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GRASS LAKE HYDROLOGIC STUDY



Prepared for

**Minnehaha Creek
Watershed
District**

February 1996



Wenck

0185-04-220 MCWD
R.1 Grass Lake Hydrologic Study

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Wenck

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February 20, 1995

Pamela Blixt
MCWD Board of Managers
5340 44th Avenue South
Minneapolis, MN 55417

Re: Addendum to Grass Lake Hydrologic Study
Wenck Project #0185-04-220

Dear Ms. Blixt:

This letter is an addendum to the December 1995 Grass Lake Hydrologic Study. The following items have been received or revised since the December 13, 1995 distribution of the study:

- The December 20, 1995 meeting of the Grass Lake Advisory Committee disclosed additional information concerning joint efforts between the City of Minneapolis and the Minnehaha Creek Watershed District.

A meeting was held on December 5, 1994 between Minneapolis City Council Member Steve Minn and representatives from the MCWD Board of Managers. Steve Minn expressed interest in a joint management policy for Grass Lake.

On November 13, 1995 a similar meeting between Council Member Minn and MCWD Managers was held. The intent of this meeting was to discuss the final outcome of the Grass Lake Hydrologic Study, and to plan for future joint management of Grass Lake.

- The City of Minneapolis surveyed the outlet between Grass Lake and Richfield Lake during the first week of January 1996. The outlet structure was filled half-full with ice along the entire length of the pipe. The outlet will be further investigated after the ice melts to determine if the outlet is obstructed.

At the December 20, 1995 Grass Lake Advisory Committee meeting, citizens requested that water quality monitoring of Grass Lake continue. As a result of this request, communication has occurred between the

Pamela Blixt
MCWD Board of Managers
February 20, 1996
Page 2

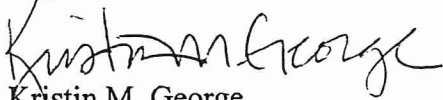
Minneapolis Park and Recreation Board (MPRB) and the Minnehaha Creek Watershed District concerning the necessity of water quality monitoring for Grass Lake.

- Appendix F includes a letter written by Ray Norrgard, MnDNR Lake Designation Coordinator, and the corresponding vegetation study.
- Appendix N was revised on November 1, 1995. The revised copy was received by the Minnehaha Creek Watershed District on December 20, 1995. The revised report may be obtained from Sarah Linnes-Robinson of the Kenny Neighborhood Association, 5516 Lyndale Ave. S., Minneapolis, MN 55419.
- Appendix M includes "Grass Lake: Past, Present, and Future," written by Lanya Ross, of Macalester College, and has been submitted under a separate cover. This report can be obtained from Sarah Linnes-Robinson of the Kenny Neighborhood Association, 5516 Lyndale Ave. S., Minneapolis, MN 55419.

If there are further concerns which cannot be addressed prior to the recommended follow-up Grass Lake Advisory Committee meeting, please contact me at 479-4246.

Sincerely,

WENCK ASSOCIATES, INC.
Engineers for the District


Kristin M. George
Civil Engineer

cc: C. Woodrow Love, MCWD Board of Managers
Monica Gross, MCWD Board of Managers
Steve Minn, City of Minneapolis, Council Member, Ward-13
Grass Lake Advisory Committee
Karen Shanberg, Naturalist Manager, Wood Lake Nature Center

Enclosure



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December 6, 1995

Pamela Blixt
MCWD Board of Managers
5340 44th Avenue South
Minneapolis, MN 55417

Re: Grass Lake Hydrologic Study
Wenck Project #0185-04-220

Dear Ms. Blixt:

Enclosed for your review is a copy of the Grass Lake Hydrologic Study. This report includes existing available hydrologic information, a summary of the Grass Lake water level and water quality monitoring programs, and pertinent information from other interested parties.

The purpose of this report is to include a water quality analysis, and to provide conclusions and recommendations based on the concerns of the Grass Lake Advisory Committee and observations found in the study.

Comments regarding this report will be addressed at the December 13, 1995 Grass Lake Advisory Committee Meeting. If there are concerns or questions that cannot be answered at this meeting, please contact me at 479-4246.

Sincerely,
WENCK ASSOCIATES, INC.
Engineers for the District

Kristin M. George
Civil Engineer

KG/ljv

cc: Monica Gross, MCWD Board of Managers
C. Woodrow Love, MCWD Board of Managers
Gene Strommen, Minnehaha Creek Watershed District, District Director
Grass Lake Advisory Committee
Karen Shanberg, Naturalist Manager, Wood Lake Nature Center

Grass Lake Hydrologic Study

Prepared for:

MINNEHAHA CREEK WATERSHED DISTRICT

Gray Freshwater Center
2500 Shadywood Road, Suite 37
Navarre, Minnesota 55331

Prepared by:

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Wenck File #0185-04-220

December 1995

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Section I

Introduction

A. DEFINING GRASS LAKE

Grass Lake is a 27 acre wetland located at the northwest quadrant of State Highway 62 and Interstate 35W. Grass Lake is also identified as DNR Protected Water 681 W, which is classified as a Type V wetland. Type V wetlands are typically defined as being inland open fresh water, less than 10 feet deep and fringed by a border of emergent vegetation. The mean depth of Grass Lake is estimated to be 2 feet, with an estimated maximum depth of 5 feet.

According to the City of Minneapolis drainage area maps, the total drainage area of the Grass Lake subwatershed is 386 acres. The land use of the 386 acres consists of ninety percent residential, four percent commercial, two percent open land, and four percent of other types. Table 1 lists pertinent physical characteristics of Grass Lake. Figure 1 shows the drainage areas for Grass Lake, Richfield Lake and Wood Lake. Nine grit chamber sump manholes were installed by the City of Minneapolis in 1994 at the inlets to Grass Lake (Figure 2). There is one outlet for the lake. The invert elevation of the outlet to Grass Lake was surveyed by Wenck Associates in April of 1995 to be 828.81 feet.

B. REQUEST FOR INVESTIGATION

On September 13, 1994, the Minnehaha Creek Watershed District (MCWD) received a letter from Nancy Goetzinger and Tom Ramsay of 5937 Dupont Avenue South, Minneapolis (Appendix A). The letter informed the MCWD of recent significant deterioration in the quality of Grass Lake. According to the letter, the initial cause for concern was the absence of emerging cattails in the spring of 1994, and the observed decline of wildlife populations. The letter concludes with a request for the MCWD to "...take all steps necessary to protect Grass Lake, to

assess whether human activity has been the cause of any degradation, and, if so, to require restoration from the responsible party.”

C. MINNEHAHA CREEK WATERSHED DISTRICT RESPONSE

At the regularly scheduled September 22, 1994, MCWD meeting of the Board of Managers, the Board heard a presentation by Tom Ramsay and Nancy Goetzinger regarding their concerns over the deteriorated quality of Grass Lake. At the regularly scheduled December 22, 1994, MCWD meeting of the Board of Managers, it was resolved to establish a Grass Lake Citizens Advisory Committee, to direct the District Engineer to commence a diagnostic investigation and hydrologic assessment of Grass Lake, and to prepare a final report with recommendations (Appendix B).

A meeting was held on December 5, 1994 between Minneapolis Council Member Steve Minn and representatives from the MCWD Board of Managers. Steve Minn expressed interest in a joint management policy for Grass Lake.

On November 13, 1995 a similar meeting between Council Member Minn and MCWD Board of Managers was held. The intent of this meeting was to discuss the final outcome of the Grass Lake Hydrologic Study, and to plan for a future joint management of Grass Lake.

D. SCOPE OF DIAGNOSTIC STUDY

A memorandum to the Grass Lake Citizens Advisory Committee, from the MCWD, dated February 8, 1995 states the scope of the diagnostic investigation and hydrologic assessment of Grass Lake. The scope of the project included the review of existing available hydrologic information, a water level monitoring program, a limited water quality monitoring program, a water quality analysis, and a final report with recommendations.

Section II

Description of Investigation

A. REVIEW OF EXISTING INFORMATION

Throughout the course of this investigation, interested parties were contacted to obtain available information regarding Grass Lake, outside impacts on Grass Lake, and general characteristics of wetlands similar to Grass Lake. The parties contacted were the City of Minneapolis, the Minneapolis Park and Recreation Board (MPRB), the Minnesota Department of Transportation (MNDOT), the Minnesota Department of Natural Resources (MNDNR), Minnesota Pollution Control Agency (MPCA) and the Wood Lake Nature Center.

According to the City of Minneapolis Public Works Department, city water was discharged into Grass Lake at a rate of approximately 100 gallons per minute (gpm) during the months of June through October of 1994. Harold Pulju, City of Minneapolis Public Works Department, stated that the purpose of discharging the water during the summer of 1994 was to 'draw polyphosphate into the 8" water main in West 61st Street... Polyphosphate is a corrosion inhibitor which forms a gelatinous coating in the interior of the main to combat "red water" problems in the area. At a rate of 100 gpm, 144,000 gallons of water would have been added to the lake each day. With a chlorine residual of 1.5 ppm, this amounts to 1.8 lbs of chlorine per day.' The chlorine concentration was measured at the storm sewer outfall located at the southwest corner of Grass Lake, by the City of Minneapolis.

The Material Safety Data Sheet (MSDS) for the liquid phosphate blend used was requested (Appendix C) from the City of Minneapolis. The MSDS listed the chemical in question as proprietary. The Kjell Corporation, the chemical company which produces the polyphosphate blend was then contacted. Bert Hellen, scientist for The Kjell Corporation calculated the total

deposition of phosphorus per month to be 1.821 lbs. The letter from The Kjell Corporation may be found in Appendix D.

Concerns regarding potential impact of this discharge on Grass Lake prompted citizens of Grass Lake to contact the City of Minneapolis Ward 13 Council Member, Steve Minn. Mr. Minn directed MPRB limnologist Jeff Lee to collect water samples. On October 25, 1994, the Grass Lake Assessment written by Jeff Lee of the Minneapolis Park and Recreation Board was completed (Appendix E). This assessment made use of previous water quality sampling on three dates and a single sampling conducted by the MPRB. In October 1988, and April and July of 1989, Grass Lake water quality was monitored by MNDOT as part of the 35W EIS process. The MPRB collected another water quality sample on September 19, 1994. Jeff Lee states in this assessment that "The importance of city drinking water being put in the lake was also looked at. That water was tested, with the chlorine level was found to be less than 1/10 of a part per million. Depending on the volume of water being put in, this being low nutrient water, could actually lead to an improved water quality conditions. Given the fact that it started later in the year this input probably didn't have an impact on the vegetational community."

The MPRB assessment also addressed the theory that wetlands are "cyclic." This theory is based on statements by Mitsch and Gosselink (1986). These statements provide documentation on the relationships between fluctuations in water levels of the wetland, vegetation in the wetland and animal habitat in the wetland. More recent research also provides evidence of these relationships.

William Clark of the Department of Animal Ecology at Iowa State University conducted a study called *Muskrat - Habitat Relationships In Managed Wetlands at Delta, Manitoba*. The study included draining a wetland complex and then raising water elevations to three different elevations: "normal (long-term average elevation), medium (30-cm above normal), and high (60 cm above normal)." This study directly correlates with the habitat-vegetation cycle of Grass Lake, finding that the vegetation decline began slightly before peak densities of muskrats were observed. This research relates to Grass Lake in that the decline of the muskrat population

would be a result of the creation of open water. William Clark states, "The hypothesized underlying causes of changes in body mass and survival were reduced access to food and suitable shelter due to the increasing area of open water and a corresponding decreased area of emergent vegetation resulting from flooding treatments."

The MNDNR completed a vegetational study of Grass Lake in August of 1995. The final report is included in Appendix F. John Parker, Area Wildlife Manager of the MNDNR, has stated that the vegetation is monotypic in nature. Bird counts provided by Thomas Ramsay and Nancy Goetzinger of Minneapolis did prompt the MNDNR to define Grass Lake as a high priority site for the Minnesota Natural Heritage Information System (Appendix G).

The State of Minnesota Storm Water Advisory Group, published a document called Guidance for Evaluating Urban Storm Water and Snowmelt Runoff Impacts to Wetlands. This document suggests that hydrologic impacts on wetlands are directly related to the "sensitivity" of a wetland. The "sensitivity" of wetlands is categorized by the susceptibility to degradation by storm water input. According to this guidance document, "Diverse, sensitive native plant communities can be readily degraded by storm water impacts resulting in monotypes of sediment and nutrient-tolerant species such as reed canary grass and/or cattails." It appears that Grass Lake may be a slightly sensitive type of wetland according to this document.

The document also suggests that these types of wetlands be viewed as candidates for rehabilitation or restoration. Another observation made in this guidance document is, "Storm water input to wetland basins supporting monotypes, such as purple loosestrife or reed canary grass, could flood out this monotypic vegetation creating open water areas that may eventually revegetate with greater diversity." Overall, the recommendation is made that best management practices be used. Appendix H of this report includes Section IV, titled "Best Management Practices," of Guidance for Evaluating Urban Storm Water and Snowmelt Runoff Impacts to Wetlands. This section gives constructive ideas for management practices which would lessen degradation caused by human activity.

Karen Shanberg, Naturalist Manager of the Wood Lake Nature center recommends that the citizens of the Grass Lake community develop a management plan for Grass Lake. Shanberg agrees that the absence of cattails could be caused by cyclical higher water levels within Grass Lake. She explains that the absence of cattails is not necessarily a sign of degradation, but typical of a wetland cycle. Shanberg also stated that cattail growth can take over a small wetland and residents are typically unhappy when the open water is not in view. A wetland management plan for Grass Lake would define the type of habitat which would be maintained, and methods of maintaining this habitat. Shanberg mentioned that half cattails and half open water is considered to be conducive to wildlife habitat.

B. PRECIPITATION AND LAKE LEVEL MONITORING

Susan Rothbaum of 6001 Girard Avenue South, Minneapolis, volunteered to begin daily precipitation monitoring and a gauge was installed on April 16, 1995. Precipitation data are presented in Table 2 and Appendix I of this report. Figure 3 shows that precipitation for the Grass Lake area in 1995 was slightly below average, however, the month of August had unusually high precipitation. Total precipitation measured during the monitoring period was approximately 21.6 inches. This compares with approximately 19 inches of precipitation which is the sum of the 30-year normals during the same time period for the Minneapolis-St. Paul Airport. Total annual precipitation records for the Minneapolis-St. Paul Airport in 1993 and 1994 are 32.21 and 29.67 inches respectively. The 30-year normal annual precipitation is 28.32 inches. It is evident from the above data that precipitation levels have been higher than normal for the past three years.

The regional evaporation rates for 1994 and 1995 appear to be some what higher than the mean regional lake evaporation. This data was obtained from the National Oceanic and Atmospheric Administration. The evaporation data for the months of May through September can be found on Figure 4, and as well as Table 3.

A lake level staff gauge was installed on April 25, 1995 at the home of Mark McHugh at 6048 Fremont Avenue South, Minneapolis. The initial elevation recorded for Grass Lake was 830.26 feet on April 25. Water elevation data from the gauge level readings are presented in Table 2 and Appendix J of this report. Figure 4 shows that for the entire summer the water level of Grass Lake was above its outlet invert (elevation 828.81 feet).

According to the MPRB Grass Lake Assessment "All indications are that some of the suggestions made by the DNR that the high water levels from last years heavy rains (1993) may have resulted in the loss of cattails is very likely." High water levels are also mentioned indirectly in the September 6, 1994 letter written by Tom Ramsay and Nancy Goetzinger.:

"On Sunday evening, September 6, 1994, following nearly an inch of rain over a 48-hour period and with the water levels as high as they have been all summer (and even last summer), we measured the water depth in that area:

Approximately five feet from the upland, it was 11 inches deep; at about 17 feet out, it was 18 inches deep; and at about 27 feet out (almost to the edge of the previous visible cattail line), it was still only 19 inches deep....."

This statement appears to conflict with the opinion that high water levels would prevent the emergence of cattails. It is widely believed that cattail reduction occurs by long-term submergence in three to five feet of water. However, King County Surface Water Management in Seattle, Washington has found that water level fluctuations greater than 18 inches, can lead to reduction in plant diversity and a loss of vegetation in shallow water areas of wetlands and ponds. Karen Shanberg, of the Wood Lake Nature Center supports the theory that large fluctuations in water levels, especially in smaller lakes will reduce vegetation. It is apparent that the lake elevations of Grass Lake over the past three years may have been unusually high.

C. WATER QUALITY MONITORING

During the months of June through September 1995, water quality was measured twice monthly. The following parameters were measured in the field: secchi disk depth (transparency), dissolved oxygen and temperature profiles, pH and conductivity. The other parameters measured in the laboratory were: chlorophyll-a, total phosphorus, orthophosphorus, ammonia nitrogen, nitrate and nitrite nitrogen, total iron, total suspended solids, chloride, and total alkalinity. Water quality monitoring data is presented in Table 4. Laboratory data reports may also be found in Appendix K. The 1988-1989 MnDOT data and September 1994 MPRB data are also included for comparison.

Grass Lake exhibited very high algal productivity in 1995. Chlorophyll-a concentrations on July 10 and October 2 were roughly three and 10 times higher, respectively, than comparable dates in 1989 (July 12) and 1988 (October 5). The higher pH and dissolved oxygen levels, as well as the continual depletion of phosphorus in its nutrient (ortho-phosphate) form all confirm the high level of algal productivity in 1995. The September 1994 data also reflect high algal productivity.

Significantly, however, the total phosphorus concentrations were no higher in 1994-95 than in the earlier years. Therefore, the recent increase in algal productivity did not result from extraordinary phosphorus inputs to the lake. Instead, it appears most likely that the algal increase is an after-effect of the disappearance of cattails in 1994.

Grass Lake has low transparency, but this is evidently due in large part to non-algal factors. The transparency variations in 1995 did not correlate with chlorophyll-a concentrations. Moreover, the range of Secchi transparencies observed in 1988-89 (0.32 to 0.52 meters) was generally similar to the range in 1995 (0.12 to 0.55 meters), despite the much higher chlorophyll-a levels in the latter year.

The measurable iron concentrations observed in 1995 indicates oxygen depletion below but very near the water surface. Actually, dissolved oxygen levels at the surface were quite high in 1995,

but again this is one of the signals of high algal productivity, which has the concomitant effect of enhancing subsurface oxygen depletion. The dissolution of iron generally requires anoxic conditions.

Specific conductance is a measure of water's ability to act as a conductor. High conductivity is an indicator of low water quality and implies high concentrations of chlorides or other dissolved solids. The unusually high specific conductance reading for the September 19, 1995 MPRB field data is an apparent outlier from typical conditions. The test taken on this sampling date was taken with field equipment, which is not typically as accurate as laboratory equipment, although Jeff Lee of the MPRB stated that the water on that day had an apparent rust color.

Chloride concentrations were some what higher in 1995 than in previous years. This may reflect increased use of road salt, or possibly increased drainage from road-salted areas. The deposition of road salt is dependent upon weather conditions and varies from year to year.

D. STUDENT REPORTS

In October 1995, Colleen Allen, a student of the University of Minnesota completed a draft comparative study called "Wetland Bird Foraging," for the Kenny Neighborhood Association on October 17, 1995. The Kenny Neighborhood Association has members who are also members of the Grass Lake Advisory Committee. This project was funded by the Center for Urban and Regional Affairs (CURA), University of Minnesota. The purpose of the study was to determine which species of birds use the wetland and how many of them are foraging. Oxborough Lake of Bloomington was used as the comparison wetland for Grass Lake. It is a Type V wetland of 20 acres. The U of M draft report can be located in Appendix L of this report. The conclusion of the U of M report states, "Statistically, we can say that four species of birds had more foraging at Grass Lake, three species had more at Oxborough Lake, and one species had equal foraging at both wetlands. The rest of the species did not have large enough sample sizes to determine significance. Data in future years will allow for statistical comparison of more species of birds."

It is anticipated that trained volunteers from the Kenny Neighborhood Association will continue to perform this study next summer so that changes can be noted over time. The final statement of this draft report is, "All of the information collected during this study reveals that Grass Lake has large numbers and a great diversity of birds. It is a uniquely rich resource and deserves to be studied and protected." Volunteers of the Kenny Neighborhood Association have been trained to continue future bird foraging studies.

Lanya Ross, an undergraduate student at the University of Minnesota also prepared a report titled "Grass Lake Past, Present and Future." This report was unavailable at the time of this draft, and has since been submitted to the Kenny Neighborhood Association.

Section III

Conclusions

1. Absence of cattails and other emergent and submergent vegetation has been accompanied by a rise in algal levels, as indicated by chlorophyll-a. Higher 1994-95 algal productivity (versus 1988-89) could be the result, not the cause, of cattail disappearance.
2. Road and highway drainage is most likely not a cause for a decline in water quality because the timing of the MNDOT Highway 62 project in 1994 is inconsistent with the absence of the cattails. Research has indicated that a minimum of 10 inches of sediment deposition would be required to kill cattails. Research has also indicated that lesser deposition can actually stimulate the growth of cattails. The MnDOT project did not result in extensive and uniform sediment deposition over all of the cattail beds in Grass Lake.
3. In general, the nutrients and chlorides in Grass Lake are low and water chemistry appears to be recovering in 1995.
4. Grass Lake nutrient levels (total phosphorus) were similar in 1994-95 to 1988-89. Calculations received from The Kjell Company which produces the polyphosphate blend used in the coating of the water main (Appendix D), provides documentation that the procedure used by the City of Minneapolis Public Works Department would not cause a significant increase in phosphorus content, or cause toxic impacts to Grass Lake.
5. City water input started in June 1994, too late to explain cattail reductions in early 1994. Furthermore, water was discharged by the City of Minneapolis at a rate of 100 gallons per minute. Assuming no discharge from the lake, this flow would only increase the elevation of Grass Lake by 1/100 of a foot per day. Therefore, the effect of the water discharge into Grass Lake on its water elevation is insignificant.

6. It was noted that Grass Lake had a high muskrat population in 1993, and a low muskrat population in 1994. Research has indicated that muskrats would only have a minimal impact on emergent cattails, however the disappearance of the muskrat population could be a result of unusually high water elevations.
7. It appears that the Grass Lake water levels have been higher than normal in the past three years. From Figure 5 the level of Grass Lake was 1.02 feet to 2.06 feet over the outlet invert all during the summer of 1995. This could have prevented cattails from emerging. It is expected that cattail growth will resume with normal water levels.

Section IV Recommendations

1. It is recommended that either the City of Minneapolis or the Minnehaha Creek Watershed District investigate the outlet of Grass Lake to determine if an obstruction or deformity in the outlet pipe is causing a change in the water elevation of Grass Lake.

The City of Minneapolis surveyed the outlet between Grass Lake and Richfield Lake. The outlet structure was filled half-full with ice along the entire pipe. The surveying was done the week of January 1, 1996. The outlet will be further investigated this spring after the ice melts to determine if the outlet is obstructed.

2. The citizens of the Grass Lake Community in conjunction with the Minnehaha Creek Watershed District should continue to monitor the lake elevation, on a weekly basis, during the months of April through October. The District could install a lake level gauge on an annual basis, as determined necessary by the citizens of Grass Lake and the MCWD.

The December 20, 1995 Grass Lake Advisory Committee meeting resolved that water quality monitoring of Grass Lake continue. Since that resolution, correspondence has occurred between the Minneapolis Park and Recreation Board (MPRB) and the Minnehaha Creek Watershed District with respect to responsible parties for water quality monitoring.

3. A follow-up Grass Lake Advisory Committee meeting should be conducted after the investigation of the outlet to conclude this investigation. Annual meetings could be conducted thereafter to determine the necessity of further lake level monitoring.

Tables

Table 1
Minnehaha Creek Watershed District
Grass Lake Physical Data

<u>Characteristic</u>	<u>Data</u>	<u>Source</u>
Subwatershed Drainage Area	386 acres	City of Mpls.
Wetland Type	Type V*	MnDNR
Estimated Maximum Depth	5 feet	MCWD Estimate
Estimated Mean Depth	2 feet	MCWD Estimate
Area of Lake	27 acres	City of Mpls.
Volume of Lake	17.5 million gallons	MCWD Estimate
Outlet Elevation	828.81 feet 828.70 feet	Wenck Associates, Inc. City of Minneapolis

* A Type V wetland consists of inland open fresh water. Shallow ponds and reservoirs are included in this type. Water is usually less than 10 feet deep and is fringed by emergent vegetation.

Table 2
Minnehaha Creek Watershed District
Grass Lake Precipitation and Lake Elevation Data for 1995

DATE	PRECIP. (inches)	LAKE ELEVATION (feet)	DATE	PRECIP. (inches)	LAKE ELEVATION (feet)
19-Jul-95	0.1	--	3-Sep-95	0	--
20-Jul-95	0	--	4-Sep-95	0	--
21-Jul-95	0	--	5-Sep-95	0	--
22-Jul-95	0.05	--	6-Sep-95	0.04	--
23-Jul-95	0	--	7-Sep-95	0.05	--
24-Jul-95	0	--	8-Sep-95	0	--
25-Jul-95	0	--	9-Sep-95	0	--
26-Jul-95	0	--	10-Sep-95	0	--
27-Jul-95	0.26	--	11-Sep-95	0	--
28-Jul-95	0.07	--	12-Sep-95	0	--
29-Jul-95	0	--	13-Sep-95	0	--
30-Jul-95	0	--	14-Sep-95	0	--
31-Jul-95	0.07	--	15-Sep-95	0.24	--
1-Aug-95	0	--	16-Sep-95	0.14	--
2-Aug-95	0	--	17-Sep-95	0	--
3-Aug-95	0	--	18-Sep-95	0	--
4-Aug-95	0.76	--	19-Sep-95	0.26	--
5-Aug-95	0	--	20-Sep-95	0.01	--
6-Aug-95	1.2	--	21-Sep-95	0.08	--
7-Aug-95	0.96	--	22-Sep-95	trace	--
8-Aug-95	0	--	23-Sep-95	0.02	--
9-Aug-95	0	--	24-Sep-95	0.22	--
10-Aug-95	0	--	25-Sep-95	0.01	--
11-Aug-95	0.32	830.82	26-Sep-95	0	--
12-Aug-95	0.29	830.83	27-Sep-95	0	--
13-Aug-95	1.15	830.79	28-Sep-95	0	--
14-Aug-95	0.05	830.71	29-Sep-95	0.55	--
15-Aug-95	0	830.56	30-Sep-95	0.72	--
16-Aug-95	0.01	830.50	1-Oct-95	0	--
17-Aug-95	0	830.47	2-Oct-95	0.52	--
18-Aug-95	0	830.47	3-Oct-95	0.04	--
19-Aug-95	0.29	830.50	4-Oct-95	0	--
20-Aug-95	0	--	5-Oct-95	0	--
21-Aug-95	0	--	6-Oct-95	1.1	--
22-Aug-95	0	--	7-Oct-95	0.02	--
23-Aug-95	0	--	8-Oct-95	0	--
24-Aug-95	0.02	--	9-Oct-95	0.45	--
25-Aug-95	0	--	10-Oct-95	0	--
26-Aug-95	0.4	830.24	11-Oct-95	0	--
27-Aug-95	0	830.23	12-Oct-95	0	--
28-Aug-95	0.04	830.27	13-Oct-95	trace	--
29-Aug-95	0.17	--	14-Oct-95	0	--
30-Aug-95	0.03	--	15-Oct-95	0	--
31-Aug-95	--	--	16-Oct-95	0	--
1-Sep-95	0	--	17-Oct-95	--	--
2-Sep-95	0	--	18-Oct-95	--	--

-- = No measurement taken

Precipitation taken by Susan Rothbaum, 6001 Girard Ave. So., Mpls.

Lake Level readings taken by Mark McHugh, 6048 Fremont Ave. So., Mpls.

Table 2
Minnehaha Creek Watershed District
Grass Lake Precipitation and Lake Elevation Data for 1995

DATE	PRECIP. (inches)	LAKE ELEVATION (feet)	DATE	PRECIP. (inches)	LAKE ELEVATION (feet)
18-Apr-95	0.948	--	3-Jun-95	0	830.13
19-Apr-95	0.06	--	4-Jun-95	0	830.11
20-Apr-95	0.02	--	5-Jun-95	0.43	830.07
21-Apr-95	0.11	--	6-Jun-95	1.35	--
22-Apr-95	0	--	7-Jun-95	0.24	--
23-Apr-95	0	--	8-Jun-95	0	830.47
24-Apr-95	0.11	--	9-Jun-95	0	--
25-Apr-95	0	830.30	10-Jun-95	0.4	830.44
26-Apr-95	0.07	--	11-Jun-95	0	830.42
27-Apr-95	0	830.31	12-Jun-95	0	830.39
28-Apr-95	0	830.29	13-Jun-95	0	--
29-Apr-95	0	830.26	14-Jun-95	0	--
30-Apr-95	0	830.23	15-Jun-95	0	--
1-May-95	0	830.21	16-Jun-95	0	--
2-May-95	0	830.19	17-Jun-95	0	--
3-May-95	0	830.17	18-Jun-95	0	--
4-May-95	0	830.15	19-Jun-95	0	830.12
5-May-95	0	830.13	20-Jun-95	0	830.07
6-May-95	0	830.11	21-Jun-95	0	830.03
7-May-95	0.03	830.08	22-Jun-95	0	829.98
8-May-95	0.32	830.04	23-Jun-95	0.02	830.12
9-May-95	0.22	830.06	24-Jun-95	0	829.94
10-May-95	0	830.07	25-Jun-95	0.48	830.04
11-May-95	0	830.03	26-Jun-95	0.65	830.08
12-May-95	0	830.00	27-Jun-95	0.17	--
13-May-95	0.41	830.19	28-Jun-95	--	--
14-May-95	0.26	830.21	29-Jun-95	--	--
15-May-95	0	830.16	30-Jun-95	--	--
16-May-95	0	830.14	1-Jul-95	0	--
17-May-95	0	830.14	2-Jul-95	0	--
18-May-95	0	--	3-Jul-95	0	--
19-May-95	0	--	4-Jul-95	0.64	--
20-May-95	0.01	830.02	5-Jul-95	0.52	--
21-May-95	0	829.98	6-Jul-95	0.06	--
22-May-95	0.16	829.98	7-Jul-95	0	--
23-May-95	0.01	829.92	8-Jul-95	0	830.20
24-May-95	0	829.90	9-Jul-95	--	830.17
25-May-95	0	829.38	10-Jul-95	0	830.14
26-May-95	0	829.87	11-Jul-95	0	830.13
27-May-95	0.49	--	12-Jul-95	0.12	830.10
28-May-95	1.22	830.36	13-Jul-95	0	--
29-May-95	0	830.31	14-Jul-95	0	--
30-May-95	0	830.26	15-Jul-95	1.36	--
31-May-95	0	830.21	16-Jul-95	0	--
1-Jun-95	trace	830.20	17-Jul-95	0	--
2-Jun-95	0	830.18	18-Jul-95	--	--

-- = No measurement taken

Precipitation taken by Susan Rothbaum, 6001 Girard Ave. So., Mpls.

Lake Level readings taken by Mark McHugh, 6048 Fremont Ave. So., Mpls.

