BCWMC

1998 Water Quality Monitoring Report

North Rice Pond, South Rice Pond, Sunset Hills (Cavanaugh) Pond

Executive Summary

The Bassett Creek Water Management Commission (BCWMC) has periodically monitored the water quality of its ten major lakes and various ponds since its formation in 1970. The objective of the lake monitoring program is to detect changes or trends in water quality over time.

This report presents the results of water quality monitoring of the three water bodies (Sunset Hill, North Rice, and South Rice) sampled during 1998. It concentrates on the three principle water quality indicators: total phosphorus (TP) concentration, chlorophyll *a* concentration, and Secchi disc transparency. It also includes analysis of aquatic macrophytes, phytoplankton, and zooplankton communities in these systems.

The conclusions from the water quality monitoring in 1998 are as follows:

Sunset Hill Pond (Cavanaugh Lake)

- The pond has a trophic status of eutrophic to slightly-hypereutrophic. This is indicative of a water body rich to extremely rich in nutrients, especially phosphorus.

- Algal blooms during the late summer contributed to significantly decreased water transparency. Algal growth in Sunset Hill Pond may be controlled by reducing phosphorus inputs to the pond.

- The phytoplankton community was dominated by blue-green algae, which is characteristic of fertile systems. Green algae, also characteristic of fertile systems, dominated the community in previous years.

- On virtually all 1998 sampling dates, water clarity conditions would substantially reduce the recreational enjoyment of most people using Sunset Hill Pond. However, wildlife viewing and aesthetic enjoyment were maintained.

- A comparison of 1998 data with data collected in previous years indicates no significant change in water quality has occurred since 1972. However, some variation between individual years has been noted. For example, during 1994 total phosphorus and chlorophyll *a* concentrations were lower than 1998 values, while Secchi disc transparency values were higher than 1998 values. However, the differences between 1998 and 1994 were not significant.

- A water quality management goal for Sunset Hill Pond has not been established previously. However, based on current water quality data, pond characteristics, and current uses, it is recommended that the pond be managed as a Level III water body. The pond's 1998 summer average total phosphorus, chlorophyll *a*, and Secchi disc values met the Level III water quality goal (total phosphorus $\leq$ 75 µg/L, chlorophyll *a* $\leq$ 40 µg/L, and Secchi disc $\geq$ 0.9 m). In 1994, the summer average Secchi disc transparency met the Level III goal, but summer average total phosphorus and chlorophyll *a* concentrations failed to meet the Level III goal.

North Rice Pond

- The pond has a trophic status of eutrophic to hypereutrophic. This indicates a water body which is rich to extremely rich in nutrients.

- Poor water transparency resulted from excessive algal blooms in the late summer. The poor water clarity conditions substantially reduced the recreational enjoyment of most people using the lake in 1998. However, the water quality was suitable for wildlife viewing and aesthetic enjoyment.

- The phytoplankton community was dominated by cryptomonads and green algae. Green algae are characteristic of fertile systems.

- Because North Rice Pond is shallow, zooplankton within the pond have no refuge (i.e., hiding place) from the pond's fisheries. Consequently, larger zooplankton are readily consumed by fish and the pond's zooplankton community is comprised of small-bodied zooplankton.

  In 1998, the zooplankton community was dominated by rotifers, small-bodied zooplankton. Small-bodied zooplankton are unable to exert biological control on the pond's algal community.

- The Bassett Creek *Water Quality Management Plan* (Barr, 1994) classified North Rice Pond as a Level III water body and established water quality goals for the pond (total phosphorus $\leq$ 75 μg/L, chlorophyll *a* $\leq$ 40 μg/L, and Secchi disc $\geq$ 0.9 m). The 1998 water quality of North Rice Pond met the Level III goals for chlorophyll *a* and Secchi disc transparency, but failed to meet the Level III goal for total phosphorus. During 1994, the pond's water quality failed to meet Level III goals for total phosphorus, chlorophyll *a*, and Secchi disc. Wherever feasible, best management practices

should be employed to reduce phosphorus loading into this system to improve its water quality and attain its water quality goal.

South Rice Pond

The pond has a trophic status of hypereutrophic. This indicates a water body which is extremely rich in nutrients, especially phosphorus.

- Water transparency in South Rice Pond was diminished throughout the summer by excessive algal blooms. Poor water clarity resulted in unsuitable conditions for swimming and other recreational uses.

- The phytoplankton community was dominated by cryptomonads and green algae. Green algae are characteristic of fertile systems.

- South Rice Pond is shallow and its zooplankton have no refuge from the pond's fisheries. Consequently, the zooplankton community was dominated by rotifers (i.e., small-bodied zooplankton) and a few cladocera (i.e., larger-bodied zooplankton) were also noted. Small-bodied zooplankton are unable to exert biological control on the pond's algal community.

