U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

REPORT

ON

LAKE BEMIDJI

BELTRAMI COUNTY

MINNESOTA

EPA REGION V

WORKING PAPER No. 84

PACIFIC NORTHWEST ENVIRONMENTAL RESEARCH LABORATORY

An Associate Laboratory of the

NATIONAL ENVIRONMENTAL RESEARCH CENTER - CORVALLIS, OREGON

and

NATIONAL ENVIRONMENTAL RESEARCH CENTER - LAS VEGAS, NEVADA

☆ GPO—697-032

REPORT
ON
LAKE BEMIDJI
BELTRAMI COUNTY
MINNESOTA
EPA REGION V
WORKING PAPER No. 84

WITH THE COOPERATION OF THE

MINNESOTA POLLUTION CONTROL AGENCY

AND THE

MINNESOTA NATIONAL GUARD

NOVEMBER, 1974

CONTENTS

F O R E W O R D

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Minnesota Pollution Control Agency for professional involvement and to the Minnesota National Guard for conducting the tributary sampling phase of the Survey.

Grant J. Merritt, Director of the Minnesota Pollution Control Agency, John F. McGuire, Chief, and Joel G. Schilling, Biologist, of the Section of Surface and Groundwater, Division of Water Quality, provided invaluable lake documentation and counsel during the course of the Survey; and the staff of the Section of Municipal Works, Division of Water Quality, were most helpful in identifying point sources and soliciting municipal participation in the Survey.

Major General Chester J. Moeglein, the Adjutant General of Minnesota, and Project Officer Major Adrian Beltrand, who directed the volunteer efforts of the Minnesota National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

