2000 and 2001 Water Quality Study

Crane Lake (BCWMC), Northwood Lake (CAMP), South Rice Lake (CAMP), Sweeney Lake (CAMP), Parkers Lake (CAMP), and Westwood Lake (CAMP), Wirth Lake (MPRB), Medicine Lake (SHRPD), and Bassett Creek (WOMP)

Prepared for
Bassett Creek Water Management Commission

March 2002

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Acronyms

BCWMC – Bassett Creek Water Management Commission
CAMP – Citizen Assisted Monitoring Program
MPRB – Minneapolis Park and Recreation Board
SHRPD – Suburban Hennepin Regional Park District
WOMP – Watershed Outlet Monitoring Program

Executive Summary

Summary

Since 1970, when the Bassett Creek Water Management Commission was formed, water quality conditions in the ten major lakes have been periodically monitored. The objective of the lake monitoring program is to detect changes or trends in water quality over time, thereby determining the effect of changing land use patterns in the watershed and the effectiveness of the Commission's efforts to prevent water quality degradation in the lakes.

This report presents the results of water quality monitoring in 2001 of Crane Lake by Barr Engineering Company (Barr). The lake was monitored for water quality (Appendix A) and biota (Appendix B). The latter included macrophytes (i.e., aquatic vascular plants), phytoplankton, and zooplankton. Monitoring results are summarized using a narrative description of the results, accompanied by a one page graphical summary of the data.

In addition, this report includes a summary of results of volunteer monitoring of lakes under the Citizen Assisted Monitoring Program (CAMP), which is coordinated by the Metropolitan Council for 2000 and 2001. The five lakes monitored in the Bassett Creek watershed were Northwood Lake, South Rice Lake, Sweeney Lake (2 sites), Parkers Lake, and Westwood Lake. The BCWMC shared sponsorship for Sweeney Lake with the Sweeney Lake Association and sponsored the volunteer monitoring at the other four lakes.

Conclusions

Crane Lake

- Crane Lake is a shallow wetland-type of lake that appears to have a relatively simple chemical, physical, and biological structure.

- Water quality goals for Crane Lake were achieved for chlorophyll *a* (maximum 40 µg/L) throughout 2001, and were achieved for total phosphorus (maximum 75 µg/L) and Secchi depth (minimum 0.9 meters) in the first half of the growing season. Water quality goals were not met in July and August for total phosphorus and in late August and September for Secchi depth.

- Macrophytes are growing throughout Crane Lake and a filamentous algal mat develops in the late summer; Purple loosestrife is a nuisance exotic species that is interspersed with the cattails surrounding the shoreline of Crane Lake.

- Crane Lake generally had better water quality in the last decade than in the previous two decades, based on total phosphorus and chlorophyll *a* concentrations measured since 1972.

Northwood Lake (CAMP)

- Algal biomass (chlorophyll *a*) appears to have responded to barley straw additions in 2000 and 2001, although the effect of the barley straw is complicated by a reduction in total phosphorus concentrations compared to previous years, which could also account for a reduction in algal biomass.

- At least one algal bloom did occur in mid-summer of 2000 and 2001, and the summer average chlorophyll *a* concentration in 2001 was about double the 2000 summer average.

- The results in 2000 from the CAMP monitoring were very similar to the Barr sample results, which supports the reliability of the CAMP data.

South Rice Lake (CAMP)

- Total phosphorus (TP) and chlorophyll *a* concentrations in 2000 were extremely high, with summer averages of 1323 µg/L and 1326 µg/L, respectively; however, the TP and chlorophyll *a* concentrations were in the expected range in 2001, with summer averages of 211 µg/L for TP and 22 µg/L for chlorophyll *a*.

- Summer average Secchi depth was 0.5 meters for both years.

Sweeney Lake (CAMP)

- Sweeney Lake was sampled at a north and south site by the CAMP volunteer for both 2000 and 2001. The north and south sites had essentially the same water quality.

- The results in 2000 from the CAMP monitoring at the south site were very similar to the Barr sample results from the same site; summer average Secchi depth was 0.3 meters lower from the Barr measurements, but the summer average TP concentrations were identical and summer average chlorophyll *a* concentrations were within 5 µg/L.

Parkers Lake (CAMP)

- CAMP data were collected for the first time 2000; no data were available from CAMP for 2001.

- Summer average Secchi depth collected by Barr in 2000 was 0.6 meters less than the summer average Secchi depth from the CAMP monitoring; however, summer averages for TP and chlorophyll *a* were very similar for the two sets of 2000 data.

