:30</i>	<i>165,903</i>	<i>3.8</i>	<i>108</i>	<i>2.1</i>
<i>Storm</i>			<i>21.9</i>	<i>0.156</i>	<i>7/8/07 15:30</i>	<i>7/9/07 13:30</i>	<i>205,354</i>	<i>4.7</i>	<i>281</i>	<i>2.0</i>
Base Grab	7/10/2007 9:51	7/10/2007 9:51	12.0	0.280	7/9/07 13:30	7/10/07 10:30	122,232	2.8	92	2.1
Base Grab	7/19/2007 9:17	7/19/2007 9:17	7.0	0.228	7/10/07 10:30	8/11/07 4:30	543,378	12.5	237	7.7
Storm Composite	8/11/2007 5:18	8/11/2007 9:48	52.0	0.302	8/11/07 4:30	8/11/07 10:30	17,395	0.4	56	0.3
<i>Base</i>			<i>10.4</i>	<i>0.198</i>	<i>8/11/07 10:30</i>	<i>8/13/07 21:30</i>	<i>44,586</i>	<i>1.0</i>	<i>29</i>	<i>0.6</i>
Storm Composite	8/13/2007 21:59	8/14/2007 9:07	64.0	0.230	8/13/07 21:30	8/14/07 9:30	358,184	8.2	1,431	5.1
Base Grab	9/12/2007 12:03	9/12/2007 12:03	6.0	0.048	8/14/07 9:30	9/18/07 8:30	973,472	22.4	365	2.9
Storm Composite	9/18/2007 9:29	9/19/2007 3:27	17.0	0.188	9/18/07 8:30	9/19/07 9:30	456,087	10.5	484	5.4
<i>Base</i>			<i>10.4</i>	<i>0.198</i>	<i>9/19/07 9:30</i>	<i>9/20/07 18:30</i>	<i>324,564</i>	<i>7.5</i>	<i>211</i>	<i>4.0</i>
Storm Composite	9/20/2007 20:42	9/22/2007 8:51	12.0	0.096	9/20/07 18:30	9/22/07 11:30	1,060,467	24.4	794	6.4
<i>Base</i>			<i>10.4</i>	<i>0.198</i>	<i>9/22/07 11:30</i>	<i>9/24/07 15:30</i>	<i>807,794</i>	<i>18.6</i>	<i>524</i>	<i>10.0</i>
<i>Storm</i>			<i>21.9</i>	<i>0.156</i>	<i>9/24/07 15:30</i>	<i>9/25/07 5:30</i>	<i>305,565</i>	<i>7.0</i>	<i>418</i>	<i>3.0</i>
<i>Base</i>			<i>10.4</i>	<i>0.198</i>	<i>9/25/07 5:30</i>	<i>9/26/07 20:30</i>	<i>532,488</i>	<i>12.2</i>	<i>346</i>	<i>6.6</i>
<i>Storm</i>			<i>21.9</i>	<i>0.156</i>	<i>9/26/07 20:30</i>	<i>9/27/07 6:30</i>	<i>155,457</i>	<i>3.6</i>	<i>213</i>	<i>1.5</i>
<i>Base</i>			<i>10.4</i>	<i>0.198</i>	<i>9/27/07 6:30</i>	<i>9/30/07 7:30</i>	<i>586,737</i>	<i>13.5</i>	<i>381</i>	<i>7.3</i>
Storm Composite	9/30/2007 18:48	9/30/2007 22:40	9.0	0.126	9/30/07 7:30	10/1/07 2:30	307,925	7.1	173	2.4
<i>Base</i>			<i>10.4</i>	<i>0.198</i>	<i>10/1/07 2:30</i>	<i>10/2/07 16:30</i>	<i>463,866</i>	<i>10.7</i>	<i>301</i>	<i>5.7</i>
<i>Storm</i>			<i>21.9</i>	<i>0.156</i>	<i>10/2/07 16:30</i>	<i>10/3/07 4:30</i>	<i>408,231</i>	<i>9.4</i>	<i>558</i>	<i>4.0</i>
<i>Base</i>			<i>10.4</i>	<i>0.198</i>	<i>10/3/07 4:30</i>	<i>10/5/07 4:30</i>	<i>962,499</i>	<i>22.1</i>	<i>625</i>	<i>11.9</i>
Storm Composite	10/5/2007 6:44	10/6/2007 0:57	27.0	0.109	10/5/07 4:30	10/7/07 10:30	6,446,596	148.1	10,866	43.9
<i>Base</i>			<i>10.4</i>	<i>0.198</i>	<i>10/7/07 10:30</i>	<i>10/7/07 23:30</i>	<i>1,442,836</i>	<i>33.1</i>	<i>937</i>	<i>17.9</i>
<i>Storm</i>			<i>21.9</i>	<i>0.156</i>	<i>10/7/07 23:30</i>	<i>10/10/07 11:30</i>	<i>8,357,328</i>	<i>192.0</i>	<i>11,426</i>	<i>81.5</i>
<i>Base</i>			<i>10.4</i>	<i>0.198</i>	<i>10/10/07 11:30</i>	<i>10/16/07 2:30</i>	<i>12,169,821</i>	<i>279.5</i>	<i>7,901</i>	<i>150.6</i>
<i>Storm</i>			<i>21.9</i>	<i>0.156</i>	<i>10/16/07 2:30</i>	<i>10/22/07 11:30</i>	<i>20,108,302</i>	<i>461.9</i>	<i>27,491</i>	<i>196.2</i>
<i>Base</i>			<i>10.4</i>	<i>0.198</i>	<i>10/22/07 11:30</i>	<i>10/29/07 9:30</i>	<i>16,090,931</i>	<i>369.6</i>	<i>10,447</i>	<i>199.1</i>
<i>Base</i>			<i>10.4</i>	<i>0.198</i>	<i>10/29/07 9:30</i>	<i>12/1/07 0:30</i>	<i>28,188,000</i>	<i>647.4</i>	<i>18,301</i>	<i>348.8</i>
<i>Base</i>			<i>10.4</i>	<i>0.198</i>	<i>12/1/07 0:30</i>	<i>1/1/08 0:00</i>	<i>401,490</i>	<i>9.2</i>	<i>261</i>	<i>5.0</i>
Storm Average			21.9	0.156						
Base Average			10.4	0.198						
Snowmelt Average			2.0	0.049						
All Average			16.4	0.156						
Total							168,125,270	3,205	109,981	1,212
CLFLWD Major Subwatershed Total Acres							9,806			
Total TP/TSS (lb/ac/yr)									11.22	0.124
Total TP/TSS (kg/ha/yr)									12.57	0.138

*Italics indicate estimated concentrations based on average base and storm flow concentrations

** Interval volumes from 1/1/07 to 3/27/07 and 10/29/07 to 1/1/08 where estimated based upon base flow

Total phosphorus loading for the County Line Ditch Site for 2007 was estimated at 0.12 lb/ac (1,121 lbs.) (Table 9). If you utilize the loading data from this site with the loading data from the Forest Lake Outlet site, you can estimate that approximately 950 lbs. of phosphorus is leaving the City of Forest Lake through the Bixby Park area. One item that the monitoring staff noticed with regards to the data at this site is that although the channel has substantial sedimentation within it, the sediment does not appear to be originating from high TSS concentrations. The sediment load in the channel and what was sampled appears to be present due to a large volume of water carrying the sediment versus small volumes carrying high concentrations. Volume control rules could substantially eliminate the problem of high loads due to transport of sediment and phosphorus.

Comfort Lake Inlet

The station for the Comfort Lake Inlet site recorded flow between March 26-October 30, 2007 (Figure 12). Total discharge during this period was 188,797,829 cf or 4,336 acre-ft. Total rainfall for the monitoring season was 22.42 inches. A peak flow of 43.58 cfs occurred on April 2, 2007 due to precipitation events between March 30 and April 2 totaling 1.68 inches.

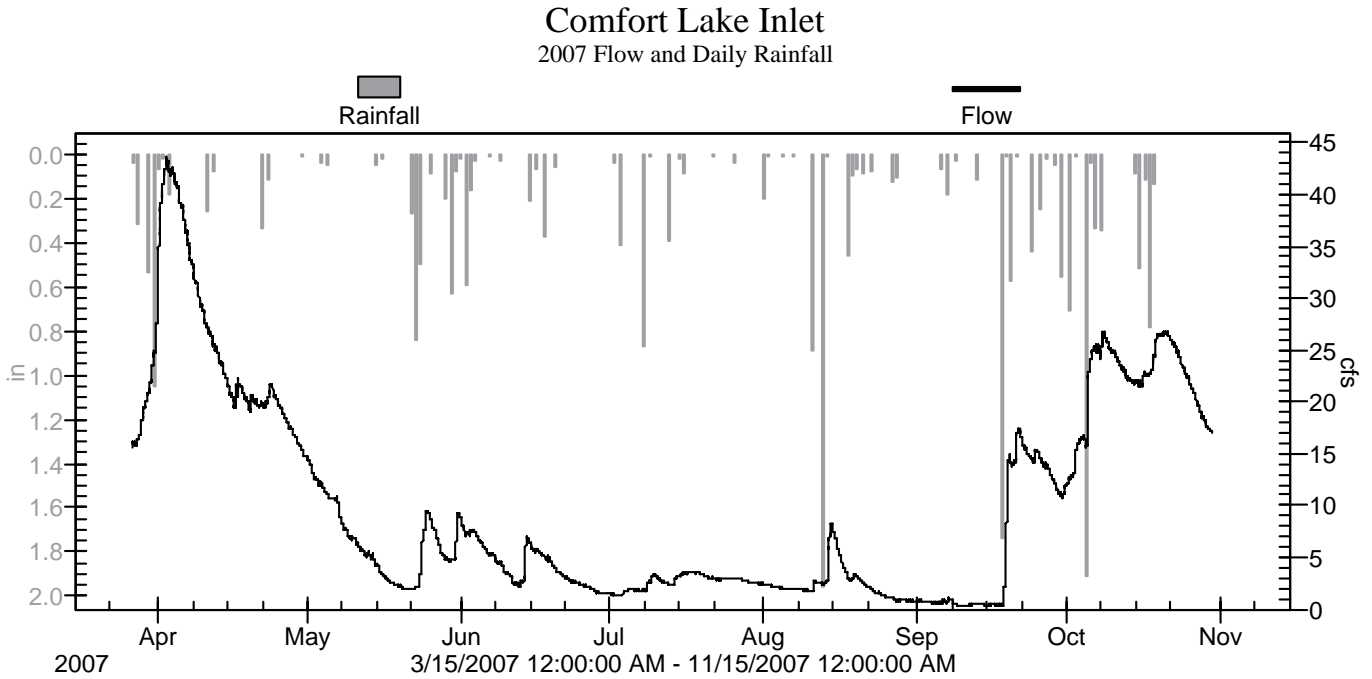


Figure 12. Comfort Lake Inlet 2007 Flow and Daily Rainfall

Grab samples were taken at the Comfort Lake Inlet site in 2007. The TSS, TKN, TP, VSS, Nitrate, Nitrite, Dissolved Phosphorus, Total Organic Carbon, and *E. Coli* results from all collected samples are listed in Table 10 and field water quality measurements are listed in Table 11. The highest TSS and TP concentrations of 25 mg/L and 0.196 mg/L respectively were collected in a storm grab sample on October 5, 2007. The highest TKN concentration of 3.00 mg/L was collected in a snowmelt grab on March 12, 2007.

Table 10. Comfort Lake Inlet 2007 Sample Chemistry Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved TP (mg/L)	TOC (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)	E. Coli (mpn/100ml)
Snowmelt Grab	3/12/07 10:30	3/12/07 10:30	~2	~1	3.00	0.052	-0.022	7.6	<0.03	0.35	0.25	
Storm Grab	4/2/07 10:09	4/2/07 10:09	3	~1	1.40	0.056	-0.046	11.9	<0.03	0.42	0.14	
Base Grab	4/23/07 14:21	4/23/07 14:21	3	~2	1.50	-0.039	<0.010		<0.03	0.18	-0.03	
E. coli Grab	5/2/07 11:00	5/2/07 11:00										31
Base Grab	5/21/07 8:46	5/21/07 8:46	~2	~1	1.50	0.052	-0.010	13.7	0.04	0.81	0.20	
Storm Grab	5/24/07 9:31	5/24/07 9:31	13	6	2.60	0.097	-0.013	14.5	0.04	0.20	0.19	
E. coli Grab	6/13/07 9:43	6/13/07 9:43										115
Base Grab	6/28/07 9:42	6/28/07 9:42	~1	~1	1.70	0.074	-0.040	9.6	0.07	0.95	0.24	
Storm Grab	7/10/07 9:31	7/10/07 9:31	3	~1	2.00	0.113	0.066	9.9	<0.03	0.32	0.16	
E. coli Grab	7/16/07 10:23	7/16/07 10:23										127
Base Grab	7/19/07 8:58	7/19/07 8:58	5	~2	1.80	0.086	<0.010	11.7	0.03	0.68	0.25	
Storm Grab	8/14/07 9:17	8/14/07 9:17	18	~7	1.60	0.173	-0.043	16.9	<0.03	0.23	0.17	
Base Grab	9/12/07 11:07	9/12/07 11:07	3	~2	1.10	-0.048	-0.021	4.6	0.10	1.76	0.06	
Storm Grab	9/19/07 13:48	9/19/07 13:48	21	~6	1.80	0.139	0.071	5.1	0.03	0.26	0.17	
Storm Grab	10/2/07 9:58	10/2/07 9:58	4	~2	2.50	0.084	0.050	15.3	<0.03	0.25	0.20	
Storm Grab	10/5/07 11:00	10/5/07 11:00	25	12	1.50	0.196	0.078	15.2	<0.03	0.29	0.24	
Storm Grab	10/16/07 14:40	10/16/07 14:40	4	~3	1.50	0.064	-0.041	14.2	<0.03	0.11	0.07	
Storm & E. Coli Grab	10/18/07 9:48	10/18/07 9:48	5	4	1.40	0.053	<0.010	13.4	<0.03	0.12	-0.04	649

