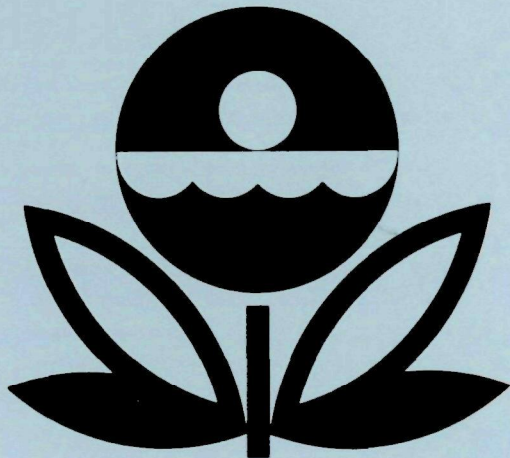


**U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY
WORKING PAPER SERIES**



REPORT
ON
ECHO RESERVOIR
SUMMIT COUNTY
UTAH
EPA REGION VIII
WORKING PAPER No. 838

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

REPORT
ON
ECHO RESERVOIR
SUMMIT COUNTY
UTAH
EPA REGION VIII
WORKING PAPER No. 838

WITH THE COOPERATION OF THE
UTAH STATE DIVISION OF HEALTH
AND THE
UTAH NATIONAL GUARD
OCTOBER, 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 and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the Utah Department of Social Services and the Utah Department of Natural Resources for professional involvement, to the Utah National Guard for conducting the tributary sampling phase of the Survey, and to those Utah wastewater treatment plant operators who voluntarily provided effluent samples and flow data.

The staffs of the Bureau of Water Quality of the Division of Health and the Division of Wildlife Resources 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 Maurice L. Watts, the Adjutant General of Utah, and Project Officer Lt. Colonel T. Ray Kingston, who directed the volunteer efforts of the Utah National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES AND RESERVOIRS

