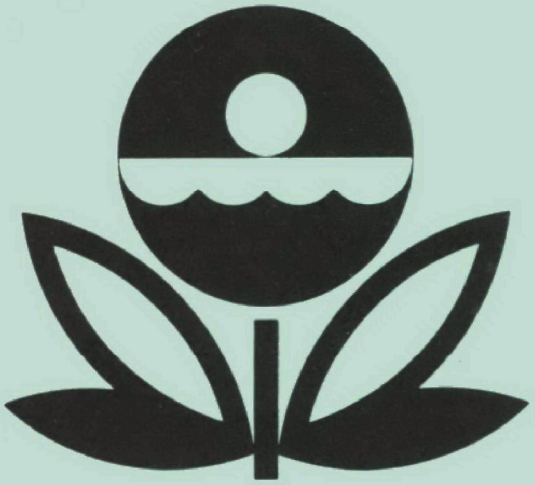
U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES



REPORT

ON

LAC LA BELLE

WAUKESHA COUNTY

WISCONSIN

EPA REGION V

WORKING PAPER No. 62

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

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WITH THE COOPERATION OF THE

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

AND THE

WISCONSIN NATIONAL GUARD

JUNE, 1975

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 nation-wide 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.

* The lake discussed in this report was included in the National Eutrophication Survey as a water body of interest to the Wisconsin Department of Natural Resources. Nutrient sources were not sampled, and this report relates only to the data obtained from lake sampling.

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

Francis H. Schraufnagel, Acting Assistant Director, and Joseph R. Ball of the Bureau of Water Quality, and Donald R. Winter, Lake Rehabilitation Program, provided invaluable lake documentation and counsel during the Survey. Central Office and District Office personnel of the Department of Natural Resources reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper series.

Major General James J. Lison, Jr., the Adjutant General of Wisconsin, and Project Officer CW-4 Donald D. Erickson, who directed the volunteer efforts of the Wisconsin National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

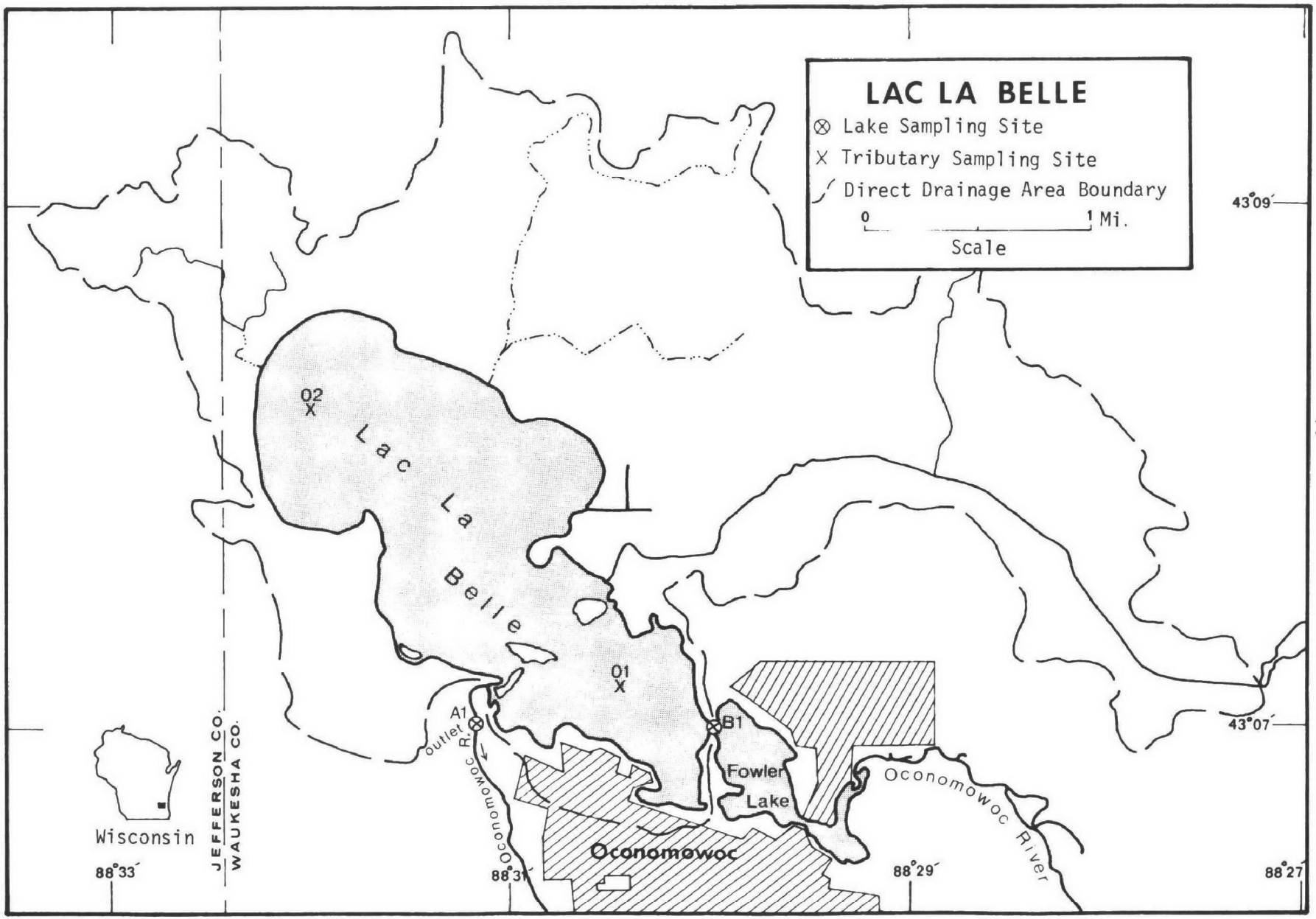
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF WISCONSIN