Westwood Lake (CAMP)

- CAMP results for 2000 and 2001 showed greater average Secchi depth in 2001 compared to 2000, but the summer average chlorophyll *a* concentration was approximately four times higher in 2001 than in 2000, because of several algal blooms in 2001.

- Secchi depth was 1.1 meters in 1997 (measured by Barr) and 1.6 meters in 2001 (measured by CAMP volunteer). More data are needed to determine if there is a positive trend in water quality.

Wirth Lake (MPRB)

- MPRB staff collected data in 2000 and 2001. Results showed there was little change in summer averages in 2001 compared to 2000 for secchi depth, total phosphorous and chlorophyll *a*.

Medicine Lake (SHRPD)

- SHRPD staff collected data in 2000 and 2001. Results showed there was little change in summer averages in 2001 compared to 2000 for secchi depth, total phosphorous and chlorophyll *a*.

Bassett Creek (WOMP)

- Water quality and quantity (stream flow) data were collected in 2000 and 2001 for the Bassett Creek WOMP site. At this time, the data set does not span a long enough time period to determine any trends. However, a brief review of data collected for the *Bassett Creek 1992 Stormwater Monitoring Study* (Barr Engineering, 1993) showed that there has been little change since 1992.

Introduction

Since 1970, when the Bassett Creek Water Management Commission (Commission) was formed, water quality conditions in the ten major lakes have been periodically monitored. The Commission's policy is to preserve water quality conditions, and to improve them where possible. Nonpoint source pollution—pollutants transported by stormwater runoff—is the predominant cause of lake water quality degradation. The objective of the lake monitoring program is to detect changes or trends in water quality over time, thereby determining the effect of changing land use patterns in the watershed and the effectiveness of the Commission's efforts to prevent water quality degradation in the lakes.

In 1991, the Commission established an annual lake water quality monitoring program that generally followed the recommendations of the Metropolitan Council (Osgood, 1989a) for a "Level 1, Survey and Surveillance" data collection effort. The lake sampling program generally involves monitoring of ten lakes on a four-year rotating basis, three or four lakes per year. Major lakes include the following water bodies, with prior monitoring years indicated parenthetically:

- Crane (1977, 1982, 1993, 1997, 2001)
- Lost (1977, 1982, 1993, 1997)
- Medicine (1977, 1982, 1983, 1984, 1988, 1994[1], 1999[1])
- Northwood (1977, 1982, 1992, 1996, 2000)
- Parker's (1977, 1982, 1992, 1996, 2000)
- Sunset Hill (Cavanaugh) (1977, 1982, 1994, 1998)
- Sweeney (1977, 1982, 1985, 1992, 1996, 2000)
- Twin (1977, 1982, 1992, 1996, 2000)
- Westwood (1977, 1982, 1993, 1997)
- Wirth (1977, 1982)

Wirth Lake is currently monitored by the Minneapolis Park Board and is, therefore, not included in the Commission's lake monitoring program. Medicine Lake is currently monitored by Suburban Hennepin Regional Park District (Hennepin Parks). The Commission periodically participates with Hennepin parks to monitor Medicine Lake.

[1] Monitoring performed jointly with Suburban Hennepin Regional Park District.

The lake sampling program occasionally includes limited monitoring for other water bodies, which has included the following ponds and the year sampled in parenthesis:

- Courtland, East Ring, and West Ring Ponds (1993)
- Grimes Pond (1996)
- North Rice and South Rice Ponds (1994, 1998)

This report presents the results of water quality monitoring in 2001 of Crane Lake (see Figure 1 for location). The lake was monitored for water quality (see Appendix A) and biota (see Appendix B). The biotic monitoring included macrophytes (i.e., aquatic vascular plants), phytoplankton, and zooplankton. Monitoring results are summarized; a narrative description of the results is accompanied by a one page graphical summary of the data. More detailed results can be found in the appendices of the report. The Commission discontinued monitoring for Lost Lake and Westward Lake during 2001 due to budgeting issues.

In addition, this report includes a summary of results of volunteer monitoring of lakes under the Citizen Assisted Monitoring Program (CAMP), which is coordinated by the Metropolitan Council for 2000 and 2001. The five lakes monitored in the Bassett Creek watershed were Northwood Lake, South Rice Lake, Sweeney Lake (2 sites), Parkers Lake, and Westwood Lake. The BCWMC shared sponsorship for Sweeney Lake with the Sweeney Lake Association and sponsored volunteer monitoring at the other four lakes.