STATE OF UTAHNAMECOUNTY

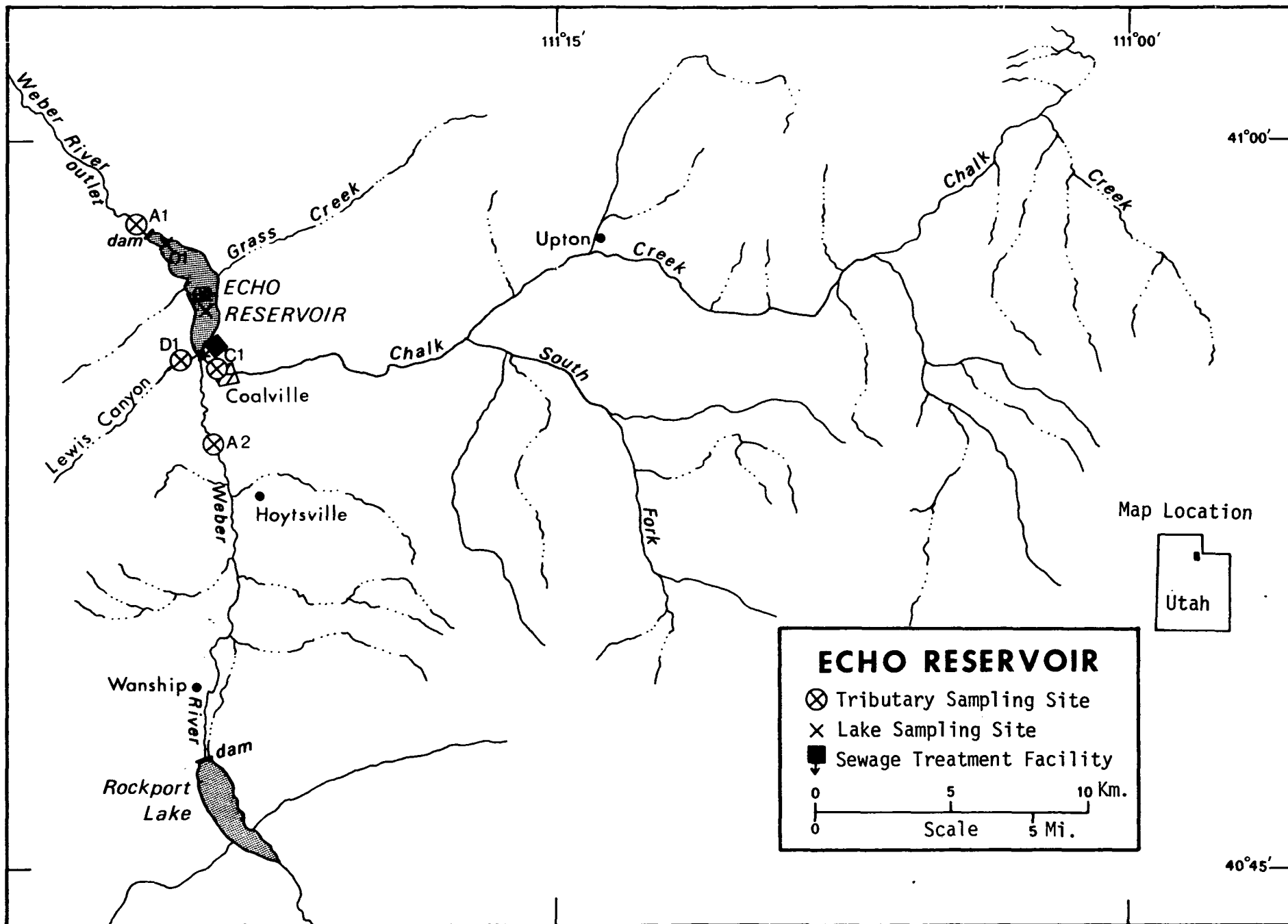
Bear
Deer Creek
Echo
Fish
Flaming Gorge

Rich, UT; Bear Lake, ID
Wasatch
Summit
Sevier
Daggett, UT;
Sweetwater, WY

Huntington
Joes Valley
Lower Bowns
Lynn
Minersville
Moon
Navajo
Newcastle
Otter Creek
Panguich
Pelican
Pineview
Piute
Porcupine
Powell

Emery
Emery
Garfield
Box Elder
Beaver
Duchesne
Kane
Iron
Piute
Garfield
Uintah
Weber
Piute
Cache
Garfield, Kane, San
Juan, UT; Coconino, AZ
Millard
Juab, Sanpete
Duchesne
Uintah
Garfield
Utah
Box Elder

Pruess
Sevier Bridge
Starvation
Steinaker
Tropic
Utah
Willard Bay



ECHO RESERVOIR
STORET NO. 4904

I. CONCLUSIONS

A. Trophic Condition

Survey data indicate that Echo Reservoir is eutrophic. It ranked twenty-sixth in overall trophic quality when the 27 Utah lakes and reservoirs sampled in 1975 were compared using a combination of six parameters*. Eighteen of the water bodies had less and one had the same median total phosphorus, 22 had less and one had the same median dissolved orthophosphorus, 19 had less median inorganic nitrogen, 13 had less mean chlorophyll a, and 21 had greater mean Secchi disc transparency. Marked depression of dissolved oxygen with depth occurred at sampling station 1 in August and September.

B. Rate-Limiting Nutrient:

The algal assay results are not considered representative of conditions in the reservoir at the times the samples were collected. However, the reservoir data indicate nitrogen limitation at both stations in May and September and at station 1 in August. Phosphorus limitation is indicated at station 2 in August.

C. Nutrient Controllability:

1. Point sources--It is calculated that the only known point source contributed 25.4% of the total phosphorus load to Echo Reservoir during the sampling year.

* See Appendix A.

The present phosphorus loading of $2.50 \text{ g/m}^2/\text{yr}$ is twice that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 11). While even complete removal of phosphorus at the Coalville wastewater treatment plant would still leave a loading of $1.87 \text{ g/m}^2/\text{yr}$, it is possible that a high degree of phosphorus control at the plant would result in persistent phosphorus limitation in the reservoir and at least some improvement in trophic condition.

2. Non-point sources--It is estimated that non-point sources contributed 74.6% of the total phosphorus load to the reservoir during the sampling year. The Weber River contributed 53.7% of the total load; Chalk Creek, 11.8%; and the minor tributaries and immediate drainage contributed an estimated 6.2%.

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

1. Surface area: 5.95 kilometers².
2. Mean depth: 15.3 meters.
3. Maximum depth: 33.5 meters.
4. Volume: 91.278×10^6 m³.
5. Mean hydraulic retention time: 134 days (based on outflow).

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>
Weber River	1,134.4	5.640
Chalk Creek	655.3	1.740
Unnamed Creek D-1	15.5	0.080
Minor tributaries & immediate drainage -	<u>84.7</u>	<u>0.227</u>
Totals	1,889.9	7.687

2. Outlet -

Weber River	1,895.9**	7.860
-------------	-----------	-------

C. Precipitation***:

1. Year of sampling: 42.0 centimeters.
2. Mean annual: 35.1 centimeters.

† Table of metric conversions--Appendix B.

†† Sudweeks, 1974; Anonymous, 1975.

