PRAIRIE ROSE LAKE MONITORING RCWP PROJECT - YEAR 4 (1984)

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I. Introduction

This report presents the results of the water quality monitoring of Prairie Rose Lake during the Rural Clean Water Program (RCWP) Project Year 4 (1984). This report is the 1984 annual supplement to the report entitled "Prairie Rose Lake Monitoring RCWP Project - Year 1 (1981), March 23, 1982". The 1981 report contains a comprehensive review of lake quality information prior to the start of the RCWP project as well as the information collected in the first RCWP project year. Annual lake monitoring reports will be prepared throughout the duration of the RCWP project.

The information presented in this report pertains only to water quality and water quality related data. The results obtained from the 1984 monitoring program are presented and discussed. Results obtained in 1983, not available for the 1983 report, have also been included in this 1984 report. In addition, a comparison has been made with the 1981, 1982 and 1983 sampling results to the 1984 results for determining trends or changes in lake quality.

Section 208 funding was obtained from EPA for a multi-year contract to perform water quality monitoring at Prairie Rose Lake. This EPA funding will ensure the continuance of an annual water quality monitoring program at Prairie Rose Lake, as required by RCWP regulations, for the 1985 RCWP project year.

II. Conclusion

The generally cool and wet April through June followed by a dry period from July through September provided contrasting climatic conditions within the 1984 lake monitoring program at Prairie Rose Lake. Although these contrasting climatic situations were present during the 1983 monitoring program, the above normal precipitation in 1983 occurred approximately one month prior to the start of the sampling program. Undoubtedly, the greater than normal precipitation received in the Prairie Rose Lake watershed during 1984 (in the first two months of the five month sampling period) was the influencing factor upon the lake's water quality from that observed in 1983 when exceptional water clarity was experienced into the start of the monitoring program.

Prairie Rose Lake's water based recreational usage has been increasing since 1982. Recreational activities at the lake were curtailed by the lake drawdown and total fisheries removal in the fall of 1981. A sport fishery restocking program commenced in late fall of 1981 and the initial phase of the restocking program was completed in 1983. The 1983 fish inventory and 1984 creel census results indicated the sport fishery is still in the developmental stage. The lake's fishery appeared to be progressing on schedule, growth and body condition of all species were quite good.

No fishkills or algal blooms were reported in 1984. Aquatic weed growth, which first appeared in 1982, was observed in 1984. White amur have been stocked in the lake to control nuisance submergent aquatic vegetation growth. Despite the excessive rainfall received in the watershed in May and June, the lake turbidity levels were generally characterized as low to normal. High lake water turbidity, especially after rainfall-runoff, was the major water quality problem at Prairie Rose Lake prior to the RCWP project implementation.

Lake water turbidity throughout the 1984 sampling season showed a positive correlation with algal populations, as indicated by the chlorophyll-a concentration. Secchi transparencies did not show a substantial change between measurements taken in the upper reach of the lake and near the dam. The similarity in secchi transparencies between the inlet and outlet of the lake supports the conclusion that suspended sediments played a minor role in the water clarity observations in 1984.

Conclusions from the 1984 water quality sampling program, conducted at three lake locations at both top and bottom depths, demonstrated the following. No change in pH was observed from previous years. The average lake surface dissolved oxygen concentrations, except near the dam, were lower than previously calculated. All other average D.O. levels were similar to those previously encountered. Thermal stratification occurred between June and August. At no time did an anoxic condition exist. Lake surface chlorophyll-a concentrations showed an increase in the 1984 results compared to the previous years' results. Measured lake turbidities from 1984 demonstrated that lake turbidity values have been on an increase since 1982. Turbidity levels since 1982 have nonetheless shown a reduction from the extreme high turbidity levels experienced in 1981 from bottom samples. Surface turbidity levels experienced in 1984 were similar to those observed in 1981 at the sampling sites nearer to the dam. Surface turbidity levels in 1984 in the upper reach of the lake were below 1981 turbidity levels at that site. Total phosphorus levels at all sampling locations were similar to those obtained during the previous years. In 1984, however, less variation between surface and bottom total phosphorus concentrations was found. Lake soluble phosphorus levels in 1984 were elevated from concentrations measured in 1983. Nitrate-nitrogen levels in 1984 parallelled the observed decreasing trend throughout the season as exhibited in 1982 and 1983. Lake total ammonia-nitrogen levels experienced in 1984 were decreased by nearly one-half of the 1983 levels at the two sampling sites closer to the dam. To determine the limiting growth factor, two algal assays were performed in 1983 and three in 1984. All algal assays, with the exception of the later 1983 algal assay, indicated that phosphorus was the limiting nutrient. Nitrogen was the limiting nutrient in the exception.

In spite of the plentiful rainfall in the early part of the sampling season, only one fecal coliform value was above the water quality standard. Bacterial sample collection following rainfall-runoff in 1984 was unsuccessful in determining peak bacterial levels after runoff. No sediment samples, fish samples, or samples at the drinking water intake were collected in 1984. The results from the 1983 samples collected at the drinking water intake suggested that pesticide levels have been decreasing since 1981. Recommendations for the 1985 monitoring program have been included.

III. Monitoring Strategy for Project Year 4 (1984)

The monitoring strategy used in RCWP Project Year 3 was modified slightly to provide the monitoring strategy used during RCWP Project Year 4. The modifications made for the 1984 sampling program were based on recommendations made from reviewing the results from the first three years of monitoring. Justification for each recommended modification can be found in Section V.C. of the 1983 report. One additional modification was made to the 1984 monitoring strategy pertaining to the annual fish analyses. The resources for the whole fish analysis were required at other higher priority locations in the state. Therefore, no analyses for pesticides and heavy metals were performed in 1984 on fish from Prairie Rose Lake.

The modifications incorporated into the monitoring strategy for 1984 compared to the strategy used in 1983 were:

1. eliminating the sediment sampling during 1984;
2. performing nutrient analyses on a biweekly frequency rather than monthly; and,
3. eliminating the annual whole fish analysis for pesticides and heavy metals in 1984.

Tables 1 and 2 outline the entire water quality monitoring program established for 1984.

Additional lake information was collected by the Iowa Conservation Commission. This information was associated with physical conditions of the lake, user numbers, and fish inventories. A complete listing of the information to be collected by the Iowa Conservation Commission can be found in the RCWP Project Year 1 Report, Section II.B.1.

TABLE 1

Fixed Schedule Summer Sampling

Sampling Location	Sampling Frequency	Sample Analysis
a) Lake surface and bottom depths at: 1 - upper reach of lake 2 - mid lake 3 - deepest point of lake (near the dam)	Biweekly from May thru September*	turbidity, chlorophyll-a, corrected chlorophyll-a, pH, temperature, dissolved oxygen, total phosphate, orthophosphate, nitrate nitrogen, ammonia nitrogen
b) Same as a	Biweekly from June thru August	fecal coliform
c) Site 3 at depths of 0, 6.5, 13, 20 and 24 feet	Monthly from May thru September	pH, temperature, dissolved oxygen
d) Not specified	Three times between May through September	algal assay

*Secchi transparency, wind speed and direction will be measured at the time samples are collected. Secchi transparency will be taken at all three sites. Cloud cover conditions will also be noted.

TABLE 2

Sample Collection During Periods Lake Water Quality Is Affected By Runoff Conditions*

Sampling Location	Sampling Frequency	Sample Analysis
a) Surface and bottom depths at drinking water intake	One rainfall event per year - sample within 24 hours of rainfall ≥ two inches during period of May-September.	pesticides
b) Same as a	Same as a.	arsenic, barium, copper
c) Surface and bottom at swimming beach	At 24-hour intervals, to a maximum of five days, following the first two rainfall-runoff events ≥ one inch during period of June-August. Thereafter, at intervals of 24 and 48 hours (or otherwise specified) following all rainfall events ≥ one inch during period of June-August (Maximum of seven events will be sampled.	fecal coliform

*Records of precipitation at lake will be maintained.

IV. Data Collected During the RCWP Project Year 4 (1984)

A. Water Quality Related Information

1. Annual User Information

1984 park user figures, as estimated by the park ranger, totalled 129,147. The information obtained on fishing was recorded by a creel clerk employed at Prairie Rose Lake from June through August. A breakdown of each major use activity and user totals per activity is shown below.

	User Totals
Fishing	
From boats	904
Shore fishing	2,443
Swimming	75,500
Pleasure boating	250
Picnicking, camping, other activities prompted by the lake's presence	50,000
Snowmobiling	25
Ice skating and cross country skiing	25

2. Fish

a. Population Inventories

Restocking of largemouth bass was concluded in July of 1983 with the addition of 10,500 fingerlings. This completed the initial restocking program following the 1981 renovation work at Prairie Rose. The only future stockings anticipated at the lake are yearly maintenance stocking of channel catfish and tiger musky. Grass carp will be added for weed control as needed.

Two population surveys were conducted at Prairie Rose during the summer of 1983; the first on August 15th and the second on October 13th. Fyke nets, electro-fishing, and a 30 foot bag seine were used by management personnel in an attempt to sample all species and sizes of fish present in the lake.

Black bullhead was the most commonly sampled species in both surveys. Two sizes of sih predominated. Bullheads in the six to eight inch range were the most common, followed by another group in the nine to 11 1/2 inch range.

The 1982 and 1983 stockings of largemouth bass were evident in both surveys. The mid-October survey found the initial stocking of bass in the 12-14 inch range. The 1983 stocking showed a range from six to nine inches.

A relatively large number of channel catfish were found over a wide range of lengths. Stocking survival from the 1981, 1982 and 1983 transplants has evidently been good. Fish sampled ranged in length from seven inches to 16 inches with the greatest concentration at approximately ten inches.

Bluegill were not found in the numbers that would be expected in either survey conducted in 1983. The 1981 stocked fish were relatively common in the 1982 survey and did successfully spawn in 1982. These 1981 stocked bluegill however were conspicuously lacking in 1983 surveys. Their reproduction was found in fairly good numbers in 1983, ranging in length from four to six inches. It is unfortunate the 1981 stocking disappeared as they would have been expected to make a significant impact on the 1984 creel.

Black crappie were introduced as adults in May, 1983. These fish successfully spawned and were sampled in the fall survey. This first spawn averaged between five to six inches in October and are expected to have an impact on the 1984 and 1985 angler harvest.

Young-of-year carp were sampled in both surveys. One must conclude the 1981 renovation was not totally successful as had been hoped. These fish ranged in length from nine to 14 inches in the October sampling. No adult carp were collected in either survey.

The results of the 1984 fish population inventories are not available at this time and will be included in next year's report.

b. Creel Census

OBJECTIVES

1) Determine standard catch statistics using an expandable creel survey from June 1 - August 31, 1984.

2) Monitor angler use of the fish attractors which have been placed in the lake since renovation.

3) Evaluate angler compliance with the minimum length limits on largemouth bass and tiger musky.

4) Determine the effectiveness of yearly maintenance stockings of channel catfish and tiger musky.

METHODS AND PROCEDURES

A creel clerk was employed at Prairie Rose Lake from June through August, 1984, and worked most weekend days and holidays during this period. The remaining days were chosen randomly to total 40 hours weekly. Creel periods, chosen randomly, were either 7:00 a.m. to 2:00 p.m. or 2:00 p.m. to 10:00 p.m. Angler counts were taken every two hours. Angler interviews were made continuously and provided statistics on hours fished; trip length; and numbers, species and sizes of fish taken.

RESULTS

Three thousand, three hundred forty-seven anglers fished Prairie Rose Lake from June through August, 1984 (Table 3). The mean trip length was 1.95 hours and fishermen spent 6,878 hours fishing. Catch rate averaged 1.5 fish per hour. Total catch equalled 9,502 fish.

Black bullhead continued to be the most often caught fish (Table 4). Eight thousand, five hundred twenty-one bullheads were harvested over the three month period, accounting for 89.7 percent of the total catch. They were followed in importance by bluegill and channel catfish.

3. Physical Conditions of Prairie Rose Lake - 1984

A weekly evaluation was kept on the general physical conditions at Prairie Rose Lake by the creel clerk from May 1st through August 18th. The lake level was full throughout the entire evaluation period. Water levels exceeded impoundment capacity, as noted by spillway releases, throughout the period. At the onset of the observation period, the lake's water level was approximately six inches above the top of the primary spillway. The lake's water level slowly decreased throughout the observation period.

No fishkills were observed or reported in 1984.

Weekly turbidity observations in the lake were considered as low to normal throughout the observation period (May 1 - August 18) with the exception of the period covered from August 5th through August 11th. During this one week period, high turbidities were noted in the upper reach and in mid-lake but normal turbidities were noted near the dam. The reason for the high turbidities was not identified. Less than one inch of rain was received during this observation week and no rainfall was received in the previous observation week. Variable turbidity due to rainfall-runoff was noted during the week of June 3 - June 9. During this observation period nearly 2 1/2 inches of total rainfall was received on three separate days within the week.

No algal blooms were observed or reported during the observation period. A significant amount of aquatic week growth was first noted during the week of June 24 - June 30 and continued through July 14th. The weed growth occurred along the southeast corner, north shore and south side of the lake.

