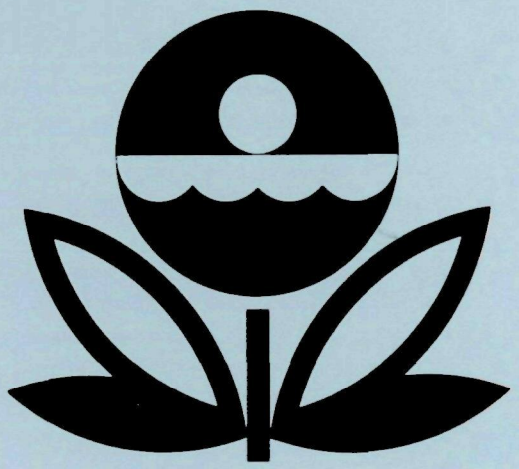
U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES



REPORT

ON

BANKS LAKE

GRANT AND DOUGLAS COUNTIES

WASHINGTON

EPA REGION X

WORKING PAPER No. 865

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

REPORT

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EPA REGION X

WORKING PAPER No. 865

WITH THE COOPERATION OF THE

WASHINGTON DEPARTMENT OF ECOLOGY

AND THE

WASHINGTON NATIONAL GUARD

JULY, 1977

REPORT ON BANKS LAKE

GRANT AND DOUGLAS COUNTIES, WASHINGTON

EPA REGION X

by

National Eutrophication Survey

Water and Land Quality Branch
Monitoring Operations Division
Environmental Monitoring & Support Laboratory
Las Vegas, Nevada

and

Special Studies Branch
Corvallis Environmental Research Laboratory
Corvallis, Oregon

Working Paper No. 865

OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY

July 1977

CONTENTS

FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater 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 nonpoint 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 freshwater 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 the U.S. Environmental Protection Agency and to augment plans implementation by the states.

ACKNOWLEDGMENTS

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the Washington Department of Ecology for professional involvement, to the Washington National Guard for conducting the tributary sampling phase of the Survey, and to those Washington wastewater treatment plant operators who provided effluent samples and flow data.

Ms. Barbara Blau, Lake Restoration Program, and the staff of the Washington Department of Ecology, Lake Restoration Program, 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.

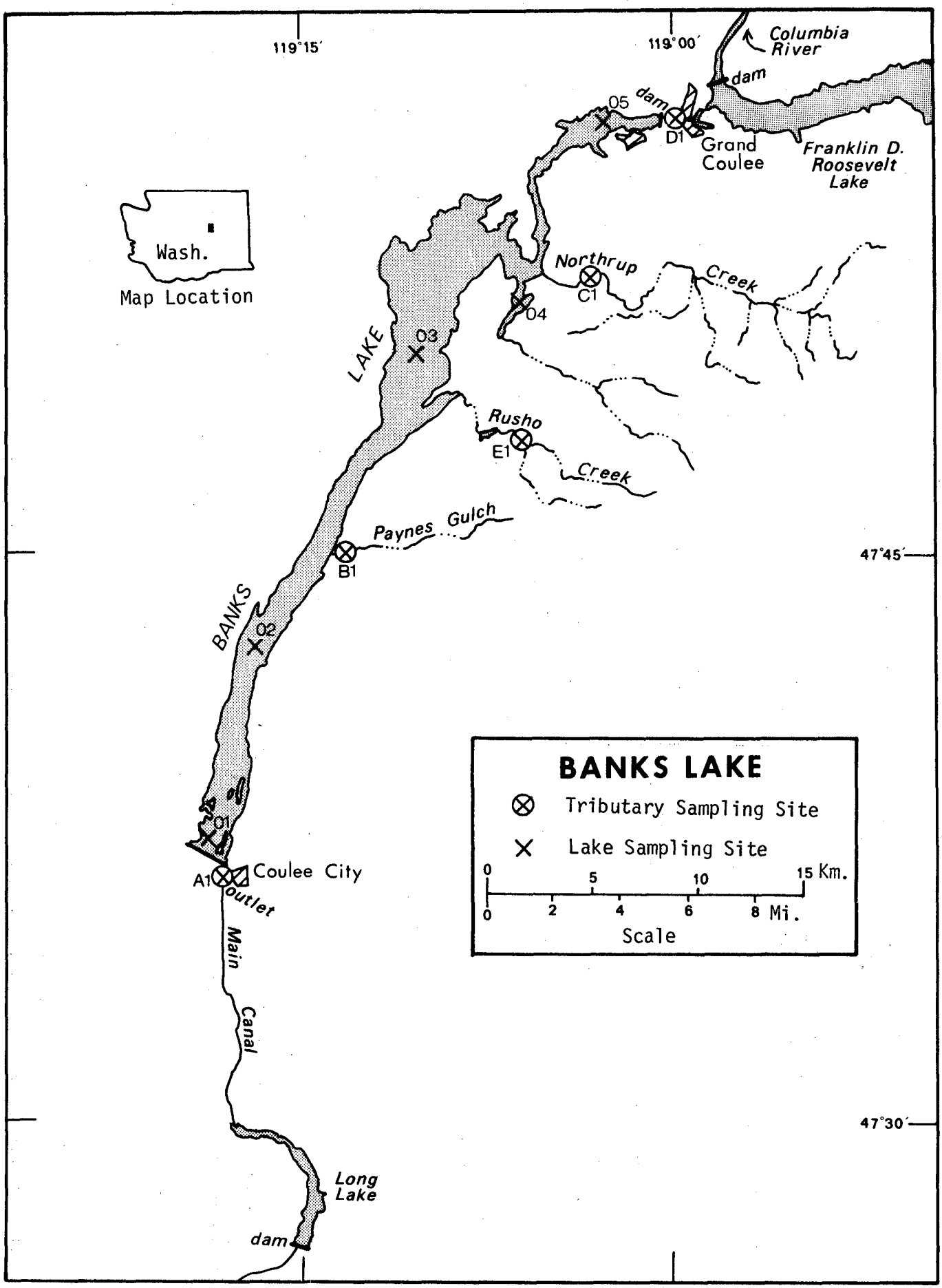
Major General Howard S. McGee, Adjutant General of Washington, and Project Officer Colonel Clinton C. Johnson, who directed the volunteer efforts of the Washington National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF WASHINGTON

