U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

REPORT

ON

LAKE BASTROP

BASTROP COUNTY

TEXAS

EPA REGION VI

WORKING PAPER No. 632

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

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Report

on

Lake Bastrop

Bastrop County

Texas

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Working Paper No. 632

With the cooperation of the

Texas Water Quality Board

and the

Texas National Guard

September, 1977

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGEMENT

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

Hugh C. Yantis, Jr., Executive Director of the Texas Water Quality Board, and John B. Latchford, Jr., Director, and the staff of the Field Operations 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.

Major General Thomas Bishop, the Adjutant General of Texas, and Project Officer Colonel William L. Seals, who directed the volunteer efforts of the Texas National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

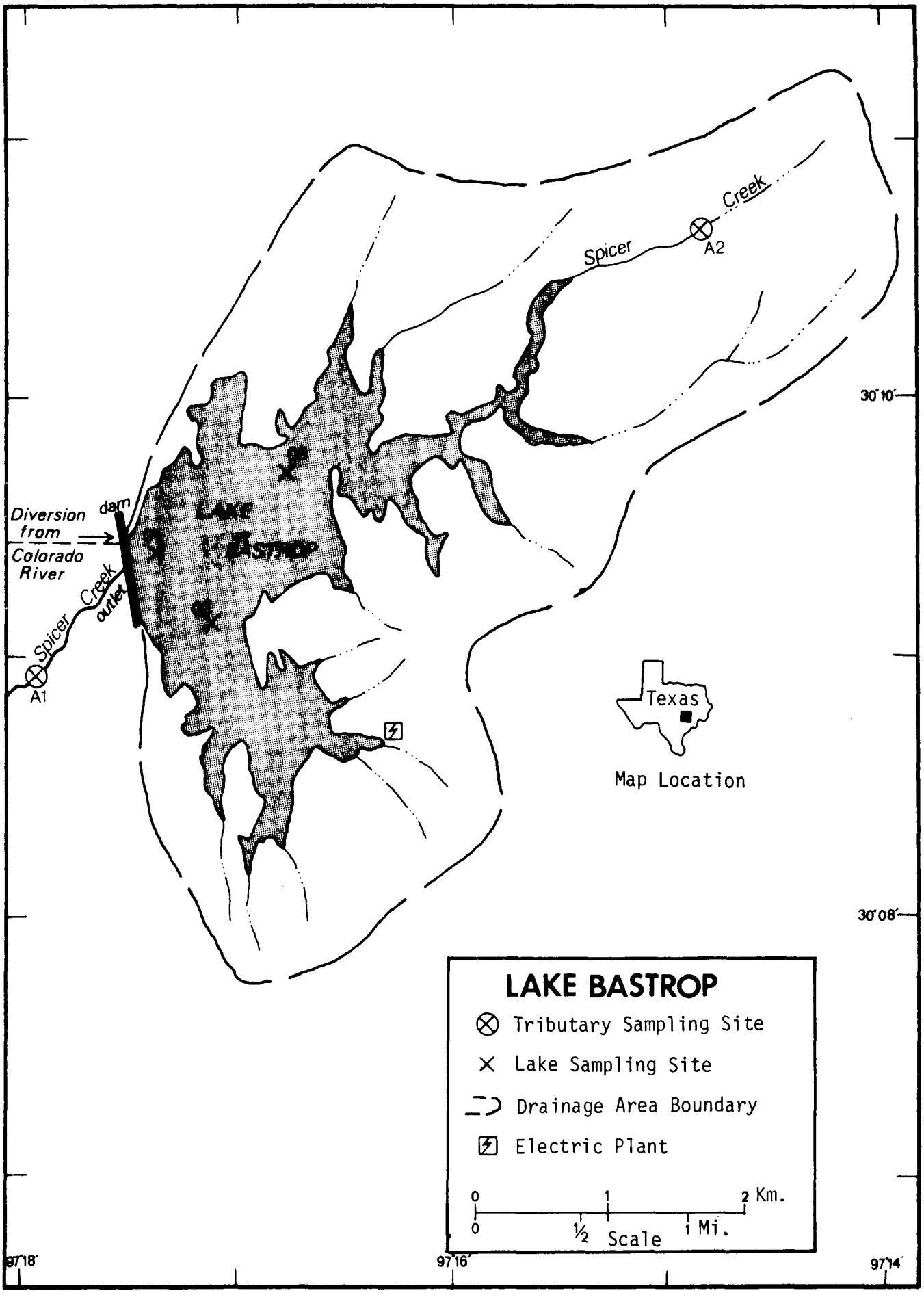
NATIONAL EUTROPHICATION SURVEY

STUDY RESERVOIRS

State of Texas

NAME	COUNTY
Amistad	Val Verde
Bastrop	Bastrop
Belton	Bell, Coryell
Braunig	Bexar
Brownwood	Brown
Buchanan	Burnet, Llano
Caddo	Harrison, Marion, TX; Caddo Parish, LA
Calaveras	Bexar
Canyon	Comal
Colorado City	Mitchell
Corpus Christi	Jim Wells, Live Oak, San Patricio
Diversion	Archer, Baylor
Eagle Mountain	Tarrant, Wise
Fort Phantom Hill	Jones
Houston	Harris
Kemp	Baylor
Lake O'The Pines	Camp, Marion, Morris, Upshur
Lavon	Collin
Lewisville (Garza-Little Elm)	Denton
Livingston	Polk, San Jacinto, Trinity, Walker

Lyndon B. Johnson	Burnet, Llano
Medina	Bandera, Medina
Meredith	Hutchinson, Moore, Potter
O. C. Fisher (San Angelo)	Tom Green
Palestine	Anderson, Cherokee, Henderson, Smith
Possum Kingdom	Palo Pinto, Stephens, Young
Sam Rayburn	Angelina, Jasper Nacogdoches, Sabine, San Augustine
Somerville	Burleson, Lee, Washington
E. V. Spence	Coke
Stamford	Haskell
Stillhouse Hollow	Bell
Tawakoni	Hunt, Rains, Van Zandt
Texoma	Cooke, Grayson TX; Bryan, Johnston, Love, Marshall, OK
Travis	Burnet, Travis
Trinidad	Henderson
Twin Buttes	Tom Green
White River	Crosby
Whitney	Bosque, Hill
Wright Patman (Texarkana)	Bowie, Cass


Spicer Creek
A2
30°10′
Diversion from Colorado River
dam
LAKE BASTROP
Spicer Creek
outlet
A1
Texas
Map Location
30°08′
LAKE BASTROP
Tributary Sampling Site
Lake Sampling Site
Drainage Area Boundary
Electric Plant
0
1
2 Km.
0
½
1 Mi.
Scale
97°18′
97°16′
97°14′

LAKE BASTROP

STORET NO. 4802