- The Bassett Creek *Water Quality Management Plan* (Barr, 1994) classified South Rice Pond as a Level III water body and established water quality goals for the pond (total phosphorus $\leq$ 75 µg/L, chlorophyll *a* $\leq$ 40 µg/L, and Secchi disc $\geq$ 0.9 m). The 1994 and 1998 water quality of South Rice Pond failed to meet the total phosphorus, chlorophyll *a*, and Secchi disc transparency goals for

a Level III water body. Wherever feasible, best management practices should be employed to reduce phosphorus loading into this system to improve its water quality and attain its water quality goal.

BCWMC 1998 Water Quality Monitoring Report: North Rice Pond, South Rice Pond, Sunset Hills (Cavanaugh) Pond

Table of Contents

List of Tables

List of Figures

List of Appendices

1.0 Introduction

The Bassett Creek Water Management Commission (BCWMC) has periodically monitored the water quality of its ten major lakes and various ponds since its formation in 1970. The Commission's policy is to preserve and improve (whenever/wherever possible) the water quality conditions throughout the watershed. Water quality degradation within the watershed has been largely attributed to nonpoint source pollution (i.e., pollutants transported by stormwater runoff). The objective of the lake monitoring program is to detect and identify changes or trends in water quality over time and relate these trends to changes in land use patterns within the watershed. An evaluation of water quality trends indicates the effectiveness of the Commission's efforts to prevent water quality degradation in the lakes.

The Commission established an annual lake water quality monitoring program in 1991. This program generally follows the recommendations of the Metropolitan Council (Osgood, 1989a) for a "Level 1, Survey" data collection effort. The lake sampling program generally involves monitoring ten lakes on a 3-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)
- Lost (1977, 1982, 1993, 1997)
- Medicine (1977, 1982, 1983, 1984, 1988, 1994[1])
- Northwood (1977, 1982, 1992, 1994, 1996)
- Parker's (1977, 1982, 1992, 1996)

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

- Sunset Hill (Cavanaugh) (1977, 1982, 1994, 1998)
- Sweeney (1977, 1982, 1985, 1992, 1996)
- Twin (1977, 1982, 1992, 1996)
- Westwood (1977, 1982, 1993, 1997)
- Wirth (1977, 1982)

The lake sampling program has also included the following ponds (and year sampled):

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

This report summarizes the results of the water quality monitoring of Sunset Hill Pond (Cavanaugh Lake), North Rice Pond, and South Rice Pond sampled during 1998. The location of these lakes within the Bassett Creek watershed is shown in Figure 1. These lakes were monitored for water quality (Appendix A) and biota (Appendix B). Monitoring results for each lake are presented in two summary formats; a narrative description, and a graphical summary. More detailed results are tabulated and mapped in the appendices of this report.

The discussion of water quality conditions focuses on three principle water quality indicators: total phosphorus concentration, concentration of chlorophyll *a*, and Secchi disc transparency. Phosphorus generally controls the growth of algae in lake systems. Of all the substances needed for biological growth, phosphorus is generally the one present in limited quantity. Consequently, when phosphorus is added to a system, it enhances algal growth. Chlorophyll *a* is the primary photosynthetic pigment in algae; therefore the

concentration of chlorophyll *a* in the water is indicative of 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 by trophic state, based on total phosphorus concentration, chlorophyll *a* concentration, and Secchi disc transparency (Table 1). The most desirable lakes in the Twin Cities Metropolitan area generally are in the mesotrophic range of water quality, but most lakes are eutrophic to hypereutrophic.

Table 1 Trophic state index classifications (TSI) for total phosphorus, chlorophyll *a*, and Secchi Disc transparency.

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

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Figure 1 Location of lakes and Ponds Included in 1998 Water Quality Study

The Recreational Suitability Index (RSI) was also calculated for each lake. The RSI is an index of recreational impairment in a lake due to decreased water clarity (i.e., Secchi disc transparency). Reduction of Secchi disc transparency is usually related to algal abundance measured by chlorophyll in the water column. The RSI also parallels an index of physical condition (Table 2). The RSI is calculated from Secchi disc transparency data and is based upon empirical relationships between chlorophyll *a* and Secchi disc depth determined from lakes in the Twin Cities metropolitan area (Osgood, 1989a). Index values in this summary were calculated using the following equation:

$$RSI = 4.38 - 6.25 \times \log_{10} (\text{Secchi disc depth})$$

Table 2 Recreational Suitability Index compared to a Physical Condition 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	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

The biotic components (i.e., macrophytes, phytoplankton, and zooplankton) of each pond were also evaluated. Each biological component provides an indication of water quality and the impacts of water quality on the biological community.

