U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

REPORT

ON

BRIGHTON LAKE

LIVINGSTON COUNTY

MICHIGAN

EPA REGION V

WORKING PAPER No. 187

PACIFIC NORTHWEST ENVIRONMENTAL RESEARCH LABORATORY

An Associate Laboratory of the

NATIONAL ENVIRONMENTAL RESEARCH CENTER - CORVALLIS, OREGON

and

NATIONAL ENVIRONMENTAL RESEARCH CENTER - LAS VEGAS, NEVADA

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WITH THE COOPERATION OF THE

MICHIGAN DEPARTMENT OF NATURAL RESOURCES

AND THE

MICHIGAN NATIONAL GUARD

MARCH, 1975

CONTENTS

	Page
Foreword	ii
List of Michigan Study Lakes	iv
Lake and Drainage Area Map	v
Sections	
I. Conclusions	1
II. Lake and Drainage Basin Characteristics	4
III. Lake Water Quality Summary	5
IV. Nutrient Loadings	10
V. Literature Reviewed	15
VI. Appendices	16

FOREWORD

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 Michigan Department of Natural Resources for professional involvement and to the Michigan National Guard for conducting the tributary sampling phase of the Survey.

A. Gene Gazlay, former Director, and David H. Jenkins, Acting Director, Michigan Department of Natural Resources; and Carlos Fetterolf, Chief Environmental Scientist, and Dennis Tierney, Aquatic Biologist, Bureau of Water Management, Department of Natural Resources, provided invaluable lake documentation and counsel during the course of the Survey. John Vogt, Chief of the Bureau of Environmental Health, Michigan Department of Public Health, and his staff were most helpful in identifying point sources and soliciting municipal participation in the Survey.

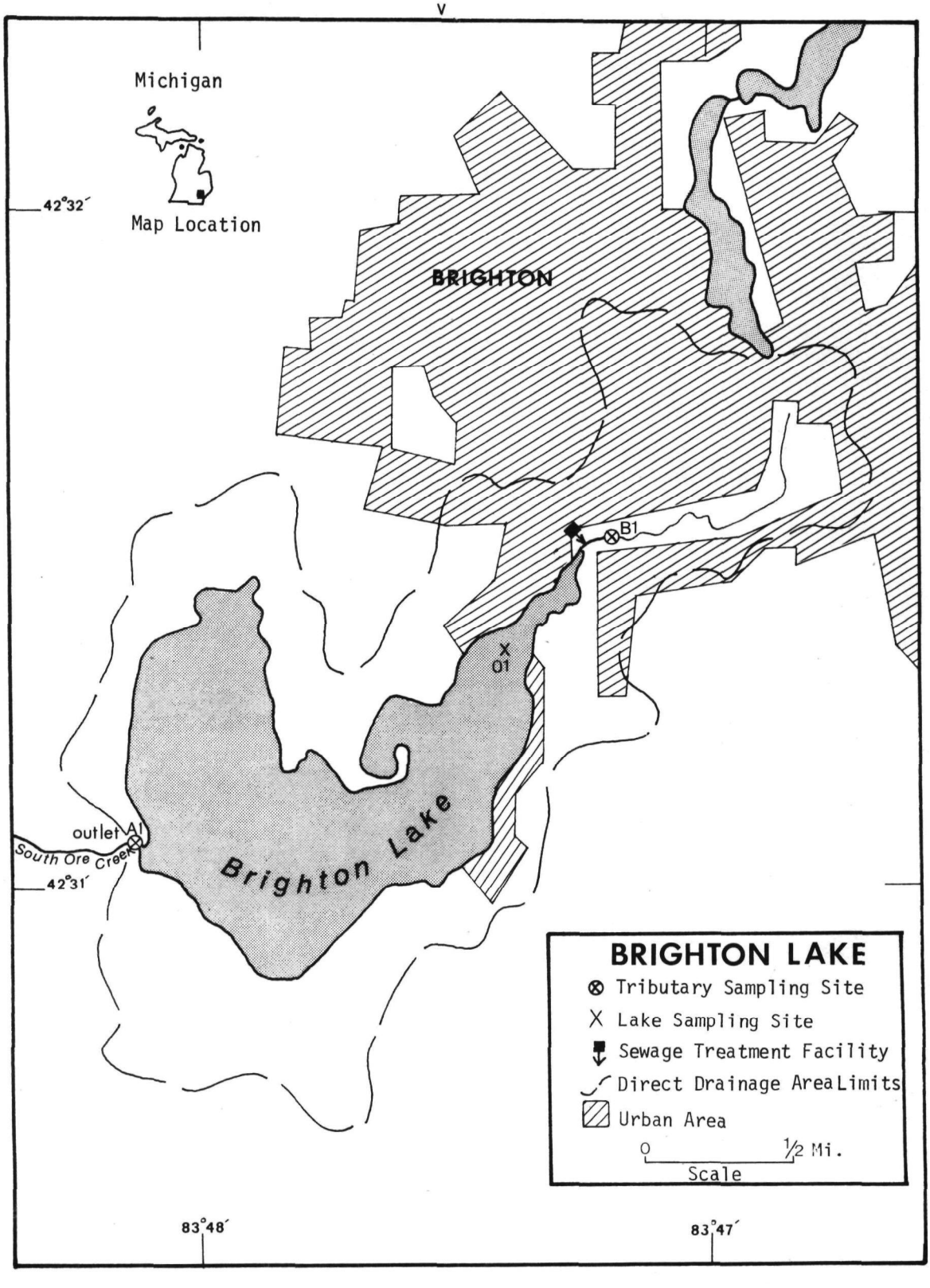
Major General Clarence A. Schnipke (Retired), then the Adjutant General of Michigan, and Project Officer Colonel Albert W. Lesky, who directed the volunteer efforts of the Michigan National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MICHIGAN