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

** Includes area of reservoir.

*** See Working Paper No. 175.

III. WATER QUALITY SUMMARY

Echo Reservoir 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 two or more depths at two stations on the reservoir (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 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 24.4 meters at station 1 and 8.5 meters at station 2.

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 ECHO RESERVOIR
STORET CODE 4904

1ST SAMPLING (5/12/75)

2ND SAMPLING (8/ 7/75)

3RD SAMPLING (9/18/75)

2 SITES

2 SITES

2 SITES

PARAMETER	RANGE		MEAN	MEDIAN	RANGE		MEAN	MEDIAN	RANGE		MEAN	MEDIAN
TEMP (C)	6.6	- 9.6	8.3	9.3	10.3	- 22.0	18.0	18.4	13.0	- 14.9	14.2	14.2
DISS OXY (MG/L)	9.2	- 10.4	9.9	10.0	1.0	- 11.2	5.6	5.2	1.6	- 7.8	5.6	6.5
CNDCTVY (MCROMO)	451.	- 502.	467.	455.	265.	- 297.	287.	292.	310.	- 341.	334.	338.
PH (STAND UNITS)	8.3	- 8.5	8.4	8.4	8.2	- 8.9	8.6	8.5	7.9	- 8.5	8.2	8.3
TOT ALK (MG/L)	188.	- 266.	224.	222.	140.	- 181.	153.	151.	170.	- 175.	172.	172.
TOT P (MG/L)	0.035	- 0.144	0.065	0.051	0.016	- 0.199	0.046	0.027	0.038	- 0.137	0.064	0.049
ORTHO P (MG/L)	0.016	- 0.041	0.022	0.017	0.005	- 0.170	0.026	0.006	0.005	- 0.027	0.012	0.006
NO2+NO3 (MG/L)	0.060	- 0.160	0.101	0.110	0.020	- 0.260	0.086	0.035	0.030	- 0.200	0.091	0.060
AMMONIA (MG/L)	0.020	- 0.050	0.033	0.030	0.100	- 0.530	0.220	0.185	0.020	- 0.030	0.025	0.025
KJEL N (MG/L)	0.300	- 0.700	0.471	0.400	0.300	- 0.600	0.420	0.400	0.200	- 0.400	0.275	0.250
INORG N (MG/L)	0.080	- 0.210	0.134	0.130	0.120	- 0.790	0.306	0.280	0.060	- 0.230	0.116	0.080
TOTAL N (MG/L)	0.410	- 0.760	0.573	0.560	0.320	- 0.860	0.506	0.470	0.230	- 0.600	0.366	0.345
CHLRPYL A (UG/L)	8.5	- 13.4	10.9	10.9	4.2	- 4.7	4.4	4.4	2.6	- 8.4	5.5	5.5
SECCHI (METERS)	0.4	- 0.6	0.5	0.5	1.8	- 1.8	1.8	1.8	1.1	- 1.8	1.5	1.5

B. Biological Characteristics:

1. Phytoplankton -

<u>Sampling Date</u>	<u>Dominant Genera</u>	<u>Algal Units per ml</u>
05/12/75	1. <u>Chroomonas (?) sp.</u>	9,336
	2. <u>Centric diatoms</u>	1,221
	3. <u>Fragilaria sp.</u>	1,103
	4. <u>Cryptomonas sp.</u>	906
	5. <u>Asterionella sp.</u>	118
	Total	12,684
08/07/75	1. <u>Chroomonas (?) sp.</u>	305
	2. <u>Cryptomonas sp.</u>	153
	3. <u>Fragilaria sp.</u>	61
	4. <u>Asterionella sp.</u>	31
	5. <u>Ankistrodesmus sp.</u>	31
	Total	581
09/18/75	1. <u>Fragilaria sp.</u>	918
	2. <u>Chroomonas (?) sp.</u>	598
	3. <u>Cryptomonas sp.</u>	160
	4. <u>Aphanizomenon sp.</u>	40
	5. <u>Asterionella sp.</u>	40
	Total	1,756

2. Chlorophyll a -

<u>Sampling Date</u>	<u>Station Number</u>	<u>Chlorophyll a (µg/l)</u>
05/12/75	1	8.5
	2	13.4
08/07/75	1	4.2
	2	4.7
09/18/75	1	2.6
	2	8.4

C. Limiting Nutrient Study:

Significant nutrient changes occurred in the samples during shipment from the field to the laboratory, and the algal assay results are not considered representative of conditions in the reservoir at the times the samples were taken (05/12/75 and 09/18/75).

The reservoir data indicate nitrogen limitation at both sampling stations in May and September; i.e., the mean inorganic nitrogen/orthophosphorus ratios were 10/1 or less, and nitrogen limitation would be expected. The August data indicate nitrogen limitation at station 1 but phosphorus limitation at station 2 (the mean N/P ratios were 8/1 and 27/1, respectively).