Table 3

**Minnehaha Creek Watershed District
Lake Evaporation Data**

	January	February	March	April	May	June	July	August	September	October	November	December
Regional Mean Monthly and Average Annual Lake Evaporation	0.32	0.35	0.85	1.80	2.95	3.95	5.70	5.60	4.40	2.95	1.30	0.38
Regional Monthly and Annual Lake Evaporation for 1994	--	--	--	--	8.67	7.36	6.58	3.94	3.09	--	--	--
Regional Monthly and Annual Lake Evaporation for 1995	--	--	--	1.45*	6.6	7.24	7.98	5.8	4.66	0.84*	--	--

* Data is for the last 10 days in April 1995, and for the first 10 days in October 1995.
SOURCE: Minnesota Climatological Data Center

Table 4
Minnehaha Creek Watershed District
Grass Lake Water Quality Data for 1995

Date	5-Oct-88 MnDOT	27-Apr-89 MnDOT	12-Jul-89 MnDOT	19-Sep-94 MPRB	1-Jun-95 Wenck	15-Jun-95 Wenck	10-Jul-95 Wenck
Secchi Disk Transparency (m)	0.32	0.38	0.52	*	0.55	--	--
Chlorophyll-a $\mu\text{g/L}$	2.58	1.85	21.9	194.2	56	64	73
Total Phosphorus mg/L	0.40	0.14	0.44	0.12	0.12	0.14	0.16
Ortho Phosphorus mg/L	0.048	0.07	0.223	0.008	<0.05	<0.05	<0.02
Ammonia Nitrogen mg/L	1.18	0.24	0.16	--	<0.1	<0.1	1.0
Nitrate Nitrogen mg/L	--	--	<0.01	--	<0.1	<0.1	<0.1
Nitrite Nitrogen mg/L	0.01	0.08	<0.01	--	<0.1	<0.1	<0.1
Nitrate + Nitrite Nitrogen mg/L	<0.01	0.04	<0.01	--	<0.1	<0.1	<0.1
Total Iron mg/L	--	--	--	--	--	0.4	0.5
Total Suspended Solids mg/L	35.0	1.4	11.0	58.5	--	--	--
Chloride mg/L	36	120	47	--	150	100	56
Total Alkalinity (as CaCO_3) mg/L	110	72	60	--	62	67	55
Temperature Celsius	6	14	24	20.8	14.9	--	23.9
Dissolved Oxygen mg/L	7.80	7.80	5.80	11.52	14.52	--	9.89
pH s.u.	7.0	6.9	8.5	9.57	9.2 (9.8)	6.1	9.6 (8.7)
Conductivity $\mu\text{mhos/cm}$	322	637	250	2280	470 (520)	510	420 (686)

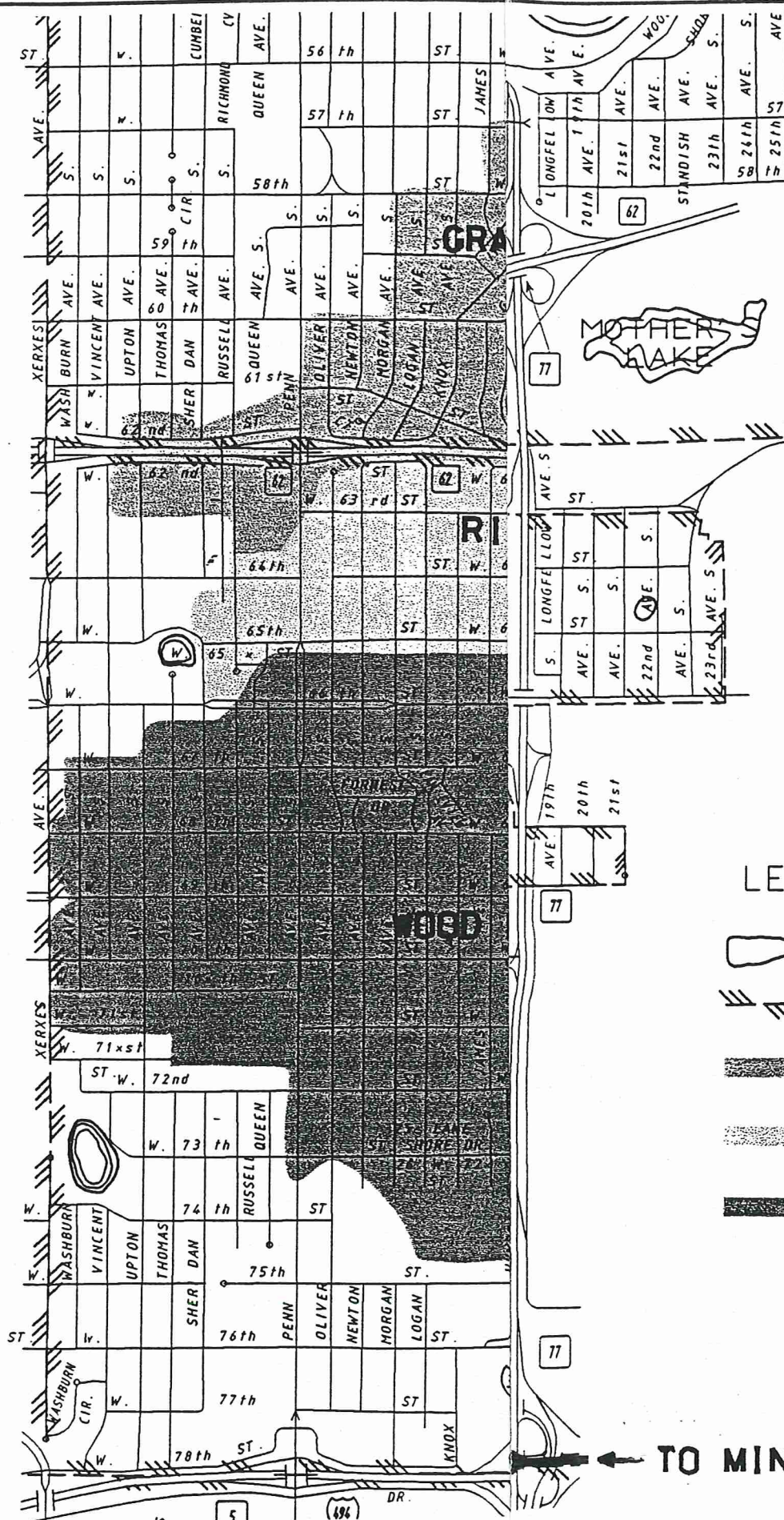
-- No sample was analyzed for this parameter
 mg/L milligrams per liter, equivalent to parts per million (ppm)
 $\mu\text{g/L}$ micrograms per liter, equivalent to parts per billion (ppb)
0 indicates field data
* Severe bloom (Odor, Scum)

Table 4
Minnehaha Creek Watershed District
Grass Lake Water Quality Data for 1995






Date	31-Jul-95 Wenck	14-Aug-95 Wenck	23-Aug-95 Wenck	7-Sep-95 Wenck	2-Oct-95 Wenck
Secchi Disk Transparency (m)	0.23	0.25	0.12	--	0.30
Chlorophyll-a $\mu\text{g/L}$	230	14	88	150	210
Total Phosphorus mg/L	0.26	0.17	0.20	0.35	0.41
Ortho Phosphorus mg/L	<0.02	<0.02	<0.02	<0.02	<0.02
Ammonia Nitrogen mg/L	<0.1	<0.1	0.9	<0.1	<0.1
Nitrate Nitrogen mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrite Nitrogen mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrate + Nitrite Nitrogen mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Total Iron mg/L	1.0	0.66	0.6	1.1	1.8
Total Suspended Solids mg/L	--	--	--	--	--
Chloride mg/L	120	61	62	63	56
Total Alkalinity (as CaCO_3) mg/L	64	54	66	70	60
Temperature Celsius	17.9	18.4	18.4	13.3	9.8
Dissolved Oxygen mg/L	--	8.27	7.65	10.26	15.60
pH s.u.	9.4	7.8 (7.9)	9.0 (8.7)	7.4 (8.1)	8.8 (9.0)
Conductivity $\mu\text{mhos/cm}$	390	240 (358)	260 (300)	320 (390)	250 (290)

-- No sample was analyzed for this parameter
 mg/L milligrams per liter, equivalent to pa
 $\mu\text{g/L}$ micrograms per liter, equivalent to
0 indicates field data
* Severe bloom (Odor, Scum)

Figures



LEGEND

-  POND
-  CITY BOUNDARY
-  GRASS LAKE WATERSHED
-  RICHFIELD LAKE WATERSHED
-  WOOD LAKE WATERSHED

TO MINNESOTA RIVER



Wenck

States, Inc.
Engineers

1800 Pioneer Creek Center
Maple Plain, MN 55359

DEC. 1995

Figure 1

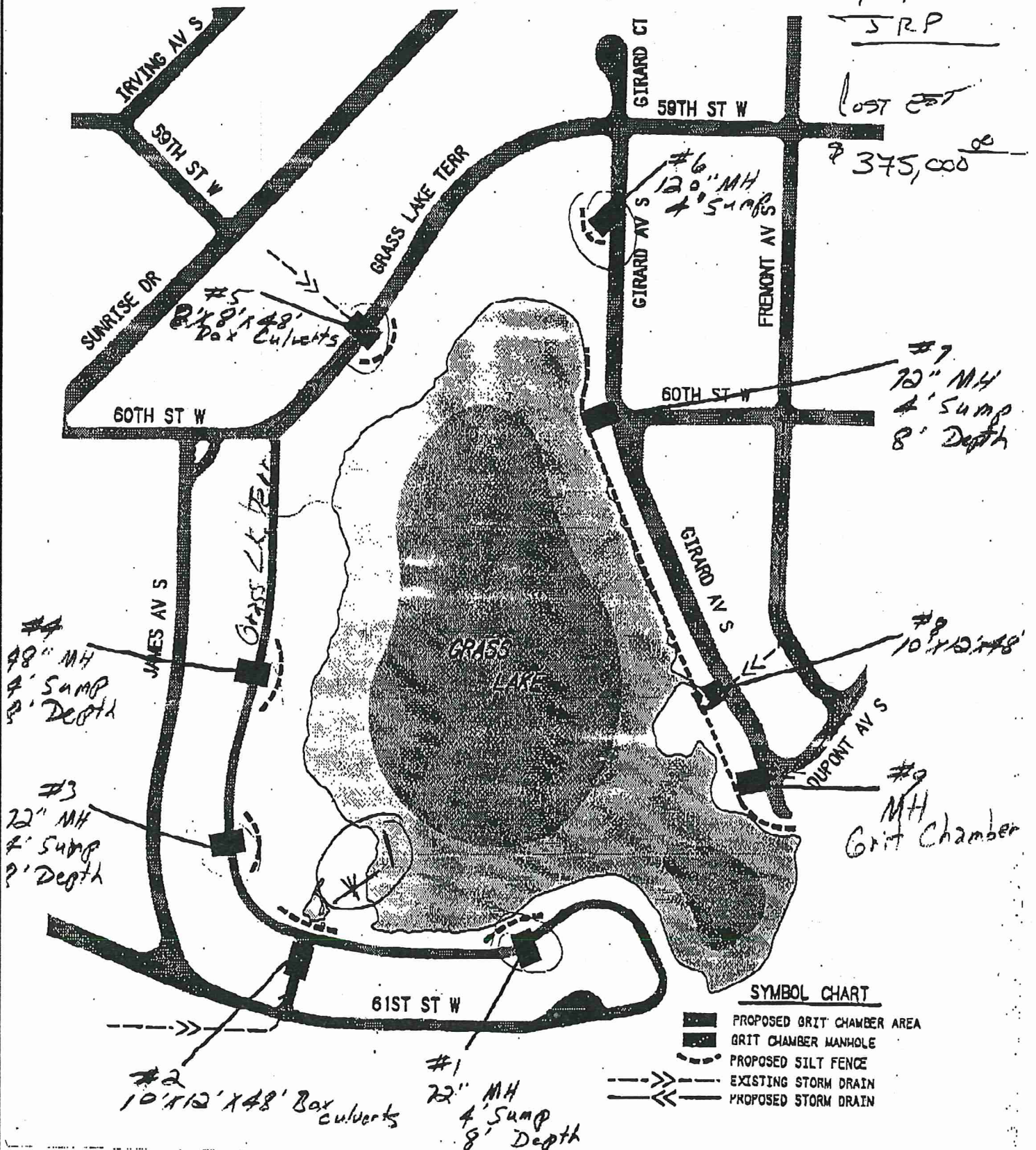
Do over existing
Pipe First
Do Deepen
First

GRASS LAKE

STORM WATER DRAINAGE & EROSION CONTROL

1/40 NEW
DAYS
EST 1/30/95
SRP

lost est
\$ 375,000



MINNEHAHA CREEK WATERSHED DISTRICT

Grass Lake Storm Sewer Inlets

COPYRIGHT



Wenck Associates, Inc.
Environmental Engineers

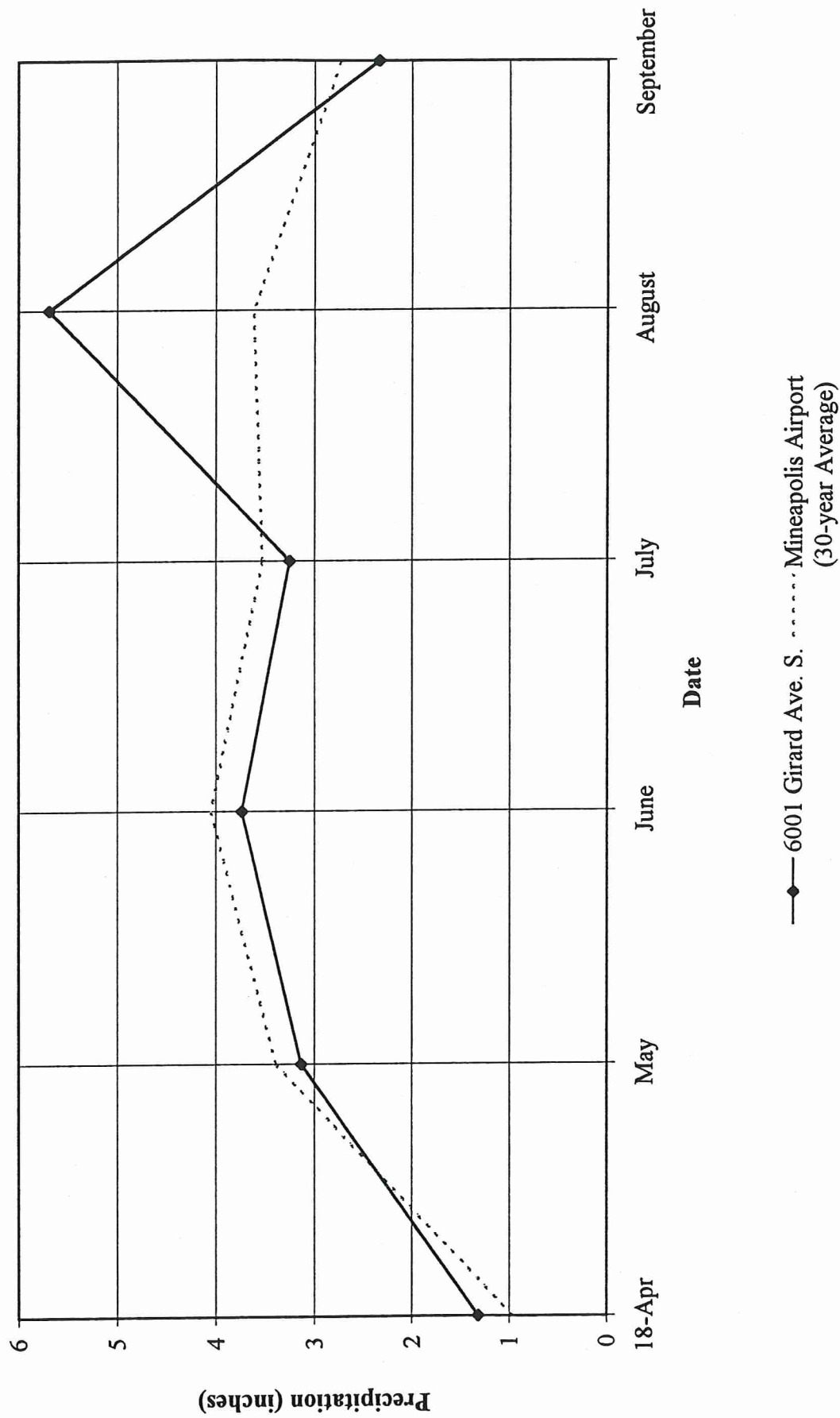
Wenck

1800 Pioneer Creek Center P.O. BOX 428
Maple Plain, MN 55359-0428

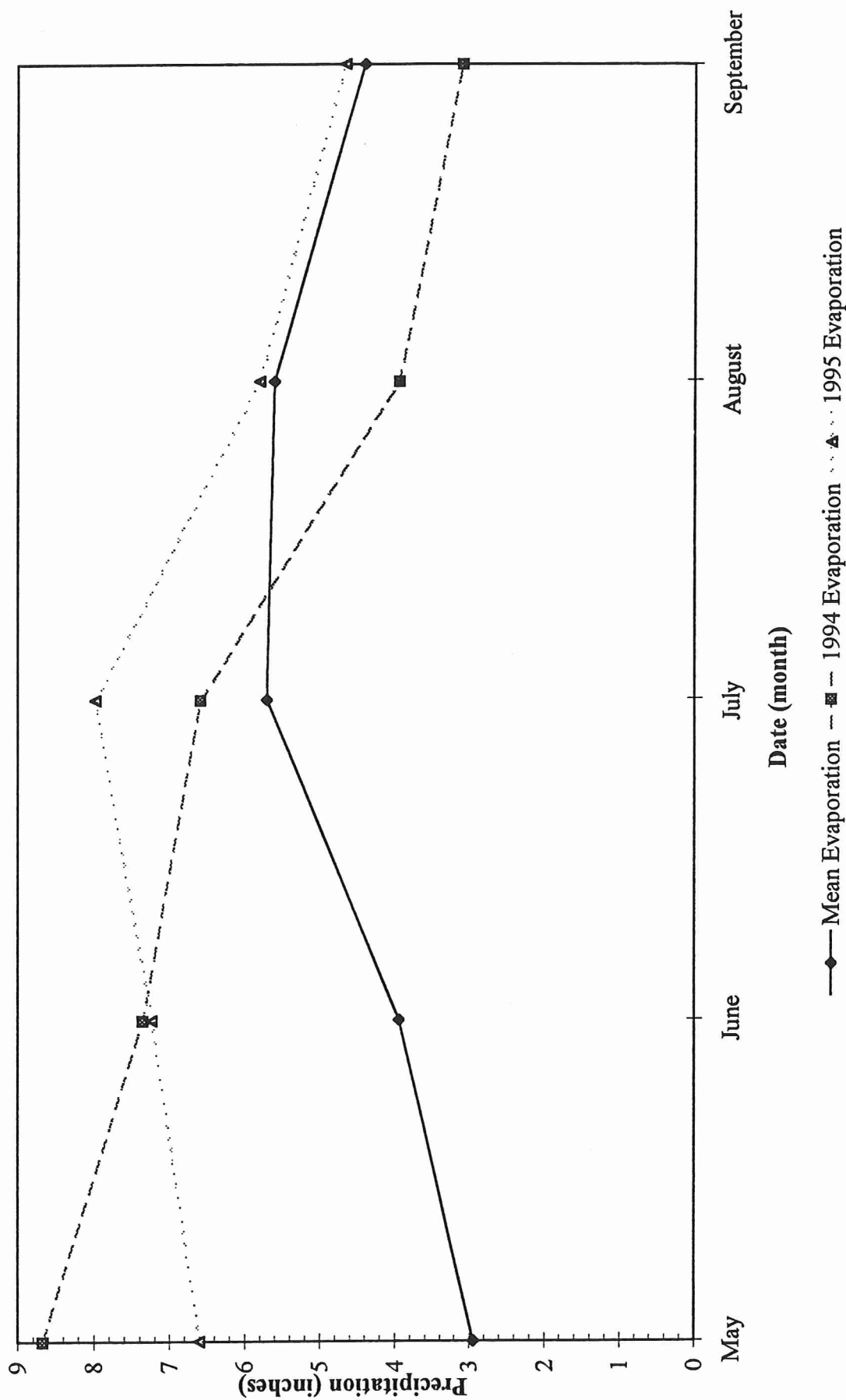
DEC.1995

Figure 2

Figure 3
 Minnehaha Creek Watershed District
 Grass Lake 1995 Precipitation Data vs. Minneapolis Airport 30-year Normal



* Precipitation data gathered by Susan Rothbaum, 6001 Girard St. So., Mpls.



SOURCE: Minnesota Climatological Data Center

MINNEHAHA CREEK WATERSHED DISTRICT

Lake Evaporation

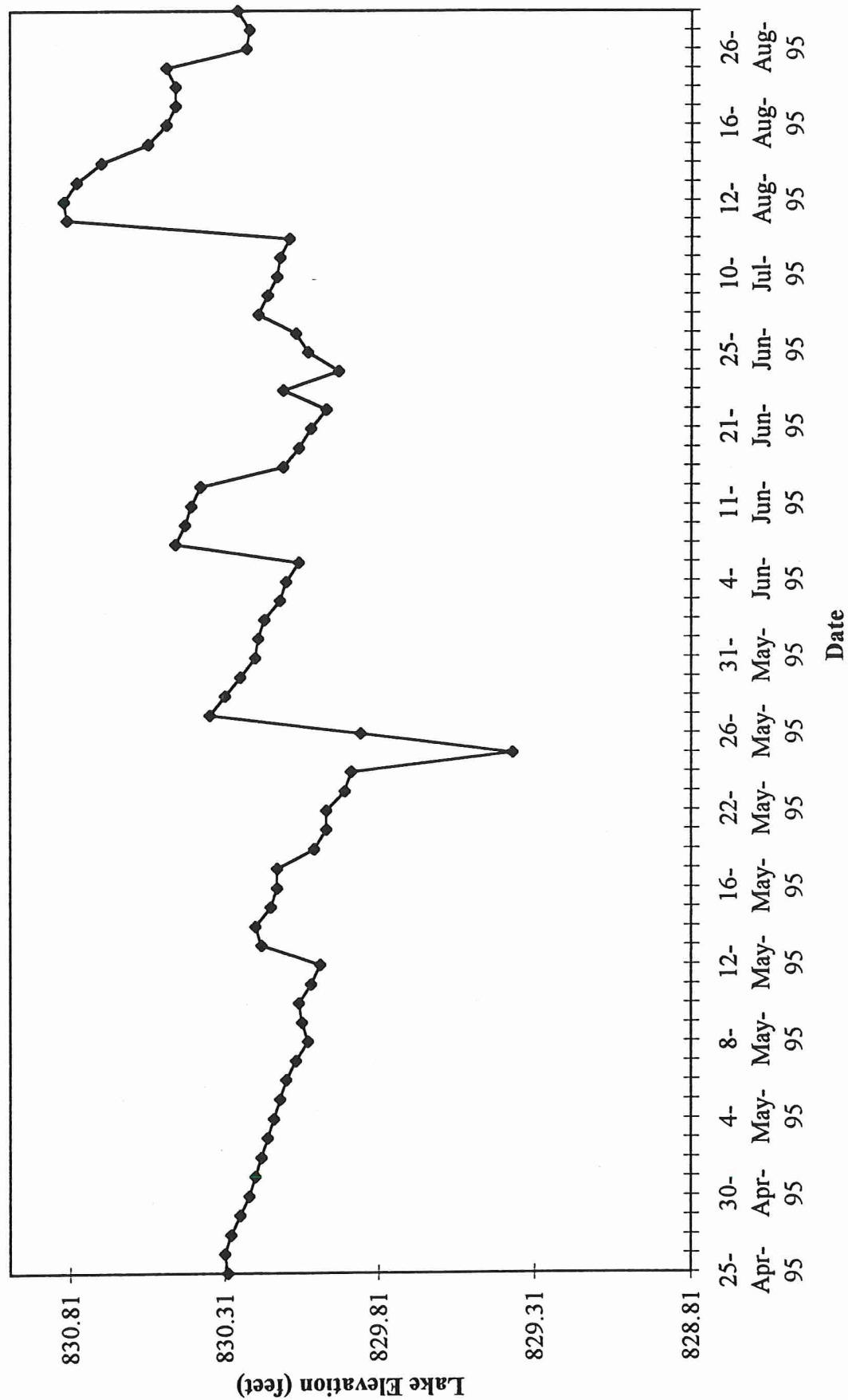
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Wenck
Wenck Associates, Inc. 1800 Pioneer Creek Ctr.
Environmental Engineers Maple Plain, MN 55359

DEC 1995

Figure 4

Figure 5
 Minnehaha Creek Watershed District
 Grass Lake Water Elevations for 1995



Appendices

Appendix A

Letter to Minnehaha Creek Watershed District from Nancy Goetezinger and Tom Ramsey

September 6, 1994

SEP 13 1994

RECEIVED

Ms. Ellen Sones, Administrator
Minnehaha Creek Watershed District
14600 Minnetonka Boulevard
Minnetonka, MN 55345

Subj: Concerns regarding water quality, habitat loss, and species loss at Grass Lake,* located near the intersection of Crosstown/62 and I35W, at site of MnDOT construction project

Dear Ms. Sones:

This letter is to follow up on our telephone conversation of Friday, August 26, 1994, which I initiated in order to express my concerns regarding what appears to be a significant degradation in the quality of a local wetland called Grass Lake. The deterioration has been coincident with not only another summer marked by substantial rainfall, but also a season-long highway interchange redesign and construction project undertaken by the Minnesota Department of Transportation (MnDOT) immediately adjacent to the wetland. The latter raises concerns regarding the possibility of human-caused degradation.

In an urban area marked by high levels of air and noise pollution, Grass Lake is a haven for both animals and people. The diversity and abundance of wildlife nesting, feeding, or making a migratory stopover there have been extremely unusual for an urban setting.** Among the highlights have been a large colony of nesting Forster's Terns: this year, approximately 100 adults fledged 100 to 150 chicks. Two species of diving ducks -- Ruddy Ducks and Redheads -- have successfully nested there for the past several years, along with Pied-billed Grebes, Mallards, Canada Geese, American Coots, Soras, and Killdeer. It is one of the country's easternmost nesting sites for Yellow-headed Blackbirds. Herons and egrets fish in the shallows, and on a typical summer evening, hundreds of bats, swallows, and Nighthawks sweep insects from the sky above the water. After the drought years, a large number of muskrats successfully reestablished; other mammals (seen in the upland bordering the wetland) include raccoons, red and gray squirrels, chipmunks, and even an occasional deer. Dozens of warblers and other bird species use the upland border for nesting and feeding.

Grass Lake is also a great source of pride and enjoyment for the surrounding neighborhood, as evidenced by the spectacular perennial beds planted around the perimeter by a local resident. The City's substantial trail improvement on the southeast end has opened the area to many who formerly did not use it. Increasingly, the wetland is a site for naturalist-led field trips: for example, it was the first stop this spring for a group of birders from Japan being hosted by local Audubon Society members.

* According to the Soil and Water Conservation District, Grass Lake is a 30-acre DNR Protected Waters wetland shown as 681W on the inventory map.

** Enclosed is a list of 104 bird species sighted at Grass Lake during 13-plus years of observation by myself and my husband, Tom Ramsay. The list is by no means comprehensive -- just what we've seen on frequent walks around the wetland.

Ms. Ellen Sones
Minnehaha Creek WSD
September 6, 1994
Page 2

Our initial cause for alarm regarding Grass Lake was the nearly complete absence of emerging cattails this year and the resulting decline in wildlife populations dependent upon them. (For example, the large muskrat population has dwindled to a handful; nesting Yellow-headed and Red-winged Blackbirds were a fraction of their usual numbers.) Last year, and in other recent past years, Grass Lake had an abundance of cattails along all but its eastern shoreline, and in a nearly complete line across the south central section of the wetland. Concurrently, we became aware of other unusual circumstances:

- The lake's water quality appears to have deteriorated significantly this year, with the water becoming and remaining unusually dense and cloudy.
- The diving ducks (Redheads and Ruddies) which have nested here successfully for the last several years did not nest this year and instead left early.
- During August and early September, Grass Lake is usually visited by large numbers of swallows and other flying insect-eaters. Such is not the case this year.

The combination of circumstances led us to question the possibility that MnDOT's highway construction project immediately adjacent to the southern shore of Grass Lake might somehow be negatively impacting the wetland, for example, by sending enough silt into it to prevent the emergence of both vegetation and insects.

In particular, following a 1.9-inch rainfall during the night of August 9 and early morning of August 10, we observed deltas of sand and soil on the pathway along the eastern/southern shoreline that had washed down from the uncovered soil on the bank of the adjacent new road bed.*** In addition, the silt fence installed nearby at the southwestern outfall of the wetland was partially submerged, allowing sediment-laden water to flow into the main body of the wetland.*** Furthermore, immediately adjacent to and outside the silt fence, a 4-inch hose connected to a nearby hydrant fed a continuous stream of fresh water, which seems likely to keep the wetland's water levels artificially high, to aggravate the flow of sediment further into the body of the wetland, and perhaps worst of all, to chlorinate the water at levels high enough to imperil plants and animals. (For your information, that fresh water influx began well in advance of August 9 and was continuing -- evidently around-the-clock -- as of the morning of September 4.)

Following a phone call I placed to the DNR prior to my conversation with you, two of that agency's representatives visited Grass Lake and subsequently expressed their belief that, while the erosion control methods employed by MnDOT were less than ideal (a flotation curtain rather than a silt fence would have been a more effective choice at the southwestern outfall), the cattails were probably flooded out by last year's heavy rains and resulting high water levels. You yourself expressed the same opinion.

*** See enclosed photo scans.

Ms. Ellen Sones
Minnehaha Creek WSD
September 6, 1994
Page 3

However, other circumstances point to problems other than high water levels:

- 1) The diving ducks which left early without nesting should have benefited from deeper-than-usual water levels.
- 2) The absence of insect-eaters points to an absence of insects. Are they not emerging? If not, why not?
- 3) Richfield's Wood Lake, just across the interchange from Grass Lake, has experienced equally high water levels with no decrease in cattails and, in fact, is so choked with cattails that dredging is now in order so as to create more open water habitat.

One of the largest areas of cattails at Grass Lake has historically been on the western border. According to the DNR, cattails will be killed by long-term submergence in from three to five feet of water. On Sunday evening, September 4, 1994, following nearly an inch of rainfall over a 48-hour period and with the water levels as high as they have been all summer (and even last summer), we measured the water depth in that area:

Approximately five feet from the upland, it was 11 inches deep; at about 17 feet out, it was 18 inches deep; and at about 27 feet out (almost to the edge of the previous visible cattail line), it was still only 19 inches deep.

Based on the DNR's guidelines, this would seem to indicate that the water levels have not been consistently deep enough to prevent cattail emergence. Furthermore, there is an outlet on the southeast corner of the wetland (at the new footbridge) which prevents water levels from remaining higher than that for more than a few days at a time.

It might not be possible to ascertain with certainty the reasons why cattails have not emerged at Grass Lake in their historic numbers or why certain wildlife patterns appear to be disrupted. (Besides high water levels, sedimentation, and chlorination, another possibility is a toxic "dump" of some sort through the stormwater system). I request however that your office investigate on-site -- and take water samples from Grass Lake -- to determine a possible man-made cause, including whether MnDOT has followed procedures under the Metropolitan Surface Water Management Act and the state's Wetlands Conservation Act which requires them to "avoid, minimize, and mitigate" impacts on wetlands.

In fact, as you have indicated, MnDOT is already in violation by virtue of having begun work on the site without submitting to your office a "stormwater management/drainage plan" for handling increased water flow from the added impervious surface. As a result, neither your office nor theirs is able to accurately state the project's current and future impacts on Grass Lake.

Ms. Ellen Sones
Minnehaha Creek WSD
September 6, 1994
Page 4

We recognize the urgent need for improvements in what has been the perilous interchange of Highways 62 and 121. Our interest is not in finding fault but rather in making certain that a public resource valued by so many -- and protected by state mandate -- is properly guarded. Enclosed is a copy of an article published last week in the *Star Tribune* about U. of M. researcher David Tilman's findings which underscore the need to nurture wildlife habitat, especially that which is demonstrably supportive of species diversity and abundance.

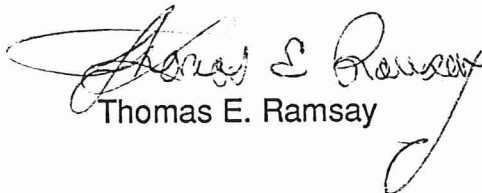
We therefore urge your office to take all steps necessary to protect Grass Lake, to assess whether human activity has been the cause of any degradation, and, if so, to require restoration from the responsible party. We also ask that we receive copies of any correspondence and findings relevant to the concerns we've expressed.

(A reminder: we have taken color photos -- some slides, some prints -- of Grass Lake during each of the last several years, each time from the same several locations, and would be happy to make those photographs available to anyone conducting an evaluation. A couple of black-and-white digitally-scanned samples are enclosed, showing differences in vegetation between 1993 and 1994, and showing the aftermath of the 1.9-inch rainfall. We also took video footage of the erosion following that rainfall, referred to on page 2.)