LAKE NAME	COUNTY
Allegan Res.	Allegan
Barton	Kalamazoo
Belleville	Wayne
Betsie	Benzie
Brighton	Livingston
Caro Res.	Tuscola
Charlevoix	Charlevoix
Chemung	Livingston
Constantine Res.	St. Joseph
Crystal	Montcalm
Deer	Marquette
Ford	Washtenaw
Fremont	Newago
Higgins	Roscommon
Holloway Res.	Genesee, Lapeer
Houghton	Roscommon
Jordon	Ionia, Barry
Kent	Oakland
Long	St. Joseph
Macatawa	Ottawa
Manistee	Manistee
Mona	Muskegon
Muskegon	Muskegon
Pentwater	Oceana
Pere Marquette	Mason
Portage	Houghton
Randall	Branch
Rogers Pond	Mecosta
Ross	Gladwin
St. Louis Res.	Gratiot
Sanford	Midland
Strawberry	Livingston
Thompson	Livingston
Thornapple	Barry
Union	Branch
White	Muskegon


Michigan
Map Location
42°32´
BRIGHTON
B1
X
01
outlet A1
South Ore Creek
Brighton Lake
42°31´
BRIGHTON LAKE
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
Direct Drainage Area Limits
Urban Area
0
½ Mi.
Scale
83°48´
83°47´

BRIGHTON LAKE

STORET NO. 2613

I. CONCLUSIONS

A. Trophic Condition:

Survey data show that Brighton Lake is eutrophic. Of the 35 Michigan lakes sampled in November when essentially all were well-mixed, 23 had less mean total phosphorus, 26 had less mean dissolved phosphorus, and 22 had less mean inorganic nitrogen; of all 41 lakes sampled, 26 had greater mean Secchi disc transparency, and none had more mean chlorophyll a*.

Ketelle and Uttormark (1971) report that Brighton Lake has a long history of algal problems.

B. Rate-Limiting Nutrient:

Algal assay results show that Brighton Lake was phosphorus limited at the time the assay sample was collected (04/30/73).

The 1972 lake data indicate nitrogen limitation in June and September but phosphorus limitation in November.

C. Nutrient Controllability:

1. Point sources--During the sampling year, Brighton Lake received a total phosphorus load at a rate of 3.6 lbs/acre/yr or 0.40 $g/m^2/yr$.. This rate is less than that proposed by Vollenweider (in press) as "dangerous" but more than his suggested "permissible" rate; i.e., the observed loading rate would be considered somewhat greater than a mesotrophic rate (see page 14).

