U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

REPORT

ON

LAKE BLOOMINGTON

McLEAN COUNTY

ILLINOIS

EPA REGION V

WORKING PAPER No. 296

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

☆G.P.O. 699-440

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WITH THE COOPERATION OF THE

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

AND THE

ILLINOIS NATIONAL GUARD

JUNE, 1975

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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 Illinois Environmental Protection Agency for professional involvement and to the Illinois National Guard for conducting the tributary sampling phase of the Survey.

Dr. Richard H. Briceland, Director of the Illinois Environmental Protection Agency; and Ronald M. Barganz, State Survey Coordinator, and John J. Forneris, Manager of Region III, Field Operations Section of the Division of Water Pollution Control, provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

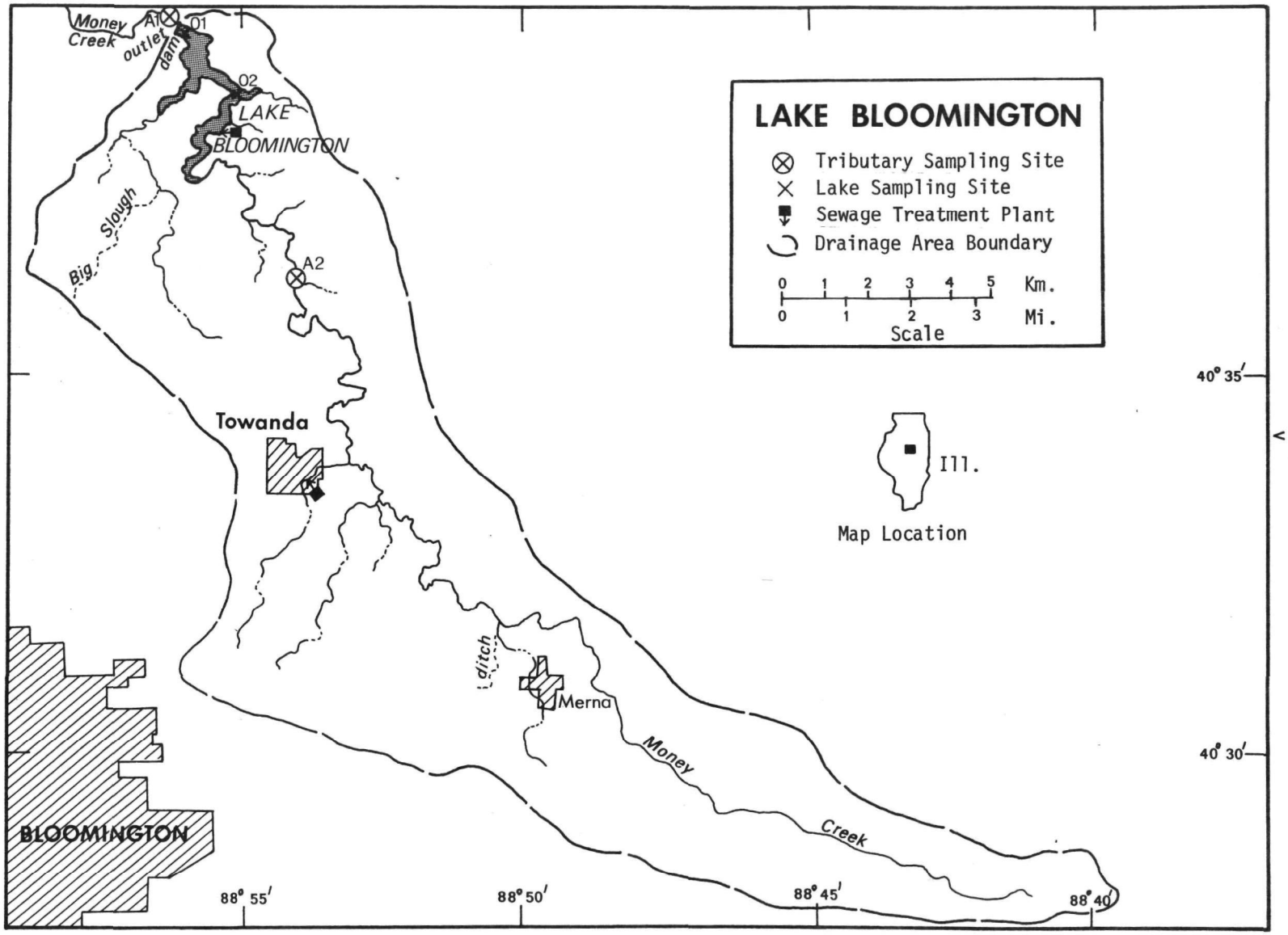
Major General Harold R. Patton, the Adjutant General of Illinois, and Project Officer Colonel Daniel L. Fane, who directed the volunteer efforts of the Illinois National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF ILLINOIS