LAKE NAME	COUNTY
Altoona	Eau Claire
Beaver Dam	Barron
Beaver Dam	Dodge
Big Eau Pleine	Marathon
Browns	Racine
Butte des Morts	Winnebago
Butternut	Price, Ashland
Castle Rock Flowage	Juneau
Como	Walworth
Crystal	Vilas
Delavan	Walworth
Eau Claire	Eau Claire
Geneva	Walworth
Grand	Green Lake
Green	Green Lake
Kegonsa	Dane
Koshkonong	Jefferson, Rock, Dane
Lac La Belle	Waukesha
Middle	Walworth
Nagawicka	Waukesha
Oconomowoc	Waukesha
Okauchee	Waukesha
Petenwell Flowage	Juneau
Pewaukee	Waukesha
Pigeon	Waupaca
Pine	Waukesha
Poygan	Winnebago, Waushara
Rock	Jefferson
Rome Pond	Jefferson, Waukesha
Round	Waupaca
Shawano	Shawano
Sinnissippi	Dodge

LAKE NAME	COUNTY
Swan	Columbia
Tainter	Dunn
Tichigan	Racine
Townline	Oneida
Trout	Vilas
Wapogassett	Polk
Wausau	Marathon
Willow	Oneida
Winnebago	Winnebago, Fond Du Lac, Calumet
Wisconsin	Columbia
Wissota	Chippewa
Yellow	Burnett


LAC LA BELLE
⊗ Lake Sampling Site
X Tributary Sampling Site
Direct Drainage Area Boundary
0
1 Mi.
Scale
43°09´
43°07´
02
Lac La Belle
01
A1
Outlet
Oconomowoc R.
B1
Fowler
Lake
Oconomowoc River
Oconomowoc
Wisconsin
JEFFERSON CO.
WAUKESHA CO.
88°33´
88°31´
88°29´
88°27´

VI

LAC LA BELLE

STORET NO. 5563

I. INTRODUCTION

Lac La Belle was included in the National Eutrophication Survey as a water body of interest to the Wisconsin Department of Natural Resources. The inlet and outlet of the lake were sampled (Appendix C), but no wastewater treatment plants impact the lake. Therefore, this report relates only to the lake sampling data.

