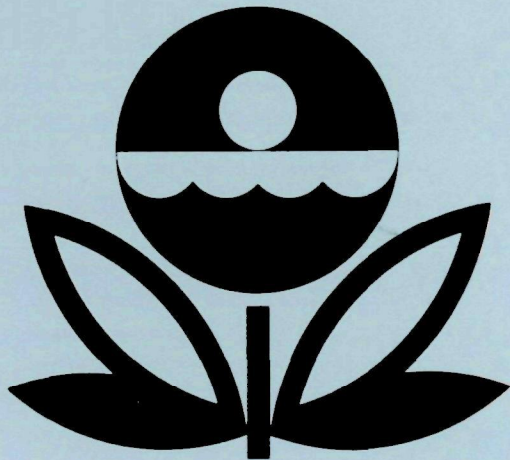


**U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY
WORKING PAPER SERIES**



REPORT
ON
WHITEFISH LAKE
FLATHEAD COUNTY
MONTANA
EPA REGION VIII
WORKING PAPER No. 804

**CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON
and
ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA**

REPORT
ON
WHITEFISH LAKE
FLATHEAD COUNTY
MONTANA
EPA REGION VIII
WORKING PAPER No. 804

WITH THE COOPERATION OF THE
MONTANA DEPARTMENT OF HEALTH & ENVIRONMENTAL SCIENCES
AND THE
MONTANA NATIONAL GUARD
MAY, 1977

CONTENTS

	<u>Page</u>
<u>Foreword</u>	ii
List of Montana Lakes and Reservoirs	iv
Lake and Drainage Area Map	v
 <u>Sections</u>	
I. Conclusions	1
II. Lake and Drainage Basin Characteristics	3
III. Lake Water Quality Summary	4
IV. Nutrient Loadings	8
V. Literature Reviewed	12
VI. Appendices	13

F O R E W O R D

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to 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 [§14(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

<u>LAKE NAME</u>	<u>COUNTY</u>
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

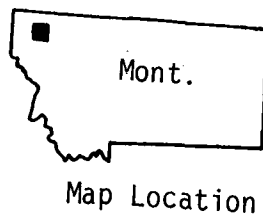
WHITEFISH LAKE

- ⊗ Tributary Sampling Site
- × Lake Sampling Site
- Drainage Area Boundary

0 5 10 Km.
0 5 Mi.
Scale

48°40'

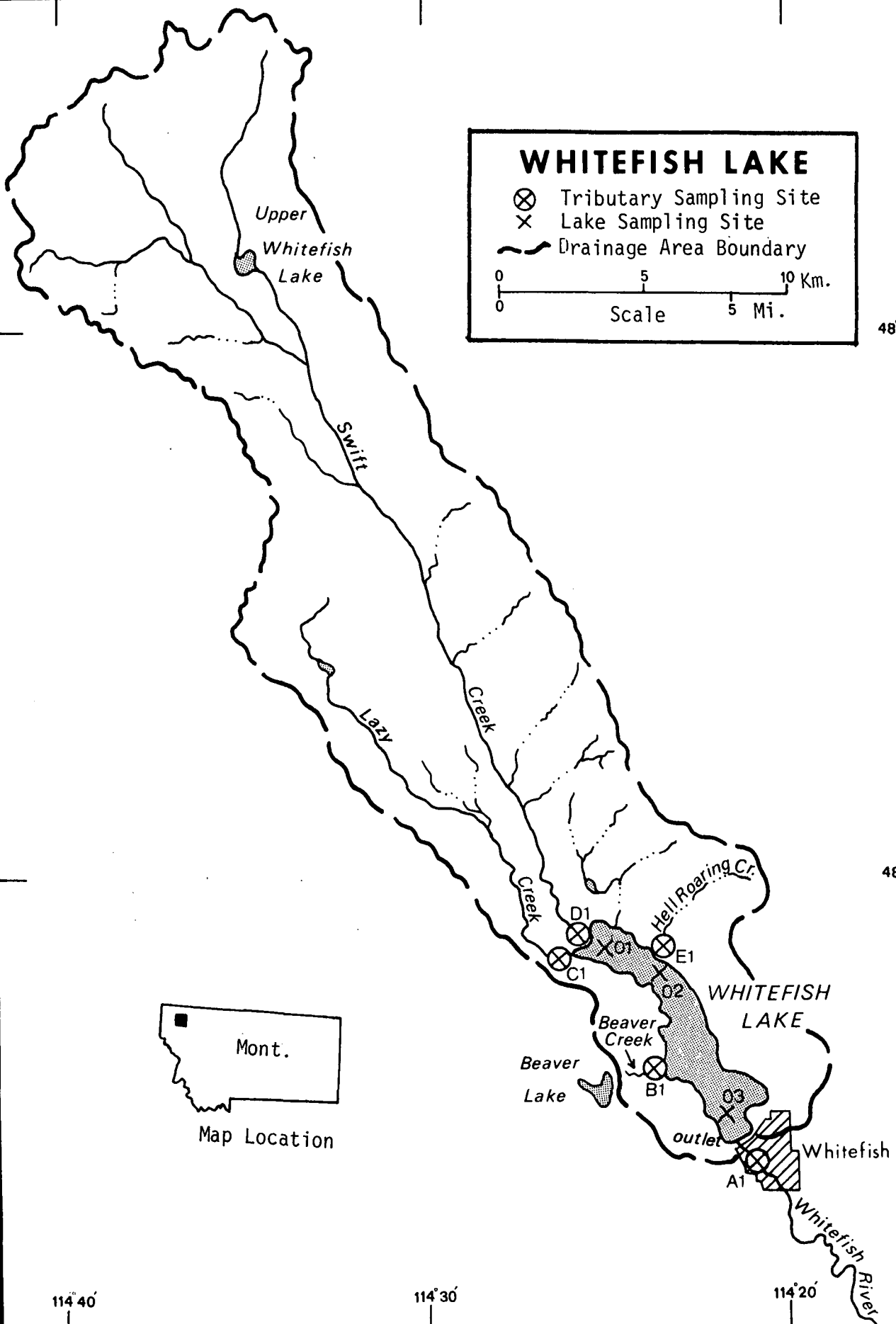
48°30'