Nitrogen limitation, as indicated by the in-reservoir nitrogen to phosphorus ratios, does not necessarily mean that the trophic condition of the reservoir can be improved by controlling nitrogen inputs. In many cases, the apparent condition of nitrogen-limitation results from excessive phosphorus input from point sources and is often accompanied by a corresponding increase in primary production. In such cases, the reversal of the enriched condition depends upon phosphorus control, not nitrogen control.

IV. NUTRIENT LOADINGS (See Appendix E for data)

For the determination of nutrient loadings, the Utah National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v). Sampling was begun in November, 1974, and was completed in May, 1975.

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

In this report, nutrient loads for sampled tributaries were calculated using mean annual concentrations and mean annual flows.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the mean concentrations in the unnamed stream at station D-1 and the mean annual ZZ flow.

The operator of the Coalville wastewater treatment plant provided monthly effluent samples, and corresponding flow data were provided by S. E. Sowby, Mountainland Association of Governments, Provo.

A. Waste Sources:

1. Known municipal* -

<u>Name</u>	<u>Pop. Served</u>	<u>Treatment</u>	<u>Mean Flow (m³/d)</u>	<u>Receiving Water</u>
Coalville	1,000	tr. filter	660.3**	Echo Reservoir

2. Known industrial - None

* Hopkins, 1975.

** Sowby, 1977.

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) -		
Weber River	8,005	53.7
Chalk Creek	1,755	11.8
Unnamed Creek D-1	325	2.2
b. Minor tributaries & immediate drainage (non-point load) -	925	6.2
c. Known municipal STP's -		
Coalville	3,785	25.4
d. Septic tanks - Unknown	?	-
e. Known industrial - None	-	-
f. Direct precipitation* -	<u>105</u>	<u>0.7</u>
Total	14,900	100.0

2. Outputs -

Reservoir outlet - Weber River 10,165

3. Net annual P accumulation - 4,735 kg.

* 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) -		
Weber River	215,390	68.0
Chalk Creek	64,585	20.4
Unnamed Creek D-1	5,140	1.6
b. Minor tributaries & immediate drainage (non-point load) -	14,580	4.6
c. Known municipal STP's -		
Coalville	10,495	3.3
d. Septic tanks - Unknown	?	-
e. Known industrial - None	-	-
f. Direct precipitation* -	<u>6,425</u>	<u>2.1</u>
Total	316,615	100.0

2. Outputs -

Reservoir outlet - Weber River 178,965

3. Net annual N accumulation - 137,650 kg.

D. Non-point Nutrient Export by Subdrainage Area:

<u>Tributary</u>	<u>kg P/km²/yr</u>	<u>kg N/km²/yr</u>
Weber River	7	190
Chalk Creek	3	99
Unnamed Creek D-1	21	332

