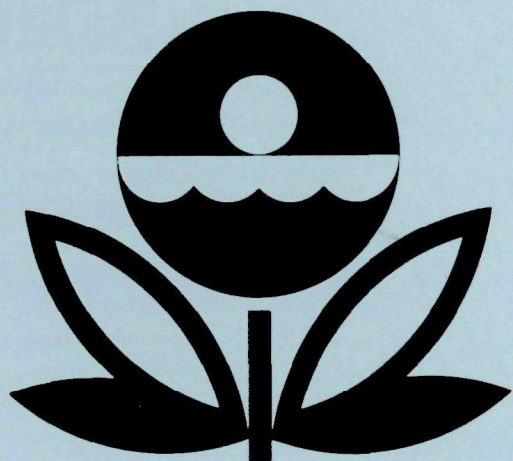


**U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY
WORKING PAPER SERIES**



REPORT
ON
GREEN MOUNTAIN RESERVOIR
SUMMIT COUNTY
COLORADO
EPA REGION VIII
WORKING PAPER No. 771

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

REPORT
ON
GREEN MOUNTAIN RESERVOIR
SUMMIT COUNTY
COLORADO
EPA REGION VIII
WORKING PAPER No. 771

WITH THE COOPERATION OF THE
COLORADO DEPARTMENT OF HEALTH
AND THE
COLORADO NATIONAL GUARD
JULY, 1977

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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 [§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) expresses sincere appreciation to the Colorado Department of Health for professional involvement, to the Colorado National Guard for conducting the tributary sampling phase of the Survey, and to those wastewater treatment plant operators who voluntarily provided effluent samples.

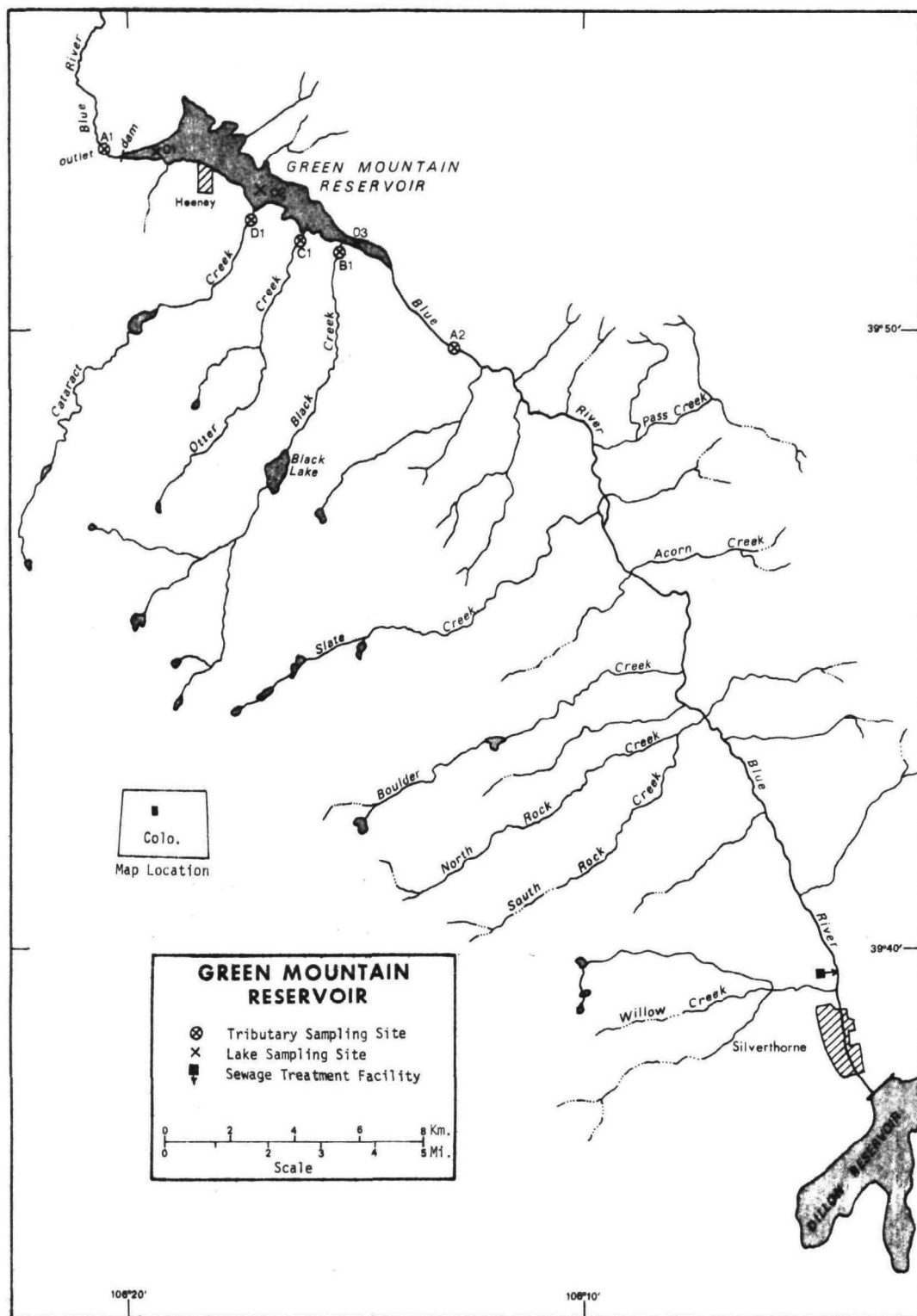
The staff of the Water Quality Control Division provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