Table 11. Comfort Lake Inlet 2007 Field Water Quality Measurements

Date/Time	Transparency (cm)	Water Temperature (C)	Dissolved Oxygen (mg/L)
4/2/07 11:09		4.2	6.90
4/23/07 14:41	>100	15.4	11.04
5/21/07 8:45	>120	12.0	6.50
5/24/07 9:30	95	16.2	2.28
6/19/07 10:18		17.3	3.87
6/28/07 9:42		16.6	2.89
7/10/07 9:31	>120	20.8	3.50
7/19/07 8:58		22.9	1.73
9/12/07 11:06	>120	11.6	5.46
10/2/07 9:58	>120	15.7	3.65
Exceeds Water Quality Standard			

Table 12. Comfort Lake Inlet 2007 Total Phosphorus and Total Suspended Solids Loading

Sample Type	Sample Collection Time		TSS (mg/L)		TP (mg/L)		Loading Interval		Interval Volume (cf)	Interval Volume (ac-ft)	Interval TSS (lb)	Interval TP (lb)
	Start	End			Start	End						
Base**			2.8	0.060	1/1/07 0:00	3/12/07 10:30	12,171,600	279.6	2,128	45.4		
Snowmelt Grab	3/12/07 10:30	3/12/07 10:30	2.0	0.052	3/12/07 10:30	3/15/07 10:15	3,758,265	86.3	469	12.2		
Base**			2.8	0.060	3/15/07 10:15	3/26/07 14:15	9,648,000	221.6	1,686	36.0		
Storm Grab	4/2/07 10:09	4/2/07 10:09	3.0	0.056	3/26/07 14:15	4/5/07 23:15	27,156,376	623.8	5,086	94.9		
Base Grab	4/23/07 14:21	4/23/07 14:21	3.0	0.039	4/5/07 23:15	4/22/07 15:15	35,665,970	819.2	6,679	86.8		
Storm			10.7	0.108	4/22/07 15:15	4/24/07 18:15	3,807,051	87.4	2,535	25.7		
Base Grab	5/21/07 8:46	5/21/07 8:46	2.0	0.052	4/24/07 18:15	5/23/07 15:15	21,830,537	501.4	2,726	70.9		
Storm Grab	5/24/07 9:31	5/24/07 9:31	13.0	0.097	5/23/07 15:15	5/25/07 23:15	1,523,936	35.0	1,237	9.2		
Base			2.8	0.060	5/25/07 23:15	5/30/07 19:15	2,416,397	55.5	422	9.0		
Storm			10.7	0.108	5/30/07 19:15	6/1/07 3:15	960,583	22.1	640	6.5		
Base			2.8	0.060	6/1/07 3:15	6/2/07 0:15	581,752	13.4	102	2.2		
Storm			10.7	0.108	6/2/07 0:15	6/4/07 2:15	1,336,810	30.7	890	9.0		
Base Grab	6/28/07 9:42	6/28/07 9:42	1.0	0.074	6/4/07 2:15	7/8/07 14:15	9,849,600	226.2	615	45.5		
Storm Grab	7/10/07 9:31	7/10/07 9:31	3.0	0.113	7/8/07 14:15	7/10/07 10:15	475,621	10.9	89	3.4		
Base Grab	7/19/07 8:58	7/19/07 8:58	5.0	0.086	7/10/07 10:15	8/13/07 21:15	7,776,905	178.6	2,427	41.8		
Storm Grab	8/14/07 9:17	8/14/07 9:17	18.0	0.173	8/13/07 21:15	8/18/07 1:15	2,039,813	46.9	2,292	22.0		
Base Grab	9/12/07 11:07	9/12/07 11:07	3.0	0.048	8/18/07 1:15	9/18/07 4:15	2,773,595	63.7	519	8.3		
Storm Grab	9/19/07 13:48	9/19/07 13:48	21.0	0.139	9/18/07 4:15	9/20/07 18:15	2,262,408	52.0	2,966	19.6		
Storm			10.7	0.108	9/20/07 18:15	9/22/07 3:15	1,976,703	45.4	1,316	13.4		
Base			2.0	0.060	9/22/07 3:15	9/24/07 18:15	3,393,733	78.0	424	12.7		
Storm			10.7	0.108	9/24/07 18:15	9/25/07 11:15	933,977	21.5	622	6.3		
Base			2.0	0.060	9/25/07 11:15	9/30/07 5:15	5,317,223	122.1	664	19.8		
Storm Grab	10/2/07 9:58	10/2/07 9:58	4.0	0.084	9/30/07 5:15	10/5/07 3:15	5,997,098	137.7	1,498	31.4		
Storm Grab	10/5/07 11:00	10/5/07 11:00	25.0	0.196	10/5/07 3:15	10/7/07 23:15	5,871,259	134.9	9,163	71.8		
Storm			10.7	0.108	10/7/07 23:15	10/9/07 3:15	2,629,139	60.4	1,751	17.8		
Base			2.8	0.060	10/9/07 3:15	10/16/07 12:15	14,783,212	339.6	2,584	55.2		
Storm Grab	10/16/07 14:40	10/16/07 14:40	4.0	0.064	10/16/07 12:15	10/17/07 22:15	2,755,992	63.3	688	11.0		
Storm Grab	10/18/07 9:48	10/18/07 9:48	5.0	0.053	10/17/07 22:15	10/22/07 21:15	11,024,121	253.2	3,441	36.5		
Base			2.8	0.060	10/22/07 21:15	10/30/07 9:30	13,658,016	313.7	2,387	51.0		
Base			2.8	0.060	10/30/07 9:30	12/1/07 0:00	27,306,000	627.2	4,773	101.9		
Base**			2.8	0.060	12/1/07 0:00	1/1/08 0:00	5,356,800	123.0	936	20.0		
Storm Average			10.7	0.108								
Base Average			2.8	0.060								
Snowmelt Average			2.0	0.052								
All Average			7.5	0.088								
Total								247,038,494	5,674	63,755	997	
CLFLWD Major Subwatershed Total Acres								13,732				
Total TP/TSS (lb/ac/yr)										4.64	0.07	
Total TP/TSS (kg/ha/yr)										5.20	0.08	

*Italics indicate estimated concentrations based on average base and storm flow concentrations
 ** Interval volumes from 1/1/07 to 3/26/07 and 10/30/07 to 1/1/08 where estimated based upon base flow

Total phosphorus loading at the Comfort Lake Inlet for 2007 was estimated at 0.07 lb/ac (997 lbs.) (Table 12). In order to properly assess the capture or release capacity of the Shallow Pond wetland area, we can compare the County Line Ditch monitoring site’s loading data and this site’s loading data to determine how this particular wetland functioned in 2007. Based on the loading estimates, the area between the County Line Ditch site and this monitoring site added approximately 200 lbs of phosphorus. It is cautioned that TSS and TP loading calculation are estimates and some variability within its interpretation exists. Based on this data, the Shallow Pond wetland area did not appear to be a large phosphorus contributor to Comfort Lake in 2007. If management options were to be addressed with projects, our opinion is to have efforts focused more on the areas upstream of the County Line Ditch monitoring site, mainly originating from the City of Forest Lake, and less on the wetland restoration of Shallow Pond.

Comfort Lake Outlet

The station for the Comfort Lake Outlet site recorded flow from March 26-July 12, 2007 (Figure 13). This site had numerous problems and difficulties throughout the monitoring season leading to a poor dataset. The flow sensor malfunctioned on April 4 and was replaced on April 20 leaving a gap in the data during that period. On July 12, vandalism began at the site where the sensor cord was cut rendering the site inoperable except for rainfall data. A replacement sensor was purchased, installed and cut again. At that time, it was decided to discontinue purchasing new sensors until we knew that the vandalism would not continue. No data was recorded with the exception of manual stage measurements and rainfall until October 29, 2007. Observations during site visits noted numerous periods of artificial damming at the outlet, which was most likely an attempt to keep an elevated lake level during dry periods. Recorded flow during operation periods was 56,286,780 cf or 1293 acre/ft. Total rainfall for the monitoring season was 21.42 inches. On April 2, 2007, the highest flow was recorded for the monitoring season at 78.51 cfs. This high flow was due to precipitation events between March 30 and April 2 totaling 1.60 inches. No water quality data was collected at the Comfort Outlet site in 2007.