LAKE NAME	COUNTY
Baldwin	Randolph
Bloomington	McLean
Carlyle	Bond, Clinton, Fayette
Cedar	Lake
Charleston	Coles
Coffeen	Montgomery
Crab Orchard	Jackson, Williamson
Decatur	Macon
DePue	Bureau
East Loon	Lake
Fox	Lake
Grass	Lake
Highland Silver	Madison
Holiday	LaSalle
Horseshoe	Madison
Long	Lake
Lou Yaeger	Montgomery
Marie	Lake
Old Ben Mine	Franklin
Pistakee	Lake, McHenry
Raccoon	Marion
Rend	Franklin, Jefferson
Sangchris	Christian
Shelbyville	Moultrie, Shelby
Slocum	Lake
Springfield	Sangamon
Storey	Knox
Vandalia	Fayette
Vermilion	Vermilion
Wee Ma Tuk	Fulton
Wonder	McHenry


LAKE BLOOMINGTON
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Plant
Drainage Area Boundary
0 1 2 3 4 5 Km.
0 1 2 3 Mi.
Scale
Ill.
Map Location
Money Creek
A1
O1
outlet dam
O2
LAKE BLOOMINGTON
Big Slough
A2
Towanda
ditch
Merna
Money Creek
BLOOMINGTON
40° 35′
40° 30′
88° 55′
88° 50′
88° 45′
88° 40′

LAKE BLOOMINGTON

STORET NO. 1703

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Lake Bloomington is eutrophic. It ranked sixteenth in overall trophic quality when the 31 Illinois lakes sampled in 1973 were compared using an index of six parameters*. Three of the lakes had less and one had the same median total phosphorus, nine had less and one had the same median dissolved phosphorus, all had less median inorganic nitrogen, 16 had less mean chlorophyll a, and six had greater mean Secchi disc transparency. Depression of dissolved oxygen with depth occurred at both sampling stations in August and at station 1 in October, 1973.

Survey limnologists reported emergent aquatic vegetation along the shorelines near station 2 and noted a slight blue-green algal bloom in August. Reportedly, severe algal blooms have not occurred in Lake Bloomington (Ferguson, 1975).

B. Rate-Limiting Nutrient:

The algal assay results and mean lake N/P ratios of over 140/1 indicate that the lake is phosphorus limited.

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* See Appendix A.

C. Nutrient Controllability:

1. Point sources--During the sampling year, point sources accounted for only 5% of the total phosphorus load to the lake. The East Bay Camp-Conference Center wastewater treatment plant contributed 3% of the phosphorus load, and the Towanda Elementary School was estimated to have contributed about 1%. The owners of the East Bay Camp-Conference Center plan to install phosphorus removal facilities in the near future (Stieferman, 1975).

The present total phosphorus loading rate of 2.17 $g/m^2/yr$ is nearly three times the rate proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic rate (see page 13). Even if all known point source phosphorus loads were eliminated, the loading rate would still be more than 2½ times the eutrophic rate; however, since Lake Bloomington is phosphorus limited, any reduction of phosphorus input should result in at least some improvement in the trophic condition of the lake.

2. Non-point sources--It is calculated that about 94% of the total phosphorus load to Lake Bloomington was contributed by non-point sources during the sampling year. Money Creek contributed nearly 59% of the total load.

Although the phosphorus export rate of Money Creek does not appear to be excessive (see page 12), the phosphorus contribution

of this stream alone would result in a loading rate more than 1½ times the eutrophic rate.

It is noted that agricultural operations are estimated to involve about 60% of the Money Creek drainage area (Wang and Evans, 1970).

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Lake Morphometry††:

1. Surface area: 1.97 kilometers^2.
2. Mean depth: 5.0 meters.
3. Maximum depth: 10.7 meters.
4. Volume: 9.850×10^6 m^3.
5. Mean hydraulic retention time: 104 days.

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

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Money Creek	126.9	0.8
Minor tributaries & immediate drainage -	51.1	0.3
Total	178.0	1.1

2. Outlets -

Bloomington municipal usage	-	0.3
Money Creek	180.0	0.8
Total	180.0**	1.1

C. Precipitation***:

1. Year of sampling: 108.6 centimeters.
2. Mean annual: 92.1 centimeters.

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† Table of metric conversions--Appendix B.
†† Forneris, 1973.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of lake.
*** See Working Paper No. 175.

III. LAKE WATER QUALITY SUMMARY

Lake Bloomington was sampled three times during the open-water season of 1973 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 v). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first visit, a single 18.9-liter 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 11.0 meters at station 1 and 5.2 meters at station 2.