Lt. Colonel Paul A. Parsons, the Deputy Adjutant General of Colorado, and Project Officer Colonel Hershel C. Yeargan, who directed the volunteer efforts of the Colorado National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY
STUDY LAKES AND RESERVOIRS

STATE OF COLORADO

<u>NAME</u>	<u>COUNTY</u>
Barker	Boulder
Barr	Adams
Blue Mesa	Boulder
Cherry Creek	Arapohoe
Cucharas	Huerfano
Dillon	Summit
Grand	Grand
Green Mountain	Summit
Holbrook	Otero
Meredith	Crowley
Milton	Weld
Navajo	Archuleta, CO; San Juan, Rio Arriba, NM
Shadow Mountain	Grand



GREEN MOUNTAIN RESERVOIR

STORET NO. 0808

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Green Mountain Reservoir is oligotrophic. It ranked second in overall trophic quality when the 13 Colorado lakes and reservoirs sampled in 1975 were compared using a combination of six parameters*. One of the water bodies had less median total phosphorus, none had less and one had the same median dissolved orthophosphorus, none had less and six had the same median inorganic nitrogen, five had less mean chlorophyll a, and two had greater mean Secchi disc transparency. No significant depression of dissolved oxygen occurred at depths as great as 39 meters.

Field limnologists did not observe algal concentrations or macrophytes.

B. Rate-Limiting Nutrient:

The results of the algal assay indicate that Green Mountain Reservoir was phosphorus limited at the time the sample was collected (10/09/75). The reservoir data indicate phosphorus limitation in August as well.

* See Appendix A.

C. Nutrient Controllability:

1. Point sources--The phosphorus contribution of point sources amounted to 13.77% of the total load to Green Mountain Reservoir during the sampling year. The nine indirect domestic sources discharging in the upstream Dillon Reservoir drainage* contributed an estimated 8.7%, the Silverthorne Sanitation District wastewater treatment plant added 4.9%, and septic tanks serving shoreline dwellings and a campground accounted for an estimated 0.2% of the total load.

The phosphorus loading of 0.77 g/m^2 measured during the sampling year is less than that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading but is more than his suggested oligotrophic loading (see page 13). The only significant point source without phosphorus removal during the sampling year was the Frisco Sanitation District (SD) plant which discharged 1,740 kg total P to Dillon Reservoir.

In regard to the Dillon Reservoir point sources, at this time the Summit Cove wastes are treated at the Summit County Phase D plant (with phosphorus removal), construction of phosphorus removal facilities at the Frisco SD plant is scheduled to begin in October, 1977, and the Copper Mountain SD is proposing land disposal of plant effluent (Lang, 1977). Allowing for phosphorus retention in that reservoir and assuming 85% removal at the plants and complete removal by land disposal, it is calculated these improvements will reduce the phosphorus load to Green Mountain Reservoir by 395 kg and lower the overall loading to 0.72

* See Working Paper No. 769.

g/m²/yr. Since both reservoirs are phosphorus limited, any reduction of phosphorus inputs would be expected to benefit both water bodies.

2. Non-point sources--The phosphorus contribution of non-point sources, including precipitation, accounted for 86.3% of the total load to Green Mountain Reservoir during the sampling year. The Blue River added 57.9%; Black Creek, 5.7%; Otter Creek, 5.2%; Cataract Creek, 3.1%; and the ungaged minor tributaries and immediate drainage contributed an estimated 12.1% of the total load.

The phosphorus export rate of Otter Creek was appreciably higher than the rates of nearby Black and Cataract creeks (see page 12). The cause of the higher rate is not known, but the mean total phosphorus concentration in Otter Creek was from five to seven times greater than the mean concentrations in the other two streams (see Appendix E).

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

1. Surface area: 8.60 kilometers².
2. Mean depth: 22.2 meters.
3. Maximum depth: 75.3 meters.
4. Volume: $190.759 \times 10^6 \text{ m}^3$.
5. Mean hydraulic retention time: 164 days.

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>
Blue River	1,323.5	9.640
Black Creek	47.9	0.862
Otter Creek	21.8	0.131
Cataract Creek	36.3	0.537
Minor tributaries & immediate drainage -	<u>113.3</u>	<u>2.290</u>
Totals	1,542.8	13.460**

2. Outlet -

Blue River	1,551.4***	13.460
------------	------------	--------

C. Precipitation****:

1. Year of sampling: 30.8 centimeters.
2. Mean annual: 42.6 centimeters.

† Table of metric conversions--Appendix B.