* See Appendix A.

Now, Vollenweider's model may not apply to water bodies with short hydraulic retention times, and the hydraulic retention time of Brighton Lake is not known. However, it seems reasonable to assume that the mean depth of this lake is about ten feet (Tierney, 1974); but, even if the mean depth is only five feet, Brighton Lake would have a mean hydraulic retention time of 117 days, and it is likely that Vollenweider's model does apply in this case.

During the sampling year, it is calculated that the City of Brighton contributed about 59% of the total phosphorus load to Brighton Lake. However, phosphorus removal has been practiced at the Brighton wastewater treatment plant since the summer of 1970; and during the Survey year, it is calculated that about 83% removal was achieved.

It is noted that an apparent phosphorus loss occurred during the sampling year (see page 14), but it is believed that the "loss" was due to phosphorus washout which would be expected following a major reduction of point-source loads. Once a new phosphorus equilibrium is established, it is probable that a persistent phosphorus limitation will result, and nuisance blooms of algae will diminish both in incidence and severity. In fact, it is reported that algal problems were almost absent in the summer of 1973 (McCauley, 1974).

2. Non-point sources--On the basis of the low non-point phosphorus export of Ore Creek during the sampling year (see page 14), it does not appear that non-point loads are significant.

In all, it is calculated that non-point sources, including rainfall, contributed less than 38% of the total phosphorus load during the sampling year.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry†:

1. Surface area: 600 acres.
2. Mean depth: unknown.
3. Maximum depth: unknown.
4. Volume: unknown.

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

1. Tributaries -

Name	Drainage area*	Mean flow*
Ore Creek (B-1)	22.1 mi^2	12.1 cfs
Minor tributaries & immediate drainage -	0.6 mi^2	0.8 cfs
Totals	22.7 mi^2	12.9 cfs

2. Outlet -

Ore Creek (A-1)	23.6 mi^2**	12.9 cfs

C. Precipitation***:

1. Year of sampling: 35.4 inches.
2. Mean annual: 31.0 inches.

† Fetterolf, 1973.
* Drainage areas are accurate within ±5%; mean daily flows for 74% of the sampling sites are accurate within ±25% and the remaining sites up to ±40%; and mean monthly flows, normalized mean monthly flows, and mean annual flows are slightly more accurate than mean daily flows.
** Includes area of lake.
*** See Working Paper No. 1, "Survey Methods, 1972".

III. LAKE WATER QUALITY SUMMARY

Brighton Lake 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 a single station on the lake and usually from two depths (see map, page v). During each visit, a single depth-integrated (near bottom to surface) sample was collected for phytoplankton identification and enumeration. Also each time, a depth-integrated sample was collected for chlorophyll a analysis. The maximum depth sampled was four feet.

The results obtained are presented in full in Appendix C, and the data for the fall sampling period, when the lake essentially was 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 C.

A five-gallon depth-integrated algal assay sample was collected by Survey limnologists in September, 1972. This sample was subsequently lost in shipment, and personnel of the Michigan Department of Natural Resources resampled the lake on April 10, 1973, and provided the algal assay sample.

A. Physical and chemical characteristics:

Parameter	Minimum	Mean	Median	Maximum
		FALL VALUES (11/15/72)		
Temperature (Cent.)	3.3	3.3	3.3	3.3
Dissolved oxygen (mg/l)	8.0	8.0	8.0	8.0
Conductivity (μmhos)	510	515	515	520
pH (units)	7.6	7.6	7.6	7.6
Alkalinity (mg/l)	189	189	189	189
Total P (mg/l)	0.104	0.109	0.109	0.114
Dissolved P (mg/l)	0.072	0.073	0.073	0.075
NO_2 + NO_3 (mg/l)	0.230	0.235	0.235	0.240
Ammonia (mg/l)	0.780	0.780	0.780	0.780
		ALL VALUES		
Secchi disc (inches)	28	44	36	68