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Lake Bastrop is meso-eutrophic; i.e., moderately well supplied with nutrients and productive. Whether nutrient enrichment is beneficial or deleterious depends on the actual or potential effect on the uses of the lake. In this regard, no nuisance conditions are known to personnel of the Texas Water Quality Board and there is little or no impairment of the designated beneficial uses of this water body.

Lake Bastrop ranked seventh in overall trophic quality when the 39 Texas reservoirs sampled in 1974 were compared using a combination of six water quality parameters*. Eight of the reservoirs had less median total phosphorus, two had less and five had the same median dissolved orthophosphorus, eight had less and two had the same median inorganic nitrogen, 20 had less mean chlorophyll a, and seven had greater mean Secchi disc transparency. Marked depression or depletion of hypolimnetic dissolved oxygen occurred at all three sampling stations in May and August.

Survey limnologists observed many submerged macrophytes in the shallows at all stations.

B. Rate-Limiting Nutrient:

The algal assay results are not considered representative of conditions in the lake at the time samples were taken due to a

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* See Appendix A.

significant loss of phosphorus in the sample during shipment from the field to the laboratory.

The lake data indicate nitrogen limitation in March and November and phosphorus limitation in May.

C. Nutrient Controllability:

1. Point sources--No known point sources discharged in the Lake Bastrop drainage during the sampling year. However, phosphorus inputs from the Colorado River diversion are substantial, and it is possible that the City of Austin contributes to the enrichment of Lake Bastrop via the diversion.

The present phosphorus loading of 0.27 $g/m^2/year$ is greater than that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 13). Improvement of the present trophic condition of Lake Bastrop is dependent upon the controllability of sources impacting the Colorado River upstream. Minimization of point-source phosphorus could result in a more phosphorus limited condition in the lake and at least slow the present rate of eutrophication.

2. Non-point sources--Non-point sources apparently contributed the entire phosphorus load to Lake Bastrop during the sampling year. Spicer Creek contributed 0.5%, the diversion from the Colorado River contributed an estimated 89.3% and the ungaged minor tributaries and immediate drainage contributed an estimated 3.6%.

As noted above, part of the load in the diversion from the Colorado River may be contributed by point sources upstream on the Colorado River. An additional investigation would be needed to determine the significance of such sources.