†† At maximum pool level (Nelson, 1955).

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

** Sum of inflows adjusted to equal outflow.

*** Includes area of reservoir.

**** See Working Paper No. 175.

III. WATER QUALITY SUMMARY

Green Mountain Reservoir 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 reservoir (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 October visit, 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 39.3 meters at station 1, 27.7 meters at station 2, and 7.3 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 GREEN MOUNTAIN RESERVOIR
STORET CODE 0808

PARAMETER	1ST SAMPLING (8/25/75)				2ND SAMPLING (10/ 9/75)				3RD SAMPLING		
	3 SITES				3 SITES				0 SITES		
	RANGE	MEAN	MEDIAN		RANGE	MEAN	MEDIAN		RANGE	MEAN	MEDIAN
TEMP (C)	10.9 - 14.8	13.4	13.6		6.8 - 13.0	12.1	12.7		*****	*****	*****
DISS OXY (MG/L)	5.9 - 7.5	7.0	7.2		7.0 - 9.6	7.6	7.4		*****	*****	*****
CNDCTVY (MCROMO)	102. - 114.	107.	108.		1. - 109.	57.	101.		*****	*****	*****
PH (STAND UNITS)	7.5 - 8.2	7.9	7.9		7.7 - 8.0	7.9	7.9		*****	*****	*****
TOT ALK (MG/L)	42. - 50.	46.	47.		54. - 71.	64.	66.		*****	*****	*****
TOT P (MG/L)	0.006 - 0.016	0.010	0.009		0.009 - 0.022	0.012	0.011		*****	*****	*****
ORTHO P (MG/L)	0.002 - 0.002	0.002	0.002		0.002 - 0.006	0.003	0.002		*****	*****	*****
NO2+NO3 (MG/L)	0.020 - 0.120	0.036	0.020		0.020 - 0.060	0.027	0.030		*****	*****	*****
AMMONIA (MG/L)	0.020 - 0.020	0.020	0.020		0.020 - 0.020	0.020	0.020		*****	*****	*****
KJEL N (MG/L)	0.200 - 0.500	0.257	0.200		0.020 - 0.200	0.188	0.200		*****	*****	*****
INORG N (MG/L)	0.040 - 0.140	0.056	0.040		0.040 - 0.080	0.047	0.050		*****	*****	*****
TOTAL N (MG/L)	0.220 - 0.520	0.293	0.245		0.040 - 0.260	0.215	0.230		*****	*****	*****
CHLRPYL A (UG/L)	7.1 - 9.8	8.3	7.9		3.1 - 4.0	3.4	3.1		*****	*****	*****
SECCHI (METERS)	1.9 - 2.4	2.1	2.0		2.7 - 4.0	3.4	3.5		*****	*****	*****

B. Biological Characteristics:

1. Phytoplankton -

<u>Sampling Date</u>	<u>Dominant Genera</u>	<u>Algal Units per ml</u>
08/25/75	1. <u>Fragilaria sp.</u>	3,470
	2. <u>Cyclotella sp.</u>	132
	3. <u>Asterionella sp.</u>	132
	4. <u>Cryptomonas sp.</u>	88
	Total	3,822
10/09/75	1. <u>Cyclotella sp.</u>	635
	2. <u>Fragilaria sp.</u>	212
	3. <u>Cryptomonas sp.</u>	60
	Total	907

2. Chlorophyll a -

<u>Sampling Date</u>	<u>Station Number</u>	<u>Chlorophyll a (µg/l)</u>
08/25/75	1	7.9
	2	7.1
	3	9.8
10/09/75	1	3.1
	2	4.0
	3	3.1

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

<u>Spike (mg/l)</u>	<u>Ortho P Conc. (mg/l)</u>	<u>Inorganic N Conc. (mg/l)</u>	<u>Maximum yield (mg/l-dry wt.)</u>
Control	0.005	0.065	0.1
0.050 P	0.055	0.065	1.7
0.050 P + 1.0 N	0.055	1.065	16.0
1.0 N	0.005	1.065	0.1

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity

of Green Mountain Reservoir was low at the time the sample was taken (10/09/75). Also, the significant increase in yield when only phosphorus was added, and the lack of response when only nitrogen was added, indicate phosphorus limitation at that time.

The reservoir data also indicate phosphorus limitation; the mean inorganic nitrogen/orthophosphorus ratios were 28/1 in August and 16/1 in October, and phosphorus limitation would be expected.

IV. NUTRIENT LOADINGS (See Appendix E for data)

For the determination of nutrient loadings, the Colorado National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the months of June and July when two or three samples were collected. Sampling was begun in September, 1974, and was completed in August, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Colorado District Office of the U.S. Geological Survey for the tributary sites nearest the reservoir.