The discussion of water quality conditions focuses on the three principal water quality indicators: total phosphorus (TP) and chlorophyll *a* concentrations, and Secchi disc transparency. Phosphorus is a nutrient that usually controls the growth of algae. Chlorophyll *a* is the primary photosynthetic pigment in lake algae; therefore, the concentration in a lake water sample indicates the amount of algae present in the lake. Secchi disc transparency is a measure of water clarity, and is inversely related to algal abundance.

The water quality conditions were classified as to trophic state, based on the total phosphorus concentration, chlorophyll *a* concentration, and Secchi disc transparency (Table 1). Most of the lakes in the Twin Cities Metropolitan Area fall within the eutrophic or hypereutrophic ranges.

The Recreational Suitability Index (RSI) was calculated for each lake. The RSI is an index of recreational impairment in a lake caused by degraded water transparency. The index represents degrees of use-impairment and parallels an index of physical condition (Table 2). Secchi disc transparency data were used to calculate the RSI, which was originally based on empirical relationships developed by Osgood (1989a) using data from lakes in the Twin Cities metro area.

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Figure 1   Location of Crane Lake 2001 Water Quality Study

Table 1
Trophic State Classifications for Total Phosphorus, Chlorophyll *a*, and Secchi Disc Transparency

Lake Classification	Total Phosphorus	Chlorophyll *a*	Secchi Disc Transparency
Oligotrophic (nutrient poor)	less than 10 µg/L	less than 2 µg/L	Greater than 15 ft (4.6 m)
Mesotrophic (moderate nutrient levels)	10 µg/L – 24 µg/L	2 µg/L - 7.5 µg/L	15 ft - 6.6 ft (4.6 m - 2.0 m)
Eutrophic (nutrient rich)	24 µg/L – 57 µg/L	7.5 µg/L - 26 µg/L	6.6 ft – 2.8 ft (2.0 m - 0.85 m)
Hypereutrophic (extremely nutrient rich)	Greater than 57 µg/L	Greater than 26 µg/L	Less than 2.8 ft (0.85 m)

Table 2
Recreational Suitability Index Compared to a Physical Conditions Index

Scale	Recreational Suitability Index	Physical Condition Index
1	Beautiful, could not be better	Crystal clear
2	Very minor aesthetic problems	Not quite crystal clear; some algae visible
3	Swimming and aesthetic enjoyment slightly impaired	Definite color caused by algae
4	Desire to swim and level of enjoyment substantially reduced	High algal levels with limited clarity and/or mild odor apparent
5	Swimming and aesthetic enjoyment nearly impossible because of algae	Severely high algal levels; includes massive floating scums, strong foul odor, or fish-kill

Source: Osgood, 1989b

Several types of biological data were compiled and evaluated during this study. Macrophyte (aquatic plants), phytoplankton, zooplankton, and fisheries data provide insight into the health of the aquatic ecosystem associated with each water body. Aquatic communities interact with each other and influence both short- and long-term variations in observed water quality.

Macrophytes (vascular aquatic plants)—describe the aquatic plants growing in the shallow (littoral) area of the lake. They are a natural part of most lake communities and provide many benefits to fish, wildlife, and people. Macrophytes are the primary producers in the aquatic food chain, providing food for other aquatic life.

Phytoplankton (algae)—form the base of the lake's food web and directly influence the lake's fish production and recreational use. Chlorophyll *a* is a measure of total phytoplankton biomass; however, identifying the species and their abundance provides additional information on the health of the ecosystem, as well as an explanation for some of the changes that occur in the chlorophyll *a* levels over time. Algae that can be eaten by zooplankton are considered desirable over the larger algal species that cannot be easily consumed. The larger species that cannot be consumed by the zooplankton also have the ability to form "blooms"—very high concentrations of algae—which can impair recreational use.

Zooplankton (microscopic crustaceans)—are vital to the health of a lake ecosystem because they feed upon the phytoplankton and are food themselves for many fish species. Protection of the lake's zooplankton community through proper water quality management practices protects the lake's fishery. Zooplankton are also important to lake water quality. The zooplankton community is generally comprised of three groups: Cladocera, Copepoda, and Rotifera. If present in abundance, large Cladocera can decrease the number of algae and improve water transparency within a lake.