Sincerely,



Nancy Goetzinger and
5937 Dupont Avenue South
Minneapolis, MN 55419-2110
612-866-8686



Thomas E. Ramsay

Enc: Bird Sightings at Grass Lake
Two sets of scanned black-and-white photos of Grass Lake
"Habitat Destruction Speeds Extinction," Minneapolis *Star Tribune*, 9/1/94

cc: Ceil Strauss, DNR
John Parker, DNR
Larry Zdon, MPCA
Fred Stark, MnDOT
Ward 13 Council Member, Steve Minn
Kenny Neighborhood Newsletter Editor

Bird Sightings at Grass Lake in
South Minneapolis (near int. I35W & Crosstown/62)

April 5, 1981, through September 4, 1994

Observed and compiled by Nancy Goetzinger and Tom Ramsay

Grebe	Red-necked	N(a)	
Grebe	Pied-billed	N	
Cormorant	Double-crested	O	
Goose	Canada	N	
Mallard		N	
Duck	Am. Black	M	
Shoveler	Northern	M	
Teal	Blue-winged	M	
Teal	Green-winged	M	
Wood Duck		N	
Redhead		N	
Duck	Ring-necked	M	
Scaup	Lesser	M	
Bufflehead		M	
Duck	Ruddy	N	
Merganser	Common	M	
Merganser	Red-breasted	M	
Merganser	Hooded	M	
Pheasant	Ring-necked	U	
Heron	Great Blue	O	
Heron	Green-backed	O	
Night-Heron	Black-crowned	C	
Egret	Great	C	
Rail	Virginia	U	
Sora		N	
Coot	American	N	
Killdeer		N	
Yellowlegs	Lesser	(b)	
Sandpiper	Spotted	(b)	
Sandpiper	Solitary	M	
Gull	Ring-billed	C	
Tern	Forster's	N	
Tern	Black	O	
Dove	Rock	O	
Dove	Mourning	C	
Owl	Great-horned	O	
Nighthawk	Common	C	
Swift	Chimney	C	
Hummingbird	Ruby-throated	C	X
Kingfisher	Belted	U	
Flicker	Northern	M	
Woodpecker	Red-headed	U	X
Sapsucker	Yellow-bellied	U	X
Woodpecker	Pileated	U	X
Woodpecker	Hairy	C	
Woodpecker	Downy	C	
Phoebe	Eastern	O	

a) A pair of Red-necked Grebes made an unsuccessful nest attempt during the early 1980's. Eggs were laid and incubated but nest was flooded prior to hatch.

b) In the early 1980's, there were mud flats/sandbars on the east side where shorebirds were common. However, this area has become progressively submerged.

N=nesting C=common O=occasional U=uncommon M=Migrant W=winter
(X= birds sighted within a 3-block radius of Grass Lake and which presumably use the Lake.)

Bird Sightings at Grass Lake - south Mpls.
Compiled by Nancy Goetzinger & Tom Ramsay

Swallow	Barn	C	
Swallow	Tree	C	
Swallow	N. Rough-winged	C	
Martin	Purple	C	
Crow	American	C	
Jay	Blue	C	
Chickadee	Black-capped	C	
Nuthatch	White-breasted	C	X
Nuthatch	Red-breasted	C	X
Creeper	Brown	C	X
Wren	House	C	X
Catbird	Gray	C	
Thrasher	Brown	O	
Robin	American	C	
Thrush	Hermit	O	
Thrush	Swainson's	O	
Kinglet	Golden-crowned	M	
Kinglet	Ruby-crowned	M	
Waxwing	Cedar	O	
Starling	European	C	
Vireo	Red-eyed	M	
Vireo	Warbling	M	
Warbler	Black & White	M	
Warbler	Prothonotary	M	
Warbler	Tennessee	M	
Warbler	Nashville	M	
Warbler	Yellow	M	
Warbler	Yellow-rumped	M	
Warbler	Blackpoll	M	
Warbler	Palm	M	
Ovenbird		M	
Waterthrush	Northern	M	
Yellowthroat	Common	U	
Warbler	Wilson's	M	
Warbler	Canada	M	
Redstart	American	M	
Sparrow	House	C	
Blackbird	Yellow-headed	N	
Blackbird	Red-winged	N	
Blackbird	Rusty	M	
Blackbird	Brewer's	M	
Grackle	Common	C	
Cowbird	Brown-headed	M	
Oriole	Northern	N	
Cardinal	Northern	C	
Grosbeak	Rose-breasted	M	X
Finch	Purple	W	
Finch	House	C	
Siskin	Pine	O	
Goldfinch	American	O	
Crossbill	White-winged	W	
Sparrow	Chipping	O	
Sparrow	White-crowned	M	X
Sparrow	White-throated	M	
Sparrow	Fox	M	
Sparrow	Song	O	
Junco	Dark-eyed	W	

N=nesting C=common O=occasional U=uncommon M=Migrant W=winter
(X= birds sighted within a 3-block radius of Grass Lake and which presumably use the Lake.)

Appendix B

Resolution Ordering Investigation of Grass Lake and Appointing Grass Lake Citizens Advisory Committee

MINNEHAHA CREEK WATERSHED DISTRICT

BOARD OF MANAGERS

Resolution Ordering Investigation of Grass Lake and Appointing Grass Lake Citizens Advisory Committee

WHEREAS, the Minnehaha Creek Watershed District (MCWD) Board of Managers has received detailed information from area residents, other concerned citizens, and public officials establishing a serious change in the wetland vegetation, appearance, and wildlife and bird population at Grass Lake in south Minneapolis;

WHEREAS, Grass Lake has been documented as a unique and special urban wetland which has provided habitat for a wide variety of rare birds and other wildlife;

WHEREAS, in June 1994, the MCWD discovered that the Minnesota Department of Transportation(MnDOT) initiated construction to rebuild an entrance ramp onto Highway 62 from Lyndale Avenue without preparing a stormwater management plan or applying for an MCWD permit; to date, MnDOT has failed to provide adequate information to the MCWD to document whether this project has properly addressed the stormwater management requirements of the MCWD;

WHEREAS, in the public hearings concerning this violation, Grass Lake area property owners presented credible information indicating a substantial decline in the quality of Grass Lake which may be related to highway drainage in the area, and documenting failures by MnDOT to provide proper erosion protection during the construction project;

WHEREAS, in a highly urbanized watershed like the MCWD, the construction or expansion of public highways and roadways are the most significant land use changes impacting upon water resources, both in terms of water quality and flood control; the stormwater runoff from newly constructed or expanded highways presents serious concerns with the increased loading of phosphorus and other nutrients, as well as a number of other pollutants, including particulates, heavy metals, pesticides, and chlorides; the large increase in hard surface presented by the additional concrete from highway projects presents serious issues with flood control and erosion as well;

WHEREAS, there are several additional highway construction projects planned by MnDOT in this area surrounding Grass Lake which raise major water quality and other stormwater management concerns for Grass Lake and other nearby wetlands or water bodies; these projects have the potential either to harm or to enhance the water quality of these affected water bodies, depending on the adequacy of the design in addressing stormwater management issues;

WHEREAS, there is a need to create accurate water quality and other hydrological data to document the current conditions of Grass Lake, to diagnose the possible cause or causes of the current conditions, and to identify potential remedies to address these conditions;

WHEREAS, there is an active neighborhood organization and numerous citizens in the Grass Lake area who have demonstrated deep interest in the protection of water resources and an active commitment to the stewardship of Grass Lake; and

WHEREAS, the MCWD through its adopted Watershed Management Plan has established as its first priority objective the improvement of the chemical and the physical quality of surface water in the District;

THEREFORE BE IT RESOLVED that the MCWD Board of Managers hereby establishes a Grass Lake Citizens Advisory Committee for the purpose of providing further information, guidance, and policy recommendations to the Board of Managers concerning the conditions at Grass Lake, as follows:

a. Membership: the Committee shall have seven (7) members, all of whom shall be citizens residing within the Minnehaha Creek Watershed District and be considered knowledgeable about Grass Lake and the concerns of area residents; one of these Committee members shall be named by the Kenny Neighborhood Association as an Association representative on the Committee;

b. Applications: the MCWD Board of Managers will invite applications from citizens interested in serving on this Committee by sending a letter describing pertinent qualifications and a statement of interest in serving on the Committee to the MCWD District Office, 15500 Wayzata Boulevard, Suite 611 Twelve Oaks Center, Wayzata, Minnesota 55391 (fax 476-7873); all applications must be received at the District Office on or before 4:30 p.m. on Wednesday, November 9, 1994;

c. Selection: the MCWD Board of Managers hold a public meeting to interview interested applicants and finalize the membership of the Committee on Thursday, November 10, 1994 at 6:00 p.m. in the Council Chambers at Minnetonka City Hall;

d. Duties: the Committee shall meet as often as necessary, but no less than quarterly, for the purpose of providing and receiving information to and from MCWD staff and managers;

e. Manager Liaison: Manager [Blixt] shall be designated as the Manager Liaison to this Committee; and

f. MnDOT and Other Agency Participation: MnDOT will be invited to send a representative to attend these meetings in order to further the communication and cooperation between MnDOT and MCWD; any other agencies, organizations or interested citizens are welcome to attend as well;

BE IT FURTHER RESOLVED that the MCWD Board of Managers directs the District Engineer to commence a diagnostic investigation of the water quality conditions in Grass Lake and an overall detailed assessment of Grass Lake's hydrology, report back to the Grass Lake Citizens Advisory Committee and the Board of Managers on at least a quarterly basis, with a final report with recommended remedial alternatives no later than November 1, 1995.

Appendix C

Material Safety Data Sheet for Polyphosphate Blend Used by the City of Minneapolis

Minneapolis Water Works
Water Plant Operations
4300 Marshall Street NE
Minneapolis, MN 55421-2500



FAX TRANSMITTAL

Please deliver the following pages to:

Fax Number 479-4242

Company Name _____

Attention Christine George

From Larry Cole

Date 10-17-95

Regarding MSDS Blended Phosphate

Number of Pages Including Cover Page 4

Our Fax Number is (612) 661-4914.

If you have any problems receiving this please call (612) 661-4917. ⁴⁹²³

Message _____

0185-04-220

In Case of Chemical Emergency

Call Chemtrec at 800-424-9300

MATERIAL SAFETY DATA SHEET

THE KJELL CORPORATION
PO BOX 834
BELOIT, WISCONSIN 53512-0834
(800) 356-0422 (608) 755-0422

Product Name: F - 25-S

Date Prepared: August 1988

Last Revision: May, 1994

=====PRODUCT INFORMATION=====

Synonyms: Blended Sodium Phosphate
Chemical Family: Liquid phosphate blend
Formula: Proprietary
Maximum Use: 29.2 mg/l (ppm)

=====PRECAUTIONARY INFORMATION=====

Precautionary Statement:
(As defined by OSHA Hazard
Communications Standard)

No Significant Health Effects Reported from
manufacturing locations

=====INGREDIENTS/COMPONENTS=====

Chemical Identity: Sodium potassium ortho/polyphosphate blend
OSHA PEL: Not listed
ACGIH TLV: Not listed
CAS #: 68915-31-1
Hazard Class: None

=====PHYSICAL DATA=====

Boiling Point: Above 212 degrees F. .
Melting Point: Not Applicable
Vapor Pressure: Not Applicable
Vapor Density (Air = 1): Not Applicable
Specific Gravity (H₂O = 1): 1.365
Evaporation Rate
(Butyl Acetate = 1): Non-Volatile
Solubility in Water by Weight: Complete
pH (neat): 6.0
pH (1% solution): 6.5
Appearance: Clear Liquid
Odor: Slight



FROM MATERIAL SAFETY DATA SHEET, ENTER
HAZARD RATING IN APPROPRIATE BOX.

HAZARD RATING

0 - MINIMAL HAZARD 2 - MODERATE HAZARD
1 - SLIGHT HAZARD 3 - SERIOUS HAZARD
4 - SEVERE HAZARD

Note: Use of an asterisk (*) or other designation
indicates that there may be chronic health effects
present. See Safety file on the product.

Material Safety Data Sheet: F - 25-S

Page 2 of 3

FIRE AND EXPLOSION DATA

Flash Point: Non-Combustible
Flammable Limites - Upper: Not Applicable
Lower: Not Applicable
Extinguishing Media: Not Applicable
Special Fire Fighting Procedures: Not Applicable
Unusual Fire & Explosion Hazards: None

REACTIVITY DATA

Stability: Stable
Incompatibility: Concentrated Chlorine and Concentrated Mineral Acids
Hazardous Polymerization: Will not occur
Conditions to Avoid: Direct mixing of concentrates of chlorine and mineral acids
Hazardous Decomposition
By products: Heat and Chlorine

HEALTH HAZARD DATA**Routes of Exposure -**

Eyes: No published data
Skin Contact: No published data
Skin Absorption: No published data
Inhalation: No published data
Ingestion: No published data

Effects of Overexposure -

Acute Exposure: No Published Data
Chronic Exposure: When good industrial Hygiene practices are followed no significant inhalation hazard or skin irritation.

Other Health Effects -

Medical Conditions
Aggravated by Exposure: None known
Carcinogenic Potential:
NTP Annual Report: Not listed
IARC Monographs: Not listed
OSHA 29CFR Part 1910 Sub z: Not listed

Additional Regulatory Information -

FDA: GRAS List; permitted in food
USDA: Permitted in meats

Material Safety Data Sheet: F - 25-S

Page 3 of 3

Emergency and First Aid Procedures -

Eyes: Flush with water. If irritation occurs seek medical attention.

Skin: Wash with water. If irritation occurs seek medical attention.

Inhalation: Remove from exposure.

Ingestion: Rinse mouth and dilute stomach contents with water or milk if available.

Decontamination Procedure: Wash with water.

Notes to Physicians: Large doses may cause nausea and diarrhea.

=====STORAGE AND HANDLING=====

Spill or Leak Procedures: Material should be wiped up for salvage or disposal. Flush with water.

Waste Disposal Method: If not salvaged, dispose in a landfill in accordance with local, state, and federal regulations.

Precautions in Storing: Should be stored in clean area for quality assurance. Keep container closed when not in use. Protect from freezing and extreme heat.

=====SPECIAL PROTECTION=====

Respiratory: None required

Eye: Not mandatory

Protective Gloves: Not mandatory

Clothing & Equipment: No special requirements

Ventilation Requirements: No special requirements

Work/Hygienic Practices: No special requirements. Follow good industrial hygiene practices.

=====TRANSPORTATION DATA=====

DOT Proper Shipping Name: Sodium phosphate solution

DOT Classification: Not regulated

DOT Labels: Not required

DOT Placards: Not required

Emergency Accident

Precautions & Procedures: Not hazardous - See instructions above for release or spill.

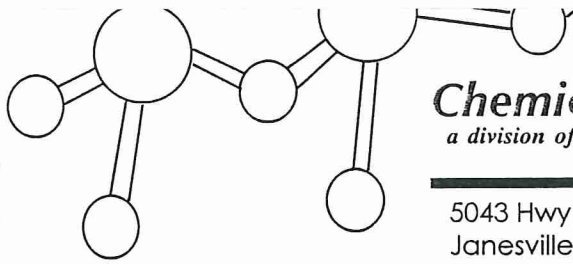
=====MANUFACTURER'S DISCLAIMER=====

While The Kjell Corporation will make every effort to insure the validity of this information, we must rely on the information supplied to us by our suppliers and thus make no warranty express or implied as to the validity of this data.

Any use of this product or method of application which is not described in the Product Data Sheet is the responsibility of the user.

Appendix D

Memorandum from Bert Hellen of The Kjell Corporation



Chemical Technology and Consulting
a division of The Kjell Corporation

5043 Hwy 51 South
Janesville, WI 53546

(608) 755-6945 Phone
(608) 755-1339 Fax

November 10, 1995

Ms. Kristin George, C.E.
Wenck & Associates
Maple Plain, MN 55359

Dear Ms. George:

The product F-25-S is thirty-one (31%) percent total phosphate and since the Minneapolis Water Department has been using 0.5 ppm as product the total phosphate is 0.155 ppm, and this would be the same as 0.0506 ppm as total P. The flow into the lake was cited to be 144,000 gallons of water per day thus $144,000 \times 3.7851/\text{g} \times 0.155 \text{ mg/l} = 84,481.2 \text{ mg/d}$ or 0.186 lb/day or 5.58 lb/month (30 days) total phosphate. This is 1.821 lbs of Phosphorus per Month.

The phosphates are mined as phosphate ores, purified into phosphorous and then converted to phosphoric acid. The acids are reacted with bases to produce more complex phosphates (poly's). Over time the polyphosphates revert back to the simplest form - orthophosphate.

The cattails that died along the shoreline were probably killed by the drought conditions that existed during this time frame. The conditions prevailing during the drought may have weakened the plants and allowed disease organisms to be incorporated into the cellular materials.

As a general rule any phosphates added to a water reservoir will enhance the growth of all aquatic organisms.

Sincerely,

Bert Hellen
Scientist

BH/dml

Appendix E

Minneapolis Park and Recreation Board Grass Lake Assessment

AES

GRASS LAKE ASSESSMENT

October 25, 1994

**Jeff Lee
Minneapolis Park and Recreation Board
Environmental Programs Section**

I. BACKGROUND

The present condition of Grass Lake prompted local residents to express concerns over the changes taking place in the wetland, and concern as to the possible causes for these changes. The lake (wetland) has changed over the last three to four years from a vegetated wetland to an open water pool with little emergent or submerged vegetation. The Minneapolis Park and Recreation Board Environmental Programs Section sampled and surveyed the wetland in September at the request of Council Member Steve Minn. Set forth in the following report are our observations, water quality data results, comparisons, conclusions and suggestions. In order to provide some context for our conclusions the wetland literature was reviewed for information pertinent to the changes occurring in Grass Lake; in no way is this meant to be a comprehensive review of the wetlands literature, but should provide useful information for lake users and managers.

II. WETLANDS

Wetlands can be difficult to define exactly, but generally meet three criteria; 1) distinguished by the presence of water; 2) have unique soils that differ from adjacent upland soils, and 3) support vegetation adapted to wet conditions (Mitsch and Gosselink, 1986). All wetland plant communities are determined by the time of the year they are wet, water depth, water quantity, duration of wetness, and duration of varying depths. The animal community of wetlands are directly dependent upon the plant community, given that a particular plant community and plant diversity directly impact the diversity of the animal community. Vegetational dependence is to the point that absence of vegetation may very well lead to an absence or greatly reduced number of animals.

Mitsch and Gosselink (1986) state that marsh cycles, the main structural feature of prairie marshes is characteristic of a 5 to 20 year cycle of dry marsh regenerating, marsh degenerating due to higher water, and marsh converting to lake-like conditions, which is related to periodic droughts and increased precipitation in following years. Kusler, *et al* (1994) state "(A)lthough the kinds and location of wetlands vary greatly, fluctuating water levels are central to all of them. Water levels rise and fall in accordance with tides, precipitation or runoff; activities of humans and other animals can also determine water levels."

Mitsch and Gosselink (1986) mention that during drought years standing water disappears and buried seeds; that is the wetland seed bank germinates when rainfall returns to normal. Once the wetland is inundated the annuals will disappear and the perennial plants emerge. Plants such as cattails, some of the reed grasses, *Scripus* spp. and some of the *Sagittarius* (arrowheads) will reappear and become dominant. Some submerge vegetation, such as coontail, milfoil, and pond weeds may be present. For the next year or more during the regeneration stage, emergent plant populations increases until reaching high density. However, after a few years these populations begin to decline, the reasons for the decline are

poorly understood.

Often times muskrat populations explode in response the vigorous vegetation growth. Their nest and trail building can decimate the plant community of a marsh. Whatever the reason, in the final stages of the cycle there is little emergent marsh vegetation. Most of the marsh area will have reverted to an open shallow lake or pond, setting the stage for the next drought cycle. Wetland use by animals follows the same cycle, increasing and decreasing with the vegetation cycle.

In relation to the fluctuating water levels and the impact, Kulzer (1993) at King County Surface Water Management in Seattle, talked about managing vegetation in small wetlands and ponds. Her work found that when water level fluctuations are greater than 18", the fluctuating water levels lead to reduction in plant diversity and a loss of vegetation in shallow water areas of wetlands and pond.

Errington (1963) has looked at muskrat impacts upon wetlands, as well as other herbivores. A large number of muskrats has been related anecdotally by some neighborhood residents. Some residents mentioned that they saw a lot of muskrats last year, even to the point that they were up feeding in people's yards. Our survey on September 19, counted 21 muskrat house remnants from the previous year. In a drive around the lake on the September 21st, 4 currently active feeders or muskrat houses were counted.

Sedimentation and sediment impacts from the MN DOT construction of Crosstown 62 have been mentioned as possible impacts. Sediment input to surface waters can have negative impacts on water quality. The sediment inputs increase turbidity, increase phosphorus concentrations and can physically disrupt plants and animals through sedimentation. All urban land uses generate higher than background levels of suspended sediments. Automobile traffic, soil erosion, breakdown of organic matter and hard surfaces, and airborne dust all contribute. Construction activities can generate the largest levels of sediment export on a per acre basis. Properly installed and maintained erosion control best management practices (BMP) can reduce these impacts (MPCA 1989). Seldom are the BMPs be effective in totally preventing sediment delivery to surface waters, this being a function of the BMP maintenance effort.

Jurik, Wang and van der Valk (1994) found that sediment input to a wetland seems to reduce germination of seeds. They also found that with older and larger seedlings, a small amount of sedimentation may actually enhance survival. Adult cattails were not affected by sediment load treatments, even when four centimeters (10") of sediment were added in a year. This large amount of sedimentation did not reduce the growth of large cattail plants (Wang, Jurik, and van der Valk, 1994). Barko, et al (1991) found that inputs of sediment may actually enhance existing plant growth by providing additional nutrients to the plants. Wang, Jurik, and van der Valk (1994) suggest that the larger the plant or plant part, the less likely it will be adversely affected by sediment burial. They also go on to say because droughts often end with a period above normal rainfall seedlings that become established

during an draw down are at risk when wetlands reflood, if the water entering contains large quantities of suspended sediments. Established plants are less impacted by sediment imports than seeds. They concluded that inputs of sediments had little affect on existing mature cattails and on litter decomposition. Moderate amounts of sediment will have little affect on adult vegetation, and may actually fertilizes plant growth.

II. PROCESS

The MPRB crews sampled the wetland on September 19, 1994. Water samples were taken from the center of the lake for analysis. Dissolved oxygen, temperature, pH, Secchi disk, and conductivity were taken on the site. The perimeter of the Grass Lake was travelled in a canoe to note plants present and general conditions. Water was also taken from the hydrant discharge at the SW corner and analyzed in the field for chlorine.

MN DOT sampled the wetland in 1998 and 1989 as part of the 35W EIS process.

Neighborhood data was provided in the letter to the MCWD, and in a visit with Tom Ramsay and Nancy Goetzinger. Tom and Nancy provided slides and pictures of the conditions in the lake in prior years (1987 and 1990 to present).

Water quality samples were sent to the same lab used by MPRB for it ongoing Minneapolis lake monitoring program. The water quality data is extremely limited.

II. RESULTS

The water quality information is more of a snapshot of conditions and does not do a good job of defining changes. The MPRB data and MN DOT data are attached.

Comparing the 1988-89 data for Grass Lake and the September 1994 data provide some useful comparisons. The total phosphorus does not appear to be dramatically different. There are some concentration fluctuations but these are not great enough to suggest drastic changes in phosphorus inputs. The chlorophyll a concentration is up, as would be expected in an open water situation where algae is dominant. The soluble reactive phosphorus was quite high during the drought years. This indicates that there wasn't much algae taking it up; and that it was being excreted either through decomposition or from the sediments. In 1994 the large algae population was using and depleting the soluble phosphorus.

I think it's interesting to make a couple of other comparisons, the Secchi disc was relatively deeper (1/2 meter) in mid summer of 1989, which was during a drought year. One would expect to have had either lower stable water conditions or relatively lower inputs of water, or both. During September 1994, which was a quite rainy month, we're seeing high suspended solids which may or may not be related to the algae, but could also be related to run-off in that this is a storm water driven system.

A comparison to Diamond Lake is also useful in that both are wetland systems impacted by storm water runoff. From the slides of conditions in 1988 and 1990, Grass Lake had more emergent vegetation than did Diamond Lake. Both did develop good cattail populations following the return to normal precipitation levels. The cattails have persisted in Diamond Lake to this date, while the cattails have disappeared from Grass. One major difference is the absence of muskrats in Diamond Lake. The cattails have receded somewhat in 1994 in Diamond, but have not disappeared. Water levels in Diamond have been higher in 1994 also. A vegetation survey was done in 1993 and will be repeated next year, it will be interesting to see if there are measurable changes in the vegetation due to higher water levels.

It is interesting that Diamond Lake had chlorophyll levels elevated this fall, as did Grass Lake. The total phosphorus concentrations are not that much different between the two wetlands. Both are in the 0.1 to 0.4 parts per million range. One thing that is interesting is that the conductivity in Grass Lake is much higher now compared to the drought years, as well as in comparison to Diamond Lake. Given the high turbidity, anoxic conditions may have occurred recently in Grass Lake (also indicated by the reddish brown color of the water).

All of these changes are what might be expected when a wetland changes over from vegetation dominated to algae dominated situation. Probably the most telling point is the chlorophyll a to phosphorus relationship. Grass Lake in September 1994 is definitely different than either 1988-89 or Diamond Lake in 1994. The absence of rooted plants has allowed the algal community to become dominant.

Richfield Lake and Wood Lake were also visited for comparison purposes. The plant diversity of Richfield Lake is much higher than Grass Lake. Wood Lake also has higher plant diversity, but being much larger is not a good comparison. Richfield Lake has flooding and elevated water levels in 1994, and given the dead maples and other trees, possibly other recent years also. Richfield Lake did not appear to have a large number of muskrats and more plant coverage. Also Richfield Lake has a greater variation in topography and water depth. This condition allows a wider variety of plant species to grow, whereas Grass Lake is more uniform in depth.

Grass Lake in the previous two years was almost totally cattails, which make for very low diversity, which makes it very susceptible to changes. Low diversity means a particular change will have a greater impact than if there were a high diversity (Tilman, 1994). Tilman looked at grassland vegetation and talked about the ability of a plant community to survive a major change. High diversity allows it maintain stable productivity, whereas low diversity can lead to severe detrimental impacts.

The photographs of Grass Lake indicated that since the drought the wetland has undergone vegetational changes that are mentioned in the literature. During the low water years of the drought emergent vegetation was found flourishing on the mud flats of the wetland. As water levels returned to "normal" some of the smartweeds, sedges and grasses were replaced by cattail and bulrushes. In 1992 and 1993 the dominant plants were cattails, and by 1994 these

too had disappeared.

III. CONCLUSIONS

Existing conditions in Grass lake are less than ideal, representing an altered and degraded wetland condition. Given the wet-dry cycles that wetlands pass through the changes were predictable. One has to ask though, why have these changes been accelerated in Grass Lake. Management strategies must be developed for Grass Lake to allow it to continue to be a neighborhood resource.

The chronology of short term successional changes usually involves a development of submergence vegetation over a period of 3 to 7 years but there are natural reversals due to reduced water levels. The use of water level regulation in a marsh is used to provide cover and food for wildlife; revegetation comes most readily after a draw down of water levels. As a management option, Fredrickson and Taylor (1982) discuss the management of wetlands for seasonal flooded improvements for wildlife habitat.

A couple of comments regarding a the letter to MCWD; water quality does appear to have deteriorated in 1994, which the 1994 water quality data supports. All indications are that some of the suggestions made by the DNR that the high water levels from last years heavy rains may have resulted in the loss of cattails is very likely.

The importance of city drinking water being put in the lake was also looked at. That water was tested, with the chlorine level was found to be less 1/10 of a part per million. Depending on the volume of water being put in, this being low nutrient water, could actually lead to an improved water quality conditions. Given the fact that it started later in the year this input probably didn't have an impact on the vegetational community.

The mention of loss of diving ducks nesting could well be due to habitat loss and vegetational decline leading to loss in nesting habitat. Absence of insect eaters is a real tough one to answer; we need an insect survey to answer this question.

Water chemistry of Grass Lake in 1994 was a totally different relationship indicating again that some of the changes in water quality were probably due to the absence of the plants which gets us back to the other problem. What leads to absence of plants? In Jurik, Wang and van der Valk (1994) they talk about the fact that increased in sediment loading can affect the entire ecosystem including food chains, algae and higher plant productivity, and diversity. These effects can be positive because nutrients are being added, or negative because the barrier of organism in the accumulated sediment. During high water years, much of the vegetation is lost due to muskrat eat outs or being drowned. Marches go dry and emergence species become reestablished and persist.

One thing that van der Valk did state is that sediment accumulations in wetlands are typically on the order of three tenths of a centimeter per year or less. One of their

concluding comments is that prairie wetlands depend on regeneration from seed banks and suggest large potential effects of sedimentation on the composition of wetland vegetation. This means if we don't have a seed bank for regeneration in the next drought then we might have problems reestablishing the plant community. Given that Grass Lake is close to Wood and Richfield lakes the regrowth following the next drought would be expected to be good (as happened in 1988).

Niering (1990) makes a couple of summary statements about the relevance of wetland dynamics. One is that biotic change in wetlands is usually not directional and generally not predictable. This is due to fluctuating water levels which increase the chance of catastrophe and these water level changes are constantly interacting with plants in ways not well understood. Natural wetlands are characterized by distinctive, usually fluctuating hydrologic regimes and as pulse systems they're highly dynamic and can persist as relatively stable entities or be in a constant state of flux. And more importantly short term wetland observation concerning vegetation change, in drier or wetter conditions can be misleading, thus dictating the need for longterm observations. Kusler and Kentula (1990) state that water depth is correlated with the survival distribution and abundance of wetland species, fluctuations in the hydrologic regimes results in changes in both plant species composition and structure.

Researchers have found plant composition was related to residence time following major precipitation events, so the length of time that the water stayed in the wetland had an impact. This ties in real well. Vegetation at sites that drain quickly following precipitation events were distinct from that which drainage was slower, or where water was loss primarily through evapotranspiration.

The construction site BMPs in place for the Crosstown reconstruction need to be better maintained. Large areas of exposed soils are a problem waiting to happen and need to be addressed.

UNANSWERED QUESTIONS/INFORMATION NEEDS

Information needs

The following are items that need to be addressed in some manner if we are to make and keep Grass Lake a viable wetland that allows for uses beyond storm water management.

What about the seed bank? Are there comfortable seed banks on the site, are there still cattail tubers, or just that they did drown out and they'll come back, Sediment survey and seed bank work could be undertaken to answer these questions; or we could wait for the next drought cycle to see what emerges from the sediment.

Muskrat inventory - what is the muskrat level? Were the numbers seen in 1993/94 high enough to lead to a destruction of the cattails?

Insect loss - have all the insects actually disappeared? A benthic survey could be undertaken.

Management needs

Water level management should be an issue. What can be done to limit the bounce experience by Grass Lake following storms?

Water quality needs to be monitored. A greater frequency of water quality monitoring is needed. Given that we have only four data points over three different years that's very small snapshot which may or may not provide a accurate record of events. Storm water treatment should be put in place in the watershed to protect the wetland, including proper erosion control measures for construction activities.

Erosion control measures are needed in Minneapolis. Minneapolis needs effective and enforceable construction control standards for both private and public construction. this means we needs standards that written, put in place and have a willingness to enforce the standards.

Unfortunately I have raised more questions than I have answered, but one point is clear - if Grass Lake is to be more than a storm water pond, a management scheme must be developed and put in place to protect the wetland.