LAKE NAME	COUNTY
American Lake	Pierce
Banks Lake	Grant, Douglas
Chelan Lake	Chelan
Diamond Lake	Pend Oreille
Green Lake	King
Keechelus Lake	Kittitas
Mayfield Lake	Lewis
Medical Lake	Spokane
Moses Lake	Grant
Ozette Lake	Clallam
Sammamish Lake	King
Lake Whatcom	Whatcom
Lower Granite Reservoir	Garfield, Whatcom


119°15'
119°00'
Columbia River
dam
dam
05
D1
Grand Coulee
Franklin D. Roosevelt Lake
Wash.
Map Location
Northrup
Creek
C1
04
LAKE
03
Rusho
E1
Creek
Paynes Gulch
B1
47°45'
BANKS
02
01
A1
Coulee City
outlet
Main
Canal
Long Lake
dam
47°30'
BANKS LAKE
Tributary Sampling Site
Lake Sampling Site
0
5
10
15 Km.
0
2
4
6
8 Mi.
Scale

REPORT ON BANKS LAKE, WASHINGTON

STORET NO. 5302

I. INTRODUCTION

Banks Lake was included in the National Eutrophication Survey as a water body of interest to the Washington Department of Ecology. A number of streams to Banks Lake were sampled; however, normalized flow data for these tributaries were not available so annual nutrient loadings to the lake could not be calculated. The tributary sampling data are included in Appendix D for the record, and are summarized in Section V of the report.

Banks Lake was created in 1951 and is primarily fed by water pumped from Franklin D. Roosevelt Reservoir through Feeder Canal (D-1) during the drier months of the year. The lake receives heavy recreational and irrigation use (Dion, et al., 1976).

II. CONCLUSIONS

A. Trophic Condition:*

Survey data indicate that Banks Lake is mesotrophic. Chlorophyll a values ranged from a low of 2.0 µg/l to a high of 27.2 µg/l, with a mean of 7.4 µg/l. Potentials for primary productivity as measured by algal assay control yields were moderate to low. Of the 13 Washington lakes sampled in 1975, 5 had greater median total phosphorus values (0.021 mg/l),

*See Appendix E.

12 had higher inorganic nitrogen levels (0.040 mg/l) and 8 had higher median dissolved orthophosphorus levels (0.007 mg/l) than Banks Lake.

Survey limnologists did not report any problem algal blooms during their visits to the lake.

C. Rate-Limiting Nutrient:

Algal assay results indicate that Banks Lake was limited by available phosphorus levels on the sample collection dates (04/03/75, 09/10/75). Lake data suggest primary limitation by nitrogen.

III. LAKE CHARACTERISTICS

A. Lake Morphometry:*

1. Surface area: 100.77 km^2.
2. Mean depth: 12.4 meters.
3. Maximum depth: 25.9 meters.
4. Volume: 1251.006 x 10^6 m^3.
5. Mean hydraulic retention time: 175 days.

B. Precipitation:

1. Year of sampling: 32.6 cm.
2. Mean annual: 32.2 cm.

*E.E. Wolcott, 1965. Hydraulic retention time calculated by dividing the lake volume by provided mean flow of the outlet.

IV. LAKE WATER QUALITY SUMMARY

Banks Lake was sampled three times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from five stations on the lake and from a number of depths at each station (see map, page v). During each visit, depth-integrated samples were collected from each station for chlorophyll a analysis and phytoplankton identification and enumeration. During the first and last visits, 18.9-liter depth-integrated samples were composited for algal assays. Maximum depths sampled were 11.3 meters at Station 01, 24.1 meters at Station 02, 18.9 meters at Station 03, 11.6 meters at Station 04, and 20.1 meters at Station 05. For a more detailed explanation of NES methods, see NES Working Paper No. 175.

The results obtained are presented in full in Appendix C and are summarized in III-A for waters at the surface and at the maximum depth for each site. Results of the phytoplankton counts and chlorophyll a determinations are included in III-B. Results of the limiting nutrient study are presented in III-C.