TABLE 3

Pressure, Harvest and Catch Rate at Prairie Rose Lake - June-August, 1984

Month	Total Angler Trips	Total hrs. Fished	Total Catch	$\overline{x}$ Trip Length (hrs)	Catch Rate (fish/hr)	Catch Rate (fish/trip)
June	1,500	3,024	5,833	2.00	2.05	3.9
July	880	1,920	2,238	1.85	1.30	2.5
August	967	1,934	1,431	2.00	0.74	1.5
Totals:	3,347	6,878	9,502	1.95	1.36	2.6

TABLE 4

Sport Harvest at Prairie Rose Lake - June-August, 1984

Species	No.	Mean Length (in)	Mean wt (oz)	T. wt (lbs)	lbs/acre	% of Total No.	% of Total Wt.
B. Bullhead							
June	5,489	7.1	3.1	1,063.5	5.2	94.1	92.7
July	1,929	7.5	3.5	421.9	2.1	86.2	86.7
August	1,103	7.2	3.0	206.8	1.0	77.1	75.6
Totals:	8,571	7.3	3.2	1,692.2	8.3	89.7	88.7
Bluegill							
June	145	5.6	3.2	49.0	.24	4.2	4.3
July	210	5.9	2.8	36.8	.18	9.4	7.6
August	202	6.0	2.7	34.1	.17	14.1	12.5
Totals:	657	5.8	2.9	119.9	.59	6.9	6.3
C. Catfish							
June	58	10.3	5.7	20.7	0.10	1.0	1.8
July	49	9.3	6.7	20.5	0.10	2.2	4.2
August	50	10.3	5.7	17.8	0.09	3.5	6.5
Totals:	157	9.9	6.0	59.0	0.29	1.7	3.1
Yellow Perch							
June	18	6.7	2.9	3.3	0.02	0.3	0.3
July	26	6.7	2.9	4.7	0.02	1.2	1.0
August	42	7.8	4.0	10.5	0.05	2.9	3.8
Totals:	86	7.0	3.3	18.5	0.09	0.9	0.9
Green Sunfish							
June	12	5.5	2.0	1.5	0.01	0.2	0.1
July	22	5.7	2.1	2.9	0.01	1.0	0.6
August	34	5.0	2.1	4.5	0.02	2.4	1.6
Totals:	68	5.4	2.1	8.9	0.04	.7	0.5
White Amur							
June	6	12.0	24.0	9.0	0.04	0.1	0.8
July	---	--	--	--	--	--	--
August	---	--	--	--	--	--	--
Totals:	6	12.0	24.0	9.0	0.04	0.1	0.5

B. Water Quality and Fish Data

In Figure 1, a map of Prairie Rose State Park, the five in-lake water quality sampling locations used in the monitoring program for Project Years 1 through 4 are identified. These sites correspond to the sampling locations described in the monitoring strategy. A description of each site is as follows:

Type of Sampling	Site #	Storet Number	Description	Maximum Depth
Fixed Schedule	1	L00580	Upper Reach of Lake	8 feet
Fixed Schedule	2	L00589	Mid-Lake South of Swimming Beach	11 feet
Fixed Schedule	3	L00578	Near Dam (also the deepest part of the lake)	24 feet
After Runoff	4	L00581	Drinking Water Intake	15 feet
After Runoff	5	L00579	Swimming Beach	11 feet

All 1984 water quality samples at Prairie Rose Lake were collected between May 2, 1984, and September 17, 1984. Table 5 provides the fixed sampling schedule established for the collection of the samples specified in Table 1 of the 1984 monitoring strategy with the exception of the algal assays. The results of the sampling outlined in Table 5 at sites #1, #2 and #3 can be found in Appendix 1984A.

The data from the September, 1983, algal assay performed by the EPA laboratory is contained in Table 6. Algal assays were performed in 1984 on three separate sampling dates. Samples for the 1984 algal assays were collected at sampling site #1 and #3, described in Table 1. The sample collected from site #3 was depth composited; whereas the sample collected from site #1 was taken just below the lake surface. The results from the 1984 algal assays were obtained from EPA and have been included in Appendix 1984A. Unfortunately the raw data from the algal assays was not sent along with the results; thus, the data, as presented in Table 6 for the 1983 algal assay, is unavailable for inclusion into this report.

A detailed listing of the recorded rainfall events in the watershed throughout the sample collection period has been included in Table 7. This information was compiled by the park ranger at Prairie Rose Lake who monitored rainfall events with a rain gage located to the lake. Although a rainfall intensity meter was located adjacent to the lake and in operation throughout the entire sampling period, it was discovered that there was a malfunction with the equipment throughout the sampling period. The rain gage proved to be a valuable back-up for obtaining rainfall records.

FIGURE 1 SAMPLING LOCATIONS USED

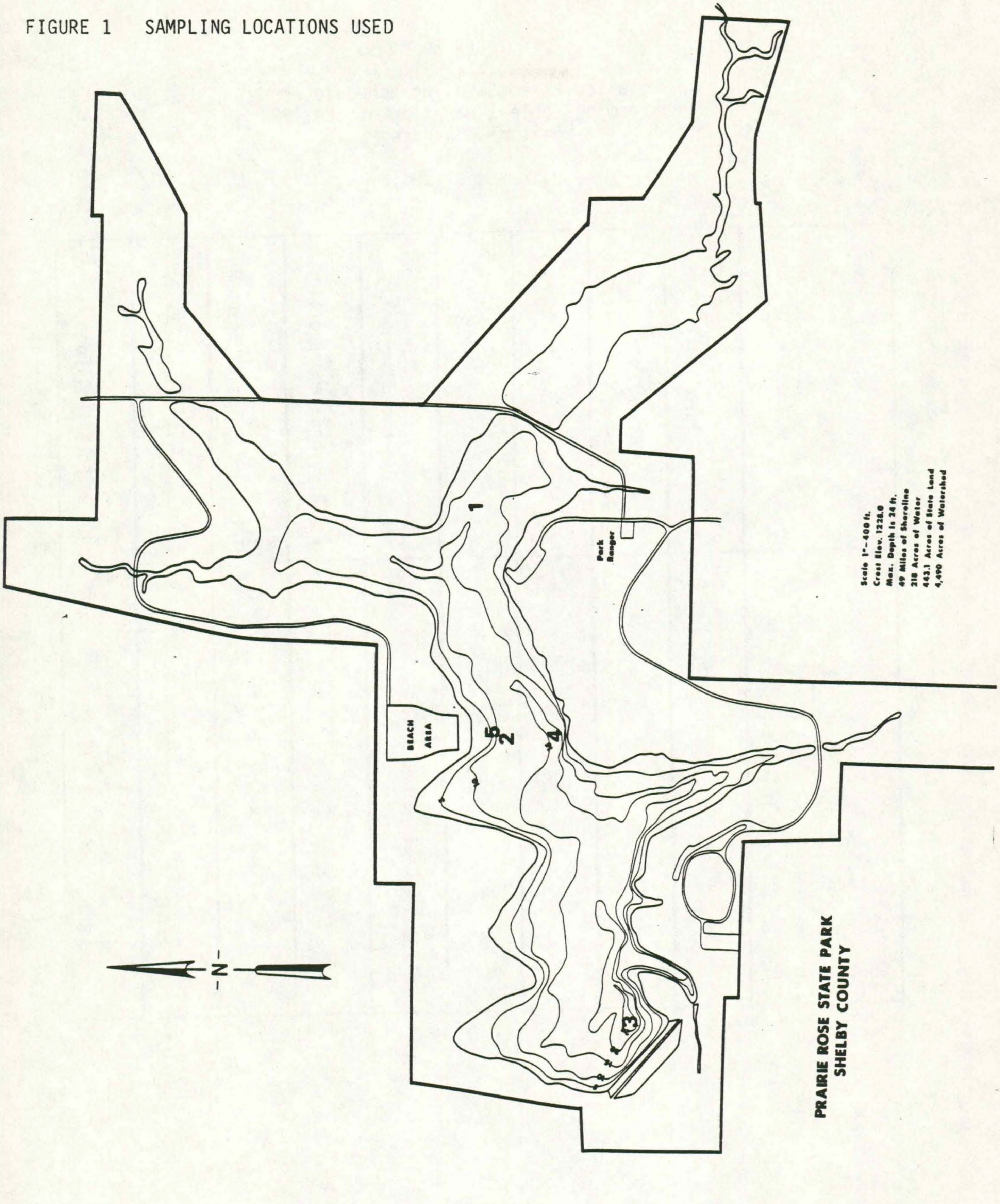


TABLE 5

Detailed Fixed Sampling Schedule For
Performing Table 1 Sampling of the 1984
Monitoring Strategy

x = analyzed

Date	Turbidity	Chlorophyll-a (corrected and uncorrected)	pH	Temperature	Dissolved Oxygen	D.O. and Temp Profile	Total and Soluble Phosphorus	Ammonia and Nitrate	Fecal Coliform
May 2	x	x	x	x	x		x	x	
May 21	x	x	x	x	x	x	x	x	
June 4	x	x	x	x	x		x	x	x
June 18	x	x	x	x	x	x	x	x	x
July 9	x	x	x	x	x		x	x	x
July 23	x	x	x	x	x	x	x	x	x
August 6	x	x	x	x	x		x	x	x
August 21	x	x	x	x	x	x	x	x	x
September 4	x	x	x	x	x		x	x	x
September 17	x	x	x	x	x	x	x	x	x

TABLE 6

Algal Assay Results
1983

Sample Collected September 26, 1983

	Ortho-Phosphate as P (mg/l)	NH_3-N (mg/l)	NO_3-N (mg/l)	Predicted Growth Factor	Total P (mg/l)	Total N (mg/l)
Raw Lake Water	.033	.17	0.00	6.46		
Filtered	.008	.07	0.05	3.44	.076	1.01
Autoclaved	.010	.24	0.00	4.30		

Algal Growth After 14 Days

(mg dry weight /l)

	Autoclaved Filtered	Filtered
Control	1.98	1.26
Control + Phosphorus (P)	2.44	1.35
Control + Nitrogen (N)	18.69	17.32
Control + P + N	16.91	20.90
Control + EDTA (E)	2.00	1.49
Control + P + E	2.11	1.81
Control + N + E	15.71	1.71
Control + P + N + E	13.98	11.92

5:1 N:P ratio (TSIN* ÷ ortho P)

* TSIN = Total soluble inorganic nitrogen (NO_2 + NO_3 + NH_3)

The N:P ratio can be used as a guide to nutrient limitation in most natural waters. Waters containing N:P ratios greater than 11:1 may be considered phosphorus limited while those containing N:P ratios less than 11:1 can be considered nitrogen limited for algal growth.

TABLE 7

1984 Rainfall

Date	Rainfall Received (inches)
May 2- 3	.06
May 4- 5	.25
May 5	.10
May 12-13	.17
May 17-18	.05
May 18	.58
May 22	1.10
May 24-25	1.05
May 26-28	.24
June 1	.80
June 4	.56
June 5	.92
June 9	.95
June 11	.90
June 12	.70
June 14-15	.60
June 16-17	.84
July 14	1.33
July 19	.30
July 26	.72
August 7	.80
August 21	.30
September 1- 2	1.50
September 7	.66
September 10	.36

Appendix 1983B presents the analytical results identifying the levels of pesticides collected in 1983 at the drinking water intake (site #4). Due to the lack of sufficient rainfall, no samples were collected in 1984 at the drinking water intake for the analyses of heavy metals and pesticides.

Appendix 1984C contains the fecal coliform results from samples taken at the swimming beach (site #5). These samples from site #5 were taken at various times following a rainfall-runoff event.

The results of the 1983 whole fish analysis for EPA's priority pollutants including heavy metals and pesticides are included in Appendix 1983D. No fish samples from Prairie Rose Lake were submitted for analysis in 1984. While the priority pollutant scan analyzes for a large number of chemical constituents, the results in Appendix 1983D list only those constituents above detectable levels.

V. Discussion

A. Water Quality Related Information

1. Annual User Totals

The annual user total at Prairie Rose Lake increased from 119,387 users in 1983 to 129,147 in 1984. This increase parallelled with a steady to increased use in park attendance observed statewide in 1984 as compared to 1983. A prolonged, cool, wet, spring and early summer in 1984 was immediately followed by a generally dry summer. More seasonable summer temperatures were experienced in 1984 compared to the torrid summer of 1983.

The most substantial lake user increase by numbers was from picnicing and camping and other similar activities associated by the lake's presence. This increase is probably attributable to the more favorable climatic conditions. Use of the beach for swimming has increased annually since 1981. The number of people using the lake for fishing purposes, which showed a decline in 1983 from the 1982 figures, demonstrated an increase in 1984. Higher lake use in 1984 for fishing is probably attributable to an improved lake fishery. The lake is currently developing its sport fishery and fishing pressure in the lake and is expected to continually increase in the years to come.

2. Fish

a. Population Inventories

Due to the overabundance of carp and gizzard shad in Prairie Rose Lake, a complete lake fishery renovation took place in the fall of 1981. In 1981 all fish were removed and a sport fishery restocking program was begun. The initial sport fishery stocking program has been completed in 1983. Future fish stockings will occur for weed control and maintenance of channel catfish and tiger musky. The sport fishery in Prairie Rose Lake is still in the developmental stage.

Bullheads, introduced to Prairie Rose Lake in the spring of 1982, provided some angling potential while the other sport species expanded. They have fulfilled their role as their numbers appear to be strong going into the winter of 1983-84. Overall, with the exception of the missing year class of bluegill and the unexpected presence of carp, the lake's fishery appears to be progressing on schedule. Growth and body condition of all species is quite good as would be expected in a new lake situation.

Fish population inventory results from sampling performed in 1984 are not presently completed and will be included in the 1985 report.

b. Creel Census

Prairie Rose Lake remains in a developing stage from a sport fishery standpoint. Harvest figures for all species remained low during the three month creel survey. Fishing pressure in 1984 increased more than 50 percent over the 1983 survey results. Significant increases in total catch, catch rate (fish per hour) and catch rate (fish per trip) were noted in the 1984 creel survey as compared to the 1983 creel results. Overall, improvement is noted over the 1983 survey and should continue in future years.

Bullheads continue to provide most of the angling although bluegill and channel catfish are becoming increasingly more important to the creel. Legal-sized largemouth bass are present in the lake as evidenced by electro-fishing surveys, but were not noted in the three month expandable creel survey.

As the lake's fishery continues to develop, bluegill, crappie, largemouth bass and channel catfish will dominate the harvest, gradually phasing out the bullhead fishery. Tiger musky will eventually make a small impact on the harvest; however, since they are stocked at a low density, the numbers harvested in relation to the major species will remain relatively insignificant.