* 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	2.50	0.80	53.2	23.1

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

"Dangerous" (eutrophic loading)	1.22
"Permissible" (oligotrophic loading)	0.61

V. LITERATURE REVIEWED

- Anonymous, 1975. Water resources data for Utah. Part 1. Surface water records. U.S. Geol. Surv., Salt Lake City.
- Hopkins, Clyde M., 1975. Treatment plant questionnaire. UT Bur. of Env. Health, Salt Lake City.
- Sowby, Stephen E., 1977. Personal communication (corrected flow data for Coalville STP). Mountainland Assoc. of Govts., Provo.
- Sudweeks, Calvin K., 1975. Personal communication (reservoir morphometry). UT Bur. of Env. Health, Salt Lake City.
- 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
0408	LAKE POWELL	0.010	0.410	339.830	3.081	13.800	0.007
4901	BEAR LAKE	0.011	0.040	253.167	0.945	9.200	0.003
4902	LOWER BOWN'S RESERVOIR	0.031	0.040	336.000	5.567	9.400	0.006
4903	DEER CREEK RESERVOIR	0.038	0.215	430.333	9.078	14.800	0.006
4904	ECHO RESERVOIR	0.047	0.170	450.333	6.967	14.000	0.012
4905	LYNN RESERVOIR	0.121	0.200	417.667	39.600	10.400	0.052
4906	FISH LAKE	0.023	0.040	152.000	12.483	10.400	0.004
4907	HUNTINGTON NORTH RESERVO	0.013	0.040	392.000	1.900	7.800	0.005
4908	JOE'S VALLEY RESERVOIR	0.012	0.045	400.000	2.483	11.200	0.003
4909	MINERSVILLE RESERVOIR	0.192	0.060	445.000	33.583	8.600	0.107
4910	MOON LAKE	0.008	0.040	381.000	2.700	9.600	0.002
4911	NAVAJO LAKE	0.016	0.040	368.000	2.000	6.000	0.003
4912	NEWCASTLE RESERVOIR	0.051	0.040	428.667	12.467	13.600	0.009
4913	OTTER CREEK RESERVOIR	0.067	0.040	453.667	11.767	10.600	0.033
4914	PANQUITCH LAKE	0.071	0.040	426.500	45.950	14.200	0.010
4915	PELICAN LAKE	0.044	0.050	438.500	6.350	8.400	0.004
4916	PINEVIEW RESERVOIR	0.028	0.300	435.083	5.692	14.600	0.006
4917	PIUTE RESERVOIR	0.047	0.150	482.625	25.329	11.600	0.007
4918	PORCUPINE RESERVOIR	0.025	0.110	440.000	7.860	12.400	0.011
4919	PRUESS RESERVOIR (GARRIS	0.057	0.140	491.000	4.533	8.800	0.008
4920	SEVIER BRIDGE RESERVOIR	0.026	0.355	449.778	18.222	12.400	0.008
4921	STARVATION RESERVOIR	0.016	0.040	394.583	5.675	13.200	0.004
4922	STEINAKER RESERVOIR	0.011	0.040	316.750	1.844	12.600	0.005
4923	TROPIC RESERVOIR	0.021	0.050	425.000	7.200	8.400	0.006
4924	UTAH LAKE	0.132	0.320	490.583	72.012	11.400	0.012
4925	WILLARD BAY RESERVOIR	0.044	0.060	457.182	7.567	11.000	0.009
5605	FLAMING GORGE RESERVOIR	0.011	0.690	285.636	2.500	10.400	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 CHLOR-A	15- MIN DO	MEDIAN DISS OXYGEN P	INDEX NO
0408	LAKE POWELL	96 (25)	4 (1)	81 (21)	73 (19)	15 (4)	42 (11)	311
4901	BEAR LAKE	90 (23)	87 (19)	96 (25)	100 (26)	77 (20)	90 (23)	540
4902	LOWER BOWN'S RESERVOIR	46 (12)	87 (19)	85 (22)	65 (17)	73 (19)	50 (13)	406
4903	DEER CREEK RESERVOIR	42 (11)	19 (5)	42 (11)	35 (9)	0 (0)	58 (14)	196
4904	ECHO RESERVOIR	31 (8)	27 (7)	19 (5)	50 (13)	12 (3)	13 (3)	152
4905	LYNN RESERVOIR	8 (2)	23 (6)	58 (15)	8 (2)	62 (15)	4 (1)	163
4906	FISH LAKE	62 (16)	65 (16)	100 (26)	23 (6)	62 (15)	79 (20)	391
4907	HUNTINGTON NORTH RESERVO	77 (20)	65 (16)	69 (18)	92 (24)	96 (25)	69 (18)	468
4908	JOE'S VALLEY RESERVOIR	81 (21)	58 (15)	62 (16)	85 (22)	46 (12)	96 (25)	428
4909	MINERSVILLE RESERVOIR	0 (0)	44 (11)	27 (7)	12 (3)	85 (22)	0 (0)	168
4910	MOON LAKE	100 (26)	87 (19)	73 (19)	77 (20)	69 (18)	100 (26)	506
4911	NAVAJO LAKE	69 (18)	87 (19)	77 (20)	88 (23)	100 (26)	85 (22)	506
4912	NEWCASTLE RESERVOIR	23 (6)	87 (19)	46 (12)	27 (7)	19 (5)	27 (7)	229
4913	OTTER CREEK RESERVOIR	15 (4)	87 (19)	15 (4)	31 (8)	54 (14)	8 (2)	210
4914	PANBUITCH LAKE	12 (3)	65 (16)	50 (13)	4 (1)	8 (2)	23 (6)	162
4915	PELICAN LAKE	37 (9)	54 (14)	35 (9)	54 (14)	90 (23)	73 (19)	343
4916	PINEVIEW RESERVOIR	50 (13)	15 (4)	38 (10)	58 (15)	4 (1)	58 (14)	223
4917	PIUTE RESERVOIR	27 (7)	31 (8)	8 (2)	15 (4)	38 (10)	46 (12)	165
4918	PORCUPINE RESERVOIR	58 (15)	38 (10)	31 (8)	38 (10)	33 (8)	19 (5)	217
4919	PRUESS RESERVOIR (GARRIS	19 (5)	35 (9)	0 (0)	69 (18)	81 (21)	37 (9)	241
4920	SEVIER BRIDGE RESERVOIR	54 (14)	8 (2)	23 (6)	19 (5)	33 (8)	37 (9)	174
4921	STARVATION RESERVOIR	73 (19)	87 (19)	65 (17)	62 (16)	23 (6)	79 (20)	389
4922	STEINAKER RESERVOIR	85 (22)	87 (19)	88 (23)	96 (25)	27 (7)	65 (17)	448
4923	TROPIC RESERVOIR	65 (17)	50 (13)	54 (14)	46 (12)	90 (23)	58 (14)	363
4924	UTAH LAKE	4 (1)	12 (3)	4 (1)	0 (0)	42 (11)	13 (3)	75
4925	WILLARD BAY RESERVOIR	37 (9)	44 (11)	12 (3)	42 (11)	50 (13)	31 (8)	216
4926	WILLARD BAY RESERVOIR	37 (9)	44 (11)	12 (3)	42 (11)	50 (13)	31 (8)	216