RANKS LAKE
STORET CODE 5302

PHYSICAL AND CHEMICAL CHARACTERISTICS

PARAMETER	(4/ 3/75) S*** = 5 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	(7/22/75) S*** = 5 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	(9/10/75) S*** = 5 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)
TEMPERATURE (DEG CENT)												
0.-1.5 M DEPTH	8	3.7- 5.3	3.9	0.0- 1.5	10	15.8- 21.4	19.3	0.0- 1.5	10	19.0- 20.8	19.9	0.0- 1.5
MAX DEPTH**	4	3.7- 5.0	3.9	6.4- 23.2	5	12.9- 17.4	14.1	7.9- 20.1	5	17.3- 19.4	18.7	7.3- 24.1
DISSOLVED OXYGEN (MG/L)												
0.-1.5 M DEPTH	10	11.2- 13.0	12.1	0.0- 1.5	10	8.4- 9.2	8.9	0.0- 1.5	10	6.4- 11.0	8.5	0.0- 1.5
MAX DEPTH**	5	12.0- 12.4	12.2	6.4- 23.2	5	4.2- 9.2	7.4	7.9- 20.1	5	4.4- 8.4	6.4	7.3- 24.1
CONDUCTIVITY (UMHOS)												
0.-1.5 M DEPTH	10	83.- 90.	85.	0.0- 1.5	10	109.- 133.	127.	0.0- 1.5	10	122.- 136.	125.	0.0- 1.5
MAX DEPTH**	5	83.- 89.	84.	6.4- 23.2	5	109.- 125.	113.	7.9- 20.1	5	118.- 126.	123.	7.3- 24.1
PH (STANDARD UNITS)												
0.-1.5 M DEPTH	10	7.9- 8.3	8.1	0.0- 1.5	10	8.2- 8.9	8.4	0.0- 1.5	10	7.8- 8.6	8.0	0.0- 1.5
MAX DEPTH**	5	8.0- 8.3	8.1	6.4- 23.2	5	7.5- 8.3	7.9	7.9- 20.1	5	7.4- 7.9	7.9	7.3- 24.1
TOTAL ALKALINITY (MG/L)												
0.-1.5 M DEPTH	10	53.- 60.	56.	0.0- 1.5	10	57.- 68.	62.	0.0- 1.5	10	59.- 70.	63.	0.0- 1.5
MAX DEPTH**	5	51.- 58.	53.	6.4- 23.2	5	57.- 65.	60.	7.9- 20.1	5	61.- 70.	63.	7.3- 24.1
TOTAL P (MG/L)												
0.-1.5 M DEPTH	10	0.017-0.039	0.022	0.0- 1.5	10	0.011-0.018	0.016	0.0- 1.5	10	0.014-0.027	0.021	0.0- 1.5
MAX DEPTH**	5	0.016-0.035	0.021	6.4- 23.2	5	0.019-0.246	0.051	7.9- 20.1	5	0.016-0.234	0.032	7.3- 24.1
DISSOLVED ORTHO P (MG/L)												
0.-1.5 M DEPTH	10	0.004-0.014	0.006	0.0- 1.5	10	0.004-0.017	0.009	0.0- 1.5	10	0.003-0.017	0.006	0.0- 1.5
MAX DEPTH**	5	0.005-0.012	0.005	6.4- 23.2	5	0.011-0.023	0.015	7.9- 20.1	5	0.005-0.028	0.015	7.3- 24.1
NO2+NO3 (MG/L)												
0.-1.5 M DEPTH	10	0.020-0.030	0.020	0.0- 1.5	10	0.020-0.020	0.020	0.0- 1.5	10	0.020-0.020	0.020	0.0- 1.5
MAX DEPTH**	5	0.020-0.020	0.020	6.4- 23.2	5	0.020-0.020	0.020	7.9- 20.1	5	0.020-0.050	0.020	7.3- 24.1
AMMONIA (MG/L)												
0.-1.5 M DEPTH	10	0.020-0.030	0.020	0.0- 1.5	10	0.020-0.040	0.030	0.0- 1.5	10	0.020-0.030	0.020	0.0- 1.5
MAX DEPTH**	5	0.020-0.030	0.020	6.4- 23.2	5	0.020-0.040	0.030	7.9- 20.1	5	0.020-0.020	0.020	7.3- 24.1
KJELDAHL N (MG/L)												
0.-1.5 M DEPTH	10	0.200-0.400	0.300	0.0- 1.5	10	0.200-0.200	0.200	0.0- 1.5	10	0.200-0.200	0.200	0.0- 1.5
MAX DEPTH**	5	0.200-0.300	0.200	6.4- 23.2	5	0.200-0.400	0.200	7.9- 20.1	5	0.200-0.200	0.200	7.3- 24.1
SECCHI DISC (METERS)												
	5	1.4- 4.0	2.7		5	2.1- 4.0	3.0		5	2.4- 5.3	5.2	

* N = NO. OF SAMPLES
** MAXIMUM DEPTH SAMPLED AT EACH SITE
*** S = NO. OF SITES SAMPLED ON THIS DATE

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
04/03/75	1. Asterionella	3,034
	2. Tabellaria	358
	3. Lyngbya	167
	4. Dinobryon	119
	5. Chroomonas	96
	Other genera	168
	Total	3,942
07/22/75	1. Melosira	690
	2. Asterionella	248
	3. Anabaena	221
	4. Ankistrodesmus	55
	5. Chroomonas	55
	Other genera	111
	Total	1,380
09/10/75	1. Asterionella	624
	2. Tabellaria	451
	3. Fragilaria	416
	4. Chroomonas	243
	5. Aphanizomenon	173
	Other genera	348
	Total	2,255

2. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll *a* (µg/l)
04/03/75	01	4.8
	02	27.2
	03	12.6
	04	12.8
	05	12.9
07/22/75	01	2.2
	02	3.0
	03	2.0
	04	5.5
	05	2.2
09/10/75	01	2.3
	02	2.9
	03	2.8
	04	11.6
	05	5.8

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.)
a. 04/03/75	Stations 01, 02		
Control	<0.008	0.024	0.2
0.05 P	<0.058	0.024	0.9
0.05 P + 1.0 N	<0.058	1.024	15.0
1.00 N	<0.008	1.024	0.2
	Stations 03-05		
Control	0.003	0.022	0.2
0.05 P	0.053	0.022	1.2
0.05 P + 1.0 N	0.053	1.022	23.7
1.00 N	0.003	1.022	0.3
b. 09/10/75	Stations 01,02		
Control	0.010	0.030	0.4
0.05 P	0.060	0.030	1.8
0.05 P + 1.0 N	0.060	1.030	11.8
1.00 N	0.010	1.030	0.3
	Stations 03-05		
Control	0.010	0.020	0.7
0.05 P	0.060	0.020	3.4
0.05 P + 1.0 N	0.060	1.020	20.3
1.00 N	0.010	1.020	0.6

2. Discussion -

The control yields of the assay alga, Selenastrum capricornutum, indicate that the potential for primary productivity of Banks Lake was low during the spring sampling (04/03/75) and moderate during the fall sampling (09/10/75). In all assays, a significant increase in yield over that of the control occurred when phosphorus was added alone, indicating phosphorus limitation. Spikes with nitrogen and phosphorus simultaneously resulted in maximum yield. Additions of nitrogen alone did not stimulate growth significantly beyond the control yields.

The mean inorganic nitrogen to orthophosphorus ratios (N/P) in the lake samples were approximately 6/1, 4/1, and 5/1 in the spring, summer, and fall, respectively, suggesting nitrogen limitation (an N/P ratio of 14/1 or greater generally reflects phosphorus limitation).

V. MEAN NUTRIENT CONCENTRATIONS IN UNGAGED STREAMS

Tributary	Mean Total P (mg/l)	Mean Total N (mg/l)
B-1 Paynes Gulch	0.259	5.734
C-1 Northrup Creek	0.196	2.219
D-1 Feeder Canal	0.039	0.465
E-1 Rusho Creek	1.120	8.019
F-1 Unnamed Stream*	0.460	7.937

*This stream was sampled as a special interest tributary and lies outside the watershed of Banks Lake.

VI. LITERATURE REVIEWED

Dion, N.P., G.C. Bortleson, J.B. McConnell and L.M. Nelson. 1976. Reconnaissance Data on Lakes in Washington. Volume 6. Washington Department of Ecology, Water Supply Bulletin 43, Volume 6.

U.S. Environmental Protection Agency. 1975. National Eutrophication Survey Methods 1973-1976. Working Paper No. 175. National Environmental Research Center, Las Vegas, Nevada, and Pacific Northwest Environmental Research Laboratory, Corvallis, Oregon.

Wolcott, E.E. 1965. Lakes of Washington, Volume II. Washington Division of Water Resources, Water Supply Bulletin, 14 and 15.

VII. APPENDICES

APPENDIX A

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-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 B

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR WASHINGTON 11/15/76

LAKE CODE 5302 - BANKS LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 727.8

TRIBUTARY	SUB-DRAINAGE AREA(S) KM	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
5302A1	727.8	0.0	0.0	17.585	89.481	157.300	179.557	199.209	184.909	112.644	46.949	0.0	0.0	82.836
530277	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 727.8
SUM OF SUB-DRAINAGE AREAS = 0.0
TOTAL FLOW IN = 0.0
TOTAL FLOW OUT = 987.63

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
5302A1	9	74	124.736	21	85.517				
	10	74	52.499						
	11	74	0.0						
	12	74	0.0	7	0.0				
	1	75	0.0	15	0.0	19	0.0		
	2	75	0.0	6	0.0	16	0.0		
	3	75	7.023	3	0.0				
	4	75	70.226	6	42.192	27	93.729		
	5	75	156.026	20	174.432				
	6	75	198.784						
	7	75	211.527	2	222.954				
	8	75	163.671	14	191.705				
5302C1	9	74	0.008	21	0.008				
	11	74	0.010						
	11	74	0.010	2	0.010				
	12	74	0.011	7	0.010				
	1	75	0.017						
	2	75	0.425						
	3	75	0.850						
	4	75	0.453	6	0.708	27	0.181		
	5	75	0.113	20	0.076	22	0.074		
	6	75	0.042						
	7	75	0.017	2	0.0	18	0.016		
	8	75	0.011	14	0.011	19	0.010		
5302D1	9	74	50.857	21	92.200				
	10	74	92.596						
	11	74	89.170	2	91.747				
	12	74	0.932	7	-69.744				
	1	75	-1.127	15	0.0	19	0.0		
	2	75	-0.739	6	0.0	16	0.0		
	3	75	3.908	3	-50.829				
	4	75	0.0	6	0.0	27	0.0		
	5	75	137.620	20	140.168				
	6	75	233.897						
	7	75	277.788	2	261.931				
	8	75	173.016	14	180.661				