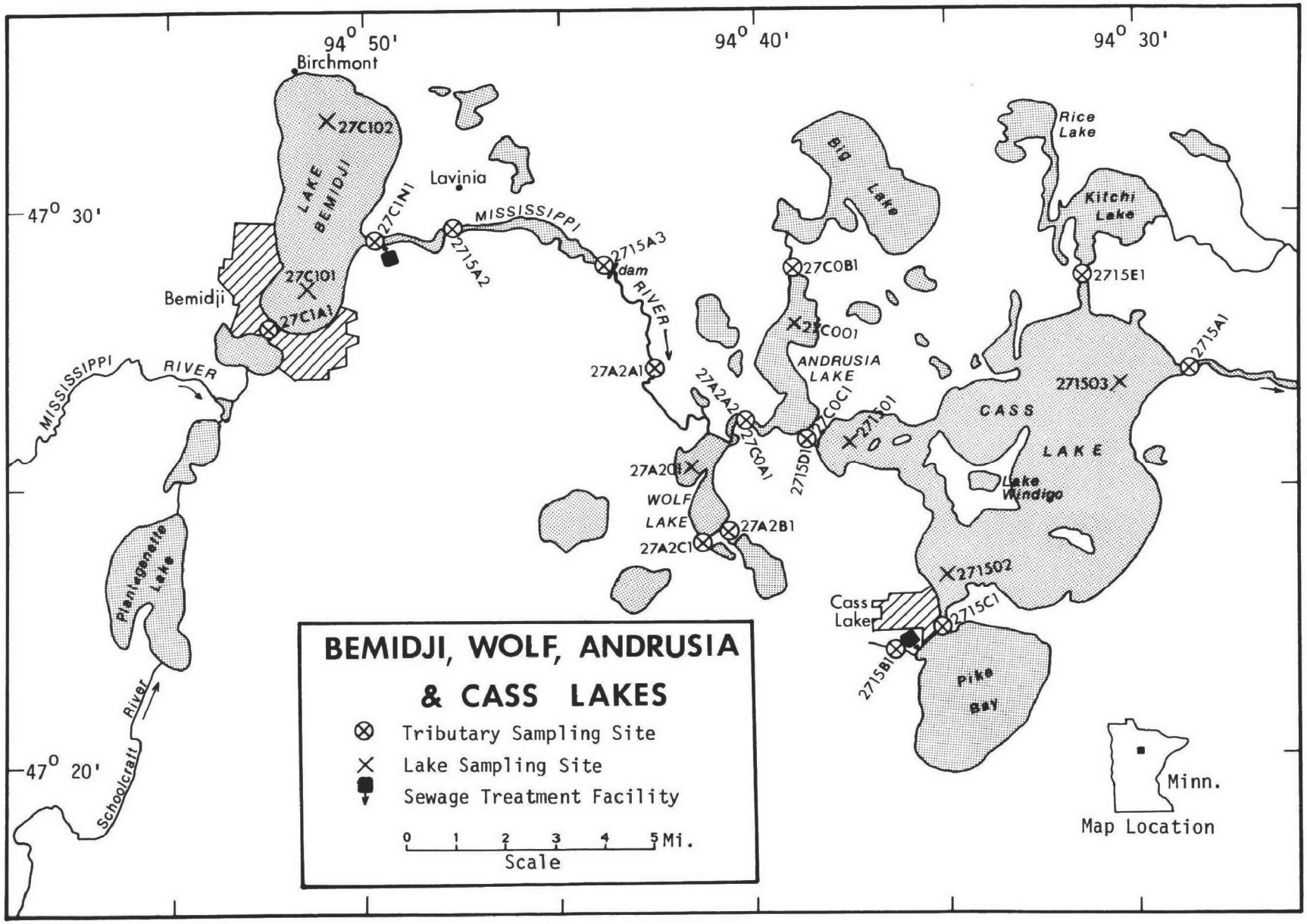
NATIONAL EUTROPHICATION SURVEY

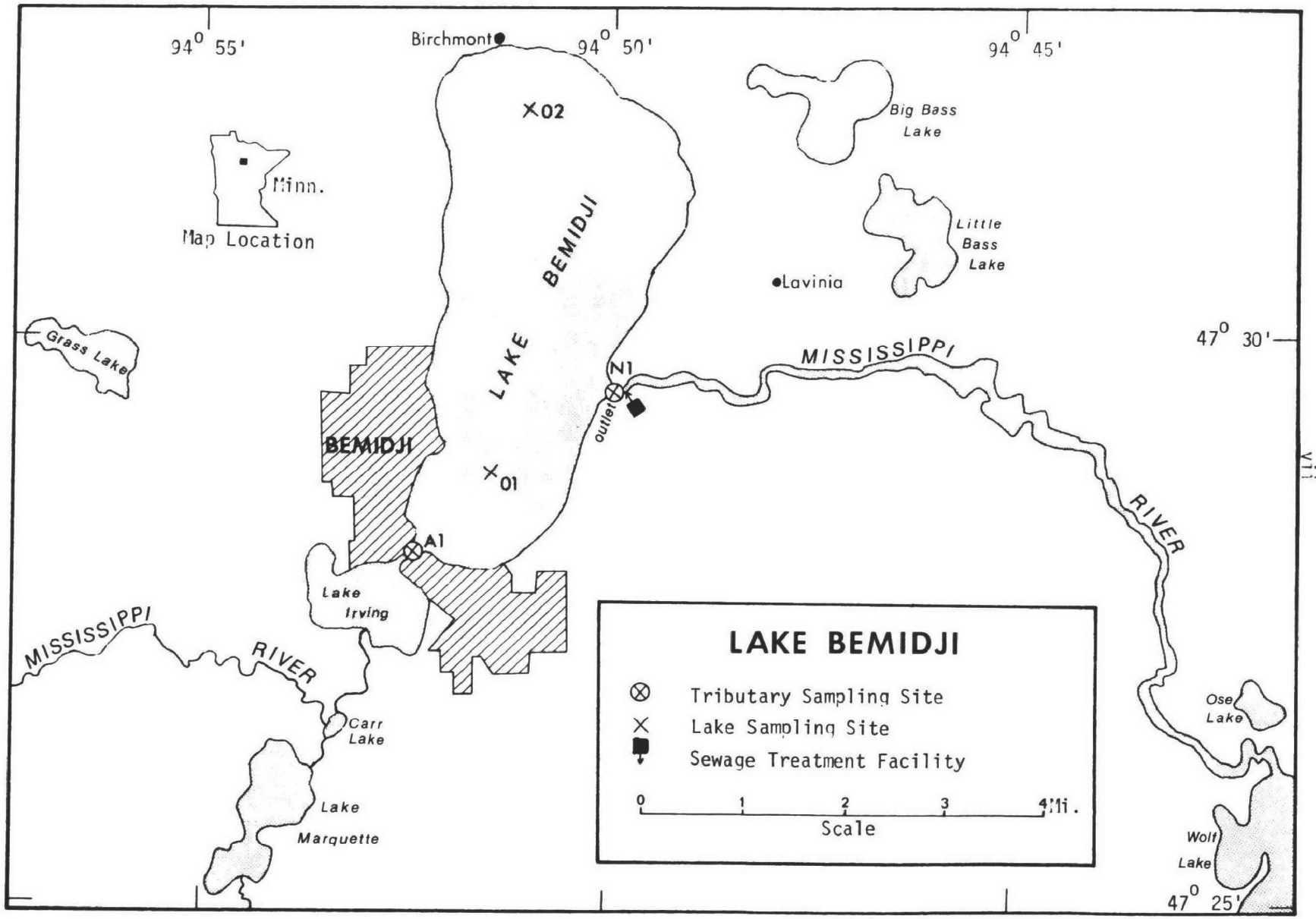
STUDY LAKES

STATE OF MINNESOTA

LAKE NAME	COUNTY
Albert Lea	Freeborn
Andrusia	Beltrami
Badger	Polk
Bartlett	Koochiching
Bear	Freeborn
Bemidji	Beltrami
Big	Stearns
Big Stone	Big Stone, MN; Roberts, Grant, SD
Birch	Cass
Blackduck	Beltrami
Blackhoof	Crow Wing
Budd	Martin
Buffalo	Wright
Calhoun	Hennepin
Carlos	Douglas
Carrigan	Wright
Cass	Beltrami, Cass
Clearwater	Wright, Stearns
Cokato	Wright
Cranberry	Crow Wing
Darling	Douglas
Elbow	St. Louis
Embarass	St. Louis
Fall	Lake
Forest	Washington
Green	Kandiyohi
Gull	Cass
Heron	Jackson
Leech	Cass
Le Homme Dieu	Douglas
Lily	Blue Earth
Little	Grant
Lost	St. Louis

LAKE NAME	COUNTY
Madison	Blue Earth
Malmedal	Pope
Mashkenode	St. Louis
McQuade	St. Louis
Minnetonka	Hennepin
Minnewaska	Pope
Mud	Itasca
Nest	Kandiyohi
Pelican	St. Louis
Pepin	Goodhue, Wabasha, MN; Pierce, Pepin, WI
Rabbit	Crow Wing
Sakatah	Le Sueur
Shagawa	St. Louis
Silver	McLeod
Six Mile	St. Louis
Spring	Washington, Dakota
St. Croix	Washington, MN; St. Croix, Pierce, WI
St. Louis Bay	St. Louis, MN; Douglas, WI
Superior Bay	St. Louis, MN; Douglas, WI
Swan	Itasca
Trace	Todd
Trout	Itasca
Wagonga	Kandiyohi
Wallmark	Chisago
White Bear	Washington
Winona	Douglas
Wolf	Beltrami, Hubbard
Woodcock	Kandiyohi
Zumbro	Olmstead, Wabasha