II. CONCLUSIONS

A. Trophic Condition:

Survey data indicate Lac La Belle is meso-eutrophic. Of the 46 Wisconsin lakes sampled, two had less mean total phosphorus, one had less and two had the same mean dissolved phosphorus, 11 had less mean inorganic nitrogen, 17 had less mean chlorophyll a, and nine had greater mean Secchi disc transparency. Some depression of dissolved oxygen occurred at the 24-foot depth in August at station 2.

Aquatic weeds are a major use-problem (Poff and Threinen, 1963), and the lake has been chemically treated to control weeds for a number of years (Lueschow, 1972).

B. Rate-Limiting Nutrient:

The algal assay results indicate Lac La Belle was phosphorus limited at the time the sample was taken (11/09/72). The lake data indicate phosphorus limitation at the other sampling times as well.

III. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry†:

1. Surface area: 1,117 acres.
2. Mean depth: 11.6 feet.
3. Maximum depth: 46 feet.
4. Volume: 12,924 acre-feet.
5. Mean hydraulic retention time: 93 days.

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

1. Tributaries -

Name	Drainage area (mi^2)*	Mean flow (cfs)*
Oconomowoc River (Fowler Lake outlet)	91.0	61.4
Minor tributaries & immediate drainage -	10.3	8.9
Totals	101.3	70.3

2. Outlet -

Oconomowoc River	103.0**	70.3

C. Precipitation***:

1. Year of sampling: 38.7 inches.
2. Mean annual: 30.7 inches.

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† Ball, 1973.

* Drainage areas are accurate within ±0.5%; mean daily flows are accurate within ±40%; mean monthly flows are accurate within ±35%; and normalized monthly flows are accurate within ±35%.

** Includes area of lake.

*** See Working Paper No. 1, "Survey Methods, 1972".

IV. LAKE WATER QUALITY SUMMARY

Lac La Belle 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 vi). During each visit, a single depth-integrated (15 feet or near bottom to surface) sample was composited from the 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 31 feet at station 1 and 26 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 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 B.

A. Physical and chemical characteristics:

FALL VALUES

(11/09/72)

Parameter	Minimum	Mean	Median	Maximum
Temperature (Cent.)	6.8	6.9	6.9	7.0
Dissolved oxygen (mg/l)	10.8	11.0	11.0	11.3
Conductivity (μmhos)	465	471	470	480
pH (units)	8.2	8.2	8.2	8.3
Alkalinity (mg/l)	189	191	191	193
Total P (mg/l)	0.012	0.014	0.014	0.016
Dissolved P (mg/l)	0.006	0.007	0.007	0.009
NO_2 + NO_3 (mg/l)	0.170	0.206	0.210	0.230
Ammonia (mg/l)	0.040	0.055	0.055	0.070

ALL VALUES

Secchi disc (inches)	60	64	78	101

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
06/23/72	1. Merismopedia	1,790
	2. Microcystis	1,356
	3. Chroococcus	362
	4. Scenedesmus	307
	5. Gloeocapsa	217
	Other genera	1,049
	Total	5,081
08/19/72	1. Merismopedia	8,825
	2. Chroococcus	979
	3. Fragilaria	783
	4. Microcystis	512
	5. Lagerheima	482
	Other genera	1,973
	Total	13,554
11/09/72	1. Stichococcus	2,453
	2. Dinobryon	641
	3. Asterionella	528
	4. Fragilaria	528
	5. Flagellates	283
	Other genera	3,378
	Total	7,811

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)
06/23/72	01	9.6
	02	6.6
08/19/72	01	5.5
	02	4.3
11/09/72	01	12.2
	02	9.4

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	0.006	0.272	0.2
0.006 P	0.012	0.272	0.3
0.012 P	0.018	0.272	2.0
0.024 P	0.030	0.272	5.8
0.060 P	0.066	0.272	6.6
0.060 P + 10.0 N	0.060	10.272	25.2
10.0 N	0.006	10.272	0.1

2. Discussion -

The results of the algal assay with Selenastrum capricornutum, indicate the potential primary productivity of Lac La Belle was relatively low at the time the sample was collected (11/09/72). Also, increased yields with increased levels of orthophosphorus indicate the lake was phosphorus

limited at that time (note the lack of yield response when only nitrogen was added).