LAKE CODE 5302 BANKS LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
530277	9	74	0.0						
	10	74	0.0						
	11	74	0.0						
	12	74	0.0						
	1	75	0.0						
	2	75	0.0						
	3	75	0.0						
	4	75	0.0						
	5	75	0.0						
	6	75	0.0						
	7	75	0.0						
	8	75	0.0						

APPENDIX C

PHYSICAL AND CHEMICAL DATA

STORET RETRIEVAL DATE 76/11/16
NATL EUTROPHICATION SURVEY
EPA-LAS VEGAS

530201
47 37 33.0 119 17 50.0 3
BANKS LAKE
53025 WASHINGTON
130591

11EPALES 2111202
0025 FEET DEPTH CLASS 00

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
75/04/03	14 05	0000	3.8	12.2	157	84	7.90	59	0.020K	0.300	0.020K	0.006
	14 05	0005	3.8	11.2		85	7.90	55	0.020	0.200K	0.020K	0.006
	14 05	0021	3.8	12.4		84	8.00	53	0.020K	0.200K	0.020K	0.005
75/07/22	12 40	0000	18.6	8.4	120	133	8.30	58	0.030	0.200K	0.020K	0.005
	12 40	0005	17.8	8.8		123	8.40	62	0.030	0.200K	0.020K	0.009
	12 40	0015	17.1	9.0		119	8.40	61	0.020	0.200K	0.020K	0.011
	12 40	0037	15.9	8.0		115	8.00	61	0.020	0.200	0.020K	0.016
75/09/10	11 50	0000	19.1	6.4	156	123	7.75	62	0.030	0.200K	0.020K	0.017
	11 50	0005	19.0	8.4		122	7.80	63	0.020K	0.200K	0.020K	0.008
	11 50	0024	18.7	8.4		121	7.90	64	0.020K	0.200K	0.020K	0.006

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT PENNING PERCENT
75/04/03	14 05	0000	0.021	4.8	
	14 05	0005	0.023		
	14 05	0021	0.021		
75/07/22	12 40	0000	0.015	2.2	
	12 40	0005	0.016		
	12 40	0015	0.021		
	12 40	0037	0.145		
75/09/10	11 50	0000	0.017	2.3	
	11 50	0005	0.022		
	11 50	0024	0.016		

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 76/11/16
NATL EUTROPHICATION SURVEY
EPA-LAS VEGAS

530202
47 53 32.0 119 15 47.0 3
BANKS LAKE
53025 WASHINGTON
130591

11EPALES 2111202
0081 FEET DEPTH CLASS 00

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
75/04/03	14 35	0000	4.0	13.0	114	83	8.00	53	0.020K	0.200	0.020K	0.005
	14 35	0005	4.0	12.4		83	8.00	53	0.020	0.200K	0.020K	0.006
	14 35	0020	4.0	12.2		85	8.10	54	0.020	0.200K	0.020K	0.005
	14 35	0050	4.0	12.4		84	8.00	51	0.020K	0.200K	0.020K	0.014J
	14 35	0076	4.0	12.2		84	8.00	51	0.020K	0.200K	0.020K	0.012J
75/07/22	12 10	0000	19.5	8.8	120	127	8.50	57	0.030	0.200	0.020K	0.005
	12 10	0005	19.0	9.0		125	8.50	59	0.040	0.200K	0.020K	0.014
	12 10	0015	17.9	8.6		125	8.40	56	0.030	0.200	0.020K	0.011
	12 10	0032	14.5	7.6		115	7.80	57	0.040	0.200	0.020K	0.007
	12 10	0045	14.0	7.2		109	7.40	57	0.030	0.300	0.020K	0.010
	12 10	0066	13.7	7.4		113	8.35	57	0.030	0.400	0.020K	0.015
75/09/10	11 25	0000	19.1	8.2	210	122	7.90	62	0.020K	0.200K	0.020K	0.009
	11 25	0005	19.1	8.2		122	7.90	60	0.020K	0.200	0.020K	0.013
	11 25	0015	18.9	8.2		123	7.90	60	0.020K	0.200K	0.020K	0.016
	11 25	0020	18.9	8.4		122	7.90	61	0.020K	0.200K	0.020K	0.016
	11 25	0050	18.8	8.4		122	7.60	62	0.020K	0.200K	0.020K	0.016
	11 25	0079	17.7	6.4		123	7.90	63	0.020	0.200	0.020K	0.015

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/04/03	14 35	0000	0.017	27.2	
	14 35	0005	0.031		
	14 35	0020	0.018		
	14 35	0050	0.017		
	14 35	0076	0.024		
75/07/22	12 10	0000	0.016	3.0	
	12 10	0005	0.017		
	12 10	0015	0.013		
	12 10	0032	0.024		
	12 10	0045	0.029		
	12 10	0066	0.246		
75/09/10	11 25	0000	0.025	2.9	
	11 25	0005	0.027		
	11 25	0015	0.018		
	11 25	0020	0.018		
	11 25	0050	0.020		
	11 25	0079	0.234		

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 76/11/16
NATL EUTROPHICATION SURVEY
EPA-LAS VEGAS