The Commission established water quality goals for the lakes in its *Water Quality Management Plan* (Barr, 1994) adopted as policy in 1994. The Water Quality Management Policy divided water bodies located in Bassett Creek watershed into four major management categories. These categories are based upon desired water quality goals and recreational uses. The categories include:

1. **Level I**–Fully support all water-based recreational activities, including swimming, scuba diving, and snorkeling.

2. **Level II**—Appropriate for all recreational uses except full body contact activities; recreational activities for these water bodies include sail boating, water skiing, motor boating, canoeing, wind surfing, and jet skiing.

3. **Level III**—Support fishing, aesthetic viewing activities and observing wildlife.

4. **Level IV**—Generally intended for runoff management (i.e., storm water detention) and have no significant recreational values.

Specific water quality goals were assigned to each level, and are described in the following summaries of water quality in Sunset Hill Pond, North Rice Pond, and South Rice Pond.

2.0 Sunset Hill Pond (Cavanaugh Lake)

2.1 Site Description

Sunset Hill Pond (Cavanaugh Lake) is located in the southeastern portion of Plymouth (Figure 1). Overflow from the pond eventually discharges to the southwestern basin of Medicine Lake. It has a surface area of 13.4 acres (5.4 ha), and a maximum depth of 8 feet (2.4 meters). The pond has a significant macrophyte (aquatic weed) community consisting of both submerged and floating leaf macrophytes (see macrophyte survey map located in Appendix B). Sunset Hill Pond receives stormwater runoff from a small industrial area to the south and from the surrounding residential area.

2.2 Water Quality Data

Sunset Hill Pond was sampled six times in 1998. Total phosphorus, chlorophyll *a* concentration, and Secchi disc transparency are shown in Figure 2. Other physical and chemical water quality parameters of the lake are listed in Appendix A.

Temperature and dissolved oxygen data indicate that during April and September, the lake was well mixed. Both water temperature and dissolved oxygen were similar throughout the entire depth of the water column for these dates. The lake was stratified during June through August. During these sampling times, the lake was thermally stratified, where surface water ranged from 2°C to 9°C higher at the surface than near bottom. Dissolved oxygen was extremely low near the bottom of the lake. This condition is typical of a highly productive (eutrophic) system during the summer months as the microbial decomposition of dead biota depresses the dissolved oxygen in the water above the sediments. The cooler, more dense water of the

lower layer does not mix with the less dense, warmer water at the surface. This thermal barrier did not allow for uniform dissolved oxygen concentrations during June, July, and August.

Epilimnetic (i.e., upper 6 feet) total phosphorus concentrations gradually declined from April to mid-July, then rapidly increased from mid-July until early September (Figure 2). Epilimnetic total phosphorus concentrations ranged from 49 μg/L to 101 μg/L. The near bottom total phosphorus concentration pattern mirrored the surface water, but the bottom total phosphorus was higher at all sampling times. The higher bottom phosphorus concentration resulted from the release of phosphorus from bottom sediments throughout the summer. Sediment phosphorus release occurs during conditions of low or no oxygen.

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Figure 2 Sunset Hill Pond 1998 Water Quality

Epilimnetic chlorophyll *a* concentrations followed a similar pattern as total phosphorus. Chlorophyll *a* declined from 24□µg/L in April to 7.5 µg/L in June, then increased to the maximum concentration of 38.8 µg/L in September. Phosphorus appears to be limiting algal growth in this lake as is evidenced by the mirroring of algal growth (i.e., chlorophyll *a* concentration) and the lake's total phosphorus concentration. Consequently, algal growth may be controlled by reducing the phosphorus load into the lake.

Secchi disc transparency in Sunset Hill Pond ranged from a high of 1.4 meters to a low of 0.5 meter. The average Secchi disc depth for the summer months was 1.0 meter. Water transparency (i.e., Secchi disc) was lowest during early September, when both total phosphorus and chlorophyll *a* concentrations were at their peak.

Carlson methodology (Carlson, 1977) was used to determine the Trophic State of Sunset Hill Pond. Table 1 presents the TSI categories and the trophic state of the pond is shown in Figure 2. The summer average chlorophyll *a* concentration and Secchi disc transparency were indicative of a eutrophic (i.e., nutrient rich and highly productive) system. The summer average total phosphorus concentration was within the range of a hypereutrophic (highly nutrient rich and extremely productive) system (Figure 2). Consequently, Sunset Hill Pond is classified as a eutrophic to slightly-hypereutrophic system. This classification describes a water body that is rich to extremely rich in nutrients. Such water bodies often experience significant to severe algal blooms and/or dense to very dense weed growth throughout the summer.