Crane Lake

Site Description

Crane Lake (also known as Dayton Pond) and its watershed are located entirely within the city limits of Minnetonka, Minnesota. The lake has a surface area of 30 acres (12 hectares), a maximum depth of 5 feet (1.5 meters), and an estimated mean depth of 3.3 feet (1.0 meters). Crane Lake is surrounded by a cattail marsh, which provides excellent waterfowl habitat, but restricts recreation. The lake is bordered by residential areas to the south and east, by Highway 394 to the north, and by Ridgedale Center to the west. The Crane Lake watershed has a total area of 353 acres (131 hectares)(excluding the landlocked and lake surface areas) and is nearly fully developed. The remaining undeveloped land is located southwest of the lake.

Crane Lake is classified as a Level III water body, which means it will support fishing, aesthetic viewing activities and observing wildlife. The specific water quality goals for Level III water bodies are:

- Maximum total phosphorus (TP) of 75 μg/L
- Maximum chlorophyll *a* concentration of 40 μg/L
- Minimum Secchi disc transparency depth of 0.9 meters (about three feet).

A watershed and lake management plan was completed for Crane Lake in 1995 by the Commission (Barr 1995).

Water Quality Data

Crane Lake was sampled six times in 2001 at one sampling station in the deepest part of the lake. Total phosphorus concentrations, chlorophyll *a* concentrations, and Secchi disc transparencies during 2001 are graphically summarized in Figure 2. These data, along with other water quality data (e.g., temperature, dissolved oxygen, and specific electrical conductivity) are tabulated in Appendix A. The average summer concentrations (shown on the graphs) were for June, July, and August.

In addition to the graphs of 2001 water quality data, Figure 2 includes a graph of the historical record for total phosphorus and chlorophyll *a* (summer averages). The historical record includes the years the Bassett Creek Water Management Commission (BCWMC) sponsored the monitoring (1977, 1982, 1993, 1997, and 2001) and many additional years of monitoring that were sponsored by the Ridgedale Center. All data, except the first year (1972), were collected by Barr staff. Secchi depth is not included in this graph because water transparency in Crane Lake is often clear to the lake bottom and therefore the Secchi depth does not accurately reflect changes in water quality. The total phosphorus and chlorophyll *a* are plotted on separate scales to enhance the year to year changes in both parameters.

Total phosphorus concentrations in 2001 indicate hypereutrophic conditions for most of the summer and the summer average of 90.8 µg/L is in the hypereutrophic range. The 2001 summer TP average is above the TP goal of maximum 75 µg/L. Since 1991, the average summer TP concentration has been near or below the TP goal (see Crane Lake Historical Record plot in Figure 2). Prior to 1991 summer average TP concentrations were frequently above 150 µg/L. The highest recorded summer average TP concentration was 680 µg/L in 1974.

Chlorophyll *a* concentrations were surprisingly low in July and early August (1.8 µg/L), but then increased to typical hypereutrophic levels in late August and early September (28.0 µg/L). The wide difference in summer chlorophyll *a* concentrations resulted in a 2001 summer average chlorophyll *a* concentration of 13.3 µg/L, which is in the eutrophic range. The lake's chlorophyll *a* goal (i.e., maximum 40 µg/L) was met throughout 2001.

Secchi disc transparency summer averages indicate eutrophic conditions through June and July and hypereutrophic conditions in August and September. The 2001 summer average for Secchi disc transparency exactly matched the Class III water quality goal of 0.9 meters.

The historical record indicates the water quality in Crane Lake has been better in the last decade than it was in the previous two decades. Total phosphorus and chlorophyll *a* concentration were generally higher before 1989. Since 1989, Crane Lake has met the Class III goal for chlorophyll *a* and has met the phosphorus goal four out of the seven years monitored.

Recreational Suitability

Based on average summer Secchi disc transparency in Crane Lake, the recreational suitability index (RSI) was 5, which is the poorest ranking of this index. This low ranking indicates that swimming and aesthetic enjoyment are impaired because of high algal biomass. Given Crane Lake is a Class III lake and therefore not managed for swimming, the swimming is not a concern for the management of the lake's water quality; however, there is a management concern if the algal biomass decomposition leads to foul odors or fish kills.

Biota

There are three components of the biota in the lake that are discussed here: macrophytes (vascular aquatic plants), phytoplankton (algae), and zooplankton (microcrustaceans). The results for 2001 are graphically summarized in Figure 2 and the detailed macrophyte survey and plankton counts are tabulated in Appendix B. Fisheries are not discussed in this report because they are managed by the Minnesota Department of Natural Resources.