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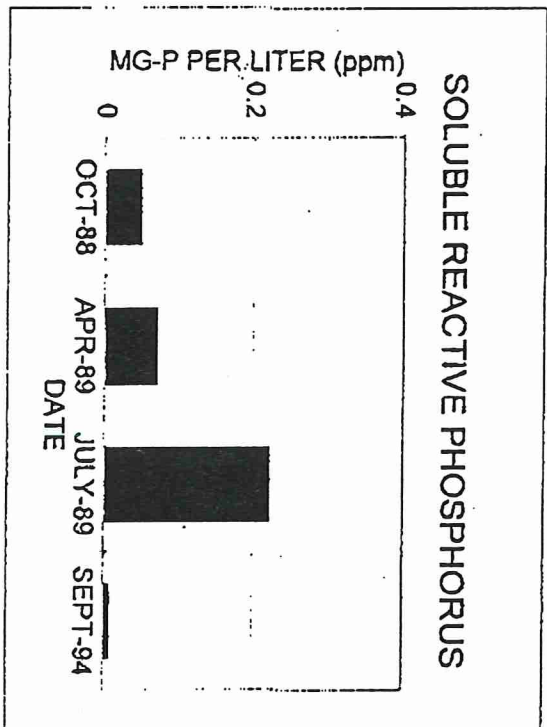
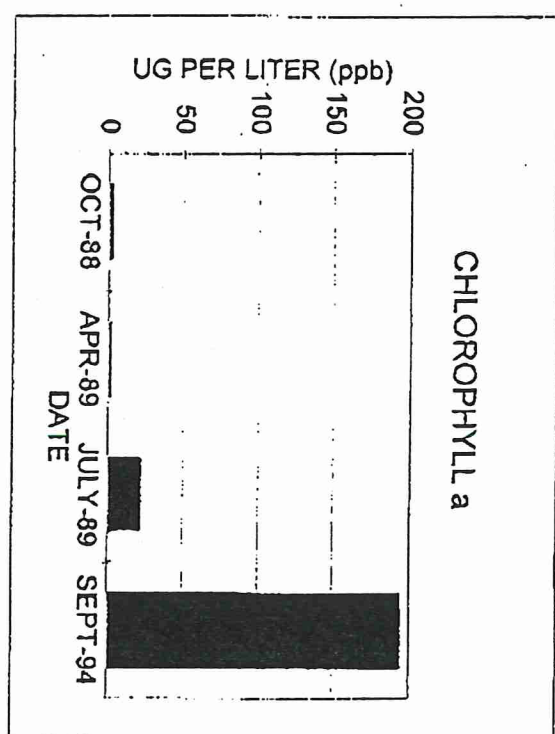
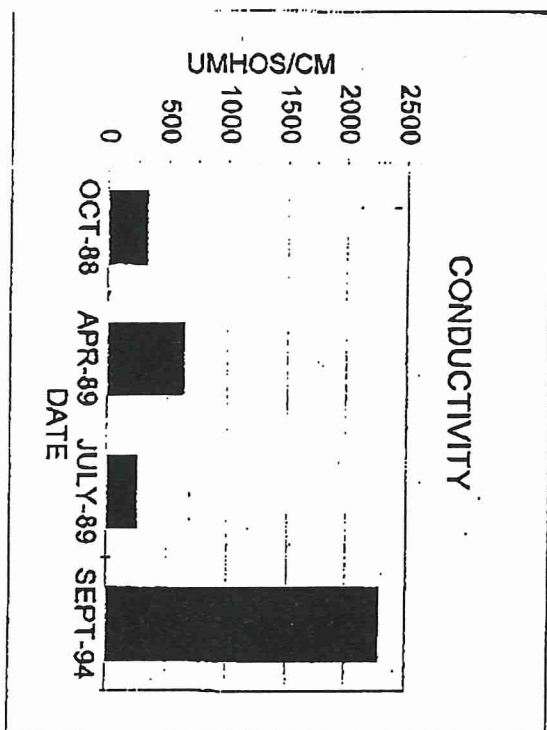
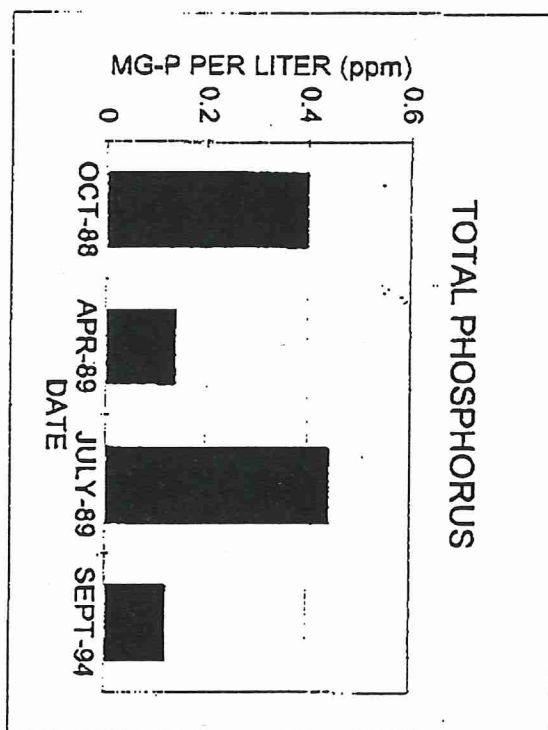
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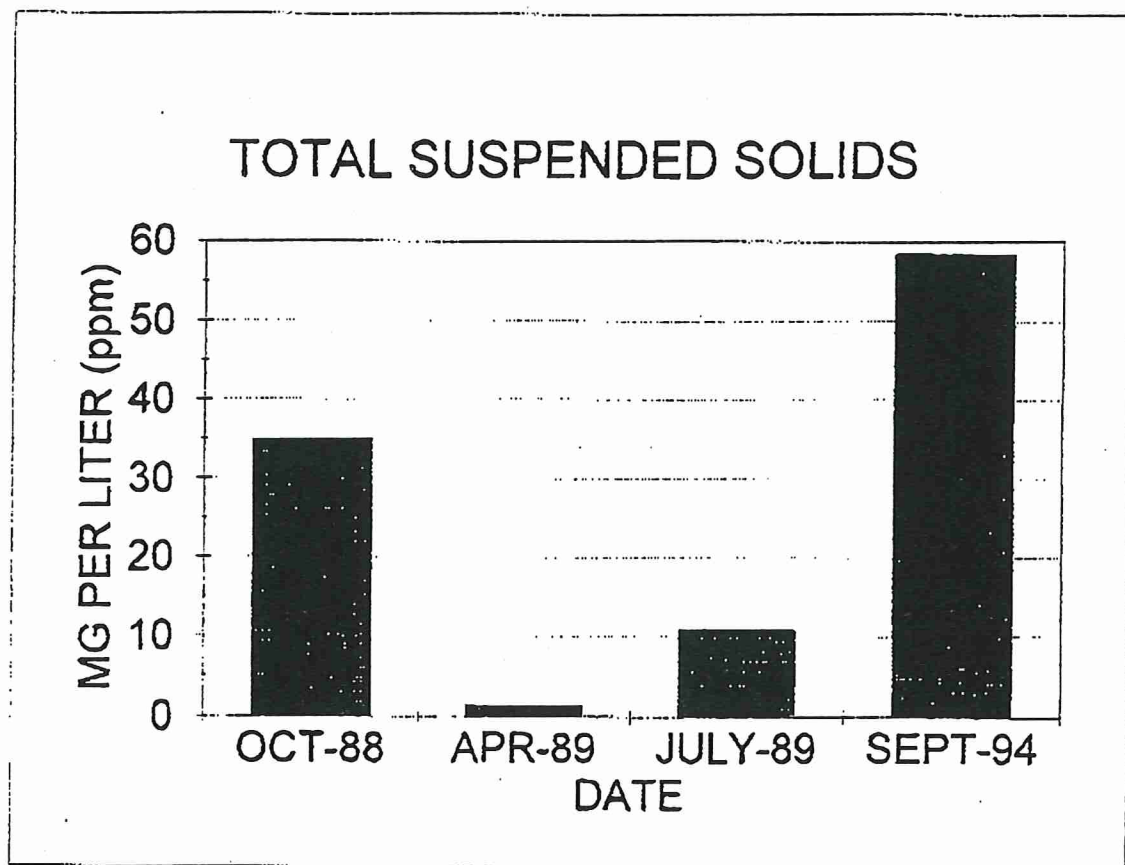
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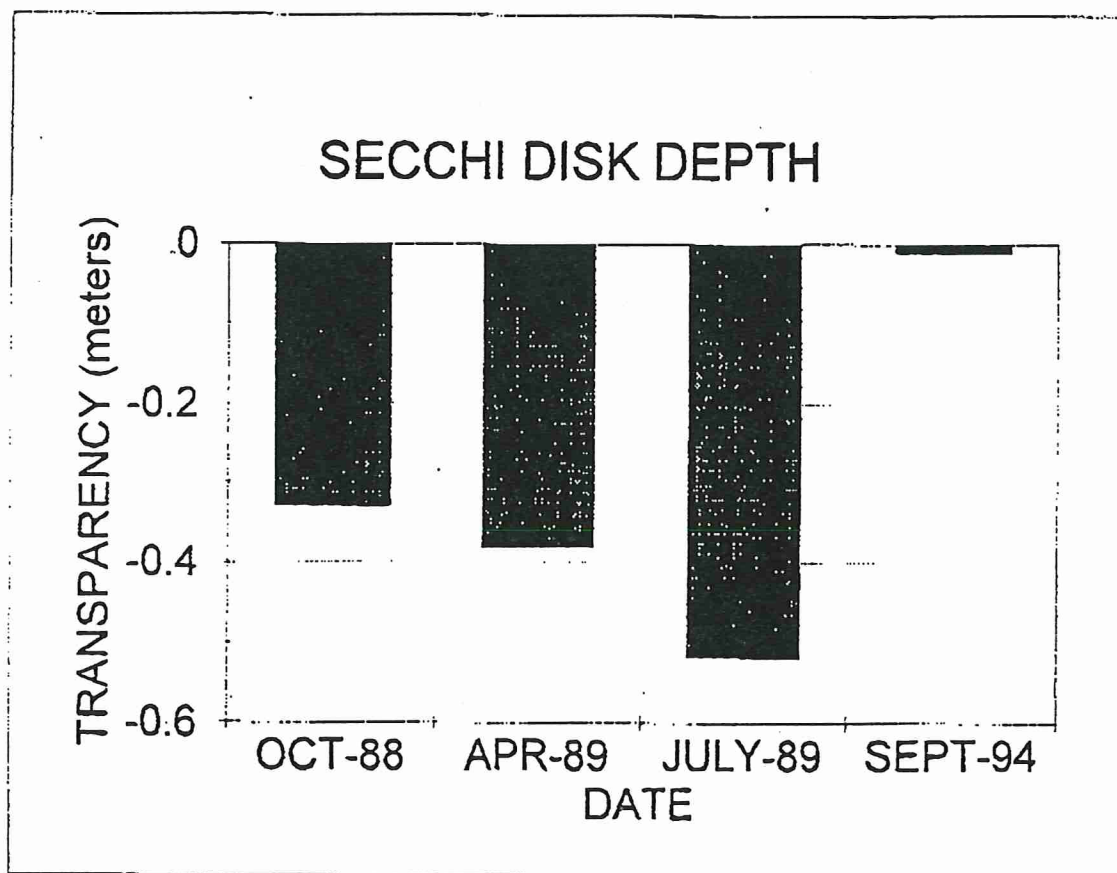
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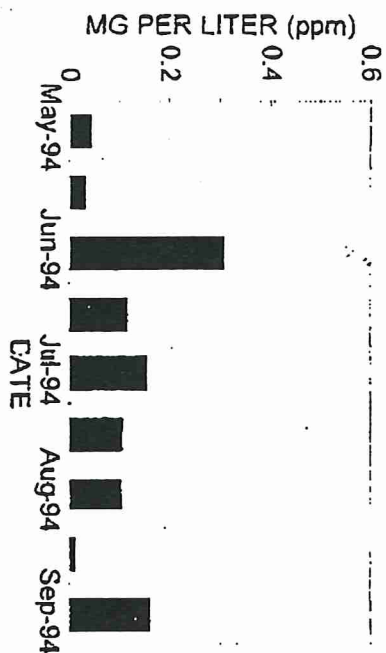
GRASS LAKE



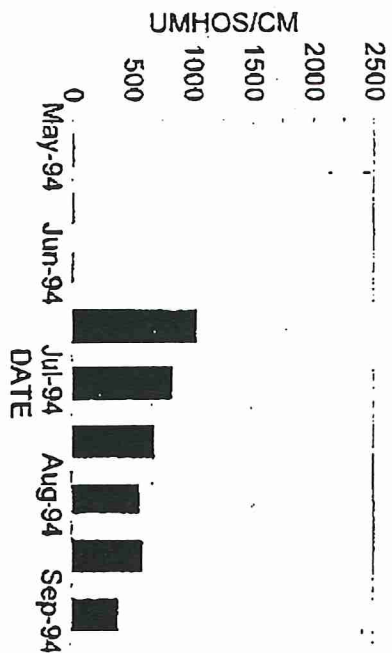
GRASS LAKE



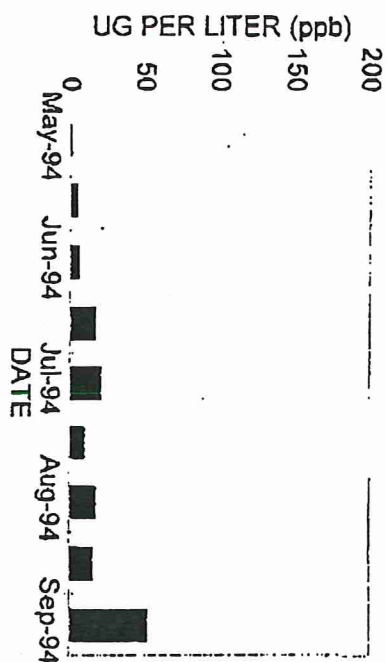
TOTAL PHOSPHORUS - DIAMOND



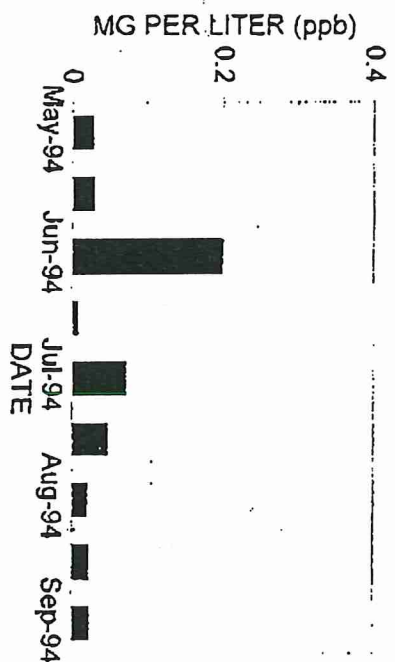
CONDUCTIVITY - DIAMOND

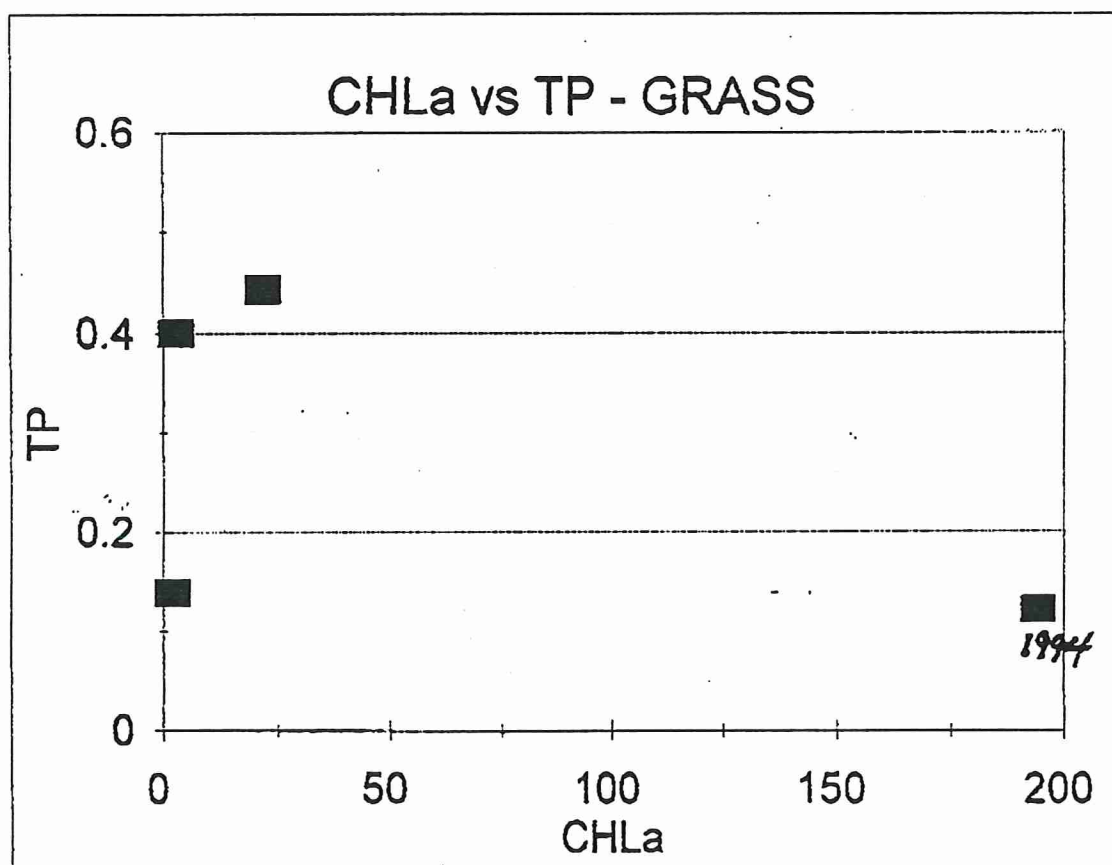
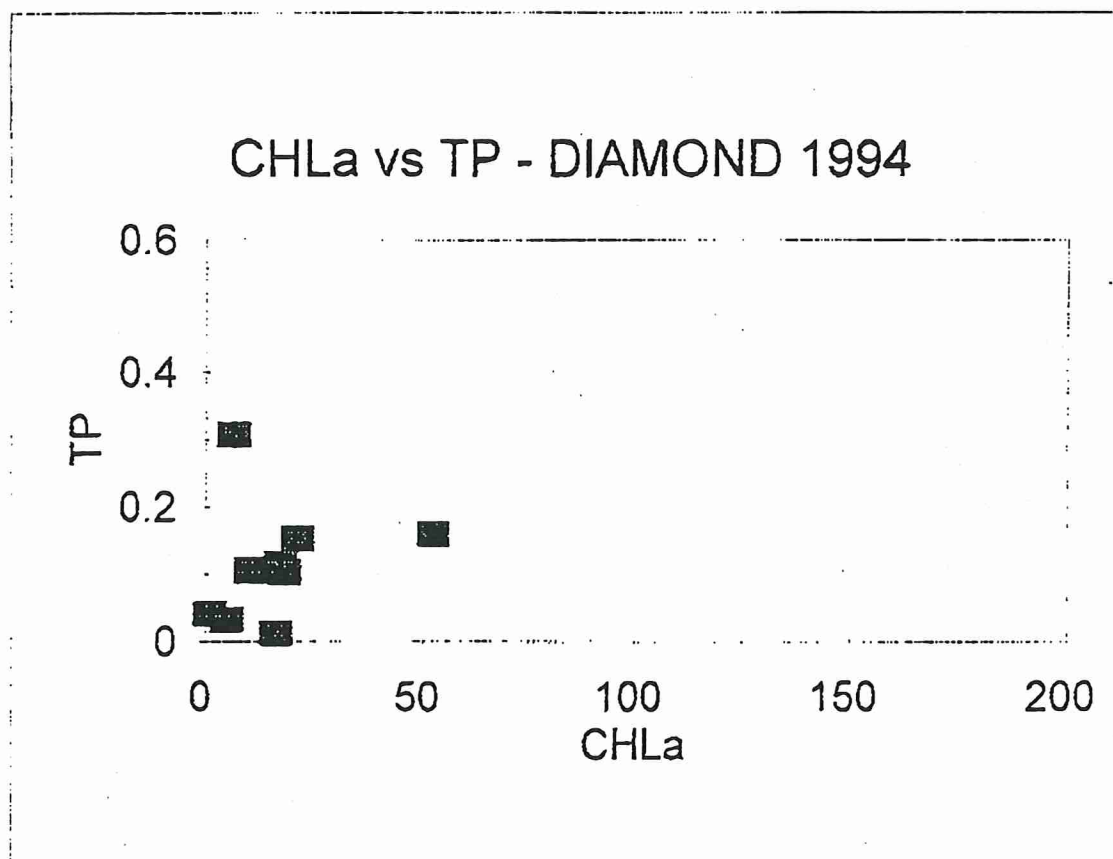


CHLOROPHYLL a - DIAMOND



SOLUBLE REACTIVE P - DIAMOND





Minneapolis Chain of Lakes

PROFILE DATA SHEET



Lake Name	Grass Lake				
Lake #					
Site ID #					
Date/Time	9/19 9:45				
Depth (m)	Temp. °C	DO (mg/L)	pH	Cond. (umho/cm)	Sample depth (X)
	00010	00300	00406	00095	
0	20.8	11.52	9.57	2280	6106
1	20.3	(8.43)	- .5M		
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					

CALIBRATION DATA:

1st slope = 97.2
 20 9-11 @ 18.4°C
 21 1993-4 muskrat houses

FIELD DATA

Site	G-1	
Secchi (M) *	0.0	
Chlor a (Bottle#)		
(Filtered ml) *		
Zooplankton		
#Tows X M		

SAMPLE COLLECTION CHECK LIST

Site (s,m,b)	Time	Sample	Depth	Bottom	Gen Chem	Nut	F

OBSERVATIONS

Sampled by: _____

1. WIND CONDITIONS:

DIRECTION: _____

Lake Elevation (ft): _____

APPROXIMATE SPEED: _____

Air Temp: _____

SITES(101 ETC.) UPWIND: _____

DOWNWIND: _____

SITES

2. COLOR OF WATER :

 Green
 Sediment
 Stain
 Clear

3a. PHYSICAL CONDITION :

 Crystal Clear (1)
 Some Algae Present (2)
 Definite Algae Present (3)
 High Algal Color (4)
 Severe Bloom (Odor, Scum) (5)

3b. SUITABILITY FOR RECREATION:

 Beautiful (1)
 Minor Aesthetic Problem (2)
 Swimming...Slightly Impaired (3)
 No Swim...Boating OK (4)
 No Aesthetics Possible (5)

4. LAKE USES OBSERVED:

 Swim
 Ski
 Fish
 Sail or Boat

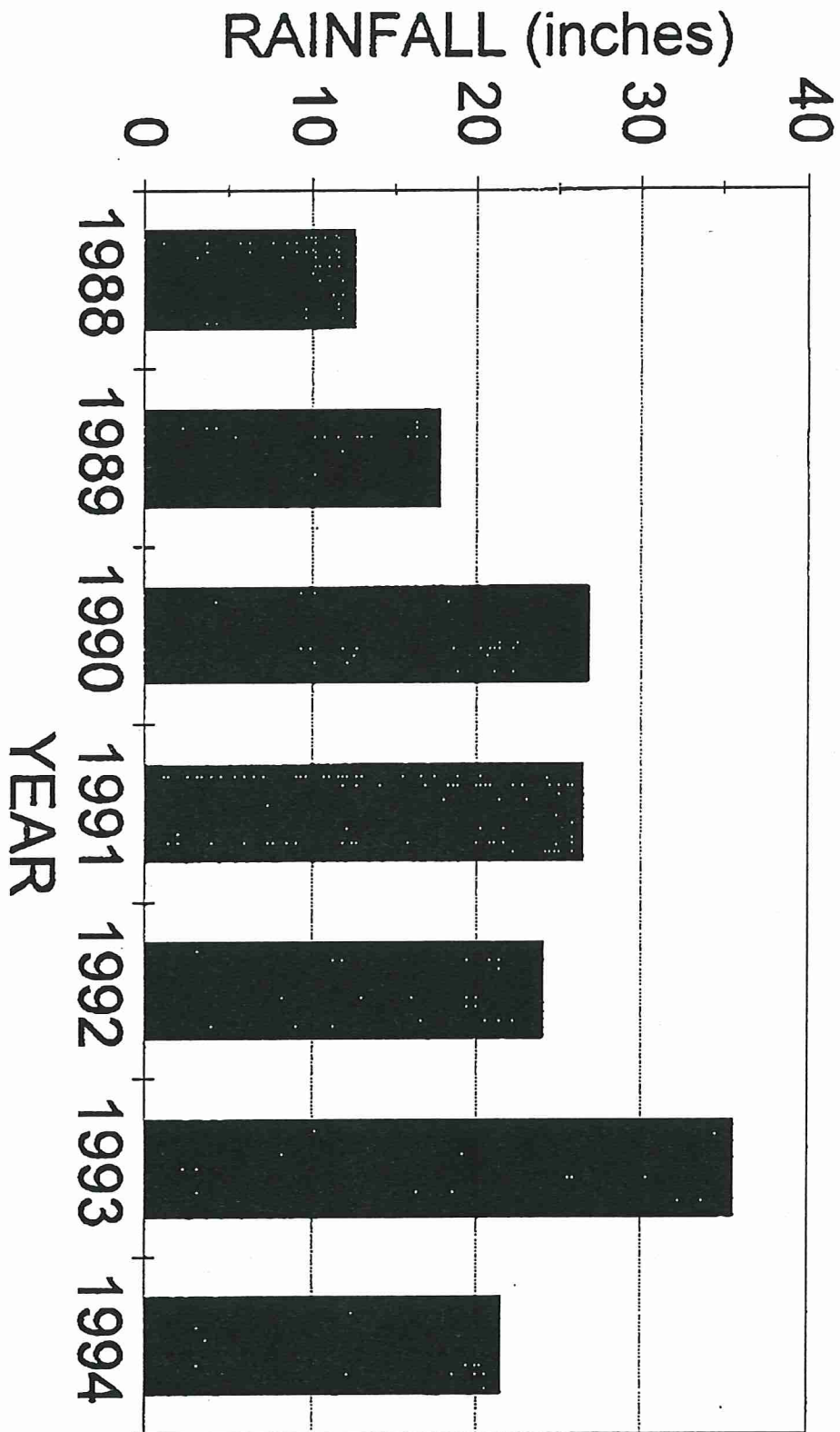
5. MACROPHYTE PROBLEMS:

 Inhibits: Navigation
 Depth: _____ Fishing
 Swimming

6. ZOOPLANKTON (TOW):

 No Zooplankton Present
 Few Zooplankton Present
 Abundant Large-Bodied Daphnia
 Abundant Small Varieties

GROWING SEASON RAINFALL



Appendix F

Department of Natural Resources Vegetation Report for Grass Lake



Minnesota Department of Natural Resources

500 Lafayette Road
St. Paul, Minnesota 55155-40__

January 2, 1996

Ms. Kristin M. George
Wenck Assoc. Inc.
1800 Pioneer Creek Center
P.O. Box 428
Maple Plain, MN 55359-0428

Dear Ms. George:

Jon Parker, Area Wildlife Manager, and I surveyed Grass Lake (DOW #27-0681) on August 25, 1995. Emergent vegetation was practically nonexistent except for arrowhead (Sagittaria sp.) and purple loosestrife (Lythrum salicaria) on the east side and occasional cattail (Typha sp.) on the north side. Submergent vegetation was found on all sampling stations with densities exceeding 30% coverage on 5 of the 9 stations. Thirty percent is the minimum coverage to meet the requirements for aquatic bed under the National Wetland Inventory classification system. Palermo pondweed (Potamogeton pusillus) and Canada waterweed (Elodea canadensis) dominated the submergent vegetation. We found a maximum depth of 3.5 feet. Excessive siltation was evident at the mouths of several of the inflow culverts.

The lake appears to be subject to substantial runoff from the surrounding residential community judging by the siltation and poor water clarity. Plant diversity is low, although wildlife use on the survey date was quite high. Over 300 waterfowl were present representing 5 species, including ruddy ducks.

I have enclosed the raw data on the aquatic plants as you requested. If you have any further questions please let me know.

Yours truly,

Ray Norrgard
Lake Designation Coordinator
Carlos Avery WMA
18310 Zodiac
Forest Lake, MN 55025

Enc.
cc: Jon Parker



SAMPLING STATION DATA
Grass Lake Draft

STATION	DEPTH	SECCHI	PLANTS	BOTTOM	NOTES	NWI CLASS
1	1'	1'	2- <u>Potamogeton pusillus</u> 4- <u>Lemna minor</u>	Gravel	Adjacent to <u>Sagittaria latifolia</u> , <u>cuneata</u> ; <u>Lythrum salicaria</u>	Unconsolidated Bottom
2	2.5'	1'	4- <u>P. pusillus</u> , 4- <u>Elodea canadensis</u>	Silt		Unconsolidated Bottom
3	2.5'	1'	3- <u>P. pusillus</u> , 1- <u>E. canadensis</u>	Silt		Unconsolidated Bottom
4	3'	1'	4- <u>P. pusillus</u> , 1- <u>E. canadensis</u>	Muck		Aquatic Bed
5	1.5'	1'	5- <u>P. pusillus</u> , 4- <u>E. canadensis</u> , 5- <u>L. minor</u>	Muck		Aquatic Bed
6	2.5'	1'	4- <u>P. pusillus</u> , 2- <u>E. canadensis</u>	Muck	Adjacent to <u>L. minor</u>	Aquatic Bed
7	3'	1'	4- <u>P. pusillus</u>	Muck		Aquatic Bed
8	1.5'	1'	4- <u>P. pusillus</u> , 5- <u>E. canadensis</u> , 4- <u>L. minor</u>	Muck		Aquatic Bed
9	3.5'	1'	2- <u>P. pusillus</u> , 1- <u>E. canadensis</u>	Muck		Unconsolidated Bottom

Plant Code: 5 = Rank; 4 = lush; 3 = moderate; 2 = scattered; 1 = sparse

Appendix G

Memorandum Regarding the Minnesota Natural Heritage Information System Categorization of Grass Lake



STATE OF
MINNESOTA
DEPARTMENT OF NATURAL RESOURCES

500 LAFAYETTE ROAD • ST. PAUL, MINNESOTA • 55155-40____
07

DNR INFORMATION
(612) 296-6157

April 13, 1995



Ken Wald
DNR Office of Planning
6th Floor

Re: Recommendations for minimizing disturbance to known locations of rare features within Minnehaha Creek Water Management District

Dear Ken:

The Minnesota Natural Heritage Information System has been reviewed to determine if any rare plant or animal species or other significant natural features are known to occur within the vicinity of the above referenced water management district. Based on this review, several known occurrences of rare species and natural communities in the area searched have been found. Following are site specific recommendations in three protection categories: high, medium and low priority.

HIGH PRIORITY SITES

WOLSFELD WOODS SCIENTIFIC AND NATURAL AREA T118N R23W sections W26, 27

Scientific and Natural Areas (SNA) protect high quality natural communities and the rare species associated with them. They receive the highest level of legal protection in the state. Wolsfeld Woods SNA supports a high quality maple-basswood forest, a rich understory and a diverse ground layer. As there is a lake and stream within the site, it is recommended that the water management plan maintain natural water levels and high water quality to minimize disturbance to the integrity of the area.

MOTHER LAKE T28N R24W section SW24

Both Forster's terns, a Special Concern species in Minnesota, and black terns, a federal candidate species (Category 2), have traditionally nested at Mother Lake, near the Twin Cities Metropolitan Airport. The Forster's terns nested in significant numbers in 1986 (43 pairs); the colony appeared inactive in 1987 and 1991, but in June 1994, one nest with two eggs was located. Black terns nested on the lake in 1981 and 1982; again, in 1994, thirteen adults and two nests with three eggs each were observed during survey work by staff from the Nongame Wildlife Program. As these species have recently undergone significant population declines, protection of the water level and water quality in the lake is extremely important. For further recommendations concerning protection of this site, please contact Joan Galli, the Nongame

Wildlife Specialist for the metro region, at 297-2277.

GRASS LAKE T28N R24W section S21

This large wetland, located near the intersection of Crosstown/62 and I35W, supported a breeding colony of Forster's terns (state Special Concern) during the 1960's. No nesting had been reported since the early 1970's until 1994, when approximately 100 adults fledged 100 to 150 young. Due to population declines for this species throughout Minnesota, Grass Lake should be regarded as a significant nesting site, and protection of water quality and maintenance of natural water levels should be addressed in the water resource management plan.