The results obtained are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR LAKE BLOOMINGTON
STORET CODE 1703

PARAMETER	1ST SAMPLING (5/11/73) 2 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (8/ 9/73) 2 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (10/17/73) 2 SITES RANGE	MEAN	MEDIAN
TEMP (C)	15.5 - 17.4	16.4	16.3	16.4 - 28.7	25.1	27.0	15.3 - 19.1	18.6	18.9
DISS OXY (MG/L)	8.1 - 9.6	9.0	9.0	0.4 - 9.0	4.9	5.7	0.2 - 8.2	6.3	7.4
CNDCTVY (MCROMO)	460. - 510.	473.	460.	424. - 518.	484.	495.	378. - 426.	389.	386.
PH (STAND UNITS)	8.2 - 8.3	8.3	8.3	7.4 - 8.5	8.0	7.9	7.5 - 8.5	8.3	8.4
TOT ALK (MG/L)	157. - 174.	162.	160.	163. - 242.	184.	175.	151. - 258.	167.	158.
TOT P (MG/L)	0.086 - 0.110	0.093	0.090	0.026 - 0.210	0.063	0.039	0.033 - 0.059	0.044	0.045
ORTHO P (MG/L)	0.059 - 0.066	0.065	0.066	0.004 - 0.095	0.019	0.007	0.013 - 0.035	0.020	0.019
NO2+NO3 (MG/L)	6.090 - 8.260	7.476	7.690	0.690 - 6.880	5.692	6.815	0.080 - 2.720	2.388	2.685
AMMONIA (MG/L)	0.040 - 0.090	0.057	0.060	0.060 - 1.800	0.330	0.120	0.050 - 3.210	0.483	0.165
KJEL N (MG/L)	0.300 - 0.500	0.429	0.400	0.900 - 3.300	1.362	1.100	0.700 - 4.100	1.190	0.850
INORG N (MG/L)	6.150 - 8.300	7.533	7.780	2.490 - 7.000	6.022	6.905	2.730 - 3.290	2.871	2.855
TOTAL N (MG/L)	6.390 - 8.760	7.904	8.090	3.990 - 8.130	7.055	7.790	3.380 - 4.180	3.578	3.540
CHLRPYL A (UG/L)	8.1 - 13.9	11.0	11.0	10.1 - 11.6	10.8	10.8	56.0 - 57.5	56.8	56.8
SECCHI (METERS)	0.5 - 0.5	0.5	0.5	1.0 - 1.8	1.4	1.4	0.6 - 1.0	0.8	0.8

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal units per ml
05/11/73	1. *Stephanodiscus sp.*	1,563
	2. *Melosira sp.*	700
	3. Flagellates	280
	4. *Cryptomonas sp.*	117
	5. Lunate cells	70
	Other genera	116
	Total	2,846
08/09/73	1. *Microcystis sp.*	2,549
	2. *Melosira sp.*	913
	3. *Synedra sp.*	266
	4. Centric diatoms	228
	5. *Euglena sp.*	190
	Other genera	724
	Total	4,870
10/17/73	1. *Closterium sp.*	7,747
	2. *Cyclotella sp.*	384
	3. *Aphanizomenon* (?) *sp.*	332
	4. *Cryptomonas sp.*	179
	5. *Coelastrum sp.*	128
	Other genera	206
	Total	8,976

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (μg/l)
05/11/73	01	8.1
	02	13.9
08/09/73	01	10.1
	02	11.6
10/17/73	01	56.0
	02	57.5

C. Limiting Nutrient Study:

1. 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	7.470	3.3
0.050 P	0.070	7.470	26.4
0.050 P + 1.0 N	0.070	8.470	25.3
1.0 N	0.020	8.470	3.5

2. Discussion -

The control yield of the assay alga, *Selenastrum capricornutum*, indicates that the potential primary productivity of Lake Bloomington was moderately high at the time the sample was collected (05/11/73). Also, the results indicate the lake was phosphorus limited at that time. Note that the addition of orthophosphorus alone resulted in a greatly increased yield while the addition of only nitrogen did not. This conclusion is supported by the very high mean N/P ratios measured in the lake at each sampling time (116/1 in May, 317/1 in August, and 144/1 in October).

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Illinois National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff months of February and March when two samples were collected. Sampling was begun in June, 1973, and was completed in May, 1974.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Illinois 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 loads shown are those measured minus point-source loads, if any.