II. RESERVOIR AND DRAINAGE BASIN CHARACTERISTICS†

A. Morphometry††:

1. Surface area: 3.67 kilometers^2.
2. Mean depth: 5.6 meters.
3. Maximum depth: >13.4 meters.
4. Volume: 20.552 x 10^6 m^3.
5. Mean hydraulic retention time: 5.2 years.

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

1. Tributaries -

Name	Drainage area (km^2)†††	Mean flow (m^3/sec)†††
Spicer Creek	2.3	0.007
Colorado River diversion	-	0.184*
Minor tributaries & immediate drainage -	18.6	0.047
Totals	20.9	0.238

2. Outlet -

Electric plant diversion	-	0.055*
Spicer Creek	24.6	0.071
Total	24.6**	0.126***

C. Precipitation****:

1. Year of sampling: 92.0 centimeters.
2. Mean annual: 82.5 centimeters.

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† Table of metric conversions--Appendix B.
†† Latchford, 1974.
††† For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
* Yost, 1976 (see page 9).
** Includes area of lake.
*** Outflow adjusted to equal sum of inflows minus evaporation loss.
**** See Working Paper No. 175.

III. WATER QUALITY SUMMARY

Lake Bastrop was sampled four times in 1974 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 vi). 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 March and November 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 17.1 meters at station 1, 9.1 meters at station 2, and 13.4 meters at station 3.

The sampling results are presented in full in Appendix D and are summarized in the following table (the August nutrient samples were not properly preserved and were not analyzed).

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR BASTROP LAKE
STORET CODE 4802

PARAMETER	1ST SAMPLING (3/14/74) 3 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (5/22/74) 3 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (8/16/74) 3 SITES RANGE	MEAN	MEDIAN
TEMP (C)	16.9 - 25.7	21.7	22.8	19.9 - 33.6	28.8	30.6	20.4 - 33.3	29.4	30.4
DISS OXY (MG/L)	3.0 - 8.8	6.4	6.3	0.2 - 8.0	4.4	5.8	0.0 - 7.6	4.4	5.0
CNDCTVY (MCROMO)	645. - 770.	713.	730.	708. - 896.	825.	840.	724. - 900.	841.	852.
PH (STAND UNITS)	7.9 - 8.7	8.4	8.5	7.3 - 8.8	8.3	8.5	7.3 - 8.8	8.2	8.4
TOT ALK (MG/L)	149. - 153.	151.	151.	121. - 155.	132.	128.	****** -**********		
TOT P (MG/L)	0.017 - 0.029	0.024	0.024	0.012 - 0.042	0.019	0.017	****** -**********		
ORTHO P (MG/L)	0.007 - 0.015	0.011	0.011	0.002 - 0.012	0.004	0.003	****** -**********		
NO2+NO3 (MG/L)	0.020 - 0.060	0.028	0.020	0.020 - 0.090	0.035	0.030	****** -**********		
AMMONIA (MG/L)	0.020 - 0.240	0.063	0.020	0.020 - 0.540	0.099	0.030	****** -**********		
KJEL N (MG/L)	0.200 - 0.600	0.487	0.500	0.300 - 0.900	0.507	0.400	****** -**********		
INORG N (MG/L)	0.040 - 0.280	0.091	0.040	0.040 - 0.570	0.134	0.050	****** -**********		
TOTAL N (MG/L)	0.220 - 0.660	0.515	0.520	0.330 - 0.990	0.541	0.450	****** -**********		
CHLRPYL A (UG/L)	5.9 - 7.0	6.4	6.4	8.2 - 49.8	32.4	39.3	6.3 - 8.2	7.2	7.1
SECCHI (METERS)	1.5 - 1.8	1.6	1.5	2.3 - 3.0	2.7	2.9	2.3 - 2.4	2.3	2.3

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR BASTROP LAKE
STORET CODE 4802

4TH SAMPLING (11/ 4/74)

PARAMETER	3 SITES RANGE	MEAN	MEDIAN
TEMP (C)	23.5 - 24.4	24.0	24.1
DISS OXY (MG/L)	6.0 - 8.0	7.2	7.2
CNDCTVY (MCROMO)	7246. - 7253.	7250.	7251.
PH (STAND UNITS)	7.9 - 8.2	8.1	8.1
TOT ALK (MG/L)	124. - 138.	132.	132.
TOT P (MG/L)	0.018 - 0.030	0.024	0.023
ORTHO P (MG/L)	0.004 - 0.016	0.009	0.008
NO2+NO3 (MG/L)	0.030 - 0.050	0.034	0.030
AMMONIA (MG/L)	0.060 - 0.140	0.081	0.070
KJEL N (MG/L)	0.300 - 0.600	0.492	0.500
INORG N (MG/L)	0.090 - 0.170	0.115	0.110
TOTAL N (MG/L)	0.330 - 0.630	0.526	0.540
CHLRPYL A (UG/L)	3.2 - 3.7	3.5	3.6
SECCHI (METERS)	1.2 - 1.5	1.4	1.5