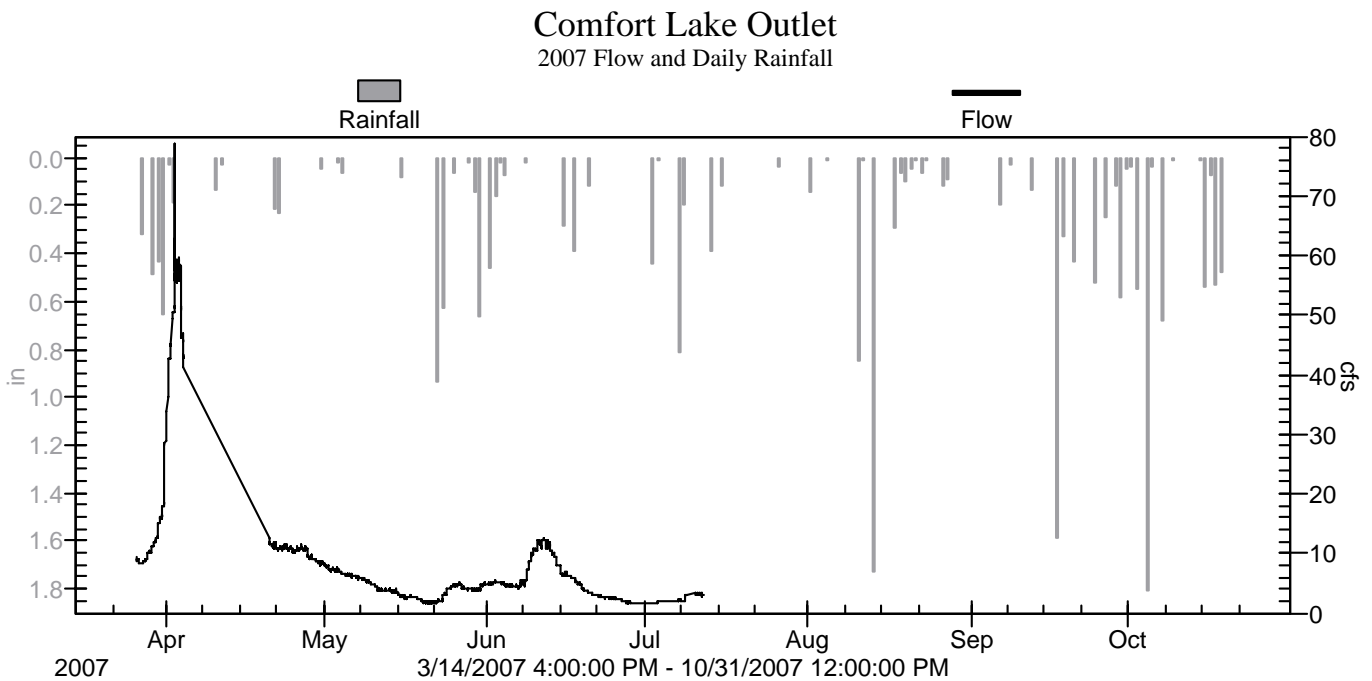


Figure 13. Comfort Lake Outlet 2007 Flow and Daily Rainfall

5. Watershed Phosphorus Flow Chart

2007 Total Phosphorus Loads and In-Lake Concentrations at Monitored Waters

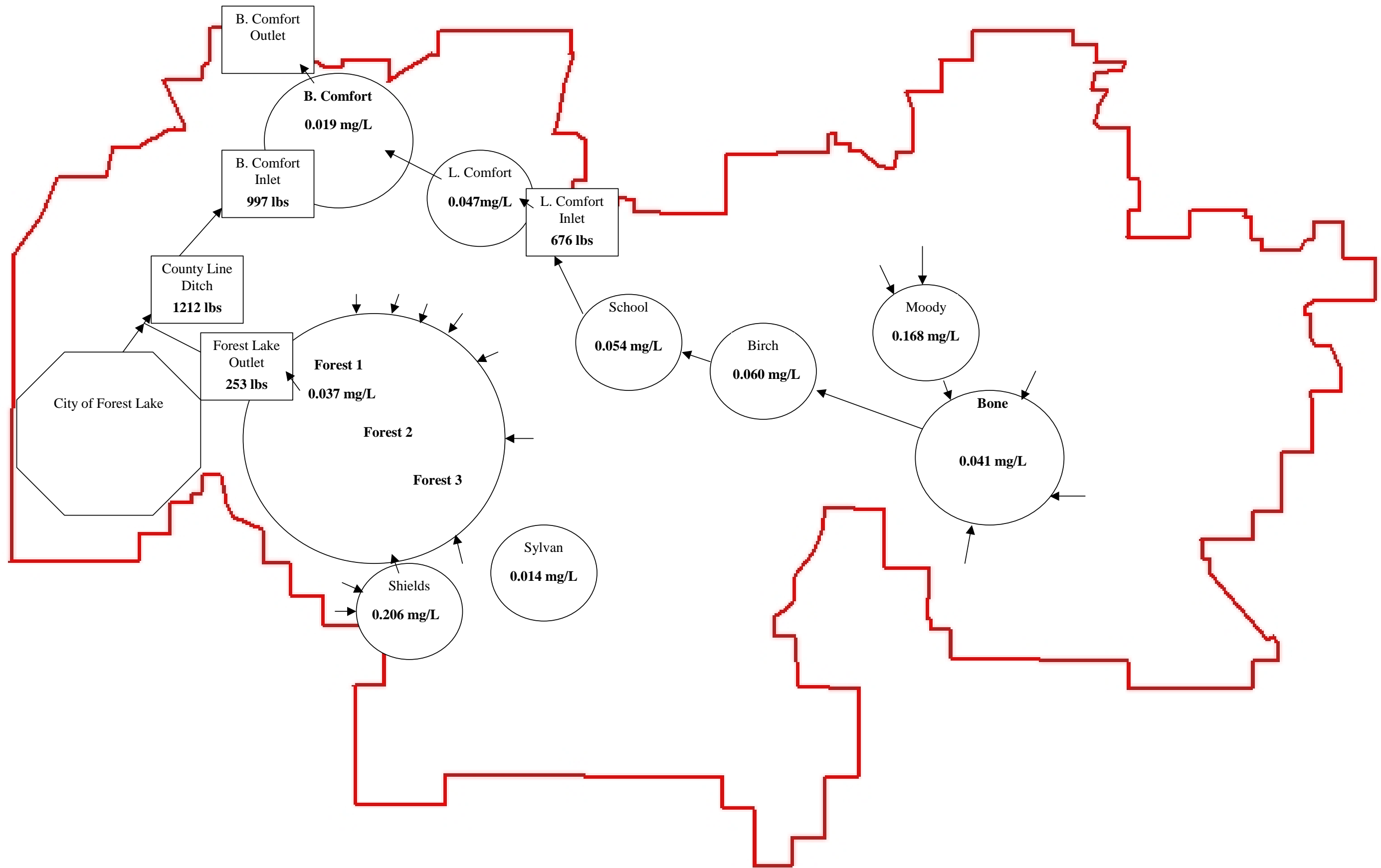


Figure 14. Watershed Summer Average Lake Phosphorus Concentrations and Total Phosphorus Load Water Quality Flow Chart

6) Historical Lake Water Quality Charts

1993-2007 Summer Surface Averages

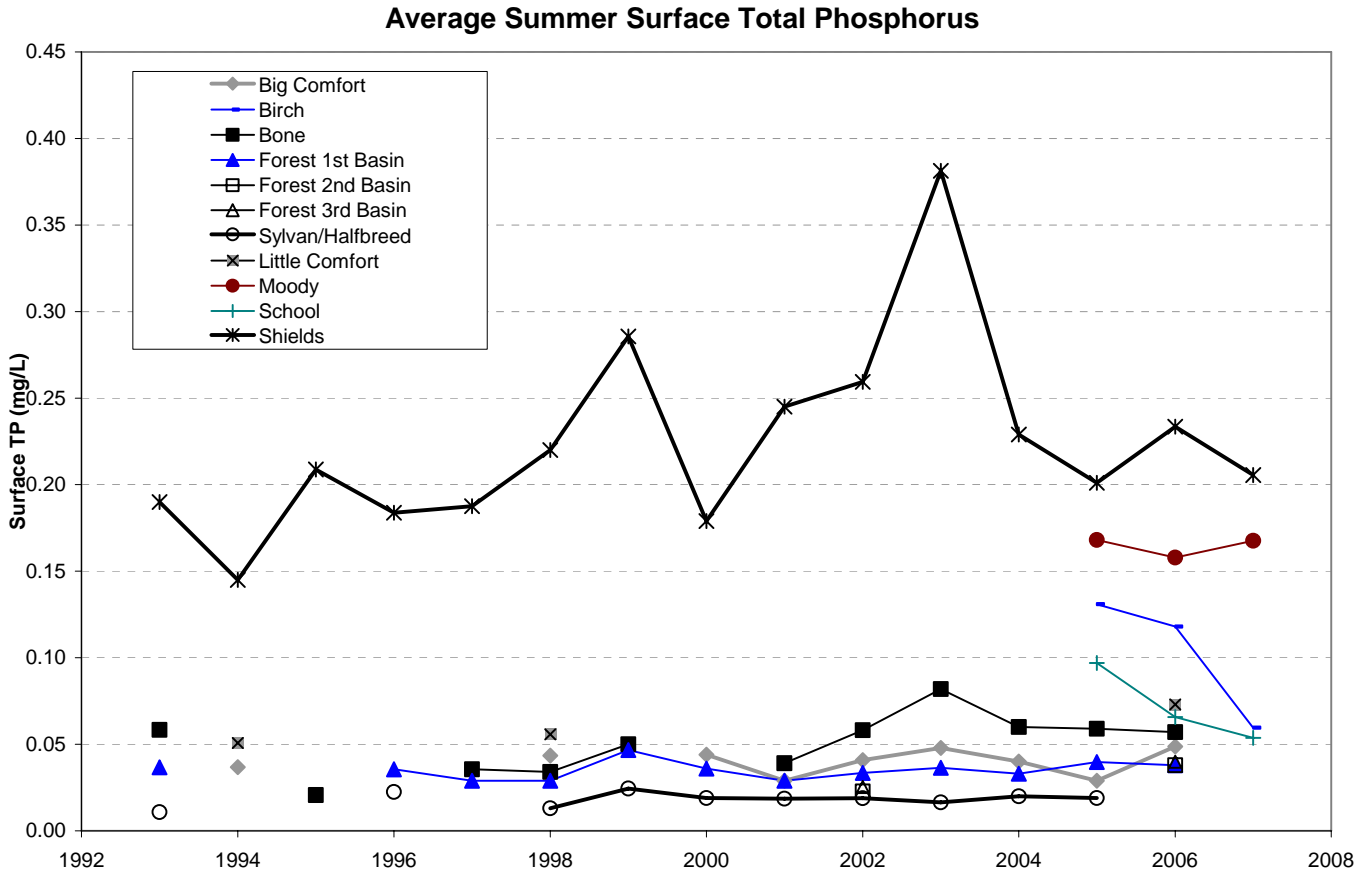


Figure 15. Historical Average Summer Surface Total Phosphorus

High concentrations of phosphorus were seen again in 2007 as well as historically in Shields Lake and Moody Lake, when compared to the rest of the watershed. Birch Lake and School Lake both had a reduction in total phosphorus in 2007 when compared to 2006. Due to a small data set on these two lakes, we cannot determine if this is a statistically significant long-term trend at this time, but do recommend continuing to track this data. One possible explanation is that because of dry conditions throughout much of the monitoring season, decreased discharge from Bone Lake and other upstream locations may have reduced the total phosphorus present in these lakes.

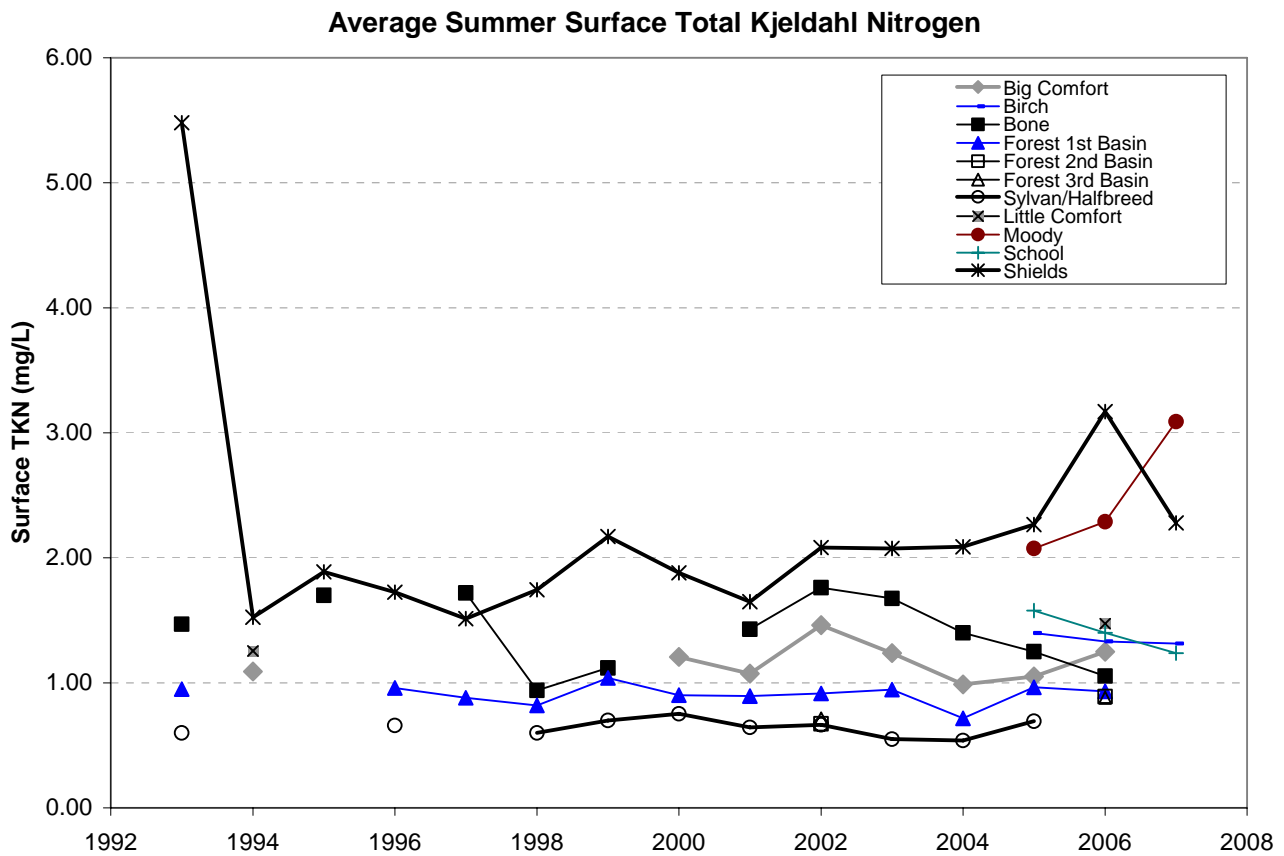


Figure 16. Historical Average Summer Surface Total Kjeldahl Nitrogen

Although nitrogen is usually not a production-limiting nutrient in this region, projects to address external and internal sources of nutrients should be thoroughly analyzed to address all nutrients including nitrogen. Locations such as agricultural production areas in this region can provide large sources of nutrients including both phosphorus and nitrogen. Future implementation to prevent runoff from these sources should be considered when locating projects.

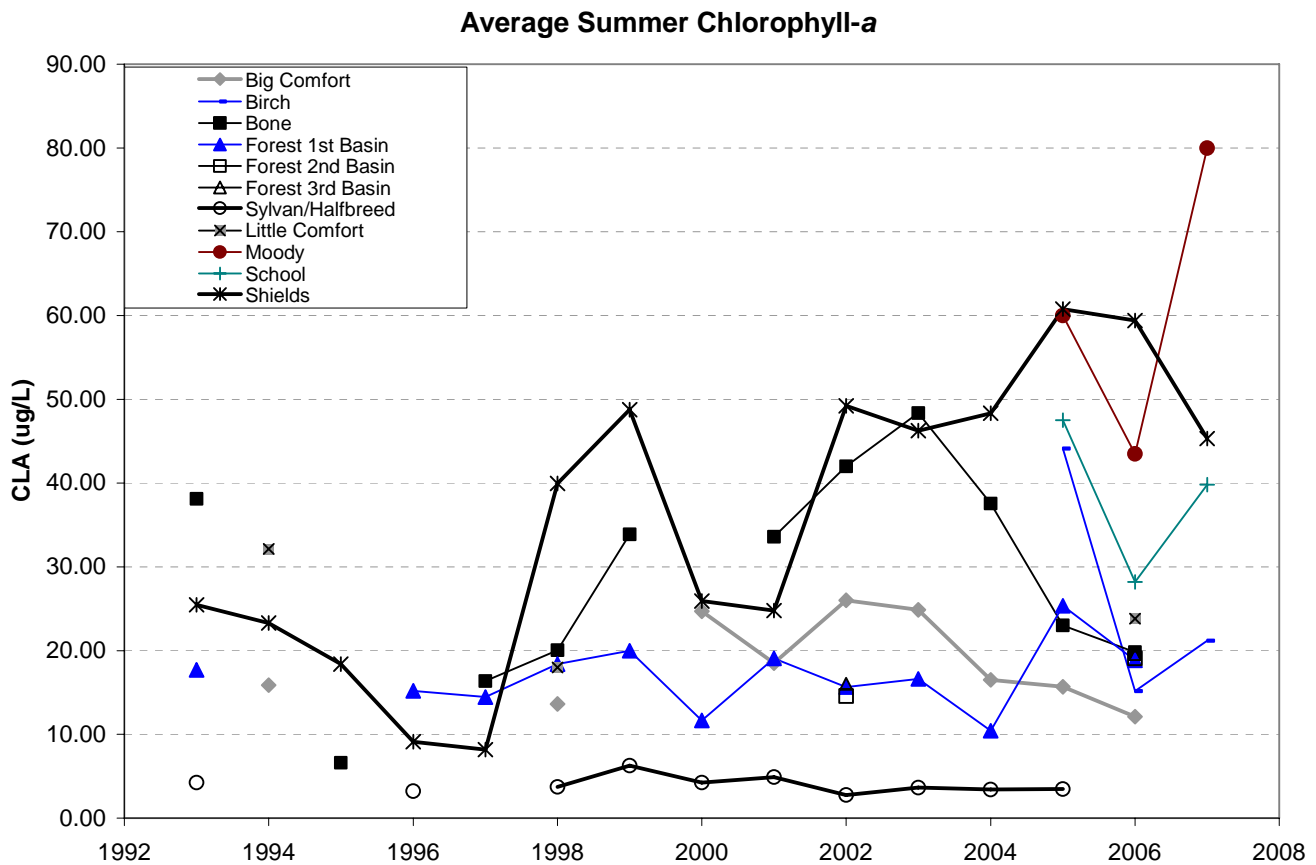


Figure 17. Historical Average Summer CLA

A significant increase in chlorophyll-a (CLA) was observed in Moody Lake in 2007 compared to 2006. School and Birch Lake both had increases in CLA as well in 2007. Interestingly, the phosphorus concentrations in School and Birch were both less than in 2006. This may indicate that some other factor such as zooplankton or the fishery that may be affecting algal production. Randy Anhorn of the CLFLWD performed a macrophyte survey on both Birch Lake and School Lake and indicated that no significant stands of curly leaf pondweed were present to contribute additional phosphorus, and in response, additional CLA in these lakes. Data shows that the production within the lakes of the CLFLWD is limited mainly by phosphorus. Addressing projects to limit nutrient-rich sources (mainly phosphorus sources), will in turn limit chlorophyll-a production and lessen impacts to the waters from algae and phytoplankton proliferation.

