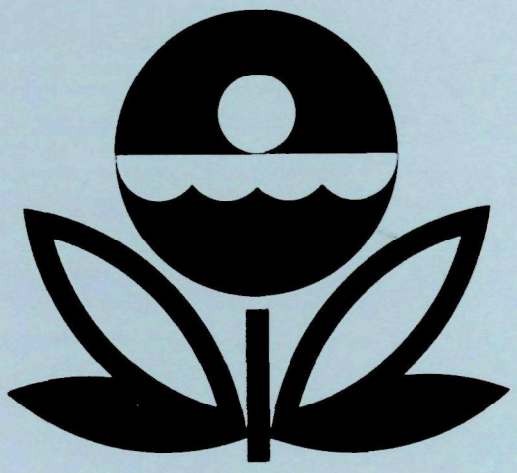
U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES



REPORT

ON

GEORGETOWN LAKE

DEER LODGE AND GRANITE COUNTIES

MONTANA

EPA REGION VIII

WORKING PAPER No. 793

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

REPORT
ON
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WITH THE COOPERATION OF THE

MONTANA DEPARTMENT OF HEALTH & ENVIRONMENTAL SCIENCES

AND THE

MONTANA NATIONAL GUARD

MAY, 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 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.

ACKNOWLEDGEMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U.S. Environmental Protection Agency) express sincere appreciation to the Montana Department of Health and Environmental Sciences for professional involvement, to the Montana National Guard for conducting the tributary sampling phase of the Survey, and to those Montana wastewater treatment plant operators who voluntarily provided effluent samples.

The staff of the Water Quality Bureau 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.

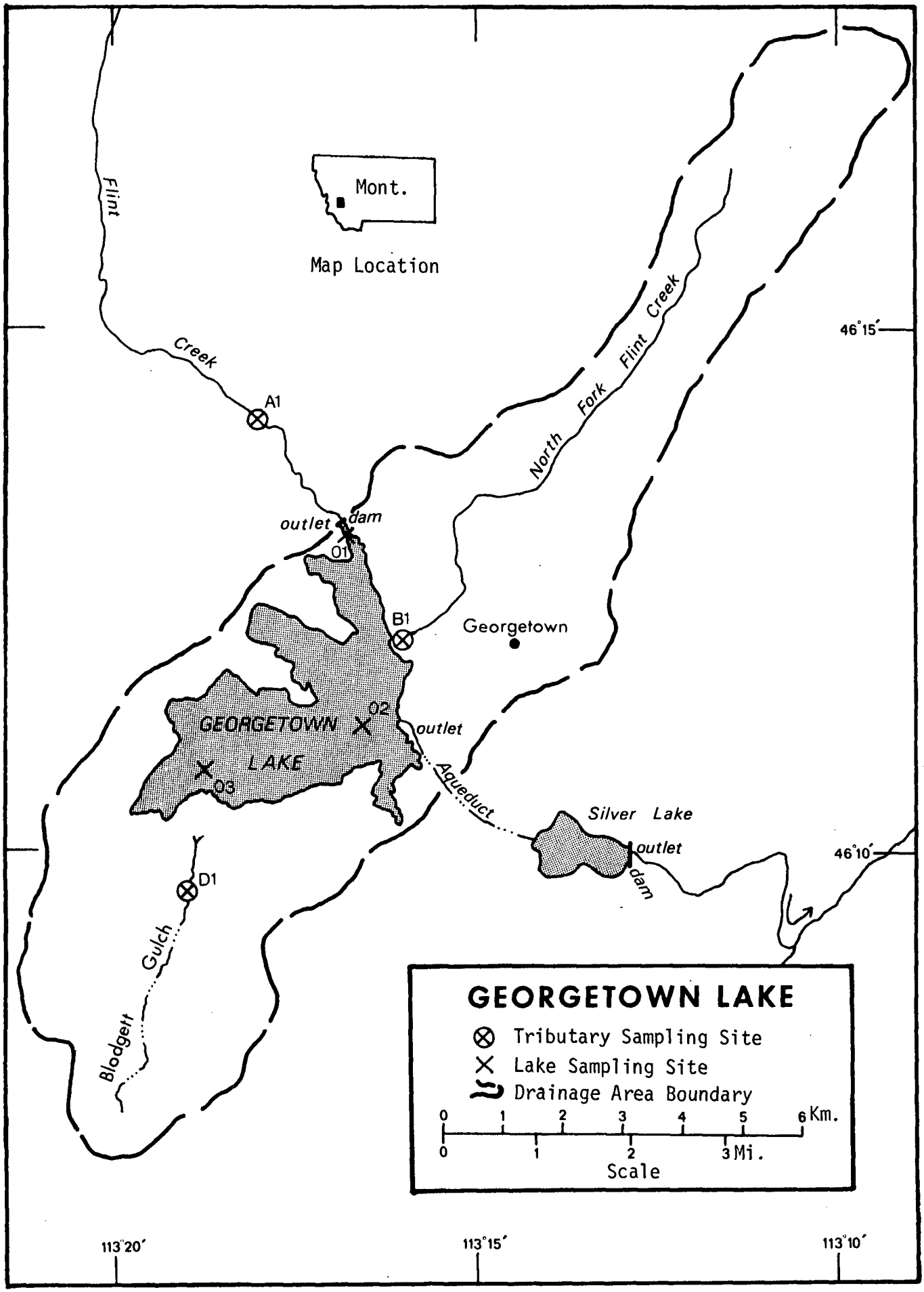
Major General John J. Womack, the Adjutant General of Montana, and Project Officer Major William Yeager, who directed the volunteer efforts of the Montana National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES AND RESERVOIRS