Intakes for the Bloomington municipal water supply are located near lake sampling station 1 at depths of six and 11 meters (Hersch, 1975). In estimating nutrient loads in the water removed by the city, the mean flow and the mean of all lake nutrient concentrations measured at or below the six-meter depth at station 1 were used.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the means of the nutrient loads, in $kg/km^2/year$, at nearby Decatur Lake tributary

* See Working Paper No. 175.

stations E-1, F-1, G-1, and H-1 and multiplying the means by the ZZ area in km^2. The Decatur Lake tributary loads were used because no unimpacted tributaries to Lake Bloomington were sampled, and the watersheds of the two lakes are similar.

The operator of the East Bay Camp-Conference Center wastewater treatment plant provided monthly effluent samples and corresponding flow data. The Towanda Elementary School did not participate in the Survey, and nutrient loads were estimated at 1.134 kg P and 3.401 kg N/capita/year.

A. Waste Sources:

1. Known muncipal -

Name	Pop. Served	Treatment	Mean Flow (m^3/d)	Receiving Water
East Bay Camp-Conference Center	198*	sand filter	49.5	Lake Bloomington
Towanda Elem. School	36**	act. sludge	13.6***	Money Creek

2. Known industrial - None

* Population based on an average of 475 people June through August, and 110 people September through May (Detrich, 1973).
** Average population equivalent based on 200+ students for 8 hours/day, 5 days/week, 9 months/year (Blake, 1975).
*** Estimated at 0.3785 m^3/capita/day.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Money Creek	2,500	58.6
b. Minor tributaries & immediate drainage (non-point load) -	1,535	35.9
c. Known municipal STP's -		
E. Bay Camp-Conf. Ctr.	130	3.0
Towanda Elem. School	40	0.9
d. Septic tanks* -	30	0.8
e. Known industrial - None	-	-
f. Direct precipitation** -	35	0.8
Total	4,270	100.0

2. Outputs -

Lake outlets -	Money Creek	2,075
	Bloomington Mun. Water Supply	860
	Total	2,935

3. Net annual P accumulation - 1,335 kg.

* Estimate based on 100 shoreline dwellings and two camps; see Working Paper No. 175.
** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/ yr	% of total
a. Tributaries (non-point load) -		
Money Creek	280,005	81.4
b. Minor tributaries & immediate drainage (non-point load) -	59,125	17.2
c. Known municipal STP's -		
E. Bay Camp-Conf. Ctr.	370	0.1
Towanda Elem. School	120	<0.1
d. Septic tanks* -	1,135	0.7
e. Known industrial - None	-	-
f. Direct precipitation** -	2,125	0.6
Total	342,880	100.0

2. Outputs -

Lake outlets -	Money Creek	325,200
	Bloomington Mun. Water Supply	51,595
	Total	376,795

3. Net annual N loss - 33,915 kg.

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

Tributary	kg P/km^2/yr	kg N/km^2/yr
Money Creek	20	2,207

* Estimate based on 100 shoreline dwellings and two camps; see Working Paper No. 175.
** See Working Paper No. 175.

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" rate is the rate at which the receiving water 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".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	2.17	0.68	174.1	loss*

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

"Dangerous" (eutrophic rate)	0.80
"Permissible" (oligotrophic rate)	0.40

* There was an apparent loss of nitrogen during the sampling year. This may have been due to nitrogen fixation in the lake, solubilization of previously sedimented nitrogen, recharge with nitrogen-rich ground water, or unknown and unsampled point sources discharging directly to the lake. Whatever the cause, a similar nitrogen loss has occurred at Shagawa Lake, Minnesota, which has been intensively studied by EPA's National Eutrophication and Lake Restoration Branch (Malueg et al., 1975).