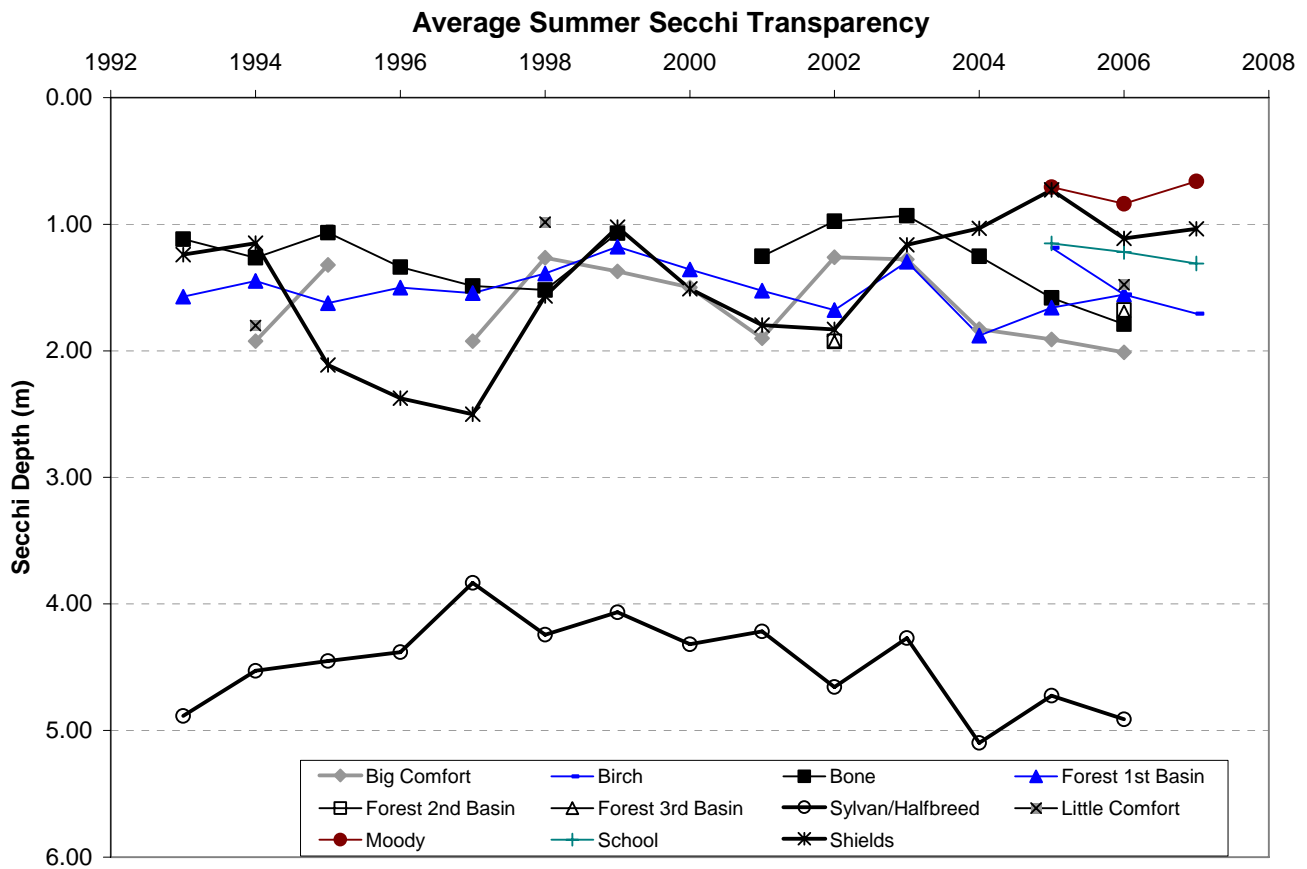


Figure 18. Historical Average Summer Secchi Transparencies

Birch Lake and School Lake showed a slight increase in transparency in 2007 compared to 2006. This increase corresponds with lower phosphorus concentrations in both lakes but does not correspond with the 2007 CLA concentrations. Shields Lake transparencies decreased slightly in 2007 compared to 2006. Moody lake had worse transparencies in 2007 compared to 2006, which corresponds with higher TP and CLA concentrations in the lake for 2007 compared to 2006.

7) Historical Stream Loading and Discharge Summary

Table 13. CLFLWD Historical Stream Discharge and Rainfall Summary

Site	Year	Monitoring Season	Total Monitored Discharge		Growing Season (June 1-Sept 30) Discharge*		Yearly Estimated Discharge		Monitored Rainfall (inches)
			Cubic Feet	Acre Feet	Cubic Feet	Acre Feet	Cubic Feet	Acre Feet	
Tributary to Sunrise River at Bone Lake North Inlet	2003	5/27/03-10/30/03	24,899,320	571.61	23,012,779	528.30	NA	NA	12.73
Tributary to Sunrise River at Bone Lake North Inlet	2005	3/29/05-11/1/05	10,010,637	229.81	3,370,684	77.38	14,075,577	323.13	20.73
Tributary to Sunrise River at Bone Lake North Inlet	2006	5/1/06-10/25/06	3,384,957	77.71	1,892,891	43.46	9,625,678	220.98	15.67
Tributary to Sunrise River at Bone Lake Outlet	2003	5/27/03-10/30/03	50,260,434	1,153.83	45,627,921	1,047.48	NA	NA	12.35
Tributary to Sunrise River at Bone Lake Outlet	2004	3/24/04-11/2/04	59,146,211	1,357.82	27,081,226	621.70	66,316,511	1,522.43	18.03
Tributary to Sunrise River at Bone Lake Outlet	2005	3/29/05-11/1/05	20,545,175	471.66	7,753,089	177.99	26,115,815	599.54	18.27
Tributary to Sunrise River at Bone Lake Outlet	2006	5/1/06-10/30/06	11,915,009	273.53	6,821,497	156.60	23,460,532	538.58	14.08
Tributary to Sunrise River at Bone Lake South Inlet	2005	4/5/05-11/1/05	13,281,086	304.89	4,581,651	105.18	23,004,776	528.12	No Data Available at Site
Tributary to Sunrise River at Bone Lake South Inlet	2006	5/1/06-10/30/06	5,506,279	126.41	2,278,834	52.32	15,794,923	362.60	No Data Available at Site
Tributary to Sunrise River at Shields Outlet/Forest Inlet	2005	4/20/05-11/1/05	17,656,788	405.35	11,446,896	262.79	27,638,328	634.49	19.63
Tributary to Sunrise River at Shields Outlet/Forest Inlet	2006	5/2/06-10/30/06	8,168,305	187.52	4,119,142	94.56	17,784,049	408.27	13.18
Sunrise River at Forest Lake Outlet	2003	5/29/03-10/11/03	139,734,323	3,207.88	134,712,756	3,092.60	NA	NA	No Data Available at Site
Sunrise River at Forest Lake Outlet	2004	3/31/04-11/2/04	170,016,264	3,903.06	93,716,849	2,151.46	233,100,967	5,351.30	No Data Available at Site
Sunrise River at Forest Lake Outlet	2005	3/24/05-11/2/05	136,280,894	3,128.60	59,097,451	1,356.70	187,748,294	4,310.14	No Data Available at Site
Sunrise River at Forest Lake Outlet	2006	5/2/06-10/25/06	47,205,184	1,083.69	21,006,901	482.26	92,349,949	2,120.08	No Data Available at Site
Sunrise River at Forest Lake Outlet	2007	3/26/07-10/29/07	95,341,217	2,188.75	5,378,189	123.47	128,950,817	2,960.32	No Data Available at Site
Sunrise River at County Line Ditch	2007	3/27/07-10/29/07	132,890,500	3,050.77	13,265,950	304.55	168,125,270	3,859.65	20.65
Tributary to Sunrise River at Little Comfort Lake Inlet	2004	5/4/04-11/2/04	102,844,258	2,361.00	79,549,516	1,826.22	172,272,256	3,954.85	19.59
Tributary to Sunrise River at Little Comfort Lake Inlet	2005	3/29/05-11/2/05	113,288,933	2,600.77	56,782,372	1,303.55	149,011,733	3,420.86	21.99
Tributary to Sunrise River at Little Comfort Lake Inlet	2006	5/4/06-10/30/06	68,248,790	1,566.79	42,677,774	979.75	131,946,491	3,029.10	16.89
Tributary to Sunrise River at Little Comfort Lake Inlet	2007	4/26/07-10/30/07	129,682,053	2,977.11	54,709,030	1,255.96	173,218,653	3,976.58	23.65
Sunrise River at Comfort Lake Inlet	2004	4/5/04-11/2/04	267,300,025	6,136.41	147,834,005	3,393.83	422,272,825	9,694.12	20.97
Sunrise River at Comfort Lake Inlet	2005	3/29/05-11/2/05	200,161,344	4,595.10	93,498,873	2,146.45	284,332,944	6,527.43	22.48
Sunrise River at Comfort Lake Inlet	2006	5/2/06-10/30/06	73,915,488	1,696.88	40,363,884	926.63	163,858,477	3,761.70	18.27
Sunrise River at Comfort Lake Inlet	2007	3/26/07-10/30/07	188,797,829	4,334.23	39,591,680	908.91	247,038,494	5,671.26	22.42
Sunrise River at Comfort Lake Outlet	2003	5/29/03-11/3/03	422,830,532	9,706.92	361,495,072	8,298.84	NA	NA	13.09
Sunrise River at Comfort Lake Outlet	2004	3/22/04-11/2/04	449,268,511	10,313.86	249,741,973	5,733.33	673,985,011	15,472.67	21.68
Sunrise River at Comfort Lake Outlet	2005	3/24/05-11/2/05	170,267,154	3,908.82	85,981,864	1,973.89	201,840,954	4,633.66	22.32
Sunrise River at Comfort Lake Outlet	2006	5/2/06-10/30/06	98,954,975	2,271.71	51,812,383	1,189.46	183,293,248	4,207.86	18.32
Sunrise River at Comfort Lake Outlet	2007	3/26/07-7/12/07	56,286,780	1,292.18	NA	NA	NA	NA	21.42

*Growing season discharge and loads are estimated using quantities just previous to and including June 1, and just post and including Sept 30.