94° 50'
94° 40'
94° 30'
47° 30'
47° 20'
Birchmont
Lavinia
Bemidji
LAKE BEMIDJI
27C102
27C101
27C1A1
27C1N1
MISSISSIPPI
RIVER
2715A2
2715A3
dam
RIVER
27A2A1
27A2A2
27C0A1
27A2C1
WOLF
LAKE
27A2B1
27A2C1
Big Lake
27C0B1
27C001
ANDRUSIA
LAKE
27C0C1
2715D1
27C101
Rice Lake
Kitchi Lake
2715E1
2715A1
271503
CASS
LAKE
Lake Windigo
271502
Cass Lake
2715C1
2715B1
Pike Bay
Plantagenette Lake
Schoolcraft River
BEMIDJI, WOLF, ANDRUSIA & CASS LAKES
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
0 1 2 3 4 5 Mi.
Scale
Minn.
Map Location


94° 55'
Birchmont
94° 50'
94° 45'
X02
Big Bass Lake
Minn.
Map Location
LAKE BEMIDJI
Little Bass Lake
Lavinia
Grass Lake
47° 30'
MISSISSIPPI
Z1
outlet
BEMIDJI
X01
RIVER
A1
Lake Irving
MISSISSIPPI
RIVER
Carr Lake
Lake Marquette
Ose Lake
Wolf Lake
47° 25'
LAKE BEMIDJI
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
0 1 2 3 4 Mi.
Scale

LAKE BEMIDJI

STORET NO. 2701

I. CONCLUSIONS

A. Trophic Condition:

Survey data show that Lake Bemidji is eutrophic. Of the 60 Minnesota lakes sampled in the fall when essentially all were well-mixed, 28 had less mean total phosphorus, 36 had less mean dissolved phosphorus, but only 5 had less mean inorganic nitrogen. Of the 80 lakes studied, 24% had less mean chlorophyll a, and 19% had greater Secchi disc transparency. Marked depression of dissolved oxygen with depth was noted at station 1 in July and September and at station 2 in July, 1972.

Reportedly, a portion of Lake Bemidji was chemically treated for algae control in 1971 (Bonnema and Johnson, 1972).

B. Rate-Limiting Nutrient:

The results of the algal assay show that the lake was nitrogen limited at the time the assay sample was collected. Lake data indicate nitrogen limitation at the other sampling times as well.

C. Nutrient Controllability:

There are no known point sources impacting Lake Bemidji within the limits of the Survey. The N/P ratio of 28/1 in the mean annual nutrient loads of the inlet (see page 12)

suggests that point sources in the drainage are not large nutrient contributors (of course, Lake Irving provides some phosphorus entrappment, but it is unlikely that it is enough to account for the N/P ratio observed).

During the sampling year, Lake Bemidji received a total phosphorus load at a rate less than that proposed by Vollenweider (in press) as "dangerous" (i.e., a eutrophic rate) but more than a "permissible" or oligotrophic rate (see page 12).

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry†:

1. Surface area: 6,420 acres.
2. Mean depth: 32 feet.
3. Maximum depth: 76 feet.
4. Volume: 205,440 acre/feet.
5. Mean hydraulic retention time: 268 days.

B. Tributary and Outlet:
(See Appendix A for flow data)

1. Tributaries -

Name	Drainage area*	Mean flow*
Lake Irving outlet (Mississippi River)	584.0 mi^2	366.3 cfs
Minor tributaries & immediate drainage -	35.5 mi^2	19.5 cfs
Totals	619.5 mi^2	385.8 cfs

2. Outlet -

Mississippi River	630.0 mi^2**	385.8 cfs**

C. Precipitation***:

1. Year of sampling: 22.2 inches.
2. Mean annual: 21.1 inches.

† DNR lake survey map (1967); mean depth by random-dot method.
* Drainage areas are accurate within ±5%; mean daily flows are accurate within ±10%; and ungaged flows are accurate within ±10 to 25% for drainage areas greater than 10 mi^2.
** Includes area of lake; outlet flow adjusted to equal sum of inflows.
*** See Working Paper No. 1, "Survey Methods".