114°40'

114°30'

114°20'



WHITEFISH LAKE

STORET NO. 3016

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Whitefish Lake is oligotrophic. It ranked first in overall trophic quality when the 15 Montana lakes and reservoirs sampled in 1975 were compared using a combination of six parameters*. One of the water bodies had less and one had the same median total phosphorus, one had less median dissolved orthophosphorus, none of the others had less but four had the same median inorganic nitrogen, two had less mean chlorophyll a, and three had greater mean Secchi disc transparency. No depression of dissolved oxygen occurred at depths as great as 51.8 meters.

Survey limnologists observed a few emergent aquatic plants near the Swift Creek inlet and the outlet in June.

B. Rate-Limiting Nutrient:

Due to significant nutrient changes in the samples, the algal assay results are not considered representative of conditions in the lake at the times of sampling.

The lake data indicate nitrogen limitation in June and phosphorus limitation in July and September.

C. Nutrient Controllability:

1. Point sources--No known wastewater treatment plants impacted Whitefish Lake during the sampling year. Lakeshore septic tanks were estimated to have contributed 0.9% of the total phosphorus load, but a shoreline survey would have to be done to

* See Appendix A.

determine the significance of those sources.

The present phosphorus loading of $0.43 \text{ g/m}^2/\text{yr}$ is less than that proposed by Vollenweider (Vollenweider & Dillon, 1974) as a eutrophic loading (see page 11). It is likely that any significant increase in the phosphorus loading would result in a noticeable degradation of water quality, and every effort should be made to limit phosphorus inputs to the lake.

2. Non-point sources--It is estimated that non-point sources contributed nearly all of the total phosphorus load to the lake during the sampling year. Swift Creek contributed 70.6%, the minor tributaries and immediate drainage contributed an estimated 18.1%, and Lazy Creek contributed about 6% of the total load.

The phosphorus export rate of unimpacted Swift Creek was a relatively high $21 \text{ kg/km}^2/\text{yr}$ compared to the mean export rate of 37 Montana tributaries gaged and sampled during the Survey ($8 \text{ kg/km}^2/\text{yr}$). The cause of the higher rate is not known; however, unimpacted McDonald Creek* also had a rather high export rate ($26 \text{ kg/km}^2/\text{yr}$), and the entire drainage of that stream is within Glacier National Park.

* See Working Paper No. 797.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS[†]A. Morphometry^{††}:

1. Surface area: 13.56 kilometers².
2. Mean depth: 32.9 meters.
3. Maximum depth: 62.5 meters.
4. Volume: 446.124 x 10⁶ m³.
5. Mean hydraulic retention time: 2.5 years.