3. Physical Conditions of Prairie Rose Lake - 1984

In 1983, above average precipitation occurred in March and drought conditions developed from the lack of sufficient rainfall and higher than normal temperatures. Somewhat similar weather patterns were repeated in 1984. In 1984 above normal precipitation occurred however in April, May and June. Rainfall was below normal during the summer of 1984 but the extreme high temperatures experienced in 1983 did not occur.

Unlike the 1983 lake conditions, very little change in water clarity was observed in 1984. The exceptional water clarity observed in the beginning of the sampling season of 1983 was not observed in 1984. The precipitation patterns between the two years are probably the reason. In 1984 the turbidity of the lake's water was generally characterized as low to normal throughout the entire observation period. Changes to the lake's water clarity, expressed by turbidity, were noted only on two weekly lake evaluations. One of the weekly evaluations noted variable lake turbidity due to rainfall runoff. The cause for the high in-lake turbidities during the other weekly evaluation, although not identified, may have been due to high algal populations.

A significant amount of aquatic weed growth was first observed in 1984 along with the north and south shoreline, and the southeast cove during the week of June 24. Weed growth continued for approximately three weeks. In 1983, aquatic weed growth also showed an increase during the month of June. The success of the white amur stocking in 1983 for vegetation control has not been evaluated.

Algal blooms, observed in 1983, were not reported in the 1984 field observations.

B. Water Quality, Fish and Sediment Data - 1984 Results (Short-Term Effects) and 1981-1984 Comparison (Long-Term Effects)

A summary of the water quality data collected in accordance with Table 1 of the 1984 monitoring strategy is contained in Table 8. Table 9 contains a summary description of rainfall occurrence in relation to the time of each sample collection. General observations regarding the 1984 water quality data contained in Appendix 1984A and Table 8 are discussed below for each parameter analyzed. The trends or observations from the 1984 results represent the short-term effects.

A comparison between the 1981, 1982, 1983 and 1984 monitoring results to demonstrate effects over the project period is also contained below. This comparison of the data collected throughout the project period will attempt to identify long term effects or trends.

1. Field pH

1984 Results

Mean in-lake pH's for all surface and bottom sites ranged between 8.3 and 8.6. All in-lake pH measurements fell between 8.0 and 9.0 standard pH units. The mean surface pH at all three sampling sites was 8.5.

1981-1984 Comparison

Mean pH (standard units) and Ranges Observed

		Site #1		Site #2		Site #3	
		surface	bottom	surface	bottom	surface	bottom
1981	Mean	8.4	8.6	8.5	8.2	8.3	8.3
1981	Range	7.5-8.6	8.5-9.0	8.0-9.0	7.5-8.6	8.0-9.0	7.5-9.5
1982	Mean	8.6	8.9	8.7	8.3	8.7	8.1
1982	Range	8.5-9.0	8.5-9.0	8.0-9.0	7.5-9.0	8.0-9.0	7.5-9.0
1983	Mean	8.5	8.5	8.6	8.2	8.8	8.3
1983	Range	8.0-9.0	6.5-9.2	7.0-9.5	7.0-9.0	8.0-9.5	7.5-9.0
1984	Mean	8.5	8.6	8.5	8.3	8.5	8.3
1984	Range	8.5-9.0	8.0-9.0	8.0-9.0	8.0-8.5	8.0-9.0	8.0-8.5

TABLE 8

Summary of the 1984 Water Quality Sampling Data*

	Site 1		Site 2		Site 3	
	Surface	Bottom	Surface	Bottom	Surface	Bottom
Field pH	N = 10 $\overline{X}$ = 8.5 S = .2 R = 8.5-9.0	N = 10 $\overline{X}$ = 8.6 S = .3 R = 8.0-9.0	N = 10 $\overline{X}$ = 8.5 S = .4 R = 8.0-9.0	N = 10 $\overline{X}$ = 8.3 S = .3 R = 8.0-8.5	N = 10 $\overline{X}$ = 8.5 S = .3 R = 8.0-9.0	N = 10 $\overline{X}$ = 8.3 S = .3 R = 8.0-8.5
Dissolved Oxygen (mg/l)	N = 10 $\overline{X}$ = 8.1 S = 1.7 R = 5.0-10.0	N = 10 $\overline{X}$ = 6.9 S = 2.9 R = 2.0-10.5	N = 10 $\overline{X}$ = 8.5 S = 2.0 R = 6.0-12.0	N = 10 $\overline{X}$ = 5.1 S = 3.4 R = 1.0-10.0	N = 10 $\overline{X}$ = 8.7 S = 2.0 R = 6.0-12.0	N = 10 $\overline{X}$ = 5.1 S = 3.2 R = 2.0-10.0
Chlorophyll a (ug/l)	N = 10 $\overline{X}$ = 60 S = 32 R = 21-116	N = 10 $\overline{X}$ = 54 S = 29 R = 16-105	N = 9 $\overline{X}$ = 51 S = 26 R = 16-94	N = 10 $\overline{X}$ = 30 S = 29 R = 8-92	N = 10 $\overline{X}$ = 46 S = 31 R = 7-102	N = 10 $\overline{X}$ = 29 S = 31 R = 6-97
Corrected Chlorophyll a (ug/l)	N = 10 $\overline{X}$ = 59 S = 32 R = 19-116	N = 10 $\overline{X}$ = 52 S = 29 R = 14-99	N = 9 $\overline{X}$ = 49 S = 25 R = 15-88	N = 10 $\overline{X}$ = 28 S = 28 R = 6-92	N = 10 $\overline{X}$ = 46 S = 31 R = 6-102	N = 10 $\overline{X}$ = 27 S = 31 R = 4-95
Total Phosphate mg/l as P	N = 10 $\overline{X}$ = .14 S = .09 R = .02-.27	N = 10 $\overline{X}$ = .14 S = .08 R = .03-.28	N = 10 $\overline{X}$ = .11 S = .09 R = .02-.29	N = 10 $\overline{X}$ = .13 S = .08 R = .02-.26	N = 10 $\overline{X}$ = .11 S = .07 R = .03-.24	N = 10 $\overline{X}$ = .15 S = .07 R = .08-.30
Soluble Phosphate mg/l as P	N = 10 $\overline{X}$ = .04 S = .04 R = <.01-.14	N = 10 $\overline{X}$ = .04 S = .07 R = .01-.14	N = 10 $\overline{X}$ = .05 S = .07 R = .01-.21	N = 10 $\overline{X}$ = .05 S = .04 R = .01-.14	N = 10 $\overline{X}$ = .04 S = .04 R = .01-.14	N = 10 $\overline{X}$ = .07 S = .05 R = .01-.16
Turbidity (NTU)	N = 10 $\overline{X}$ = 15.8 S = 8.2 R = 3.5-31	N = 10 $\overline{X}$ = 17.5 S = 8.3 R = 5.3-32	N = 10 $\overline{X}$ = 11.5 S = 5.3 R = 2.5-20	N = 10 $\overline{X}$ = 19.2 S = 15.0 R = 4.6-50	N = 10 $\overline{X}$ = 10.9 S = 4.7 R = 2.3-18	N = 10 $\overline{X}$ = 14.8 S = 6.6 R = 5.5-28
Secchi Transparency (inches)	N = 10 $\overline{X}$ = 22 S = 13 R = 12-54		N = 10 $\overline{X}$ = 25 S = 16 R = 12-68		N = 10 $\overline{X}$ = 30 S = 20 R = 18-84	
Nitrate (NO_3 + NO_2) mg/l as N	N = 10 $\overline{X}$ = 1.3 S = 1.3 R = <.1-2.8	N = 10 $\overline{X}$ = 1.6 S = 1.4 R = .1-4.3	N = 10 $\overline{X}$ = 1.2 S = 1.1 R = <.1-2.5	N = 10 $\overline{X}$ = 1.2 S = 1.1 R = <.1-2.5	N = 10 $\overline{X}$ = 1.2 S = 1.1 R = <.1-2.4	N = 10 $\overline{X}$ = 1.2 S = .8 R = <.1-2.3
Total Ammonia mg/l as N	N = 10 $\overline{X}$ = .11 S = .12 R = <.01-.39	N = 10 $\overline{X}$ = .10 S = .11 R = .01-.39	N = 10 $\overline{X}$ = .07 S = .05 R = <.01-.16	N = 10 $\overline{X}$ = .30 S = .23 R = .05-.69	N = 10 $\overline{X}$ = .05 S = .05 R = <.01-.15	N = 10 $\overline{X}$ = .52 S = .69 R = .04-2.4
Un-ionized Ammonia mg/l as N	N = 10 $\overline{X}$ = .012 S = .014 R = <.0014-.046	N = 10 $\overline{X}$ = .012 S = .015 R = .0024-.046	N = 10 $\overline{X}$ = .0073 S = .0061 R = <.004-.018	N = 10 $\overline{X}$ = .021 S = .022 R = .0029-.071	N = 10 $\overline{X}$ = .0060 S = .0055 R = <.0013-.017	N = 10 $\overline{X}$ = .040 S = .074 R = .0023-.25

*less than values have been assumed to be zero in the calculations

N = number of samples taken
$\overline{X}$ = mean
S = standard deviation of the mean
R = range

TABLE 9

Comparison of Table 1 Sampling Dates with Rainfall Data

Date of Sampling	Rainfall
May 2	approximately 1.5 inches of rainfall received April 29
May 21	last rainfall May 18 - .58 inches
June 4	.56 inches of rain received prior to sample collection
June 18	last rainfall on June 16 through 17 - .84 inches
July 9	last rainfall on June 16 through 17 - .84 inches
July 23	last rainfall on July 19 - .30 inches
August 6	last rainfall on July 26 - .72 inches
August 21	last rainfall on August 7 - .80 inches
September 4	last rainfall on September 1 through 2 - 1.50 inches
September 17	last rainfall on September 10 - .36 inches

The range of pH values observed during the 1984 sampling period was much less than that encountered in the three previous years. A comparison of the 1984 mean pH surface and bottom values at each site however showed very little change from the data collected in the previous years. There appears to be a general trend in observed pH values among the sampling sites. The mean bottom pH's at sites #2 and #3 have consistently been lower than or equal to the mean surface pH's at these respective locations. However, the mean bottom pH at site #1 has been equal to or greater than the mean surface pH's at site #1 for all four years.

2. Dissolved Oxygen (D.O.)

<u>1984 Results</u>

Mean surface D.O. concentrations at all three sites were quite similar, ranging from 8.1 mg/l at site #1 to 8.7 mg/l at site #3. All surface D.O. measurements ranged between 5.0 mg/l and 12.0 mg/l. During the month of September, lower D.O. concentrations were observed at sites #2 and #3 as compared to earlier sampling results. At site #1, the lowest D.O. concentrations were observed in the latter part of August and in September. The 1984 mean bottom D.O. concentrations at sites #2 and #3 were the same (5.1 mg/l) and were lower than the mean bottom D.O. concentration calculated from site #1 (6.9 mg/l).

On only two of ten sampling dates did the D.O. concentration at the eight foot depth at site #1 fall below 5.0 mg/l, Iowa's D.O. water quality standard for B(w) waters (waters for the propagation and protection of aquatic life). With the exception of the D.O. values recorded at site #1 in August, the D.O. concentration at the surface and bottom of site #1 showed very little difference. One-half of the bottom samples (5 of 10) collected from site #2 and six of ten samples collected from site #3 fell below 5.0 mg/l. At no time during the sampling season did anoxic conditions exist.

Monthly dissolved oxygen and temperature profiles at site #3, the deepest sampling site, showed that minor stratification occurred from June through August. The most pronounced thermal stratification was observed on July 23rd with a 5°C (9°F) difference between the lake's surface and bottom water temperature. Although only minor temperature decreases were observed when stratification occurred, D.O. concentrations at lake depths of 13 feet or deeper were substantially reduced as compared to the respective surface D.O. concentration.

1982-1984 Comparison

Mean Dissolved Oxygen (mg/l) and Ranges Observed

		Site #1		Site #2		Site #3	
		surface	bottom	surface	bottom	surface	bottom
1982	Mean	8.4	6.9	8.9	4.8	8.6	5.0
1982	Range	6.0-10.0	4.0-10.0	6.0-10.0	2.0-8.0	6.0-10.0	2.0-8.0
1983	Mean	9.0	6.8	9.4	5.7	9.1	5.7
1983	Range	7.0-13.0	3.0-10.0	8.0-11.0	1.0-11.0	8.0-11.0	1.0-11.0
1984	Mean	8.1	6.9	8.5	5.1	8.7	5.1
1984	Range	5.0-10.0	2.0.10.5	6.0-12.0	1.0-10.0	6.0-12.0	2.0-10.0

The 1984 mean surface D.O. concentrations at site #1 and site #2 were lower by at least .3 and .4 mg/l, respectively, than calculated for the previous two years. However, the 1984 mean surface D.O. concentration at site #3 and the 1984 mean bottom concentration at all three sites fell between the mean values determined for the two previous years.

Dissolved oxygen concentrations recorded over the last three years reveal some general trends in D.O. levels expected at the three collection sites. Surface and bottom D.O. concentrations at site #1 show less variation in D.O. (between the two depths) than the variations exhibited at site #2 and site #3. It is most likely that this observation is due to better mixing which occurs at the shallower depths. While the 1984 surface D.O. mean concentrations exhibited a slight increasing trend from site #1 to site #3; the data collected during the last three years reveals that, in general, surface D.O. concentrations show no variation based upon sampling location.

Thermal stratification has occurred during the summer months in each annual sampling program at Prairie Rose Lake. The lowest D.O. concentration ever recorded was 1.0 mg/l. The D.O. and temperature profile from site #3 performed in 1984 demonstrated that reduced D.O. levels did not occur solely at the lake's bottom. When the lake stratified in 1984, the lower nine feet at the 24 foot depth location exhibited lower D.O. levels than found at the near surface depths.