III. LAKE WATER QUALITY SUMMARY

Lake Bemidji, one of a chain of upper Mississippi River lakes (see map, page vi), was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the lake and from a number of depths at each station (see map, page vii). During each visit, a single depth-integrated (15 feet to surface) sample was composited from the two stations for phytoplankton identification and enumeration; and during the last visit, a single five-gallon depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 48 feet at station 1 and 46 feet at station 2.

The results obtained are presented in full in Appendix B, and the data for the fall sampling period, when the lake was essentially well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix B.

A. Physical and chemical characteristics:

Parameter	Minimum	Mean	Median	Maximum
		FALL VALUES (10/21/72)		
Temperature (Cent.)	6.1	6.8	6.8	7.4
Dissolved oxygen (mg/l)	10.0	10.7	10.8	11.1
Conductivity (μmhos)	290	295	295	300
pH (units)	8.4	8.4	8.4	8.4
Alkalinity (mg/l)	154	157	156	161
Total P (mg/l)	0.037	0.052	0.050	0.067
Dissolved P (mg/l)	0.028	0.040	0.038	0.055
NO_2 + NO_3 (mg/l)	0.020	0.028	0.030	0.040
Ammonia (mg/l)	0.030	0.046	0.050	0.060
		ALL VALUES		
Secchi disc (inches)	69	85	86	100

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
07/11/72	1. Microcystis	2,803
	2. Anabaena	940
	3. Dinobryon	723
	4. Melosira	163
	5. Fragilaria	90
	Other genera	543
	Total	5,262
09/08/72	1. Microcystis	2,355
	2. Lyngbya	2,283
	3. Anabaena	1,377
	4. Dinobryon	399
	5. Flagellates	217
	Other genera	1,231
	Total	7,862
10/21/72	1. Melosira	1,747
	2. Anabaena	723
	3. Fragilaria	602
	4. Stephanodiscus	422
	5. Chroococcus	346
	Other genera	1,521
	Total	5,361

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll a (µg/l)
07/11/72	01	9.2
	02	8.3
09/08/72	01	6.6
	02	6.9
10/21/72	01	8.9
	02	17.0

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.020	0.047	1.3
0.006 P	0.026	0.047	1.3
0.012 P	0.032	0.047	1.2
0.024 P	0.044	0.047	1.0
0.060 P	0.080	0.047	1.4
0.060 P + 10.0 N	0.080	10.047	37.1
10.0 N	0.020	10.047	7.8

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Lake Bemidji was moderate at the time the sample was collected. Also, the lack of significant change in yield with increasing increments of orthophosphorus, until nitrogen was also added, shows that the lake was nitrogen limited. Note the increase in yield when only nitrogen was added.

The lake data indicate nitrogen limitation at the other sampling times as well (N/P ratios were 9/1 or less).

IV. NUTRIENT LOADINGS
(See Appendix C for all data)

For the determination of nutrient loadings, the Minnesota National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page vii), except for the high runoff months of April and May when extra samples were collected. Sampling was begun in October, 1972, and was completed in September, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Minnesota District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated by using the means of the nutrient loads, in lbs/mi^2/year, in streams tributary to nearby Leech Lake at stations 2746C-1, D-1, F-1, G-1, H-1, and J-1 and multiplying the means by the ZZ area in mi^2.