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

1. Tributaries -

<u>Name</u>	<u>Drainage area (km²)*</u>	<u>Mean flow (m³/sec)*</u>
Lazy Creek	43.5	0.79
Swift Creek	198.1	3.48
Minor tributaries & immediate drainage -	<u>70.6</u>	<u>1.30</u>
Totals	312.2	5.57

2. Outlet -

Whitefish River	325.8**	5.57**
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C. Precipitation^{***}:

1. Year of sampling: 73.6 centimeters.
2. Mean annual: 75.3 centimeters.

† Table of metric conversions--Appendix B.

†† Horpestad, 1975.

* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976.

** Includes area of lake; outflow adjusted to equal sum of inflows.

*** See Working Paper No. 175.

III. WATER QUALITY SUMMARY

Whitefish 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 a number of depths at three stations on the lake (see map, page v). During each visit, a single depth-integrated (4.6 m to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first and last visits, 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 39.6 meters at station 1, 50.6 meters at station 2, and 51.8 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 WHITEFISH LAKE (LOWER)
STORET CODE 3016

PARAMETER	1ST SAMPLING (6/ 2/75)				2ND SAMPLING (7/28/75)				3RD SAMPLING (9/ 5/75)			
	3 SITES				3 SITES				3 SITES			
	RANGE	MEAN	MEDIAN		RANGE	MEAN	MEDIAN		RANGE	MEAN	MEDIAN	
TEMP (C)	3.1 - 10.7	6.6	6.3		2.0 - 19.0	10.1	8.1		4.9 - 17.4	12.0	14.6	
DISS OXY (MG/L)	9.2 - 10.8	10.3	10.2		8.0 - 9.8	9.1	9.2		8.4 - 10.6	9.3	9.1	
CNDCTVY (MCROMO)	97. - 118.	106.	105.		91. - 146.	116.	104.		103. - 137.	120.	126.	
PH (STAND UNITS)	7.7 - 8.3	8.0	8.0		7.6 - 8.4	8.1	7.9		7.6 - 8.3	8.1	8.2	
TOT ALK (MG/L)	83. - 103.	92.	89.		82. - 88.	85.	86.		81. - 91.	86.	86.	
TOT P (MG/L)	0.007 - 0.061	0.018	0.010		0.004 - 0.129	0.019	0.006		0.006 - 0.039	0.010	0.007	
ORTHO P (MG/L)	0.010 - 0.016	0.012	0.011		0.002 - 0.006	0.003	0.003		0.002 - 0.006	0.002	0.002	
NO2+NO3 (MG/L)	0.020 - 0.020	0.020	0.020		0.020 - 0.040	0.022	0.020		0.020 - 0.040	0.021	0.020	
AMMONIA (MG/L)	0.020 - 0.030	0.022	0.020		0.020 - 0.030	0.021	0.020		0.020 - 0.020	0.020	0.020	
KJEL N (MG/L)	0.200 - 0.500	0.265	0.200		0.200 - 0.200	0.200	0.200		0.200 - 0.300	0.206	0.200	
INORG N (MG/L)	0.040 - 0.050	0.042	0.040		0.040 - 0.070	0.043	0.040		0.040 - 0.060	0.041	0.040	
TOTAL N (MG/L)	0.220 - 0.520	0.285	0.220		0.220 - 0.240	0.222	0.220		0.220 - 0.320	0.227	0.220	
CHLRPYL A (UG/L)	1.1 - 1.9	1.6	1.9		0.9 - 1.1	1.0	0.9		1.0 - 2.4	1.6	1.4	
SECCHI (METERS)	1.5 - 4.1	2.9	3.2		7.3 - 7.3	7.3	7.3		6.1 - 7.0	6.4	6.1	

B. Biological characteristics:

1. Phytoplankton -

<u>Sampling Date</u>	<u>Dominant Genera</u>	<u>Algal Units per ml</u>
06/02/75	1. <u>Fragilaria sp.</u>	259
	2. <u>Synedra sp.</u>	216
	3. <u>Stephanodiscus sp.</u>	86
	4. <u>Asterionella sp.</u>	86
	5. <u>Chroomonas sp.</u>	86
	Other genera	<u>2</u>
	Total	735
07/28/75	1. <u>Fragilaria sp.</u>	524
	2. <u>Dinobryon sp.</u>	489
	3. <u>Asterionella sp.</u>	105
	4. <u>Cryptomonas sp.</u>	70
	5. <u>Scenedesmus sp.</u>	70
	Other genera	<u>174</u>
	Total	1,432
09/05/75	1. <u>Dinobryon sp.</u>	314
	2. <u>Sphaerocystis sp.</u>	140
	3. <u>Schroederia sp.</u>	<u>35</u>
	Total	489