3. Chlorophyll-a

1984 Results

The mean surface chlorophyll-a concentration demonstrated a decreasing trend approaching the dam (from site #1 to site #3).

The surface chlorophyll-a concentration at site #1 was generally higher than the chlorophyll-a bottom concentration at site #1. However, the surface and bottom mean corrected chlorophyll-a concentrations at site #1 demonstrated that the elevated concentrations were slight (59 ug/l compared to 52 ug/l). The mean surface chlorophyll-a concentrations at sites #2 and #3 were nearly twice their respective mean bottom concentration.

In-lake chlorophyll-a concentrations at all surface and bottom locations from May 2nd to June 4th appeared lower than the chlorophyll-a concentrations detected for the remainder of the sampling season. At site #2 and site #3 between June 18th and August 6th, the mean surface to bottom chlorophyll-a concentration ratio was 4.7 and 6.2, respectively. However, from May 2 to June 4th, this ratio did not exceed 2.0 at any sampling site. Thus, in this mid-season period, substantially higher chlorophyll-a concentrations were observed in surface samples as compared to bottom sample concentrations.

Algal productivity occurs in the photic zone (zone of light penetration). Higher chlorophyll-a concentrations are expected at the surface as compared to samples collected below the photic zone. Only in a well mixed shallow lake would chlorophyll-a concentrations be expected to be uniform throughout the water column. The mean chlorophyll-a concentrations at site #1 showed no substantial difference between surface and bottom samples; thus, mixing is considered to be the influencing factor since the mean secchi transparency depth at site #1 was only 22 inches.

Chlorophyll-a concentrations were determined both as uncorrected and corrected for pheophytin. Pheophytin, a decomposition product of dead algal cells, produces a positive chlorophyll-a interference. Dead and decomposing algal cells may sink to the lake bottom and interfere with the chlorophyll-a analysis. Thus, high bottom chlorophyll-a concentrations, assumed to be related to mixing, could actually be the influence of accumulating dead and decomposing algal cells. Uncorrected and corrected chlorophyll-a values were examined to see if pheophytin was interfering with bottom chlorophyll-a concentrations. Since the mean bottom values for the uncorrected and corrected chlorophyll-a analyses only varied by 1-2 ug/l, pheophytin has been shown not to be a concern in bottom chlorophyll-a sample results.

1981-1984 Comparison

Mean Chlorophyll-a (ug/l) and Ranges Observed*

		Site #1		Site #2		Site #3	
		surface	bottom	surface	bottom	surface	bottom
1981	Mean	33.7	33	21.8	24.4	17.3	24.1
1981	Range	16.0-85.0	14.0-68.8	12.0-38.0	16.0-38.0	9.0-33.0	7.0-87.0
1982	Mean	12(11)	14(11)	13(12)	16(13)	12(10)	15(11)
1982	Range	3(2)-29(29)	7(7)-30(21)	3(2)-27(26)	3(3)-43(34)	4(4)-24(18)	4(3)-28(24)
1983	Mean	40(37)	41(39)	43(41)	24(22)	39(37)	21(19)
1983	Range	4(4)-98(95)	3(3)-73(71)	3(3)-145(139)	3(1)-67(67)	3(3)-120(114)	3(2)-65(64)
1984	Mean	60(59)	54(52)	51(49)	29(28)	46(46)	29(27)
1984	Range	21(19)-116(116)	16(14)-105(99)	16(15)-94(88)	8(6)-92(92)	7(6)-102(102)	6(4)-97(95)

* Corrected Chlorophyll-a in parenthesis

In comparing the 1981 through 1984 chlorophyll-a monitoring results, it appears that algal populations are increasing. The mean algal populations, calculated from the 1984 data, were higher than the previous years' data. The largest increase in algal populations, compared to data collected in 1983, occurred at site #1. During each year of the four year period for chlorophyll-a testing, chlorophyll-a values at the surface and bottom of site #1 did not demonstrate a significant difference between the two depths. The 1983 and 1984 data at site #2 and site #3 showed nearly a two-fold increase in surface algal concentrations compared to bottom concentrations. This trend was not observed in the 1981 and 1982 data.

4. Total and Soluble Phosphorus

1984 Results

Observed total phosphorus (as P) concentrations from the 1984 lake sampling results ranged from .02-.30 mg/l. No trends throughout the sampling season were apparent. The mean surface total phosphorus concentrations at sites #2 and #3 were the same at .11 mg/l. A mean surface total phosphorus concentration of .14 mg/l at site #1 in the upper reach of the lake was slightly elevated as compared to the mean's at the other in-lake sampling sites (.11 mg/l). The mean bottom total phosphorus concentrations at sites #2 and #3, ranging from .13-.15 mg/l, were higher than respective mean surface values. The mean bottom and surface total phosphorus concentration at site #1 was .14 mg/l. In reviewing the surface and bottom total phosphorus concentrations collected from each site, the mean data generally parallels the following observations for any sampling date. On each sampling date, the surface and bottom total phosphorus concentration at site #1 did not vary by more than .03 mg/l, demonstrating consistent total phosphorus concentrations throughout the water column. At sites #2 and #3 however, the surface and bottom total phosphorus concentrations demonstrated greater variation. Generally speaking, the total phosphorus bottom concentrations were higher than the respective surface concentration at sites #2 and #3.

Throughout the sampling period, total soluble phosphorus concentrations of <.01 to .16 mg/l were recorded. The mean soluble phosphorus concentrations at the three lake surface sample collection sites were nearly identical ranging only from .04 to .05 mg/l. The mean soluble phosphorus concentrations from the bottom samples showed an increase from .04 to .07 mg/l from site #1 to site #3, respectively. In general, on most sampling dates, a higher bottom soluble phosphorus concentration was found at site #3 as compared to the concentrations observed at sites #1 and #2.

1981-1984 Comparison

Mean Total Phosphorus (mg/l as P) and Ranges Observed

		Site #1		Site #2		Site #3	
		surface	bottom	surface	bottom	surface	bottom
1981	Mean	.12	.15	.08	.18	.08	.16
1981	Range	.07-.16	.08-.28	.05-.12	.10-.32	.05-.13	.09-.23
1982	Mean	.07	.08	.05	.06	.06	.11
1982	Range	.02-.11	.04-.11	.01-.07	.01-.09	.01-.11	.03-.17
1983	Mean	.19	.21	.18	.23	.18	.29
1983	Range	.03-.38	.04-.39	.08-.34	.08-.37	.06-.35	.08-.59
1984	Mean	.14	.14	.11	.13	.11	.15
1984	Range	.02-.27	.03-.28	.02-.29	.02-.26	.03-.24	.08-.30

The total phosphorus data collected over the four year period demonstrates the following general trends: mean surface concentrations at sites #2 and #3 are nearly the same, but nonetheless, lower than the mean surface concentration found at site #1; and, the mean bottom total phosphorus concentration at sites #2 and #3 are larger than respective mean surface concentrations. The total phosphorus concentration range experienced in 1984 was lower than that observed in 1983 but higher than observed in 1981 and 1982. While the mean total phosphorus concentration of bottom samples at sites #2 and #3 in 1984 were higher than the respective surface concentrations, the magnitude of this difference was much less pronounced in 1984 than that observed in previous years. For example, from 1981 to 1983, the ratio of the mean surface to mean bottom concentration averaged 65%; however, in 1984 this ratio was 73%.

In 1981 the percent of soluble, reactive phosphorus found in the total phosphorus concentration ranged from 0 to 77%; in 1982 from 0 to 40%; in 1983 from 0 to 78%; and, in 1984 from 0 to 100%. The average percent of measurable soluble, reactive phosphorus to total phosphorus was 29%, 8%, 16% and 38% in 1981 through 1984, respectively. Soluble phosphorus concentrations experienced in 1984 were generally much elevated over the concentrations experienced in 1983. With the exception of site #3 bottom a two to four fold increase from 1983 soluble phosphorus concentrations was experienced in 1984. In 1984 the highest mean soluble phosphorus concentrations were calculated from surface sampling results at all sampling sites. The mean bottom concentrations in 1984, although generally elevated from 1983 results, fell within the mean soluble phosphorus concentrations experienced in 1981 and 1982.

5. Turbidity

<u>1984 Results</u>

Turbidity values experienced in 1984 during the lake monitoring period ranged from 2.5 to 50 NTU's. The mean surface turbidity values decreased from site #1 to site #3 with respective mean turbidity values ranging from 15.8 to 10.9 NTU's. Mean bottom turbidity values ranged from 14.8 to 19.2 and did not exhibit any increasing or decreasing trends from site #1 to site #3.

Surface and bottom turbidity values at site #1 for each sampling date were rather consistent (throughout the lake's profile) with an observed maximum difference of 4.2 NTU's. This consistency is reflected in the mean values calculated for site #1. The surface and bottom turbidity values at sites #2 and #3 varied considerably. Mean turbidity values at sites #2 and #3 demonstrate a general higher turbidity in samples collected from the lake bottom as compared to surface samples.

Individual surface turbidity values appear to correlate with the surface corrected chlorophyll-a concentrations. Plots of the data from sites #1, #2 and #3 are included in Figures 2-4. A correlation of the bottom sample results was not attempted since bottom samples generally had lower chlorophyll-a concentrations and higher turbidities as compared to surface results.

FIGURE 2

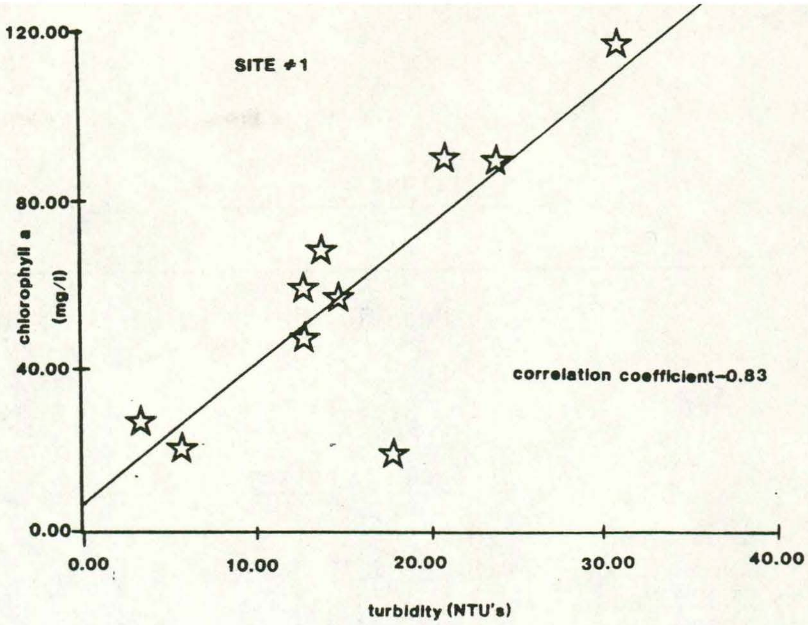


FIGURE 3

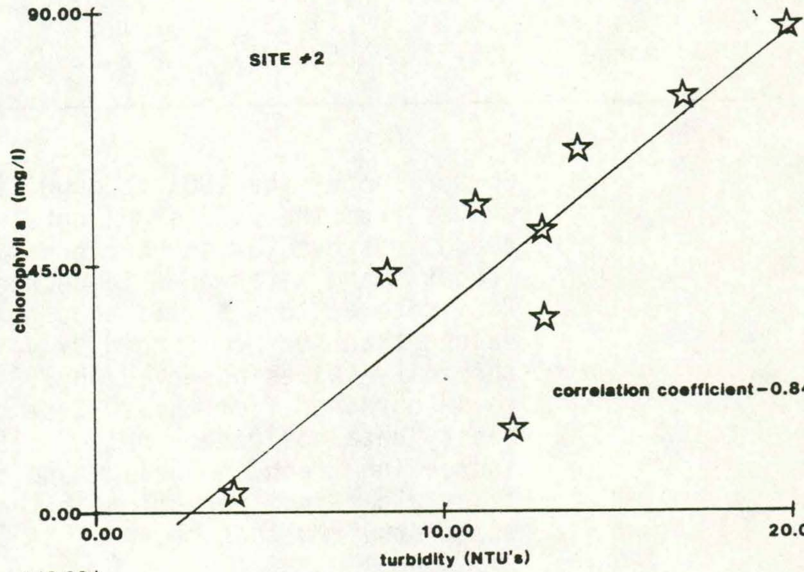
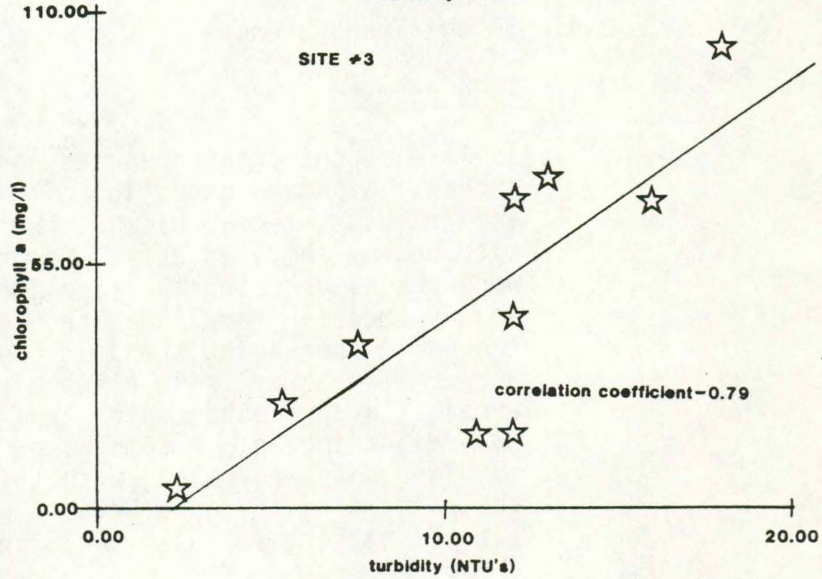


FIGURE 4



1981-1984 Comparison

Mean Turbidity (NTU's) and Ranges Observed

		Site #1		Site #2		Site #3	
		surface	bottom	surface	bottom	surface	bottom
1981	Mean	20.7	31.1	10.7	102	8.8	84.3
1981	Range	4.9-75.0	12.0-85.0	5.1-23.0	17.2-540.0	1.9-15.0	13.0-340.0
1982	Mean	7.1	14.7	3.0	12.2	2.7	10.3
1982	Range	2.8-32	4.4-44	1.5-4.8	2.1-22	1.2-4.2	4.7-16.0
1983	Mean	12	15	8.2	19	7.5	18
1983	Range	2.3-28	2.7-24	1.6-24	1.9-60	1.6-20	2.0-55
1984	Mean	15.8	17.5	11.5	19.2	10.9	14.8
1984	Range	3.5-31	5.3-32	2.5-20	4.6-50	2.3-18	5.5-28

Comparison of the 1981 through 1984 data shows that turbidity values from the 1984 sampling season followed the general data trends observed at the three sampling sites previously. Those trends among sites are: a decrease in surface turbidity values from site #1 to site #3; and, generally higher bottom turbidity values than surface turbidity values at sites #2 and #3. The turbidity values observed in 1984 are somewhat comparable to those obtained from the 1983 sampling season. Although the turbidity data collected in 1982, 1983 and 1984 generally shows an increasing trend in surface and bottom lake turbidity, there remains a distinct reduction in the bottom in-lake turbidity measurements from that observed in 1981.