A. Waste Sources:

1. Known municipal - None
2. Known industrial - None

---

* See Working Paper No. 1.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	lbs P/ yr	% of total
a. Tributaries (non-point load) -		
Lake Irving outlet (Mississippi River)	23,120	91.4
b. Minor tributaries & immediate drainage (non-point load) -	990	3.9
c. Known municipal - None	-	-
d. Septic tanks* -	190	0.8
e. Known industrial - None	-	-
f. Direct precipitation** -	1,000	3.9
Total	25,300	100.0

2. Outputs -

Lake outlet - Mississippi River 16,290

3. Net annual P accumulation - 9,010 pounds

* Estimated 777 persons residing on lake shore (Holt, et al., 1971); see Working Paper No. 1.
** See Working Paper No. 1.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	lbs N/ yr	% of total
a. Tributaries (non-point load) -		
Lake Irving outlet (Mississippi River)	653,760	85.2
b. Minor tributaries & immediate drainage (non-point load) --	44,410	5.8
c. Known municipal - None	-	-
d. Septic tanks* -	7,300	1.0
e. Known industrial - None	-	-
f. Direct precipitation** -	61,850	8.0
Total	767,320	100.0

2. Outputs -

Lake outlet - Mississippi River 575,490

3. Net annual N accumulation - 191,830 pounds

* Estimated 777 persons residing on lake shore (Holt, et al., 1971); see Working Paper No. 1.
** See Working Paper No. 1.

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	lbs P/mi^2/yr	lbs N/mi^2/yr	N/P Ratio
Lake Irving outlet (Mississippi River)	40	1,120	28/1

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (in press). Essentially, his "dangerous" rate is the rate at which the receiving waters would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible".

	Total Phosphorus		Total Nitrogen	
Units	Total	Accumulated	Total	Accumulated
lbs/acre/yr	3.9	1.4	119.5	29.9
grams/m^2/yr	0.44	0.16	13.4	3.3

Vollenweider loading rates for phosphorus ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Lake Bemidji:

"Dangerous" (eutrophic rate)	0.70
"Permissible" (oligotrophic rate)	0.35

V. LITERATURE REVIEWED

Anonymous, 1948. Lake survey report, Lake Bemidji, Beltrami County. MN Dept. Nat. Resources, Minneapolis.

Bonnema, Kenneth, and William G. Johnson, 1972. Control of aquatic vegetation, algae, leeches, and swimmer's itch. MN Dept. Nat. Resources, Minneapolis.

Holt, Charles S., Roger A. Schulz, and Curtis M. Hadland; 1971. Patterns of lakeshore usage around Lake Bemidji. Jour. Minn. Acad. Sci., V. 37, Nos. 2 and 3.

Hoekstra, Donald J., 1968. Nitrogen and phosphorus analysis of six Mississippi headwater lakes. MS, Limnology Inst., Bemidji State College, Bemidji.

Schilling, Joel, 1974. Personal communication (lake map). MPCA, Minneapolis.

Vollenweider, Richard A., (in press). Input-output models. Schweiz. A. Hydrol.

VII. APPENDICES

APPENDIX A

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR MINNESOTA 10/30/74

LAKE CODE 27C1 HEMIDJI LAKE

TOTAL DRAINAGE AREA OF LAKE 630.00

TRIBUTARY	SUB-DRAINAGE AREA	NORMALIZED FLOWS JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
27C1A1	584.00	280.00	163.00	298.00	757.00	763.00	524.00	334.00	263.00	422.00	174.00	138.00	272.00	366.30
27C1A2	630.00	278.01	162.08	297.89	815.25	816.25	560.01	356.43	280.00	446.83	185.70	147.94	276.00	385.86
27C1Z7	45.50	8.37	5.04	12.40	49.80	49.40	40.60	19.20	8.95	15.60	9.47	6.46	8.82	19.53

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 630.00
SUM OF SUB-DRAINAGE AREAS = 629.50
TOTAL FLOW IN = 4622.09
TOTAL FLOW OUT = 4622.39