2. Chlorophyll a -

<u>Sampling Date</u>	<u>Station Number</u>	<u>Chlorophyll a (µg/l)</u>
06/02/75	1	1.1
	2	1.9
	3	1.9
07/28/75	1	0.9
	2	0.9
	3	1.1
09/05/75	1	1.4
	2	1.0
	3	2.4

C. Limiting Nutrient Study:

Significant changes in nutrient levels in the samples occurred prior to the beginning of the algal assays, and the results are not considered representative of conditions in the lake at the times the samples were collected (06/02/75 and 09/05/75).

The lake data indicate nitrogen limitation in June (the mean inorganic nitrogen/orthophosphorus ratio was 4/1) but phosphorus limitation in July and September (the mean N/P ratios were 14/1 and 21/1, respectively).

IV. NUTRIENT LOADINGS (See Appendix E for data)

For the determination of nutrient loadings, the Montana 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 May and June when two samples were collected. Sampling was begun in October, 1974, and was completed in July, 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 tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the means of the nutrient loads, in kg/km²/year, at stations C-1 and D-1 and multiplying the means by the ZZ area in km².

No known wastewater treatment plants impacted Whitefish Lake during the sampling year.

* See Working Paper No. 175.

A. Waste Sources:

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

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

<u>Source</u>	<u>kg P/ yr</u>	<u>% of total</u>
a. Tributaries (non-point load) -		
Lazy Creek	375	6.4
Swift Creek	4,130	70.6
b. Minor tributaries & immediate drainage (non-point load) -	1,060	18.1
c. Known municipal STP's - None	-	-
d. Septic tanks* -	55	0.9
e. Known industrial - None	-	-
f. Direct precipitation** -	<u>235</u>	<u>4.0</u>
Total	5,855	100.0

2. Outputs -

Lake outlet - Whitefish River 2,580

3. Net annual P accumulation - 3,275 kg.

* Estimate based on 198 lakeshore dwellings and one park; see Working Paper No. 175.

** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

<u>Source</u>	<u>kg N/ yr</u>	<u>% of total</u>
a. Tributaries (non-point load) -		
Lazy Creek	16,485	10.3
Swift Creek	95,660	60.1
b. Minor tributaries & immediate drainage (non-point load) -	30,430	19.1
c. Known municipal STP's - None	-	-
d. Septic tanks* -	2,145	1.3
e. Known industrial - None	-	-
f. Direct precipitation** -	<u>14,640</u>	<u>9.2</u>
Total	159,360	100.0

2. Outputs -

Lake outlet - Whitefish River 87,710

3. Net annual N accumulation - 71,650 kg.

D. Non-point Nutrient Export by Subdrainage Area:

<u>Tributary</u>	<u>kg P/km²/yr</u>	<u>kg N/km²/yr</u>
Lazy Creek	9	379
Swift Creek	21	483

E. Mean Nutrient Concentrations in Ungaged Streams:

<u>Tributary</u>	<u>Mean Total P Conc. (mg/l)</u>	<u>Mean Total N Conc. (mg/l)</u>
Beaver Creek	0.012	0.643
Hell Roaring Creek	0.014	0.558

* Estimate based on 198 lakeshore dwellings 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.

	<u>Total Phosphorus</u>		<u>Total Nitrogen</u>	
	<u>Total</u>	<u>Accumulated</u>	<u>Total</u>	<u>Accumulated</u>
grams/m ² /yr	0.43	0.24	11.8	5.3

Vollenweider phosphorus loadings
(g/m²/yr) based on mean depth and mean
hydraulic retention time of Whitefish Lake:

"Dangerous" (eutrophic loading)	0.70
"Permissible" (oligotrophic loading)	0.35

V. LITERATURE REVIEWED

Horpestad, Abe, 1975. Personal communication (lake morphometry).
MT Dept. of Health & Env. Sci., Helena.

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.