2.3 Recreational Suitability

Secchi disc transparencies were used to determine the Recreational Suitability Index (RSI), (Osgood, 1989a) values for each sampling date. RSI values in Sunset Hill Pond ranged from 3.5 (slight impairment of

recreational activities) in July to 6.3 (swimming and aesthetic enjoyment nearly impossible because of algae) in September 1998 (Table 3). The RSI at all other sampling times on Sunset Hill Pond suggested that recreational enjoyment would be substantially reduced due to elevated levels of algal biomass. The highest recreational suitability quality corresponded to the lowest total phosphorus (TP) concentrations found in the surface water. Conversely, the lowest recreational suitability quality corresponded to the highest concentration of TP in the surface waters.

Table 3 Recreational Suitability Index (RSI) for Sunset Hill Pond during 1998.

Sample Date	Calculated RSI	RSI Description
1 April	4.4	Desire to swim and aesthetic enjoyment substantially reduced
16 June	4.4	Desire to swim and aesthetic enjoyment substantially reduced
13 July	3.5	Swimming and aesthetic enjoyment slightly impaired
10 August	4.4	Desire to swim and aesthetic enjoyment substantially reduced
24 August	4.4	Desire to swim and aesthetic enjoyment substantially reduced
8 September	6.3	Swimming and aesthetic enjoyment nearly impossible because of algae

2.4 Biota

2.4.1 Macrophytes

Aquatic macrophytes were sampled in June and August of 1998. With the exception of the deepest portion of the lake, vegetation was found throughout Sunset Hill Pond (Figures 3-4). Most of the near-shore area of the pond was ringed with White and Yellow Water Lily (*Nymphaea tuberosa* and *Nuphar variegata*, respectively). Cattail (*Typha spp.*) and Arrowhead (*Sagittaria spp.*) were the primary shoreline emergent plants. Common submergent vegetation included Elodea (*Elodea canadensis*), Pondweed (*Potamogeton*

spp.), Coontail (*Ceratophyllum demersum*), and Northern watermilfoil (*Myriophyllum exalbescens*). Undesirable nonnative plants such as Purple loosestrife (*Lythrum salicaria*), Curly-leaf Pondweed (*Potamogeton crispus*), and Eurasian Water Milfoil (*Myriophyllum spicatum*) were not present in the pond. The macrophyte community appears to be relatively diverse with 12 species present, and provides a suitable wildlife habitat.

2.4.2 Phytoplankton

Phytoplankton, also called algae, are small aquatic plants naturally present in all lakes. They derive energy from sunlight (through photosynthesis) and from dissolved nutrients found in lake water. They provide food for several types of animals, including zooplankton, which in turn are eaten by fish. In 1998, phytoplankton were sampled on five occasions during June through August. During all sample occasions, the phytoplankton community in Sunset Hill Pond was dominated by blue-green algae (Appendix B). Blue-green algal growth is often stimulated by

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Figure 3 _____

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Figure 4 _____

excess phosphorus loads. The growing conditions during the summer months are favorable to blue-greens, and they have a competitive advantage over the other algal species during this time. Blue-green algae are referred to as nuisance algae because they:

- are generally inedible to fish, waterfowl, and most zooplankters;
- float at the lake surface in expansive algal blooms;
- may be toxic to animals when occurring in large blooms; and
- since they are most likely to be present during the summer months, they can disrupt lake recreation.

The second most dominant form of algae in Sunset Hill Pond was the chlorophyta, or green algae. Large numbers of green algae are also indicative of a eutrophic condition. The highest counts of both blue-green and green algae correspond to the highest chlorophyll concentration during 1998 (early September).

2.4.3 Zooplankton

Zooplankton are the second step in the food chain, and are considered vital to a lake's fishery. They are microscopic animals which feed on particulate plant matter, including algae, and are in turn eaten by fish. In 1998, zooplankton were sampled on five occasions during June through August to determine abundance and species composition in Sunset Hill Pond (Appendix B). Healthy zooplankton communities are characterized by balanced densities (number per meter squared) of three major groups of zooplankton: cladocera, copepoda, and rotifera. Fish predation, however, may alter community structure and reduce the numbers of

larger-bodied zooplankters. Although the three groups were represented during each sample occasion, the zooplankton community in Sunset Hill Pond was dominated by rotifers during three of the five sample events. Fish predation of the larger-bodied zooplankters likely resulted in dominance by smaller-bodied zooplankters during most sample events.

2.5 Historical Trends

A trend analysis of Sunset Hill Lake was completed to determine if the lake had experienced significant degradation or improvement during the years for which water quality data are available. Data collected during 1972, 1977, 1982, 1994, and 1998 were analyzed. Two criteria must be met to conclude the lake's water quality has significantly improved or declined. First, the trend was considered significant if the slope of the regression was statistically significant at the 95 percent confidence level. Second, a conclusion of improved water quality requires concurrent decreases in total phosphorus and chlorophyll *a* concentrations, and increases in Secchi disc transparencies; a conclusion of degradation requires the inverse relationship.