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VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
1703	LAKE BLOOMINGTON	0.050	5.730	464.667	26.200	14.800	0.020
1706	LAKE CARLYLE	0.084	1.270	477.889	17.367	11.000	0.032
1708	LAKE CHARLESTON	0.160	4.680	490.667	12.000	8.400	0.065
1711	COFFEEN LAKE	0.032	0.260	456.222	7.700	14.900	0.012
1712	CRAB ORCHARD LAKE	0.082	0.200	482.222	59.867	13.800	0.013
1714	LAKE DECATUR	0.129	3.750	479.571	43.000	14.500	0.062
1725	LONG LAKE	0.704	1.190	482.667	49.333	8.800	0.398
1726	LAKE LOU YAEGER	0.186	1.600	489.583	10.662	11.400	0.076
1727	LAKE MARIE	0.098	0.370	467.667	39.533	14.700	0.057
1733	PISTAKEE LAKE	0.203	0.370	485.667	75.867	7.000	0.062
1735	REND LAKE	0.071	0.210	471.500	23.533	12.700	0.012
1739	LAKE SHELBYVILLE	0.062	3.290	461.333	17.161	14.800	0.019
1740	SILVER LAKE (HIGHLAND)	0.226	0.970	489.500	5.822	14.800	0.057
1742	LAKE SPRINGFIELD	0.108	3.265	483.385	13.013	10.800	0.059
1748	VERMILION LAKE	0.109	4.695	481.500	31.150	14.200	0.050
1750	WONDER LAKE	0.426	0.890	486.000	98.533	7.800	0.132
1751	LAKE STORY	0.072	2.510	459.333	17.250	14.800	0.021
1752	DEPUE LAKE	0.438	4.050	490.000	58.833	7.600	0.276
1753	LAKE SANGCHRIS	0.050	1.970	475.417	19.292	14.500	0.009
1754	LAKE HOLIDAY	0.167	3.135	485.167	51.217	7.200	0.046
1755	FOX LAKE	0.219	0.375	486.167	63.850	8.800	0.083
1756	GRASS LAKE	0.301	0.820	481.000	83.500	5.900	0.093
1757	EAST LOON LAKE	0.076	0.120	450.000	22.300	14.900	0.018
1758	SLOCUM LAKE	0.865	0.200	487.333	221.100	5.800	0.362
1759	CEDAR LAKE	0.029	0.170	400.333	5.767	12.800	0.013
1761	LAKE WEMATUK	0.069	1.770	466.333	7.967	14.500	0.031
1762	RACCOON LAKE	0.106	0.310	484.333	19.217	13.800	0.020
1763	BALDWIN LAKE	0.044	0.140	461.167	11.333	13.200	0.007

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500- MEAN SEC	MEAN CHLORA	15- MIN DO	MEDIAN DISS ORTHO P
1764	LAKE VANDALIA	0.116	0.480	478.111	11.276	14.800	0.023
1765	OLD BEN MINE RESERVOIR	0.930	0.205	478.333	31.433	11.200	0.575
1766	HORSESHOE LAKE	0.127	0.705	482.833	182.250	6.800	0.018

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NO
1703	LAKE BLOOMINGTON	88 (26)	0 (0)	80 (24)	47 (14)	13 (2)	68 (20)	296
1706	LAKE CARLYLE	63 (19)	40 (12)	63 (19)	63 (19)	63 (19)	53 (16)	345
1708	LAKE CHARLESTON	37 (11)	7 (2)	0 (0)	77 (23)	77 (23)	27 (8)	225
1711	COFFEEN LAKE	97 (29)	77 (23)	93 (28)	93 (28)	2 (0)	92 (27)	454
1712	CRAB ORCHARD LAKE	67 (20)	90 (27)	43 (13)	20 (6)	42 (12)	85 (25)	347
1714	LAKE DECATUR	40 (12)	13 (4)	53 (16)	33 (10)	30 (8)	32 (9)	201
1725	LONG LAKE	7 (2)	43 (13)	40 (12)	30 (9)	72 (21)	3 (1)	195
1726	LAKE LOU YAEGER	30 (9)	37 (11)	7 (2)	87 (26)	57 (17)	23 (7)	241
1727	LAKE MARIE	60 (18)	68 (20)	73 (22)	37 (11)	23 (7)	42 (12)	303
1733	PISTAKEE LAKE	27 (8)	68 (20)	23 (7)	13 (4)	90 (27)	32 (9)	253
1735	REND LAKE	77 (23)	80 (24)	70 (21)	50 (15)	53 (16)	92 (27)	422
1739	LAKE SHELBYVILLE	83 (25)	17 (5)	83 (25)	70 (21)	13 (2)	73 (22)	339
1740	SILVER LAKE (HIGHLAND)	20 (6)	47 (14)	10 (3)	97 (29)	13 (2)	42 (12)	229
1742	LAKE SPRINGFIELD	53 (16)	20 (6)	33 (10)	73 (22)	67 (20)	37 (11)	283
1748	VERMILION LAKE	50 (15)	3 (1)	47 (14)	43 (13)	37 (11)	47 (14)	227
1750	WONDER LAKE	13 (4)	50 (15)	20 (6)	7 (2)	80 (24)	13 (4)	183
1751	LAKE STORY	73 (22)	27 (8)	90 (27)	67 (20)	13 (2)	63 (19)	333
1752	DEPUE LAKE	10 (3)	10 (3)	3 (1)	23 (7)	83 (25)	10 (3)	139
1753	LAKE SANGCHRIS	88 (26)	30 (9)	67 (20)	57 (17)	30 (8)	97 (29)	369
1754	LAKE HOLIDAY	33 (10)	23 (7)	27 (8)	27 (8)	87 (26)	50 (15)	247
1755	FOX LAKE	23 (7)	63 (19)	17 (5)	17 (5)	72 (21)	20 (6)	212
1756	GRASS LAKE	17 (5)	53 (16)	50 (15)	10 (3)	97 (29)	17 (5)	244
1757	EAST LOON LAKE	70 (21)	100 (30)	97 (29)	53 (16)	2 (0)	77 (23)	399
1758	SLOCUM LAKE	3 (1)	87 (26)	13 (4)	0 (0)	100 (30)	7 (2)	210
1759	CEDAR LAKE	100 (30)	93 (28)	100 (30)	100 (30)	50 (15)	85 (25)	528
1761	LAKE WEMATUK	80 (24)	33 (10)	77 (23)	90 (27)	30 (8)	57 (17)	367
1762	RACCOON LAKE	57 (17)	73 (22)	30 (9)	60 (18)	42 (12)	68 (20)	330
1763	BALDWIN LAKE	93 (28)	97 (29)	87 (26)	80 (24)	47 (14)	100 (30)	504