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 shown are those measured minus point-source loads, if any.

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 B-1 and D-1 and multiplying the means by the ZZ area in km².

The operator of the Silverthorne Sanitation District wastewater treatment plant provided monthly effluent samples and corresponding flow data. The indirect point-source loads leaving upstream Dillon Reservoir were calculated by multiplying the nutrient loads leaving that reservoir via

* See Working Paper No. 175/

the Blue River (1,860 kg P and 155,490 kg N) by the fractions of the total nutrient loads contributed by the point sources (0.306 for P and 0.075 for N).

A. Waste Sources:

1. Known domestic* -

<u>Name</u>	<u>Pop. Served</u>	<u>Treatment</u>	<u>Mean Flow (m³/d)</u>	<u>Receiving Water</u>
Silverthorne SD	1,000	phosphorus removal	2,211.0	Blue River

2. Indirect domestic - During the sampling year, nine domestic point sources with a combined population equivalence of about 5,330 discharged in the Dillon Reservoir drainage, and a portion of the nutrient loads from those sources reached Green Mountain Reservoir via the Blue River. Phosphorus removal was provided at four of the treatment plants (P.E. ca. 3,750).

3. Industrial - Mining activities in Dillon Reservoir drainage, particularly in the Tenmile Creek watershed, are reported to contribute to elevated levels of molybdenum in that reservoir (Anonymous, 1974). The nutrient significance of the mining operations is not known but is assumed to be minimal.

* Treatment plant questionnaire.

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) -		
Blue River	3,810	57.9
Black Creek	375	5.7
Otter Creek	345	5.2
Cataract Creek	205	3.1
b. Minor tributaries & immediate drainage (non-point load) -	795	12.1
c. Known municipal STP's -		
Silverthorne SD	325	4.9
Indirect - Dillon Reservoir drainage	570	8.7
d. Septic tanks* -	10	0.2
e. Industrial - Unknown	?	-
f. Direct precipitation** -	<u>150</u>	<u>2.3</u>
Total	6,585	100.0

2. Outputs -

Reservoir outlet - Blue River 6,390

3. Net annual P accumulation - 195 kg.

* Estimate based on 30 shoreline dwellings and one campground; 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) -		
Blue River	103,755	59.1
Black Creek	10,705	6.1
Otter Creek	2,055	1.2
Cataract Creek	5,600	3.2
b. Minor tributaries & immediate drainage (non-point load) -	21,355	12.2
c. Known municipal STP's -		
Silverthorne SD	10,690	6.1
Indirect - Dillon Reservoir drainage	11,660	6.6
d. Septic tanks* -	355	0.2
e. Industrial - Unknown	?	-
f. Direct precipitation** -	<u>9,285</u>	<u>5.3</u>
Total	175,460	100.0

2. Outputs -

Reservoir outlet - Blue River 168,530

3. Net annual N accumulation - 6,930 kg.

D. Non-point Nutrient Export by Subdrainage Area:

<u>Tributary</u>	<u>kg P/km²/yr</u>	<u>kg N/km²/yr</u>
Blue River	3	78
Black Creek	8	223
Otter Creek	16	94
Cataract Creek	6	154

* Estimate based on 30 shoreline dwellings and one campground; see Working Paper No. 175.

** See Working Paper No. 175.

E. 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	0.77	0.02	20.4	0.8

Vollenweider phosphorus loadings
(g/m²/yr) based on mean depth and mean
hydraulic retention time of Green Mountain Reservoir:

"Dangerous" (eutrophic loading)	1.34
"Permissible" (oligotrophic loading)	0.67

V. LITERATURE REVIEWED

Anonymous, 1974. Dillon Reservoir - Blue River study, Colorado, June, July, August - 1973. Tech. Invest. Br., Surv. & Anal. Div., EPA Region VIII, Denver.

Lang, Derald E., 1977. Personal communication (review of preliminary report; status of waste treatment facilities as of July, 1977). CO Dept. of Health, Denver.

Nelson, Wesley C., 1955. Green Mountain Reservoir studies, 1949-1950. CO Dept. of Game & Fish, Denver.