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	4901	BEAR LAKE	540
2	4911	NAVAJO LAKE	506
3	4910	MOON LAKE	506
4	4907	HUNTINGTON NORTH RESERVO	468
5	4922	STEINAKER RESERVOIR	448
6	4908	JOE'S VALLEY RESERVOIR	428
7	5605	FLAMING GORGE RESERVOIR	415
8	4902	LOWER BOWN'S RESERVOIR	406
9	4906	FISH LAKE	391
10	4921	STARVATION RESERVOIR	389
11	4923	TROPIC RESERVOIR	363
12	4915	PELICAN LAKE	343
13	0408	LAKE POWELL	311
14	4919	PRUESS RESERVOIR (GARRIS	241
15	4912	NEWCASTLE RESERVOIR	229
16	4916	PINEVIEW RESERVOIR	223
17	4918	PORCUPINE RESERVOIR	217
18	4925	WILLARD BAY RESERVOIR	216
19	4913	OTTER CREEK RESERVOIR	210
20	4903	DEER CREEK RESERVOIR	196
21	4920	SEVIER BRIDGE RESERVOIR	174
22	4909	MINERSVILLE RESERVOIR	168
23	4917	PIUTE RESERVOIR	165
24	4905	LYNN RESERVOIR	163
25	4914	PANQUITCH LAKE	162
26	4904	ECHO RESERVOIR	152
27	4924	UTAH LAKE	75

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 UTAH

10/18/76

LAKE CODE 4904 ECHO RES

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 1895.9

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS)												MEAN
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
4904A1	1895.9	3.11	3.11	2.83	5.95	18.69	20.95	12.46	10.19	6.51	3.40	3.68	3.11	7.86
4904A2	1134.4	3.40	3.40	4.53	7.08	11.33	14.44	5.66	3.96	3.40	3.40	3.68	3.40	5.64
4904C1	655.3	0.54	0.59	0.99	3.17	7.33	4.45	1.10	0.57	0.48	0.51	0.57	0.54	1.74
4904D1	15.5	0.028	0.028	0.042	0.142	0.340	0.198	0.042	0.028	0.028	0.028	0.028	0.028	0.080
4904ZZ	90.6	0.057	0.085	0.142	0.425	0.963	0.566	0.142	0.085	0.057	0.057	0.085	0.057	0.227

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 1895.9
SUM OF SUB-DRAINAGE AREAS = 1895.9

TOTAL FLOW IN = 92.20
TOTAL FLOW OUT = 94.01

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW
4904A1	11	74	0.651	10	0.623		
	12	74	0.680	21	0.680		
	1	75	0.680	4	0.680		
	2	75	3.398	2	0.736		
	3	75	4.814	23	5.663		
	4	75	17.273	5	11.327		
	5	75	14.442				
	6	75	23.786				
	7	75	22.087				
	8	75	11.893				
4904A2	9	75	13.309				
	10	75	7.362				
	11	74	5.125	10	5.097		
	12	74	3.681	21	2.237		
	1	75	4.021	4	2.350		
	2	75	3.908	2	5.239		
	3	75	3.936	23	3.879		
	4	75	5.493	5	3.823		
	5	75	7.844				
	6	75	30.101				
	7	75	19.029				
	8	75	4.049				
	9	75	4.078				
	10	75	4.701				