WOODLAKE NATURE CENTER T28N R24W sections SE28, NE33

Woodlake supported between 15 and 100 pairs of breeding Forster's terns throughout the 1970's; in the 1980's they nested sporadically. However, nesting has not occurred since 1986. If water quality and natural water levels were maintained, the potential exists for the birds to utilize the area as a breeding site again.

A Blanding's turtle (*Emydoidea blandingii*) was found in Woodlake Nature Center in 1993. Similar water recommendations would enhance the wetland habitat for this state Threatened species.

MORRIS T. BAKER PARK RESERVE T118N R23W sections 7, 8, 17, 18, 19, 20, W28, 29, 30

A high quality maple-basswood forest, a Special Concern plant and a great blue heron colony occur within Baker Park Reserve. The heron colony has been active 1990-1993; no information was received in 1994. Protection of water resources within and adjacent to the park will likely minimize disturbance to the biological integrity of the area.

CARVER PARK RESERVE T116N R24W sections 1, 2, 3, 4, W 5, 9, 10, 11, 12, NW13, N 14, N 15

Five osprey nests (*Pandion haliaetus*) are located within Carver Park. As fish is the sole prey eaten by this state Special Concern species, maintaining water quality in the lakes within the park should be a priority in the water resource management plan.

MEDIUM PRIORITY SITES

HARDSCRABBLE POINT WOODS T117N R24W section N26

A high quality maple-basswood forest, owned by The Nature Conservancy, is located on a point of land at the western end of Lake Minnetonka. It is recommended that water levels that will not adversely impact the forest be

Appendix H

Best Management Practices

Table 5

LONG LIST OF BEST MANAGEMENT PRACTICES

Tier 1 SOURCE CONTROLS BY PROPERTY OWNERS*Ordinances and Land Use controls aimed at the prevention of contact between storm water and pollutants*

- Catch Basin Stenciling Program
- Comprehensive Management Plan Requirements for New Developments
- Elimination of Illegal Connections
- Erosion Control
- Fertilizer and Pesticide Controls
- Illicit Dumping and Littering Enforcement
- Land Use Controls
- Landscaping Requirements to Reduce "Connected Impervious Areas"
- Maintenance of Vacant Lots
- Maintenance of Parking Lots
- Pet Ordinances
- Proper Storage of Chemicals
- Prevent Sweeping of Yard Wastes into Streets
- Public Education
- Special Requirements for Specific Commercial/Industrial Activities

Tier 2 SOURCE CONTROLS BY CITY*Maintenance activities which remove pollutants from streets and sewers before contact with storm water*

- Limit Infiltration into Storm Sewers
- Effective Use of Deicing Chemicals
- Management of Household Hazardous Wastes and Used Motor Oils
- Management of Residential/Commercial Yard Wastes
- Monitor Runoff From Municipal Landfills and Other Industrial Sites
- Outlet/Streambank Protection
- Spill Response and Prevention
- Street Cleaning
- Storm Drain Maintenance

Tier 3 MINOR STRUCTURAL CONTROLS*Structures designed for partial removal of pollutants from storm water.*

- First Flush Diversion to Sanitary Treatment Plant
- In-line Sediment Traps
- Oil/Grease Separators, Litter Skimmers

Tier 4 ELIMINATION OF DISCHARGE*Structures designed for zero discharge to surface waters.*

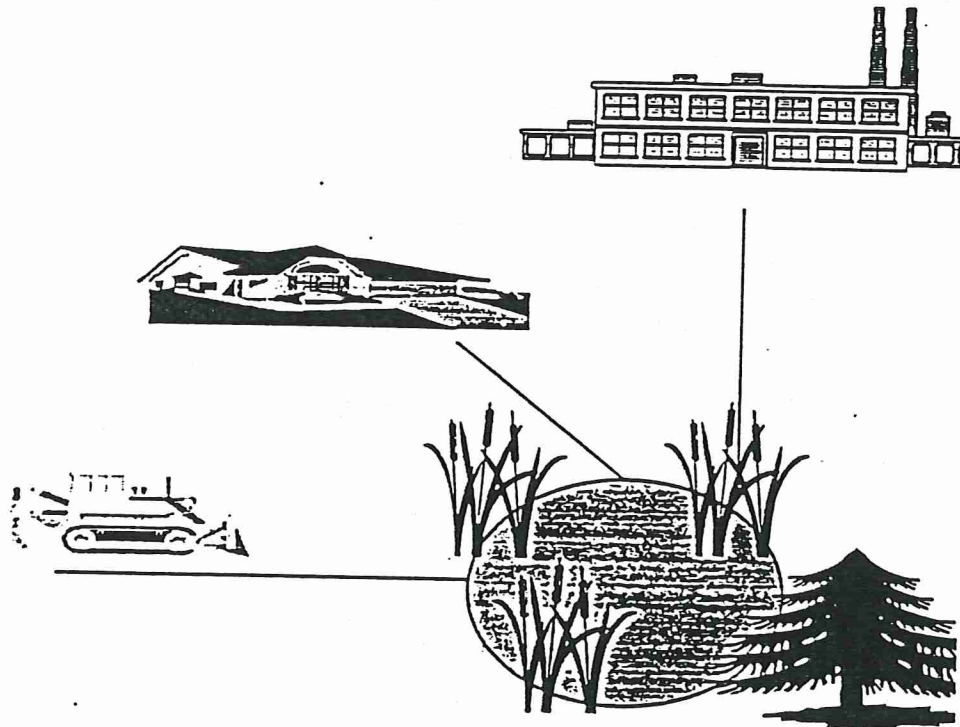
- Diversion to Sanitary Treatment System
- Infiltration Basins
- Porous Pavements for Streets

Tier 5 MAJOR STRUCTURAL CONTROLS*Structures designed to treat the storm water*

- Detention Basins
- Storm Water Treatment Facilities
- Swirl Concentrators

PROVISIONAL DATA
SUBJECT TO REVISION

GUIDANCE FOR EVALUATING URBAN
STORM WATER AND SNOWMELT
RUNOFF
IMPACTS TO WETLANDS



STATE OF MINNESOTA

STORM WATER ADVISORY GROUP

DRAFT MAY 1995

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SECTION VI

BEST MANAGEMENT PRACTICES

Best Management Practices (BMPs) are generally defined as the best practices available for a particular site. They have also been defined as "a combination of land use, conservation practices, and management techniques, which when applied to a unit of land will result in the opportunity for reasonable development with an acceptable level of water quality." There are also many other legal and commonly used definitions. (See Appendix VI-A)



One goal should be to preserve and utilize the natural drainage system. Keep pavement and other impervious surfaces out of low areas, swales and valleys. This means working for site plans that keep the roads and parking areas high in the landscape and along ridges wherever possible as shown schematically in Figure VI-2.

This is more difficult to achieve than it appears because it goes against long established policies which ultimately will increase flows destroying the waterways we wish to utilize.

Avoidance



The first and best BMP is generally avoiding impacts. In order to avoid impacts, we must develop policies that reproduce pre-development hydrological conditions. It means looking at reproducing the full spectrum of hydrologic conditions: peak discharge, runoff volume, infiltration capacity, base flow levels, ground water recharge, and maintenance of water quality. A comprehensive approach to hydrology is difficult and involves the whole context of site planning. The issues of runoff volume, infiltration recharge and water quality revolve around the amount of impervious surface required by development and its configuration in terms of its relationship to drainage paths and vegetative cover. Try to avoid connecting streets, roofing and parking areas with pipes or other structures. Utilize natural topography and vegetated waterways to convey acceptable levels of runoff (Figure VI-1).

Avoid development construction activity in the most sensitive areas. This means avoid development along the shoreline of lakes or streams, in natural drainage ways or in areas which are dominated by steep slopes, dense vegetation, porous soils, scientific and natural areas, or other identified resources.

Fit development to the terrain by choosing road patterns to provide access schemes which match land form. For example, in rolling or dissected terrain (typical in much of Minnesota) use strict street hierarchies with local streets branching from collectors in short loops and cul-de-sacs along ridge lines. This approach results in a road pattern which resembles the branched patterns of ridge lines and drainage ways in the natural landscape. This facilitates the development of plans which work with the land form and minimize disruption of existing grades and natural drainage (See Figures VI-3 and 4).

Quantity and Quality Connections

Not This!

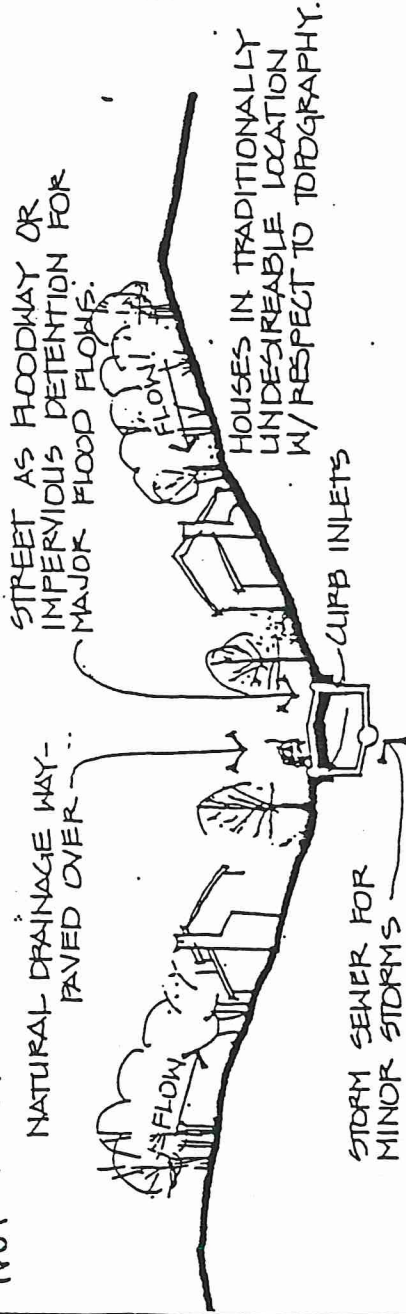


FIGURE VI-1 Conventional curb-and-gutter streets with storm sewers tend to gravitate to low areas where the hydraulic efficiency of the storm sewer is maximized.

This!!

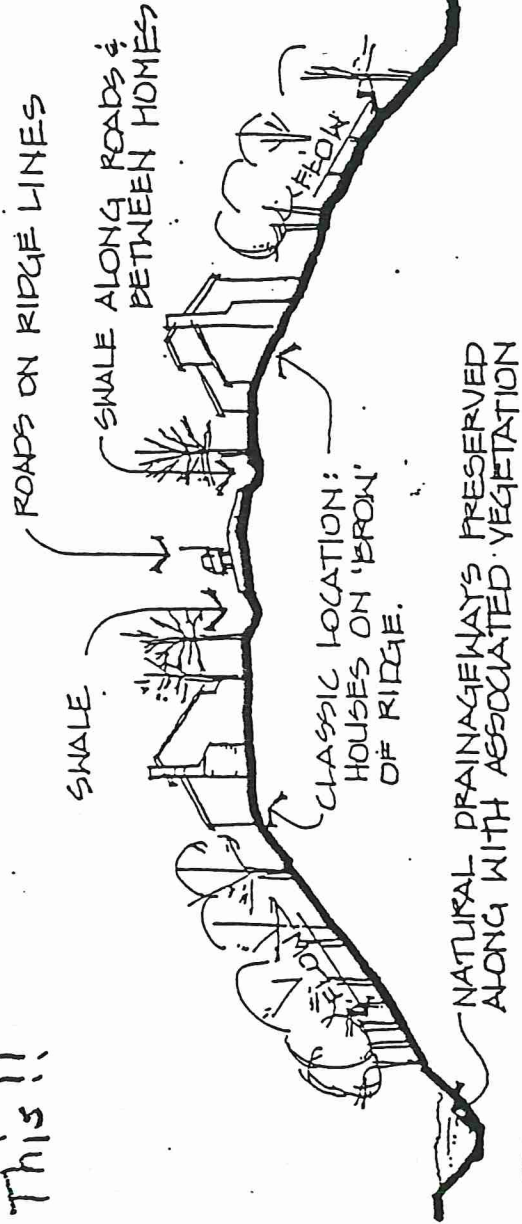
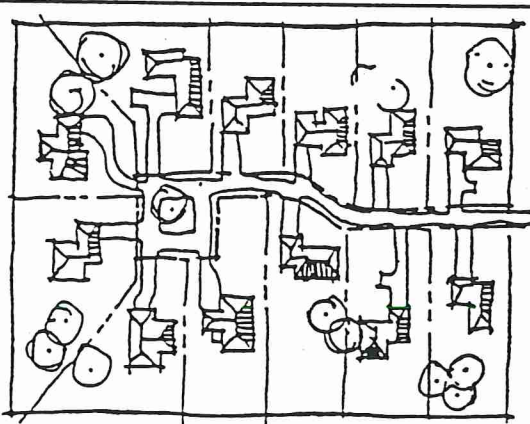


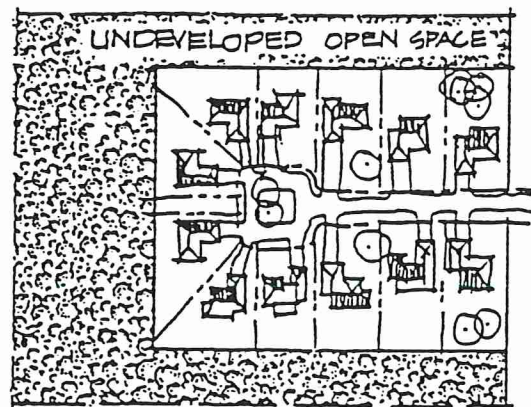
FIGURE VI-2 Place roads along ridge lines. Keep construction areas away from low areas and valley flow lines.



FIGURE VI-3 Use sensitive areas such as natural drainage areas to form boundaries or buffer zones between clusters of housing.



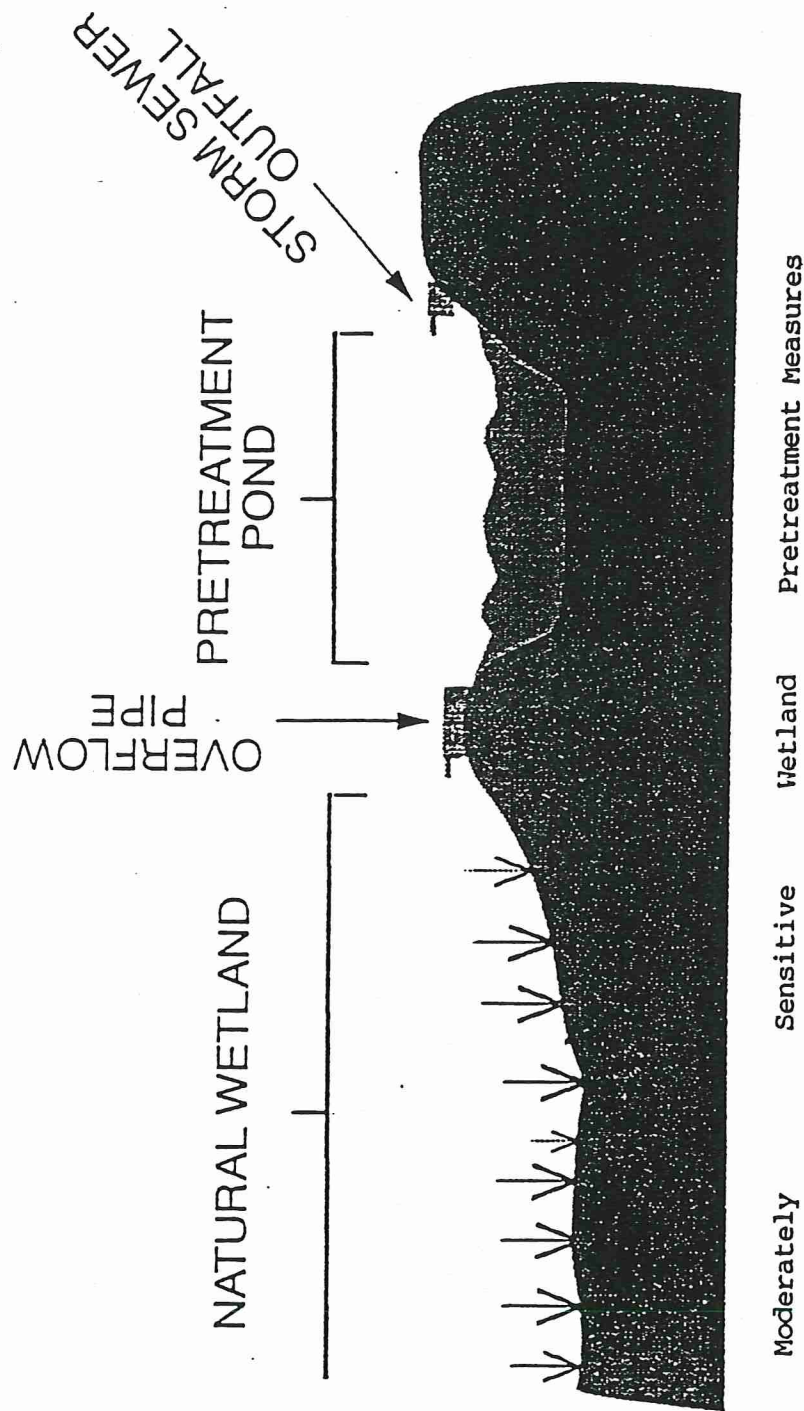
2 DU/AC GROSS DENSITY
2 DU/AC NET DENSITY
12 DWELLING UNITS ON 6 ACRES



2 DU/AC GROSS DENSITY
4 DU/AC NET DENSITY
12 DWELLING UNITS ON 3 ACRES

FIGURE VI-4 Cluster development using the PUD approach can result in narrower lot frontages, shorter street and utility rows plus the preservation of significant blocks of undeveloped open space.

PRETREATMENT OF STORM WATER



To properly implement BMP's it is important to understand the storm water problems that need correction. This means to identify the sources of problem pollutants, including concentrations loading and flows. Then design the control program to fit local needs. There are important differences between the pollutants expected from various source areas (Bannerman, 1992). We should also be aware that source areas can vary in importance, depending on the type of rainfall (Pitt, 1993). If the hydrology does not correctly predict sources of pollutants and flows, then we cannot get the expected storm water control benefits.

As explained in detail in the Section on hydrology, most of the pollutant loads are associated with the relatively small rains of less than one inch. It is estimated that 75 to 85 percent of runoff is generated by storms under 1.25 inches in depth (Pitt, 1993). In the Minnesota metropolitan area, we know that over 90 percent of our daily rainfall events are under 1 inch in depth (State Climatologist, 1993). Since many existing urban runoff models originate from drainage and flood evaluating procedures that emphasize flood events, this has lead to some incorrect assumptions regarding runoff from the smaller, but important, rainfall events (Pitt, 1993). The assumptions regarding impervious and pervious areas that could be correct for large rainfall events are often incorrect for small events.

The significance of storm hydrology to the receiving waters increases with the sensitivity of the receiving water. Ponds which provide pretreatment prior to discharge to a wetland (see Figure VI-5) may be acceptable for most situations, but may not be acceptable for highly sensitive

wetlands or where thermal impacts could be critical. Sensitive wetlands can be affected by small changes in water depth and duration of inundation. Therefore, sensitive wetlands, and waterbodies that have been stressed by flow changes and pollutant loading will need to have the small storm hydrology addressed in detail. Without proper hydrologic data, we cannot correctly assess hydrologic and pollutant loading changes. Chapters on hydrology and wetland sensitivity discusses these issues in greater detail.

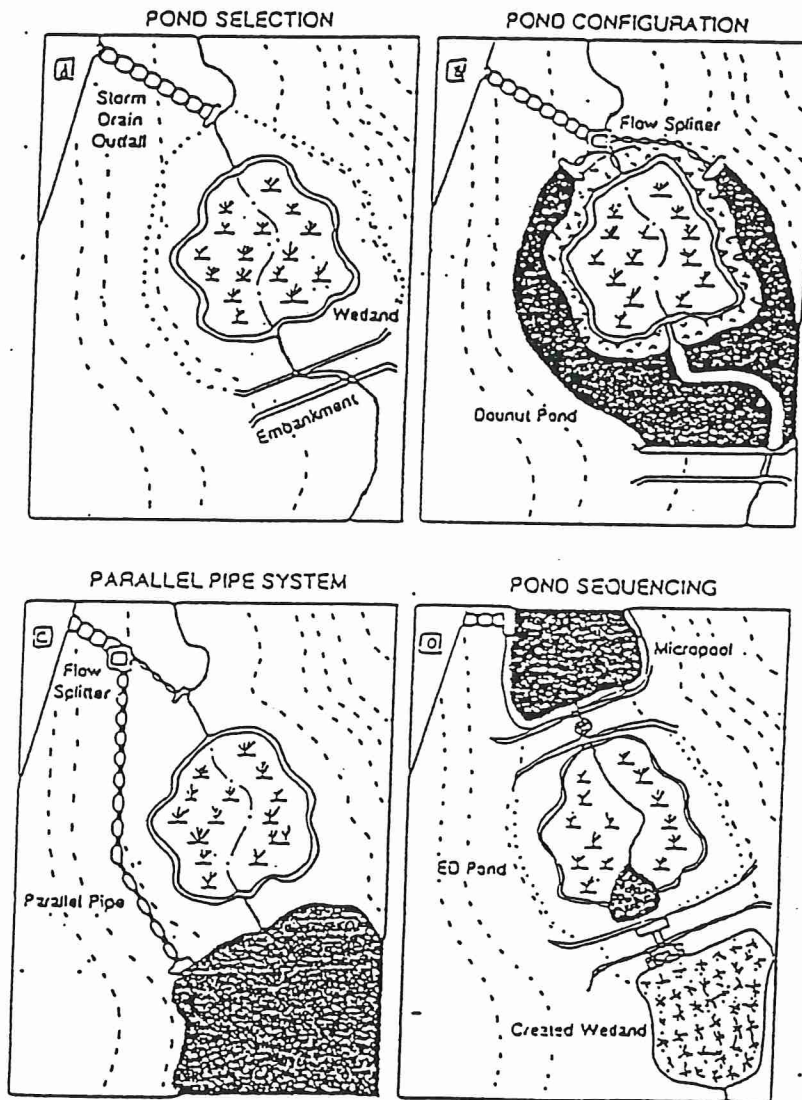
BMPs for Highly Sensitive Wetlands

A common method of utilizing wetlands for storm water has been to increase the depth of ponding on a permanent or temporary basis. The end result was the transformation of a natural wetland into a storm water wetland, with the attendant loss of diversity and functional values. The transformation occurs regardless of whether the natural wetland is replaced by a permanent pool or by temporary extended detention.

No single method of BMPs will reproduce the hydrology once development has occurred upstream. However, the Washington Metropolitan Council of Governments suggests several structural alternatives that are close to reproducing natural hydrology (Schuler, 1992). The preferred course of action is to locate the storm water control in an upstream or off-stream location. This is easier said than done, as some quantity of base flow is required to maintain water elevations within a storm water wetland. (See Figure VI-6, Panel A)

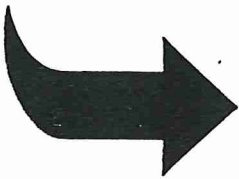
Highly Sensitive Wetland Pretreatment Measures

Techniques for Fingerprinting a Stormwater Wetland Around a Natural Wetland



Panel A. Existing natural wetland is severely impacted by upstream stormwater inputs and frequent inundation. Panel B. Existing wetland is protected by berm; stormwater bypassed to the two arms of the wet pond. Panel C. Excess stormwater diverted around natural wetland to a more favorable location via a parallel pipe system. Panel D. Stormwater pretreated before it reaches wetland, where temporary extended detention is provided. A downstream stormwater wetland is created to compensate for impacts to the existing wetland.

An alternative is to create a "donut" configuration around the wetland, as shown in Figure VI-6, Panel B. In this scenario, a flow splitter is installed upstream of the sensitive wetland. The required storage for the storm water pond or wetland is then excavated outside of the natural wetland. The upstream flow splitter is used to apportion flow to the wetland and the storm water system. The base flow is directed into the existing wetland while the storm flow is routed to the storm water ponds.



A second fingerprinting technique is to install a parallel pipe system that diverts storm

flows around the existing wetland to a downstream storm water control system, Figure VI-5 (Panel C). Again, a flow splitter is installed above the sensitive wetland that diverts the storm flows from the development away from the wetland, yet sends dry weather base flow to the wetland. The design should attempt to mimic the original water balance to the wetland. In some cases, it is possible to split the needed base flow away from the stream into an off-line or storm water system, which empties downstream of the wetland to be protected. (See Figure VI-6, Panel C) This usually involves extensive sewer construction with related storm sewer costs. It also results in the transfer of the problem rather than creation of solutions which could have provided enhancement opportunities.

A third fingerprinting technique involves employing a series of smaller storm water pools and wetland areas above and below the sensitive wetland. One such scheme is shown in Figure IV-5 (Panel D). Runoff is pre-treated before it enters the sensitive wetland. This scenario will still result in

significant storm water influence to the existing wetland, but it does reduce the overall degradation that might occur.

Temperature



One study (Galli, John, December, 1990) concluded that the temperature in small, free flowing headwater streams was largely determined by the following interrelated factors:

- 1) air temperature and other local meteorological conditions;
- 2) watershed imperviousness;
- 3) riparian canopy coverage;
- 4) stream order/size.

Others (Salo Engineering, MPCA correspondence, September 14, 1994) summarized the critical factors as:

- 1) climate, which means temperature, solar heating, and wind loss;
- 2) soil moisture;
- 3) rainfall; and
- 4) stream level, meaning drought or full flowing conditions.

These summaries of critical factors do not conflict, but they do show that there may be different ways of grouping or summarizing the critical data.

The Metropolitan Washington Council of Governments (Galli, December, 1990) studied temperature and dissolved oxygen effects from four BMPs:

- 1) infiltration-dry pond;
- 2) extended detention artificial wetland;

- 3) extended detention dry pond; and
- 4) wet pond.

They concluded that none of the four BMPs were "thermally neutral." All four BMPs caused a raise in temperature and each violated Maryland standards some of the time. Temperature standard violations occurred under both base flow and storm flow conditions. The infiltration-dry pond produced the smallest temperature increases; whereas, the wet pond had the highest recorded maximum change in temperature.

In Minnesota, it is not clear what the affect of ponding strategies might be on temperature, and especially in the affect on the aquatic environment. While most fish species would probably not be significantly affected by the changes in temperature produced by ponds, trout are extremely sensitive to temperature changes and it may be significantly affected in certain cases. Another significant affect may be the impact to aquatic macroinvertebrates--that is aquatic insects. Cold water aquatic insects, such as stone flies, could be eliminated or severely stressed under certain temperature change conditions. The change in insect populations may also change the success and viability of the cold water fishery population.

Comprehensive Approach

The Washington Council of Governments recommends a long-term holistic approach to watershed management. The BMP design feature considerations that they recommend include increasing the performance of infiltration devices by improving the infiltration design capacity and intentionally over sizing the basins. They also

recommend buffer strips and shading of pilot and riprap outflow channels via landscaping or other means. They recommend that the practice of employing long wide riprap outfall channels be seriously re-examined. Whenever possible, outflow channels should be heavily shaded and should include a deep narrow base flow channel to quickly return the water back to a natural stream channel. They also recommend that long periods of extended detention control be carefully examined. They recommend a six to twelve hour detention period limit be established for sensitive areas and that shading in the storage pool be required. In addition, they recommend future research on the case specific effects of BMPs and the effectiveness for controlling temperature increases. Water temperature monitoring for thermally sensitive areas should be greatly increased.

Construction BMP's

Once a plan is formulated to avoid impacts of the proposed project to the maximum practicable extent, the next step is to minimize impacts of construction. Careful planning is an important part of erosion and sediment control. With careful planning, problem areas can be anticipated, which will minimize both the erosion potential and the cost of sediment control measures. There are several good manuals listing available BMPs that are appropriate for construction sites. These include the MPCA "Protecting Water Quality in Urban Areas" or the Board of Water and Soil Resources' "Minnesota Construction Site Erosion and Sediment Control Planning Handbook." The Minnesota Department of



Transportation "Manual of Practice" is also an excellent source. The problem is finding the proper BMPs for site specific situations.

Housekeeping and Prevention



We must utilize housekeeping practices and maintenance to avoid problems related to pollutant loading. Erosion

control ordinances, street sweeping, fuel storage plans, trash removal education and other measures should be implemented as needed.

Minimizing and Mitigating Post Project Hydrologic Changes

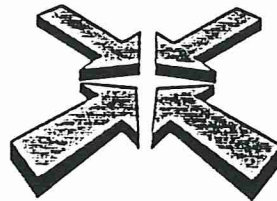
Generally, some form of storm water detention will be needed to achieve a desired level of hydrologic control from developments. The advantage to deciding this in the planning stage is that storm water detention structures can serve several purposes if properly planned. These structures can trap pollutants, reduce peak discharges and improve aesthetics and recreation. Storm water detention practices can also serve as sediment basins during construction on the site. Regardless of the practices selected, the cost of structural measures is usually lower if they are planned and installed at the time of development. The actual post project BMPs are discussed later.

BMPs as a System

It is usually necessary to use a combination of practices to meet the water quality goal rather than rely upon one practice such as a detention pond. Housekeeping practices should always be used, but will rarely

achieve the desired results alone. Figure IV-7 provides a general indication of the effectiveness of various structural BMPs. This is a general chart that is only intended to provide an awareness of the capabilities of various BMPs. Combinations of BMPs must be adopted on a site specific basis.

Effect on Other Resources



When planning a BMP, consider the effect it will have on other resources.

Without proper design, it is possible to shift a water quality problem to some other location. Stream temperature, peak flow timing, aesthetics and ground water can be adversely affected by improperly designed BMPs. Examples of other resources that can be adversely affected are fish and wildlife. Studies have shown that pollutants such as trace metals can bioaccumulate in plants and fish that live in areas where sediment from urban storm water is trapped (Smith, 1988; Meiorin, 1986). Many BMPs trap pollutants that need to be disposed of in an environmentally sound manner.

Public Acceptance

In an urban environment, aesthetics are an important consideration for gaining public acceptance of BMPs. In many cases, practices such as detention ponds can be a visual asset to the surrounding area. However, if a detention pond is designed in a square shape with uniform slopes, it will not appear natural and can detract from the surrounding area.

Odor, insects, weeds, turbidity and trash are also important to residents who

A COMPARATIVE ASSESSMENT OF THE EFFECTIVENESS OF STRUCTURAL URBAN BEST MANAGEMENT PRACTICES

GROUP	URBAN BMP OPTIONS	RELIABILITY FOR POLLUTANT REMOVAL	LONGEVITY*	APPLICABLE TO MOST DEVELOPMENTS	REGIONAL CONCERNS	ENVIRONMENTAL CONCERNS	COMPARATIVE COST	SPECIAL CONSIDERATIONS
I	Extended Detention Ponds	Moderate, but not always reliable	20+ years, but frequent clogging and short detention common	Widely applicable	Very low	Possible stream warming and habitat destruction	Lowest cost alternative in size range	Recommended with design improvements and with the use of micropools & wetlands
	Wet Pond	Moderate to high	20+ years	Widely applicable	Possible stream warming, trophic shifts, habitat destruction, safety hazards, sacrifice of upstream channels	Moderate to high compared to conventional storm water detention	Recommended, with careful site evaluation
	Storm Water Wetlands	Moderate to high	20+ years	Space may be limiting	winter die off	Stream warming, natural wetland alteration	Marginally higher than wet ponds	Recommended
	Multiple Pond Systems	Moderate to high; redundancy increases reliability	20+ years	Many pond options	Selection of appropriate pond option minimizes overall environmental impact	Most expensive pond option	Recommended
II	Infiltration Trenches	Presumed moderate	50% failure rate within five years	Highly restricted (soils, ground water, slope, area, sediment input)	Arid and cold regions; sole-source aquifers	Slight risk of ground water contamination	Cost-effective on smaller rehab costs can be considerable	Recommended with pretreatment and geotechnical evaluation
	Infiltration Basins	Presumed moderate, if working	60-100% failure within five years	Highly restricted (see infiltration trench)	Arid and cold regions; sole-source aquifers	Slight risk of ground water contamination	Construction cost moderate, but rehab cost high	Not widely recommended until longevity is improved
	Porous Pavement	High (if working)	75% failure within five years	Extremely restricted (traffic, soils, ground water, slope, area, sediment input).	Cold climates; wind erosion; sole-source aquifers	Possible ground water impacts; uncontrolled runoff	Cost-effective compared to conventional asphalt when working properly	Recommended in highly restricted applications with careful construction and effective maintenance
III	Sand Filters and Peat Filters	Moderate to high	20+ years	Applicable (for smaller developments)	Few restrictions	Minor	Comparatively high construction costs and frequent maintenance	Recommended, with local demonstration
IV	Grassed Swales	Low to moderate, but unreliable	20+ years	Low density development and roads	Arid and cold regions	Minor	Low, compared to curb and gutter	Recommended, with checkdams, as one element of a BMP system
	Filter Strips Pocket Wetlands	Unreliable in urban settings	Unknown, but may be limited	Restricted to low density area	Arid and cold regions	Minor	Low	Recommended as one element of a BMP system
V	Water Quality Inlets Expanded Pipes	Presumed low	20+ years	Small, highly impervious catchments (<2 acres)	Few	Resuspension of hydrocarbon loadings. Disposal of hydrocarbon and toxic residuals	High, compared to trenches and sand filters	Not currently recommended as a primary BMP option

I=Ponds; II=Infiltration; III=Filters; IV=Biofilters; V=Inlets

*Based on current designs and prevailing maintenance practices

**Adverse Flood Route Timing can increase peak floods

***Increased flow volume can extend duration of erosive flows
****Significant ground water concerns especially in industrial areasAdopted from Schular
Oct 92

live near structural BMPs. With regular maintenance, these problems can usually be overcome or are very temporary.