B. Biological characteristics:

1. Phytoplankton (incomplete at this time) -

Sampling Date	Dominant Genera	Number per ml
06/15/72	1. Fragilaria	4,985
	2. Scenedesmus	3,328
	3. Asterionella	1,205
	4. Dinobryon	1,024
	5. Oocystis	994
	Other genera	1,310
	Total	12,846
09/21/72	1. Oscillatoria	2,242
	2. Microcystis	705
	3. Melosira	705
	4. Aphanocapsa	633
	5. Fragilaria	434
	Other genera	1,212
	Total	5,931
11/15/72	1. Flagellates	344
	2. Chroococcus	72
	3. Dinobryon	58
	4. Cryptomonas	51
	5. Crucigenia	36
	Other genera	242
	Total	803

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)
06/15/72	01	51.4
09/20/72	01	77.4
11/15/72	01	3.9

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	0.011	0.140	2.4
0.01 P	0.021	0.140	3.9
0.02 P	0.031	0.140	4.4
0.05 P	0.061	0.140	4.1
0.05 P + 5.0 N	0.061	5.140	22.1
0.05 P + 10.0 N	0.061	10.140	20.7
10.0 N	0.011	10.140	1.9

2. Discussion -

The control yield of the assay alga, *Selenastrum capricornutum*, indicates that Brighton Lake had a moderately high potential primary productivity at the time the sample was collected (04/30/73). Also, the increased yield with the first orthophosphorus spike indicates the lake was phosphorus limited. The lack of significant yield response after the first phosphorus spike indicates the lake would become nitrogen limited if the orthophosphorus concentrations were increased to about 0.020 mg/l (assuming no change in inorganic nitrogen).

Note that the addition of only nitrogen resulted in a yield not significantly different than the control yield.

The 1972 lake data indicate nitrogen limitation in June and September (N/P ratios were about 1/1) but phosphorus limitation in November (N/P = 14/1).

IV. NUTRIENT LOADINGS
(See Appendix D for data)

For the determination of nutrient loadings, the Michigan 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 April and May when two samples were collected. Sampling was begun in October, 1972, and was completed in October, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Michigan 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 "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated by using the nutrient loads, in $lbs/mi^2/year$, in Ore Creek at station B-1 and multiplying by the ZZ area by mi^2.

The operator of the Brighton wastewater treatment plant provided nine monthly effluent samples and corresponding flow data.

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* See Working Paper No. 1.

A. Waste Sources:

1. Known municipal† -

Name	Pop. Served*	Treatment	Mean Flow (mgd)	Receiving Water
Brighton	2,457	trickling filter + P-removal	0.484	Ore Creek

2. Known industrial - None

† Sprow, 1973.
* 1970 Census.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	lbs P/ yr	% of total
a. Tributaries (non-point load) -		
Ore Creek (B-1)	700	32.6
b. Minor tributaries & immediate drainage (non-point load) -	20	0.9
c. Known municipal STP's -		
Brighton	1,280	59.5
d. Septic tanks* -	60	2.8
e. Known industrial - None	-	-
f. Direct precipitation** -	90	4.2
Total	2,150	100.0

2. Outputs -

Lake outlet - Ore Creek 3,400

3. Net annual P loss - 1,250 pounds

* Estimate based on 90 lakeshore dwellings; 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) -		
Ore Creek (B-1)	25,950	47.7
b. Minor tributaries & immediate drainage (non-point load) -	700	1.3
c. Known municipal STP's -		
Brighton	18,590	34.2
d. Septic tanks* -	2,120	6.2
e. Known industrial - None	-	-
f. Direct precipitation** -	5,780	10.6
Total	53,140	100.0

2. Outputs -

Lake outlet - Ore Creek 34,900

3. Net annual N accumulation - 18,240 pounds

* Estimate based on 90 lakeshore dwellings; 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
Ore Creek (B-1)	32	1,174

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 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 very short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
Units	Total	Accumulated	Total	Accumulated
lbs/acre/yr	3.6	loss*	88.6	30.4
grams/m^2/yr	0.40	-	9.9	3.4

Vollenweider loading rates for phosphorus (g/m^2/yr) based on surface area and mean outflow of Brighton Lake:

"Dangerous" (eutrophic rate)	0.44
"Permissible" (oligotrophic rate)	0.22

* See Discussion, page 2.