STATE OF MONTANA

LAKE NAME	COUNTY
Canyon Ferry	Broadwater, Lewis and Clark
Clark Canyon	Beaverhead
Flathead	Flathead, Lake
Georgetown	Deer Lodge, Granite
Hebgen	Gallatin
Koocanusa	Lincoln, MT; British Columbia, Can.
Mary Ronan	Lake
McDonald	Flathead
Nelson	Phillips
Seeley	Missoula
Swan	Lake
Tally	Flathead
Tiber	Liberty, Toole
Tongue River	Big Horn
Whitefish	Flathead
Yellowtail	Carbon, Bighorn, MT; Bighorn, WY


Mont.
Map Location
Flint
Creek
A1
North Fork Flint Creek
46°15′
outlet
dam
01
B1
Georgetown
GEORGETOWN LAKE
02
03
outlet
Aqueduct
Silver Lake
outlet
dam
46°10′
D1
Gulch
Blodgett
GEORGETOWN LAKE
Tributary Sampling Site
Lake Sampling Site
Drainage Area Boundary
0 1 2 3 4 5 6 Km.
0 1 2 3 Mi.
Scale
113°20′
113°15′
113°10′

GEORGETOWN LAKE

STORET NO. 3004

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Georgetown Lake is eutrophic. It ranked ninth in overall trophic quality when the 15 Montana lakes and reservoirs sampled in 1975 were compared using a combination of six parameters*. Eight of the water bodies had less and one had the same median total phosphorus, ten had less median dissolved orthophosphorus, none had less but four had the same median inorganic nitrogen, 12 had less mean chlorophyll a, and seven had greater mean Secchi disc transparency. Some depression of dissolved oxygen with depth occurred at stations 1 and 3 in July.

The Montana Department of Fish and Game reports that extensive growths of aquatic vegetation occur in the lake (Whitney, 1972). Fish kills occasionally occur due to oxygen depletion during periods of ice cover (Ketelle and Uttormark, 1971).

B. Rate-Limiting Nutrient:

The algal assay results indicate that Georgetown Lake was nitrogen limited at the time the sample was collected (07/29/75).

The lake data indicate nitrogen limitation at all three stations in July and at two of the three stations in September.

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* See Appendix A.

C. Nutrient Controllability:

1. Point sources--No known municipal or industrial wastewater treatment plants impacted Georgetown Lake during the sampling year.

Septic tanks serving lakeshore dwellings, camps, and a park are estimated to have added 7% of the measurable phosphorus load to the lake, but a shoreline survey would be necessary to determine the actual contributions of those sources. However, in terms of fishing pressure per hectare, Georgetown Lake is the most heavily used of all Montana lakes (Whitney, op. cit.), and septic tank loads may be of greater significance than is estimated.

During the sampling year, the phosphorus loading to the lake from measurable sources amounted to only 18% of that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 11). However, the trophic condition of the lake indicates the actual loading probably is at or near a eutrophic loading (i.e., about 4,250 kg/yr). If so, the load contributed by the submarine springs must be substantial.