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 CHLOROP	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)	228
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

09/09/76

LAKE CODE 3016 WHITEFISH LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 325.8

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS)												
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
3016A1	325.8	1.98	1.84	2.83	7.08	16.42	18.41	7.08	2.69	2.27	1.98	2.12	2.12	5.58
3016C1	43.5	0.23	0.17	0.14	0.28	2.27	3.40	1.13	0.57	0.42	0.34	0.28	0.28	0.79
3016D1	198.1	0.42	0.42	0.57	2.69	11.33	16.99	4.25	1.42	1.27	0.85	0.85	0.71	3.48
3016ZZ	84.2	0.17	0.14	0.23	0.85	3.96	6.51	1.70	0.71	0.57	0.28	0.25	0.23	1.30

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 325.8
SUM OF SUB-DRAINAGE AREAS = 325.8

TOTAL FLOW IN = 66.88
TOTAL FLOW OUT = 66.83

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
3016A1	10	74	2.124	6	2.265				
	11	74	1.982	3	1.841				
	12	74	1.869	8	1.841				
	1	75	1.586	5	1.841				
	2	75	1.501	10	2.492				
	3	75	1.784	9	2.124				
	4	75	2.265	6	1.671				
	5	75	11.327	3	4.559	17	15.518		
	6	75	20.105	1	15.404	8	21.521		
3016C1	7	75	9.684	14	9.769				
	8	75	4.248						
	9	75	3.256						
	10	74	0.425	6	0.425				
	11	74	0.311	3	0.368				
	12	74	0.283	8	0.283				
	1	75	0.227	5	0.227				
	2	75	0.170	10	0.0				
	3	75	0.142						
	4	75	0.198	6	0.142				
	5	75	2.322	3	0.566	17	2.832		
	6	75	4.248	1	3.398	8	4.248		
	7	75	1.841	14	1.699				
	8	75	0.850						
	9	75	0.736						

TRIBUTARY FLOW INFORMATION FOR MONTANA

09/09/76

LAKE CODE 3016 WHITEFISH LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS (CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
3016D1	10	74	0.991	6	1.161				
	11	74	0.878	3	0.793				
	12	74	0.623	8	0.680				
	1	75	0.425	5	0.510				
	2	75	0.396	10	0.311				
	3	75	0.453	9	0.510				
	4	75	1.161	6	0.396				
	5	75	10.874	2	2.435	17	20.558		
	6	75	20.445	1	20.558	8	27.326		
	7	75	6.230	14	6.060				
	8	75	2.010						
	9	75	1.642						

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/08/05

301601
48 28 40.0 114 24 45.0 3
WHITEFISH LAKE (LOWER)
30029 MONTANA

130291

11EPALES 2111202
0134 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 CONDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CAC03 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
75/06/02	10 00	0000	10.2	10.2	60	113	7.90	87	0.020	0.200	0.020K	0.011
	10 00	0005	7.6	10.6		106	7.85	86	0.020	0.200	0.020K	0.011K
	10 00	0015	6.7	10.6		105	7.80	83	0.020	0.200K	0.020K	0.012K
	10 00	0025	6.3	10.6		102	7.80	85	0.020	0.200	0.020K	0.012K
	10 00	0050	4.7	10.4		99	7.85	87	0.030	0.200	0.020K	0.012K
	10 00	0100	3.5	10.2		97	7.70	87	0.020	0.200	0.020K	0.012K
	10 00	0130	3.4	10.2		98	8.30	87	0.020K	0.200	0.020K	0.012K
75/07/28	15 50	0000	19.0	8.8	288	141	8.40	88	0.020	0.200K	0.020K	0.003
	15 50	0005	18.7	8.4		133	8.40	87	0.020	0.200K	0.020K	0.003
	15 50	0020	18.3	8.6		141	8.40	88	0.020	0.200K	0.020K	0.002
	15 50	0035	8.2	9.8		103	7.90	88	0.020	0.200K	0.020K	0.004
	15 50	0085	3.0	9.4		101	7.80	87	0.020	0.200	0.020K	0.005
	15 50	0126	2.3	9.2		104	7.80	88	0.020	0.200K	0.020K	0.004
75/09/05	17 25	0000	16.5	8.8	276	133	8.25	83	0.020K	0.200K	0.020K	0.002K
	17 25	0005	16.5	9.4		133	8.30	84	0.020K	0.200K	0.020K	0.002K
	17 25	0034	15.4	9.0		129	8.30	86	0.020K	0.200K	0.020K	0.002K
	17 25	0060	8.2	10.0		105	8.00	81	0.020K	0.200K	0.020K	0.002K
	17 25	0090	5.8	9.4		103	7.80	86	0.020K	0.200K	0.020K	0.002K
	17 25	0116	5.4	8.8		103	7.70	86	0.020K	0.200K	0.020K	0.002K