A comparison of 1998 data with data collected in previous years indicates no significant change in water quality has occurred since 1972. However, some variation between individual years has been noted. For example, during 1994, total phosphorus and chlorophyll *a* concentrations were lower than 1998 values while Secchi disc transparency values were higher than 1998 values. However, the differences were not significant. These statistically non-significant trends indicate the lake's water quality is stable.

2.6 Conclusions

Sunset Hill Pond is a shallow, wetland-type pond with a relatively diverse macrophyte community. The water quality of the water body has shown no significant change over time, and is currently at a eutrophic to

slightly-hypereutrophic condition. Although a water quality management goal has not been previously established for this water body, it is recommended that the lake be managed as a Level III (i.e., support fishing, aesthetic viewing activities and observing wildlife). Water quality goals for Level III water bodies include maximum total phosphorus concentration of 75 μg/L, a maximum chlorophyll concentration of 40 μg/L, and a minimum Secchi disc transparency of 0.9 meters (~3.0 feet). In 1998, the summer average total phosphorus, chlorophyll *a*, and Secchi disc values met the Level III goal. In 1994, the summer average Secchi disc transparency met the Level III goal, but summer average total phosphorus and chlorophyll *a* concentrations failed to meet the Level III goal.

3.0 North Rice Pond

3.1 Site Description

North Rice Pond is located North of Bassett Creek's main stem in Robbinsdale (Figure 1). It has a surface area of approximately 3.7 acres (1.5 ha), and a maximum depth of 5 feet (1.5 meters). The pond can be classified as a Type V wetland, which is defined as having a maximum depth of less than 2 meters, surrounded by emergent vegetation, and dense macrophyte (aquatic weeds) growth (maps in Appendix B). The pond supports boating and swimming (to some extent) activities and wildlife/aesthetic viewing.

3.2 Water Quality Data

North Rice Pond is classified as a Level III water body. Level III water bodies support fishing and aesthetic viewing activities. Water quality goals for Level III water bodies include a maximum total phosphorus concentration of 75 μg/L, a maximum chlorophyll concentration of 40 μg/L, and a minimum Secchi disc transparency of 0.9 meters (~ 3.0 feet).

North Rice Pond was sampled six times in 1998. Results of data analysis are plotted in Figure 3. All water quality data are included in Appendix A.

Temperature and dissolved oxygen data indicate the pond was well mixed in April and September and was stratified in June and July of 1998. Because of the pond's shallow depth, the entire pond warmed to a relatively uniform temperature by August. In general, low dissolved oxygen concentrations were noted throughout the water column, and no oxygen was noted near the bottom during the July and August sampling

dates. The very low levels of dissolved oxygen (often <3.5 mg/L) throughout the pond is indicative of a very productive system where decomposition of algae consumes most of the available oxygen by bacterial respiration.

Total phosphorus concentrations declined from April to July, then increased dramatically from July to September (Figure 3). With the exception of April, near-bottom total phosphorus was greater than surface water total phosphorus. Surface water total phosphorus ranged from 63 μg/L to 188 μg/L, and near-bottom total phosphorus ranged from 82 μg/L to 192 μg/L. Simultaneous occurrence of oxygen depletion and higher phosphorus concentrations in the near-bottom waters indicates apparent internal phosphorus loading (i.e., recycling of phosphorus from sediments) occurred throughout the summer period.

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Figure 3 (or 5?) North Rice Pond 1998 Water Quality

Chlorophyll *a* concentrations followed the same pattern as total phosphorus with a decline in concentration from April to June, and a subsequent increase during the rest of the season (Figure 3). The summer average for chlorophyll *a* was 33.4 μg/L. A large increase in chlorophyll concentration following an increase in total phosphorus indicates phosphorus controls algal growth in the lake.

Relatively poor water transparency was noted throughout the summer period. The average summer Secchi disc transparency was 1 meter (Figure 3). The lowest transparency (i.e., 0.5 meters on September 8) was preceded by the lake's highest chlorophyll and total phosphorus concentrations. The lake's highest transparency (i.e., 1.5 meters) occurred on August 10.

Carlson methodology (Carlson, 1977) was used to determine the trophic state of North Rice Pond. The results are summarized in Figure 3. The summer average total phosphorus and chlorophyll *a* concentrations were indicative of a hypereutrophic system. The summer average Secchi disc transparency was indicative of a eutrophic system. Consequently, North Rice Pond is classified as eutrophic to hypereutrophic. This classification describes a water body that is rich to extremely-rich in nutrients. Such water bodies often experience significant to severe algal blooms and/or dense to very dense weed growth throughout the summer.