B. Biological Characteristics:

1. Phytoplankton* -

Sampling Date	Dominant Genera	Algal Units per ml
03/14/74	1. *Pediastrum sp.*	834
	2. *Oocystis sp.*	371
	3. *Chroomonas sp.*	278
	4. *Cryptomonas sp.*	232
	5. *Scenedesmus sp.*	185
	Other genera	394
	Total	2,294
05/22-23/74	1. Pennate diatoms	827
	2. *Oscillatoria sp.*	674
	3. *Merismopedia sp.*	643
	4. *Pediastrum sp.*	337
	5. *Chroomonas sp.*	214
	Other genera	552
	Total	3,247
11/04/74	1. *Chroomonas sp.*	690
	2. *Cryptomonas sp.*	235
	3. *Pediastrum sp.*	63
	4. *Tetraedron sp.*	47
	5. *Nitzschia sp.*	31
	Other genera	16
	Total	1,082

* The August phytoplankton sample was lost in shipment.

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (μg/l)
03/14/74	1	7.0
	2	6.4
	3	5.9
05/22-23/74	1	8.2
	2	39.3
	3	49.8
08/16/74	1	8.2
	2	7.1
	3	6.3
11/04/74	1	3.6
	2	3.2
	3	3.7

C. Limiting Nutrient Study:

Because of significant changes in nutrients in the algal assay samples from the time of collection to the beginning of the assay, the results are not representative of conditions in the lake at the time of sampling.

The lake data indicate nitrogen limitation in March and November and phosphorus limitation in May (i.e., the mean inorganic nitrogen to orthophosphorus ratios were 8 to 1, 13 to 1, and 34 to 1, respectively).

IV. NUTRIENT LOADINGS
(See Appendix E for data)

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

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

The level of the lake is maintained by pumping water from the Colorado River. Diversions during 1964-73 ranged from 165,288 to 13,963,106 m^3/yr (0.005 - 0.443 m^3/sec); the ten year average is 5,797,403 m^3/yr (0.184 m^3/sec). Water from the lake is used in the cooling towers of an electric plant. Up to 13,260,017 m^3/yr (0.420 m^3/sec) is authorized (Yost, 1976).

In this report, nutrient loads for sampled tributaries were calculated using mean annual concentrations and mean annual flows. Nutrient loads in the Colorado River diversion were calculated using the mean annual flow and the mean concentrations at the U.S.G.S.

water quality sampling station (08158650) located 15.4 km downstream from the Austin gaging station (Anonymous, 1976). Nutrient loads in the electric plant withdrawal were calculated using the mean estimated flow and mean concentrations at lake sampling station 2.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the mean concentrations in Spicer Creek at station A-2 and the mean annual ZZ flow.

No known point sources discharged within the Lake Bastrop drainage basin during the sampling year.

A. Waste Sources:

1. Known municipal - None

2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Spicer Creek	5	0.5
Colorado River diversion	880	89.3
b. Minor tributaries & immediate drainage (non-point load) -	35	3.6
c. Known municipal STP's - None	-	-
d. Septic tanks - None	-	-
e. Known industrial - None	-	-
f. Direct precipitation* -	65	6.6
Total	985	100.0

2. Outputs -

Reservoir outlet - Electric plant diversion	40
Spicer Creek	65
Total	105

3. Net annual P accumulation - 880 kg.

* See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
Spicer Creek	140	1.2
Colorado River diversion	7,070	58.4
b. Minor tributaries & immediate drainage (non-point load) -	930	7.7
c. Known municipal STP's - None	-	-
d. Septic tanks - None	-	-
e. Known industrial - None	-	-
f. Direct precipitation* -	3,960	32.7
Total	12,100	100.0

2. Outputs -

Reservoir outlet -	Electric plant diversion	895
	Spicer Creek	1,900
	Total	2,795

3. Net annual N accumulation - 9,305 kg.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
Spicer Creek	2	61

* 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	0.27	0.24	3.3	2.5

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Lake Bastrop:	
"Dangerous" (eutrophic loading)	0.22
"Permissible" (oligotrophic loading)	0.11

V. LITERATURE REVIEWED

Anonymous, 1976. Water resources data for Texas, water year 1975. Water-Data Rept. TX-75-1, U.S. Geol. Surv., Austin.