Zooplankton

Generally a healthy zooplankton community will have balanced densities (number per square meter) of the three major groups: cladocera, copepods, and rotifers. The zooplankton community in Crane Lake was somewhat balanced in the June sample, but became dominated by copepods in August and rotifers in September. The total density of zooplankton was greatest in September and lowest in early August. This seasonal difference was the opposite of phytoplankton densities, as discussed below. The inverse relationship between zooplankton and phytoplankton is expected because the primary food for herbivorous zooplankton is phytoplankton.

Although a zooplankton sample was collected on the July 18th sample date, but the sample was decomposed and no zooplankton species could be identified. Hence, July data are not available.

Phytoplankton

Total phytoplankton densities were highest in August, and consisted primarily of green algae (Chlorophyta). The summer phytoplankton densities do not agree with the chlorophyll *a* concentration, but they do follow the pattern in the TP concentrations. The results suggest a lack of homogeneity in the TP, chlorophyll *a*, and phytoplankton samples. Alternatively, there may have been some analytical error in the chlorophyll *a* analysis and the true average in chlorophyll *a* was higher than observed from these data. When bluegreen algae (Cyanophyta) are abundant the apparent lack of agreement between phytoplankton numbers and chlorophyll *a* concentration can at least in part be caused by a change in the "packaging" or biovolumes of the algal cells. The bluegreen algae can form "flakes" that consist of many individual algal cells.   However, bluegreen algae were at relatively insignificant concentrations in Crane Lake.

Macrophytes

Vegetation was found throughout the lake. Submerged aquatic plants covered most of the lake□s surface in June and in August. The macrophytes were less dense on the eastern part of the lake. In the August survey, floating mats of filamentous algae were observed on the western end of the lake. Cattails (*Typha spp.*) and Purple loosestrife (*Lythrum salicaria*) were present along the entire shore of the lake. Purple loosestrife is an exotic emergent that has attractive flowers, but provides poorer wildlife habitat than native emergent species that it displaces, such as cattails.

Conclusions

- Crane Lake is a shallow wetland-type of lake that appears to have a relatively simple chemical, physical, and biological structure

- Water quality goals for Crane Lake were achieved for chlorophyll *a* throughout 2001, and were achieved for total phosphorus and Secchi depth in the first half of the growing season. Water quality goals were not met in July and August for total phosphorus and in late August and September for Secchi depth

- Macrophytes are growing throughout Crane Lake and a filamentous algal mat develops in the late summer; Purple loosestrife is a nuisance exotic species that is interspersed with the cattails surrounding the shoreline of Crane Lake

- Crane Lake generally had better water quality in the last decade than in the previous two decades, based on total phosphorus and chlorophyll *a* concentrations measured since 1972

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Figure 2 Crane Lake 2001 Chemical and Biological Data Summary

Results from 2000 and 2001 CAMP Monitoring of Lakes in Bassett Creek Watershed

The Metropolitan Council has collected lake water quality data since 1980. The Council sponsored and coordinated the Citizen-Assisted Monitoring Program (CAMP) for nine years. The program is currently coordinated by the Metropolitan Council Environmental Services (MCES) limnologist, Randall J. Anhorn. He authored the latest published report: *2000 Study of the Water Quality of 124 Metropolitan Area Lakes*, October 2001. Fourteen of the lakes were monitored by the Council and 108 lakes were monitored by volunteers. Five of the lakes monitored by volunteers were in the Bassett Creek watershed: Northwood Lake, South Rice Lake, Sweeney Lake, Parkers Lake, and Westwood Lake. The results from these five lakes are presented below.

The CAMP volunteers measure surface water temperature and Secchi Disc transparency; surface water samples are collected for analysis of total phosphorus (TP), total Kjeldahl nitrogen, and chlorophyll *a*. Monitoring begins in mid-April and continues on a biweekly basis to mid-October, resulting in approximately 14 samples per year. For quality assurance, the Council staff supervise volunteers during a monitoring event and/or collect a separate set of samples during the same week that volunteers are sampling. The combined data for 1993-2000 has shown no statistical difference between the sample results from volunteers and Council staff.

Northwood Lake

Northwood Lake monitoring in 2000 and 2001 was sponsored by the BCWMC, and the monitoring volunteer was Steve Bur. The lake had not previously been in CAMP. Results from Northwood Lake are shown in Figure 3 and summer averages are summarized in Table 1. Barr had sampled Northwood Lake for the BCWMC in 2000 as part of the routine lake monitoring (Barr 2001), but did not monitor Northwood Lake in 2001.