6. Secchi Transparency

1984 Results

In-lake secchi transparencies observed in 1984 ranged from 12-84 inches. With the exception of the May 21, 1984, secchi transparency results, secchi disk depths did not exceed 30 inches at any site on any sampling date. No increasing or decreasing trends were observed during the sampling season from the data collected at any specific sampling site. The mean secchi transparency showed an increasing trend in the direction of the shallow to deeper lake areas (site #1 to site #3). This increase (difference) in mean secchi depths from site #1 to site #3, however, was only eight inches. A comparison of the results from individual sampling dates revealed, with the exception of the May 21 data, the range of difference between secchi transparency values at site #1 to site #3 was 0 to 13 inches.

Generally, lakes act as sediment traps. Water clarity as measured by secchi transparency should increase as the distance to the dam decreases. The lack of substantial secchi depth differences between sites #1 and #3 suggest that water clarity is not highly affected by solids that have a tendency to settle out but rather by algae or finer materials such as clay which remain suspended in the water column.

1981-1984 Comparison

Mean Secchi Transparency (inches) and Ranges Observed

		Site #1 Surface	Site #2 Surface	Site #3 Surface
1981	Mean	16.1	20.8	23.4
1981	Range	9-24	12-30	18-36
1982	Mean	38	60	74
1982	Range	8-60	36-96	36-120
1983	Mean	42	66	66
1983	Range	18-84	18-156	18-156
1984	Mean	22	25	30
1984	Range	12-54	12-68	18-84

In comparing the 1981 to 1984 secchi transparency results, the 1984 data demonstrates an overall decrease in water clarity from 1982 and 1983, but an increase in clarity from that observed in 1981. Whereas substantial changes in secchi depths between site #1 and site #2 were recorded in 1982 and 1983, this was not apparent in the 1984 observations.

7. Nitrogen Series (Ammonia and Nitrate)

1984 Results

Nitrate

In-lake nitrate data collected in 1984 showed a definite decreasing trend throughout the sampling period. All nitrate measurements taken from May 2nd through July 9th approached or exceeded 2.0 mg/l. Nitrate concentrations began to decrease on July 23rd and all surface nitrate measurements recorded thereafter were <.1 mg/l. Bottom sample nitrate concentrations after July 23rd ranged from <.1 to .6 mg/l.

The mean nitrate concentration at sites #2 and #3 for both sampling depths was the same at 1.2 mg/l. The mean nitrate concentration at site #1 (1.3 mg/l surface, 1.6 bottom) was slightly higher than that calculated for sites #2 and #3 (1.2 mg/l and surface and bottom).

Total Ammonia

Total ammonia measurements recorded in 1984 ranged from <.01 to 2.4 mg/l. On only one occasion did the ammonia concentration exceed the state's total ammonia water quality standard of 2.0 mg/l for class B(w) waters. The cause for the high ammonia cannot be identified. No rainfall-runoff preceded sample collection for more than one week.

Mean surface ammonia concentrations decreased from site #1 to site #3. Mean bottom ammonia concentrations increased from site #1 to site #3. Surface and bottom ammonia concentrations at site #1 were generally quite similar on any sampling date. However, a substantial difference between surface and bottom ammonia concentrations was observed at sites #2 and #3, with bottom concentrations exceeding surface concentrations. Over a four-fold difference between the mean surface and mean bottom ammonia concentrations was observed at site #2 and at site #3 over a ten-fold difference occurred.

Un-ionized Ammonia

The in-lake un-ionized ammonia levels detected in 1984 ranged from <.0013 to .25 mg/l. At each of the three lake monitoring sites, un-ionized ammonia concentrations frequently exceeded EPA's "Red Book" criteria guideline values of .016 mg/l NH_3-N. Five of 20 samples collected at each site #1 and site #2 and seven of 20 samples from site #3 exceeded the EPA criteria.

<u>1981-1984 Comparison</u>

In 1981 the nitrate-nitrogen concentration remained constantly at or below .2 mg/l NO_3-N at all three sites with the exception of an observed maximum value of .6 mg/l NO_3-N. During 1982, nitrate-nitrogen concentrations averaged nearly ten times higher (1.7-2.1 mg/l) than observed in 1981. The maximum observed value in 1982 of 3.6 mg/l was six times higher than the maximum observed in 1981. In 1983 high nitrate-nitrogen concentrations, up to 4.9 mg/l, were observed at the start of the sampling program but diminished to levels below detectability near the end of the sampling period.

Nitrate concentrations in 1984 paralleled the 1983 sampling results. In 1984, concentrations approaching or exceeding 2.0 mg/l were experienced up until July 9, 1984. Several weeks later, in-lake nitrate measurements were generally below detectable levels.

Total ammonia concentrations observed in 1984 showed a decrease from the 1983 results. A decrease of nearly one-half was most notable at sites #2 and #3 in both the surface and bottom samples. The total ammonia reductions at site #1 in 1984 were less pronounced.

The substantially higher nitrate concentrations observed in 1982 and the beginning of 1983 may be related to the observed decrease in algal productivity. Algal productivity has been related to a number of factors. Under suitable conditions for algal growth, i.e., temperature, light penetration, etc., the most emphasized factors for algal productivity have been the nutrients, nitrogen (N) and phosphorus (P). Trace metals have also been implicated in affecting algal productivity. For algal growth both N and P must be available. If one nutrient is lacking in sufficient quantities it is called the limiting nutrient. Algal cells are able to utilize nitrate and soluble phosphate for supplying these nutrients. Ammonia has also been identified as a primary nutrient source for algal cells however, under aerobic conditions, ammonia is readily oxidized to nitrate by nitrifying bacteria via the nitrogen cycle.

In comparing 1981 and 1982 for algal growth conditions, one would have predicted a higher algal productivity corresponding to the substantial increase in water clarity in 1982. The chlorophyll-a data, however, indicates that algal growth was higher in 1981. The increase in water clarity in 1983 did initiate substantial algal growth that year, thus, sufficient nutrients were available for algal growth. Nutrients should continue to be monitored on a more frequent basis and algal assays should be continued to determine the influencing factor to algal growth.

8. Algal Assays

<u>1983 Results</u>

In the algal assay, a growth factor is first calculated on raw, filtered and filtered autoclaved samples. This factor is used to predict changes that may be observed between the filtered and filtered, autoclaved results. Algal assays measure algal populations after 14 days exposed to various combinations of the nutrients, nitrogen and phosphorus, and the metal complexing agent EDTA.

While the sampling protocol called for algal assays to be conducted three times from May through September, only two samples were collected, one on May 17, 1983, and the second on September 26, 1983. The results from the May 17, 1983 sample collection (presented in Table 7 of RCWP Project-Year 3 Report) showed that lake water quality at the time of sample collection was very low in available (ortho-phosphate) phosphorus and very high in nitrates. From the water quality analysis alone phosphorus limitation on algal growth would be expected due to the low concentration. The results from the September 26, 1983 sample collection are presented in Table 6 of this report. The algal assay bottle that results, found in Table 6, indicate that nitrogen was the limiting nutrient. An increase in algal growth occurred with the addition of nitrogen, and phosphorus and nitrogen combinations. Growth did not occur with the addition of phosphorus alone. An unexplainable anomoly exists in the observed growth during the addition of both N and EDTA - to the filtered sample. The expected higher growth did not occur in this sample but did for the autoclaved filtered sample.

1984 Results

Samples for algal assays were collected three times throughout the 1984 sampling period - June 4, July 23 and September 4. On each sampling date a grab sample was taken at site #1 and a depth composited sample was collected at site #3. The algal assay test for all samples submitted in 1984 indicated that phosphorus was the limiting nutrient.

9. Fecal Coliform

From all the samples taken in accordance with the fixed schedule monitoring in Table 1, only one sample, was found to be in excess of Iowa's water quality standards of 200 organisms/100 ml for primary contact, Class "A" waters. This sample was collected on June 18, 1984, from site #2 - bottom depth. The fecal coliform level found in this sample was 590 organisms/100 ml.

The suspected cause of the high coliform levels found in the sample collected on June 18th is from rainfall-runoff. Rainfall totalling .84 inches was received on June 16 through June 17th. In reviewing the rainfall data in Table 7, frequent rains in June, prior to the 18th, should have produced saturated soil conditions leading to runoff rather than soil saturation from the rainfall.

10. Bottom Sediment Sampling at Sites #1-#3

Following one of the recommendations contained in the 1983 monitoring report, sediment sampling and analysis were not conducted in 1984.

11. Drinking Water Intake (Site #4)

No samples were collected for fecal coliform, metals and pesticide analysis at the surface and bottom depths by the drinking water intake in 1984. According to Table 2 these samples were to be collected within 24 hours of a rainfall greater than or equal to two inches. Unfortunately no rainfall events approached that amount. In mid August the park ranger was notified to collect a sample if rainfall of 1.5 inches or more was received. However, the only rainfall which approached that amount happened to occur over a holiday weekend which interferred with sample collection.

Pesticide results from 1983 are contained in Appendix 1983B. These results were not available at the time the 1983 was compiled. This sample was collected approximately 24 hours following a 1.9 inch rainfall.

Fecal coliform levels at sites #1, #2 and #5 at the time of the 1983 sample collection for pesticide analysis were elevated; indicating that the lake's water quality was affected by runoff. The only pesticides found in the surface and bottom samples collected in 1983 were atrazine and cyanazin. Table 10 demonstrates the trends of in-lake pesticide levels found at the drinking water intake from 1981 to 1983.

Table 10

Pesticide Levels Found at the Drinking Water Intake
(results expressed as mg/l)

		1981	1982	1983
Atrazine	S*	3.1	.58	.08
	B	1.9	.62	.10
Lasso	S	.3	.11	<.05
	B	.3	.13	<.05
Cyanazin	S	5.3	.68	.14
	B	4.5	.81	.20
Dyfonate	S	.2	NR	<.03
	B	NR	NR	<.03
Dieldrin	S	.014	NR	<.01
	B	.015	NR	<.01
Banvel (dicamba)	S	NR	.08	NR
	B	NR	.09	NR
Dual (metolachlor)	S	NR	.22	NR
	B	NR	.21	NR

* S = surface sample
B = bottom sample
NR = no results

In reviewing the results found in Table 10 it appears that pesticide concentrations at the drinking water intake, following a runoff event, are decreasing. Continual decreases since 1981 are observed with the pesticide levels for atrazine, cyanazin and lasso. Whereas many of the values in Table 10 have been reported as NR (no results), it is more probable that no results were provided because the result was below detectable levels rather than that parameter was not analyzed. If this assumption is made then all pesticides have shown a reduction in concentration since the start of the RCWP project. Since the values in Table 10 are reported as concentrations rather than loadings, caution must also be asserted in using these results as being conclusive. Variability in the effect from the runoff event may have had a profound effect upon for providing the observed decreasing trend. Monitoring should be continued to verify the existence of the trend.

12. Fecal Coliform Sampling at the Swimming Beach (Site #5)

The purpose for sample collection at the swimming beach after rainfall is to determine whether watershed runoff is impacting primary contact water usage (swimming). Fecal coliform is generally used as a pathogenic indicator for human health safety. According to Iowa's water quality standards, the level of 200 organisms/100 ml applies to primary contact (Class A) waters. Although fecal coliform levels above this level are not violations to the water quality standards if caused by runoff, this sampling will tell whether high fecal coliform levels are associated with runoff.

Fecal coliform samples were to be collected for five consecutive days following two separate runoff events. The purpose of this sampling was to determine when the peak effect of runoff to coliform counts would occur. Unfortunately, this sampling endeavor was only carried out once. Rainfall received between June 1 and August 31 that was sufficient to meet the one inch rainfall criteria occurred only once. For that rainfall, which occurred on July 14, samples were collected 48, 72, 96 and 120 hours after rainfall from the surface and bottom of the swimming beach. The results of the fecal coliform analysis, found in Appendix 1984C, did not demonstrate a noticeable increase in the fecal coliform concentration and for the most part represented ambient (non-runoff) conditions. The most elevated fecal coliform concentration observed from these samples collected was 50 organisms/100 ml which is far below Iowa's fecal coliform water quality standards. Either the 1.33 inch rainfall event was adsorbed by the soil and produced little runoff, or, a reduction in fecal coliform loading transported to the lake during runoff is taking place. However, since the last rainfall event prior to the July 14 rainfall occurred on June 16th through the 17th it is more likely that the results were on the low side because little runoff occurred.