530203
47 51 40.0 119 10 08.0 3
BANKS LAKE
53025 WASHINGTON
130591

11EPALES 2111202
0064 FEET DEPTH CLASS 00

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
75/04/03	11	20 0000	3.7	12.2	102	83	8.10	55	0.020K	0.300	0.020K	0.014J
	11	20 0005	3.8	12.2		83	8.10	56	0.020K	0.200K	0.020K	0.014J
	11	20 0015	3.7	12.0		83	8.10	57	0.020K	0.200K	0.020K	0.004
	11	20 0030	3.7	12.3		84	8.10	59	0.020	0.200	0.020K	0.009
	11	20 0060	3.7	12.2		83	8.10	58	0.020K	0.200	0.020K	0.005
75/07/22	11	40 0000	20.3	8.8	144	127	8.60	68	0.030	0.200K	0.020K	0.004
	11	40 0005	19.7	8.8		127	8.30	68	0.030	0.200K	0.020K	0.004
	11	40 0015	19.5	8.8		125	8.35	54	0.030	0.200K	0.020	0.010J
	11	40 0036	15.3	8.6		110	7.80	53	0.040	0.200	0.020	0.007
	11	40 0062	12.9	4.2		111	7.50	58	0.040	0.400	0.020K	0.023
75/09/10	10	50 0000	19.9	8.2	210	125	8.00	59	0.020K	0.200K	0.020K	0.003
	10	50 0005	19.9	11.0		125	8.00	61	0.020K	0.200K	0.020K	0.004
	10	50 0015	19.3	8.4		122	7.90	61	0.020K	0.200K	0.020K	0.005
	10	50 0026	19.1	8.2		121	7.90	60	0.020K	0.200K	0.020K	0.006
	10	50 0045	18.5	7.4		120	7.70	61	0.020K	0.200K	0.020K	0.011
	10	50 0061	17.3	4.4		118	7.40	62	0.020K	0.200K	0.050	0.028

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/04/03	11	20 0000	0.019	12.6	
	11	20 0005	0.017		
	11	20 0015	0.017		
	11	20 0030	0.021		
	11	20 0060	0.021		
75/07/22	11	40 0000	0.011	2.0	
	11	40 0005	0.013		
	11	40 0015	0.011		
	11	40 0036	0.021		
	11	40 0062	0.051		
75/09/10	10	50 0000	0.015	2.8	
	10	50 0005	0.014		
	10	50 0015	0.015		
	10	50 0026	0.021		
	10	50 0045	0.021		
	10	50 0061	0.038		

K VALUE KNOWN TO BE LESS THAN INDICATED

J VALUE KNOWN TO BE ESTIMATED

STORET RETRIEVAL DATE 76/11/15
NATL EUTROPHICATION SURVEY
EPA-LAS VEGAS

530204
47 51 33.0 119 06 35.0 3
BANKS LAKE
53025 WASHINGTON
130591

11EPALES 2111202
0041 FEET DEPTH CLASS 00

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
75/04/03	10 45	0000	5.1	12.0	54	90	8.30	53	0.020K	0.400	0.020K	0.004
	10 45	0005	5.3	12.0		89	8.30	59	0.020	0.300	0.020	0.014J
	10 45	0015	5.1	12.1		90	8.25	57	0.020	0.300	0.020	0.005
	10 45	0025	5.1	12.1		90	8.25	59	0.020	0.300	0.020K	0.004
	10 45	0038	5.0	12.0		89	8.25	56	0.020	0.300	0.020K	0.007
75/07/22	11 10	0000	21.4	9.0	81	129	8.95	64	0.020	0.200	0.020K	0.010J
	11 10	0005	20.1	9.2		129	8.95	65	0.030	0.200	0.020K	0.012J
	11 10	0020	19.8	8.2		125	8.30	66	0.020	0.200	0.020K	0.010J
	11 10	0026	17.4	6.4		125	7.80	65	0.020	0.200K	0.020K	0.011J
75/09/10	10 25	0000	20.8	9.6	96	136	8.40	70	0.020K	0.200K	0.020K	0.004
	10 25	0005	20.8	10.4		127	8.60	69	0.020K	0.200K	0.020K	0.003
	10 25	0015	19.6	10.0		124	8.50	71	0.020K	0.200	0.020K	0.003
	10 25	0031	18.7	6.2		123	7.90	61	0.020K	0.200	0.020K	0.005

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/04/03	10 45	0000	0.035	12.8	
	10 45	0005	0.039		
	10 45	0015	0.030		
	10 45	0025	0.028		
	10 45	0038	0.035		
75/07/22	11 10	0000	0.017	5.5	
	11 10	0005	0.018		
	11 10	0020	0.022		
	11 10	0026	0.043		
75/09/10	10 25	0000	0.021	11.6	
	10 25	0005	0.021		
	10 25	0015	0.023		
	10 25	0031	0.032		