Dougherty, John P., 1975. Evaporation data in Texas. Report 192, TX Water Dev. Bd., Austin.

Latchford, John B., Jr., 1974. Personal communication (lake morphometry). TX Water Qual. Bd., Austin.

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.

Yost, I. D., 1976. Personal communication (hydrological records of diversion from Colorado River; electric plant authorized withdrawal). U.S. Geol. Surv., Austin.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	4809	CANYON RESERVOIR	445
2	4823	LAKE MEREDITH	441
3	4813	EAGLE MOUNTAIN LAKE	430
4	4816	KEMP LAKE	423
5	4801	AMISTAD LAKE	402
6	4805	BROWNWOOD LAKE	394
7	4802	BASTROP LAKE	393
8	4838	WHITE RIVER RESERVOIR	390
9	4825	POSSUM KINGDOM RESERVOIR	387
10	4835	TRAVIS LAKE	384
11	4803	BELTON RESERVOIR	384
12	4831	STILLHOUSE HOLLOW RESERV	372
13	4812	DIVERSION LAKE	372
14	4808	CALAVERAS LAKE	362
15	4839	WHITNEY LAKE	357
16	4822	MEDINA LAKE	342
17	4827	SAM RAYBURN RESERVOIR	322
18	4828	E V SPENCE RESERVOIR	321
19	4837	TWIN BUTTES RESERVOIR	311
20	4810	LAKE COLORADO CITY	310
21	4824	PALESTINE LAKE	302
22	4818	LAKE OF THE PINES	298
23	4807	CADDO LAKE	297
24	4814	FT PHANTOM HILL LAKE	296
25	4806	LAKE BUCHANAN	261
26	4830	STAMFORD LAKE	259
27	4819	LAVON RESERVOIR	258
28	4832	TAWAKONI LAKE	253

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
29	4821	LYNDON B JOHNSON LAKE	238
30	4834	TEXOMA LAKE	217
31	4829	SOMERVILLE LAKE	208
32	4826	SAN ANGELO RESERVOIR	200
33	4833	TEXARKANA LAKE	176
34	4815	GARZA LITTLE ELM RESERVO	173
35	4836	TRINIDAD	169
36	4804	BRAUNIG LAKE	159
37	4811	CORPUS CRISTI LAKE	155
38	4817	HOUSTON LAKE	139
39	4820	LIVINGSTON LAKE	91

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
4801	AMISTAD LAKE	0.013	0.500	371.474	2.042	14.900	0.009
4802	BASTROP LAKE	0.022	0.090	419.917	12.392	15.000	0.007
4803	BELTON RESERVOIR	0.016	0.185	378.312	8.025	15.000	0.007
4804	BRAUNIG LAKE	0.134	0.150	461.625	22.762	14.800	0.062
4805	BROWNWOOD LAKE	0.027	0.100	470.375	4.887	14.400	0.007
4806	LAKE BUCHANAN	0.036	0.250	437.625	8.606	15.000	0.012
4807	CADDO LAKE	0.055	0.070	463.333	14.808	11.400	0.013
4808	CALAVERAS LAKE	0.038	0.060	461.667	22.500	13.000	0.007
4809	CANYON RESERVOIR	0.010	0.450	384.812	2.500	14.800	0.006
4810	LAKE COLORADO CITY	0.042	0.090	473.625	12.675	10.200	0.012
4811	CORPUS CRISTI LAKE	0.113	0.130	475.187	19.756	14.000	0.050
4812	DIVERSION LAKE	0.025	0.080	470.111	15.867	9.000	0.009
4813	EAGLE MOUNTAIN LAKE	0.024	0.070	469.625	5.662	11.000	0.008
4814	FT PHANTOM HILL LAKE	0.060	0.105	474.909	6.317	9.800	0.022
4815	GARZA LITTLE ELM RESERVO	0.045	0.380	475.782	14.156	14.600	0.018
4816	KEMP LAKE	0.023	0.110	455.000	10.217	10.400	0.007
4817	HOUSTON LAKE	0.097	0.260	486.187	16.650	12.400	0.036
4818	LAKE OF THE PINES	0.031	0.090	440.000	12.919	15.000	0.011
4819	LAVON RESERVOIR	0.063	0.180	485.333	5.400	8.800	0.018
4820	LIVINGSTON LAKE	0.196	0.555	465.469	16.112	15.000	0.128
4821	LYNDON B JOHNSON LAKE	0.042	0.420	456.500	8.100	14.900	0.013
4822	MEDINA LAKE	0.010	0.600	403.562	12.944	15.000	0.004
4823	LAKE MEREDITH	0.021	0.070	439.312	3.037	14.900	0.009
4824	PALESTINE LAKE	0.031	0.180	442.625	10.619	14.800	0.010
4825	POSSUM KINGDOM RESERVOIR	0.023	0.070	419.045	9.495	15.000	0.009
4826	SAN ANGELO RESERVOIR	0.098	0.140	481.000	24.675	10.200	0.011
4827	SAM RAYBURN RESERVOIR	0.029	0.150	439.458	6.267	15.000	0.009
4828	E U SPENCE RESERVOIR	0.026	0.080	462.583	[illegible]	15.000	0.008