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/05

301601
48 28 40.0 114 24 45.0 3
WHITEFISH LAKE (LOWER)
30029 MONTANA

130291

11EPALES 2111202
0134 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/06/02	10 00	0000	0.011	1.1	
	10 00	0005	0.009		
	10 00	0015	0.010		
	10 00	0025	0.008		
	10 00	0050	0.009		
	10 00	0100	0.010		
	10 00	0130	0.009		
75/07/28	15 50	0000	0.006	0.9	
	15 50	0005	0.006		
	15 50	0020	0.004		
	15 50	0035	0.066		
	15 50	0085	0.034		
	15 50	0126	0.129		
75/09/05	17 25	0000	0.007	1.4	
	17 25	0005	0.007		
	17 25	0034	0.007		
	17 25	0060	0.009		
	17 25	0090	0.008		
	17 25	0116	0.015		

STORET RETRIEVAL DATE 76/08/05

301602
48 27 00.0 114 22 32.0 3
WHITEFISH LAKE (LOWER)
30029 MONTANA

130291

11EPALES 2111202
0165 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 CAC03 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
75/06/02	10 50	0000	10.1	10.2	126	117	8.20	87	0.020K	0.300	0.020K	0.011K
	10 50	0005	9.8	10.0		116	8.20	89	0.020K	0.300	0.020K	0.011K
	10 50	0015	8.2	10.8		110	8.20	88	0.020K	0.200	0.020K	0.010K
	10 50	0025	6.3	10.6		105	8.20	88	0.020K	0.200	0.020K	0.010K
	10 50	0050	5.0	10.2		100	8.00	90	0.020	0.300	0.020K	0.014J
	10 50	0100	3.6	10.2		99	7.90	100	0.030	0.200	0.020	0.016
	10 50	0161	3.1	10.0		97	8.20	100	0.020	0.200	0.020K	0.011
75/07/28	15 15	0000	19.0	8.8		138	8.40	83	0.020	0.200K	0.020K	0.003
	15 15	0005	18.7	8.0		146	8.40	83	0.020	0.200K	0.020K	0.002
	15 15	0035	8.1	9.6		112	8.00	83	0.020	0.200K	0.020K	0.003
	15 15	0060	3.6	9.6		101	7.85	85	0.020	0.200K	0.020K	0.003
	15 15	0110	2.4	9.8		99	7.80	87	0.020	0.200K	0.020K	0.003
	15 15	0161	2.0	9.2		104	7.60	88	0.030	0.200K	0.030	0.006
75/09/05	17 55	0000	17.4	8.8	240	137	8.20	87	0.020K	0.200K	0.020K	0.002K
	17 55	0005	17.4	8.8		135	8.30	89	0.020K	0.200K	0.020K	0.002
	17 55	0020	16.5	9.6		133	8.35	89	0.020K	0.200K	0.020K	0.002K
	17 55	0034	13.8	10.6		123	8.25	88	0.020K	0.200K	0.020K	0.002K
	17 55	0075	6.7	9.6		105	7.95	91	0.020K	0.200K	0.020K	0.002K
	17 55	0125	5.1	9.6		103	7.80	91	0.020K	0.200K	0.020K	0.002K
	17 55	0166	4.9	8.4		103	7.60	82	0.020K	0.200	0.040	0.006

K* VALUE KNOWN TO BE LESS
THAN INDICATED

J* VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 76/08/05

301602
48 27 00.0 114 22 32.0 3
WHITEFISH LAKE (LOWER)
30029 MONTANA

130291

11EPALES 2111202
0165 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/06/02	10 50	0000	0.008	1.9	
	10 50	0005	0.007		
	10 50	0015	0.009		
	10 50	0025	0.009		
	10 50	0050	0.061		
	10 50	0100	0.027		
	10 50	0161	0.012		
75/07/28	15 15	0000	0.007	0.9	
	15 15	0005	0.004		
	15 15	0035	0.006		
	15 15	0060	0.006		
	15 15	0110	0.008		
	15 15	0161	0.043		
75/09/05	17 55	0000	0.007	1.0	
	17 55	0005	0.008		
	17 55	0020	0.006		
	17 55	0034	0.007		
	17 55	0075	0.007		
	17 55	0125	0.006		
	17 55	0166	0.039		