The lake received barley straw treatment in both 2000 and 2001. In the first year of barley straw application, it appeared to significantly reduce the chlorophyll *a* concentration in the lake compared to past years (Barr 2001). Secchi depth was usually at or near the bottom of the lake (1.2-1.3 m). The exception was one sample date—July 9, 2000—when Secchi depth was 0.5 meters, which corresponded to the highest TP concentration (200 µg/L). A similar pattern occurred in 2001. Secchi depth was at or near the lake bottom in May, June, September, and October. Secchi depth declined to 0.7 meters on July 28, 2001, and remained at 1.0 meters through August. The date of lowest transparency corresponded, as it did in 2000, to the highest observed TP concentration (260 µg/L).

Comparing the 1996 and 2000 data from the BCWMC reports, the decline in chlorophyll *a* concentration was accompanied by a similar reduction in phosphorus concentration. The 1996 summer average TP concentration was 270 µg/L and the 2000 summer average TP concentration in Northwood Lake was 120 µg/L. Therefore, the reduction in algal biomass (chlorophyll) could at least in part be due to the reduction phosphorus concentration.

Parkers Lake

Parkers Lake monitoring in 2000 was sponsored by the BCWMC and the monitoring volunteer was Bob Videen. The lake had not previously been in CAMP. Results from Parkers Lake are shown in Figure 4 and summer averages are summarized in Table 1. Parkers Lake data was available from

Table 3
Summer Averages (June-August) for 2000 and 2001

Lake / Year		Secchi Depth (m)	Total Phosphorus (µg/L)	Chlorophyll *a* (µg/L)
Northwood Lake				
	2000*	1.3	121	17
	2000	1.1	135	17
	2001	1.1	167	39
South Rice Lake				
	2000	0.5	1323	1326
	2001	0.5	211	22
Sweeney Lake South				
	2000*	0.9	48	32
	2000	1.2	48	27
	2001	1.3	33	20
Sweeney Lake North				
	2000	1.2	52	30
	2001	1.5	33	30
Parkers Lake				
	2000*	2.4	18.3	6.3
	2000	3.0	20	4.2
Westwood Lake				
	2000	1.3	28	6.8
	2001	1.6	24	29

* from Barr 2001

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Figure 3 Secchi Depth (SDM), Total Phosphorus (TP), and Chlorophyll a (CLA) for Northwood Lake in 2000 and 2001

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Figure 4 Secchi Depth (SDM), Total Phosphorus (TP), and Chlorophyll a (CLA) for Parkers Lake in 2000

CAMP for the first time in 2000, but not 2001. BCWMC sponsored the CAMP volunteer sampling and had sampled Parkers Lake in 2000 as well by Barr Engineering Company (Barr 2001). The summer averages for TP, chlorophyll, and Secchi depth from CAMP and BCWMC were very similar (Table 1). Parkers Lake had the greatest transparency and lowest chlorophyll concentration of the Bassett Creek watershed lakes sampled in 2000. Parkers Lake has consistently been in the mesotrophic range for water quality.

South Rice Lake

South Rice Lake monitoring in 2000 and 2001 was sponsored by the BCWMC and the monitoring volunteers were Jan and Dave Olfe. The lake had not previously been in CAMP. Results from South Rice Lake are shown in Figure 5 and summer averages are summarized in Table 1. Chlorophyll *a* and TP concentrations were extremely high in 2000. Chlorophyll concentrations in late July through early September ranged from 1200 µg/L to 3300 µg/L. The TP concentrations during that same period were 230 µg/L to 2000 µg/L. (The extreme upper concentration is similar to discharge from a domestic wastewater treatment plant.) The 2000 summer averages (June-August) for TP and chlorophyll concentrations were 1323 µg/L and 1326 µg/L, respectively. In 2001, chlorophyll and TP concentrations were back to a reasonable range, although they remained high for lake concentrations.

Barr sampled North Rice and South Rice ponds in 1998 for the BCWMC (Barr 1999). Summer averages in 1998 were: Secchi depth, 0.6 meters; chlorophyll *a*, 96.3 µg/L; and total phosphorus, 384 µg/L. Therefore, if it is assumed that the results from 2000 are either incorrect or an anomaly, South Rice Lake water quality appears to have improved from 1998 to 2001. More years of data are needed to demonstrate that a positive trend in water quality has actually occurred in the lake.