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
4829	SOMERVILLE LAKE	0.053	0.115	473.833	24.491	13.000	0.013
4830	STAMFORD LAKE	0.073	0.060	482.714	18.457	10.600	0.012
4831	STILLHOUSE HOLLOW RESERV	0.018	0.160	406.250	3.917	15.000	0.010
4832	TAWAKONI LAKE	0.046	0.100	466.417	18.246	13.200	0.013
4833	TEXARKANA LAKE	0.106	0.120	478.500	19.119	12.400	0.030
4834	TEXOMA LAKE	0.042	0.160	451.321	12.493	15.000	0.018
4835	TRAVIS LAKE	0.018	0.250	389.913	5.595	15.000	0.007
4836	TRINIDAD	0.389	0.110	479.500	24.300	10.000	0.240
4837	TWIN BUTTES RESERVOIR	0.029	0.250	454.917	8.708	14.800	0.009
4838	WHITE RIVER RESERVOIR	0.020	0.110	434.500	4.333	15.000	0.009
4839	WHITNEY LAKE	0.028	0.120	430.500	6.912	15.000	0.008

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
4801	AMISTAD LAKE	95 (36)	5 (2)	100 (38)	100 (38)	39 (14)	63 (21)	402
4802	BASTROP LAKE	79 (30)	76 (28)	82 (31)	47 (18)	17 (0)	92 (34)	393
4803	BELTON RESERVOIR	92 (35)	26 (10)	97 (37)	68 (26)	17 (0)	84 (31)	384
4804	BRAUNIG LAKE	5 (2)	42 (16)	50 (19)	8 (3)	49 (17)	5 (2)	159
4805	BROWNWOOD LAKE	66 (25)	70 (26)	29 (11)	87 (33)	58 (22)	84 (31)	394
4806	LAKE BUCHANAN	47 (18)	21 (7)	74 (28)	63 (24)	17 (0)	39 (14)	261
4807	CADDO LAKE	26 (10)	91 (33)	42 (16)	32 (12)	76 (29)	30 (10)	297
4808	CALAVERAS LAKE	45 (17)	100 (38)	47 (18)	11 (4)	67 (25)	92 (34)	362
4809	CANYON RESERVOIR	99 (37)	8 (3)	95 (36)	97 (37)	49 (17)	97 (37)	445
4810	LAKE COLORADO CITY	39 (14)	76 (28)	26 (10)	42 (16)	88 (33)	39 (14)	310
4811	CORPUS CRISTI LAKE	8 (3)	47 (18)	18 (7)	13 (5)	61 (23)	8 (3)	155
4812	DIVERSION LAKE	68 (26)	83 (31)	32 (12)	29 (11)	97 (37)	63 (21)	372
4813	EAGLE MOUNTAIN LAKE	71 (27)	91 (33)	34 (13)	79 (30)	79 (30)	76 (28)	430
4814	FT PHANTOM HILL LAKE	24 (9)	66 (25)	21 (8)	74 (28)	95 (36)	16 (6)	296
4815	GARZA LITTLE ELM RESERVO	34 (13)	13 (5)	16 (6)	34 (13)	55 (21)	21 (7)	173
4816	KEMP LAKE	76 (29)	61 (22)	55 (21)	55 (21)	84 (32)	92 (34)	423
4817	HOUSTON LAKE	16 (6)	16 (6)	0 (0)	24 (9)	72 (27)	11 (4)	139
4818	LAKE OF THE PINES	54 (20)	76 (28)	66 (25)	39 (15)	17 (0)	46 (17)	298
4819	LAVON RESERVOIR	21 (8)	29 (11)	3 (1)	84 (32)	100 (38)	21 (7)	258
4820	LIVINGSTON LAKE	3 (1)	3 (1)	39 (15)	26 (10)	17 (0)	3 (1)	91
4821	LYNDON B JOHNSON LAKE	39 (14)	11 (4)	53 (20)	66 (25)	39 (14)	30 (10)	238
4822	MEDINA LAKE	99 (37)	0 (0)	89 (34)	37 (14)	17 (0)	100 (38)	342
4823	LAKE MEREDITH	82 (31)	91 (33)	71 (27)	95 (36)	39 (14)	63 (21)	441
4824	PALESTINE LAKE	54 (20)	32 (12)	63 (24)	53 (20)	49 (17)	51 (19)	302
4825	POSSUM KINGDOM RESERVOIR	74 (28)	91 (33)	84 (32)	58 (22)	17 (0)	63 (21)	387
4826	SAN ANGELO RESERVOIR	13 (5)	45 (17)	8 (3)	0 (0)	88 (33)	46 (17)	200
4827	SAM RAYBURN RESERVOIR	59 (22)	39 (15)	68 (26)	76 (29)	17 (0)	63 (21)	322
[illegible]	[illegible]	[illegible]	[illegible]	45 ([illegible]7)	50 (19)	17 (0)	76 (28)	321