2. Non-point sources--It is estimated that non-point sources contributed 93% of the measurable phosphorus load during the sampling year. The North Fork of Flint Creek contributed about 12%, and the ungaged minor tributaries and immediate drainage contributed an estimated 55.8%. However, as noted above, the submarine springs probably are the most significant non-point source.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Morphometry††:

1. Surface area: 11.20 kilometers^2.
2. Mean depth: 3.4 meters.
3. Maximum depth: 11.6 meters.
4. Volume: 38.288 x 10^6 m^3.
5. Mean hydraulic retention time: 342 days.

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

1. Tributaries -

Name	Drainage area (km^2)†††	Mean flow (m^3/sec)†††
North Fork Flint Creek	37.3	0.144
Submarine springs*	-	0.493
Minor tributaries & immediate drainage -	88.8	0.660
Totals	126.1	1.297

2. Outlets -

Anaconda Aqueduct	-	0.527
Flint Creek	137.3	0.770
Totals	137.3**	1.297

C. Precipitation***:

1. Year of sampling: 52.0 centimeters.
2. Mean annual: 38.3 centimeters.

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† Table of metric conversions--Appendix B.
†† Horpestad, 1975.
††† For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
* Submarine spring flow accounts for difference between surface inflow and outflow (Knight et al., 1976).
** Includes area of lake.
*** See Working Paper No. 175.

III. WATER QUALITY SUMMARY

Georgetown Lake was sampled two 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 a number of depths at three stations on the lake (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 in July, 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 9.4 meters at station 1, 5.5 meters at station 2, and 4.6 meters at station 3.

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

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR GEORGETOWN RESERVOIR
STORET CODE 3004

PARAMETER	1ST SAMPLING (7/29/75) 3 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (9/ 4/75) 3 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING 0 SITES RANGE	MEAN	MEDIAN
TEMP (C)	14.2 - 16.9	16.1	16.5	13.3 - 14.0	13.8	13.8	****** -**********		
DISS OXY (MG/L)	4.8 - 9.4	8.0	8.4	6.6 - 9.6	8.7	8.9	****** -**********		
CNDCTVY (MCROMO)	162. - 186.	169.	167.	136. - 147.	144.	145.	****** -**********		
PH (STAND UNITS)	8.6 - 9.1	8.9	8.9	8.0 - 8.8	8.5	8.6	****** -**********		
TOT ALK (MG/L)	100. - 109.	104.	103.	91. - 101.	97.	98.	****** -**********		
TOT P (MG/L)	0.018 - 0.031	0.023	0.022	0.020 - 0.027	0.023	0.022	****** -**********		
ORTHO P (MG/L)	0.011 - 0.015	0.012	0.012	0.002 - 0.007	0.003	0.002	****** -**********		
NO2+NO3 (MG/L)	0.020 - 0.020	0.020	0.020	0.020 - 0.020	0.020	0.020	****** -**********		
AMMONIA (MG/L)	0.020 - 0.030	0.022	0.020	0.020 - 0.020	0.020	0.020	****** -**********		
KJEL N (MG/L)	0.300 - 0.600	0.373	0.400	0.300 - 0.400	0.370	0.400	****** -**********		
INORG N (MG/L)	0.040 - 0.050	0.042	0.040	0.040 - 0.040	0.040	0.040	****** -**********		
TOTAL N (MG/L)	0.320 - 0.620	0.393	0.420	0.320 - 0.420	0.390	0.420	****** -**********		
CHLRPYL A (UG/L)	3.6 - 10.4	6.1	4.2	4.6 - 12.3	7.9	6.8	****** -**********		
SECCHI (METERS)	3.4 - 4.8	4.1	4.3	2.0 - 3.0	2.6	2.7	****** -**********		

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
07/29/75	1. Fragilaria sp.	732
	2. Oocystis sp.	628
	3. Cryptomonas sp.	384
	4. Flagellates	384
	5. Tetraedron sp.	314
	Other genera	174
	Total	2,616
09/04/75	1. Chroomonas sp.	641
	2. Fragilaria sp.	529
	3. Oscillatoria sp.	84
	4. Anabaena sp.	56
	5. Microcystis sp.	56
	Other genera	110
	Total	1,476

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
07/29/75	1	4.2
	2	3.6
	3	10.4
09/04/75	1	6.8
	2	4.6
	3	12.3

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	0.015	0.035	3.6
0.05 P	0.065	0.035	3.7
0.05 P + 1.0 N	0.065	1.035	23.1
1.0 N	0.015	1.035	7.8

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates the potential primary productivity of Georgetown Lake was moderately high at the time the sample was collected (07/29/75). Also, the lack of yield increase with the addition of phosphorus until nitrogen was also added indicates nitrogen limitation at that time. Note that the addition of nitrogen alone resulted in a yield significantly greater than that of the control.