Table 14. CLFLWD Historical Loading and Rainfall Summary

Site	Year	Monitoring Season	Total Monitored Load		Growing Season (June 1-Sept 30) Load*		Total Yearly Estimated Load		Monitored Rainfall (inches)
			TP (lbs.)	TSS (lbs.)	TP (lbs.)	TSS (lbs.)	TP (lbs.)	TSS (lbs.)	
Tributary to Sunrise River at Bone Lake North Inlet	2003	5/27/03-10/30/03	724	127,509	654	129,443	NA	NA	12.73
Tributary to Sunrise River at Bone Lake North Inlet	2005	3/29/05-11/1/05	174	23,675	89	14,745	226	24,817	20.73
Tributary to Sunrise River at Bone Lake North Inlet	2006	5/1/06-10/25/06	133	1,913	74	1,085	315	5,225	15.67
Tributary to Sunrise River at Bone Lake Outlet	2003	5/27/03-10/30/03	323	72,438	297	66,763	NA	NA	12.35
Tributary to Sunrise River at Bone Lake Outlet	2004	3/24/04-11/2/04	311	32,963	146	14,138	339	35,283	18.03
Tributary to Sunrise River at Bone Lake Outlet	2005	3/29/05-11/1/05	80	36,608	36	30,343	97	38,776	18.27
Tributary to Sunrise River at Bone Lake Outlet	2006	5/1/06-10/30/06	25	1,716	14	1,018	49	3,158	14.08
Tributary to Sunrise River at Bone Lake South Inlet	2005	4/5/05-11/1/05	186	39,562	117	34,695	231	41,383	No Data Available at Site
Tributary to Sunrise River at Bone Lake South Inlet	2006	5/1/06-10/30/06	142	8,223	71	4,734	229	14,324	No Data Available at Site
Tributary to Sunrise River at Shields Outlet/Forest Inlet	2005	4/20/05-11/1/05	420	79,186	237	19,188	420	79,186	19.63
Tributary to Sunrise River at Shields Outlet/Forest Inlet	2006	5/2/06-10/30/06	161	6,218	92	3,372	332	8,620	13.18
Sunrise River at Forest Lake Outlet	2003	5/29/03-10/11/03	553	209,842	551	209,614	NA	NA	No Data Available at Site
Sunrise River at Forest Lake Outlet	2004	3/31/04-11/2/04	1,050	152,505	598	107,761	1,235	167,533	No Data Available at Site
Sunrise River at Forest Lake Outlet	2005	3/24/05-11/2/05	346	66,240	141	27,981	457	83,383	No Data Available at Site
Sunrise River at Forest Lake Outlet	2006	5/2/06-10/25/06	98	12,992	41	5,738	173	24,263	No Data Available at Site
Sunrise River at Forest Lake Outlet	2007	3/26/07-10/29/07	132	NA	8	NA	253	NA	No Data Available at Site
Sunrise River at County Line Ditch	2007	3/27/07-10/29/07	1,131	105,867	420	35,317	1,212	109,981	20.65
Tributary to Sunrise River at Little Comfort Lake Inlet	2004	5/4/04-11/2/04	785	499,570	584	474,947	1,283	1,220,397	19.59
Tributary to Sunrise River at Little Comfort Lake Inlet	2005	3/29/05-11/2/05	748	365,776	461	211,373	1,023	697,890	21.99
Tributary to Sunrise River at Little Comfort Lake Inlet	2006	5/4/06-10/30/06	1,079	517,829	834	411,398	1,551	643,540	16.89
Tributary to Sunrise River at Little Comfort Lake Inlet	2007	4/26/07-10/30/07	527	35,733	202	13,620	676	43,113	23.65
Sunrise River at Comfort Lake Inlet	2004	4/5/04-11/2/04	1,414	353,891	899	255,626	1,963	403,759	20.97
Sunrise River at Comfort Lake Inlet	2005	3/29/05-11/2/05	900	111,027	392	33,117	1,119	125,039	22.48
Sunrise River at Comfort Lake Inlet	2006	5/2/06-10/30/06	1,443	105,433	913	52,781	1,887	175,089	18.27
Sunrise River at Comfort Lake Inlet	2007	3/26/07-10/30/07	782	53,763	242	15,064	997	63,755	22.42
Sunrise River at Comfort Lake Outlet	2003	5/29/03-11/3/03	1,445	301,964	1,308	285,063	NA	NA	13.09
Sunrise River at Comfort Lake Outlet	2004	3/22/04-11/2/04	1,736	535,972	1,076	401,584	2,065	566,195	21.68
Sunrise River at Comfort Lake Outlet	2005	3/24/05-11/2/05	603	243,997	326	153,936	670	251,622	22.32
Sunrise River at Comfort Lake Outlet	2006	5/2/06-10/30/06	246	32,873	122	16,097	563	60,519	18.32
Sunrise River at Comfort Lake Outlet	2007	3/26/07-7/12/07	NA	NA	NA	NA	NA	NA	21.42

*Growing season discharge and loads include quantities estimated from just previous to and including June 1, and just post and including Sept 30.

8) Appendices and References

Appendix A
Appendix B
References

Appendix A

Appendix Glossary

(In Order Found in Appendix)

DNR ID #	Minnesota Department of Natural Resources Identification Number			
Date	Date Sample Taken			
TP (ug/L)	Total Phosphorus Two-Meter Composite Concentrations in ug/L or ppb			
TKN (ug/L)	Total Kjeldahl Nitrogen Two-Meter Composite Concentrations in ug/L or ppb			
CLA (ug/L)	Chlorophyll- α Two-Meter Composite Concentrations in ug/L or ppb			
Total Chloride (mg/L)	Total Chloride Two-Meter Composite Concentrations in mg/L or ppm			
Secchi (m)	Secchi Disk Transparency in Meters			
TSI (TP)	Carlson's Trophic State Index for Total Phosphorus in ug/L or ppb $= (14.42 * \text{LN}(\text{TP})) + 4.15$			
TSI (CLA)	Carlson's Trophic State Index for Chlorophyll α in ug/L or ppb $= (9.81 * \text{LN}(\text{CLA})) + 30.6$			
TSI (SD)	Carlson's Trophic State Index for Secchi Disk Transparency in meters $= 60 - (14.41 * (\text{LN}(\text{SD})))$			
Summer Mean	Average of all samples taken June 1 through September 30 of any given year			
Lake Grade	Lake Grading System Developed by the Metropolitan Council in 1989			
Grade	Percentile	TP (ug/l)	CLA (ug/l)	SD (m)
A	<10	<23	<10	>3.0
B	10 - 30	23-32	10-20	2.2-3.0
C	30-70	32-68	20-48	1.2-2.2
D	70-90	68-152	48-77	0.7-1.2
F	>90	>152	>77	<0.7

Big Comfort Lake
DNR ID #13-0053
Wyoming Township, Chisago County

Date	TP (ug/L)	TKN (ug/L)	CLA (ug/L)	Total Chloride (mg/L)	Secchi (m)	TSI (TP)	TSI (CLA)	TSI (SD)
Summer Mean								
1986 Ave								
1987 Ave					2.56			46
1988 Ave					2.41			47
1989 Ave					2.83			45
1990 Ave								
1991 Ave								
1992 Ave								
1993 Ave								
1994 Ave	37	1092	16	19	1.92	56	58	51
1995 Ave					1.32			56
1996 Ave								
1997 Ave					1.92			51
1998 Ave	43		14		1.26	59	56	57
1999 Ave					1.37			55
2000 Ave	44	1208	25		1.50	59	62	54
2001 Ave	29	1073	19		1.90	53	59	51
2002 Ave	41	1463	26		1.26	58	63	57
2003 Ave	48	1238	25		1.28	60	62	56
2004 Ave	40	988	17		1.83	57	58	51
2005 Ave	29	1046	16		1.91	53	58	51
2006 Ave	49	1250	12		2.01	60	55	50
2007 Ave	19	991	10		1.64	47	53	53
Total Ave	38	1150	18		1.81	57	59	51
Grades						Average Summer Grade		
1987 Grade					B	B		
1988 Grade					B	B		
1989 Grade					B	B		
1990 Grade								
1991 Grade								
1992 Grade								
1993 Grade								
1994 Grade					C	C		
1995 Grade					C	C		
1996 Grade								
1997 Grade					C	C		
1998 Grade	C		B		C	C+		
1999 Grade					C	C		
2000 Grade	C		C		C	C		
2001 Grade	B		B		C	B-		
2002 Grade	C		C		C	C		
2003 Grade	C		C		C	C		
2004 Grade	C		B		C	C+		
2005 Grade	C		B		C	C+		
2006 Grade	C		B		C	C+		
2007 Grade	A		A		C	B+		
Ave Letter Grade	C		B		C	C+		

Birch
DNR ID #13-0042
Wyoming Township, Chisago County

Date	TP (ug/L)	TKN (ug/L)	CLA (ug/L)	Total Chloride (mg/L)	Secchi (m)	TSI (TP)	TSI (CLA)	TSI (SD)
Summer Mean								
2005 Ave	131	1398	44		1.19	74	68	58
2006 Ave	118	1332	15		1.55	73	57	54
2007 Ave	60	1314	21		1.71	63	60	52
Total Ave	125	1365	30		1.37	74	64	55
Grade						Average Summer Grade		
2005 Grade	D		C		C	D		
2006 Grade	D		B		C	C		
2007 Grade	C		C		C	C		
Total Grade	D		C		C	C		

Bone Lake
DNR ID #82-0054
City of New Scandia, Washington County

Date	TP (ug/L)	TKN (ug/L)	CLA (ug/L)	Total Chloride (mg/L)	Secchi (m)	TSI (TP)	TSI (CLA)	TSI (SD)
Summer Mean								
1986 Ave					1.02			60
1987 Ave					1.62			53
1988 Ave					1.06			59
1989 Ave	46	1291	28		1.31	59	63	56
1990 Ave					1.29			56
1991 Ave								
1992 Ave								
1993 Ave	58	1470	38		1.12	63	66	58
1994 Ave					1.27			57
1995 Ave	21	1700	7		1.07	48	49	59
1996 Ave					1.34			56
1997 Ave	36	1720	16		1.49	56	58	54
1998 Ave	34	940	20		1.52	55	60	54
1999 Ave	50	1120	34		1.07	61	65	59
2000 Ave								
2001 Ave	39	1430	34		1.25	57	65	57
2002 Ave	58	1763	42	10	0.98	63	67	60
2003 Ave	82	1675	48	10	0.93	68	69	61
2004 Ave	60	1400	38	9	1.25	63	66	57
2005 Ave	59	1250	23	8	1.58	63	61	53
2006 Ave	57	1054	20	14	1.79	62	60	52
2007 Ave	41	1183	23		1.11	58	61	58
Total Ave	49	1384	29	10	1.27	60	63	57
Grades						Average Summer Grade		
1986 Grade					C	C		
1987 Grade					B	B		
1988 Grade					C	C		
1989 Grade					B	B		
1990 Grade					B	B		
1991 Grade								
1992 Grade								
1993 Grade	C		C		C	C		
1994 Grade					B	B		
1995 Grade	A		A		C	B		
1996 Grade					B	B		
1997 Grade	C		B		B	B		
1998 Grade	C		C		B	C		
1999 Grade	C		C		C	C		
2000 Grade								
2001 Grade	C		C		B	C		
2002 Grade	C		C		C	C		
2003 Grade	D		C		C	C		
2004 Grade	C		C		C	C		
2005 Grade	C		C		C	C		
2006 Grade	C		B		C	C		
2007 Grade	C		B		C	C		
Ave Letter Grade	C		C		C	C		

Forest Lake 1st Basin (West)
DNR ID #82-0159
City of Forest Lake, Washington County

Date	TP (ug/L)	TKN (ug/L)	CLA (ug/L)	Total Chloride (mg/L)	Secchi (m)	TSI (TP)	TSI (CLA)	TSI (SD)
Summer Mean								
1986 Ave					1.70			52
1987 Ave					1.61			53
1988 Ave					1.74			52
1989 Ave					2.10			49
1990 Ave								
1991 Ave								
1992 Ave								
1993 Ave	37	950	18		1.57	56	59	53
1994 Ave					1.45			55
1995 Ave					1.62			53
1996 Ave	36	960	15		1.50	56	57	54
1997 Ave	29	880	14		1.54	53	57	54
1998 Ave	29	820	18		1.39	53	59	55
1999 Ave	47	1040	20		1.18	60	60	58
2000 Ave	36	901	12		1.36	56	55	56
2001 Ave	29	894	19		1.53	53	60	54
2002 Ave	33	915	16		1.68	55	58	53
2003 Ave	36	946	17		1.30	56	58	56
2004 Ave	33	717	10		1.88	54	54	51
2005 Ave	40	966	25		1.66	57	62	53
2006 Ave	38	932	19	23	1.56	57	59	54
2007 Ave	37	966	25		1.03	56	62	60
Total Ave	35	914	18		1.55	56	59	54
Grade						Average Summer Grade		
1986 Grade					C			C
1987 Grade					C			C
1988 Grade					C			C
1989 Grade					C			C
1990 Grade								
1991 Grade								
1992 Grade								
1993 Grade	C		B		C			C
1994 Grade					C			C
1995 Grade					C			C
1996 Grade	C		B		C			C
1997 Grade	B		B		C			B
1998 Grade	B		B		C			B
1999 Grade	C		B		C			C
2000 Grade	C		B		C			C
2001 Grade	B		B		C			B
2002 Grade	C		B					B
2003 Grade	B		B		C			B
2004 Grade	C		A		B			B
2005 Grade	C		C		C			C
2006 Grade	C		B		C			C
2007 Grade	C		C		C			C
Letter Grade	C		B		C			C

Forest Lake 2nd Basin (Middle)

DNR ID #82-0159

City of Forest Lake, Washington County

Date	TP (ug/L)	TKN (ug/L)	CLA (ug/L)	Total Chloride (mg/L)	Secchi (m)	TSI (TP)	TSI (CLA)	TSI (SD)
Summer Mean								
2002 Ave	24	681	15		1.64	50	57	53
2006 Ave	38	891	19	23	1.68	57	60	53
2007 Ave								
Total Ave	31	786	17	23	1.66	54	58	53
Grade						Average Summer Grade		
2002 Grade	B		B		C	B		
2006 Grade	C		B		C	C		
2007 Grade								
Letter Grade	B		B		C	B		

Forest Lake 3rd Basin (East)

DNR ID #82-0159

City of Forest Lake, Washington County

Date	TP (ug/L)	TKN (ug/L)	CLA (ug/L)	Total Chloride (mg/L)	Secchi (m)	TSI (TP)	TSI (CLA)	TSI (SD)
Summer Mean								
2002 Ave	26	744	18		1.64	51	59	53
2006 Ave	40	882	20	23	1.69	57	60	52
2007 Ave								
Total Ave	33	813	19	23	1.67	55	59	53
Grade						Average Summer Grade		
2002 Grade	B		B		C	B		
2006 Grade	C		B		C	C		
2007 Grade								
Letter Grade	C		B		C	C		