TRIBUTARY FLOW INFORMATION FOR UTAH

10/18/76

LAKE CODE 4904 ECHO RES

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW
4904C1	11	74	0.765	10	0.708		
	12	74	0.651	21	0.736		
	1	75	0.623	4	0.566		
	2	75	0.595	2	0.623		
	3	75	0.934	23	0.963		
	4	75	1.246	5	0.991		
	5	75	7.985				
	6	75	13.535				
	7	75	3.851				
	8	75	0.906				
4904D1	9	75	1.189				
	10	75	1.019				
	11	74	0.028				
	12	74	0.028				
	1	75	0.028				
	2	75	0.028				
	3	75	0.042				
	4	75	0.057				
	5	75	0.368				
	6	75	0.623				
4904ZZ	7	75	0.170				
	8	75	0.042				
	9	75	0.057				
	10	75	0.042				
	11	74	0.113				
	12	74	0.085				
	1	75	0.085				
	2	75	0.085				
	3	75	0.113				
	4	75	0.170				
	5	75	1.048				
	6	75	1.756				
	7	75	0.510				
	8	75	0.113				
	9	75	0.142				
	10	75	0.142				

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/08/12

490401
40 57 51.0 111 25 37.0 3
ECHO RESERVOIR
49043 UTAH

11EPALES 2111202
0072 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
75/05/12	15 15	0000	9.3	10.4	24	455	8.50	250	0.030	0.700	0.060	0.017
	15 15	0005	9.3	10.4		456	8.50	246	0.020	0.400	0.060	0.016
	15 15	0015	6.9	10.0		454	8.35	266	0.020	0.300	0.110	0.016
	15 15	0035	6.8	9.2		451	8.30	222	0.040	0.400	0.130	0.025
	15 15	0068	6.6	9.4		451	8.40	198	0.050	0.400	0.160	0.017
75/08/07	16 05	0000	21.5	6.8	72	297	8.90	150	0.280	0.300	0.020K	0.006
	16 05	0005	19.3	4.8		289	8.50	152	0.100	0.300	0.020	0.006
	16 05	0015	17.5	4.4		281	8.40	154	0.250	0.300	0.050	0.005
	16 05	0030	16.2	4.4		273	8.35	150	0.140	0.300	0.120	0.005
	16 05	0060	13.1	3.8		265	8.45	156	0.200	0.400	0.230	0.031
	16 05	0080	10.3	1.0		291	8.20	181	0.530	0.600	0.260	0.170
75/09/18	15 50	0000	14.3	6.8	72	337	8.50	171	0.020K	0.300	0.060	0.005
	15 50	0005	14.2	6.2		310	8.40	170	0.020K	0.300	0.060	0.006
	15 50	0024	13.9	4.8		333	8.10	172	0.020K	0.200	0.130	0.014
	15 50	0045	13.3	1.6		338	7.95	174	0.020K	0.400	0.180	0.027
	15 50	0071	13.0	2.8		330	7.90	175	0.030	0.400	0.200	0.024

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/05/12	15 15	0000	0.051	8.5	
	15 15	0005	0.048		
	15 15	0015	0.036		
	15 15	0035	0.035		
	15 15	0068	0.056		
75/08/07	16 05	0000	0.024	4.2	
	16 05	0005	0.029		
	16 05	0015	0.021		
	16 05	0030	0.016		
	16 05	0060	0.044		
	16 05	0080	0.199		
75/09/18	15 50	0000	0.043	2.6	
	15 50	0005	0.038		
	15 50	0024	0.070		
	15 50	0045	0.137		
	15 50	0071	0.079		

STORET RETRIEVAL DATE 76/08/12

490402
40 56 13.0 111 24 12.0 3
ECHO RESERVOIR
49043 UTAH

11EPALES 2111202
0011 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
75/05/12	15 35	0000	9.6	10.0	14	502	8.50	197	0.030	0.600	0.060	0.021
	15 35	0005	9.3	9.6		502	8.45	188	0.040	0.500	0.130	0.041
75/08/07	16 20	0000	22.0	6.6	72	297	8.60	149	0.140	0.400	0.020K	0.012
	16 20	0005	21.9	7.4		292	8.85	140	0.160	0.500	0.020	0.006
	16 20	0015	21.3	11.2		293	8.89	144	0.170	0.500	0.020K	0.006
	16 20	0028	17.3	5.6		295	8.45	157	0.230	0.600	0.100	0.009
75/09/18	16 15	0000	14.9	7.6	44	339	8.30	172	0.030	0.200	0.040	0.007
	16 15	0005	14.9	7.8		341	8.40	173	0.030	0.200	0.030	0.006
	16 15	0011	14.9	7.4		340	8.40	172	0.030	0.200	0.030	0.006

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/05/12	15 35	0000	0.083	13.4	
	15 35	0005	0.144		
75/08/07	16 20	0000	0.033	4.7	
	16 20	0005	0.026		
	16 20	0015	0.025		
	16 20	0028	0.047		
75/09/18	16 15	0000	0.049	8.4	
	16 15	0005	0.050		
	16 15	0011	0.049		