The lake data indicate phosphorus limitation at the other sampling times as well; i.e., N/P ratios were 20/1 or greater, and phosphorus limitation would be expected.

V. LITERATURE REVIEWED

Ball, Joseph R., 1973. Personal communication (lake morphometry). WI Dept. Nat. Resources, Madison.

Lueschow, Lloyd A., 1972. Biology and control of aquatic nuisances in recreational waters. Tech. Bull. No. 57, WI Dept. Nat. Resources, Madison.

McKersie, Jerome, George Hansel, Floyd Stautz, and Dick Narf; 1969. Report on an investigation of the pollution in the upper Rock River drainage made during 1967-1968. WI Dept. Nat. Resources, Madison.

Poff, Ronald J., and C. W. Threinen, 1963. Surface water resources of Waukesha County. WI Cons. Dept., Madison.

VI. APPENDICES

APPENDIX A

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR WISCONSIN 9/30/74

LAKE CODE 5563 LAC LA BELLE

TOTAL DRAINAGE AREA OF LAKE 103.00

TRIBUTARY	SUB-DRAINAGE AREA	NORMALIZED FLOWS JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
5563A1	103.00	40.50	44.50	111.30	161.90	94.10	111.30	50.60	35.40	44.50	46.60	63.80	39.50	70.27
5563B1	91.00	35.00	39.00	100.00	140.00	82.00	97.00	44.00	31.00	39.00	40.00	56.00	34.00	61.36
5563ZZ	12.00	4.60	5.10	13.00	18.00	21.00	13.00	5.80	4.10	5.20	5.30	7.30	4.50	8.92

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 103.00
SUM OF SUB-DRAINAGE AREAS = 103.00
TOTAL FLOW IN = 843.90
TOTAL FLOW OUT = 844.00

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
5563A1	9	72	160.00	23	250.00				
	10	72	180.00						
	11	72	130.00						
	12	72	52.00	9	44.00				
	1	73	120.00						
	2	73	90.00	11	90.00				
	3	73	200.00	18	270.00				
	4	73	440.00	14	290.00	29	290.00		
	5	73	300.00	26	240.00	28	380.00		
	6	73	120.00	16	110.00				
	7	73	33.00	1	49.00				
	8	73	22.00	26	23.00				
5563B1	9	72	140.00	23	220.00				
	10	72	160.00						
	11	72	120.00						
	12	72	46.00	9	38.00				
	1	73	100.00						
	2	73	73.00	11	73.00				
	3	73	170.00	18	240.00				
	4	73	400.00	14	260.00	29	250.00		
	5	73	270.00	26	220.00	28	340.00		
	6	73	110.00	16	97.00				
	7	73	29.00	1	43.00				
	8	73	20.00	26	20.00				
5563ZZ	9	72	22.00	23	34.00				
	10	72	25.00						
	11	72	18.00						
	12	72	7.00	9	5.90				
	1	73	8.00						
	2	73	4.40	11	4.40				
	3	73	14.00	18	19.00				
	4	73	91.00	14	60.00	29	42.00		
	5	73	44.00	26	36.00	28	56.00		
	6	73	12.00	16	12.00				
	7	73	5.30	1	7.80				
	8	73	3.60	26	3.70				

APPENDIX B

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/09/30

556301
43 07 00.0 088 30 30.0
LAC LA BELLE
55 WISCONSIN

11EPALES
5

2111202
0026 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
72/06/23	13 45	0000	18.9	8.9	72	400	8.50	174	0.070	0.050	0.013	0.007
	13 45	0024	16.0	7.9		410	8.30	176	0.080	0.080	0.013	0.009
72/08/19	06 40	0000			90	400	8.50	170	0.060	0.100	0.013	0.006
	06 40	0004	25.7	8.9		395	8.50	170	0.050	0.090	0.011	0.007
	06 40	0015	22.9	8.3		405	8.15	172	0.130	0.140	0.013	0.008
	06 40	0020	20.4	6.0		410	8.00	174	0.110	0.130	0.014	0.006
	06 40	0024	19.5	4.5		410	8.00	176	0.110	0.190	0.012	0.006
72/11/09	15 10	0000			101	480	8.20	193	0.190	0.070	0.014	0.009
	15 10	0004	7.0	10.8		470	8.20	192	0.180	0.060	0.014	0.007
	15 10	0015	7.0	10.8		470	8.20	192	0.190	0.060	0.013	0.006
	15 10	0031	7.0	10.8		475	8.20	193	0.170	0.060	0.012	0.006