The lake data indicate nitrogen limitation at all stations in July (the mean inorganic nitrogen/orthophosphorus ratios were 4/1 or less) and at stations 1 and 2 in September (the mean N/P ratios were 10/1 and 13/1, respectively); however, phosphorus limitation is indicated at station 3 in September (the mean N/P ratio was 20/1).

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Montana National Guard collected monthly near-surface grab samples when possible from each of the tributary sites indicated on the map (page v), except for the high runoff month of June when two samples were collected. Sampling was begun in October, 1974, and was completed in September, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Montana District Office of the U.S. Geological Survey for the outlet and the North Fork Flint Creek.

In this report, nutrient loads for sampled tributaries were calculated using mean annual concentrations and mean annual flows. Nutrient loads for the Anaconda Aqueduct were calculated using the mean concentrations in the Flint Creek outlet (station A-1) and the monthly flows provided by the Anaconda Company.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the mean concentrations in the North Fork Flint Creek at station B-1 and the mean annual ZZ flow.

Nutrient loads were not estimated for the extensive submarine spring flows known to occur in the lake (Shields, 1976).

A. Waste Sources:

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

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
North Fork Flint Creek	95	12.2
Submarine springs	?	-
b. Minor tributaries & immediate drainage (non-point load) -	435	55.8
c. Known municipal STP's - None	-	-
d. Septic tanks* -	55	7.0
e. Known industrial - None	-	-
f. Direct precipitation** -	195	25.0
Total	780	100.0

2. Outputs -

Lake outlet - Aqueduct	500	
Flint Creek	730	
Total	1,230	

3. Net annual P accumulation - unknown; unmeasured load in spring flow.

* Estimate based on 143 lakeshore dwellings, eight camps, and one park; 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) -		
North Fork Flint Creek	3,920	10.8
Submarine springs	?	-
b. Minor tributaries & immediate drainage (non-point load) -	17,960	49.8
c. Known municipal STP's - None	-	-
d. Septic tanks* -	2,125	5.9
e. Known industrial - None	-	-
f. Direct precipitation** -	12,090	33.5
Total	36,095	100.0

2. Outputs -

Lake outlet - Aqueduct	15,255
Flint Creek	22,290
Total	37,545

3. Net annual N accumulation - unknown; unmeasured load in spring flow.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
North Fork Flint Creek	3	105

E. Mean Nutrient Concentrations in Ungaged Stream:

Tributary	Mean Total P Conc. (mg/l)	Mean Total N Conc. (mg/l)
Blodgett Gulch	0.097	0.823

* Estimate based on 143 lakeshore dwellings, eight camps, and one park; see Working Paper No. 175.
** See Working Paper No. 175.

F. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading 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	0.07*	?	3.2*	?

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Georgetown Lake:

"Dangerous" (eutrophic loading)	0.38
"Permissible" (oligotrophic loading)	0.19

* Measurable loading.

V. LITERATURE REVIEWED

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Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

Whitney, Arthur N., 1972. Personal communication (use and condition of Georgetown Lake). MT Dept. of Fish & Game, Helena.

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
3001	CANYON FERRY RESERVOIR	0.047	0.170	442.800	5.816	14.400	0.029
3002	CLARK CANYON RESERVOIR	0.049	0.160	398.750	2.375	12.000	0.027
3003	FLATHEAD LAKE	0.008	0.050	267.833	1.273	9.000	0.004
3004	GEORGETOWN RESERVOIR	0.022	0.040	367.333	6.983	10.200	0.011
3005	HEBGEN RESERVOIR	0.022	0.040	367.700	4.083	13.800	0.020
3006	KOOCANUSA RESERVOIR	0.045	0.100	337.643	2.669	10.400	0.044
3007	MARY RONAN LAKE	0.020	0.040	371.091	4.673	14.200	0.006
3008	MC DONALD LAKE	0.006	0.180	190.667	0.467	6.400	0.002
3009	NELSON RESERVOIR	0.029	0.075	456.750	7.233	11.400	0.007
3010	SEELEY LAKE	0.015	0.040	362.857	2.171	13.200	0.010
3011	SWAN LAKE	0.010	0.050	282.750	3.289	9.600	0.004
3012	TALLY LAKE	0.011	0.050	339.167	2.083	9.200	0.004
3013	TIBER RESERVOIR	0.018	0.180	448.555	2.806	9.600	0.004
3014	TONGUE RIVER RESERVOIR	0.051	0.050	474.111	16.878	13.600	0.008
3016	WHITEFISH LAKE (LOWER)	0.008	0.040	290.000	1.400	7.000	0.003