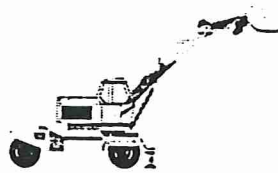
Physical Site Suitability

BMPs should only be used in areas where the physical site characteristics are suitable. Some of the physical characteristics that are important are soil type, watershed area, water table, depth to bedrock, site size and topography. If these conditions are not suitable, a BMP can lose effectiveness, require excessive maintenance, or stop working altogether after a short period of time. Sometimes, unfavorable site conditions can be overcome with special design features. For example, the bottom of a detention pond can be sealed to prevent seepage into permeable soils at a site where a permanent pool is desired. In other cases, a practice will be excluded from consideration for a site because of conditions that are not practical to overcome. An example of this would be where a high water table or clay soils eliminate an infiltration basin from consideration. The physical site conditions must be examined for each practice.

Cost Effectiveness

Economics is an important consideration in the selection of BMPs that will achieve the water quality goal at the least cost. This

should be considered when selecting BMPs and deciding how they will be implemented. To properly compare alternatives, all costs for the design life of a BMP should be included. These include expected maintenance costs as well as the initial costs for land, engineering and construction. To create a true economic picture of a BMP, benefits other than water quality and flood prevention should also be considered. Some benefits such as increases in land values for property adjacent to an attractive detention pond are direct economic benefits. Other benefits such as incidental recreation



benefits or wildlife benefits may be more difficult to quantify.

Maintenance Requirements

Maintenance is an important part in the operation of any BMP. The initial design of the BMP should take maintenance requirements into account. A feature such as a forebay in a detention pond may increase annual maintenance costs slightly, but the interval between costly sediment cleanouts in the whole pond may be extended significantly. Locations for disposal of material should be taken into account during this phase of planning.

For further information, we recommend the following:

1. MPCA, October 1989. "Protecting Water Quality in Urban Areas."
2. Metropolitan Washington Council of Governments, March 1992. "A Current Assessment of Urban Best Management Practices, Techniques for Reducing Nonpoint Source Pollution in the Coastal Zone."

3. Metropolitan Washington Council of Governments. Design of Storm Water Wetland System, Guidelines for Creating Diverse and Effective Storm Water Wetland Systems in the Mid-Atlantic Region. Anacosta Restoration Team, Department of Environmental Programs.

Minnesota Statutes and Definitions of BMPs¹

MS 103F.711 Minnesota Clean Water Partnership Act

“Best Management Practices” means practices, techniques, and measures that prevent or reduce water pollution from nonpoint sources by using the most effective and practicable means of achieving water quality goals. Best management practices include, but are not limited to, official controls, structural and nonstructural controls, and operation and maintenance procedures.

“Official controls” means ordinances and regulations that control the physical development of the whole or part of a local government unit or that implement the general objectives of the government unit.

MS 103h Ground Water Act

“Best Management Practices” means practicable voluntary practices that are capable of preventing and minimizing degradation of ground water, considering economic factors, availability, technical feasibility, implementability, effectiveness and environmental effects. Best management practices apply to schedules of activities; design and operation standards; restrictions of practices; maintenance procedures; management plan practices to prevent site releases, spillage, or leaks; application and use of chemicals; drainage from raw material storage; operating procedures; treatment requirements; and other activities causing ground water degradation.

See attached flow chart.

MS 103G.2241 Wetland Conservation Act

“Best Management Practices” means state-approved and published practices associated with draining, filling, or replacement wetlands that are capable of preventing and minimizing degradation of surface water and ground water.

This act sets the guidelines for the avoid, minimize and mitigate policy for protection of wetlands. This also states in order to qualify for the exemptions provided for by the act you must use BMPs.

MS 17.498 Rules; Financial Assurance. (aquaculture) no definition.

MS 17.115 Shared Savings and Loan Program.

¹ Klang, Jim, June 1994, Minnesota Pollution Control Agency office memorandum

MS 17.116 Sustainable Agriculture Demonstration Grants

Both statutes use the term BMP without a definition, yet meaning practices which are not water quality related.

MS 18B.04 Pesticide Impact on Environment. No definition given

MS 18C.005 Fertilizers, Soil Amendments Refers to MS Ch. 103H.

MS Section 103B.3365 (Reding Bill)

Best Management Practices means any design criteria or land use management technique (or combination) to limit nonpoint pollution from land uses that is either advocated by a formal publication of a state or federal agency publication or a public research institution.

Federal and State Delegations of Authority

MS 103F.751 Nonpoint Source Pollution Control Plan and Program Evaluation

For the purpose of coordinating the programs and activities used to control nonpoint sources of pollution to achieve Minnesota's water quality goals, the agency (MPCA) shall:

- 1) develop a state plan for the control of nonpoint source water pollution in order to meet the requirements of the federal Clean Water Act;
- 2) work through the environmental quality board to coordinate the activities and programs of federal, state and local agencies involved in nonpoint source pollution control, and where appropriate, develop agreements with federal and state agencies to accomplish the purposes and objectives of the state nonpoint source pollution control plan; and
- 3) evaluate the effectiveness of programs in achieving water quality goals and recommend to the legislature under sections 103F.701 to 103F.761.

MS 103h Provides for the Department of Agriculture and MPCA Authority

Clean Water Act authority has been delegated to the MPCA by EPA and MS 115 and 116 for:

NPDES Programs
Construction Grants Program
Section 319 Nonpoint Source Pollution coordination

History of MPCA Programs and Objectives

Two pronged approach

- 1) categorical state-wide
- 2) specific targeted

CWA Section 208, 208 Ag Report August 1979,, the report laid out many of the BMPs and management practices in use today.

CWA Section 319 Management Plan, 1988 (see attachment)

LCMR project in 1987 to 1989 which developed BMPs without a specific program application in mind.

MS Chapter 103H, 1989-1990

- 1) doesn't alter any pre-existing statute
- 2) defines who can develop ground water BMPs
- 3) voluntary before regulatory flow path

The variety of statutes have created confusion between definitions, procedures and authority.

Who has authority to identify BMPs

Why is this authority important

WCA decisions are based on BMP implementation
Publications and reproduction of information
Public vs. private interests
Local vs. state interests
Regulation vs. voluntary

The language is not precise and this causes problems.

the word BMP
the words "developing" versus "identifying"

Local Jurisdiction

In the past, MPCA programs have encouraged the locals to choose when to enforce BMPs rather than encourage volunteer use, ordinance or incentive promotional paths, for BMP adoption. However, recently Renville District Court has issued a finding which states the local governments can no longer require stricter feedlot controls (BMPs) by ordinance, that the state permit program requires.

Upcoming changes in Federal Clean Water Act

Both the Baucus and Oberstar reauthorization of the CWA versions include mandatory BMP language for some categories.

Coastal Zone Management

This program is still being negotiated, however, EPA is suggesting for MPCA to adopt the management measures as a minimum. There is also discussion about 100 percent adoption of Management Measures in the watershed and a legal means for the state to have authority to require adoption.

Where should we go from here?

Continue to identify BMPs and their efficiencies, limits and costs.

Create a new term to clarify the confusion due to the lack of precise language.

Identify a process for "state approved" or define the authorities and their limits.

Appendix I

Precipitation Data

95

MINNESOTA CLIMATOLOGICAL NETWORK

04

04

am

27

1

Year

Month

Ob Time

County

Township

Range

Section

006 pm

Name SUSAN ROTHBAUM			County Name HENNEPIN		Township Name	
Address 6001 GIRARD AVE. S., MPLS.			Telephone No. (612) 861-2508			
24-HOUR AMOUNTS			At the end of each month, forward forms to: Office of State Climatology, Went ^{Went} Atwater, Inc. Department of Natural Resources University of Minnesota, 279 North Hall St. Paul, Minnesota 55108		REMARKS: Give times and comments about events. (Temperature and Phenology items are very useful).	
RAIN MELTED SNOW ETC. (INS & HOTS)	SNOW (INS & TENTHS)	SNOW ON GROUND (INCHES)	Type of Gauge: (Check One)			
			Cyl.	<input checked="" type="checkbox"/>	Test Tube	
			Wedge		Other	
x			01			
x			02			
x			03			
x			04			
x			05			
x			06			
x			07			
x			08			
x			09			
x			10			
x			11			
x			12			
x			13			
x			14			
x			15			
GAUGE IN PLACE 2:00 PM			16			
NOT 24 hrs so empty'd but didn't read			17			
0.948			18	overcast, rain all day ^{wet} snow flurries 6 p.m. snowing harder by 6:30		
0.06			19	from snow pm of 4-18; clear by dawn & clear all day		
0.02			20	drippy drizzle - late afternoon		
0.11			21	drizzly am clear pm 30's am hi-low 50's		
0			22	clear all day hi 58		
0			23	" overcast by 6:30 hi 65		
0.11			24			
0			25	rain overcast all day hi 55		
0.07			26	rain am clear afternoon hi 50		
0			27			
0			28	High of 60°		
0			29	overcast all day hi 60		
0			30	partly sunny hi ~65		
			31			
TOTALS						

WENCZ 8/4

MINNESOTA CLIMATOLOGICAL NETWORK

95 05 06 am 27 1
Year Month Ob Time County Township Range Section

Name Susan Rothbaum			County Name Hennepin		Township Name	
Address 6001 Girard Ave S. Mpls MN 55419			Telephone No. (612) 861-2508			
24-HOUR AMOUNTS			REMARKS: Give times and comments about events. (Temperature and Phenology items are very useful).		Type of Gauge: (Check One)	
RAIN MELTED SNOW ETC (INS & HOTH)	SNOW (INS & TENTHS)	SNOW ON GROUND (INCHES)			Cyl.	Test Tube
					Wedge	Other
0			01			
0			02			
0			03			
0			04			
0			05	mostly sunny	hi 70	
0			06	overcast	hi 70	
.03			07	rain after 6 pm 5-16 overcast all day	hi 70	
.32			08	rainy day		
.22			09	rain overnight overcast all day	hi low 50s	
0			10	overcast am clear afternoon		
0			11	dry - clear then a few scattered small clouds, then hazy	hi 60s	
0			12	small puffy clouds, overcast evening	hi ~70	
.41			13	rain till late afternoon then clearing	hi 66	
.26			14	overcast 5-13, overcast am clear pm	hi 65	
0			15	sunny rain, cloudy late afternoon then clear	hi 72°	
0			16	sun clouds & sprinkles clear afternoon	hi 75	
0			17	clear		
0			18			
0			19	clear till 6 pm hot	hi 76-78	
.01			20	swift thunderstorm 8 pm 5-19 windy	hi 70	
0			21	Sunny all day with little clouds	hi 70	
.16			22			
.01			23			
0			24	Sunny	hi 60-65°	
0			25	Sunny - cumulus clouds increasing	hi 73°	
0			26	Sunny - Partly Cloudy		
.49			27	Rain, Rainy		
1.22			28	Rain, Clearing		
0			29	clear		
0			30	clear		
0			31	Partly cloudy		
3.13			TOTALS			

WEXLE 9/4

MINNESOTA CLIMATOLOGICAL NETWORK

95 06 06 am 27 1
Year Month Ob Time County Township Range Section

Name Susan Rothbaum			County Name Hennepin		Township Name	
Address 6001 Girard Ave. S. Minneapolis MN 55419			Telephone No. (612) 861-2508			
24-HOUR AMOUNTS			At the end of each month, forward forms to: Office of State Climatology Department of Natural Resources University of Minnesota, 279 North Hall St. Paul, Minnesota 55108		REMARKS: Give times and comments about events. (Temperature and Phenology items are very useful).	
RAIN MELTED SNOW ETC. INS. & HDTHS)	SNOW INS & TENTHS	SNOW ON GROUND INCHES			Type of Gauge: (Check One)	
					Cyl.	Test Tube
					Wedge	Other
Trace			01	Cloudy, warm		
0			02	Hazy, partly cloudy		
0			03	Clear, hot	Hi 84°F	
0			04	Hazy, hot	hi ~88	
.43			05	Thunder storms, cloudy	hi ~88-90	
1.35			06	lots of big heavy rain - some hail - cooler	hi 80	
.24			07	some rain overcast all day	cold - hi 46	
0			08	overcast & cool	hi ~65	
0			09	" "	"	
.4			10	Pots of rain	"	
0			11	clear	hi 70	
0			12	S		
0			13	Sunny	hi 82	
0			14	Sunny	hi 86	
0			15	Sunny - cumulus, then clear	hi 87	
0			16	hazy, bright	hi 93	
0			17	hazy, eve blue w/ many small cumulus	hi 94	97
0			18	hazy, humid	hi 94°	
0			19	hazy, humid	hi 94°	
0			20	hazy	hi	
0			21	hazy	hi	
0			22	hazy, T storms eve	hi 82°	
.02			23			
0			24			
.48			25			
.65			26	T storms late afternoon	82°	
.17			27			
			28			
			29			
			30			
			31			
3.74			TOTALS			

Wendy 8/4

MINNESOTA CLIMATOLOGICAL NETWORK

95 07 06 am 27 1
Year Month Ob Time County Township Range Section

Name Susan Rothbaum			County Name Hennepin		Township Name	
Address 6001 Girard Ave. S. Mpls MN 55419			Telephone No. (612) 861-2508			
24-HOUR AMOUNTS			REMARKS: At the end of each month, forward forms to: Office of State Climatology Department of Natural Resources University of Minnesota, 279 North Hall St. Paul, Minnesota 55108 Give times and comments about events. (Temperature and Phenology items are very useful).		Type of Gauge: (Check One)	
RAIN MELTED SNOW ETC (INS & HOTHES)	SNOW (INS & TENTHS)	SNOW ON GROUND (INCHES)			Cyl.	Test Tube
0			01		Wedge	Other
0			02			
0			03			
.64			04			
.52			05	cloudy, rainy		
.06			06			
0			07			
0			08			
0			09			
0			10			
0			11			
.12			12	ts storms		
0			13			1040
0			14	hazy + hot		
1.36			15			
0			16			
0			17			
.44			18			
.1			19			
0			20			
0			21			
.05			22			
0			23			
0			24			
0			25			
0			26			
.26			27			
.07			28			
0			29			
0			30	hot		
.27			31			
3.25			TOTALS			

MCWD/Gross Lake

MINNESOTA CLIMATOLOGICAL NETWORK

95 08 06 am 27 00 00 00 1
Year Month Ob Time County Township Range Section

Name Susan Rothbaum			County Name Hennepin			Township Name		
Address 6001 Girard Ave. S. Mpls MN 55419						Telephone No. (612) 861-2508		
24-HOUR AMOUNTS			At the end of each month, forward forms to: Office of State Climatology Department of Natural Resources University of Minnesota, 279 North Hall St. Paul, Minnesota 55108			REMARKS: Give times and comments about events. (Temperature and Phenology Items are very useful).		
Type of Gauge: (Check One)								
Cyl. <input checked="" type="checkbox"/> Test Tube <input type="checkbox"/>								
Wedge <input type="checkbox"/> Other <input type="checkbox"/>								
RAIN MELTED SNOW ETC (INS & FTHS)	SNOW (INS & TENTHS)	SNOW ON GROUND (INCHES)	01	Clear, sunny, cumulus hi in 70s				
0			02	few lots of clouds hi low 80s				
0			03	overcast, clearer toward evening, hi low 80s				
.76			04	a.m. - heavy rain 70's				
0			05	rain overcast midday 80s				
1.2			06	rain a.m. - cloudy midday - evening - hard rain, tstorm				
.96			07	overcast a.m. - partly sunny afternoon mid-80s				
0			08	overcast all day low 80s				
0			09	a.m. - sunny, then overcast mid 80s				
0			10	overcast 80s				
.32			11	tstorms a.m. - overcast - 80s				
.29			12	tstorms a.m. - overcast midday - rain after 6 86				
1.15			13	sunny a.m. - overcast afternoon 100% humid - tstorm early eve				
.05			14	sunny				
0			15					
.01			16	overcast then clearing & cumulus				
0			17	overcast a.m. 90s				
0			18	partly sunny (Tstorms late) 92°				
.29			19	sunny hi 70s				
0			20	clear, sunny 70s				
0			21					
0			22	overcast				
0			23	90s				
.02			24					
0			25					
.40			26					
0			27	overcast				
.04			28	sporadic rain, some sun, mostly overcast				
.17			29	rainy + overcast				
.03			30	rainy a.m. then overcast				
			31					
5.69			TOTALS					



MINNESOTA CLIMATOLOGICAL NETWORK

95	09	06	am	27				1
Year	Month	Ob Time		County	Township	Range	Section	

Name <u>Susan Rothbaum</u>			County Name <u>Hennepin</u>		Township Name	
Address <u>6001 Girard Ave S. mpls MN 55419</u>			Telephone No. <u>(612) 861-2508</u>			
24-HOUR AMOUNTS			REMARKS:		Type of Gauge: (Check One)	
RAIN MELTED SNOW ETC (INS & HOTS)	SNOW INS & TENTHS	SNOW ON GROUND (INCHES)	At the end of each month, forward forms to Office of State Climatology Department of Natural Resources University of Minnesota, 370 North Hall St. Paul, Minnesota 55108		Cyl. <input checked="" type="checkbox"/> Test Tube <input type="checkbox"/>	
			Give times and comments about events. (Temperature and Phenology Items are very useful).		Wedge <input type="checkbox"/> Other <input type="checkbox"/>	
0			01	mixed sun/cloudy		
0			02	"		
0			03	(out of town)		
0			04	sunny		
0			05			
.04			06			
.05			07	sunny w/ cumulus cool (low 60s ?)		
0			08	sunny + clear low 60s		
0			09	sunny + clear "		
0			10	sunny, cumulus low 70s		
0			11	partly sunny mid 70s		
0			12	hazy sun - overcast		
0			13	sunny, clear, windy		
0			14	clear		
.24			15			
.14			16			
0			17	sunny		
.01 0			18	rainy, overcast		
.26			19	rainy, overcast		
.01			20	sunny early, then overcast		
.08			21	SEEDS ^{blew?} INTO GAUGE + PLUGGED IT		
trace			22			
.02			23			
.22			24			
.01			25	overcast		
0			26	sunny + clear mid 70s		
0			27	sunny + clear		
0			28	" high 70s +		
.55			29	rainy - storms at night		
.72			30	partly sunny day, then rain		
			31			
2.34			TOTALS			



MINNESOTA CLIMATOLOGICAL NETWORK

95

Year

10

Month

6

Ob Time

am

pm

County

Township

Range

Section

1

Name			County Name		Township Name	
Address			Telephone No.		()	
24-HOUR AMOUNTS			At the end of each month, forward forms to Office of State Climatology Department of Natural Resources University of Minnesota, 279 North Hall St. Paul, Minnesota 55108		REMARKS: Give times and comments about events. (Temperature and Phenology Items are very useful).	
RAIN MELTED SNOW ETC. INS & MOths	SNOW INS & TENTHS	SNOW ON GROUND INCHES			Type of Gauge (Check One)	
					Cyl.	Test Tube
					Wedge	Other
0			01			
0.52			02	raining		
0.04			03	mostly overcast		
0			04			
0			05	Sunny a.m., then cloudy rainy later		
1.1			06	overcast, light rain		
0.02			07			
0			08	sunny a.m., then overcast, rain later		
0.45			09			
0			10	Warmer 60s?		
0			11			
0			12			
T			13			
0			14			
0			15			
0			16			
			17			
			18			
			19			
			20			
			21			
			22			
			23			
			24			
			25			
			26			
			27			
			28			
			29			
			30			
			31			
TOTALS						

Appendix J

Lake Elevation Data

MCWD LAKE LEVEL MONITORING PROGRAM

1995

Location: Grass Lake
 Staff Gauge Zero Elevation: 829.14
 Reader:
 Month: April

	Date	Time	Staff Reading	Lake Elevation	Comments
1.)					
2.)					
3.)					
4.)					
5.)					
6.)					
7.)					
8.)					
9.)					
10.)					
11.)					
12.)					
13.)					
14.)					
15.)					
16.)					
17.)					
18.)					
19.)					
20.)					
21.)					
22.)					
23.)					
24.)					
25.)	4/25/95	2:30	1.16	830.3	Staff gauge installed
26.)	APRIL				MEETING
27.)		6 pm	1.17	830.31	
28.)		8 pm	1.15	830.29	
29.)		8 pm	1.12	830.26	
30.)		630 pm	1.09	830.23	
31.)	x	x	x	x	x

Please return this form to:
 Kristin George
 Wenck Associates, Inc.
 P.O. Box 428
 1800 Pioneer Creek Ctr.
 Maple Plain, MN 55359-02428

MCWD LAKE LEVEL MONITORING PROGRAM

1995

Location:

Grass Lake

Staff Gauge Zero Elevation:

829.14

Reader:

Month: may

	Date	Time	Staff Reading	Lake Elevation	Comments
1.)		8 pm	1.07	830.21	
2.)		6:30 pm	1.05	830.19	
3.)		8 pm	1.03	830.17	
4.)		8 pm.	1.01	830.15	
5.)		6:30 pm	0.99	830.13	upper 60's
6.)	SAT.	7 pm	0.97	830.11	
7.)	SUN.	6 pm	0.94	830.08	
8.)		8 pm.	0.90	830.04	RAIN MOST OF DAY
9.)			0.92		LIGHT RAIN - MOST OF DAY
10.)			0.93		
11.)		5:45 pm	0.89		69°
12.)		8:45 pm	.86		72°
13.)	SAT.	8 pm	1.05		RAIN - HOT ALL DAY
14.)	SUN.	6 pm	1.07		
15.)		8:15 pm	1.02		
16.)		7:30 pm	1.00		
17.)		7:00 am	1.00		windy
18.)			-		JAC - IN 70's
19.)			-		" "
20.)	SAT.	1:30 pm	0.88		windy
21.)	SUN.	4:30 pm	.84		
22.)		8 pm	.84		
23.)		6:30 pm	.78		
24.)		5 pm	.76		
25.)		8 pm	.74		
26.)		8 pm	.73		light rain
27.)	SAT.	-	-		RAIN =
28.)	SUN.	8 pm	1.22		RAIN =
29.)		4 pm	1.17		70's
30.)		8 pm	1.12		
31.)		8 pm	1.07		

Please return this form to:

Kristin George

Wenck Associates, Inc.

P.O. Box 428

1800 Pioneer Creek Ctr.

Maple Plain, MN 55359-02428

MCWD LAKE LEVEL MONITORING PROGRAM

1995

Location:

Grass Lake

Staff Gauge Zero Elevation:

829.14

Reader:

Month: JUNE

	Date	Time	Staff Reading	Lake Elevation	Comments
1.)		8pm	1.06		
2.)			1.04		HOT
3.)	SAT		0.99		HOT
4.)	SUN		0.97		HOT
5.)			0.93		
6.)					
7.)					
8.)			1.33		
9.)					
10.)	SAT		1.30		
11.)	SUN		1.28		
12.)			1.25		
13.)					
14.)					
15.)					
16.)					
17.)	SAT				
18.)	SUN				
19.)			.98		
20.)			.93		
21.)			.89		
22.)			.84		
23.)			.88		
24.)	SAT		.80		
25.)	SUN		.90		
26.)			.94		
27.)					
28.)					
29.)					
30.)					
31.)	-	-	-	-	-

Please return this form to:

Kristin George

Wenck Associates, Inc.

P.O. Box 428

1800 Pioneer Creek Ctr.

Maple Plain, MN 55359-02428

MCWD LAKE LEVEL MONITORING PROGRAM

1995

Location:

Grass Lake

Staff Gauge Zero Elevation:

829.14

Reader:

Month: July

	Date	Time	Staff Reading	Lake Elevation	Comments
1.)					
2.)					
3.)					
4.)					
5.)					
6.)					
7.)					
8.)			1.06		
9.)			1.03		
10.)			1.00		
11.)			.99		
12.)			.96		
13.)					
14.)					
15.)					
16.)					
17.)					
18.)					
19.)					
20.)					
21.)					
22.)					
23.)			0.99		
24.)			0.96		
25.)			0.95		
26.)					
27.)					
28.)					
29.)					
30.)					
31.)					

Please return this form to:
 Kristin George
 Wenck Associates, Inc.
 P.O. Box 428
 1800 Pioneer Creek Ctr.
 Maple Plain, MN 55359-02428

MCWD LAKE LEVEL MONITORING PROGRAM

1995

Location:

Grass Lake

Staff Gauge Zero Elevation:

829.14

Reader:

Month: Aug.

	Date	Time	Staff Reading	Lake Elevation	Comments
1.)					
2.)					
3.)					
4.)					
5.)					
6.)					
7.)					
8.)					
9.)					
10.)					
11.)			1.68		
12.)			1.69		
13.)			1.65		
14.)			1.57		
15.)			1.42		
16.)			1.36		
17.)			1.38		
18.)			1.33		
19.)			1.36		
20.)					
21.)					
22.)					
23.)					
24.)					
25.)					
26.)			1.10		
27.)			1.09		
28.)			1.13		
29.)					
30.)					
31.)					

Please return this form to:

Kristin George

Wenck Associates, Inc.

P.O. Box 428

1800 Pioneer Creek Ctr.

Maple Plain, MN 55359-02428

Appendix K

Laboratory Data Reports

Mn/DOT Central Shop

TEL: 612-296-

ISSW RETENTION PONDS, MINNEAPOLIS

Post-It™ brand fax transmittal memo 7671		# of pages	1
To	Jeff Lee	From	Dave Miller
Co.	Mpls PK Bd	Co.	Mn/DOT
Dept.		Phone #	797 3066
Fax #	348 9354	Fax #	

	GRASS	GRASS	GRASS	GRASS
SITE NUMBER	527-442	527-442	527-442	527442
DATE	10/5/88	1/11/89	4/27/89	7/12/89
LAB SAMPLE NUMBER	87618	*	8905199	8912083
TIME COLLECTED	1000		0913	0920
WATER TEMPERATURE (degrees C)	6		14	24
D.O. (mg/l)	7.8		7.8	5.8
SECCHI DISK READING (feet)	1.0		1.25	1.7
pH (unit)	7		6.9	8.5
CONDUCTIVITY (mho's)	322		637	250
TURBIDITY (ntu's)	14		3	3
AMMONIA NITROGEN (mg/l)	1.18		.24	.16
ORGANIC NITROGEN (mg/l)	2.41		1.10	1.82
NITRITE NITROGEN (mg/l)	.01		.08	<.01
NITRATE+NITRITE NITROGEN (mg/l)	<.01		.04	<.01
CALCIUM as CaCO3 (mg/l)	190.00		57.00	38.00
MAGNESIUM as CaCO3 (mg/l)	73.00		19.00	12.00
TOTAL HARDNESS as CaCO3 (mg/l)	260.00		76.00	50.00
ALKALINITY as CaCO3 (mg/l)	110.00		72.00	60.00
CHLORIDE (mg/l)	36.00		120.00	47.00
TOTAL PHOSPHORUS (mg/l)	.400		.139	.443
CHLOROPHYLL A (ug/l)	2.58		1.83	21.90
ORTHOPHOSPHORUS (mg/l)	.048		.07	.223
BOD-FIVE DAY (mg/l)	10.00		3.20	3.30
COD (mg/l)	49.00		33.00	53.00
OIL AND GREASE (mg/l)	.90		<.5	-
TOTAL ORGANIC CARBON (mg/l)	13.00		14.00	16.00
SUSPENDED SOLIDS (mg/l)	35.00		1.40	11.00
TOTAL SOLIDS (mg/l)	210.00		310.00	220.00
TOTAL VOLATILE SOLIDS (mg/l)	83.00		140.00	87.00
SUSPENDED VOLATILE SOLIDS (mg/l)	23.00		1.60	8.60
KJELDAHL NITROGEN (mg/l)	3.59		1.34	1.98
pH (unit)	7.80		7.80	8.50
BICARB. ALK. as CaCO3 (mg/l)	110.00		72.00	58.00
CARBONATE ALK. as CaCO3 (mg/l)	<1		<1.00	1.70
FREE CARBON DIOXIDE (mg/l)	3.50		2.30	<1.00
COPPER (ug/l)	200.00		1.80	1.40
LEAD (ug/l)	2200.00		3.50	14.00
CADMIUM (ug/l)	10.00		.037	.071

* No sample obtained, pond was frozen throughout to bottom.