Halfbreed (Sylvan) Lake

DNR ID #82-0080

City of Forest Lake/City of New Scandia, Washington County

Date	TP (ug/L)	TKN (ug/L)	CLA (ug/L)	Total Chloride (mg/L)	Secchi (m)		TSI (TP)	TSI (CLA)	TSI (SD)
Summer Mean									
1974 Ave					4.70				38
1975 Ave									
1976 Ave									
1977 Ave									
1978 Ave					2.38				48
1979 Ave					2.98				44
1980 Ave					3.14				44
1981 Ave					3.11				44
1982 Ave					3.93				40
1983 Ave					4.85				37
1984 Ave					4.44				39
1985 Ave					3.96				40
1986 Ave					3.24				43
1987 Ave					4.36				39
1988 Ave					4.52				38
1989 Ave					4.13				40
1990 Ave					3.77				41
1991 Ave					4.83				37
1992 Ave					4.83				37
1993 Ave	11	600	4		4.88	39	45		37
1994 Ave					4.53				38
1995 Ave					4.45				38
1996 Ave	23	660	3		4.38	49	42		39
1997 Ave					3.83				41
1998 Ave	13	600	4		4.24	41	44		39
1999 Ave	24	700	6		4.07	50	49		40
2000 Ave	19	753	4		4.32	47	45		39
2001 Ave	19	644	5		4.22	46	46		39
2002 Ave	19	665	3		4.66	47	41		38
2003 Ave	17	551	4		4.27	45	43		39
2004 Ave	20	538	3		5.10	47	43		37
2005 Ave	19	693	3		4.72	47	43		38
2006 Ave					4.91				37
2007 Ave	14	615	3		4.65	42	40		38
Total Ave	18	638	4		4.21	46	44		39
Grade						Average Summer Grade			
1974 Grade					A				A
1975 Grade									
1976 Grade									
1977 Grade									
1978 Grade					B				B
1979 Grade					B				B
1980 Grade					A				A
1981 Grade					A				A
1982 Grade					A				A
1983 Grade					A				A
1984 Grade					A				A
1985 Grade					A				A
1986 Grade					A				A
1987 Grade					A				A
1988 Grade					A				A
1989 Grade					A				A
1990 Grade					A				A
1991 Grade					A				A
1992 Grade					A				A
1993 Grade	A		A		A				A
1994 Grade					A				A
1995 Grade					A				A
1996 Grade	B		A		A				A
1997 Grade					A				A
1998 Grade	A		A		A				A
1999 Grade	B		A		A				A
2000 Grade	A		A		A				A
2001 Grade	A		A		A				A
2002 Grade	A		A		A				A
2003 Grade	A		A		A				A
2004 Grade	A		A		A				A
2005 Grade	A		A		A				A
2006 Grade					A				A
2007 Grade	A		A		A				A
Letter Grade	A		A		A				A

Little Comfort
DNR ID #13-0054
Wyoming Township, Chisago County

Date	TP (ug/L)	TKN (ug/L)	CLA (ug/L)	Total Chloride (mg/L)	Secchi (m)	TSI (TP)	TSI (CLA)	TSI (SD)
Summer Mean								
1994 Ave	51	1255		32	1.80	61	65	52
1998 Ave	56			18	0.98	62	59	60
2006 Ave	73	1473		24	1.48	66	62	54
2007 Ave	47	924		10	1.67	60	53	53
Total Ave	64	1473		21	1.23	64	60	57
Grade						Average Summer Grade		
1994 Grade	C		C		C	C		
1998 Grade	C		B		D	C		
2006 Grade	D		C		C	C		
2007 Grade	C		A		C	B		
Total Grade	C		C		C	C		

Moody
DNR ID #13-0023
Chisago Township, Chisago County

Date	TP (ug/L)	TKN (ug/L)	CLA (ug/L)	Total Chloride (mg/L)	Secchi (m)	TSI (TP)	TSI (CLA)	TSI (SD)
Summer Mean								
2005 Ave	168	2075	60		0.70	78	71	65
2006 Ave	158	2290	44		0.84	77	68	63
2007 Ave	168	3089	80		0.66	78	74	66
Total Ave	163	2183	52		0.77	78	69	64
Grade						Average Summer Grade		
2005 Grade	F		D		D	D		
2006 Grade	F		C		D	D		
2007 Grade	F		F		F	F		
Total Grade	F		D		D	D		

School
DNR ID #13-0057
Wyoming Township, Chisago County

Date	TP (ug/L)	TKN (ug/L)	CLA (ug/L)	Total Chloride (mg/L)	Secchi (m)	TSI (TP)	TSI (CLA)	TSI (SD)
Summer Mean								
2005 Ave	97	1578	48		1.15	70	68	58
2006 Ave	66	1400	28		1.22	65	63	57
2007 Ave	53	1238	40		1.31	61	67	56
Total Ave	81	1489	38		1.19	68	66	58
Grade						Average Summer Grade		
2005 Grade	D		C		D	D		
2006 Grade	C		C		C	C		
2007 Grade	C		C		C	C		
Total Grade	C		C		C	C		

Shields Lake
DNR ID #82-0162
City of Forest Lake, Washington County

Date	TP (ug/L)	TKN (ug/L)	CLA (ug/L)	Total Chloride (mg/L)	Secchi (m)	TSI (TP)	TSI (CLA)	TSI (SD)
Summer Mean								
1991 Ave	100	1750			1.45	71		55
1992 Ave	90	2033			1.07	69		59
1993 Ave	190	5480	25		1.24	80	62	57
1994 Ave	145	1525	23		1.15	76	61	58
1995 Ave	209	1888	18		2.11	81	59	49
1996 Ave	184	1726	9		2.38	79	52	48
1997 Ave	188	1513	8		2.50	80	51	47
1998 Ave	220	1744	40		1.57	82	67	54
1999 Ave	286	2170	49		1.02	86	69	60
2000 Ave	179	1880	26		1.51	79	63	54
2001 Ave	245	1650	25		1.80	83	62	52
2002 Ave	259	2083	49		1.83	84	69	51
2003 Ave	381	2075	46		1.16	90	68	58
2004 Ave	229	2089	48		1.03	82	69	60
2005 Ave	201	2267	61		0.73	81	71	65
2006 Ave	234	3170	59		1.11	83	71	58
2007 Ave	206	2280	45		1.04	81	68	59
Total Ave	209	2195	36		1.45	81	66	55
Grade						Average Summer Grade		
1991 Grade	D				C	C		
1992 Grade	D				D	D		
1993 Grade	F		C		C	D		
1994 Grade	D		C		C	C		
1995 Grade	F		B		C	C		
1996 Grade	F		A		B	C		
1997 Grade	F		A		B	C		
1998 Grade	F		C		C	D		
1999 Grade	F		D		D	D		
2000 Grade	F		C		C	D		
2001 Grade	F		C		C	D		
2002 Grade	F		D		C	D		
2003 Grade	F		C		C	D		
2004 Grade	F		C		C	D		
2005 Grade	F		D		D-	D		
2006 Grade	F		D		D	D		
2007 Grade	F		C		D	D		
Total Grade	F		C-		C+	D		

Appendix B: Lake Elevations and Precipitation

Big Comfort Lake

DNR ID #13-53

Wyoming Township, Chisago County

Period of record: 06/11/1952 to 11/26/07

of readings: 660

Highest recorded: 888.32 ft (07/02/1975)

Lowest recorded: 884.8 ft (10/08/1969)

Recorded range: 3.52 ft

Average water level: 886.21 ft

Last reading: 886.10 ft (11/26/2007)

[OHW elevation: 887.2 ft](#)

Datum: 1929 (ft)

Annual Averages	Elevation (ft)
1965	885.60
1966-1968	NA
1969	884.99
1970	NA
1971	885.90
1972	886.04
1973	885.93
1974	885.60
1975	886.74
1976	886.01
1977	885.56
1978	886.31
1979	886.16
1980	885.98
1981	885.89
1982	885.96
1983	886.32
1984	887.02
1985	886.23
1986	886.69
1987	886.15
1988	885.99
1989	886.23
1990	886.63
1991	886.95
1992	886.45
1993	886.90
1994	886.45
1995	886.81
1996	886.43
1997	886.49
1998	NA
1999	886.62
2000	885.92
2001	885.92
2002	886.23
2003	886.19
2004	886.06
2005	885.91
2006	886.28
2007	885.95
Total Average	886.21

Date	Total Precip (in)
1980	30.39
1981	31.26
1982	31.24
1983	30.29
1984	36.74
1985	32.11
1986	35.72
1987	21.92
1988	25.62
1989	23.28
1990	34.72
1991	39.41
1992	25.61
1993	38.00
1994	34.65
1995	42.41
1996	31.87
1997	27.08
1998	30.56
1999	31.96
2000	26.70
2001	33.00
2002	41.50
2003	26.53
2004	30.69
2005	31.71
2006	28.65
2007	33.06
Average	31.67

Date	Elevation (ft)
3/31/2000	886.05
3/31/2000	886.05
5/13/2000	885.97
5/20/2000	885.77
5/24/2000	885.70
6/6/2000	885.97
6/6/2000	885.67
6/8/2000	885.93
6/13/2000	885.67

6/20/2000	885.67
6/22/2000	885.97
6/24/2000	885.97
6/25/2000	886.37
6/30/2000	885.67
7/7/2000	885.67
7/8/2000	885.97
7/9/2000	886.37
7/10/2000	886.57
7/12/2000	886.67
7/18/2000	886.20
7/19/2000	886.13
7/31/2000	885.72
8/10/2000	885.54
8/22/2000	885.51
8/29/2000	885.65
9/13/2000	885.80
9/25/2000	885.85
9/25/2000	885.83
10/3/2000	885.89
10/26/2000	885.76
5/8/2001	887.58
5/15/2001	886.84
5/21/2001	886.28
5/30/2001	886.12
6/7/2001	885.90
6/13/2001	886.18
6/13/2001	886.10
6/18/2001	886.28
6/20/2001	886.71
6/25/2001	885.94
6/28/2001	885.92
7/2/2001	885.83
7/9/2001	885.68
7/10/2001	885.64
7/25/2001	885.97
8/6/2001	885.80
8/7/2001	885.80

8/13/2001	885.68
8/14/2001	885.66
8/20/2001	885.74
8/27/2001	885.72
8/28/2001	885.74
9/3/2001	885.72
9/10/2001	885.82
9/13/2001	885.76
9/17/2001	885.70
9/24/2001	885.76
9/28/2001	885.70
10/1/2001	885.68
10/8/2001	885.68
10/10/2001	885.70
10/22/2001	885.71
10/29/2001	885.69
11/5/2001	885.69
11/12/2001	885.69
11/18/2001	885.69
12/10/2001	885.76
4/11/2002	886.28
4/16/2002	886.62
4/22/2002	886.35
4/29/2002	886.35
5/6/2002	886.16
5/9/2002	886.74
5/10/2002	886.83
5/10/2002	886.83
5/10/2002	886.88
5/12/2002	887.13
5/13/2002	887.17
5/16/2002	886.41
5/18/2002	887.03
5/22/2002	886.73
5/28/2002	886.13
5/29/2002	886.73
5/29/2002	886.03
6/1/2002	885.93
6/5/2002	886.23
6/6/2002	886.21
6/10/2002	885.97
6/10/2002	886.03
6/11/2002	885.98
6/15/2002	885.82
6/16/2002	885.73
6/17/2002	885.79
6/19/2002	885.93
6/24/2002	886.07
6/25/2002	886.23
6/28/2002	886.61
6/29/2002	886.63
6/30/2002	886.53
7/1/2002	886.63
7/6/2002	886.29

7/8/2002	886.28
7/9/2002	886.29
7/15/2002	886.21
7/17/2002	886.07
7/22/2002	885.85
7/27/2002	885.78
7/29/2002	885.95
7/29/2002	885.95
8/4/2002	886.23
8/5/2002	886.33
8/8/2002	886.45
8/19/2002	885.73
8/20/2002	885.76
8/26/2002	886.17
8/27/2002	886.11
9/3/2002	886.25
9/6/2002	886.55
9/8/2002	886.43
9/9/2002	886.57
9/9/2002	886.56
9/14/2002	886.43
9/16/2002	886.29
9/18/2002	886.11
9/25/2002	885.92
9/30/2002	885.93
10/1/2002	885.87
10/3/2002	886.03
10/6/2002	886.23
10/11/2002	886.53
10/16/2002	886.43
10/21/2002	886.29
10/28/2002	886.17
10/29/2002	886.09
11/4/2002	885.89
11/5/2002	885.87
11/12/2002	885.85
11/18/2002	885.73
11/25/2002	885.63
12/2/2002	885.53
12/9/2002	885.43
3/18/2003	885.89
3/25/2003	885.89
3/31/2003	885.92
4/9/2003	885.86
4/14/2003	885.79
4/15/2003	885.81
4/22/2003	886.55
4/28/2003	886.25
5/2/2003	886.09
5/2/2003	886.09
5/5/2003	886.09
5/6/2003	886.15
5/6/2003	886.15
5/12/2003	886.83