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
3001	CANYON FERRY RESERVOIR	14 (2)	14 (2)	21 (3)	21 (3)	0 (0)	7 (1)	77
3002	CLARK CANYON RESERVOIR	7 (1)	21 (3)	29 (4)	64 (9)	36 (5)	14 (2)	171
3003	FLATHEAD LAKE	89 (12)	61 (8)	93 (13)	93 (13)	86 (12)	75 (9)	497
3004	GEORGETOWN RESERVOIR	39 (5)	79 (10)	50 (7)	14 (2)	57 (8)	29 (4)	268
3005	HEBGEN RESERVOIR	39 (5)	79 (10)	43 (6)	36 (5)	14 (2)	21 (3)	232
3006	KOOCANUSA RESERVOIR	21 (3)	29 (4)	71 (10)	57 (8)	50 (7)	0 (0)	226
3007	MARY RONAN LAKE	50 (7)	96 (13)	36 (5)	29 (4)	7 (1)	57 (8)	275
3008	MC DONALD LAKE	100 (14)	4 (0)	100 (14)	100 (14)	100 (14)	100 (14)	504
3009	NELSON RESERVOIR	29 (4)	36 (5)	7 (1)	7 (1)	43 (6)	50 (7)	172
3010	SEELEY LAKE	64 (9)	96 (13)	57 (8)	71 (10)	29 (4)	36 (5)	353
3011	SWAN LAKE	79 (11)	46 (6)	86 (12)	43 (6)	68 (9)	75 (9)	397
3012	TALLY LAKE	71 (10)	61 (8)	64 (9)	79 (11)	79 (11)	75 (9)	429
3013	TIBER RESERVOIR	57 (8)	4 (0)	14 (2)	50 (7)	68 (9)	75 (9)	268
3014	TONGUE RIVER RESERVOIR	0 (0)	46 (6)	0 (0)	0 (0)	21 (3)	43 (6)	110
3016	WHITEFISH LAKE (LOWER)	89 (12)	79 (10)	79 (11)	86 (12)	93 (13)	93 (13)	519

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	3016	WHITEFISH LAKE (LOWER)	519
2	3008	MC DONALD LAKE	504
3	3003	FLATHEAD LAKE	497
4	3012	TALLY LAKE	429
5	3011	SWAN LAKE	397
6	3010	SEELEY LAKE	353
7	3007	MARY RONAN LAKE	275
8	3013	TIBER RESERVOIR	268
9	3004	GEORGETOWN RESERVOIR	268
10	3005	HEBGEN RESERVOIR	232
11	3006	KOOCANUSA RESERVOIR	228
12	3009	NELSON RESERVOIR	172
13	3002	CLARK CANYON RESERVOIR	171
14	3014	TONGUE RIVER RESERVOIR	110
15	3001	CANYON FERRY RESERVOIR	77

APPENDIX B

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 C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR MONTANA 12/0376

LAKE CODE 3004 GEORGETOWN LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 137.3

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
3004A1	137.3	0.44	0.47	0.45	0.56	0.79	1.58	1.38	0.95	0.88	0.66	0.58	0.48	0.77
300481	37.3	0.014	0.014	0.014	0.028	0.142	0.566	0.425	0.283	0.142	0.057	0.028	0.014	0.144
3004C1	0.0	1.274	1.274	1.274	1.274	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.274	0.527
3004ZZ	88.1	0.24	0.24	0.24	0.42	1.70	2.83	0.85	0.28	0.25	0.31	0.31	0.28	0.66

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 137.3
SUM OF SUB-DRAINAGE AREAS = 125.4
TOTAL FLOW IN = 16.07
TOTAL FLOW OUT = 9.23