K VALUE KNOWN TO BE LESS THAN INDICATED

J VALUE KNOWN TO BE ESTIMATED

STORET RETRIEVAL DATE 76/11/16
NATL EUTROPHICATION SURVEY
EPA-LAS VEGAS

530205
47 56 26.0 119 03 32.0 3
BANKS LAKE
53025 WASHINGTON

130591

11EPALES 2111202
0065 FEET DEPTH CLASS 00

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
75/04/03	10 00	0000		12.0	108	87	8.30	60	0.020	0.400	0.030	0.005
	10 00	0005		12.0		87	8.20	57	0.030	0.300	0.020K	0.006
	10 00	0020		12.1		85	8.20	55	0.020	0.300	0.020K	0.002
	10 00	0030		12.0		87	8.15	53	0.030	0.300	0.020K	0.003
	10 00	0060		12.1		85	8.15	51	0.030	0.300	0.020K	0.005
75/07/22	10 45	0000	17.2	9.2	156	115	8.30	57	0.020K	0.200K	0.020K	0.011J
	10 45	0005	15.8	9.2		109	8.20	61	0.030	0.200K	0.020K	0.017J
	10 45	0015	15.3	9.4		109	8.15	58	0.030	0.200K	0.020K	0.011J
	10 45	0035	14.9	9.4		109	8.10	59	0.030	0.200K	0.020K	0.013J
	10 45	0061	14.1	9.2		109	7.90	60	0.040	0.200K	0.020K	0.014J
75/09/10	10 00	0000	20.4	8.6	204	126	8.10	65	0.020K	0.200K	0.020K	0.006
	10 00	0005	20.3	8.6		125	8.05	66	0.020K	0.200K	0.020K	0.007
	10 00	0015	20.2	8.2		124	8.00	66	0.020K	0.200K	0.020K	0.013
	10 00	0024	20.2	8.6		133	7.90	65	0.020K	0.200K	0.020K	0.010
	10 00	0045	20.1	8.2		127	7.80	67	0.020K	0.200K	0.020K	0.010
	10 00	0066	19.4	6.4		126	7.60	70	0.020	0.200K	0.020K	0.017

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/04/03	10 00	0000	0.033	12.9	
	10 00	0005	0.020		
	10 00	0020	0.020		
	10 00	0030	0.022		
	10 00	0060	0.016		
75/07/22	10 45	0000	0.013	2.2	
	10 45	0005	0.017		
	10 45	0015	0.026		
	10 45	0035	0.016		
	10 45	0061	0.019		
75/09/10	10 00	0000	0.017	5.8	
	10 00	0005	0.021		
	10 00	0015	0.021		
	10 00	0024	0.019		
	10 00	0045	0.020		
	10 00	0066	0.032		

J VALUE KNOWN TO BE ESTIMATED

K VALUE KNOWN TO BE LESS THAN INDICATED

APPENDIX D

TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 75/11/15
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

5302A1
47 37 04.0 119 18 00.0 4
MAIN CANAL
53 7.5 COULEE CITY
O/BANKS LAKE 130591
SMPL FROM DRY FALLS DAM .5 MI NW CITY PK
11EPALES 2111204
0000 FEET DEPTH CLASS 00

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
74/09/21	15	00	0.014	0.100	0.007	0.005K	0.017
75/04/06	18	45	0.005	0.100	0.030	0.010	0.010
75/04/27	16	25	0.010	0.150	0.065	0.055	0.059
75/05/20	23	00	0.015	0.250	0.035	0.020	0.040
75/07/02	20	00	0.005	0.050K	0.015	0.010	0.022
75/08/14	21	25	0.005	0.100	0.015	0.005	0.030

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 74/11/14
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

5302B1
47 45 12.0 119 13 10.0 4
PAYNES GULCH
53 7.5 STMBOT RK SW
T/BANKS LAKE 130591
BRDG ON HWY 155 11 MI NE OF COULEE CITY
11EPALES 2111204
0000 FEET DEPTH CLASS 00

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
74/09/21	14 45		2.760	0.450	0.030	0.020	0.025
74/12/07	13 43		5.200	1.000	0.005K	0.010	0.150
75/01/19	13 20		5.600	0.600	0.104	0.104	0.104
75/02/06	15 25		6.900	0.700	0.112	0.152	0.152
75/02/16	15 40		5.500	0.900	0.104	0.128	0.140
75/03/03	17 35		1.680	2.900	0.144	0.264	0.910
75/03/19	16 00			2.600	0.010		0.940
75/04/06	20 00		6.000	0.950	0.040	0.130	0.160
75/04/27	17 00		4.600	0.800	0.060	0.100	0.121
75/05/20	22 45		4.600	0.800	0.065	0.060	0.090
75/07/02	19 15		4.600	0.800	0.055	0.045	0.060

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 76/11/16
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

5302C1
47 52 25.0 119 03 40.0 4
NORTHRUP CREEK
53 7.5 STMBOT RK SE
T/BANKS LAKE 130591
RRDG ON DRT RD 7 MI S OF ELECTRIC CITY
11EPALES 2111204
0000 FEET DEPTH CLASS 00

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
74/09/21	18	15	0.384	0.200	0.015	0.110	0.110
74/12/07	13	05	0.800	0.750	0.035		0.095
75/03/19	17	10	3.850	1.450	0.185	0.330	0.520
75/04/06	20	45	3.670	1.450	0.047	0.210	0.380
75/04/27	20	45	0.780	0.750	0.040	0.060	0.060
75/05/20	22	30	1.150	0.400	0.035	0.095	0.120
75/07/02	19	00	0.650	0.500	0.055	0.125	0.140
75/08/14	20	00	0.390	0.575	0.045	0.120	0.140

STORET RETRIEVAL DATE 76/11/16
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