STORET RETRIEVAL DATE 75/08/05

301603
48 25 26.0 114 21 31.0 3
WHITEFISH LAKE (LOWER)
30029 MONTANA

130291

11EPALES 2111202
0076 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 CONDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CAC03 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
75/06/02	11 20	0000	10.7	9.2	162	118	8.20	97	0.030	0.300	0.020K	0.011
	11 20	0005	9.7	10.2		117	8.20	100	0.020	0.200K	0.020K	0.010
	11 20	0015	9.0	10.2		114	8.15	102	0.020	0.400	0.020K	0.013
	11 20	0030	6.1	10.4		105	8.00	99	0.030	0.400	0.020K	0.015
	11 20	0050	4.4	10.4		100	7.95	103	0.020	0.400	0.020K	0.011
	11 20	0072	4.1	10.4		99	7.95	103	0.020K	0.500	0.020K	0.012
75/07/28	14 50	0000	18.1	8.2	288	139	8.40	83	0.020	0.200K	0.020K	0.002K
	14 50	0005	17.9	9.0		139	8.40	82	0.020	0.200K	0.020K	0.002
	14 50	0015	17.3			133	8.40	83	0.020	0.200K	0.020K	0.002
	14 50	0040	7.1	9.6		98	7.90	84	0.020	0.200K	0.020K	0.002
	14 50	0080	3.0	9.8		96	7.85	85	0.020K	0.200K	0.020K	0.002
	14 50	0130	2.3	9.4		94	7.75	86	0.030	0.200K	0.040	0.003
	14 50	0170	2.2	9.2		91	7.80	86	0.020	0.200K	0.030	0.004
75/09/05	18 30	0000	17.0	9.0	240	135	8.20	83	0.020K	0.200	0.020K	0.002K
	18 30	0005	16.9	9.0		135	8.30	91	0.020K	0.200K	0.020K	0.002K
	18 30	0025	16.1	9.2		129	8.30	84	0.020K	0.200	0.020K	0.002K
	18 30	0038	10.7	10.6		113	8.10	85	0.020K	0.200K	0.020K	0.002K
	18 30	0074	6.3	9.0		109	7.90	86	0.020K	0.300	0.020K	0.003

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/05

301603
48 25 26.0 114 21 31.0 3
WHITEFISH LAKE (LOWER)
30029 MONTANA

130291

11EPALES 2111202
0076 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/06/02	11 20	0000	0.011	1.9	
	11 20	0005	0.011		
	11 20	0015	0.037		
	11 20	0030	0.029		
	11 20	0050	0.038		
	11 20	0072	0.045		
75/07/24	14 50	0000	0.005	1.1	
	14 50	0005	0.005		
	14 50	0015	0.012		
	14 50	0040	0.006		
	14 50	0080	0.005		
	14 50	0130	0.007		
	14 50	0170	0.006		
75/09/05	18 30	0000	0.007	2.4	
	18 30	0005	0.006		
	18 30	0025	0.006		
	18 30	0038	0.007		
	18 30	0074	0.017		

APPENDIX E

TRIBUTARY DATA

STORET RETRIEVAL DATE 76/08/05

3015A1
 48 24 40.0 114 20 30.0 4
 WHITEFISH RIVER
 30 7.5 WHITEFISH
 0/WHITEFISH LAKE 130291
 HWY 93 BRDG IN TOWN OF WHITEFISH
 11EPALES 2111204
 0000 FEET DEPTH CLASS 00

DATE	TIME	DEPTH	00630 NO2&N03 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
FROM	OF	FEET					
TO	DAY						
74/10/06	09 30		0.004	0.600	0.015	0.015	0.015
74/11/03	09 00		0.008	1.300	0.030	0.005K	0.010K
74/12/08	11 25		0.008	0.800	0.020	0.005K	0.010K
75/01/05	09 45		0.008	0.300	0.005K	0.005K	0.010K
75/02/10	11 00		0.008	1.200	0.008	0.008K	0.020
75/03/09	12 20		0.112	0.300	0.016	0.032	0.032
75/04/06	09 00		0.005	0.450	0.125	0.005K	0.010K
75/05/03	13 30		0.005	0.700	0.030	0.005K	0.010
75/05/17	13 15		0.080	0.175	0.015	0.005K	0.040
75/06/01	17 00		0.010	0.750	0.010	0.005K	0.010K
75/06/08	09 00		0.005	0.100	0.005	0.005K	0.010K
75/07/14	09 45		0.005	0.600	0.015	0.005K	0.010K