V. LITERATURE REVIEWED

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VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	FALL VALUES MEAN TOTAL P	FALL VALUES MEAN DISS P	FALL VALUES MEAN INORG N	ALL VALUES 500- MEAN SEC	ALL VALUES MEAN CHLORA	ALL VALUES 15- MIN DO
26A0	HOLLOWAY RESERVOIR	0.062	0.043	1.461	439.375	10.678	9.200
26A1	CARO RESERVOIR	0.117	0.022	3.835	473.000	11.967	9.500
26A2	BOARDMAN HYDRO POND	0.006	0.005	0.358	363.500	1.267	6.600
2603	ALLEGAN LAKE	0.123	0.057	1.168	470.222	20.311	12.600
2606	BARTON LAKE	0.121	0.086	1.489	456.167	27.800	14.850
2609	BELLEVILLE LAKE	0.118	0.048	1.420	465.250	28.262	8.200
2610	BETSIE LAKE	0.025	0.008	0.273	461.667	4.567	7.400
2613	BRIGHTON LAKE	0.109	0.073	1.015	456.000	44.233	7.500
2617	LAKE CHARLEVOIX	0.007	0.006	0.230	351.250	3.008	9.240
2618	LAKE CHEMUNG	0.044	0.014	0.132	404.333	13.483	14.800
2621	CONSTANTINE RESERVOIR	0.027	0.008	0.910	456.167	39.317	7.500
2629	FORD LAKE	0.105	0.058	1.536	456.167	14.733	14.000
2631	FREMONT LAKE	0.372	0.342	1.406	441.667	28.500	14.800
2640	JORDAN LAKE	0.180	0.144	1.998	427.667	20.517	14.900
2643	KENT LAKE	0.040	0.015	0.417	455.000	33.944	13.000
2648	LAKE MACATAWA	0.197	0.120	2.358	477.600	25.600	12.200
2649	MANISTEE LAKE	0.018	0.010	0.304	451.333	6.317	11.380
2659	MUSKEGON LAKE	0.087	0.043	0.469	436.444	9.511	14.800
2665	PENTWATER LAKE	0.027	0.017	0.496	430.667	16.083	14.800
2671	RANDALL LAKE	0.246	0.183	0.818	457.333	27.217	8.020
2672	ROGERS POND	0.026	0.015	0.183	435.500	8.133	9.600
2673	ROSS RESERVOIR	0.034	0.021	0.460	465.333	10.383	8.200
2674	SANFORD LAKE	0.016	0.008	0.307	458.750	13.791	8.300
2683	THORNAPPLE LAKE	0.042	0.032	1.737	442.833	14.650	10.800
2685	UNION LAKE	0.083	0.064	1.252	455.500	15.667	8.200
2688	WHITE LAKE	0.027	0.019	0.367	417.778	9.211	13.400
2691	MONA LAKE	0.307	0.241	0.963	451.667	27.783	14.100
2692	LONG LAKE	0.163	0.148	0.749	418.400	10.067	13.600

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	FALL VALUES MEAN TOTAL P	FALL VALUES MEAN DISS P	FALL VALUES MEAN INORG N	ALL VALUES 500-MEAN SEC	ALL VALUES MEAN CHLORA	ALL VALUES 15-MIN DO
2693	ST LOUIS RESERVOIR	0.134	0.093	1.227	462.667	5.583	8.420
2694	CRYSTAL LAKE	0.009	0.006	0.164	380.000	2.986	13.000
2695	HIGGINS LAKE	0.007	0.005	0.058	268.500	1.043	9.400
2696	HOUGHTON LAKE	0.018	0.008	0.136	420.833	9.217	8.200
2697	THOMPSON LAKE	0.043	0.029	0.436	407.889	11.967	14.800
2698	PERE MARQUETTE LAKE	0.032	0.024	0.346	448.667	11.833	8.600
2699	STRAWBERRY LAKE	0.069	0.050	0.567	419.800	11.117	13.600