5302D1
47 19 25.0 119 56 40.0 4
FEEDER CANAL
53 7.5 ELECTRIC CTY
T/BANKS LAKE 130591
SEC RD .2 MI SW OF JCT WITH HWY 174
11EPALES 2111204
0000 FEET DEPTH CLASS 00

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
74/09/21	13 50		0.063	0.100K	0.015	0.005	0.005
74/12/07	11 20		0.050	1.100	0.010	0.005	0.060
75/05/20	22 00		0.090	0.350	0.020	0.025	0.070
75/07/02	18 45		0.005	0.200	0.030	0.010	0.020
75/08/14	20 30		0.015	0.050	0.025	0.015	0.040

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 76/11/16
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

5302E1
47 48 05.0 119 06 20.0 4
RASHO CREEK
53 7.5 STMBOT BK SE
T/BANKS LAKE 130591
AT RD 49NE XING 8 MI N OF HARTLINE
11EPALES 2111204
0000 FEET DEPTH CLASS 00

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
75/03/03	17	00	0.576	3.850	0.200	0.272	1.900
75/03/19	16	55	3.300	5.000	0.060	0.240	1.800
75/04/06	19	30	10.500	2.700	0.185	0.300	0.710
75/04/27	16	00	4.500	1.650	0.030	0.035	0.070

STOPET RETRIEVAL DATE 75/11/16
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

53021F
47 30 39.0 119 05 02.0 4
UNNAMED STREAM
53 7.5 HARTLINE
T/BANKS LAKE 130591
AT RD S NE KING .5 MI S OF JCT W HWY 2
11EPALES 2111204
0000 FEET DEPTH CLASS 00

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
75/03/19	15	30	7.100	1.600	0.270	0.320	0.720
75/04/06	19	05	11.500	1.900	0.095	0.240	0.560
75/04/27	15	35	0.960	0.750	0.035	0.090	0.100

APPENDIX E

PARAMETRIC RANKINGS OF LAKES SAMPLED BY NES IN 1975

STATE OF WASHINGTON

Mean or median values for six of the key parameters evaluated in establishing the trophic conditions of Washington lakes sampled are presented to allow direct comparison of the ranking, by parameter, of each lake relative to the others. Median total phosphorus, median inorganic nitrogen and median dissolved orthophosphorus levels are expressed in mg/l. Chlorophyll a values are expressed in µg/l. To maintain consistent rank order with the preceding parameters, the mean Secchi disc depth, in inches, is subtracted from 500. Similarly, minimum dissolved oxygen values are subtracted from 15 to create table entries.

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
5301	AMERICAN LAKE	0.027	0.105	343.000	4.822	15.000	0.007
5302	BANKS LAKE	0.021	0.040	364.533	7.373	10.800	0.007
5303	CHELAN LAKE	0.005	0.070	111.900	0.905	6.400	0.003
5304	DIAMOND LAKE	0.014	0.060	303.667	14.537	14.200	0.010
5305	GREEN LAKE	0.027	0.050	415.000	2.983	10.600	0.009
5306	KEECHELUS LAKE	0.007	0.040	280.250	1.400	9.200	0.002
5307	MAYFIELD LAKE	0.014	0.100	402.000	4.250	10.600	0.007
5308	MEDICAL LAKE	0.275	0.225	401.714	16.425	15.000	0.166
5309	MOSES LAKE	0.115	0.150	463.600	29.060	14.600	0.038
5310	OZETTE LAKE	0.010	0.110	403.333	1.225	7.200	0.009
5311	SAMMAMISH LAKE	0.015	0.210	374.000	7.290	14.600	0.006
5312	WHATCOM LAKE	0.009	0.320	288.000	3.422	10.800	0.009
5313	LOWER GRANITE RESERVOIR	0.033	0.150	435.500	4.875	7.200	0.022

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
5301	AMERICAN LAKE	29 (3)	50 (6)	67 (8)	50 (6)	4 (0)	58 (7)
5302	BANKS LAKE	42 (5)	100 (12)	58 (7)	25 (3)	46 (5)	71 (8)
5303	CHELAN LAKE	100 (12)	67 (8)	100 (12)	100 (12)	100 (12)	92 (11)
5304	DIAMOND LAKE	62 (7)	75 (9)	75 (9)	17 (2)	33 (4)	25 (3)
5305	GREEN LAKE	29 (3)	83 (10)	17 (2)	75 (9)	62 (7)	46 (5)
5306	KEECHELUS LAKE	92 (11)	92 (11)	92 (11)	83 (10)	75 (9)	100 (12)
5307	MAYFIELD LAKE	62 (7)	58 (7)	33 (4)	58 (7)	62 (7)	71 (8)
5308	MEDICAL LAKE	0 (0)	8 (1)	42 (5)	8 (1)	4 (0)	0 (0)
5309	MOSES LAKE	8 (1)	29 (3)	0 (0)	0 (0)	21 (2)	8 (1)
5310	OZETTE LAKE	75 (9)	42 (5)	25 (3)	92 (11)	87 (10)	33 (4)
5311	SAMMAMISH LAKE	50 (6)	17 (2)	50 (6)	33 (4)	21 (2)	83 (10)
5312	WHATCOM LAKE	83 (10)	0 (0)	83 (10)	67 (8)	46 (5)	46 (5)
5313	LOWER GRANITE RESERVOIR	17 (2)	29 (3)	8 (1)	42 (5)	87 (10)	17 (2)