K VALUE KNOWN TO BE
 LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/05

301681
48 26 20.0 114 23 20.0 4
BEAVER CREEK
30 7.5 BEAVER LAKE
T/WHITEFISH LAKE 130291
GRT NTHRN RR BRDG 1.1 MI E OF BEAVER LK
11EPALES 2111294
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
74/10/06	10 30		0.016	0.500	0.020	0.005K	0.010
75/05/02	15 40		0.015	1.250	0.030	0.005K	0.010K
75/05/17	15 00		0.010	0.150	0.025	0.005K	0.010K
75/06/01	14 30		0.005	1.200	0.020	0.005	0.010
75/06/08	10 45		0.005	0.500	0.045	0.005	0.020
75/07/14	12 00		0.005	0.200	0.025	0.005K	0.010K

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/05

3016C1
48 28 25.0 114 26 15.0 4
LAZY CREEK
30 7.5 BEAVER LAKE
T/WHITEFISH LAKE 130291
UNPVD RD BRDG .9 MI W OF INEZ POINT
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
74/10/06	11 15		0.016	0.600	0.040	0.005K	0.010
74/11/03	09 30		0.016	0.400	0.010	0.010	0.010
74/12/08	11 40		0.032	0.500	0.010	0.005	0.010
75/01/05	10 30		0.064	0.300	0.005K	0.005	0.020
75/03/09	13 00		0.104	1.400	0.016	0.032	0.032
75/04/06	04 30		0.020	0.900	0.103	0.005K	0.020
75/05/03	14 10		0.015	0.800	0.140	0.005	0.025
75/05/17	14 30		0.345	0.050K	0.015	0.005K	0.010K
75/06/01	16 00		0.005	1.050	0.015	0.005	0.010K
75/06/08	10 00		0.005	0.300	0.010	0.005K	0.020
75/07/14	10 30		0.005	0.950	0.025	0.010	0.020

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/05

301601
48 29 00.0 114 25 50.0 4
SWIFT CREEK
30 7.5 BEAVER LAKE
T/WHITEFISH LAKE 130291
UNPVD RD BRDG .9 MI SW OF SMITH LAKE
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
74/10/06	11 15		0.016	2.500	0.120	0.005K	0.005K
74/11/03	09 45		0.016	0.800	0.030	0.005	0.010K
74/12/08	11 50		0.016	0.100K	0.015	0.005K	0.010K
75/01/05	10 45		0.048	0.100K	0.005K	0.005K	0.010K
75/02/10	11 00		0.072	1.100	0.025	0.008K	0.030
75/03/09	13 05		0.272	0.900	0.024	0.019	0.030
75/04/06	09 30		0.025	0.600	0.025	0.010	0.010
75/05/02	14 30		0.045	0.600	0.025	0.005	0.040
75/05/17	13 30		0.075	0.300	0.005	0.005	0.040
75/06/01	16 15		0.085	0.850	0.015	0.005	0.060
75/06/08	11 00		0.070	1.100	0.045	0.005	0.070
75/07/14	11 00		0.005	0.100	0.015	0.005K	0.010K

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/05

3016E1
48 28 35.0 114 23 25.0 4
HELL ROARING CREEK
30 7.5 BEAVER LAKE
T/WHITEFISH LAKE 130291
HWY 487 BRDG .2 MI NE OF HELL ROARING 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
74/10/06	11 30		0.008	0.400	0.015	0.005K	0.005K
74/11/03	09 45		0.016	1.300	0.040	0.005	0.010K
74/12/08	12 15		0.008	0.100K	0.025	0.005K	0.010K
75/01/05	11 30		0.024	0.100K	0.016	0.005K	0.010K
75/02/10	11 00		0.070	0.800	0.032	0.015	0.030
75/03/09	11 15		0.176	0.300	0.008	0.040	0.040
75/04/06	10 00		0.015	0.450	0.130	0.005K	0.010K
75/05/04	14 50		0.020	0.550	0.020	0.005K	0.010K
75/05/17	14 00		0.010	0.092	0.085	0.005K	0.010K
75/06/01	16 30		0.020	1.050	0.015	0.005K	0.010K
75/06/08	11 30		0.025	0.950	0.025	0.005K	0.015
75/07/14	11 30		0.010	0.200	0.005	0.005K	0.010K

K VALUE KNOWN TO BE
LESS THAN INDICATED