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500- MEAN SEC	MEAN CHLORA	15- MIN DO	MEDIAN DISS ORTHO P	INDEX NO
1764	LAKE VANDALIA	47 (14)	60 (18)	60 (18)	83 (25)	13 (2)	60 (18)	323
1765	OLD BEN MINE RESERVOIR	0 (0)	83 (25)	57 (17)	40 (12)	60 (18)	0 (0)	240
1766	HORSESHOE LAKE	43 (13)	57 (17)	37 (11)	3 (1)	93 (28)	80 (24)	313

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	1759	CEDAR LAKE	528
2	1763	BALDWIN LAKE	504
3	1711	COFFEEN LAKE	454
4	1735	REND LAKE	422
5	1757	EAST LOON LAKE	399
6	1753	LAKE SANGCHRIS	369
7	1761	LAKE WEMATUK	367
8	1712	CRAB ORCHARD LAKE	347
9	1706	LAKE CARLYLE	345
10	1739	LAKE SHELBYVILLE	339
11	1751	LAKE STORY	333
12	1762	RACCOON LAKE	330
13	1764	LAKE VANDALIA	323
14	1766	HORSESHOE LAKE	313
15	1727	LAKE MARIE	303
16	1703	LAKE BLOOMINGTON	296
17	1742	LAKE SPRINGFIELD	283
18	1733	PISTAKEE LAKE	253
19	1754	LAKE HOLIDAY	247
20	1756	GRASS LAKE	244
21	1726	LAKE LOU YAEGER	241
22	1765	OLD BEN MINE RESERVOIR	240
23	1740	SILVER LAKE (HIGHLAND)	229
24	1748	VERMILION LAKE	227
25	1708	LAKE CHARLESTON	225
26	1755	FOX LAKE	212
27	1758	SLOCUM LAKE	210
28	1714	LAKE DECATUR	201

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
29	1725	LONG LAKE	195
30	1750	WONDER LAKE	183
31	1752	DEPUE LAKE	139

APPENDIX B

CONVERSIONS FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107 x 10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR ILLINOIS 10/23/75

LAKE CODE 1703 LAKE BLOOMINGTON

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 180.0

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1703A1	180.0	1.17	1.73	2.15	2.22	1.75	1.46	0.88	0.46	0.33	0.37	0.53	0.63	1.13
1703A2	126.9	0.80	1.21	1.50	1.54	1.21	1.02	0.61	0.32	0.22	0.25	0.36	0.43	0.78
1703ZZ	53.6	0.36	0.52	0.66	0.68	0.54	0.44	0.27	0.14	0.10	0.12	0.17	0.20	0.35

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 180.0 TOTAL FLOW IN = 13.67
SUM OF SUB-DRAINAGE AREAS = 180.5 TOTAL FLOW OUT = 13.67

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
1703A1	6	73	5.32	3	0.03				
	7	73	0.23	3	1.27				
	8	73	0.24	5	0.03				
	9	73	0.0	9	0.0				
	10	73	0.0	14	0.0				
	11	73	0.0	4	0.0				
	12	73	0.18	1	0.0				
	1	74	3.34	5	0.19				
	2	74	2.80	2	3.88	16	1.39		
	3	74	3.74	2	2.18	20	3.03		
	4	74	1.81	6	2.55				
	5	74	3.00	4	0.68				
1703A2	6	73	3.96	3	0.76				
	7	73	0.74	3	1.13				
	8	73	0.25	5	0.37				
	9	73	0.05	9	0.06				
	10	73	0.25	14	1.08				
	11	73	0.14	4	0.11				
	12	73	1.22	1	0.24				
	1	74	3.54	5	1.10				
	2	74	2.18	2	2.92	16	1.19		
	3	74	2.80	2	1.73	20	2.32		
	4	74	1.47	6	1.98				
	5	74	2.32	4	0.68				
1703ZZ	6	73	1.70	3	0.34				
	7	73	0.31	3	0.51				
	8	73	0.11	5	0.20				
	9	73	0.03	9	0.03				
	10	73	0.12	14	0.54				
	11	73	0.06	4	0.05				
	12	73	0.51	1	0.10				
	1	74	1.47	5	0.45				
	2	74	0.93	2	1.27	16	0.51		
	3	74	1.25	2	0.76	20	1.02		
	4	74	0.65	6	0.88				
	5	74	1.02	4	0.34				