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
0801	BARKER RESERVOIR	0.023	0.045	419.000	5.333	9.400	0.006
0802	BARR LAKE	0.930	1.090	451.333	28.767	10.200	0.730
0803	BLUE MESA RESERVOIR	0.019	0.040	395.750	6.817	13.800	0.005
0804	CHERRY CREEK LAKE	0.054	0.040	469.333	23.322	10.000	0.007
0805	CUCHARAS RESERVOIR	0.263	0.040	490.000	27.400	14.800	0.015
0806	DILLON RESERVOIR	0.009	0.040	181.750	3.150	9.200	0.002
0807	GRAND LAKE	0.013	0.040	366.500	4.900	10.200	0.003
0808	GREEN MOUNTAIN RESERVOIR	0.010	0.040	391.167	5.833	9.100	0.002
0809	HOLBROOK LAKE	0.329	0.070	490.333	111.933	9.000	0.028
0810	LAKE MEREDITH	0.397	0.110	489.667	164.678	10.400	0.098
0811	MILTON RESERVOIR	0.846	2.280	429.333	5.900	9.200	0.808
0812	NAVAJO RESERVOIR	0.036	0.050	479.400	2.180	10.000	0.013
0813	SHADOW MOUNTAIN LAKE	0.020	0.040	427.000	5.700	9.200	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
0801	BARKER RESERVOIR	58 (7)	42 (5)	67 (8)	75 (9)	58 (7)	58 (7)	358
0802	BARR LAKE	0 (0)	8 (1)	42 (5)	17 (2)	29 (3)	8 (1)	104
0803	BLUE MESA RESERVOIR	75 (9)	87 (9)	75 (9)	42 (5)	8 (1)	67 (8)	354
0804	CHERRY CREEK LAKE	42 (5)	87 (9)	33 (4)	33 (4)	46 (5)	50 (6)	291
0805	CUCHARAS RESERVOIR	33 (4)	58 (6)	8 (1)	25 (3)	0 (0)	33 (4)	157
0806	DILLON RESERVOIR	100 (12)	58 (6)	100 (12)	92 (11)	75 (8)	96 (11)	521
0807	GRAND LAKE	83 (10)	87 (9)	92 (11)	83 (10)	29 (3)	79 (9)	453
0808	GREEN MOUNTAIN RESERVOIR	92 (11)	58 (6)	83 (10)	58 (7)	92 (11)	96 (11)	479
0809	HOLBROOK LAKE	25 (3)	25 (3)	0 (0)	8 (1)	100 (12)	25 (3)	183
0810	LAKE MEREDITH	17 (2)	17 (2)	17 (2)	0 (0)	17 (2)	17 (2)	85
0811	MILTON RESERVOIR	8 (1)	0 (0)	50 (6)	50 (6)	75 (8)	0 (0)	183
0812	NAVAJO RESERVOIR	50 (6)	33 (4)	25 (3)	100 (12)	46 (5)	42 (5)	296
0813	SHADOW MOUNTAIN LAKE	67 (8)	87 (9)	58 (7)	67 (8)	75 (8)	79 (9)	433

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	0806	DILLON RESERVOIR	521
2	0808	GREEN MOUNTAIN RESERVOIR	479
3	0807	GRAND LAKE	453
4	0813	SHADOW MOUNTAIN LAKE	433
5	0801	BARKER RESERVOIR	358
6	0803	BLUE MESA RESERVOIR	354
7	0812	NAVAJO RESERVOIR	296
8	0804	CHERRY CREEK LAKE	291
9	0811	MILTON RESERVOIR	183
10	0809	HOLBROOK LAKE	183
11	0805	CUCHARAS RESERVOIR	157
12	0802	BARR LAKE	104
13	0810	LAKE MEREDITH	85

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 COLORADO

09/24/76

LAKE CODE 0808 GREEN MOUNTAIN

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 1551.4

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS)												MEAN
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
0808A1	1551.4	9.34	8.78	9.63	12.46	18.12	21.24	22.65	16.71	13.31	11.04	8.50	9.34	13.46
0808A2	1323.5	3.40	3.11	2.97	5.95	17.27	31.71	18.12	11.89	7.65	5.24	4.11	3.96	9.64
0808B1	47.9	0.085	0.085	0.088	0.311	1.586	3.398	2.718	1.133	0.453	0.207	0.136	0.102	0.862
0808C1	21.8	0.020	0.023	0.028	0.102	0.425	0.595	0.187	0.051	0.042	0.037	0.034	0.025	0.131
0808D1	36.3	0.034	0.037	0.040	0.246	1.218	2.747	1.331	0.425	0.147	0.108	0.059	0.042	0.537
0808ZZ	121.7	0.28	0.27	0.31	0.68	1.84	3.11	2.27	1.27	0.76	0.51	0.40	0.40	1.01

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 1551.4
SUM OF SUB-DRAINAGE AREAS = 1551.1

TOTAL FLOW IN = 145.80
TOTAL FLOW OUT = 161.12

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
0808A1	9	74	18.066	28	14.130				
	10	74	9.599	27	8.212				
	11	74	7.419	24	7.532				
	12	74	7.391	21	7.391				
	1	75	7.362	26	7.277				
	2	75	7.192	26	7.108				
	3	75	7.079						
	4	75	13.649	1	7.051	27	13.762		
	5	75	10.421						
	6	75	7.787	2	11.978	12	11.978	29	2.775
	7	75	21.974	12	25.683	26	25.995		
	8	75	19.001	28	14.413				
0808A2	9	74	5.380	28	5.097				
	10	74	4.389	27	4.248				
	11	74	3.540	24	3.540				
	12	74	3.256	21	2.605				
	1	75	2.888	26	2.152				
	2	75	2.690	26	2.152				
	3	75	2.718						
	4	75	3.738	1	2.718	27	5.154		
	5	75	10.760						
	6	75	15.857	2	17.556	12	17.273	29	14.158
	7	75	29.450	12	43.891	26	25.202		
	8	75	15.291	28	10.336				