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
3004A1	10	74	0.340	5	0.340				
	11	74	0.119	2	0.340				
	12	74	0.076	7	0.085				
	1	75	0.082	4	0.085				
	2	75	0.096	1	0.085				
	3	75	0.116	1	0.113				
	4	75	0.122	5	0.113				
	5	75	0.343	4	0.125				
	6	75	1.662	1	1.274	7	1.274		
	7	75	3.710						
	8	75	2.223						
	9	75	1.048	7	0.934				
300481	10	74	0.028	5	0.034				
	11	74	0.023	2	0.023				
	12	74	0.014	7	0.014				
	1	75	0.011	4	0.014				
	2	75	0.011	1	0.008	21	0.0		
	3	75	0.008	1	0.006				
	4	75	0.014	5	0.008				
	5	75	0.048	4	0.014				
	6	75	0.821	1	0.142	7	0.283		
	7	75	1.671	29	0.850				
	8	75	0.340	3	0.566				
	9	75	0.198	7	0.227				

LAKE CODE 3004 GEORGETOWN LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
3004C1	10	74	0.0						
	11	74	0.0	2	0.0				
	12	74	0.0	7	0.425				
	1	75	0.0	4	0.0				
	2	75	0.0	1	0.0				
	3	75	0.0	1	0.425				
	4	75	0.0	5	0.425				
	5	75	0.0	4	0.425				
	6	75	0.0	1	0.425	7	0.425		
	7	75	0.0	29	0.425				
	8	75	0.0	3	0.425				
	9	75	0.0	7	0.425				

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/08/05

300401
46 12 45.0 113 15 50.0 3
GEORGETOWN RESERVOIR
30023 MONTANA

11EPALES 2111202
0034 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
75/07/29	10 20	0000	16.9	9.0	132	162	9.10	102	0.020	0.300	0.020K	0.012
	10 20	0005	16.9	9.0		167	8.90	103	0.020	0.300	0.020K	0.011
	10 20	0015	16.2	8.0		162	8.90	105	0.020	0.600	0.020K	0.011
	10 20	0030	14.2	5.6		162	8.60	100	0.020	0.300	0.020K	0.011
75/09/04	09 20	0000	14.0	6.6	108	145	8.00	99	0.020K	0.400	0.020K	0.004
	09 20	0005	14.0	8.2		143	8.30	91	0.020K	0.400	0.020K	0.003
	09 20	0023	13.9	8.6		143	8.45	92	0.020K	0.300	0.020K	0.002K
	09 20	0031	13.9	8.8		145	8.50	97	0.020K	0.400	0.020K	0.007

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/07/29	10 20	0000	0.031	4.2	
	10 20	0005	0.023		
	10 20	0015	0.022		
	10 20	0030	0.021		
75/09/04	09 20	0000	0.021	6.8	
	09 20	0005	0.020		
	09 20	0023	0.021		
	09 20	0031	0.022		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/05

300402
46 11 00.0 113 15 35.0 3
GEORGETOWN RESERVOIR
30023 MONTANA

11EPALES 2111202
0022 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
75/07/29	10 45	0000	16.7	9.4	188	172	8.90	104	0.030	0.400	0.020K	0.015
	10 45	0005	16.8	8.4		174	8.90	105	0.020	0.300	0.020K	0.015
	10 45	0010	16.2	8.2		179	8.90	105	0.020K	0.400	0.020K	0.012
	10 45	0018	14.8	7.2		186	8.60	109	0.020	0.400	0.020K	0.013
75/09/04	09 45	0000	13.9	8.8	120	147	8.60	100	0.020K	0.300	0.020K	0.004
	09 45	0005	13.8	9.2		147	8.60	99	0.020K	0.300	0.020K	0.002
	09 45	0016	13.8	9.6		147	8.65	101	0.020K	0.400	0.020K	0.002

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/07/29	10 45	0000	0.029	3.6	
	10 45	0005	0.019		
	10 45	0010	0.021		
	10 45	0018	0.022		
75/09/04	09 45	0000	0.021	4.6	
	09 45	0005	0.022		
	09 45	0016	0.025		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/05