13. Whole Fish Analysis

The complete results from the priority pollutant scan on whole fish samples, collected in 1983, can be found in Appendix 1983D.

Two composite samples were analyzed. One sample consisted of three largemouth bass. The other sample was comprised of three channel catfish and two black bullheads.

Of all the chemicals tested by EPA for in the priority pollutant scan, the following chemicals were detected in either of the fish samples above the limits of detection (for each respective analytical analysis): methylbenzene, ethylbenzene, arsenic, chromium, copper, mercury, nickel, selenium and zinc. The "Report of the Analysis of Fishes Collected During 1983 from the Ambient Fish Tissue Monitoring Program Sites in Iowa, Activity No. E155", prepared by the U.S. Environmental Protection Agency, Region VII discusses each of these chemical constituents in regards to toxicity, pollutant sources, and ranges observed. These discussions for each of the chemicals found above the limits of detection have been included in Appendix 1983D.

Summarizing the discussion contained in the EPA report of fish sample results collected in 1983 throughout Iowa, it was speculated that methylbenzene and ethylbenzene may have been found in the analytical results from contamination during sample collection. Since both these organic compounds are used as gasoline additives it is reasonable to assume that during the electroshocking, fumes from the gasoline generator may have contaminated the samples. These organic compounds were not found in the 1982 or 1981 priority pollutant scan of fish collected from Prairie Rose Lake.

With respect to the "detectable metals" found in the fish from Prairie Rose Lake, virtually all fish samples collected and analyzed by the EPA laboratory has contained detectable levels of chromium, copper, nickel, selenium, and zinc. These metals are suspected of being animal nutrients, and therefore may be inherent components of fish tissues. Mercury and arsenic were detectable in 33 of 34 fish composites analyzed in 1983. None of the metals concentrations found in the whole fish analysis from samples collected from Prairie Rose Lake exceeded either the NAS/NAE guidelines or the FDA action level.

C. Recommended Modifications to the 1984 Monitoring Strategy

The following modifications to the 1984 monitoring strategy are recommended for use in the 1985 monitoring strategy.

1. Maintain the alternative monitoring strategy for collecting fecal coliform samples at the swimming beach following runoff. This strategy is presented in Table 2 of the 1984 monitoring strategy.

2. Algal assays should continue to be performed on three occasions during the sampling period. Samples should be collected at site #1 and site #3. Depth composited samples should be collected from site #3. Sampling should be conducted in May, July and September.

3. Collection of sediment samples at sites #1, 2 and 3 which was discontinued in 1984 and should be resumed in 1985. Continuation of the sediment sampling only on an intermittent basis will provide adequate information.

4. Lake monitoring should focus on nutrient levels. Biweekly rather than monthly samples should be collected for NH_3-N, NO_3-N, and total and soluble phosphorus analysis. The nutrients are becoming very important role to the impacts of the lake's water quality.

5. If insufficient rainfall is received to collect samples at the drinking water intake for metals, pesticides, and fecal coliform analysis (outlined in Table 2) these samples should be collected during non-runoff conditions in mid August.

Prairie Rose Lake
Site #1
Upper Reach of Impoundment

DATE	TIME OF DAY	DEPTH (FEET)	WATER TEMP CENT	WATER TEMP FAHN	WIND VELOCITY MPH	WIND DIR. FROM NORTH - °	TURB NTU	TRANSP SECCHI INCHES	DO MG/L	LAB PH SU	FIELD PH SU	ORG N N MG/L	$NH_3 + NH_4$ N-TOTAL MG/L	UN-IONIZED AMMONIA NH_3-N MG/L	NO_3-N TOTAL MG/L	T PHOS as P MG/L	PHOS-DISSOLV. as P MG/L	FEC COLI ORG /100 ML	CHL A UG/L	CORR CHL A UG/L
5-02-84	1145	0	10.0	50.0	20	90	18.0	12	9.9	8.1	8.5		.13	.0072	2.8	.22	.14	N.D.	21	19
5-02-84	1200	8	10.5	50.9	20	90	19	--	10.2	8.2	8.5		.11	.0063	4.3	.19	.14	N.D.	16	14
5-21-84	0900	0	16.0	60.8	15	225	3.5	54	10.0	8.4	8.5		.09	.0079	2.4	.06	.02	N.D.	27	27
5-21-84	0910	8	16.0	60.8	15	225	7.7	--	10.5	8.4	8.5		.04	.0034	2.4	.05	.01	N.D.	24	23
6-04-84	0855	0	18.0	64.4	15	18	5.9	30	9.0	8.4	9.0		.08	.020	2.4	.02	.02	70	22	21
6-04-84	0905	8	18.0	64.4	15	180	5.3	--	9.0	8.4	9.0		.12	.031	2.4	.03	.01	70	25	24
6-18-84	0900	0	21.0	69.8	5	315	31	15	9.0	8.7	8.5		.19	.023	2.7	.21	.05	190	116	116
6-18-84	0905	8	20.0	68.0	5	315	32	--	5.0	8.5	8.0		.11	.0042	2.7	.19	.05	110	79	79
7-09-84	0845	0	21.0	69.8	5	225	13	18	8.0	8.4	8.5		.06	.0071	2.2	.06	<.01	<10	59	59
7-09-84	0850	8	22.0	71.6	5	225	16	--	8.5	8.4	8.5		.06	.0076	2.2	.08	.01	20	50	46
7-23-84	1325	0	26.0	78.8	2	270	15	24	8.0	8.7	8.5		<.01	<.0014	.9	.09	<.01	<10	57	57
7-23-84	1325	8	25.0	77.0	2	270	17	--	8.0	8.8	9.0		.01	.0036	.9	.12	.02	<10	39	38
8-06-84	0900	0	23.0	73.4	3	225	21	12	9.0	8.9	8.5		.02	.0027	<.1	.21	.03	<10	89	89
8-06-84	0915	8	23.0	73.4	3	225	25	--	3.0	8.5	8.5		.06	.0081	.2	.23	.03	10	85	85
8-21-84	0845	0	21.0	69.8	10	135	13	18	5.0	7.4	8.5		.39	.046	<.1	.15	.03	<10	50	47
8-21-84	0900	8	21.0	69.8	10	135	12	--	2.0	7.4	8.5		.39	.046	.2	.12	.02	<10	50	47
9-04-84	1030	0	20.0	68.0	1.5	270	14	24	6.0	8.5	8.5		.01	.0011	<.1	.09	.06	20	68	68
9-04-84	1040	8	19.0	66.2	1.5	270	15	--	6.0	8.5	9.0		.02	.0054	.3	.12	.05	10	65	65
9-17-84	0930	0	15.0	59.0	8	135	24	12	7.0	8.6	8.5		.12	.0096	<.1	.27	.08	<10	95	89
9-17-84	0935	8	15.0	59.0	8	135	26	--	7.0	8.6	8.5		.03	.0024	.1	.28	.06	<10	105	99

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Appendix 1984A

Prairie Rose Lake
Site #2
Mid-Lake

DATE	TIME OF DAY	DEPTH (FEET)	WATER TEMP CENT	WATER TEMP FAHN	WIND VELOCITY MPH	WIND DIR. FROM NORTH - °	TURB NTU	TRANSP SECCHI INCHES	DO MG/L	LAB PH SU	FIELD PH SU	NH_3 + NH_4 N-TOTAL MG/L	UN-IONIZED AMMONIA NH_3-N MG/L	NO_3-N TOTAL MG/L	T PHOS as P MG/L	PHOS-DISSOLVED, as P MG/L	FEC COLI ORG /100 ML	CHL A UG/L	CORR CHL A UG/L
5-02-84	1223	0	10.0	50.0	20	90	12	18	10.0	8.3	8.5	.04	.0022	1.8	.16	.14	N.D.	16	15
5-02-84	1230	11	10.5	50.9	20	90	14	--	9.5	8.3	8.5	.05	.0029	1.8	.16	.14	N.D.	14	14
5-21-84	0930	0	17.0	62.6	15	225	2.5	68	10.0	8.5	8.5	.08	.0073	2.3	.03	.01	N.D.	N.D.	N.D.
5-21-84	0925	11	16.0	60.8	15	225	4.6	--	10.0	8.1	8.5	.08	.0068	2.5	.05	.02	N.D.	10	7
6-04-84	0945	0	18.0	64.4	15	180	4.4	30	10.0	8.7	9.0	.02	.0051	2.3	.02	.02	<10	18	17
6-04-84	0950	11	16.0	60.8	15	180	8.1	--	9.0	8.1	8.5	.18	.015	2.1	.02	.01	170	12	11
6-18-84	0920	0	21.0	69.8	5	315	13(14)	18(18)	9.0(9.0)	8.4	8.0(8.0)	.11(.07)	.0045	2.5(2.5)	.11(11)	.05(.04)	40(80)	36(31)	35(30)
6-18-84	0930	11	19.0	66.2	5	315	50	--	6.0	7.8	8.0	.42	.015	2.4	.23	.11	590	15	13
7-09-84	0910	0	22.0	71.6	5	225	13	18	8.0	8.4	8.5	.09	.011	2.1	.06	.01	<10	53	51
7-09-84	0910	11	20.0	68.0	5	225	18	--	1.0	8.0	8.5	.42	.047	1.9	.08	.01	<10	18	15
7-23-84	0915	0	26.0	78.8	2	270	8.5	30	7.0	8.8	9.0	<.01	<.004	1.0	.08	.01	<10	43	43
7-23-84	1350	11	21.0	69.8	2	270	6.6	--	2.0	8.1	8.0	.69	.028	.7	.10	.02	<10	8	6
8-06-84	0945	0	24.0	75.2	3	225	17	18	12.0	8.9	9.0	.05	.017	<.1	.29	.21	<10	75	75
8-06-84	1000	11	21.0	69.8	3	225	7.8	--	2.0	8.6	8.5	.60	.071	.2	.14	.03	<10	15	14
8-21-84	0910	0	22.0	71.6	10	135	11.0	20	7.0	7.8	8.0	.09	.0040	<.1	.07	.01	<10	55	55
8-21-84	0920	11	22.0	71.6	10	135	16.0	--	2.0	7.3	8.0	.34	.015	<.1	.13	.07	20	62	57
9-04-84	1050	0	20.0	68.0	1.5	270	14.0	20	6.0	8.3	8.5	.16	.018	<.1	.09	.05	30	65	65
9-04-84	1055	11	19.0	66.2	1.5	270	35	--	4.0	8.0	8.0	.19	.0068	<.1	.18	.06	110	51	47
9-17-84	0950	0	15.0	59.0	8	135	20	12	6.0	8.5	8.5	.05	.0040	<.1	.24	.04	<10	94	88
9-17-84	0958	11	15.0	59.0	8	135	32	--	6.0	8.4	8.5	.06	.0048	<.1	.26	.06	<10	92	92

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Appendix 1984A (continued)

Prairie Rose Lake
Site #3
Near Dam

DATE	TIME OF DAY	DEPTH (FEET)	WATER TEMP CENT	WATER TEMP FAHN	WIND VELOCITY MPH	WIND DIR. FROM NORTH - °	TURB NTU	TRANSP SECCHI INCHES	DO MG/L	LAB PH SU	FIELD PH SU	ORG N N MG/L	$NH_3 + NH_4$ N-TOTAL MG/L	UN-IONIZED AMMONIA NH_3-N MG/L	NO_3-N TOTAL MG/L	T PHOS as P MG/L	PHOS-DISSOLV. as P MG/L	FEC COLI ORG /100 ML	CHL A UG/L	CORR CHL A UG/L
5-02-84	1245	0	10.5	50.9	20	90	11	22	10.0	8.4	8.5		.03	.0017	1.6	.16	.14	N.D.	17	17
5-02-84	1250	24	10.5	50.9	20	90	17	--	10.0	8.3	8.5		.04	.0023	1.6	.20	.13	N.D.	19	18
5-21-84	0940	0	17.0	62.6	15	225	2.3	84	9.5	8.5	8.5		.06	.0055	2.4	.03	.01	N.D.	7	6
5-21-84	0955	24	15.0	59.0	15	225	9.5	--	9.5	8.1	8.5		.17	.014	2.0	.14	.07	N.D.	8	6
6-04-84	1015	0	18.0	64.4	15	180	5.4	30	11.0	8.7	9.0		.04	.010	2.2	.03	.02	<10	24	24
6-04-84	1020	24	15.0	59.0	15	180	12	--	9.0	8.2	8.5		.21	.017	2.0	.09	.07	<10	13	12
6-18-84	0950	0	21.0	69.8	5	315	12	28	8.5	8.3	8.0		.07	.0029	2.4	.15	.03	20	18	17
6-18-84	1000	24	18.0	64.4	5	315	17	--	3.0	8.1	8.0		.21	.0070	2.3	.15	.04	30	13	10
7-09-84	0930	0	21.0	69.8	5	225	12	28	8.0	8.4	8.5		.10	.012	2.1	.05	.01	<10	44	43
7-09-84	0940	24	20.0	68.0	5	225	16	--	4.0	8.0	8.0		.45	.017	1.8	.08	.01	<10	14	10
7-23-84	1400	0	25.0	77.8	2	270	7.6	30	7.0	8.7	8.5		<.01	<.0015	1.0	.08	.01	<10	37	37
7-23-84	1415	24	20.0	68.0	2	270	5.5	--	2.0	8.0	8.0		.76	.029	.7	.09	.01	<10	6	4
8-06-84	1020	0	24.0	75.2	3	225	16(16)	18	12.0(12.0)	8.7(7.8)	9.0(9.0)		.02(.01)	.0069	<.1(<.1)	.15(.14)	.01(.01)	<10(<10)	68(66)	68(66)
8-06-84	1035	24	19.0	66.2	3	225	7.3	--	2.0	7.7	8.5		2.4	.25	.6	.22	.16	140	9	8
8-21-84	0930	0	23.0	73.4	10	135	12	20	9.0	7.8	8.5		<.01	<.0013	<.1	.08	.04	<10	74	69
8-21-84	0840	24	22.0	71.6	10	135	19	--	2.0	7.5	8.5		.30	.038	<.1	.12	.05	10	68	67
9-04-84	1105	0	20.0	68.0	1.5	270	13	24	6.0	8.4	8.5		.15	.017	<.1	.10	.05	<10	73	73
9-04-84	1110	24	19.0	66.2	1.5	270	17	--	4.0	7.9	8.0		.45	.016	.4	.12	.06	60	43	40
9-17-84	1010	0	16.0	60.8	8	135	18	15	6.0	8.5	8.5		.05	.0043	<.1	.24	.04	20	102	102
9-17-84	1020	24	16.0	60.8	8	135	28	--	6.0	8.1	8.5		.22	.019	.4	.30	.10	<10	97	95