Sweeney Lake

Sweeney Lake monitoring in 2000 and 2001 was sponsored by the BCWMC and the Sweeney Lake Association. The monitoring volunteer was Dave Hanson. The lake had not previously been in CAMP. Two sample stations were monitored: a north and south station. Results from 2000 and 2001 for Sweeney Lake are shown in Figure 6 (South Sample Site) and Figure 7 (North Sample Site). Barr

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Figure 5 Secchi Depth (SDM), Total Phosphorus (TP), and Chlorophyll a (CLA) for South Rice Lake in 2000 and 2001

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Figure 6 Secchi Depth (SDM), Total Phosphorus (TP), and Chlorophyll a (CLA) for Sweeney Lake South in 2000 and 2001

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Figure 7   Secchi Depth (SDM), Total Phosphorus (TP), and Chlorophyll a (CLA) for Sweeney Lake North in 2000 and 2001

sampled Sweeney Lake (south station) in 2000 for the BCWMC (Barr 2001) and the results were very similar to the CAMP results (Table 1). The summer average TP concentrations were identical for the two sets of 2000 data, despite differences in the number of samples and the sample dates. The CAMP results for the north and south sites showed similar water quality for both 2000 and 2001. There may have been a slight improvement in water quality in 2001, but more monitoring data will be required to determine if there is indeed a positive trend in water quality.

Westwood Lake

Westwood Lake monitoring in 2000 and 2001 was sponsored by the BCWMC and the monitoring volunteer was from the Westwood Hills Nature Center. Westwood Lake had been sampled as part of CAMP in 1993, but not in subsequent years until the monitoring began again in 2000. Results for Westwood Lake are shown in Figure 8 and summer averages are summarized in Table 1.

There appears to have been several algal blooms in Westwood during 2001, which resulted in an elevated summer average for chlorophyll, but did not appear to affect transparency. Secchi depth was in fact better in 2001 than in 2000 by 0.3 meters. The discrepancy between Secchi depth and chlorophyll concentration in 2001 could be caused by either large filamentous blue-green algae or from duckweed collected in the water sample, but cleared away for the Secchi depth measurement.

Barr had sampled Westwood Lake in 1997 as part of the routine lake monitoring for BCWMC (Barr 1998). Summer averages in 1997 were: Secchi depth, 1.1 meters; chlorophyll *a*, 12 µg/L; total phosphorus, 36 µg/L. Therefore, it appears Westwood Lake water quality has shown improvement since 1997.

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Figure 8 Secchi Depth (SDM), Total Phosphorus (TP), and Chlorophyll a (CLA) for Westwood Lake in 2000 and 2001

Results from 2000 and 2001 MPRB and SHRPD Monitoring of Lakes in Bassett Creek Watershed

In 2000 and 2001, the Minneapolis Parks and Recreation Board (MPRB) and Suburban Hennepin Regional Park District (SHRPD) collected water quality data for Wirth Lake and Medicine Lake, respectively. The results from this monitoring are presented below.

Wirth Lake

MPRB staff collected 12 samples from Wirth Lake during 2000 and 13 samples during 2001. Results for secchi depth, total phosphorous and chlorophyll *a* are shown in Figure 9 and summer averages are displayed in Table 4. In 2001 compared to 2000, there was little change in summer averages. Additionally, temperature, dissolved oxygen (DO), conductivity and pH profiles were measured in the field and several other water quality parameters were analyzed using the samples. These data are summarized in Appendix D.

Medicine Lake

SHRPD staff collected 13 samples from Medicine Lake during 2000 and 16 samples during 2001. Results for secchi depth, total phosphorous and chlorophyll *a* are shown in Figure 10 and summer averages are displayed in Table 4. In 2001 compared to 2000, there was little change in summer averages. Additionally, temperature, dissolved oxygen (DO), conductivity and pH profiles were measured in the field and several other water quality parameters were analyzed using the samples. These data are summarized in Appendix E.