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/23	13 45	0000	9.6J
72/08/19	06 40	0000	5.5J
72/11/09	15 10	0000	12.2J

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/09/30

556302
43 08 00.0 088 32 00.0
LAC LA BELLE
55 WISCONSIN

11EPALES 2111202
5 0004 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
72/06/23	14 05	0000	19.0	8.4	60	405	8.40	177	0.060	0.050	0.015	0.009
72/08/19	07 15	0000			60	400	8.50	166	0.050	0.090	0.010	0.006
	07 15	0004	25.8	8.5		400	8.50	165	0.060	0.100	0.011	0.006
72/11/09	14 45	0000			99	470	8.30	189	0.230	0.050	0.013	0.007
	14 45	0004	6.8	11.3		470	8.30	190	0.230	0.050	0.016	0.007
	14 45	0015	6.8	11.0		465	8.30	190	0.230	0.050	0.016	0.007
	14 45	0026	6.8	11.0		470	8.30	191	0.230	0.040	0.014	0.008

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/23	14 05	0000	6.6J
72/08/19	07 15	0000	4.3J
72/11/09	14 45	0000	9.4J

J VALUE KNOWN TO BE IN ERROR

APPENDIX C

TRIBUTARY DATA

STORET RETRIEVAL DATE 74/10/02

5563A1 LS5563A1
43 07 00.0 088 31 00.0
OCONOMOWOC RIVER
55 15 WATERTOWN
O/LAC LA BELLE
US 16 BRDG ABOVE OCONOMOWOC 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
72/09/23	15 30		0.130	1.600	0.102	0.005K	0.021
72/11/05	12 45		0.147	0.600	0.018	0.005K	0.016
72/12/09	13 30		0.260	0.750	0.017	0.011	0.015
73/01/06	14 45		0.280	0.960	0.046	0.005K	0.015
73/02/11	13 40		0.350	0.770	0.024	0.008	0.015
73/03/18	11 00		0.530	1.800	0.066	0.005K	
73/04/14	14 30		0.330	0.820	0.013	0.005K	0.025
73/05/26	14 20		0.270	0.840	0.009	0.005K	0.020
73/05/28	14 30		0.250	1.000	0.036	0.014	0.020
73/06/15	14 40		0.094	1.120	0.056	0.005K	0.020
73/07/01	11 00		0.088	0.880	0.039	0.005K	0.025
73/08/25	13 30		0.013	0.560	0.018	0.011	0.020

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 74/10/02

555381 LS556381
43 07 00.0 088 30 00.0
FOX/LEP LAKE OUTLET
55 15 HARTLAND
1/LAC LA BELLE
ST HWY 67 BRDG IN OCONOMOWOC
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
72/09/23	15	30	0.062		0.161	0.005K	0.020
72/11/05	13	00	0.094	0.640	0.034	0.005K	0.015
72/12/09	14	20	0.154	0.650	0.015	0.005K	0.010
73/01/05	14	00	0.200	0.810	0.048	0.005K	0.015
73/02/11	14	00	0.240	0.690	0.024	0.007	0.010
73/03/18	10	30	0.294	0.560	0.025	0.005K	
73/04/14	13	30	0.252	0.850	0.013	0.005K	0.015
73/04/29	14	15	0.160	0.920	0.018	0.005K	0.015
73/05/26	14	50	0.198	1.380	0.075	0.005K	0.015
73/05/29	14	50	0.240	0.830	0.030	0.007	0.020
73/06/16	14	30	0.058	1.000	0.038	0.005K	0.015
73/07/01	10	33	0.012	2.000	0.043	0.005K	0.015
73/08/26	14	30	0.010K	0.580	0.016	0.008	0.015

K VALUE FOUND TO BE LESS THAN INDICATED