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Appendix 1984A (continued)

Site #3
Dissolved Oxygen (D.O.) and Temperature Profiles

Date	Depth Meters	Feet	Time	Field pH	Temp °C	°F	D.O. (mg/l)
5-21-84	0	0	0940	8.5	17	62.6	9.5
	2	6.5	0943	8.5	17	62.6	9.5
	4	13	0946	8.5	16	60.8	9.5
	6	20	0950	8.5	15	59.0	9.5
	bottom	24	0955	8.5	15	59.0	9.5
6-18-84	0	0	0950	8.0	21	69.8	8.5
	2	6.5	0952	8.0	21	69.8	8.0
	4	13	0955	8.0	20	68.0	6.0
	6	20	0958	8.0	19	66.2	3.0
	bottom	24	1000	8.0	18	64.4	3.0
7-23-84	0	0	1400	8.5	25	77.0	7.0
	2	6.5	1404	8.5	23	73.5	6.0
	4	13	1407	8.0	21	69.8	3.0
	6	20	1410	8.0	20	68.0	2.0
	bottom	24	1415	8.0	20	68.0	2.0
8-21-84	0	0	0930	8.5	23	73.5	9.0
	2	6.5	0932	8.5	23	73.5	7.0
	4	13	0935	8.5	23	73.5	5.0
	6	20	0938	8.5	22	71.6	2.0
	bottom	24	0940	8.5	22	71.6	2.0
9-17-84	0	0	1010	8.5	16	60.8	6.0
	2	6.5	1012	8.5	16	60.8	6.0
	4	13	1014	8.5	16	60.8	6.0
	6	20	1016	8.5	16	60.8	6.0
	bottom	24	1030	8.5	16	60.8	6.0

Appendix 1984A (continued)

1984 Algal Assay Results

PRAIRIE ROSE LAKE

WC 3500
6/4/84
Station #1

	OP	NH_3 NO_3	Growth
Raw	0.002 (0.86)	0.04 + 2.71 (104.50)	0.86
Filtered	0.010 (4.30)	0.12 + 2.60 (103.36)	4.30
Auto	0.002 (0.86)	0.04 + 2.85 (109.82)	0.86

	TP	TN
Raw Water	.03 (12.90)	0.63 (23.94)

The Algal Assay Bottle Test indicated that, based on nutrients immediately available, Phosphorus was the limiting nutrient

1375:1 N:P ratio

WC3501
6/4/84
Station #3

	OP	NH_3 NO_3	Growth
Raw	0.009 (3.87)	0.4 + 3.46 (146.68)	3.87
Filtered	0.005 (2.15)	0.1 + 2.98 (117.04)	2.15
Auto Claved	0.002 (0.86)	0.04 + 3.35 (128.82)	0.86

	TP	TN
Raw Water	.04 (17.20)	0.60 (22.80)

The Algal Assay Bottle Test indicated that, based on nutrients immediately available, Phosphorus was the limiting nutrient.

428:1 N:P ratio

WC3503
7/23/84
Station #1

PRARIE ROSE LAKE

	OP	NH_3 NO_3	Growth
Raw	0.10 (43.00)	0.40 + 1.09 (56.62)	43.00
Filtered	0.015 (6.45)	0.42 + 1.09 (57.38)	6.45
Auto	0.011 (4.73)	0.29 + 1.10 (52.82)	4.73
	TP	TN	
Raw Water	0.076 (32.68)	1.50 (57.00)	

The Algal Assay Bottle Test indicated that, based on nutrients immediately available, Phosphorus was the limiting nutrient.

15:1 N:P ratio

WC3504
7/23/84
Station #3

	OP	NH_3 NO_3	Growth
Raw	0.014 (6.02	0.40 + 1.52 (72.96)	6.02
Filtered	0.013 (5.59)	0.43 + 1.32 (66.50)	5.59
Auto	0.001 (0.43)	0.42 + 1.35 (67.26)	0.43
	TP	TN	
Raw Water	0.044 (18.92)	0.94 (35.72)	

The Algal Assay Bottle Test indicated that, based on nutrients immediately available, Phosphorus was the limiting nutrient.

137:1 N:P ratio

1984 Algal Assay Results (continued)

WC3505
9/4/84
Station #1

PRAIRIE ROSE LAKE

	OP	NH_3 NO_3	Growth
Raw	0.044 (18.92)	0.30 + 1.76 (78.28)	18.92
Filtered	0.37 (159.10)	0.49 + 0.01 (19.00)	19.00
Auto	0.15 (64.50)	0.42 + 0.04 (17.48)	17.48
	TP	TN	
Raw Water	.155	1.19	

The Algal Assay Bottle Test indicated that, based on nutrients immediately available, Phosphorus was the limiting nutrient

47:1 N:P ratio

WC3506
9/4/84
Station #3

	OP	NH_3 NO_3	Growth
Raw	.047 (20.21)	0.43 + 0.14 (21.66)	20.21
Filtered	.027 (11.61)	0.55 + 0.05 (22.80)	11.61
Auto	.014 (6.02)	0.48 + 0.05 (20.14)	6.02
	TP	TN	
Raw Water	0.143 (68.64)	1.06 (40.28)	

The Algal Assay Bottle Test indicated that, based on nutrients immediately available, Phosphorus was the limiting nutrient.

12:1 N:P ratio

Appendix 1983B

Drinking Water Intake

Site #4

MG/L

Date	Depth	Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Nickel	Mercury	Selenium	Zinc	Hexavalent Chromium
8-22-83	0	<.01	.1	<.001	<.01	<.01	<.01	<.1	<.001	<.01	.04	<.05
	11	<.01	.2	<.001	.01	<.01	<.01	<.1	<.001	<.01	.04	<.05

Date Collected	Depth (feet)	Atrazine	Dieldrin	Lasso	Dyfonate	Cyanazin
8-22-83	0	.08	<.01	<.05	<.03	.14
8-22-83	11	.10	<.01	<.05	<.03	.20

rlz/WRY272P02.22

Appendix 1984C

In-Lake Location at Swimming Beach
North Side of Lake
Site #5

In-Lake Location at Swimming Beach
North Side of Lake
Site #5

Date	Time	Depth (feet)	Fecal Coliform Organisms/100 ml	
July 16, 1984	1430	0	<10	Note: Sample collected 48 hours after a 1.33 inch rainfall on July 14, 1984
July 17, 1984	1530	0	<10	Note: 72 hours after July 14, 1984 rainfall
	1545	11	<10	
July 18, 1984	1545	0	<10	Note: 96 hours after July 14, 1984 rainfall
	1545	11	<10	
July 19, 1984	1500	0	<10	Note: 120 hours after July 14, 1984 rainfall
	1500	11	20	

Toxicants Detected in the 1983
Iowa Fishes (mg/kg wet weight).

	Chlordane	cis Chlordane	trans Chlordane	trans Nonachlor	Heptachlor Expoxide	Aldrin	Dieldrin	p,p'DDT	p,p'DDD	p,p'DDE	PCB 1254	PCB 1260	alpha Endosulfan
. Mississippi River above Davenport	.43	*	*	*	*	*	*	*	*	.09	*	*	*
. Mississippi River below Davenport	.260	*	*	.039	*	*	.063	*	.061	*	*	*	*
. Des Moines River above Des Moines	*	*	.026	*	.033	*	.190	*	.034	.057	*	*	*
. Des Moines River below Des Moines	.370	.049	.037	.024	.043	*	.110	*	*	.097	*	*	*
. (same as above) (Edible Portion)	.290	.031	.033	.040	.048	*	.140	*	.049	.140	*	*	*
. South Skunk River above Ames	*	*	*	*	.035	*	*	*	*	.150	*	*	*
. South Skunk River below Ames	*	*	*	*	.027	*	.110	*	.046	.061	*	*	*
. Missouri River at Sioux City	*	*	*	*	*	*	*	*	*	*	*	*	*
. Missouri River at Council Bluffs	*	*	*	.022	.029	*	.110	*	.027	.045	*	*	*
0. Nodaway River near Shambaugh	.320	*	*	.027	.012	*	.088	*	*	.031	*	*	*
1. (same as above) (Edible Portion)	*	*	*	.021	.012	.038	.060	*	*	.035	*	*	*
2. Skunk River below Augusta	.420	*	.054	.034	.027	*	.120	*	.036	.045	*	*	*
3. (same as above) (Edible Portion)	.310	.033	.030	.045	.027	*	.120	*	*	.077	*	*	*
4. Shell Rock River near Northwood	*	*	*	*	*	*	*	*	.030	.043	*	*	*
5. Little Sioux River at Linn Grove	*	*	*	*	.018	*	.063	*	*	.024	*	*	*
6. Little Sioux River near Sioux Rapids		*	*	*	.043	*	.120	*	*	.054	*	*	.031
7. Nishnabotna River near Hamburg	.260	.026	.043	.024	.021	*	.150	*	.041	.077	*	*	*
8. Iowa River at Wapello	*	*	*	*	.049	*	.130	*	*	.069	*	*	*
9. (same as above) (Edible Portion)	.360	.038	.044	.049	.073	*	.280	*	.054	.079	*	*	*
0. Prairie Rose Lake (Catfish)	*	*	*	*	*	*	*	*	*	*	*	*	*
1. (same as above) (Largemouth Bass)	*	*	*	*	*	*	*	*	*	*	*	*	*
2. Green Valley Lake (Channel Catfish)	*	*	*	*	.024	*	.073	*	*	.021	*	*	*
3. (same as above) (Largemouth Bass)	*	*	*	*	*	*	*	*	*	*	*	*	*
4. (Cedar River near Palo (E.P.)	*	*	*	.021	.046	.073	.190	*	*	.069	*	*	*
5. (Cedar River at Cedar Rapids (E.P.)	.380	.045	.025	.078	.045	*	.220	*	.050	.170	*	*	*
6. Iowa River at Marshalltown (E.P.)	.220	*	.046	*	.072	*	.200	*	.035	.086	*	*	*
27. Chariton River near Chariton	*	*	*	.029	.011	*	.037	*	*	.025	*	*	*
28. Maquoketa River near Monticello	.093	.008	.006	.012	.006	*	.024	*	.008	.013	*	.025	*
29. (same as above) (E.P.)	.079	*	*	.009	.005	*	.018	*	*	.012	*	.033	*
30. Wapsipinicon River near Troy Mills	.23	.025	.023	.012	.007	*	.028	*	.013	.028	*	.037	*
31. (same as above) (E.P.)	.097	.005	*	.010	.009	*	.033	.011	.013	.025	*	.036	*
32. Rock River near Rock Rapids	.2	.023	.024	.024	.018	*	.084	*	*	.016	*	*	*
33. (same as above) (E.P.)	.099	*	*	.013	.010	*	.059	*	.068	.022	*	.026	*
34. Upper Iowa River near Dorchester	.43	.027	.046	.043	.008	*	*	*	*	.085	.41	.26	*

* Not Detected N.A. - Not Analyzed For

Appendix 1983D

Appendix 1983D (continued)

Toxicants Detected in the 1983 Iowa Fishes (mg/kg wet weight).