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
4829	SOMERVILLE LAKE	29 (11)	55 (21)	24 (9)	3 (1)	67 (25)	30 (10)	208
4830	STAMFORD LAKE	18 (7)	97 (37)	5 (2)	18 (7)	82 (31)	39 (14)	259
4831	STILLHOUSE HOLLOW RESERV	88 (33)	37 (14)	87 (33)	92 (35)	17 (0)	51 (19)	372
4832	TAWAKONI LAKE	32 (12)	70 (26)	37 (14)	21 (8)	63 (24)	30 (10)	253
4833	TEXARKANA LAKE	11 (4)	51 (19)	13 (5)	16 (6)	72 (27)	13 (5)	176
4834	TEXOMA LAKE	39 (14)	34 (13)	61 (23)	45 (17)	17 (0)	21 (7)	217
4835	TRAVIS LAKE	88 (33)	21 (7)	92 (35)	82 (31)	17 (0)	84 (31)	384
4836	TRINIDAD	0 (0)	61 (22)	11 (4)	5 (2)	92 (35)	0 (0)	169
4837	TWIN BUTTES RESERVOIR	59 (22)	21 (7)	58 (22)	61 (23)	49 (17)	63 (21)	311
4838	WHITE RIVER RESERVOIR	84 (32)	61 (22)	76 (29)	89 (34)	17 (0)	63 (21)	390
4839	WHITNEY LAKE	63 (24)	51 (19)	79 (30)	71 (27)	17 (0)	76 (28)	357

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 TEXAS 07/02/76

LAKE CODE 4802 BASTROP

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 24.6

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
4802A1	24.6	0.093	0.085	0.042	0.091	0.147	0.085	0.028	0.020	0.110	0.082	0.048	0.028	0.07
4802A2	2.3	0.011	0.008	0.003	0.008	0.017	0.008	0.003	0.0	0.011	0.008	0.003	0.003	0.00
4802ZZ	22.3	0.068	0.054	0.031	0.062	0.096	0.054	0.017	0.008	0.071	0.054	0.034	0.014	0.04

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 24.6 TOTAL FLOW IN = 0.65
SUM OF SUB-DRAINAGE AREAS = 24.6 TOTAL FLOW OUT = 0.86

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
4802A1	9	74	0.085	7	0.001				
	10	74	0.068	4	0.034				
	11	74	0.850	1	0.164				
	12	74	0.311	6	0.215				
	1	75	0.142	3	0.190				
	2	75	0.272	7	0.275				
	3	75	0.057	7	0.071				
	4	75	0.184	11	0.031	25	0.020		
	5	75	0.481	9	0.102	23	4.248		
	6	75	0.623	6	0.040	11	0.595		
	7	75	0.011	3	0.0				
	8	75	0.595	1	0.0				
4802A2	9	74	0.008	4	0.0				
	10	74	0.017	4	0.0				
	11	74	0.093	1	0.017				
	12	74	0.034	6	0.023				
	1	75	0.017	3	0.020				
	2	75	0.031	7	0.031				
	3	75	0.006	7	0.008				
	4	75	0.020	11	0.0	25	0.0		
	5	75	0.001	9	0.011	23	0.481		
	6	75	0.071	6	0.0				
	7	75	0.001	3	0.0				
	8	75	0.000	1	0.0				
4802ZZ	9	74	0.008						
	10	74	0.006						
	11	74	0.079						
	12	74	0.028						
	1	75	0.014						
	2	75	0.025						
	3	75	0.006						
	4	75	0.017						
	5	75	0.045						
	6	75	0.059						
	7	75	0.001						
	8	75	0.057						