Table 4
Summer Averages (June-August) for 2000 and 2001

Lake / Year		Secchi Depth (m)	Total Phosphorus (µg/L)	Chlorophyll *a* (µg/L)
Wirth Lake				
	2000	1.3	49	25
	2001	1.3	48	24
Medicine Lake				
	2000	1.7	53	18
	2001	1.7	40	17

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Figure 9   Secchi Depth (SDM), Total Phosphorus (TP), and Chlorophyll a (CLA) for Wirth Lake in 2000 and 2001

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Figure 10 Secchi Depth (SDM), Total Phosphorus (TP), and Chlorophyll a (CLA) for Medicine Lake in 2000 and 2001

Results from 2000 and 2001 WOMP Stream Monitoring for Bassett Creek

In 2000, the BCWMC, in cooperation with Metropolitan Council Environmental Services (MCES), began monitoring Bassett Creek as part of the Watershed Outlet Monitoring Program (WOMP). The WOMP program is coordinated by MCES and consists of a network of monitoring stations located throughout the Metro Area. The objective of this program is to collect water quality and quantity (stream flow) data needed to assess current conditions, develop target pollutant loads, and to provide continued monitoring after best management practices (BMPs) are implemented in the watersheds.

The Bassett Creek WOMP site is located at Irving Avenue, ¼ mile upstream of the storm sewer tunnel that runs beneath downtown Minneapolis to the Mississippi River. Data collection consists of continuous measurements of stream flow, temperature and conductivity, as well as monthly base flow grab samples and storm event composite samples. The samples are analyzed in the MCES laboratory for many water quality parameters. The monitoring results for 2000 and 2001 are presented in graphs in Appendix F.

At this time, the WOMP data set does not span a long enough time period to determine trends in water quality or quantity. However, a brief review of data collected in the *Bassett Creek 1992 Stormwater Monitoring Study* (Barr Engineering, 1993), indicated there has been little change in water quality and quantity since 1992.

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Appendix A

Water Quality Data for 2000 and 2001

Appendix B

Crane Lake Macrophyte Surveys; Phytoplankton and Zooplankton Analyses for 2001

Appendix C

Field and Laboratory Methods

Appendix C: Field and Laboratory Methods

Crane Lake Sample Collection

The epilimnetic sample at Crane Lake's central sampling site was collected with a 0- to 1-meter integrated composite sampler.

Phytoplankton samples were collected as subsamples from the epilimnetic composite sample. Zooplankton samples were collected with a Wisconsin-type net towed from just above the lake bottom to the surface.

At the sample site the following parameters were measured at 0 and 1-meters:

- Water temperature
- Dissolved oxygen concentration
- Specific electrical conductivity
- Secchi disc transparencies were also measured at each site.

Macrophytes were surveyed and mapped twice in the lake.

Crane Lake Chemical Analyses

Procedures for the chemical analyses are presented in the accompanying table.

Table C-1 Procedures for Chemical Analysis Performed on Water Samples

Analysis	Procedure	Reference
Total Phosphorus	Persulfate digestion, manual ascorbic acid	Standard Methods, 18th Edition, 1992, USEPA Methods of Chemical Analysis of Water and Wastes, 365.4
Soluble Reactive Phosphorus	Manual ascorbic acid	Standard Methods, 18th Edition, 1992, USEPA Methods of Chemical Analysis of Water and Wastes, 365.3
Nitrite + Nitrate Nitrogen	Copperized reduction column and lachat flow injection ion analyzer	USEPA Methods of Chemical Analysis of Water and Wastes, 351.1
Total Kjeldahl Nitrogen	Digestion, treatment with sodium hypochlorite and sodium phenolate, run on technician autoanalyzer II	USEPA Methods of Chemical Analysis of Water and Wastes, 351.1
Chlorophyll *a*	Spectrophotometric	Standard Methods, 18th Edition, 1992, 10200
pH	Potentiometric measurement, glass electrode	Standard Methods, 29th Edition, 1998, 4500H&B, page 4-87
Specific Conductance	Wheatstone bridge	Standard Methods, 20th Edition, 1998, 2510B, page 2-9
Temperature	Thermometric	Standard Methods, 20th Edition, 1998, 2550B, page 2-61
Dissolved Oxygen	Electrode	Standard Methods, 20th Edition, 1998, 4500-OA, page 4-12 and Manual of Analytical Methods, Water Chemistry Unit, Laboratory of Hygiene, Madison, Wisconsin
Phytoplankton Identification and Enumeration	Inverted microscope	Standard Methods, 16th Edition, 1985, 1002F (2-d), 1002H (2)
Zooplankton Identification and Enumeration	Sedgewick Rafter	Standard Methods, 16th Edition, 1985, 1002F (7)
Transparency	Secchi disc	

Appendix D

Wirth Lake Water Quality Data

Appendix E

Medicine Lake Water Quality Data

Appendix F

Bassett Creek WOMP Site Data