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 75/10/23

170301
40 39 43.0 088 56 20.0
LAKE BLOOMINGTON
17113 ILLINOIS

11EPALES 2111202
3 0031 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	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/05/11	13 15	0000	16.3		18	460	8.30	157	0.060	0.500	7.460	0.066
	13 15	0004	15.9	9.0		460	8.20	157	0.060	0.300	6.090	0.066
	13 15	0015	15.7	8.7		460	8.20	157	0.070	0.400	6.800	0.066
	13 15	0027	15.5	8.1		460	8.20	160	0.090	0.400	7.690	0.066
73/08/09	18 10	0000	28.3	8.6	72	497	8.40	163	0.120	1.200	6.880	0.004
	18 10	0005	27.8			492						
	18 10	0010	27.4			491						
	18 10	0015	26.1	5.0		489	7.90	167	0.070	0.900	6.880	0.007
	18 10	0020	22.5	0.4		434	7.40	178	0.190	1.000	5.540	0.016
	18 10	0025	17.6			424						
	18 10	0030	16.4	0.4		436	7.40	242	1.800	3.300	0.690	0.095
73/10/17	12 50	0000	19.1		38	388	8.40	162	0.180	0.900	2.690	0.018
	12 50	0005	19.1	7.2		388	8.40	161	0.170	0.900	2.720	0.018
	12 50	0010	19.1	7.4		386	8.40	159	0.160	0.700	2.680	0.013
	12 50	0020	19.1	7.4		386	8.10	157	0.240	0.800	2.690	0.019
	12 50	0030	18.8	5.2		400	7.90	168	0.610	1.300	2.290	0.021
	12 50	0036	15.3	0.2		426	7.50	258	3.210	4.100	0.080	0.035

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/05/11	13 15	0000	0.086	8.1
	13 15	0004	0.092	
	13 15	0015	0.095	
	13 15	0027	0.110	
73/08/09	18 10	0000	0.026	10.1
	18 10	0015	0.029	
	18 10	0020	0.036	
	18 10	0030	0.210	
73/10/17	12 50	0000	0.034	56.0
	12 50	0005	0.033	
	12 50	0010	0.035	
	12 50	0020	0.037	
	12 50	0030	0.044	
	12 50	0036	0.059	

STORET RETRIEVAL DATE 75/10/23

170302
40 38 50.0 088 55 00.0
LAKE BLOOMINGTON
17113 ILLINOIS

11EPALES 2111202
3 0018 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	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/05/11	13 45	0000	17.4		21	480	8.30	165	0.040	0.500	8.110	0.064
	13 45	0004	17.4	9.6		480	8.30	165	0.040	0.400	7.920	0.065
	13 45	0015	16.8	9.4		510	8.30	174	0.040	0.500	8.260	0.059
73/08/09	18 40	0000	28.7	6.6	40	518	8.50	173	0.060	1.300	6.830	0.011
	18 40	0005	28.3	9.0		511	8.50	174	0.080	1.000	6.880	0.007
	18 40	0010	27.7			504						
	18 40	0015	26.6	6.4		509	7.90	176	0.120	1.000	6.800	0.007
	18 40	0017	24.1	2.6		500	7.90	196	0.200	1.200	5.040	0.007
73/10/17	13 20	0000	18.9		23	378	8.50	153	0.070	1.000	2.660	0.019
	13 20	0005	18.9	7.4		380	8.50	151	0.050	0.800	2.690	0.020
	13 20	0010	18.9	7.8		380	8.50	151	0.090	0.700	2.680	0.020
	13 20	0015	18.8	8.2		379	8.50	153	0.050	0.700	2.700	0.021

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/05/11	13 45	0000	0.090	13.9
	13 45	0004	0.087	
	13 45	0015	0.088	
73/08/09	18 40	0000	0.039	11.6
	18 40	0005	0.040	
	18 40	0015	0.046	
	18 40	0017	0.079	
73/10/17	13 20	0000	0.047	57.5
	13 20	0005	0.051	
	13 20	0010	0.050	
	13 20	0015	0.052	