INSTRUMENTAL RESEARCH, INC.
7813 MADISON ST. MINNEAPOLIS, MN 55412-784-6936

September 20, 1994

Jeffrey T. Lee
Environmental Programs Manager
Minneapolis Park & Recreation Board
Environmental Programs Section
3800 Bryant Avenue South
Minneapolis, Minnesota 55409-1029

SUBJECT: Grass Lake Chemistry

Chl-a	194.2 mg / M ³
Phcophyten-a	39.3 mg / M ³
Total Phosphorus	0.121 mg / l
Dissolved Total Phosphorus	0.020 mg / l
Soluble Reactive Phosphorus	0.008 mg / l
Total Suspended Solids	58.5 mg / l
Silica	0.195 mg / l

Sincerely,

Delman R. Hogen, President

DRH / ch

Laboratory Certification Status:

Minnesota Department of Health Laboratory No. 027-003-130

See hi 0.0
20.8°C
11.52 ppm DO
9.57 pH
2280 cond
8.53

LABORATORY ANALYSIS REPORT**DATE:** June 21, 1995**PAGE:**

8 Of 9

CLIENT: Wenck Associates
1800 Pioneer Creek Dr.
Maple Plain, MN 55359**PROJECT NO.:** 060195-200127
COLLECTION DATE: 05/31/95-06/01/95
COLLECTED BY: Client
RECEIVED DATE: 06/01/95
PROJECT DESCRP.: MCWD 0185-04-163**CONTACT:** Kent Torve**Sample No.:** 9506018914
Sample ID.: Diamond

<u>ANALYSIS</u>	<u>UNITS</u>	<u>MDL</u>	<u>Surface</u> <u>RESULT</u>	<u>ANALYSIS</u> <u>DATE</u>
Chlorophyll a (SM 10200 H)	mg/L	0.001	0.020	05/26/95
Phosphorus, Total (365.2)	mg/L	0.05	0.09	06/02/95
Phosphorus, Ortho (365.2)	mg/L	0.05	ND	05/26/95
Ammonia Nitrogen (350.1)	mg/L	0.1	ND	06/08/95
Nitrate + Nitrite Nitrogen (353.2)	mg/L	0.1	ND	05/31/95
Nitrogen, Nitrate (353.2)	mg/L	0.1	ND	05/31/95
Nitrogen, Nitrite (353.2)	mg/L	0.1	ND	05/26/95
Chloride (325.2)	mg/L	1	300	06/01/95
Alkalinity, Total (310.2)	mg/L	1	76	06/07/95
pH (150.1)		0.1	8.7	05/30/95
Specific Conductivity (120.1)	umhos/cm	1	920	06/01/95

Sample No.: 9506018915
Sample ID.: Grass Surface

<u>ANALYSIS</u>	<u>UNITS</u>	<u>MDL</u>	<u>RESULT</u>	<u>ANALYSIS</u> <u>DATE</u>
Chlorophyll a (SM 10200 H)	mg/L	0.001	0.056	05/26/95
Phosphorus, Total (365.2)	mg/L	0.05	0.12	06/02/95
Phosphorus, Ortho (365.2)	mg/L	0.05	ND	05/26/95
Ammonia Nitrogen (350.1)	mg/L	0.1	ND	06/08/95
Nitrate + Nitrite Nitrogen (353.2)	mg/L	0.1	ND	05/31/95
Nitrogen, Nitrate (353.2)	mg/L	0.1	ND	05/31/95
Nitrogen, Nitrite (353.2)	mg/L	0.1	ND	05/26/95
Chloride (325.2)	mg/L	1	150	06/01/95
Alkalinity, Total (310.2)	mg/L	1	62	06/07/95
pH (150.1)		0.1	9.2	05/30/95
Specific Conductivity (120.1)	umhos/cm	1	470	06/01/95

ND means Not Detected

MDL means Method Detection Limit

mg/L means Milligrams Per Liter which is equivalent to Parts Per Million (ppm)



301 West County Road E2 • St. Paul, MN 55112
(612) 633-0101 • FAX (612) 633-1402

LABORATORY ANALYSIS REPORT

DATE: June 29, 1995

PAGE: 1 Of 1

CLIENT: Wenck Associates
1800 Pioneer Creek Dr.
Maple Plain, MN 55359

PROJECT NO.: 061595-200127
COLLECTION DATE: 06/15/95
COLLECTED BY: Client
RECEIVED DATE: 06/15/95
PROJECT DESCRP.: MCWD 0185-04-220

CONTACT: Kent Torve

ANALYSIS	UNITS	Sample No.:	9506021122	ANALYSIS
		Sample ID.:	Grass Lake	
		MDL	RESULT	DATE
Chlorophyll a (SM 10200 H)	ug/L	1	64	06/23/95
Phosphorus, Total (365.2)	mg/L	0.05	0.14	06/23/95
Phosphorus, Ortho (365.2)	mg/L	0.05	ND	06/16/95
Ammonia Nitrogen (350.1)	mg/L	0.1	ND	06/20/95
Nitrogen, Nitrate (353.2)	mg/L	0.1	ND	06/16/95
Nitrogen, Nitrite (353.2)	mg/L	0.1	ND	06/16/95
Nitrate + Nitrite Nitrogen (353.2)	mg/L	0.1	ND	06/16/95
Chloride (325.2)	mg/L	1	100	06/19/95
Alkalinity, Total (310.2)	mg/L	10	67	06/21/95
pH (150.1)		0.1	6.1	06/19/95
Specific Conductivity (120.1)	umhos/cm	1	510	06/21/95
Iron, Total (200.7)	mg/L	0.1	0.4	06/20/95

ND means Not Detected

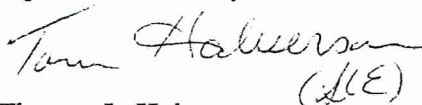
MDL means Method Detection Limit

mg/L means Milligrams Per Liter which is equivalent to Parts Per Million (ppm)

ug/L means Micrograms Per Liter which is equivalent to Parts Per Billion (ppb)

This report has been reviewed by me for technical accuracy and completeness. The analyses were performed using EPA or other approved methodologies and the results were reported on an "as received" basis unless otherwise noted. Organic soil analyses were reported on a dry weight basis. Please contact me if you have any questions or comments regarding this report. Spectrum Labs, Inc. appreciates the opportunity to provide this analytical service for you.

Report Submitted By,


(LH)

Thomas L. Halverson
Laboratory Manager

TLH:cfs
WA180-1



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KMG

RECEIVED BY

AUG 8 1995

LABORATORY ANALYSIS REPORT

DATE: August 4, 1995

PAGE:

1 Of 1

WENCK ASSOCIATES, INC.

CLIENT: Wenck Associates
1800 Pioneer Creek Ctr.
Maple Plain, MN 55359

PROJECT NO.: 071995-200127
COLLECTION DATE: 7/10/95
COLLECTED BY: Client
RECEIVED DATE: 7/11/95
PROJECT DESCRP.: MWCD: Grass Lake #0185-04220

CONTACT: Brian Holst

<u>ANALYSIS</u>	<u>UNITS</u>	<u>Sample No.:</u>	9507023807	<u>ANALYSIS</u>
		<u>Sample ID.:</u>	Grass Lake	
		<u>MDL</u>	<u>RESULT</u>	<u>DATE</u>
Phosphorus, Total (365.2)	mg/L	0.05	0.16	7/13/95
Ortho Phosphate (365.2)	mg/L	0.02	ND	7/12/95
Ammonia Nitrogen (350.1)	mg/L	0.1	1.0	8/01/95
Nitrate + Nitrite Nitrogen (353.2)	mg/L	0.1	ND	7/12/95
Nitrate Nitrogen (353.2)	mg/L	0.1	ND	7/12/95
Nitrite Nitrogen (353.2)	mg/L	0.1	ND	7/12/95
Chloride (325.2)	mg/L	1	56	7/25/95
Alkalinity, Total as CaCO ₃ (310.2)	mg/L	10	55	7/17/95
pH (150.1)		0.1	9.6	7/11/95
Specific Conductivity (120.1)	umhos/cm	1	420	7/17/95
Iron, Total (200.7)	mg/L	0.1	0.5	7/13/95
Chlorophyll-a (SM 10200H)	ug/L	1	73	7/13/95

ND means Not Detected

MDL means Method Detection Limit

mg/L means Milligrams Per Liter which is equivalent to Parts Per Million (ppm)

ug/L means Micrograms Per Liter which is equivalent to Parts Per Billion (ppb)

This report has been reviewed by me for technical accuracy and completeness. The analyses were performed using EPA or other approved methodologies and the results were reported on an "as received" basis unless otherwise noted. Organic soil analyses were reported on a dry weight basis. Please contact me if you have any questions or comments regarding this report. Spectrum Labs, Inc. appreciates the opportunity to provide this analytical service for you.

Report Submitted By,

Thomas L. Halverson
Laboratory Manager

TLH:wmh
wa216-1



A member of The Marmon Group of Companies

LABORATORY ANALYSIS REPORT**DATE:** August 24, 1995**PAGE:** 3 Of 3**CLIENT:** Wenck Associates
1800 Pioneer Creek Ctr.
Maple Plain, MN 55359**PROJECT NO.:** 080195-200127
COLLECTION DATE: 7/31/95
COLLECTED BY: Client
RECEIVED DATE: 8/01/95
PROJECT DESCRP.: 0185-05-163**CONTACT:** Kent Torve

		Sample No.:	9507027110	
		Sample ID.:	Lake Nokomis	
			Bottom	ANALYSIS
ANALYSIS	UNITS	MDL	RESULT	DATE
Total Phosphorus (365.2)	mg/L	0.02	0.50	8/08/95
Ortho Phosphate (365.2)	mg/L	0.02	ND	8/02/95
Ammonia Nitrogen (350.1)	mg/L	0.1	3.2	8/11/95
Nitrate Nitrogen (353.2)	mg/L	0.1	ND	8/11/95
Nitrite Nitrogen (353.2)	mg/L	0.1	ND	8/11/95
Nitrate + Nitrite Nitrogen (353.2)	mg/L	0.1	ND	8/11/95
Chloride (325.2)	mg/L	1.0	61	8/22/95
Alkalinity, Total as CaCO ₃ (310.2)	mg/L	10	140	8/09/95
pH (150.1)		0.1	6.8	8/01/95
Specific Conductivity (120.1)	umhos/cm	10	500	8/09/95
Iron, Total (200.7)	mg/L	0.1	3.4	8/02/95

		Sample No.:	9507027111	
		Sample ID.:	Grass Lake	
			Surface	ANALYSIS
ANALYSIS	UNITS	MDL	RESULT	DATE
Chlorophyll-a (SM 10200H)	ug/L	1	230	8/10/95
Total Phosphorus (365.2)	mg/L	0.02	0.26	8/08/95
Ortho Phosphate (365.2)	mg/L	0.02	ND	8/02/95
Ammonia Nitrogen (350.1)	mg/L	0.1	ND	8/11/95
Nitrate Nitrogen (353.2)	mg/L	0.1	ND	8/11/95
Nitrite Nitrogen (353.2)	mg/L	0.1	ND	8/11/95
Nitrate + Nitrite Nitrogen (353.2)	mg/L	0.1	ND	8/11/95
Chloride (325.2)	mg/L	10	120	8/22/95
Alkalinity, Total as CaCO ₃ (310.2)	mg/L	10	64	8/09/95
pH (150.1)		0.1	9.4	8/01/95
Specific Conductivity (120.1)	umhos/cm	10	390	8/09/95
Iron, Total (200.7)	mg/L	0.1	1.0	8/02/95

ND means Not Detected

MDL means Method Detection Limit

mg/L means Milligrams Per Liter which is equivalent to Parts Per Million (ppm)

ug/L means Micrograms Per Liter which is equivalent to Parts Per Billion (ppb)

LABORATORY ANALYSIS REPORT**DATE:** September 14, 1995**PAGE:**

1 Of 1

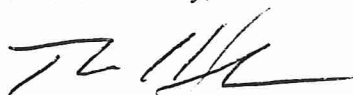
SEP 19 1995**CLIENT:** Wenck Associates
1800 Pioneer Creek Ctr.
Maple Plain, MN 55359**PROJECT NO.:** 081495-200127
COLLECTION DATE: 8/14/95
COLLECTED BY: Kristen George
RECEIVED DATE: 8/14/95
PROJECT DESCRP.: 0185-04-2200**CONTACT:** Kent Torve

<u>ANALYSIS</u>	<u>UNITS</u>	<u>Sample No.:</u>	9508027707	<u>ANALYSIS</u>
		<u>Sample ID.:</u>	Grass Lake	
		<u>MDL</u>	<u>RESULT</u>	<u>DATE</u>
Chlorophyll-a (SM 10200H)	ug/L	1	14	9/13/95
Total Phosphorus (365.2)	mg/L	0.05	0.17	8/15/95
Ortho Phosphate (365.2)	mg/L	0.02	ND	8/14/95
Ammonia Nitrogen (350.1)	mg/L	0.1	ND	8/16/95
Nitrate Nitrogen (353.2)	mg/L	0.1	ND	8/14/95
Nitrite Nitrogen (353.2)	mg/L	0.1	ND	8/23/95
Nitrate + Nitrite Nitrogen (353.2)	mg/L	0.1	ND	8/23/95
Chloride (325.2)	mg/L	10	61	8/22/95
Alkalinity, Total as CaCO ₃ (310.2)	mg/L	10	54	8/16/95
pH (150.1)		0.1	7.8	8/16/95
Specific Conductivity (120.1)	umhos/cm	1	240	8/10/95
Iron, Total (200.7)	mg/L	0.05	0.66	8/14/95

*ND means Not Detected**MDL means Method Detection Limit**mg/L means Milligrams Per Liter which is equivalent to Parts Per Million (ppm)**ug/L means Micrograms Per Liter which is equivalent to Parts Per Billion (ppb)*

This report has been reviewed by me for technical accuracy and completeness. The analyses were performed using EPA or other approved methodologies and the results were reported on an "as received" basis unless otherwise noted. Organic soil analyses were reported on a dry weight basis. Please contact me if you have any questions or comments regarding this report. Spectrum Labs, Inc. appreciates the opportunity to provide this analytical service for you.

Report Submitted By,

Thomas L. Halverson
Laboratory ManagerTLH:skt
wa257-1



301 West County Road E2 • St. Paul, MN 55112
(612) 633-0101 • FAX (612) 633-1402

LABORATORY ANALYSIS REPORT

DATE: September 14, 1995

PAGE: 1 Of 1

CLIENT: Wenck Associates
1800 Pioneer Creek Ctr.
Maple Plain, MN 55359

PROJECT NO.: 082395-200127
COLLECTION DATE: 8/23/95
COLLECTED BY: Client
RECEIVED DATE: 8/23/95
PROJECT DESCRP.: 0185-04-2200

CONTACT: Kent Torve

ANALYSIS	UNITS	Sample No.:	9508030229	ANALYSIS
		Sample ID.:	Grass Lake	
		MDL	RESULT	DATE
Chlorophyll-a (SM 10200H)	ug/L	1	88	9/13/95
Total Phosphorus (365.2)	mg/L	0.02	0.20	8/28/95
Ortho Phosphate (365.2)	mg/L	0.02	ND	8/24/95
Ammonia Nitrogen (350.1)	mg/L	0.1	0.9	9/01/95
Nitrate Nitrogen (353.2)	mg/L	0.1	ND	8/23/95
Nitrite Nitrogen (353.2)	mg/L	0.1	ND	8/23/95
Nitrate + Nitrite Nitrogen (353.2)	mg/L	0.1	ND	8/23/95
Chloride (325.2)	mg/L	10	62	8/25/95
Alkalinity, Total as CaCO ₃ (310.2)	mg/L	10	66	8/29/95
pH (150.1)		0.1	9.0	8/23/95
Specific Conductivity (120.1)	umhos/cm	10	260	8/29/95
Iron, Total (200.7)	mg/L	0.1	0.6	8/28/95

ND means Not Detected

MDL means Method Detection Limit

mg/L means Milligrams Per Liter which is equivalent to Parts Per Million (ppm)

ug/L means Micrograms Per Liter which is equivalent to Parts Per Billion (ppb)

This report has been reviewed by me for technical accuracy and completeness. The analyses were performed using EPA or other approved methodologies and the results were reported on an "as received" basis unless otherwise noted. Organic soil analyses were reported on a dry weight basis. Please contact me if you have any questions or comments regarding this report. Spectrum Labs, Inc. appreciates the opportunity to provide this analytical service for you.

Report Submitted By,

Thomas L. Halverson
Laboratory Manager

TLH:wmh
wa249-1



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LABORATORY ANALYSIS REPORT**DATE:** September 29, 1995**PAGE:** 1 Of 1**CLIENT:** Wenck Associates
1800 Pioneer Crk Ctr
Maple Plain, MN 55359**PROJECT NO.:** 090895-200127
COLLECTION DATE: 9/07/95
COLLECTED BY: Client
RECEIVED DATE: 9/08/95
PROJECT DESC: 0185-04-220

<u>ANALYSIS</u>	<u>UNITS</u>	<u>Sample No.:</u>	<u>Sample ID.:</u>	<u>Grass Lk</u>	<u>ANALYSIS</u>
				<u>RESULT</u>	
Phosphorus, Total (365.2)	mg/L	0.02		0.35	9/13/95
Phosphorus, Ortho (365.2)	mg/L	0.02		ND	9/11/95
Ammonia Nitrogen (350.1)	mg/L	0.1		ND	9/27/95
Nitrate + Nitrite Nitrogen (353.2)	mg/L	0.1		ND	9/12/95
Nitrogen, Nitrate (353.2)	mg/L	0.1		ND	9/12/95
Nitrogen, Nitrite (353.2)	mg/L	0.1		ND	9/08/95
Chloride (325.2)	mg/L	1		63	9/19/95
Alkalinity Total as CaCO ₃ (310.2)	mg/L	10		70	9/15/95
pH (150.1)		0.1		7.4	9/12/95
Specific Conductance (120.1)	umhos/cm	1		320	9/15/95
Iron (200.7)	mg/L	0.1		1.1	9/12/95
Chlorophyll a (SM10200H)	ug/L	1		150	9/13/95

ND means Not Detected

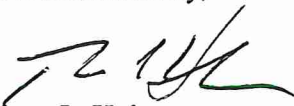
MDL means Method Detection Limit

mg/L means Milligrams Per Liter which is equivalent to Parts Per Million (ppm)

ug/L means Micrograms Per Liter which is equivalent to Parts Per Billion (ppb)

This report has been reviewed by me for technical accuracy and completeness. The analyses were performed using EPA or other approved methodologies and the results were reported on an "as received" basis unless otherwise noted. Organic soil analyses were reported on a dry weight basis. Please contact me if you have any questions or comments regarding this report. Spectrum Labs, Inc. appreciates the opportunity to provide this analytical service for you.

Report Submitted By,


Thomas L. Halverson
Laboratory ManagerTLH:slt
wa272-1

LABORATORY ANALYSIS REPORT**DATE:** October 26, 1995**PAGE:**

1 Of 1

CLIENT: Wenck Associates
1800 Pioneer Crk Ctr
Maple Plain, MN 55359**PROJECT NO.:** 100395-200127
COLLECTION DATE: 10/02/95
COLLECTED BY: Client
RECEIVED DATE: 10/03/95
PROJECT DESC: 0185-04-220**CONTACT:** Kent Torve

		Sample No.:	9509036800	
		Sample ID.:	Grass Lake	ANALYSIS
ANALYSIS	UNITS	MDL	RESULT	DATE
Chlorophyll <i>a</i> (SM10200H)	ug/L	1	210	10/19/95
Phosphorus, Total (365.2)	mg/L	0.02	0.41	10/12/95
Phosphorus, Ortho (365.2)	mg/L	0.02	ND	10/04/95
Ammonia Nitrogen (350.1)	mg/L	0.1	ND	10/23/95
Nitrogen, Nitrate (353.2)	mg/L	0.1	ND	10/13/95
Nitrogen, Nitrite (353.2)	mg/L	0.1	ND	10/09/95
Nitrate + Nitrite Nitrogen (353.2)	mg/L	0.1	ND	10/13/95
Chloride (325.2)	mg/L	1	56	10/22/95
Alkalinity Total as CaCO ₃ (310.2)	mg/L	10	60	10/20/95
pH (150.1)		0.1	8.8	10/04/95
Specific Conductance (120.1)	umhos/cm	1	250	10/20/95
Iron, Total (200.7)	mg/L	0.1	1.8	10/06/95

*ND means Not Detected**MDL means Method Detection Limit**mg/L means Milligrams Per Liter which is equivalent to Parts Per Million (ppm)**ug/L means Micrograms Per Liter which is equivalent to Parts Per Billion (ppb)*

This report has been reviewed by me for technical accuracy and completeness. The analyses were performed using EPA or other approved methodologies and the results were reported on an "as received" basis unless otherwise noted. Organic soil analyses were reported on a dry weight basis. Please contact me if you have any questions or comments regarding this report. Spectrum Labs, Inc. appreciates the opportunity to provide this analytical service for you.

Report Submitted By,

Thomas L. Halverson
Laboratory ManagerTLH:wmh
wa299-2

Appendix L

**Wetland Bird Foraging, A Comparative Study,
Colleen Allen, University of Minnesota**

***Wetland Bird Foraging, A Comparative Study,
Colleen Allen, University of Minnesota**

*This report was revised on November 1, 1995, and can be obtained from the Kenny
Neighborhood Association, 5516 Lyndale Avenue South, Minneapolis, MN 55419

Wetland Bird Foraging

A comparative study

Colleen Allen
University of Minnesota
Fisheries and Wildlife
October 17, 1995

This project was funded by Center for Urban and Regional Affairs (CURA)
University of Minnesota

For the Kenny Neighborhood Association

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Introduction

A small wetland pond, known as Grass Lake, has been the pride of and recently the focal concern of area neighborhood residents. Located in the south-west corner of the city of Minneapolis, Grass Lake is potentially exposed to all sorts of human disturbances. Of particular concern to residents, are sedimentation from recent construction of major freeways (I35W and Minn Hwy 62; Cross-town), and the introduction of potentially chlorinated water from the city drinking water system.

Grass Lake is a 30 acre type five wetland with an average depth of two feet. While the neighborhood is residential, the lake is completely surrounded by a 50 - 100 foot zone of trees, shrubs, and native prairie plants. In past years, the wetland has been rich in emergent vegetation, however this year emergents were sparse. It has a tributary drainage area of 386 acres. *check*

Grass Lake is a particularly rich wetland resource, but appears to have deteriorated in recent years. (This has been the focus of several studies in the past (Gottschalk, 1991; Lee, 1994).) It is presently being studied by the Minnehaha Creek Watershed District, and by two separate researchers from CURA, one of which encompasses this study.

At its inception, this study was to be an inventory of organisms found at or near the wetland. The purpose was to produce a baseline of wildlife information, which was to be used for comparison over the years and on which to base recommendations to various government authorities. Since the neighborhood residents seemed to already have a pretty good handle on this area, (Ramsay and Goetzinger, 1994), the study was expanded to wetland bird foraging because of its quantitative aspect.

Wetland bird foraging is dependent upon food availability (Weller, 1994). If there is not something for the birds to eat, they will not be foraging in the area. They can easily move if they need to. This activity is highly visible and quantifiable for many species of birds (Cooper, 1994).

The purpose of this analysis is to determine which species of birds are on the wetland and how many of them are foraging. An ecologically similar wetland is also examined for comparison. The results will be compared over the years to see how bird foraging activity changes. In this way we can make suggestions about the health of the wetlands.

Methods

To choose an ecologically similar wetland to Grass Lake, the DNR Protected Wetlands Inventory (1988) was searched. Factors influencing selection were: type, size, similarity of surroundings, similarity of vegetation, hydrology, and accessibility of location. A wetland free from impacts of major freeway construction was sought, since this is suspected to be a factor in the decline of the health of Grass Lake.

compared to 300+
I chose Oxborough Lake in Bloomington for the second wetland in this project. It is a type five wetland of 20 acres. It has an average depth of 2 feet with its deepest point being 3 1/2 feet. It also has a residential neighborhood. It is surrounded by approximately 60% tree, shrub, and other vegetation. The rest of the wetland has lawns leading up to it. Emergent vegetation was sparse, as it was at Grass Lake this year. Storm water drainage into the wetland consists of 1150 acres of tributary drainage area. This wetland is accessible for continued study as it is located about 10 miles south of Grass Lake near Lyndale and 92nd Ave.

Since all of the birds on a wetland could not be seen from one place, several observation points were determined at each wetland. Five stations were chosen for Grass Lake, and three were chosen for Oxborough Lake. From these stations, all of the birds on or over the wetlands could be seen, and many of the birds in the canopy and surrounding upland vegetation.

Resident volunteers were trained to collect information. They went out on counts with me and were given the "Volunteer Information" packet that is an attachment at the end of this paper. This year, two volunteers collected a total of 8 observations at each wetland. I collected 19 observations at each wetland. In future years, the volunteers will collect all of the data needed to keep this project going.

Counts were done two or three times per week starting on July 1, 1995. Information collected at each count consisted of: date, time, wetland number (1 = Grass, 2 = Oxborough), station number, observer, sky conditions, temperature, wind direction, velocity, visibility, species (entered by AOU species number, see appendix 1), number of each species foraging, number not foraging, number unknown, and comments. Birds were determined to be foraging by observation of known foraging techniques (Ehrlich, 1988). Please see volunteer information for worksheet on common foraging behaviors.

I used a grab sample technique to obtain an index of species abundance (Lancia, Nichols, and Pollock, 1994). I counted birds that were foraging and not foraging when I got to them at the sight. If a bird changed its foraging behavior after I counted the species, or if a new bird flew in, I did not change the count. The counts were for one particular point in time.

Results

Results from all counts are summarized in Appendix 1. Total foraging observations, and total species observations are recorded for each wetland. Percentages are calculated for each species at each wetland.

Table 1 is chi square analysis for species with sufficient sample size (at least 5 foraging and 5 not foraging) at each wetland.

<u>Species</u>	<u>x²</u>	<u>p</u>	<u>significant</u>
132 Mallard	67.8	.001	Yes - Grass
144 Wood Duck	3.34	.10	Yes - Oxborough
172 Canada Goose	4.11	0.5	Yes - Oxborough
273 Killdeer	22.32	.001	Yes - Oxborough
498 Red-winged Blackbird	1.19	--	No
613 Barn Swallow	22.58	.001	Yes - Grass
617 N. Rough-winged Swallow	39.22	.001	Yes - Grass
688.2 House Sparrow	9.48	.01	Yes - Grass

Table 1

Biodiversity

Biodiversity is a complex topic of much scientific debate. Briefly, there are two basic measures. Species richness is a count of the number of species present at a given place during a given time period. Relative abundance relates the number of species with the number of individuals of the species. Some species will be represented by many individuals, and others will have only one individual (Magurran, 1988).

Species richness is a very straightforward measure. Grass Lake had a total of fifty-three species of birds observed during the course of this study. Twenty-nine species of birds were observed at Oxborough Lake.

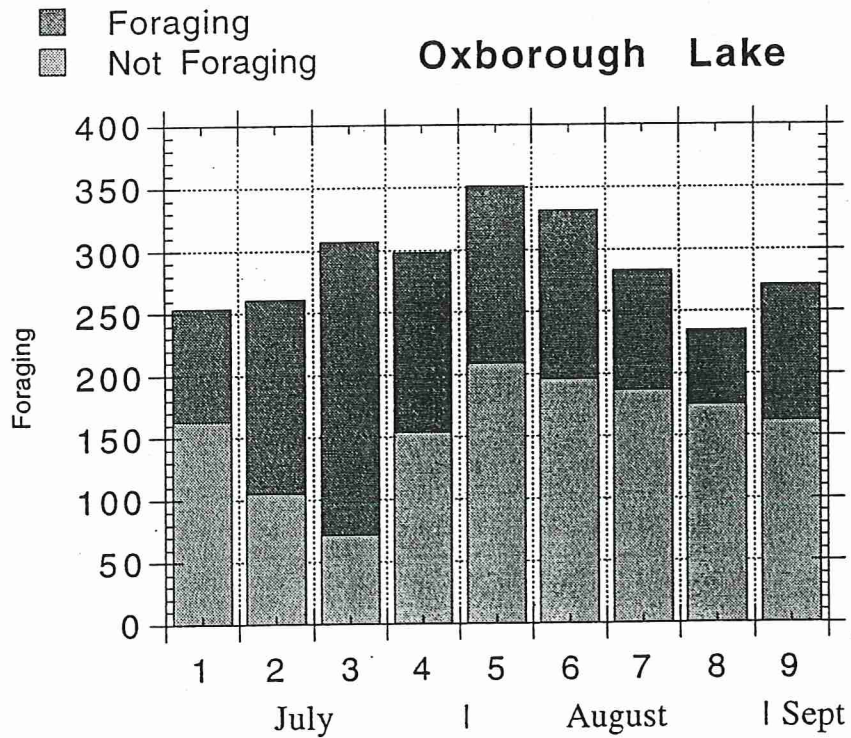
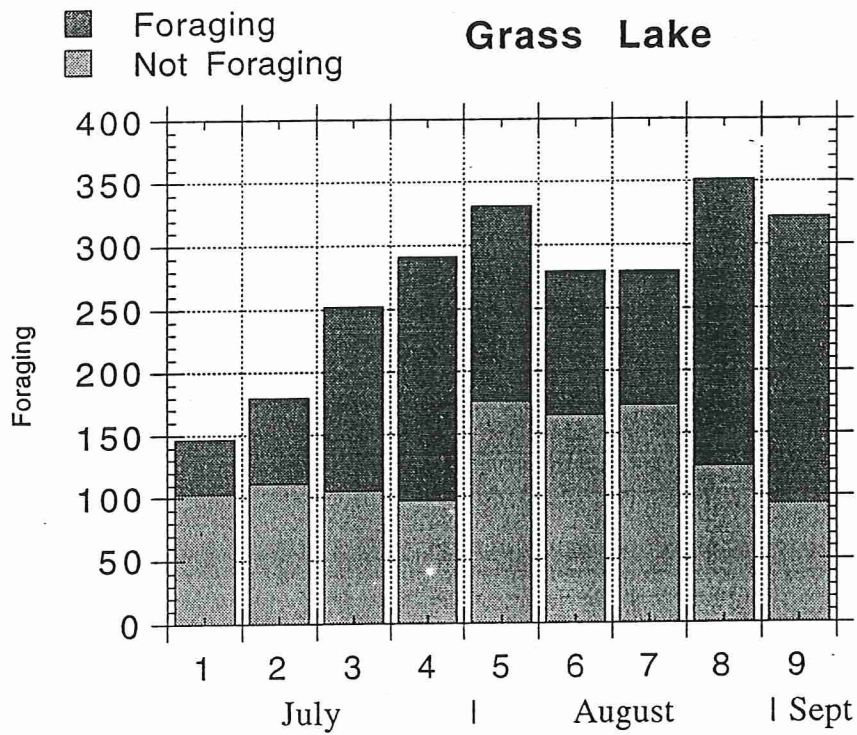
Relative abundance is a much more complicated measure. There are many different indices that can be calculated. For the purposes of this study, I have chosen the Shannon Diversity Index, as it is one of the most widely used and accepted methods (Magurran, 1988). It combines the relative abundance for many species into one number, the Shannon number. Also calculated are evenness, standard deviation, and statistical significance. Calculations from the index are shown in table 2 .