TRIBUTARY FLOW INFORMATION FOR COLORADO

09/24/76

LAKE CODE 0808 GREEN MOUNTAIN

MEAN MONTHLY FLOWS AND DAILY FLOWS (CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
0808H1	9	74	0.210	28	0.113				
	10	74	0.116	27	0.076				
	11	74	0.102	24	0.096				
	12	74	0.059	21	0.051				
	1	75	21.291	26	0.054				
	2	75	0.054	26	0.057				
	3	75	0.051						
	4	75	0.096	1	0.048	27	0.144		
	5	75	0.736						
	6	75	3.115	2	0.991	12	1.161	29	4.332
	7	75	4.531	12	4.870	26	2.464		
0808C1	8	75	1.104	28	0.680				
	9	74	0.028	28	0.025				
	10	74	0.028	27	0.025				
	11	74	0.028	24	0.023				
	12	74	0.017	21	0.017				
	1	75	0.014	26	0.014				
	2	75	0.017	26	0.017				
	3	75	0.017						
	4	75	0.057	1	0.028	27	0.091		
	5	75	0.218						
	6	75	0.566	2	0.159	12	0.187	29	0.821
	7	75	0.396	12	0.481	26	0.184		
0808D1	8	75	0.113	28	0.139				
	9	74	0.059	28	0.028				
	10	74	0.037	27	0.028				
	11	74	0.037	24	0.037				
	12	74	0.020	21	0.020				
	1	75	0.020	26	0.020				
	2	75	0.023	26	0.023				
	3	75	0.023						
	4	75	0.045	1	0.020	27	0.159		
	5	75	0.566						
	6	75	2.265	2	0.680	12	0.934	29	3.540
	7	75	2.549	12	2.775	26	1.104		
0808ZZ	8	75	0.510	28	0.283				
	9	74	0.651						
	10	74	0.396						
	11	74	0.368						
	12	74	0.368						
	1	75	0.249						
	2	75	0.241						
	3	75	0.241						
	4	75	0.481						
	5	75	0.651						
	6	75	1.416						
	7	75	2.832						
	8	75	1.557						

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/09/24

080801

39 52 34.0 106 18 57.0 3

GREEN MOUNTAIN RESERVOIR

08117 COLORADO

11EPALES 751210 2111202

0070 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
75/08/25	13 30	0000	13.5	7.2	96	114	7.60	48	0.020K	0.200K	0.020K	0.002K
	13 30	0005	13.8	7.2		110	8.10	49	0.020K	0.200K	0.020K	0.002K
	13 30	0022	13.5	7.0		109	7.90	49	0.020K	0.200K	0.020K	0.002K
	13 30	0040	12.6	6.8		108	7.85	49	0.020K	0.200	0.030	0.002K
	13 30	0066	11.0	5.9		103	7.60	42	0.020K	0.200K	0.120	0.002K
75/10/09	16 50	0000	13.0	7.2	156	101	7.75	60	0.020K	0.200K	0.030	0.003
	16 50	0005	12.8	7.2		106	7.80	66	0.020K	0.200K	0.030	0.002K
	16 50	0018	12.5	7.2		1	7.80	67	0.020K	0.200K	0.030	0.002K
	16 50	0045	12.5	7.2		1	7.80	71	0.020K	0.200K	0.030	0.002
	16 50	0090	12.4	7.4		1	7.75	70	0.020K	0.200K	0.030	0.002K
	16 50	0129	12.5	7.0		1	7.70	70	0.020K	0.200K	0.030	0.002K

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT. REMNING PERCENT
75/08/25	13 30	0000	0.010		7.9
	13 30	0005	0.009		
	13 30	0022	0.008		
	13 30	0040	0.008		
	13 30	0066	0.006		
75/10/09	16 50	0000	0.010		3.1
	16 50	0005	0.009		
	16 50	0018	0.010		
	16 50	0045	0.009		
	16 50	0090	0.011		
	16 50	0129	0.022		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/09/24