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

LAKE CODE	LAKE NAME	FALL VALUES: MEAN TOTAL P	FALL VALUES: MEAN DISS P	FALL VALUES: MEAN INORG N	ALL VALUES: 500-MEAN SEC	ALL VALUES: MEAN CHLORA	ALL VALUES: 15-MIN DO	INDEX NO
26A0	HOLLOWAY RESERVOIR	46 (16)	43 (15)	17 (6)	57 (20)	60 (21)	63 (22)	286
26A1	CARO RESERVOIR	29 (10)	54 (19)	0 (0)	3 (1)	49 (17)	54 (19)	189
26A2	BOARDMAN HYDRO POND	97 (34)	97 (34)	69 (24)	91 (32)	94 (33)	97 (34)	545
2603	ALLEGAN LAKE	20 (7)	31 (11)	31 (11)	6 (2)	29 (10)	40 (14)	157
2606	BARTON LAKE	23 (8)	20 (7)	14 (5)	29 (9)	14 (5)	3 (1)	103
2609	BELLEVILLE LAKE	26 (9)	37 (13)	20 (7)	11 (4)	11 (4)	79 (26)	184
2610	BETSIE LAKE	77 (27)	77 (27)	80 (28)	17 (6)	86 (30)	94 (33)	431
2613	BRIGHTON LAKE	31 (11)	23 (8)	34 (12)	34 (12)	0 (0)	90 (31)	212
2617	LAKE CHARLEVOIX	91 (32)	91 (32)	83 (29)	94 (33)	89 (31)	60 (21)	508
2618	LAKE CHEMUNG	49 (17)	71 (25)	94 (33)	86 (30)	46 (16)	11 (2)	357
2621	CONSTANTINE RESERVOIR	71 (25)	83 (29)	40 (14)	29 (9)	3 (1)	90 (31)	316
2629	FORD LAKE	34 (12)	29 (10)	11 (4)	29 (9)	37 (13)	23 (8)	163
2631	FREMONT LAKE	0 (0)	0 (0)	23 (8)	54 (19)	9 (3)	11 (2)	97
2640	JORDAN LAKE	11 (4)	11 (4)	6 (2)	69 (24)	26 (9)	0 (0)	123
2643	KENT LAKE	57 (20)	69 (24)	63 (22)	40 (14)	6 (2)	36 (12)	271
2648	LAKE MACATAWA	9 (3)	14 (5)	3 (1)	0 (0)	23 (8)	43 (15)	92
2649	MANISTEE LAKE	80 (28)	74 (26)	77 (27)	46 (16)	80 (28)	46 (16)	403
2659	MUSKEGON LAKE	37 (13)	40 (14)	54 (19)	60 (21)	69 (24)	11 (2)	271
2665	PENTWATER LAKE	69 (24)	63 (22)	51 (18)	66 (23)	31 (11)	11 (2)	291
2671	RANDALL LAKE	6 (2)	6 (2)	43 (15)	23 (8)	20 (7)	86 (30)	184
2672	ROGERS POND	74 (26)	66 (23)	86 (30)	63 (22)	77 (27)	51 (18)	417
2673	ROSS RESERVOIR	60 (21)	57 (20)	57 (20)	9 (3)	63 (22)	79 (26)	325
2674	SANFORD LAKE	86 (30)	80 (28)	74 (26)	20 (7)	43 (15)	71 (25)	374
2683	THORNAPPLE LAKE	54 (19)	46 (16)	9 (3)	51 (18)	40 (14)	49 (17)	249
2685	UNION LAKE	40 (14)	26 (9)	26 (9)	37 (13)	34 (12)	79 (26)	242
2688	WHITE LAKE	66 (23)	60 (21)	66 (23)	80 (28)	74 (26)	31 (11)	377
2691	MONA LAKE	3 (1)	3 (1)	37 (13)	43 (15)	17 (6)	20 (7)	123
2692	LONG LAKE	14 (5)	9 (3)	46 (16)	77 (27)	66 (23)	27 (9)	239