	<u>Grass</u>	<u>Oxborough</u>
Number of Species (S)	53	29
Mean No. Obs. (x)	236	181
Shannon No. (H')	1.568	1.014
Evenness (E)	.39488	.30110
Standard Deviation (SD)	.02345	.02387

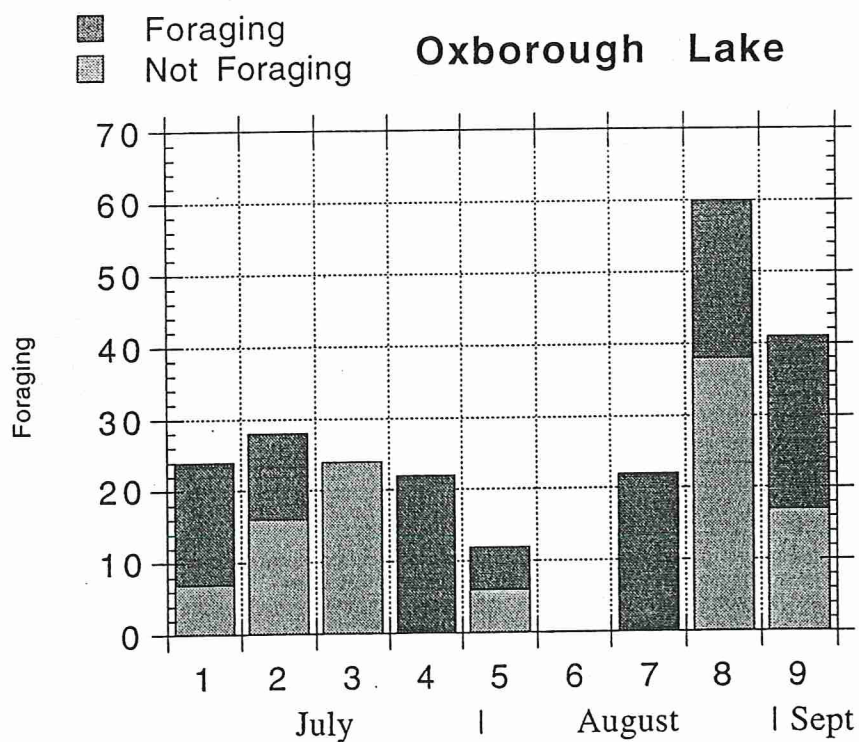
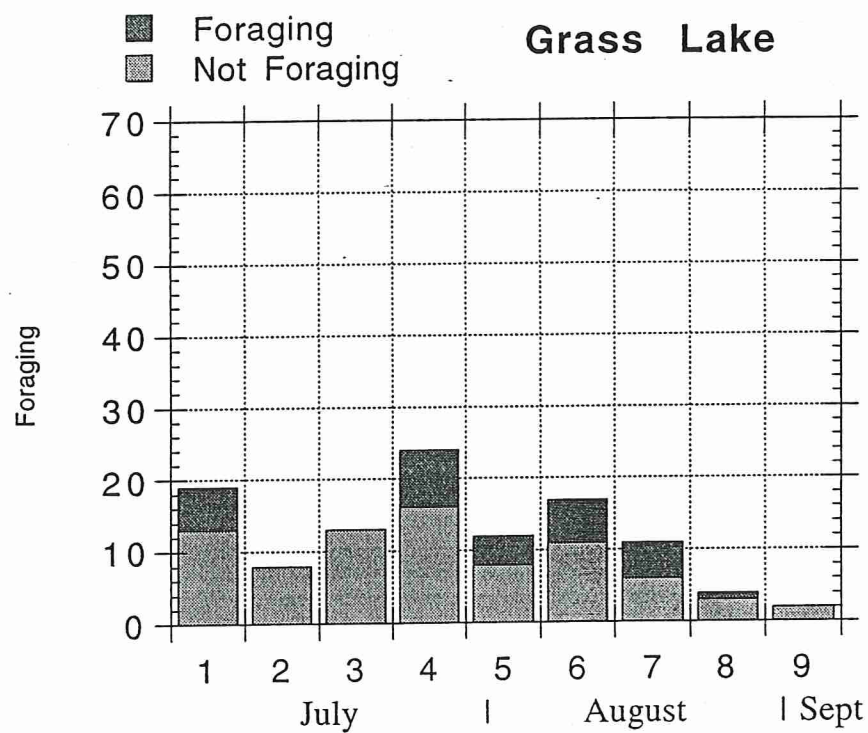
Test for significance $t = 16.5$; $p = .001$

Table 2

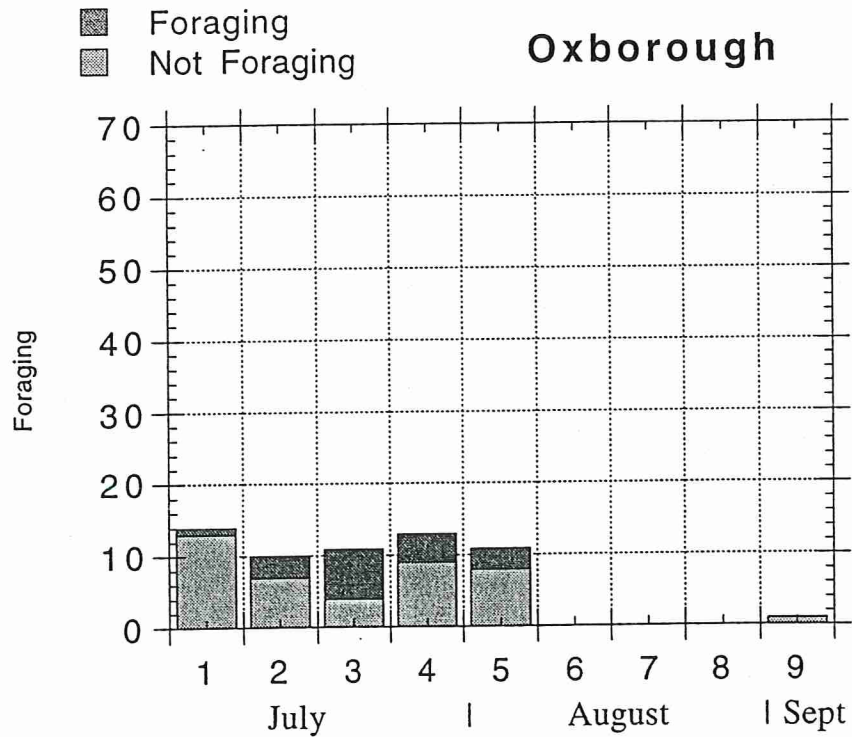
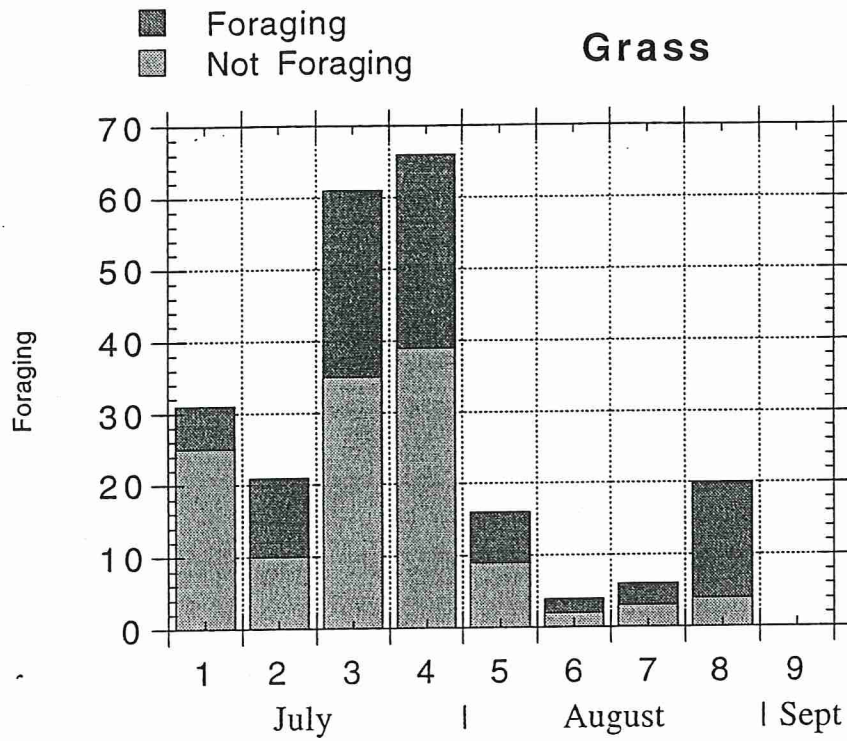
Comparison of Mallard Foraging by Week



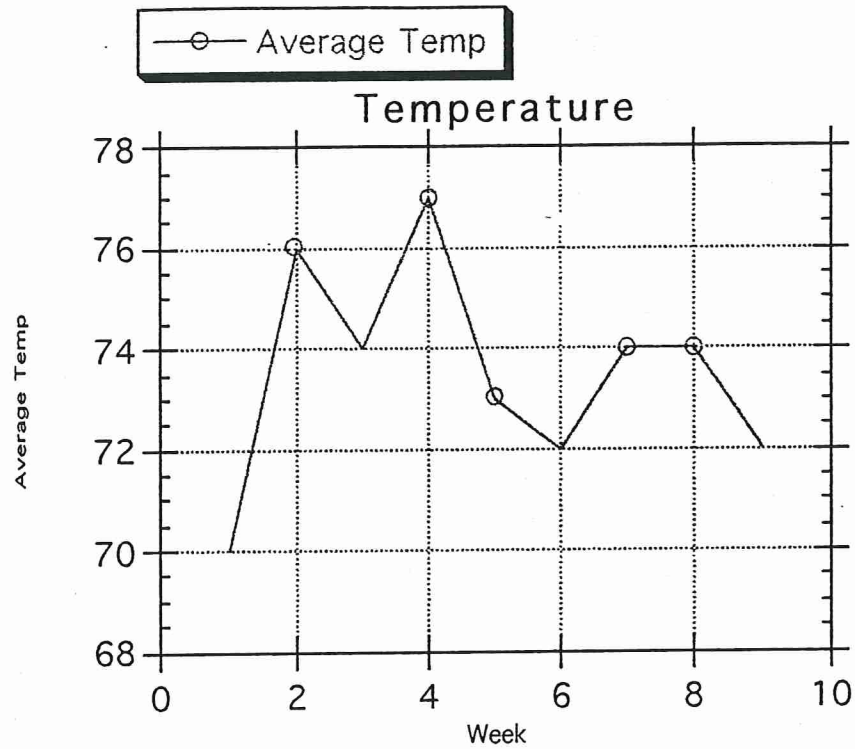
Comparison of Canada Goose Foraging by Week



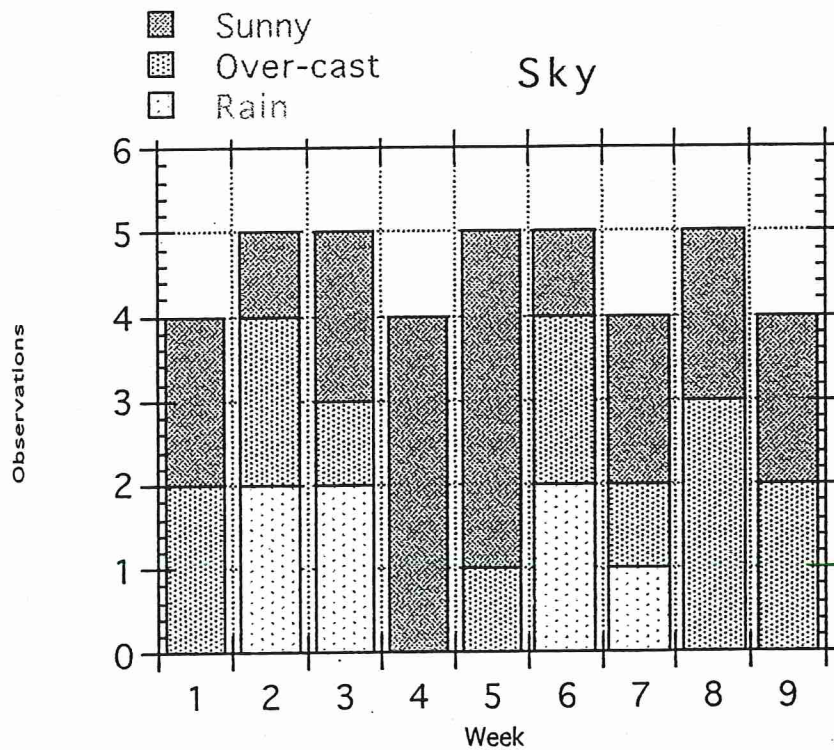
Comparison of Red-winged Blackbird Foraging by Week



Weather Information



Average Temperature at Time of Count



Sky Conditions for Each Observation by Week

Discussion and Conclusions

The chi square analysis lets us say something statistically significant about this study. By calculating chi square analysis (table 1), we are able to see statistical significance for some species. The χ^2 value is the chi-squared statistic. The "p" value is the significance level. Common "p" values range from .10 to .001. A "p" value of .10 would allow us to say that we are 90% sure that there is a statistically significant difference. With a value of .001, we can say that we are 99.9% sure.

There was significantly more mallard foraging at Grass Lake than at Oxborough Lake. Though percentages do not appear much different (53.8% foraging at Grass, and 44.3% at Oxborough), chi square analysis shows that this difference is highly significant ($p = .001$).

There was more wood duck foraging at Oxborough Lake than at Grass Lake. This difference was also statistically significant, though to a lower degree than for mallards ($p = .10$). The percentages appear quite different (58.8% foraging at Grass, and 70.2% at Oxborough).

For Canada geese, and for killdeer, there was statistically more foraging at Oxborough Lake. For the two types of swallows, and the house sparrow, there was statistically more foraging at Grass Lake. The red-winged blackbirds did not show a significant difference. The foraging in red-wings this year, was about equal for both of the wetlands.

Statistically, we can say that four species of birds had more foraging at Grass Lake, three species had more at Oxborough Lake, and one species had equal foraging at both wetlands. The rest of the species did not have a large enough sample sizes to determine significance. Data in future years will allow for statistical comparison of more species of birds.

The Shannon Diversity Index calculations are perhaps the most useful information obtained during this study. They can be compared over the years to observe trends in biodiversity. They can also be compared to other ecologically similar wetlands for which the index may be used in the future. A discussion of the variables used in the index follows.

The number of species (S) is the number of different species observed. The mean number of observations (x) is the average number of birds (all species combined) observed during one count. The Shannon number (H') is the result of a series of complex calculations. This is the number that can be used for comparison. Higher Shannon numbers indicate more species that are well represented in the sample and less species that have only one or a few individuals. Though there were more species at Grass Lake with only one individual, there were also more species with a greater number of individuals. This is why the Shannon number is higher at Grass Lake. Evenness (E) is calculated using the Shannon number. It tells us that the individuals in each species at Grass were more spread out than at Oxborough Lake. Notice that the standard deviation (SD) is slightly higher at Oxborough Lake. The t test is similar to the chi square analysis in the previous section of this paper. It tells us that the difference between the two Shannon numbers is highly significant ($p = .001$).

[All of the information collected during this study reveals that Grass Lake has large numbers and a great diversity of birds. It is a uniquely rich resource and deserves to be studied and protected.

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Appendix 1

Summary of 1995 observations

006 Pied-billed Grebe

Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	146	65.8	76	34.2	0	0	222
2	5	71.4	2	28.6	0	0	7

054 Ring-billed Gull

Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	5	26.3	11	57.9	3	15.8	19
2	2	33.3	4	66.7	0	0	6

069 Forster's Tern

Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	12	30.8	27	69.2	0	0	39
2	0	0	0	0	0	0	0

120 Double-crested Cormorant

Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	0	0	1	100	0	0	1
2	0	0	0	0	0	0	0

132 Mallard

Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	2131	53.8	1831	46.2	0	0	3962
2	1590	44.3	1999	55.7	0	0	3589

140 Blue-winged Teal

Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	4	50	4	50	0	0	8
2	0	0	0	0	0	0	0

144 Wood Duck

Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	178	57.2	133	42.8	0	0	311
2	40	70.2	17	29.8	0	0	57

146 Red Head

Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	4	100	0	0	0	0	4
2	0	0	0	0	0	0	0

150	Ring-necked Duck						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	1	50	1	50	0	0	2
2	0	0	0	0	0	0	0
167	Ruddy Duck						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	25	47.2	28	52.8	0	0	53
2	0	0	0	0	0	0	0
172	Canada Goose						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	46	33.6	91	66.4	0	0	137
2	101	43.3	132	56.7	0	0	233
194	Great Blue Heron						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	3	60	2	40	0	0	5
2	4	57.9	3	42.9	0	0	7
196	Great Egret						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	34	64.2	19	35.8	0	0	53
2	17	81	4	19	0	0	21
201	Green-backed Heron						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	12	52.2	11	47.8	0	0	23
2	0	0	0	0	0	0	0
202	Black-crowned Night Heron						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	0	0	2	100	0	0	2
2	0	0	0	0	0	0	0
221	American Coot						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	48	56.5	37	43.6	0	0	85
2	0	0	0	0	0	0	0

233	Stilt Sandpiper						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	1	100	0	0	0	0	1
2	0	0	0	0	0	0	0

263	Spotted Sandpiper						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	5	100	0	0	0	0	5
2	0	0	0	0	0	0	0

273	Killdeer						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	17	35.4	31	64.6	0	0	48
2	32	86.5	5	13.5	0	0	37

316	Mourning Dove						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	14	43.8	18	56.2	0	0	32
2	2	20	8	80	0	0	10

331	Northern Harrier						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	1	100	0	0	0	0	1
2	0	0	0	0	0	0	0

337	Red-tailed Hawk						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	1	100	0	0	0	0	1
2	0	0	0	0	0	0	0

390	Belted Kingfisher						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	2	100	0	0	0	0	2
2	1	50	1	50	0	0	2

394	Downy Woodpecker						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	8	100	0	0	0	0	8
2	1	50	1	50	0	0	2

412	Northern Flicker						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	2	66.7	1	33.3	0	0	3
2	2	66.7	1	33.3	0	0	3

420	Common Nighthawk						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	2	100	0	0	0	0	2
2	0	0	0	0	0	0	0

423	Chimney Swift						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	15	100	0	0	0	0	15
2	0	0	0	0	0	0	0

456	Eastern Phoebe						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	3	100	0	0	0	0	3
2	0	0	0	0	0	0	0

477	Blue Jay						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	0	0	10	100	0	0	10
2	0	0	5	100	0	0	5

488	American Crow						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	4	18.2	18	81.8	0	0	22
2	4	7.0	52	91.2	1	1.8	57

493	European Starling						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	1	50	1	50	0	0	2
2	12	31.6	26	68.4	0	0	38

495	Brown-headed Cowbird						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	0	0	1	100	0	0	1
2	0	0	1	100	0	0	1

497	Yellow-headed Blackbird						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	3	100	0	0	0	0	3
2	1	100	0	0	0	0	1
498	Red-winged Blackbird						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	103	40.1	143	55.6	11	4.3	257
2	22	34.4	42	65.6	0	0	64
507	Northern Oriole						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	0	0	0	0	0	0	0
2	0	0	1	100	0	0	1
511	Common Grackle						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	22	55	18	45	0	0	40
2	2	66.7	1	33.3	0	0	3
517	Purple Finch						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	2	40	3	60	0	0	5
2	4	100	0	0	0	0	4
519	House Finch						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	9	56.3	4	25	3	18.7	16
2	0	0	0	0	0	0	0
529	American Goldfinch						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	5	35.7	9	64.3	0	0	14
2	0	0	0	0	0	0	0
560	Chipping Sparrow						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	1	100	0	0	0	0	1
2	0	0	0	0	0	0	0
581	Song Sparrow						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	0	0	4	100	0	0	4
2	0	0	0	0	0	0	0

593	Northern Cardinal						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	3	37.5	5	62.5	0	0	8
2	3	37.5	5	62.5	0	0	8
613	Barn Swallow						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	55	87.3	8	12.7	0	0	63
2	48	50.5	47	49.5	0	0	95
617	Northern Rough-winged Swallow						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	47	81	11	19	0	0	58
2	40	31.5	87	68.5	0	0	127
624	Red-eyed Vireo						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	1	100	0	0	0	0	1
2	0	0	0	0	0	0	0
636	Black-and-White Warbler						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	1	100	0	0	0	0	1
2	0	0	0	0	0	0	0
645	Nashville Warbler						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	2	100	0	0	0	0	2
2	0	0	0	0	0	0	0
662	Blackburnian Warbler						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	2	100	0	0	0	0	2
2	0	0	0	0	0	0	0
685	Wilson's Warbler						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	1	33.3	2	66.7	0	0	3
2	0	0	0	0	0	0	0

688.2	House Sparrow						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	178	65.4	94	34.6	0	0	272
2	56	48.7	59	51.3	0	0	115
704	Gray Catbird						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	0	0	2	100	0	0	2
2	0	0	1	100	0	0	1
721	House Wren						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	0	0	2	100	0	0	2
2	0	0	0	0	0	0	0
727	White-breasted Nuthatch						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	0	0	0	0	0	0	0
2	0	0	2	100	0	0	2
735	Black-capped Chickadee						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	6	18.8	26	81.2	0	0	32
2	2	25	6	75	0	0	8
761	American Robin						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	15	42.9	20	57.9	0	0	35
2	13	72.2	4	22.2	1	5.6	18
000	Domestic Ducks						
Wetland	#Foraging	%	#NotForaging	%	#Unknown	%	Total
1	0	0	0	0	0	0	0
2	11	73.3	4	26.6	0	0	15

Appendix 2

Volunteer Information

Bird Foraging Study, Grass Lake

Volunteer Guide for Kenny Neighborhood Residents

Organizational Background:

The Kenny Neighborhood Association (KNA) is a volunteer-based community organization that assists residents in identifying and addressing community issues. As identified through neighborhood outreach efforts, KNA is concentrating on issues related to the natural habitat and water quality of Grass Lake. Studies being conducted in 1995 include an investigation of the proposed expansion of the Crosstown Highway, and a 'bird foraging' study.

Project Background:

Colleen Allen, a graduate student at the U of M, is conducting a bird foraging study on Grass Lake to assess the health and bio-diversity of the wetland. This study consists of taking a mental "snapshot" of the lake and counting the amount of each type of bird and noting the number foraging and how many aren't (see enclosed hand-out of foraging characteristics). This is also being done on another urban wetland (Oxborough Lake in Bloomington) for comparison. This research will be used to establish benchmarks for the quality of Grass Lake as a natural habitat and the impact of environmental actions on the wetland.

Colleen will be training interested residents on how to do this study so that the bird and bio-diversity information can be reliably gathered and evaluated over time.

Volunteer Responsibilities:

- Volunteers will be linked with Colleen through KNA staff. Colleen will work with residents until they feel comfortable to perform and enter the bird foraging data alone.
- Volunteers will then sign-up for days that they can perform the study, check the materials out of the KNA office, and perform the bird counting for the days they have chosen. It is hoped that volunteers can perform counts one day per week throughout mid-September. It is important that volunteers count at both Grass and Oxborough Lake due to possible variations in each individual researcher's style of collecting data.
- Volunteers may be asked to train, or work with, newer neighborhood volunteers on how to perform this study. Please feel free to recruit the help of your neighborhood friends!
- Volunteers must provide their own binoculars. A birdbook (for those unusual species!) is also helpful.
- It is hoped that volunteers trained this year can continue to perform this study next summer, or at minimum train new volunteers, so that changes in the lake can be noted over time.

The Kenny Neighborhood Association thanks you for your time, interest, and skill!

Project Proposal

Wetland Bird Foraging Study

Colleen Clark
University of Minnesota
Department of Fisheries and Wildlife

Background:

Neighborhood residents of the Grass lake community have noticed a major decline in the quality of Grass lake. Residents are concerned about the possible impacts of freeway (I35) expansion and storm water runoff.

Proposal:

I propose a time budget study of wetland bird foraging. Birds can be used as an indicator of wetland quality. Bird foraging is dependent upon the presence of suitable food resources. If the resources are not available, the birds will not forage in the area. Bird foraging is also visible and quantifiable. Insectivorous and other wetland birds will be evaluated based on their presence and foraging frequency. A comparable, ecologically similar wetland will serve as a control for this project. Time budgets for several bird species at each location will be calculated. This will allow for a quantifiable comparison between Grass lake and the control site.

A successful study of this type was conducted by Peterson and Cooper (1987). This study used bird foraging as an indicator to determine harmful effects of center pivot irrigation systems. The study ended up being a powerful argument in disallowing use of the system in wetlands protected by government easements.

Methods and Materials

A control site will be chosen on the basis of size, depth, hydrology, and residential surroundings. The freeway (I35) and/or the amount of storm water runoff diverted to the wetland under study will serve as a variable.

A survey of insectivorous and other wetland birds will be made at each site. Several species will be evaluated for study. Birds will be chosen on the basis of presence at each site, and abundance.

Time budget analysis will be used for equal number of hours for the same species of birds at each site. Methods will be similar to Grant, Henson and Cooper (1994). Time budgets will be recorded on a NEC computer for analysis. Statistically significant differences in the amount of bird foraging will be evaluated.

Literature Cited

- Grant, T.A., P. Henson, and J.A. Cooper. 1994. Feeding Ecology of Trumpeter Swans Breeding in South Central Alaska. *J. Wildl. Manage.* 58(4):774-780.
- Peterson, T.L. and J.A. Cooper. 1987. Impacts of Center Pivot Irrigation Systems on Birds in Prairie Wetlands. *J. Wildl. Manage.* 51(1):238-247.

Grass Lake Bird Foraging Study
Procedure for GRASS3 Program

Turn on power switch on right side of computer
Plug in printer and turn on power
Be sure CAPS key is down (caps lock)
Use arrow keys to move cursor to GRASS3.BA
Press enter (return)

FOLLOW INSTRUCTIONS ON SCREEN

Press any key (except spacebar) to continue

Check date and time

enter Y if date and time are correct

enter N if they are not and follow instructions to change them

enter D if error in date

enter T if error in time

enter B if error in both date and time

enter date in format shown "YR/MO/DAY"

remember to put in Quotation marks " "

enter time in format shown "HR:MN:SEC"

remember to put in Quotation marks " "

Enter Wetland Number

1 = Grass Lake

2 = Oxborough Lake

Enter station number (See Maps)

Grass has 5 stations

Oxborough has 3 stations

Enter Observer Initial (Must be programmed in, see Coordinator for
your initial)

Enter weather information to the best of your knowledge

Sky? Use function keys at top

f1 - O-cast

f2 - L-rain

f3 - M-rain

f4 - H-rain

f5 - Sunny

Temp? Enter temperature to the best of your knowledge
in degrees Fahrenheit

Wind Direction? Enter to the best of your knowledge N E S W or
combination

Wind speed? Enter to the best of your knowledge in Miles per Hour

Visibility - enter visibility in percent visible
100 for all, 50 for half, etc.

All OK enter Y

If not - enter N - re enter information that is not correct - default for
info that is correct

Press any key to begin

Enter species number from the list

Check to be sure that the species number is correct, enter Y if it is

Enter E to enter the foraging information directly

Enter number feeding

Enter number not feeding

Enter number unknown

Enter comments

Enter K to use the tally function or (Keys)

Push F for each foraging bird

Push N for each bird that is not foraging

Push U for each bird that is unknown to be foraging or not

Push Q when you are finished entering

Add any comments you may have

Check that Foraging, not, and unknown numbers are correct
and that comments are correct

If they are not press line number to change

1 - to change species number

2 - to change number feeding

3 - to change number not feeding

4 - to change number unknown

5 - to change comments

Press 9 when correct

Enter the next species number OR

Enter QUIT if you are finished with the station

Enter Y to confirm

Enter Y for another station

Enter station number OR

Enter N if you are finished

The next screen is the interval screen

It should say weather conditions, time, and seconds remaining

At this point you may wait the interval (which is set at an hour) and repeat the observation

OR

Press the f4 (Function 4) key which is set at Quit to Quit the program

Press Y to confirm

Turn off computer and printer

Restart at the Next Wetland

Trouble shooting

Screen says: ?SN ERROR or

nothing appears on screen, but it allows you to type

Try entering: MENU

If screen goes blank

Try shutting computer off and then back on

You will have to enter in all of the weather information again.

This computer is designed to shut down when not in continuous use.

If computer freezes up

Try ESC to escape or

Try Shift STOP

It should give you an error signal

enter MENU as above

Time: _____

Station	1	2	3	4	5
---------	---	---	---	---	---

Visibility: _____ %

Sky: O-cast L-rain M-rain H-rain Sunny

Wind Speed: _____

[illegible]

Foraging Behaviors of some common wetland birds:

By Colleen Allen
for the Grass Lake Bird Foraging Study

Pied Billed Grebe - Diver - Eats aquatic insects, snails, fish, frogs, and occasional vegetation - Dives under water to eat - sinks to hide, leaving only head and neck sticking up out of water

Forster's Tern - Flies around wetland eating insects, also eats dead fish, frogs (live or dead) - aerial forager, dives occasionally

Mallard - Eats shoots and seeds of sedges, grass, aquatic vegetation, grain, acorns, aquatic invertebrates, insects - Tail up with head down (dabbling), pecking in water

Wood Duck - Eats seeds, acorns, berries, grains, aquatic and terrestrial insects, other invertebrates- dabbling, pecking with bill on water or land

Ruddy Duck - Diving duck - eats aquatic insect larve, snails, and other invertebrates, aquatic vegetation- dives under surface of water, strains animals from soft substrate, surface periodically

Canada Goose - Terrestrial grazers - eat mostly grass, also shoots, roots, seeds, bulbs, grain, berries, insects, crustaceans, and mollusks - often eat on lawns, will also eat in the water, pecking at water or head under water

Great Blue Heron - Stalk and strike - Stands motionless and quickly spears prey - eats lots of fish, also aquatic invertebrates, small mammals, nestlings, and human food scraps

Great Egret - Stalk and strike - eats fish, insects, frogs, crayfish, other invertebrates and small vertebrates, and small birds

Green-backed Heron - Stalk and strike - eats fish, insects, and other invertebrates

Black-crowned Night Heron - Stalk and strike - eats fish, insects, eggs, young birds (terns, herons), small mammals, amphibians, and other lower vertebrates

American Coot - Eats aquatic vegetation, algae, fish, tadpoles, crustaceans, snails, worms, aquatic and terrestrial insects, and eggs of other wetland nesting birds - dips at surface, gleans food from ground and vegetation

Killdeer - Eats around 75% insects, also other invertebrates- probing in mud, gleaning from ground

Mourning Dove - Eats seeds - Glean from vegetation

Blue Jay - Omnivorous - Eats variety of plants and animals - Eats acorns, fruit, nuts, seeds, insects, carrion, bird eggs and nestlings - Hawking - Short flights taken from perch to capture flying insects.

American Crow - Omnivorous - Eats insects and other invertebrates, carrion, bird eggs and nestlings, other small vertebrates, and seeds, fruit, and nuts

European Starling - Eats insects, other invertebrates, fruit, seeds, and berries

Yellow-headed Blackbird - Eats insects, spiders, seeds - gleans from ground and foliage, also Hawking

Red-winged Blackbird- Eats insects, spiders, seeds - gleans from ground and foliage, also Hawking

Common Grackle - Omnivorous - Eat insects, crustaceans, spiders, other terrestrial and aquatic invertebrates, fish, bird eggs, nestlings, fruit, grain, grass and forb seeds, acorns, nuts - glean from ground and vegetation, also steal food from other birds, esp. Robins

Brown-headed Cowbird - Eats insects, spiders, snails, grain, grass and forb seeds - Gleans from ground

Purple Finch - Eats seeds, tree buds and blossoms (Winter, early spring), insects (spring), fruit (summer) - glean from ground and vegetation

House Finch - Eats seeds, fruit, buds, tree sap, (eats almost no insects, feeds nestlings seeds) - gleans from ground and vegetation

American Goldfinch - Eats seeds of decid. trees, forbs, and grasses, floral buds, berries, insects - gleans from ground and vegetation

Chipping Sparrow - Eats insects, spiders, grass and forb seeds - gleans from ground and vegetation, also Hawking

Song Sparrow - Eats insects, grass and forb seeds, berries - gleans from ground and vegetation

Northern Cardinal - Eats insects, seeds, and fruit - gleans from ground, often visit bird feeders

Barn Swallow - Eats mostly insects, also occasional berries and seeds - aerial forage

N. Rough-winged Swallow - Eats insects - aerial forage, occasionally takes from ground

House Sparrow - Insects, spiders, grass and forb seeds, blossoms, fruit - Gleans from ground and vegetation

Black-capped Chickadee - Eats insects, spiders and their eggs, conifer seeds, fruit - gleans from bark and vegetation

American Robin- Eats insects, earthworms, snails, fruit - Gleans from ground and vegetation

Reference from:

Ehrlich, P.R., D.S. Dobkin, and D.Wheye. 1988. The Birder's Handbook. Simon & Shuster Inc., New York.

Appendix of Foraging Behaviors

Aerial Foraging - Captures flying insects while in continuous flight

Bark Gleaning - Taking insects from the bark of trees, and drilling into trees

Dabbling - While floating in shallow water, pivots head down and raises tail above water to reach submerged plants or animals

Diving - Dives under surface of the water to feed on bottom

Ground Gleaning - Picking up food from the ground, and/or shoreline

Hawking - Short flights from perch to capture flying insects

Stalk and Strike - Stands motionless and quickly spears prey

Terrestrial Grazer - Grazes on Land

Vegetation Gleaning - Taking items such as insects, seeds, or fruit from leaves or branches, not from the ground

Birds

Pied-billed Grebe	006	PBGR
Ring-billed Gull	054	RBGU
Forster's Tern	069	FOTE
Mallard	132	MALL
Wood Duck	144	WODU
Red Head	146	REDH
Ruddy Duck	167	RUDU
Canada Goose	172	CAGO
Great Blue Heron	194	GTBH
Great Egret	196	GREG
Green-backed Heron	201	GNBH
Black-crowned Night-Heron	202	BCNH
American Coot	221	AMCO
Spotted Sandpiper	263	SPSA
Killdeer	273	KILL
Mourning Dove	316	MODO
Northern Harrier	331	NOHA
Belted Kingfisher	390	BEKI
Downy Woodpecker	394	DOWO
Northern Flicker	412	NOFL
Blue Jay	477	BLJA
American Crow	488	AMCR
European Starling	493	EUST
Yellow-headed Blackbird	497	YHBL
Red-winged Blackbird	498	RWBL
Northern Oriole (Baltimore)	507	
Common Grackle	511	COGR
Purple Finch	517	PUFI
House Finch	519	HOFI
American Goldfinch	529	AMGO
Chipping Sparrow	560	CHSP
Song Sparrow	581	SOSP
Northern Cardinal	593	NOCA
Barn Swallow	613	BARS
N. Rough-winged Swallow	617	NRWS
House Sparrow	688.2	HOSP
Black-capped Chickadee	735	BCCH
American Robin	761	AMRO

Appendix M

Student Report, Lanya Ross, University of Minnesota

***Student Report, Lanya Ross, Macalester College**

* This section of the Grass Lake Hydrologic Study was to include "Grass Lake: Past, Present, and Future," but instead was submitted under a separate cover and can be obtained from the Kenny Neighborhood Association, 5516 Lyndale Avenue South, Minneapolis, MN 55419