3.3 Recreational Suitability

Secchi disc transparencies were used to calculate the Recreational Suitability Index (RSI) for each sampling date of 1998 (Osgood, 1989a). RSI for North Rice Pond ranged from a low of 3.3 to a maximum of 6.3 (Table 4). In April and June, RSI values were indicative of substantially reduced recreational enjoyment. Sample dates in July and early August suggested that swimming and aesthetic enjoyment would be only

slightly impaired. However, both late August and September RSI values show that swimming and aesthetic enjoyment would be nearly impossible because of severe algal blooms and reduced water transparency (See Table 2). The recreational suitability in North Rice Pond for 1998 was elevated (i.e., poor) when chlorophyll concentrations were elevated.

Table 4 Recreational Suitability Index (RSI) for North Rice Pond during 1998.

Sample Date	Calculated RSI	RSI Description
1 April	4.4	Desire to swim and aesthetic enjoyment substantially reduced
16 June	4.4	Desire to swim and aesthetic enjoyment substantially reduced
13 July	3.8	Swimming and aesthetic enjoyment slightly impaired
10 August	3.3	Swimming and aesthetic enjoyment slightly impaired
24 August	5.0	Swimming and aesthetic enjoyment nearly impossible because of algae
8 September	6.3	Swimming and aesthetic enjoyment nearly impossible because of algae

3.4 Biota

3.4.1 Macrophytes

Aquatic macrophyte (i.e., aquatic plant) surveys of North Rice Pond were completed during June and August 1998. Results of these surveys are found in Appendix B. With the exception of a 400-foot section of the West shore, the entire pond was surrounded by Cattail (*Typha spp.*), and Purple Loosestrife (*Lythrum salicaria*) during the two sample events. Areas containing Cattail and Purple Loosestrife were also noted within the body of water. Submerged aquatic plants within the pond were primarily comprised of coontail (*Ceratophyllum demersum*), but also included Sago Pondweed (*Potamogeton pectinatus*), and

Leafy/Narrowleaf Pondweed (*Potamogeton spp.*). A total of five aquatic plant species were noted in North Rice Pond, indicating a relatively low diversity.

3.4.2 Phytoplankton

In 1998, phytoplankton in North Rice Pond were sampled on five occasions during June through August. The pond's phytoplankton community was dominated by green algae and cryptomonad algae (Appendix B). Blue-green algae were also present and were often the third most dominant major group present. Green algae and blue-green algae are indicative of a productive (eutrophic) system. Although little is known of cryptomonad ecology, they are commonly noted in Minnesota lakes of varying water quality. The phytoplankton community in North Rice Pond provides food for several types of animals, including zooplankton, which in turn are eaten by fish. Although blue-green algae are generally considered inedible, green algae and cryptomonads are generally considered edible.

3.4.3 Zooplankton

The zooplankton community in North Rice Pond provides food for the lake's fishery, but has little predatory impact on the lake's algal community. The zooplankton community exhibited relatively high species richness (Appendix B). However, the richness in species was largely dominated by rotifers (small-bodied zooplankters). The rotifers graze primarily on extremely small particles of plant matter, and do not significantly affect the lake's water quality. The abundance of small-bodied zooplankters is indicative of fisheries predation upon the larger-bodied animals. Fish "sight feed" and select the largest animals in sight, thereby, minimizing the number of large-bodied zooplankters in a water body. Escape from predation by the larger-bodied zooplankters is dependent upon the presence of a "refuge" within a lake. The shallow nature

of North Rice Pond prevents a refuge for zooplankton to hide from the pond's fisheries. Consequently, only smaller-bodied zooplankters survived predation from the pond's fisheries.

3.5 Historical Trends

North Rice Pond has been sampled on two occasions, during 1994 and during 1998. Consequently, a statistical analysis of data is not feasible because of limited data. A comparison of 1994 and 1998 data indicates that summer average total phosphorus and chlorophyll *a* concentrations were somewhat lower in 1998 , and Secchi disc transparency was slightly higher (i.e., 2.5 feet in 1994 and 3.3 feet in 1998).

3.6 Conclusions

North Rice Pond is a shallow, wetland-type pond. The water quality of the pond is currently at a eutrophic (nutrient rich and very productive) to hypereutrophic (very nutrient rich and extremely productive) condition. Severe algal blooms and reduced water transparency resulted in severe recreational use impairment during 1998. However, the pond provides a suitable habitat for wildlife and provides aesthetic enjoyment. The Bassett Creek *Water Quality Management Plan* (Barr, 1994) classified Nouth Rice Pond as a Level III water body and established water quality goals for the pond (total phosphorus $\leq$ 75 μg/L, chlorophyll *a* $\leq$ 40 μg/L, and Secchi disc $\geq$ 0.9 m). Its 1994 water quality failed to meet the total phosphorus and Secchi disc goals for this classification. Its 1998 summer average total phosphorus concentration failed to meet the goal for classification as Level III. Wherever feasible, best management practices should be employed to reduce phosphorus loading into this system to improve its water quality and attain its water quality goal.