5/16/2003	887.11
5/16/2003	887.11
5/19/2003	887.05
5/23/2003	887.35
5/27/2003	887.17
5/29/2003	887.00
5/29/2003	887.00
6/11/2003	886.09
6/16/2003	885.95
6/20/2003	885.85
6/27/2003	886.87
6/27/2003	886.97
7/1/2003	887.24
7/7/2003	887.31
7/10/2003	887.19
7/11/2003	887.15
7/14/2003	886.93
7/15/2003	887.13
7/21/2003	887.13
7/21/2003	887.13
7/23/2003	886.51
8/4/2003	885.83
8/6/2003	885.81
8/11/2003	885.7
8/18/2003	885.55
8/21/2003	885.6
8/25/2003	885.55
9/2/2003	885.45
9/4/2003	885.45
9/8/2003	885.45
9/15/2003	885.71
9/18/2003	885.63
9/23/2003	885.65
9/29/2003	885.60
10/2/2003	885.51
10/7/2003	885.79
10/13/2003	885.67
10/14/2003	885.65
10/20/2003	885.60
10/27/2003	885.58
11/3/2003	885.63
11/3/2003	885.61
11/13/2003	885.61
11/18/2003	885.61
11/24/2003	885.71
12/1/2003	885.61
4/21/2004	885.94
4/22/2004	885.97
4/26/2004	885.99
5/3/2004	885.99
5/4/2004	885.93
5/10/2004	885.77
5/17/2004	886.03
5/18/2004	886.08

5/24/2004	886.27
5/28/2004	886.45
6/1/2004	886.99
6/2/2004	887.07
6/7/2004	887.11
6/9/2004	887.02
6/14/2004	886.77
6/16/2004	886.87
6/21/2004	886.77
6/28/2004	886.85
6/29/2004	886.85
7/6/2004	885.73
7/12/2004	885.73
7/14/2004	885.81
7/19/2004	885.73
7/21/2004	885.69
8/2/2004	885.79
8/9/2004	885.81
8/16/2004	885.89
8/23/2004	885.83
8/25/2004	885.85
8/30/2004	885.96
9/7/2004	886.03
9/9/2004	885.86
9/13/2004	885.74
9/20/2004	885.75
9/22/2004	885.71
9/27/2004	885.67
9/27/2004	885.69
10/4/2004	885.65
10/6/2004	885.67
10/11/2004	885.65
10/19/2004	885.68
10/20/2004	885.69
10/25/2004	885.87
11/01/2004	886.08
11/08/2004	885.83
11/15/2004	885.77
11/22/2004	885.90
11/29/2004	885.93
4/11/2005	885.94
4/14/2005	885.98
4/18/2005	886.00
4/22/2005	886.00
4/25/2005	886.00
4/26/2005	885.99
5/2/2005	885.82
5/9/2005	885.88
5/13/2005	885.96
5/16/2005	885.82
5/23/2005	885.88
5/24/2005	885.92

5/31/2005	885.98
6/5/2005	885.72
6/9/2005	885.88
6/13/2005	886.08
6/20/2005	886.46
6/21/2005	886.48
7/7/2005	886.10
7/11/2005	885.92
7/18/2005	885.80
7/22/2005	885.66
7/25/2005	885.76
8/1/2005	885.70
8/2/2005	885.74
8/5/2005	885.68
8/15/2005	885.50
8/16/2005	885.48
8/29/2005	885.78
9/1/2005	885.80
9/14/2005	886.00
9/30/2005	886.08
10/11/2005	886.40
9/11/2006	886.09
9/14/2006	886.11
9/18/2006	886.29
9/20/2006	886.21
9/25/2006	886.28
10/2/2006	886.35
10/3/2006	886.35
10/9/2006	886.31
10/16/2006	886.35
10/17/2006	886.35
10/23/2006	886.33
10/30/2006	886.33
4/2/2007	886.51
4/9/2007	886.39
4/17/2007	886.13
4/23/2007	886.07
4/30/2007	885.95
5/7/2007	885.81
5/14/2007	885.69
5/21/2007	885.53
5/29/2007	885.69
6/4/2007	885.75
6/11/2007	885.93
6/11/2007	885.95
6/19/2007	885.72
6/19/2007	885.71
6/25/2007	885.61
7/2/2007	885.49
7/9/2007	885.61
7/10/2007	885.59

7/16/2007	885.71
7/23/2007	885.67
7/30/2007	885.63
8/6/2007	885.58
8/7/2007	885.57
8/13/2007	885.63
8/20/2007	886.01
8/27/2007	886.10
8/28/2007	886.13
9/4/2007	886.12
9/5/2007	886.13
9/10/2007	886.09
9/17/2007	886.03
9/24/2007	886.27
10/1/2007	886.18
10/8/2007	886.57
10/15/2007	886.43
10/22/2007	886.48
10/29/2007	886.29
11/5/2007	886.13
11/13/2007	886.03
11/19/2007	886.05
11/26/2007	886.10

Bone Lake
DNR ID #82-54
New Scandia Township, Washington County

Period of record: 06/01/1965 to 10/6/2007
of readings: 400
Highest recorded: 910.97 ft (07/07/1975)
Lowest recorded: 906.7 ft(11/07/1966)
Recorded range: 4.27 ft
Average water level: 908.44
Last reading: 907.79 ft (10/6/2006)
[OHW elevation: 909.1 ft](#)
Datum: 1929 (ft)

Annual Averages	Elevation (ft)
1965	909.86
1966	907.38
1967	908.55
1968	908.44
1969	NA
1970	908.00
1971	908.56
1972	909.29
1973	908.36
1974	908.25
1975	909.19
1976	909.39
1977	907.88
1978	908.75
1979	908.26
1980	908.68
1981	908.52
1982	907.95
1983-1989	NA
1990	907.83
1991-1993	NA
1994	907.99
1995	908.62
1996	908.13
1997	908.20
1998	908.58
1999	909.08
2000	908.39
2001	NA
2002	908.51
2003	NA
2004	908.33
2005	908.09
2006	908.45
2007	907.82
Total Average	908.44

Date	Total Precip (in)
1980	30.39
1981	31.26
1982	31.24
1983	30.29
1984	36.74
1985	32.11
1986	35.72
1987	21.92
1988	25.62
1989	23.28
1990	34.72
1991	39.41
1992	25.61
1993	38.00
1994	34.65
1995	42.41
1996	31.87
1997	27.08
1998	30.56
1999	31.96
2000	26.70
2001	33.00
2002	41.50
2003	26.53
2004	30.69
2005	31.71
2006	28.65
2007	33.06
Average	31.67

Date	Elevation (ft)
4/7/2000	908.45
5/29/2000	908.23
6/2/2000	908.33
6/17/2000	908.33
7/1/2000	908.35
7/9/2000	908.77
7/12/2000	908.95
7/19/2000	908.63
7/26/2000	908.57
8/3/2000	908.51

8/11/2000	908.27
8/20/2000	908.21
9/1/2000	908.17
9/10/2000	908.17
10/1/2000	908.17
10/17/2000	908.15
4/18/2001	909.35
4/17/2002	909.10
7/15/2002	908.38
7/23/2002	908.18
7/31/2002	908.18
8/8/2002	908.24
8/21/2002	908.30
8/30/2002	908.26
9/6/2002	909.14
9/15/2002	908.82
11/19/2002	908.48
4/15/2003	908.65
4/13/2004	908.79
4/26/2004	908.79
5/4/2004	908.48
5/10/2004	908.41
5/14/2004	908.59
5/17/2004	908.65
5/18/2004	908.66
5/24/2004	908.85
6/3/2004	909.53
6/7/2004	909.31
6/9/2004	909.17
6/10/2004	909.09
6/24/2004	908.51
7/2/2004	908.27
7/8/2004	908.25
7/14/2004	908.21
7/19/2004	907.09
7/26/2004	908.01

8/3/2004	907.99
8/10/2004	907.85
8/12/2004	907.87
8/25/2004	907.79
8/25/2004	907.85
9/7/2004	907.93
9/9/2004	907.89
9/16/2004	908.05
9/20/2004	908.05
9/22/2004	908.04
10/6/2004	907.95
10/20/2004	907.89
11/1/2004	908.29
4/12/2005	908.64
4/14/2005	908.66
4/18/2005	908.66
4/26/2005	908.40
5/4/2005	908.20
5/16/2005	908.18
5/24/2005	908.24
6/2/2005	908.14
6/9/2005	908.22
6/22/2005	908.28
7/7/2005	908.36
7/22/2005	907.88
7/28/2005	907.92
8/2/2005	907.86
8/11/2005	907.74
8/16/2005	907.60
8/29/2005	907.64
8/30/2005	907.60
9/14/2005	907.70
10/3/2005	907.80
10/11/2005	908.16
10/19/2005	908.10
10/20/2005	908.10
11/1/2005	908.06
4/18/2006	908.94
5/8/2006	908.41
5/16/2006	908.35
5/30/2006	908.19
6/1/2006	908.15
6/14/2006	908.15
6/19/2006	908.29
7/5/2006	908.13
7/17/2006	907.87
7/24/2006	907.79
8/9/2006	907.87
8/21/2006	907.77
9/6/2006	907.83
9/8/2006	907.81
9/25/2006	907.85
10/6/2006	907.79

4/10/2007	908.81
5/19/2007	908.01
5/26/2007	908.06
6/1/2007	908.09
6/8/2007	908.01
6/15/2007	907.93
6/22/2007	907.91
6/29/2007	907.79
7/6/2007	907.79
7/13/2007	907.72
7/20/2007	907.31
7/27/2007	907.57
8/3/2007	907.47
8/11/2007	907.45
8/17/2007	907.51
8/24/2007	907.57
8/31/2007	907.51
9/7/2007	907.49
9/14/2007	907.47
9/19/2007	907.51
9/21/2007	907.67
9/28/2007	907.77
10/6/2007	908.09
10/12/2007	908.21
10/19/2007	908.33
10/26/2007	908.39

Forest Lake (West)

DNR ID #82-159

Forest Lake Township, Washington County

Period of record: 4/30/1965 to 8/15/2007
 # of readings: 631
 Highest recorded: 902.23 ft (06/25/1993)
[Highest known: 902.6 ft \(1975\)](#)
 Lowest recorded: 899.45 ft (10/07/1969)
 Recorded range: 2.78 ft
 Average water level: 901.42 ft
 Last reading: 900.97 ft (8/15/2007)
[OHW elevation: 901.8 ft](#)
 Datum: 1929 (ft)

Annual Averages	Elevation (ft)
1965	901.39
1966	901.03
1967	901.11
1968	901.24
1969	900.71
1970	901.07
1971	901.28
1972	901.17
1973	901.29
1974	901.34
1975	901.45
1976	900.99
1977	NA
1978	901.84
1979	901.71
1980	901.72
1981-1987	NA
1990	901.46
1991	901.45
1992	901.24
1993	901.58
1994	901.39
1995	901.61
1996	901.36
1997	901.37
1998	901.44
1999	901.49
2000	901.68
2001	901.64
2002	901.55
2003	901.69
2004	901.56
2005	901.45
2006	901.25
2007	901.26
Total Average	901.42

Date	Total Precip (in)
1980	30.39
1981	31.26
1982	31.24
1983	30.29
1984	36.74
1985	32.11
1986	35.72
1987	21.92
1988	25.62
1989	23.28
1990	34.72
1991	39.41
1992	25.61
1993	38.00
1994	34.65
1995	42.41
1996	31.87
1997	27.08
1998	30.56
1999	31.96
2000	26.70
2001	33.00
2002	41.50
2003	26.53
2004	30.69
2005	31.71
2006	28.65
2007	33.06
Average	31.67

Date	Elevation (ft)
3/31/2000	901.45
6/11/2000	901.77
6/15/2000	901.75
6/19/2000	901.75
6/26/2000	901.75
7/5/2000	901.70
7/7/2000	901.90
7/9/2000	902.07
7/29/2000	901.75

8/13/2000	901.65
8/19/2000	901.65
9/9/2000	901.50
9/10/2000	901.57
10/12/2000	901.25
5/7/2001	902.15
5/8/2001	901.83
5/8/2001	902.08
5/15/2001	901.93
5/16/2001	901.88
5/25/2001	901.83
5/29/2001	901.78
6/3/2001	901.73
6/4/2001	901.65
6/10/2001	901.77
6/18/2001	901.79
6/22/2001	901.75
6/25/2001	901.69
6/26/2001	901.67
6/28/2001	901.65
7/4/2001	901.53
7/5/2001	901.48
7/7/2001	901.43
7/9/2001	901.43
7/15/2001	901.34
7/23/2001	901.43
8/17/2001	901.19
8/19/2001	901.29
9/16/2001	901.15
4/22/2002	901.73
5/10/2002	901.89
5/10/2002	901.90
5/13/2002	901.90
5/22/2002	901.65
5/28/2002	901.52
6/1/2002	901.45
6/19/2002	901.50

6/22/2002	901.58
6/24/2002	901.74
7/1/2002	901.64
7/7/2002	901.50
7/9/2002	901.51
7/11/2002	901.52
7/18/2002	901.43
7/21/2002	901.35
7/26/2002	901.43
7/30/2002	901.40
8/3/2002	901.35
8/4/2002	901.55
8/6/2002	901.55
8/22/2002	901.50
8/22/2002	901.55
8/29/2002	901.42
9/1/2002	901.36
9/2/2002	901.56
9/6/2002	901.67
9/7/2002	901.64
9/14/2002	901.53
9/19/2002	901.40
9/21/2002	901.41
10/2/2002	901.45
10/10/2002	901.69
10/27/2002	901.57
11/10/2002	901.47
11/14/2002	901.43
5/2/2003	901.60
5/10/2003	901.64
5/12/2003	901.84
5/13/2003	901.86
5/13/2003	901.86
5/19/2003	901.79
5/20/2003	901.96
5/27/2003	901.84
6/3/2003	901.69
6/20/2003	901.56
6/24/2003	901.46
6/25/2003	901.94
6/28/2003	902.07
6/29/2003	902.08
7/8/2003	901.83
7/26/2003	901.51
7/28/2003	901.48
8/5/2003	901.44
8/13/2003	901.34
9/7/2003	901.02
4/21/2004	901.59
5/23/2004	901.69
5/23/2004	901.69
5/24/2004	901.71
5/27/2004	901.75
5/28/2004	901.75