	Dichloromethane	1,2 Dichloroethane	1,1,1 Trichloroethane	1,1,2,2-Tetrachloroethane	Methylbenzene	Ethylbenzene	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel
Mississippi River above Davenport	*	*	*	*	*	*	*	.061	.388	3.36	*	.05	.328
Mississippi River below Davenport	*	*	*	*	*	*	.08	.100	.459	.891	*	.02	1.49
Des Moines River above Des Moines	*	*	*	*	*	*	*	.056	.278	.722	*	.08	.267
Des Moines River below Des Moines	*	*	*	*	*	*	*	.076	.281	.835	.509	.01	1.11
(same as above) (Edible Portion)	*	*	*	*	*	*	N.A.	*	.227	.381	*	.03	.119
South Skunk River above Ames	*	*	*	*	*	*	*	.061	.353	.951	*	.03	.694
South Skunk River below Ames	*	*	.022	*	*	*	*	.058	.310	1.02	*	.05	.588
Missouri River at Sioux City	*	*	*	*	*	*	.06	.053	.355	.698	*	.04	.628
Missouri River at Council Bluffs	*	*	*	*	*	*	.05	.055	.401	.822	*	.01	.472
Nodaway River near Shambaugh	*	*	*	*	*	*	*	.079	.366	.496	*	.03	.375
(same as above) (Edible Portion)	*	*	*	*	*	*	*	*	.227	.283	*	.04	.123
Skunk River below Augusta	*	*	*	*	*	*	.07	.085	.442	1.03	*	.03	.287
(same as above) (Edible Portion)	*	*	*	*	*	*	*	*	.212	.485	*	.04	.466
Shell Rock River near Northwood	*	*	*	*	*	*	*	*	.296	.890	*	.01	.129
Little Sioux River at Linn Grove	*	*	*	.026	*	*	*	*	.310	.669	*	.02	.983
Little Sioux River near Sioux Rapids	*	*	*	*	*	*	*	.083	.394	.717	*	.02	.311
Nishnabotna River near Hamburg	*	*	*	*	*	*	*	.129	.342	.995	*	.02	.149
Iowa River at Wapello	*	*	*	*	*	*	*	.167	.446	1.27	*	.03	.351
(same as above) (Edible Portion)	*	*	*	*	*	*	*	*	.207	.189	*	.02	.357
Prairie Rose Lake (Catfish)	*	*	*	*	.030	.012	.05	*	.355	.706	*	.03	.853
(same as above) (Largemouth Bass)	*	*	*	*	.020	*	*	*	.339	.283	*	.05	.343
Green Valley Lake (Channel Catfish)	.110	*	*	*	*	*	.08	*	.476	.353	*	.01	.645
(same as above) (Largemouth Bass)	*	*	*	*	*	*	.05	*	.383	.649	*	*	.189
(Cedar River near Palo (E.P.)	*	*	*	*	*	*	*	*	.263	.190	*	.03	.101
(Cedar River at Cedar Rapids (E.P.)	*	*	*	*	*	*	*	*	.201	.201	*	.04	.182
Iowa River at Marshalltown (E.P.)	*	*	*	*	.057	*	*	*	.262	.309	*	.01	.168
Chariton River near Chariton	*	*	*	*	*	*	*	.053	.496	.830	*	.04	.208
Maquoketa River near Monticello	*	.099	*	*	*	*	*	*	.395	.432	*	.01	*
(same as above) (E.P.)	*	.084	*	*	*	*	*	*	.331	.339	*	.02	.159
Wapsipinicon River near Troy Mills	*	*	*	*	*	*	*	*	.242	.419	*	.02	.211
(same as above) (E.P.)	*	*	*	*	*	*	*	*	.286	.242	*	.02	.112
Rock River near Rock Rapids	*	*	*	*	*	*	*	*	.261	.780	*	.02	.150
(same as above) (E.P.)	*	*	*	*	*	*	*	*	.254	.262	*	.06	*
Upper Iowa River near Dorchester	*	*	*	*	*	*	*	*	.253	.304	*	.13	.161

No[illegible]tec[illegible] - [illegible] An[illegible]ed

Appendix 1983D (continued)

Toxicants Detected in the 1983
Iowa Fishes (mg/kg wet weight).

		Selenium	Zinc											Percent Lipid
.	Mississippi River above Davenport	.039	74.7											10
.	Mississippi River below Davenport	0.51	45.5											10
.	Des Moines River above Des Moines	0.69	47.8											10
.	Des Moines River below Des Moines	0.73	50.7											10
.	(same as above) (Edible Portion)	N.A.	27.5											10
.	South Skunk River above Ames	1.04	71.1											5
.	South Skunk River below Ames	1.10	68.3											5
.	Missouri River at Sioux City	1.09	34.9											10
.	Missouri River at Council Bluffs	1.22	48.5											10
0.	Nodaway River near Shambaugh	1.27	13.2											5
1.	(same as above) (Edible Portion)	0.73	14.4											5
2.	Skunk River below Augusta	0.88	70.4											10
3.	(same as above) (Edible Portion)	0.54	12.2											5
4.	Shell Rock River near Northwood	0.32	51.8											10
5.	Little Sioux River at Linn Grove	0.75	62.6											10
6.	Little Sioux River near Sioux Rapids	0.99	36.9											15
7.	Nishnabotna River near Hamburg	1.04	47.2											5
8.	Iowa River at Wapello	0.84	85.3											15
9.	(same as above) (Edible Portion)	0.20	10.7											10
20.	Prairie Rose Lake (Catfish)	0.57	22.0											5
21.	(same as above) (Largemouth Bass)	1.37	13.3											5
22.	Green Valley Lake (Channel Catfish)	0.32	16.9											10
23.	(same as above) (Largemouth Bass)	0.56	14.9											5
24.	(Cedar River near Palo (E.P.)	0.04	11.4											15
25.	(Cedar River at Cedar Rapids (E.P.)	0.15	11.2											20
26.	Iowa River at Marshalltown (E.P.)	0.33	14.4											10
27.	Chariton River near Chariton	0.31	19.2											5
28.	Maquoketa River near Monticello	0.43	19.8											15
29.	(same as above) (E.P.)	0.39	12.7											5
30.	Wapsipinicon River near Troy Mills	0.40	14.7											5
31.	(same as above) (E.P.)	0.32	11.4											10
32.	Rock River near Rock Rapids	0.61	16.0											10
33.	(same as above) (E.P.)	0.63	11.3											10
34.	Upper Iowa River near Dorchester	0.40	14.2											5

* Not Detected N.A. - Not Analyzed For

Ethylbenzene

Ethylbenzene is a colorless liquid with a vapor pressure of 20 mm Hg (at 38.6°C), and a water solubility of 866 mg/l. Six to 7 billion pounds of the compound were produced in the United States in 1975, of which 98 percent was used in the manufacture of styrenes. Significant quantities of ethylbenzene are present in mixed zylenes which, in turn, are used as diluents in the paint industry, in agricultural sprays for insecticides, and in gasoline blends (which may contain as much as 20 percent ethylbenzene).

Because of its use in numerous commercial products, and its presence in various petroleum combustion processes, ethylbenzene is widely distributed in the environment. To date, there is no available data suggesting ethylbenzene is a carcinogen.

Ethylbenzene produces symptoms in four freshwater fishes at levels ranging 32,000 to 155,000 ug/l.[14] In a fathead-minnow embryo-larval test (a sub-acute test), no adverse effects were observed at concentrations as high as 440 ug/l.[14] Although no measured bioconcentration factors have been observed in the literature, the estimated steady-state BCF for ethylbenzene is 95.[14]

Ethylbenzene was detected in the Prairie Rose Lake catfish at .012 mg/kg (Table 3). Like methylbenzene, it is suspected of being introduced during the sampling process.

Methylbenzene (toluene)

Methylbenzene is a clear, colorless liquid at room temperature with a vapor pressure of 30 mm Hg, and a water solubility of 535 mg/l. Methylbenzene is produced mainly from petroleum or petrochemical processes. Seventy percent of the methylbenzene produced is converted to benzene, 15 percent is used as feedstock, and the remainder is used in the production of other chemicals, as a gasoline additive, and as a solvent for paints and coatings. Each year, industry discharges 4,840 kilo-kilograms of methylbenzene into the aquatic environment. Although methylbenzene can be acutely, and sub-acutely toxic to man, there has been no evidence that it is a carcinogen based on available information.

Methylbenzene produces symptoms of acute toxicity in freshwater fish and invertebrates at levels ranging from 12,700 to 313,000 ug/l.[13] Levels that produce symptoms of chronic toxicity are not known. Information on measured bioconcentration factors for methylbenzene is also unavailable. However, the estimated steady-state BCF* is 27.1.[13]

Methylbenzene was detected in the catfish and the largemouth bass from Prairie Rose Lake at .030 and .020 mg/kg, respectively. It was also found in the edible portion sample from the Iowa River at Marshalltown (.057 mg/kg) (Table 3). Again, because toluene is a gasoline additive, its presence in the fishes may have been the result of contamination during collection.

* Based on the equation "log BCF = (0.85 Log P) - 0.70" where P equals the octanol/water partition coefficient for the compound, and the aquatic organisms are assumed to contain 7.6 percent lipid.

Cadmium

Sources of cadmium in the environment caused by man include industries involved in electroplating, paint and pigment manufacture, plastics manufacture, and from the smelting and refining of copper, lead, and zinc. Other sources include surface mine drainage and the application of phosphate fertilizers (a major source). Cadmium is strongly absorbed to clays, muds, humic and organic materials and some hydrous oxides, all of which tend to remove it from the water column by precipitation.

Cadmium is extremely toxic and cumulates in aquatic organisms. However, these effects are dependent on several factors, such as metal species, organism species, pH, water hardness, and the presence of organic complexing agents. Freshwater fishes and invertebrates have shown acute toxicity from cadmium at levels ranging from 1 to 73,500 ug/l, and chronic toxicity from 0.15 to 50 ug/l.[16] Reports of cadmium bioconcentration factors greater than 1,000 in fishes are not uncommon. Generally speaking, however, fish and crustaceans bioconcentrate cadmium less than 400 times background.[17]

Cadmium was detected in 14 of the 34 composites at levels ranging from .053 to .167 mg/kg (Table 3). Both arsenic and cadmium were absent, or at least below detection limits, in the edible portion samples, indicating little risk to human consumers from these elements.

Lead

The United States consumes about 1.3 million metric tons of lead each year. One half of this goes into making storage batteries while another one fifth goes into the production of leaded gasoline. The remainder is used in making pigments, ceramics, metallic lead products, and lead containing alloys. Lead reaches the aquatic environment through precipitation, fallout of lead dust, street run-off, and from both industrial and municipal wastewater discharges. The earth itself is a source of lead since rocks and soils contain from 10 to 30 mg/kg of the metal.

Part of the toxicity of lead is dependent on its solubility. Metallic lead, or the common minerals containing lead, are insoluble in ambient waters. At a pH of 9.0, the solubility of lead is about 1 ug/l. At pH 5.5, however, the solubility dramatically increases to 10,000,000 ug/l. Lead toxicity to freshwater animals is also water hardness dependent. Both the acute and chronic toxicities of lead decrease as hardness increases. Studies have shown that lead produces acute toxicity in freshwater fishes and macro-invertebrates at levels ranging from 124 to 542,000 ug/l, and chronic toxicity at 12 to 174 ug/l.[17] Invertebrates tend to bioaccumulate more lead than do fishes. Invertebrates bioaccumulate lead from 499 to 1,700 times background, while brook trout and bluegills bioaccumulate lead 42 and 45 times background, respectively.[17] Fishes accumulate very little lead in the edible tissues.

Lead was present in the Des Moines River below Des Moines whole-fish sample at .509 mg/kg (Table 3). It was not detected in the edible portion sample from this site. Lead was not detected in the fish collected in 1982; however, in 1980 and 1981, lead was detected in samples below Des Moines at .170 and .240 mg/kg, respectively.[18,19]

Mercury

Major users (and potential sources of mercury in the environment) include the electrical apparatus industry (mercury batteries, alkaline energy cells, vapor discharge lamps, rectifiers, and switches), chlorine and caustic soda manufacturing industries, and general laboratory applications. Mercury occurs in aquatic systems in three forms: elemental (metallic), inorganic (mercurous and mercuric salts), and in organic compounds. The latter form, specifically, methylmercury, is the most toxic to aquatic organisms and to humans. Methylmercury produces chronic toxicity in Daphnia magna and brook trout at 1.00 and 0.52 ug/l, respectively.[20] In the environment, elemental mercury is oxidized to divalent (inorganic) mercury. Certain microorganisms convert inorganic mercury and other organic mercury compounds into the toxic methylmercury. Mercury readily bioaccumulates in aquatic organisms. Fathead minnows bioconcentrate mercury 63,000 times background.[20] Mercury in aquatic organisms poses a threat to consumers because it is stored in the methylated form. Under chronic exposure, when steady-state is reached, the level of mercury in the muscles of fishes is about the same as in the whole body.[20]

Mercury was detected in 33 of the 34 composites at levels ranging from .01 to .15 mg/kg (Table 3). None exceeded either the NAS/NAE guideline of .5 mg/kg, or the FDA actionable level of 1.0 mg/kg.

Chromium, Copper, Nickel, Selenium, and Zinc (nutrient metals)

Since the EPA Region VII laboratory began analyzing fishes on a routine basis in 1980, virtually every sample has contained detectable levels of the above metals. A reason for this may be because chromium, copper, nickel, selenium and zinc are known or are suspected of being animal nutrients, and may, therefore, be inherent components of fish tissues. Fishes are, however, capable of bioaccumulating these metals as much as 432 times background.[21] Metal residue levels higher than background may be indicative of contamination in the area. Table 5 provides a background reference of the above metals in Iowa carp.

All 11 samples of whole carp contained levels of chromium that were close to the Table 5 mean of .478 mg/kg. There were from one to three samples under the other four metals that were at, or slightly above, two standard deviations from the mean for those metals. One notable example of this was the copper in the sample from the Mississippi River above Davenport (3.36 mg/kg) which was almost four times the Table 5 mean (.899). The significance of this is not certain since the available data base is believed to be, at present, too small to be used as a guideline for recommending follow-up action.

Appendix 1983D (continued)

Appendix 1983D (continued)

Arsenic

Arsenic and its compounds are used in the manufacturing of glass, cloth and electrical semiconductors; as fungicides, herbicides, and wood preservatives; and as growth stimulants for plants and animals, as well as in veterinary applications. The United States consumes half the world production of arsenic (approximately 37,500 tons) each year. The principal emission source of arsenic in the U.S. is thought to be coal-fueled power plants, which emit about 3,000 tons of arsenic a year. Arsenic also enters the environment under natural conditions since as much as 5 mg/kg of the metalloid can be found in the earth's crust.

Sodium arsenite, a trivalent form of arsenic, is acutely toxic to freshwater aquatic invertebrates at levels ranging from 812 to 5,278 ug/l.[15] Freshwater fishes demonstrate acute toxicity to the same compound at levels ranging from 13,340 to 41,760 ug/l.[15] Sodium arsenite (+5) is apparently as toxic to freshwater organisms as sodium arsenite (+3). Water hardness apparently has no effect on the toxicity of arsenic. Studies also indicate that very little arsenic is bioaccumulated. Bioconcentration factors of 0 (rainbow trout and scuds) to 17 (snails) have been reported.[15] Bluegills bioaccumulate only 4 times background, and when placed in arsenic-free waters, they lost one-half of their body burden of arsenic in one day.[15]

Thirty-three of the 34 composites were analyzed for arsenic. Out of those 33, the metalloid was detected in seven samples at very low levels (.05 to .08 mg/kg) (Table 3).