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
27C1A1	10	72	160.00	14	211.00				
	11	72	131.00	5	131.00				
	12	72	409.00	10	397.00				
	1	73	308.00	20	268.00				
	2	73	174.00	18	174.00				
	3	73	814.00	17	2440.00				
	4	73	236.00	1	250.00	14	217.00		
	5	73	230.00	19	209.00				
	6	73	191.00						
	7	73	145.00	8	129.00				
	8	73	206.00	11	206.00				
	9	73	300.00	16	350.00				
27C1A2	10	72	172.00	14	227.00				
	11	72	140.00	5	140.00				
	12	72	418.00	10	405.00				
	1	73	303.00	20	264.00				
	2	73	174.00	18	174.00				
	3	73	819.00	17	2460.00				
	4	73	205.00	1	217.00	14	189.00		
	5	73	203.00	19	195.00				
	6	73	190.00						
	7	73	180.00	8	160.00				
	8	73	200.00	11	200.00				
	9	73	500.00	16	580.00				
27C1Z7	10	72	8.67	14	11.00				
	11	72	6.10	5	6.10				
	12	72	13.30	10	13.00				
	1	73	9.21	20	8.00				
	2	73	5.39	18	5.40				
	3	73	33.90	17	102.00				
	4	73	18.90	1	20.00	14	17.00		
	5	73	18.40	19	17.00				
	6	73	15.30						
	7	73	11.40	8	10.10				
	8	73	16.20	11	16.00				
	9	73	175.00	16	203.00				

APPENDIX B

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/10/30

27C101
47 28 40.0 094 51 42.0
LAKE BEMIDJI
27 MINNESOTA

11EPALES 2111202
3 0045 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/11	10 00	0000			87	360	8.30	171	0.040	0.060	0.024	0.008
	10 00	0004	20.9	9.4		350	8.30	174	0.040	0.060	0.019	0.008
	10 00	0015	20.0	8.2		350	8.20	175	0.040	0.050	0.020	0.008
	10 00	0040	11.1	0.2		380	7.40	183	0.040	0.370	0.093	0.067
72/09/08	11 25	0000			84	310	8.10	156	0.040	0.060	0.032	0.016
	11 25	0004	17.5	7.6		305	8.05	156	0.020	0.040	0.022	0.012
	11 25	0015	17.3	6.1		305	8.00	157	0.030	0.070	0.029	0.017
	11 25	0022	17.2	7.3		290	8.00	158	0.050	0.130	0.028	0.016
	11 25	0030	17.2	6.9		310	7.95	157	0.040	0.130	0.036	0.017
	11 25	0039	16.4	5.0		310	7.80	158	0.030	0.240	0.051	0.031
	11 25	0048	12.7	0.3		355	7.25	182	0.090	0.830	0.404	0.222
72/10/21	15 20	0000			72	300	8.40	155	0.040	0.060	0.060	0.046
	15 20	0004	6.8	11.1		295	8.40	157	0.020	0.040	0.030	0.008
	15 20	0015	6.5	10.8		290	8.40	157	0.020	0.040	0.053	0.041
	15 20	0022	6.5	10.8		290	8.40	161	0.030	0.050	0.037	0.021
	15 20	0030	6.5	10.8		300	8.40	160	0.030	0.050	0.046	0.026
	15 20	0041	6.4	10.6		300	8.40	160	0.030	0.060	0.050	0.030

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/07/11	10 00	0000	9.2J
72/09/08	11 25	0000	6.6J
72/10/21	15 20	0000	8.9J

J* VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 77/12/22

270102
47 32 00.0 094 51 30.0
LAKE BEMIDJI
27 MINNESOTA

11EPALES 2111202
4 0039 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSPARENCY SECCHI INCHES	00094 CONDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/11	10 30 0000				60	350	8.40	174	0.040	0.050	0.013	0.007
	11 30 0104	21.1	.6			350	8.40	171	0.040	0.050	0.014	0.008
	10 30 0915	21.4	5.1			345	8.40	172	0.030	0.050	0.015	0.006
	10 30 1335	11.7	1.3			370	7.40	176	0.070	0.140	0.030	0.021
72/10/04	11 00 0000				48	303	8.20	149	0.020	0.080	0.025	0.011
	11 00 0004	17.4	7.4			303	8.20	149	0.020	0.070	0.025	0.011
	11 00 0015	17.5	7.2			300	8.15	150	0.030	0.080	0.021	0.010
	11 00 0030	17.4	7.5			300	8.15	149	0.030	0.080	0.021	0.010
	11 00 0131	17.4	7.5			300	8.15	148	0.020	0.070	0.020	0.009
72/11/21	14 40 0000				120	300	8.40	155	0.020	0.030	0.067	0.055
	14 40 0004	7.4	12.2			300	8.40	154	0.020	0.030	0.041	0.028
	14 40 0015	7.2	12.1			300	8.40	154	0.030	0.040	0.063	0.054
	14 40 0130	7.2	11.8			296	8.40	156	0.030	0.040	0.066	0.051
	14 40 0230	7.1	11.7			290	8.40	155	0.030	0.050	0.054	0.042
	14 40 0335	7.1	11.7			295	8.40	156	0.040	0.060	0.048	0.035
	14 40 0345	7.1	11.5			300	8.40	155	0.030	0.050	0.040	0.028

DATE FROM TO	TIME OF DAY	DEPTH FEET	00217
72/07/11	10 30 0000		0.01
72/10/04	11 00 0000		0.02
72/11/21	14 40 0000		0.02

J# VALUE KNOWN TO BE IN ERROR

APPENDIX C

TRIBUTARY DATA

STORET RETRIEVAL DATE 74/10/30

27C1A1 LS27C1A1
47 28 00.0 094 52 30.0
MISSISSIPPI RIVER
27 7.5 BEMIDJI WEST
1/LAKE BEMIDJI
BRDG .5 MI UPSTREAM LAKE IRVING
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/14			0.070	0.610	0.044	0.005K	0.030
72/11/05	10 30		0.025	0.480	0.026	0.016	0.024
72/12/10	10 05		0.015	0.540	0.019	0.005K	0.012
73/01/20	09 30		0.063	0.480	0.130	0.009	0.015
73/02/18	12 00		0.115	0.940	0.154	0.011	0.025
73/03/17	08 50		0.170	0.580	0.115	0.009	0.030
73/04/01	13 30		0.054	0.580	0.028	0.008	0.040
73/04/14	09 00		0.011	2.600	0.030	0.006	0.032
73/05/19	09 40		0.010K	0.540	0.005K	0.010	0.035
73/06/03	09 35		0.010K	0.580	0.010	0.006	0.030
73/07/08	08 35		0.010K	1.050	0.011	0.011	0.055
73/08/11	08 15		0.010K	1.260	0.025	0.015	0.070
73/09/16	09 30		0.027	1.470	0.056	0.018	0.045

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 74/10/30

27C1N1 LS27C1N1
47 29 30.0 094 50 00.0
MISSISSIPPI RIVER
27 7.5 BEMIDJI EAST
0/LAKE BEMIDJI
BETWN BEMIDJI STP AND RR TRESTLE
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/12/10	10 20		0.006	0.720	0.032	0.009	0.019
73/01/20	09 45		0.010K	0.420	0.032	0.005K	0.005K
73/02/18	12 10		0.019	0.560	0.030	0.005K	0.010
73/03/17	08 58		0.072	1.120	0.058	0.005K	0.020
73/04/01	13 45		0.010K	0.540	0.009	0.005K	0.030
73/04/14	09 05		0.016	0.520	0.005K	0.005K	0.020
73/05/19	09 50		0.010K	0.500	0.005K	0.005K	0.030
73/06/03	09 15		0.010K	2.100	0.026	0.005K	0.025
73/07/08	09 45		0.010K	0.630	0.012	0.009	0.020
73/08/11	08 20		0.025	0.620	0.031	0.005K	0.025
73/09/16	09 40		0.013	0.660	0.025	0.017	0.045

K VALUE KNOWN TO BE LESS
THAN INDICATED