4.0 South Rice Pond

4.1 Site Description

South Rice Pond is located North of Bassett Creek's main stem in Golden Valley and Robbinsdale and receives the overflow from North Rice Pond (Figure 1). It has a surface area of about 3.2 acres (1.3 ha), and a maximum depth of 3 feet (0.9 meters). The pond can be classified as a Type V wetland, which is defined as having a maximum depth of less than 2.0 meters, surrounded by emergent vegetation and dense macrophyte growth (Appendix B). The pond supports boating activities and wildlife/aesthetic viewing.

4.2 Water Quality Data

South Rice Pond was classified as a Level III water body (i.e., support fishing, aesthetic viewing activities, and observing wildlife) in the Bassett Creek *Water Quality Management Plan* (Barr, 1994). Water quality goals for Level III water bodies include a maximum total phosphorus concentration of 75 μg/L, a maximum chlorophyll concentration of 40 μg/L, and a minimum Secchi disc transparency of 0.9 meters (~ 3.0 feet).

South Rice Pond was sampled 6 times in 1998. Total phosphorus, chlorophyll *a* concentration, and Secchi disc transparency data are shown in Figure 4. Other physical and chemical water quality parameters of the pond are listed in Appendix A.

Temperature data indicate that the pond was mixed in April, late August, and September. The temperature profile indicates stratification occurred in June, July, and early August. Dissolved oxygen data indicate that the pond had relatively high dissolved oxygen in April and June, and that in June the pond was well stratified

with respect to both temperature and dissolved oxygen. However, dissolved oxygen levels were extremely low from July through September throughout the entire water column. The low oxygen levels are indicative of decomposition throughout a very productive system resulting in dissolved oxygen depression throughout the water column. The presence of low oxygen levels throughout the pond indicated the oxygen demand within the pond exceeded oxygen additions to the pond from wind mixing or photosynthesis.

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Figure 4 (or 6?) South Rice Pond 1998 Water Quality

Total phosphorus concentrations for South Rice Pond increased from a low of 99 μg/L in April to a peak of 895 μg/L in July. The phosphorus concentration decreased to spring levels by September. The summer average concentration was 384 μg/L (Figure 4). Near bottom total phosphorus concentrations were generally similar to surface water total phosphorus concentrations. However, bottom total phosphorus concentrations reached a measured maximum of 1,035 mg/L in July. The data indicate phosphorus is recycled from the sediments during periods when the water above the sediments becomes devoid of oxygen. However, with sufficient wind energy, mixing may occur in South Rice Pond. Periods of mixing add the phosphorus released from the sediments to the pond's surface waters where it is available for algal growth.

Concentrations of chlorophyll *a* ranged from a minimum concentration of 4.4 μg/L in June to a maximum concentration of 179.4 μg/L on August 10 (Figure 4). The data indicate that the pond experienced algal blooms during most of the summer. The seasonal pattern of chlorophyll concentrations was similar to phosphorus concentrations, confirming that the pond's algal growth is directly related to phosphorus levels.

Secchi disc measurements in South Rice Pond generally mirrored phosphorus and chlorophyll *a*. The Secchi disc transparencies (Figure 4) ranged from 1.5 feet in June to 0.2 feet in early August. The seasonal patterns clearly show that the lake's water transparency is largely determined by algal abundance. The data indicate severe recreational use impairment results from algal blooms and reduced water transparency.

Carlson methodology (Carlson, 1977) was used to determine the trophic state of South Rice Pond. The results are summarized in Figure 4. Summer average total phosphorus, chlorophyll *a*, and Secchi disc transparency values were indicative of a hypereutrophic system. The classification describes a water body that is extremely rich in nutrients. Such water bodies often experience severe algal blooms and/or very dense weed growth all summer.

4.3 Recreational Suitability

Recreational suitability was calculated for South Rice Pond as discussed previously. Index values ranged from 3.3 to 8.7 (Table 5). RSI values suggest that severe algal blooms throughout the summer (July through September) severely impaired the recreational use of the pond (see Table 2). Recreational suitability was 3.3 (recreational activities slightly impaired) on June 16 when chlorophyll concentrations were lowest (i.e., Secchi disc transparency greatest). The Recreational Suitability Index on August 10 was 8.7 (recreational activities nearly impossible because of reduced water transparency) when chlorophyll concentrations were highest (i.e., Secchi disc transparency lowest).

Table 5 Recreational Suitability Index (RSI) in South Rice Pond for 1998.