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

LAKE CODE	LAKE NAME	FALL VALUES: MEAN TOTAL P	FALL VALUES: MEAN DISS P	FALL VALUES: MEAN INORG N	ALL VALUES: 500-MEAN SEC	ALL VALUES: MEAN CHLORA	ALL VALUES: 15-MIN DO	INDEX NO
2693	ST LOUIS RESERVOIR	17 (6)	17 (6)	29 (10)	14 (5)	83 (29)	69 (24)	229
2694	CRYSTAL LAKE	89 (31)	89 (31)	89 (31)	89 (31)	91 (32)	36 (12)	483
2695	HIGGINS LAKE	94 (33)	94 (33)	97 (34)	97 (34)	97 (34)	57 (20)	536
2696	HOUGHTON LAKE	83 (29)	86 (30)	91 (32)	71 (25)	71 (25)	79 (26)	481
2697	THOMPSON LAKE	51 (18)	49 (17)	60 (21)	83 (29)	51 (18)	11 (2)	305
2698	PERE MARQUETTE LAKE	63 (22)	51 (18)	71 (25)	49 (17)	54 (19)	66 (23)	354
2699	STRAWBERRY LAKE	43 (15)	34 (12)	49 (17)	74 (26)	57 (20)	27 (9)	284

APPENDIX B

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR MICHIGAN 2/3/75

LAKE CODE 2613 BRIGHTON LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ MI) 23.60

TRIBUTARY	SUB-DRAINAGE AREA(SQ MI)	NORMALIZED FLOWS(CFS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
2613A1	23.60	9.57	13.81	28.20	31.46	20.12	9.86	7.30	4.14	3.25	5.92	9.47	12.13	12.92
2613B1	22.10	8.90	12.90	26.30	29.50	18.80	9.20	6.80	3.90	3.10	5.60	8.80	11.40	12.09
2613ZZ	1.50	0.60	0.90	1.80	2.00	1.30	0.60	0.50	0.30	0.20	0.40	0.60	0.80	0.83

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 23.60 TOTAL FLOW IN = 155.20
SUM OF SUB-DRAINAGE AREAS = 23.60 TOTAL FLOW OUT = 155.23

MEAN MONTHLY FLOWS AND DAILY FLOWS(CFS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
2613A1	10	72	14.00	29	34.00				
	11	72	26.00						
	12	72	34.00	2	20.00				
	1	73	54.00	7	78.00				
	2	73	22.00	4	40.00				
	3	73	72.00	4	52.00				
	4	73	40.00	6	52.00	22	36.00		
	5	73	30.00	6	22.00	20	17.00		
	6	73	14.00	2	26.00				
	7	73	6.60	7	9.00				
	8	73	4.50	4	5.20				
	9	73	2.20	8	1.40				
	10	73	4.30	13	3.80				
2613B1	10	72	13.00	29	31.00				
	11	72	24.00						
	12	72	31.00	2	18.00				
	1	73	50.00	7	72.00				
	2	73	20.00	4	37.00				
	3	73	66.00	4	48.00				
	4	73	37.00	6	48.00	22	33.00		
	5	73	28.00	6	20.00				
	6	73	13.00	2	24.00				
	7	73	6.10	7	8.30				
	8	73	4.20	4	4.80				
	9	73	2.00	8	1.30				
	10	73	3.90	13	3.50				

TRIBUTARY FLOW INFORMATION FOR MICHIGAN 2/3/75

LAKE CODE 2613 BRIGHTON LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS(CFS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
2613ZZ	10	72	0.80						
	11	72	1.60						
	12	72	2.00						
	1	73	3.20						
	2	73	1.30						
	3	73	4.30						
	4	73	2.40						
	5	73	1.80						
	6	73	0.80						
	7	73	0.40						
	8	73	0.30						
	9	73	0.10						
	10	73	0.30						