080802
39 52 15.0 106 16 57.0 3
GREEN MOUNTAIN RESERVOIR
08117 COLORADO

11EPALES 751210 2111202
0095 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
75/08/25	14 00	0000	14.8	7.4	80	107	8.20	43	0.020K	0.200K	0.030	0.002K
	14 00	0005	14.7	7.5		107	8.20	44	0.020K	0.200K	0.020K	0.002K
	14 00	0021	14.3	7.0		105	8.10	44	0.020K	0.200K	0.020K	0.002K
	14 00	0055	12.2	6.6		102	7.75	43	0.020K	0.200K	0.060	0.002K
	14 00	0091	10.9	6.7		104	7.50	47	0.020K	0.200K	0.080	0.002K
75/10/09	16 30	0000	12.9	7.4	138	108	7.80	63	0.020K	0.200K	0.030	0.003
	16 30	0005	12.9	7.8		108	7.90	63	0.020K	0.200K	0.020	0.002K
	16 30	0016	12.8	7.8		107	7.90	66	0.020K	0.200K	0.020K	0.002K
	16 30	0040	12.7	7.4		104	7.90	67	0.020K	0.200K	0.020	0.005
	16 30	0062	12.5	7.4		107	7.90	66	0.020K	0.200K	0.020	0.002K

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/08/25	14 00	0000	0.009	7.1	
	14 00	0005	0.009		
	14 00	0021	0.009		
	14 00	0055	0.008		
	14 00	0091	0.014		
75/10/09	16 30	0000	0.013	4.0	
	16 30	0005	0.011		
	16 30	0016	0.010		
	16 30	0040	0.010		
	16 30	0062	0.012		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/09/24

080803
39 50 07.0 106 14 30.0 3
GREEN MOUNTAIN RESERVOIR
08117 COLORADO

11EPALES 751210 2111202
0027 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
75/08/25	14 30	0000	14.6	7.2	75	109	7.70	46	0.020K	0.300	0.020K	0.002K
	14 30	0005	14.7	7.3		108	8.05	44	0.020K	0.400	0.020K	0.002K
	14 30	0018	14.0	7.2		108	8.00	50	0.020K	0.500	0.020	0.002K
	14 30	0024	13.2	7.2		109	8.10	50	0.020K	0.400	0.020	0.002K
75/10/09	16 00	0000	12.7	7.8	108	109	7.95	56	0.020K	0.200K	0.020	0.006
	16 00	0005	12.8	8.0		1	8.00	54	0.020K	0.020K	0.020K	0.002
	16 00	0015	10.0	8.2		1	8.00	54	0.020K	0.200K	0.020	0.002K
	16 00	0023	6.8	9.6		1	8.00	71	0.020K	0.200K	0.060	0.003

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/08/25	14 30	0000	0.010	9.8	
	14 30	0005	0.013		
	14 30	0018	0.014		
	14 30	0024	0.016		
75/10/09	16 00	0000	0.016	3.1	
	16 00	0005	0.012		
	16 00	0015	0.011		
	16 00	0023	0.012		

K VALUE KNOWN TO BE
LESS THAN INDICATED

APPENDIX E
TRIBUTARY AND WASTEWATER
TREATMENT PLANT DATA

STORET RETRIEVAL DATE 76/09/24

0808A1
39 52 00.0 106 20 00.0 4
BLUE RIVER
08 SUMMIT CO HWY MP
0/GREEN MOUNTAIN RES 110391
SEC RD BRDG 24.8 MI NW OF SILVERTHORNE
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 ORTHOP MG/L P	00665 PHOS-TOT MG/L P
74/09/28	12 07		0.080	0.200	0.010	0.005K	0.005K
74/11/24	15 00		0.056	0.400	0.020	0.005K	0.010K
74/12/21	16 25		0.048	0.100K	0.024	0.008K	0.010K
75/01/26	14 14		0.075	0.900		0.017	0.030
75/02/26	14 50		0.080	0.400	0.016	0.008K	0.010K
75/04/01	15 30		0.100	0.450	0.010	0.005K	0.010K
75/06/02	11 20		0.115	0.350	0.020	0.005K	0.020
75/06/12	11 25		0.105	0.100	0.025	0.005K	0.010K
75/06/29	10 30		0.125	0.250	0.020	0.010	0.020
75/07/12	10 25		0.145	0.100	0.010	0.005	0.020
75/07/26	10 30		0.135	0.250	0.015	0.005K	0.010K
75/08/28	10 27		0.010	0.150	0.005	0.005K	0.030

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/09/24

0808A2
39 49 30.0 106 13 00.0 4
BLUE RIVER
08 SUMMIT CO HWY MP
T/GREEN MOUNTAIN RES 110391
RT 9 BRDG 17 MI NNW OF SILVERTHORNE
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
74/09/28	10 40		0.104	0.200	0.005	0.005K	0.010
74/11/24	13 40		0.120	0.100	0.010	0.005K	0.010K
74/12/21	15 15		0.120	0.100	0.024	0.008K	0.010K
75/01/26	12 45		0.120	0.800	0.048	0.019	0.020
75/04/01	14 30		0.135	1.350	0.035	0.005K	0.010K
75/04/27	12 30		0.150		0.020	0.005	0.030
75/06/02	10 10		0.175	0.237	0.055	0.005K	0.022
75/06/12	12 05		0.125	0.100	0.040	0.005K	0.010K
75/06/29	10 05		0.085	0.250	0.010	0.005	0.010
75/07/12	10 00		0.035	0.250	0.010	0.005	0.030
75/07/26	10 10		0.030	0.150	0.015	0.005K	0.020
75/08/28	10 00		0.100	0.100	0.005K	0.005K	0.010K