Sample Date	Calculated RSI	RSI Description
1 April	4.7	Desire to swim and aesthetic enjoyment substantially reduced
16 June	3.3	Swimming and aesthetic enjoyment slightly impaired
13 July	7.6	Swimming and aesthetic enjoyment nearly impossible because of algae
10 August	8.7	Swimming and aesthetic enjoyment nearly impossible because of algae
24 August	5.8	Swimming and aesthetic enjoyment nearly impossible because of algae
8 September	5.8	Swimming and aesthetic enjoyment nearly impossible because of algae

4.4 Biota

4.4.1 Macrophytes

Aquatic macrophyte (i.e., aquatic plant) surveys of South Rice Pond were completed during June and August 1998. Macrophyte data is compiled in Appendix B. The pond was completely surrounded by Cattail (*Typha sp.*) and Purple Loosestrife (*Lythrum salicaria*) during both sampling times. Submerged aquatic plants were present throughout the pond and consisted primarily of Coontail (*Ceratophyllum demersum*) and Elodea (*Elodea canadensis*). Sago pondweed (*Potamogeton pectinatus*) was also present in the pond. A total of five aquatic plant species were noted in North Rice Pond, indicating a relatively low diversity.

4.4.2 Phytoplankton

The phytoplankton community in South Rice Pond was dominated by cryptomonads and green algae (Appendix B). Blue-green algae and diatoms were also present in high numbers. Although little is known of cryptomonad ecology, they are commonly noted in Minnesota lakes of varying water quality. Green and blue-green algae were also present in high numbers and are both indicative of highly productive systems. The presence of a diverse diatom community indicates the presence of silica (i.e., substance needed by diatoms). South Rice Pond has a richness of species, and an even distribution between the four dominant groups of phytoplankton. The phytoplankton community in South Rice Pond provides food for several types of animals, including zooplankton, which in turn are eaten by fish. Although blue-green algae are generally considered inedible, green algae, diatoms, and cryptomonads are generally considered edible. Phytoplankton total numbers and chlorophyll *a* followed a similar pattern, thereby confirming the presence of excessive algal blooms during July through September.

4.4.3 Zooplankton

South Rice Pond was sampled five times in 1998 to enumerate and identify the zooplankton community in this water body. The dominant zooplankton overall were rotifers (Appendix B). However, the June sampling

date was dominated by cladocerans. During the remainder of the sampling periods, cladocerans were the least abundant of the divisions of zooplankton, and were not present in samples taken in July.

The zooplankton community in South Rice Pond provides food for the lake's fishery, but has little predatory impact on the lake's algal community. The rotifers graze primarily on extremely small particles of plant matter, and do not significantly affect the lake's water quality. The abundance of small-bodied zooplankters is indicative of fisheries predation upon the larger-bodied animals. Fish "sight feed" and select the largest animals in sight, thereby, minimizing the number of large-bodied zooplankters in a water body. Escape from predation by the larger-bodied zooplankters is dependent upon the presence of a "refuge" within a lake. The shallow nature of South Rice Pond prevents a refuge for zooplankton to hide from the pond's fisheries. Consequently, only smaller-bodied zooplankters survived predation from the pond's fisheries.

4.5 Historical Trends

South Rice Pond has been sampled on two occasions, during 1994 and during 1998. Consequently, a statistical analysis of data is not feasible because of limited data. A comparison of 1994 and 1998 data indicates the summer average total phosphorus and chlorophyll *a* concentrations were higher in 1998 and the summer average Secchi disc transparency was lower in 1998. The pond's hypereutrophic trophic classification (very rich in nutrients and extremely productive) was the same in 1994 and 1998.

4.6 Conclusions

South Rice Pond is a shallow, wetland-type pond. The water quality of the pond is currently hypereutrophic (very rich in nutrients and extremely productive). Severe algal blooms and reduced water transparency resulted in severe recreational use impairment during 1998. However, the water body continues to provide

adequate wildlife habitat and aesthetic benefits. The Bassett Creek *Water Quality Management Plan* (Barr, 1994) classified South Rice Pond as a Level III water body and established water quality goals for the pond (total phosphorus $\leq$ 75 μg/L, chlorophyl *a* $\leq$ 40 μg/L, and Secchi disc $\geq$ 0.9 m). The water quality of South Rice Pond failed to meet the total phosphorus, chlorophyl *a*, and Secchi disc goals for a Level III classification during 1994 and 1998. Best management practices for reduction of phosphorus loading into this pond should be used whenever possible in order to maintain or improve its water quality.

References

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Appendix A

1998 Water Quality Data

Sunset Hill Pond (Cavanaugh Lake)

North Rice Pond

South Rice Pond

Appendix B

1998 Biological Data

Sunset Hill Pond (Cavanaugh Lake)

North Rice Pond

South Rice Pond