5/31/2004	901.97
6/2/2004	902.04
6/5/2004	902.01
6/10/2004	901.90
6/15/2004	901.83
6/20/2004	901.65
7/3/2004	901.43
7/9/2004	901.40
7/19/2004	901.35
7/25/2004	901.25
8/1/2004	901.15
8/13/2004	901.06
8/22/2004	900.99
8/30/2004	900.97
4/16/2005	901.52
4/22/2005	901.47
4/24/2005	901.48
4/30/2005	901.44
5/6/2005	901.39
5/13/2005	901.41
5/17/2005	901.42
5/19/2005	901.52
6/7/2005	901.48
6/10/2005	901.59
6/14/2005	901.74
6/21/2005	901.74
6/28/2005	901.79
7/11/2005	901.55
7/16/2005	901.42
7/19/2005	901.34
7/19/2005	901.35
8/9/2005	901.17
8/15/2005	901.11
9/3/2005	901.06
04/26/2006	901.53
05/07/2006	901.44
06/09/2006	901.48
06/21/2006	901.48
07/13/2006	901.13
07/24/2006	901.02
07/26/2006	901.16
08/01/2006	901.16
08/02/2006	901.27
08/09/2006	901.16
08/15/2006	901.12
08/24/2006	901.24
09/26/2006	901.12
4/9/2007	901.66
4/15/2007	901.62
4/22/2007	901.57
4/24/2007	901.58
5/8/2007	901.34

5/19/2007	901.24
5/23/2007	901.22
5/25/2007	901.34
5/30/2007	901.36
5/31/2007	901.44
6/22/2007	901.22
6/28/2007	901.12
7/8/2007	901.16
7/26/2007	900.94
8/4/2007	900.80
8/12/2007	900.77
8/15/2007	900.97

Halfbreed (Sylvan) Lake

DNR ID #82-80

Forest Lake Township/New Scandia Township, Washington County

Period of record: 09/17/1981 to 9/5/2007

of readings: 374

Highest recorded: 938 ft (7/3/2003)

[Highest known: 938 ft \(7/3/2003\)](#)

Lowest recorded: 934.52 ft (11/22/1990)

Recorded range: 3.48 ft

Average water level: 936.82 ft

Last reading: 935.74 ft (9/5/2007)

[OHW elevation: 937.1 ft](#)

Datum: 1929 (ft)

Annual Averages	Elevation (ft)
1981	936.85
1982-1989	NA
1990	934.71
1991	936.28
1992	936.29
1993	937.08
1994	936.88
1995	937.08
1996	937.07
1997	936.82
1998	936.81
1999	936.97
2000	936.50
2001	937.00
2002	937.27
2003	937.47
2004	936.99
2005	937.23
2006	936.78
2007	936.26
Total Average	936.82

Date	Total Precip (in)
1980	30.39
1981	31.26
1982	31.24
1983	30.29
1984	36.74
1985	32.11
1986	35.72
1987	21.92
1988	25.62
1989	23.28
1990	34.72
1991	39.41
1992	25.61
1993	38.00
1994	34.65
1995	42.41
1996	31.87

Date	Total Precip (in)
1997	27.08
1998	30.56
1999	31.96
2000	26.70
2001	33.00
2002	41.50
2003	26.53
2004	30.69
2005	31.71
2006	28.65
2007	33.06
Average	31.67

Date	Elevation (ft)
4/7/2000	936.80
4/12/2000	936.76
4/24/2000	936.72
5/4/2000	936.70
5/10/2000	936.68
5/26/2000	936.68
5/26/2000	936.68
6/8/2000	936.74
6/14/2000	936.66
6/14/2000	936.66
6/17/2000	936.64
6/22/2000	936.62
6/30/2000	936.66
6/30/2000	936.66
7/6/2000	936.57
7/9/2000	936.90
7/19/2000	936.74
7/20/2000	936.64
7/20/2000	936.64
7/31/2000	936.58
8/6/2000	936.46
8/6/2000	936.46
8/10/2000	936.48
8/22/2000	936.36
8/25/2000	936.36

8/25/2000	936.36
8/29/2000	936.44
9/2/2000	936.30
9/2/2000	936.30
9/14/2000	936.36
9/21/2000	936.26
9/21/2000	936.26
9/25/2000	936.20
9/26/2000	936.20
9/28/2000	936.18
10/3/2000	936.14
10/9/2000	936.04
10/26/2000	936.02

4/18/2001	937.11
4/21/2001	937.21
4/22/2001	937.19
4/23/2001	937.45
4/27/2001	937.43
5/15/2001	937.39
5/30/2001	937.41
6/7/2001	937.43
6/20/2001	937.57
6/28/2001	937.41
7/10/2001	937.06
7/24/2001	936.89
7/27/2001	936.77
7/27/2001	936.85
8/7/2001	936.77
8/8/2001	936.75
8/14/2001	936.61
8/14/2001	936.65
8/22/2001	936.55
8/28/2001	936.61
9/15/2001	936.65
10/10/2001	936.73
12/1/2001	936.75
12/22/2001	936.69

4/1/2002	937.31
4/17/2002	937.11
5/1/2002	937.33
5/9/2002	937.33
5/10/2002	937.31
5/13/2002	937.31
6/3/2002	937.17
6/4/2002	937.11
6/10/2002	937.15
6/11/2002	937.21
6/17/2002	937.15
6/18/2002	937.21
6/25/2002	937.17
6/26/2002	937.41
7/9/2002	937.19
7/16/2002	937.17
7/17/2002	937.15
7/29/2002	937.21
8/8/2002	937.23
8/10/2002	937.21
8/15/2002	937.11
8/20/2002	937.05
8/27/2002	937.19
9/6/2002	937.41
9/10/2002	937.35
9/14/2002	937.25
9/18/2002	937.25
9/21/2002	937.23
9/25/2002	937.19
10/1/2002	937.23
10/11/2002	937.48
10/16/2002	937.45
10/20/2002	937.25
10/25/2002	937.45
10/29/2002	937.45
10/30/2002	937.47
11/5/2002	937.39
11/13/2002	937.35
11/14/2002	937.37
4/15/2003	937.04
4/21/2003	937.22
5/6/2003	937.18
5/16/2003	937.49
5/27/2003	937.68
6/5/2003	937.57
6/8/2003	937.62
6/11/2003	937.62
6/15/2003	937.47
6/25/2003	937.95
6/27/2003	937.94
7/2/2003	937.94
7/3/2003	938.00
7/11/2003	937.91
7/23/2003	937.80
8/6/2003	937.79

8/14/2003	937.64
8/21/2003	937.54
8/21/2003	937.54
9/4/2003	937.24
9/18/2003	937.18
10/1/2003	937.04
10/10/2003	936.92
10/14/2003	937.00
10/26/2003	936.92
11/4/2003	936.94
4/13/2004	936.99
4/22/2004	937.11
5/4/2004	936.99
5/18/2004	937.11
6/2/2004	937.49
6/16/2004	937.47
6/29/2004	937.31
7/14/2004	937.15
7/26/2004	936.90
8/12/2004	936.78
8/25/2004	936.65
9/9/2004	936.75
9/22/2004	936.81
10/6/2004	936.69
10/20/2004	936.65
11/1/2004	936.94
4/12/2005	937.61
4/14/2005	937.59
4/26/2005	937.51
5/13/2005	937.41
5/24/2005	937.47
6/9/2005	937.47
6/22/2005	937.46
7/7/2005	937.35
7/22/2005	937.05
8/2/2005	936.99
8/16/2005	936.75
9/1/2005	936.78
9/14/2005	936.79
9/30/2005	936.94
10/14/2005	937.33
10/28/2005	937.23
4/18/2006	937.06
5/5/2006	937.02
5/17/2006	937.00
6/2/2006	936.78
6/16/2006	936.85
6/30/2006	936.84
7/13/2006	936.59
7/27/2006	936.54
8/11/2006	936.60
8/24/2006	936.50

9/8/2006	936.52
9/22/2006	936.46
10/4/2006	936.42
10/18/2006	936.32
10/25/2006	936.28
4/10/2007	936.78
4/28/2007	936.72
5/9/2007	936.60
5/16/2007	936.50
5/23/2007	936.40
5/29/2007	936.44
6/4/2007	936.56
6/20/2007	936.32
7/3/2007	936.06
7/23/2007	935.88
8/9/2007	935.58
8/30/2007	935.84
9/5/2007	935.74

Shields Lake
DNR ID #82-162
Forest Lake Township, Washington County

Period of record: 06/04/1991 to 8/29/07
of readings: 185
Highest recorded: 903.99 ft (6/27/2002)
Lowest recorded: 899.77 ft (10/2/2006)
Recorded range: 4.22 ft
Average water level: 901.88 ft
Last reading: 900.73 (8/29/2007)
OHW elevation: 902.5 ft
Datum: 1929 (ft)

Annual Averages	Elevation (ft)
1996	901.70
1997	901.90
1998	901.91
1999	902.13
2000	901.79
2001	901.98
2002	902.39
2003	902.07
2004	901.85
2005	902.20
2006	901.89
2007	901.00
Total Average	901.88

Date	Total Precip (in)
1980	30.39
1981	31.26
1982	31.24
1983	30.29
1984	36.74
1985	32.11
1986	35.72
1987	21.92
1988	25.62
1989	23.28
1990	34.72
1991	39.41
1992	25.61
1993	38.00
1994	34.65
1995	42.41
1996	31.87
1997	27.08
1998	30.56
1999	31.96
2000	26.70
2001	33.00
2002	41.50
2003	26.53
2004	30.69
2005	31.71
2006	28.65
2007	33.06
Average	31.67

Date	Elevation (ft)
4/7/2000	901.97
4/12/2000	901.91
5/23/2000	901.81
6/8/2000	902.11
6/22/2000	901.91
7/6/2000	901.79
7/19/2000	902.15
7/31/2000	901.85
8/10/2000	901.69
8/22/2000	901.67
8/29/2000	901.74
9/14/2000	901.75
9/25/2000	901.64
9/28/2000	901.61
10/9/2000	901.53
10/26/2000	901.57
4/18/2001	902.70
4/27/2001	903.34
5/15/2001	902.09
5/30/2001	902.08
6/7/2001	901.88
6/20/2001	902.44
6/28/2001	902.12
7/10/2001	901.74
7/25/2001	901.74
8/7/2001	901.67
8/14/2001	901.53
8/28/2001	901.59
9/13/2001	901.54
9/28/2001	901.56
10/17/2001	901.62
4/17/2002	902.61
5/10/2002	903.67
5/28/2002	902.01
6/6/2002	902.03
6/26/2002	903.27
7/9/2002	902.09

7/17/2002	902.09
7/29/2002	902.17
8/8/2002	902.45
8/15/2002	902.19
8/20/2002	902.09
8/27/2002	902.29
9/6/2002	902.73
9/10/2002	902.73
9/18/2002	902.19
9/25/2002	902.03
10/1/2002	902.05
10/11/2002	902.97
10/16/2002	902.53
10/25/2002	902.31
10/29/2002	902.25
11/5/2002	902.13
11/13/2002	902.09
4/15/2003	902.02
5/6/2003	902.22
5/16/2003	902.72
5/29/2003	902.16
6/11/2003	902.10
6/27/2003	903.99
7/11/2003	902.22
7/23/2003	901.96
8/6/2003	901.78
8/21/2003	901.66
9/4/2003	901.46
9/18/2003	901.56
10/1/2003	901.52
10/14/2003	901.54
4/13/2004	901.95
4/22/2004	902.25
5/4/2004	901.95
5/18/2004	902.21
6/16/2004	902.25
6/29/2004	901.85
7/14/2004	901.86

7/26/2004	901.65
8/12/2004	901.58
8/25/2004	901.55
9/9/2004	901.55
9/22/2004	901.81
10/6/2004	901.73
10/20/2004	901.69
4/12/2005	902.30
4/14/2005	902.24
4/26/2005	902.14
5/13/2005	902.12
5/24/2005	902.32
6/9/2005	902.28
6/13/2005	902.38
6/22/2005	902.60
7/7/2005	902.38
7/22/2005	902.01
8/2/2005	901.88
8/16/2005	901.70
9/1/2005	901.86
9/14/2005	901.92
9/30/2005	902.32
10/14/2005	902.68

4/18/2006	901.23
4/18/2006	901.23
5/4/2006	901.43
5/17/2006	901.27
6/1/2006	900.93
6/15/2006	901.25
6/28/2006	901.23
7/6/2006	900.95
7/25/2006	900.73
8/7/2006	900.93
8/22/2006	900.75
9/7/2006	900.93
9/14/2006	900.81
9/19/2006	900.60
10/2/2006	899.77
10/17/2006	900.57

4/9/2007	901.51
4/13/2007	901.49
5/8/2007	900.99
6/4/2007	901.11
7/2/2007	900.65
7/30/2007	900.51
8/29/2007	900.73

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