300403
46 10 35.0 113 18 55.0 3
GEORGETOWN RESERVOIR
30023 MONTANA

11EPALES 2111202
0019 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
75/07/29	11 10	0000	16.5	9.0	168	166	8.90	102	0.020	0.400	0.020K	0.013
	11 10	0005	16.5	9.4		168	9.10	102	0.020	0.400	0.020K	0.011
	11 10	0015	15.5	4.8		165	9.00	102	0.030	0.300	0.020K	0.011
75/09/04	10 10	0000	13.6	9.2	80	140	8.75	96	0.020K	0.400	0.020K	0.002K
	10 10	0005	13.5	9.0			8.80	99	0.020K	0.400	0.020K	0.002
	10 10	0015	13.3	9.4		136	8.80	96	0.020K	0.400	0.020K	0.002

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/07/29	11 10	0000	0.024	10.4	
	11 10	0005	0.018		
	11 10	0015	0.019		
75/09/04	10 10	0000	0.024	12.3	
	10 10	0005	0.027		
	10 10	0015	0.025		

K VALUE KNOWN TO BE
LESS THAN INDICATED

APPENDIX E

TRIBUTARY DATA

STORET RETRIEVAL DATE 76/08/05

300441
46 12 54.0 113 16 47.0 4
FLINT CREEK
30 7.5 GEORGETWN LK
0/GEORGETOWN LAKE 130291
BELOW FLINT CREEK DAM
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
74/10/05	10 45		0.104	0.600	0.010	0.005	0.015
74/11/02	09 55		0.024	1.000	0.025	0.005	0.010K
74/12/07	11 30		0.048	1.100	0.020	0.005	0.010K
75/01/04	12 45		0.096	1.500	0.040	0.010	0.010
75/02/01	12 45		0.072	0.800	0.064	0.008	0.020
75/03/01	11 00		0.072	0.900	0.120	0.008	0.040
75/04/05	12 50		0.095	0.900	0.130	0.025	0.050
75/05/04	13 00		0.230	0.400	0.130	0.030	0.050
75/06/01	05 00		0.100	2.000	0.180	0.030	0.070
75/06/07	13 30		0.065	0.800	0.115	0.020	0.050
75/07/29	13 00		0.045	0.300	0.010	0.010	0.030
75/08/03	14 00		0.045	0.300	0.020	0.005	0.030
75/09/07	11 20		0.085	0.250	0.005K	0.005K	0.010

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/05

300481
46 11 49.0 113 16 00.0 4
NFORK FLINT CREEK
30 7.5 GEORGETWN LK
T/GEORGETOWN LAKE 130291
BRDG ON US RT 10A 1.4 M SE FLINT CRK DAM
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
74/10/05	11 20		0.024	1.775	0.025	0.005K	0.005
74/11/02	10 15		0.008	0.900	0.020	0.005K	0.010K
74/12/07	11 55		0.016	0.100K	0.005	0.005K	0.010K
75/01/04	13 00		0.016	1.000	0.020	0.005	0.030
75/02/01	13 10		0.024	0.600	0.016	0.008K	0.010K
75/03/01	11 15		0.024	0.680	0.024	0.008K	0.012
75/04/05	13 20		0.025	1.200	0.025	0.005	0.070
75/05/04	13 30		0.040	0.300	0.015	0.005K	0.010K
75/06/01	05 20		0.050	2.100	0.090	0.005	
75/06/07	13 45		0.015	0.750	0.025	0.005	0.040
75/07/29			0.005	0.250	0.010	0.005K	0.020
75/08/03	14 30		0.005	0.650	0.015	0.005K	0.020
75/09/07	10 45		0.015	0.650	0.010	0.005K	0.010K

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/05

3004D1
46 09 20.0 113 18 50.0 4
BLODGETT GULCH
30 7.5 GEORGETWN LK
T/GEORGETOWN LAKE 130291
BRDG ON UNPVD RD 2.2 MI SW OF DENTONS PT
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
74/10/02	10	40	0.008	0.900	0.010	0.010	0.200
74/10/05	12	40	0.028	0.500	0.020	0.010	0.125
75/06/01	18	10	0.050	2.700	0.075	0.005	0.220
75/06/07	14	00	0.140		0.065	0.035	
75/07/29	15	15	0.005	0.200	0.025	0.005K	0.010
75/08/03	16	00	0.005	0.425	0.015	0.005K	0.010
75/09/07	10	25	0.020	0.100K	0.015	0.010	0.020

K VALUE KNOWN TO BE
LESS THAN INDICATED