K VALUE KNOWN TO BE
LESS THAN INDICATED

APPENDIX E

TRIBUTARY AND WASTEWATER
TREATMENT PLANT DATA

STORET RETRIEVAL DATE 76/08/12

4904A1
41 58 00.0 111 26 10.0 4
WEBER RIVER
49 7.5 COALVILLE
O/ECHO RESERVOIR 150791
GAGE STATN .5 MI BELOW ECHO 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
74/11/10	10 35		0.085	0.800	0.055	0.023	0.030
74/12/21	07 30		0.112	0.500	0.025	0.010	0.030
75/01/04	13 15		0.232	0.400	0.015	0.020	0.060
75/02/02	12 45		0.152	0.400	0.088	0.024	0.050
75/03/23	11 00		0.165	0.300	0.050	0.015	0.030
75/04/05	11 30		0.150	0.550	0.070	0.010	0.060
75/05/14	09 30		0.110	1.100	0.300	0.007	0.030

STORET RETRIEVAL DATE 76/08/12

4904A2
40 53 49.0 111 24 05.0 4
WEBER RIVER
49 7.5 COALVILLE
T/ECHO RESERVOIR
BRDG ON LGHT DTY RD 1.5 M S OF COALVILLE
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
74/11/10	11 40		0.120	0.900	0.055	0.022	0.030
74/12/21	09 00		0.248	2.000	0.027	0.020	0.030
75/01/04	14 00		0.200	0.500	0.045	0.025	0.030
75/02/02	13 30		0.192	0.200	0.024	0.016	0.030
75/03/23	12 00		0.230	0.450	0.030	0.015	0.070
75/04/05	13 00		0.190	0.600	0.055	0.015	0.080
75/05/14	11 00		0.250	2.400	0.045	0.055	

STORET RETRIEVAL DATE 76/08/12

4904C1
40 55 14.0 111 24 07.0 4
CHALK CREEK
49 7.5 COALVILLE
T/ECHO RESERVOIR
US 189 BRDG .2 MI N OF JCT W ST RT 133
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
74/11/10	10 55		0.288	0.900	0.030	0.010	0.010
74/12/21	08 00		0.336	1.800	0.025	0.005	0.020
75/01/04	13 30		0.384	0.300	0.005	0.005	0.010
75/02/02	13 00		0.330	0.200	0.016	0.016	0.020
75/03/23	11 30		0.200	0.200	0.020	0.010	0.070
75/04/05	12 00		0.080	0.400	0.020	0.005K	0.060
75/05/14	10 20		0.420	2.400	0.140	0.050	

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/12

490401
40 55 13.0 111 24 42.0 4
UNNAMED STREAM
49 7.5 COALVILLE
T/ECHO RESERVOIR
BRDG ON LGHT DTY RD 2 MI W OF COALVILLE
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					
74/11/10	12	05	1.280	0.600	0.020	0.050	0.060
74/12/12	09	30	1.360	0.400	0.020	0.085	0.110
75/01/04	14	40	1.320	0.400	0.020	0.070	0.130
75/02/02	14	15	0.850	0.500	0.040	0.080	0.180
75/03/23	12	15	1.400	0.400	0.015	0.055	0.230
75/04/20	13	30	1.250	0.950	0.135	0.045	0.150
75/05/14	11	30	1.350	2.200	0.155	0.005	0.040

STORET RETRIEVAL DATE 76/06/12

490421 TF490421 P001000
 40 56 00.0 111 24 00.0 4
 COALVILLE
 49 7.5 COALVILLE
 D/ECHO RES.
 ECHO RES.
 11EPALES 2141204
 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	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
75/01/15	15 35		0.400	24.000	0.400K	4.800	8.400	0.150	0.600
75/04/10	12 30		0.300	28.000	9.100	3.400	9.800	0.050	0.650
75/05/02	14 40		0.350	27.000	5.750	3.750	11.000	0.600	0.700
75/05/29	15 00		0.600	15.500	3.600	2.200	10.000	0.750	0.650
75/06/24	19 30		2.750	8.500	0.025K	1.700	3.500	0.670	0.650
75/07/02	14 30		1.000	9.795	0.025K	1.350	2.050	0.800	
75/09/09	14 00		1.700	8.700	0.025K	1.880	4.800	0.432	0.432
75/10/30	12 00		1.300	21.000	5.500	4.000	6.600	0.100	0.100
75/12/16	12 00		0.900	26.000	9.600	3.750	8.000	0.270	0.260

K VALUE KNOWN TO BE
 LESS THAN INDICATED