APPENDIX C

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 75/02/04

261301
42 31 30.0 083 47 30.0
BRIGHTON LAKE
26 MICHIGAN

11EPALES 2111202
4 0000 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
72/06/15	10 12	0000	22.2	10.2	36	430	8.98	157	0.040	0.050	0.620	0.220
72/09/20	14 20	0000			28	650	8.40	188	0.110	0.360	0.642	0.485
	14 20	0004	21.3	7.5		650	8.40	188	0.120	0.360	0.644	0.482
72/11/15	11 40	0000			68	520	7.60	189	0.230	0.780	0.104	0.072
	11 40	0004	3.3	8.0		510	7.60	189	0.240	0.780	0.114	0.075

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/15	10 12	0000	51.4J
72/09/20	14 20	0000	77.4J
72/11/15	11 40	0000	3.9J

J VALUE KNOWN TO BE IN ERROR

APPENDIX D

TRIBUTARY and WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 75/02/04

2613A1 LS2613A1
42 31 00.0 083 48 00.0
SOUTH ORE CREEK
26 7.5 BRIGHTON
O/BRIGHTON LAKE
RD BRDG W SIDE OF BRIGHTON LAKE
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
72/10/29	13 15		0.250	2.850	0.205	0.140	0.357
73/01/07	10 00		0.390	1.260	0.220	0.010	0.036
73/02/04	10 00		0.310	0.857	0.078	0.007	0.065
73/03/04	09 00		0.290	1.050	0.399	0.030	0.060
73/04/06	09 45		0.013	1.000	0.008	0.014	0.075
73/04/22	11 20		0.019	0.870	0.009	0.008	0.055
73/05/06	09 20		0.025	0.880	0.005K	0.010	0.080
73/05/20	13 10		0.010K	0.975	0.008	0.011	0.072
73/06/02	08 45		0.017	0.850	0.014	0.005K	0.060
73/07/07	12 50		0.012	1.320	0.063	0.105	0.220
73/08/04	08 30			1.760	0.250	0.189	0.300
73/09/08	12 00		0.010K	1.470	0.090	0.088	0.250
73/10/13	09 40		0.010K	1.500	0.039	0.018	0.090

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/04

261381 LS261381
42 31 30.0 083 47 30.0
UNNAMED CREEK NE CORNER OF LAKE
26 7.5 BRIGHTON
T/BRIGHTON LAKE
BRDG 0.1 N BRIGHTON LAKE RDABOV STP
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
72/10/29	13 00		0.150	0.700	0.160	0.006	0.018
72/12/02	09 30		0.210	1.890	0.058	0.006	0.020
73/01/07	11 00		0.420	1.700	0.076	0.005K	0.019
73/02/04			0.250	0.500	0.032	0.005K	0.020
73/03/04	12 30		0.690	0.840	0.033	0.006	0.030
73/04/06	09 30		0.072	0.520	0.023	0.005K	0.015
73/04/22	11 15		0.038	0.660	0.025	0.006	0.025K
73/05/06	09 10		0.010K	0.630	0.019	0.005K	0.015
73/06/02	08 50		0.058	0.875	0.144	0.018	0.045
73/07/07	12 45		0.034	0.855	0.040	0.017	0.050
73/08/04				0.990	0.063	0.020	0.040
73/09/08	12 15		0.078	0.935	0.170	0.007	0.045
73/10/13	09 30		0.046	0.750	0.081	0.007	0.035

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/04

261350 P0261350 P002300
42 31 30.0 083 47 30.0
BRIGHTON
26 7.5 BRIGHTON
D/BRIGHTON LAKE
BRIGHTON LAKE
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
73/01/18	10 00		1.050	13.600	2.400	0.132	0.700	0.500	0.480
73/02/14	09 00		1.280	15.000	4.800	0.420	0.970	0.500	0.500
73/03/15	10 00		1.100	10.000	0.440	0.270	0.590	0.500	0.480
73/07/27	10 00		2.900	7.500	4.700	0.880	1.400	0.550	0.350
73/08/28	13 30			11.800	1.180	0.570	0.890	0.580	0.520
73/09/14	11 00		5.700	1.300		0.560	0.820	0.550	0.510
73/10/17	12 30		4.000	12.000	9.900	0.370	0.490	0.560	0.520
73/11/15	13 00		11.400	1.750	0.048	1.050		0.570	0.510
73/12/14	11 00		3.360	9.500	0.210	0.390	1.050	0.520	0.510