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/09/24

0808d1
39 51 30.0 106 15 30.0 4
BLACK CREEK
08 SUMMIT CO HWY MP
T/GREEN MOUNTAIN RES 110391
SEC RD BRDG 3.8 MI SE OF HEENEY
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE	TIME	DEPTH	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
FROM TO	OF DAY	FEET					
74/09/28	11 05		0.012	0.500	0.010	0.005K	0.005
74/11/24	14 00		0.032	0.300	0.010	0.005K	0.010K
75/01/26	13 15		0.104	0.400	0.032	0.015	0.015
75/04/27	13 05		0.170	0.150	0.010	0.005	0.020
75/06/02	10 25		0.040	0.150	0.015	0.005K	0.020
75/06/12	13 00		0.065	0.400	0.050	0.005K	0.010K
75/06/29	11 00		0.065	0.600	0.015	0.005	0.020
75/07/12	11 50		0.065	0.325	0.015	0.005	0.025
75/07/26	11 00		0.045	0.150	0.010	0.005K	0.010K
75/08/28	11 49		0.020	0.050K	0.005K	0.005K	0.010K

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/09/24

0808C1
39 51 20.0 106 16 00.0 4
OTTER CREEK
08 SUMMIT CO HWY MP
T/GREEN MOUNTAIN RES 110391
SEC RD BRDG 3.0 MI SE OF HEENEY
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE	TIME	DEPTH	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
FROM	OF						
TO	DAY	FEET					
74/09/28	11	28	0.016	0.400	0.010	0.040	0.057
74/11/24	14	11	0.072	0.600	0.020	0.030	0.030
75/06/02	10	45	0.035	0.550	0.030	0.025	0.050
75/06/12	12	50	0.045	0.350	0.035	0.045	0.050
75/06/29	10	55	0.010	0.450	0.025	0.040	0.070
75/07/12	10	45	0.010	0.550	0.020	0.050	0.090
75/07/26	10	55	0.035	0.350	0.040	0.085	0.120
75/08/28	11	31	0.025	0.350	0.005	0.055	0.130

STORET RETRIEVAL DATE 76/09/24

080801
39 51 45.0 106 17 00.0 4
CATARACT CREEK
08 SUMMIT CO HWY MP
T/GREEN MOUNTAIN RES 110391
SEC RD BRDG 1.8 MI SE OF HEENEY
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
74/09/28	11 45		0.092	0.200	0.005	0.005K	0.005K
74/11/24	14 30		0.048	0.500	0.007	0.005K	0.010K
75/04/27	13 25		0.105	0.650	0.035	0.005K	0.010
75/06/02	11 00		0.025	0.250	0.025	0.005K	0.010
75/06/12	12 40		0.020	0.150	0.030	0.005K	0.010K
75/06/29	10 45		0.025	0.250	0.020	0.010	0.010
75/07/12	10 35		0.015	0.250	0.040	0.005	0.020
75/07/26	10 45		0.015	0.150	0.010	0.005K	0.010K
75/08/28	11 00		0.010	0.100	0.005	0.005K	0.010K

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/09/24

0808AA P00808AA P001000
 39 39 45.0 106 04 55.0 4
 SILVERTHORNE
 08 7.5 DILLION
 T/GREEN MT. RES. 110391
 LOWER BLUE RIVER
 11EPALES 2141204
 0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 N02&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	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
75/01/31	08 45		0.080	16.000	13.000	0.073	0.960	0.390	0.434
75/03/03	09 15		0.080	17.000	11.600	0.140	0.760	0.484	0.426
75/03/31	15 00		0.080	17.500	13.200	0.140	0.190	0.531	0.515
75/04/30	15 00		1.100	6.300	5.400	0.088	0.100K	0.751	0.673
75/05/28	14 30		0.550	4.400	4.100	0.050K	0.100K	1.040	0.851
75/06/11	15 15		0.300	4.700	4.200	0.050K	0.150	0.796	0.881
75/07/02	15 30		4.900	6.500	4.800	0.043	0.110	0.688	0.712
75/07/23	15 00		6.500	6.100	4.900	0.050K	0.250	0.743	0.741
75/08/14	15 00		13.200	6.500	3.600	0.025K	0.300	0.562	0.623
75/09/04	15 15		14.350	4.900	2.300	0.060	0.730	0.510	0.458
75/09/24	15 00		15.000	5.600	1.800	0.620	1.200	0.464	0.456
75/10/15	17 15		18.000	4.350	1.300	0.390	0.530	0.387	0.410
75/11/05	10 30		16.800	1.900	0.600	0.908	0.920	0.440	0.413

K VALUE KNOWN TO BE
 LESS THAN INDICATED