APPENDIX E

TRIBUTARY and WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 75/10/23

1703A1
40 39 50.0 088 56 14.0
MONEY CREEK
17055 MCLEAN CO MAP
O/LAKE BLOOMINGTON
ST RD 473 BRDG BELO DAM 9 N BLOOMINGTON
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
73/06/03	09 15		7.800	2.200	0.052	0.012	0.035
73/07/06	17 00		8.100	3.000	0.138	0.009	0.045
73/08/05	17 30		5.500	2.200	0.022	0.008	0.020
73/09/09	17 00		0.132	4.200	0.231	0.023	0.185
73/10/14	13 00		0.210	1.800	0.210	0.019	0.145
73/11/04	11 00		3.100	1.150	0.023	0.017	0.030
73/12/01	13 00		2.700	0.800	0.040		0.165
74/01/05	11 18		2.100	0.900	0.800	0.005K	0.030
74/02/02	14 00		10.400	1.000	0.075	0.090	0.125
74/02/16	16 00		8.750	0.900	0.060	0.040	0.055
74/03/02	13 00		9.500	0.500	0.010	0.035	0.070
74/03/20	13 50		10.860	0.700	0.025	0.015	0.050
74/04/06	14 15		10.000	1.000	0.035	0.005K	0.005K
74/05/04	17 45		10.500	1.200	0.120	0.010	0.020

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/10/23

1703A2
40 36 18.0 088 53 55.0
MONEY CREEK
17 MCLEAN CO MAP
I/LAKE BLOOMINGTON
CO 12 BRDG 2.5 MI N OF TOWANDA
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
73/06/03	08 45		9.900	1.400	0.132	0.029	0.095
73/07/06	18 00		12.000	0.250	0.072	0.042	0.090
73/08/05	19 30		8.400	3.200	0.140	0.023	0.090
73/09/09	17 00		0.147	1.900	0.056	0.026	0.195
73/10/14	11 30		8.000	1.200	0.063	0.071	0.210
73/11/04	10 25		7.700	0.150	0.028	0.037	0.100
73/12/01	10 30		7.900	0.100K	0.016	0.048	0.200
74/01/05	13 40		13.000	0.900	0.052	0.024	0.040
74/02/02	11 00		13.000	0.300	0.025	0.035	0.070
74/02/16	13 00		12.300	0.700	0.035	0.020	0.040
74/03/02	11 00		14.400	1.100	0.030	0.015	0.120
74/03/20	13 45		14.100	0.500	0.025	0.025	0.085
74/04/06	11 15		11.000	1.400	0.060	0.025	0.035
74/05/04	15 50		12.000	0.700	0.070	0.020	0.042

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/10/23

170321 SF170321 P000198
40 36 27.0 088 59 40.0
EAST BAY CAMP CONFERENCE CENTER
17113 15 NORMAL
D/LAKE BLOOMINGTON
LAKE BLOOMINGTON
11EPALES 2141204
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	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/07/14	11 00								
CP(T)-			0.440	29.200	8.100	4.350	14.630	0.013	0.028
73/07/14	15 00								
73/08/15	08 00								
CP(T)-			3.800	20.000	2.650	5.750	15.000	0.044	0.030
73/08/15	11 00								
73/09/15	09 00		4.400	21.000		4.860	6.950	0.015	0.016
73/10/15	08 00								
CP(T)-			11.600	0.150	0.030	2.310	2.500	0.012	0.006
73/10/15	15 00								
73/11/15	07 30								
CP(T)-			10.000	0.820	0.064	2.200	2.400	0.005	0.003
73/11/15	15 00								
73/12/13	08 00								
CP(T)-			7.900	5.500	0.066	1.900	1.900	0.006	0.006
73/12/14	10 00								
74/01/14	08 30								
CP(T)-			5.500	0.500K	0.360	0.300	0.340	0.005	0.006
74/01/15	12 30								
74/02/12	08 30								
CP(T)-			8.800	2.450	0.040K	1.360	1.550	0.006	0.006
74/02/15	09 00								
74/03/12	08 30								
CP(T)-			5.400	1.000K	0.050K	0.780	0.790	0.006	0.008
74/03/15	08 30								
74/04/11	08 30								
CP(T)-			8.000	1.000K	0.230	0.860	1.050	0.007	0.009
74/04/15	09 00								
74/05/13	08 00								
CP(T)-			11.000	1.000K	0.150	1.500	1.650	0.010	0.010
74/05/15	09 00								
74/06/11	12 00								
CP(T)-			6.021	26.000	14.300	3.550	3.900	0.019	0.018
74/06/14	12 00								
74/07/13	08 30								
CP(T)-			4.800	16.000	0.230	2.800	3.200	0.011	0.024
74/07/15									

K VALUE KNOWN TO BE
LESS THAN INDICATED