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/02/11

480201
30 09 20.0 097 17 30.0
BASTROP LAKE
48021 TEXAS

11EPALES
3

2111202
0060 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/03/14	14 00	0000	23.6		72	740	8.70	151	0.020	0.600	0.020	0.015
	14 00	0006	23.6	8.8		740	8.70	150	0.020	0.600	0.020	0.007
	14 00	0015	23.5	8.4		740	8.45	150	0.020	0.500	0.020K	0.014
	14 00	0030	19.3	5.0		675	7.95	151	0.050	0.500	0.030	0.013
	14 00	0045	17.0	4.6		645	7.90	153	0.170	0.600	0.050	0.007
	14 00	0056	16.9	4.6		645	7.90	153	0.200	0.600	0.060	0.013
74/05/22	15 25	0000	33.1		120	886	8.80	121	0.030	0.400	0.050	0.005
	15 25	0005	33.0	7.8		883	8.80	121	0.020	0.400	0.030	0.003
	15 25	0015	30.6	6.8		840	8.80	124	0.020	0.300	0.030	0.003
	15 25	0026	25.9	0.8		779	7.80	132	0.040	0.400	0.050	0.005
	15 25	0040	21.5	0.2		727	7.70	142	0.170	0.400	0.050	0.006
	15 25	0055	19.9	0.2		708	7.70	155	0.540	0.900	0.030	0.005
74/08/16	13 00	0000	31.7	7.4	90	878	8.60					
	13 00	0010	31.6	7.6		871	8.70					
	13 00	0023	30.0	4.6		842	8.40					
	13 00	0035	27.2	0.6		802	7.60					
	13 00	0050	20.4	0.0		724	7.50					
74/11/04	14 50	0000	24.1	7.4	61	7246	8.23	124	0.070	0.500	0.040	0.004
	14 50	0005	24.0	7.2		7249	8.21	135	0.060	0.300	0.050	0.007
	14 50	0015	24.1	7.6		7249	8.19	138	0.060	0.300	0.030	0.007
	14 50	0026	24.1	7.6		7248	8.15	136	0.060	0.600	0.030	0.014

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/03/14	14 00	0000	0.029	7.0	
	14 00	0006	0.028		
	14 00	0015	0.026		
	14 00	0030	0.019		
	14 00	0045	0.017		
	14 00	0056	0.018		
74/05/22	15 25	0000	0.014	8.2	
	15 25	0005	0.015		50.0
	15 25	0015	0.017		
	15 25	0026	0.023		1.0
	15 25	0040	0.019		
	15 25	0055	0.042		
74/08/16	13 00	0000		8.2	
	13 00	0005			50.0
	13 00	0023			1.0
74/11/04	14 50	0000	0.025	3.6	
	14 50	0005	0.026		
	14 50	0015	0.028		
	14 50	0026	0.030		

K VALUE KNOWN TO BE

STORET RETRIEVAL DATE 76/02/11

480202
30 09 25.0 097 17 17.0
BASTROP LAKE
48021 TEXAS

11EPALES 2111202
3 0031 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/03/14	14 35	0000	23.0		60	730	8.70	153	0.020K	0.600	0.020	0.010
	14 35	0006	23.0	8.6		730	8.70	152	0.020K	0.400	0.020	0.011
	14 35	0015	22.7	8.0		725	8.60	152	0.020K	0.200	0.020	0.007
	14 35	0027	20.0	5.8		690	8.25	152	0.030	0.300	0.030	0.014
74/05/23	09 45	0000	31.5		114	861	8.75	128	0.080	0.900	0.090	0.012
	09 45	0005	31.5	7.8		861	8.75	126	0.020	0.400	0.030	0.003
	09 45	0015	29.9	7.0		835	8.60	126	0.020K	0.400	0.020	0.002
	09 45	0026	24.8	1.2		768	7.60	141	0.100	0.500	0.030	0.004
74/08/16	13 30	0000	31.8	7.4	96	872	8.80					
	13 30	0005	31.5	7.6		869	8.70					
	13 30	0020	30.5	5.4		855	8.40					
	13 30	0030	29.0	2.0		831	7.80					
74/11/04	15 10	0000	23.5	7.0	60	7251	8.23	137	0.070	0.600	0.030	0.005
	15 10	0005	23.5	7.4		7251	8.14	137	0.070	0.500	0.030	0.011
	15 10	0010	23.5	8.0		7251	8.19	132	0.070	0.500	0.040	0.009

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/03/14	14 35	0000	0.025	6.4	
	14 35	0006	0.029		
	14 35	0015	0.027		
	14 35	0027	0.022		
74/05/23	09 45	0000	0.018	39.3	
	09 45	0005	0.012		50.0
	09 45	0015	0.015		
	09 45	0026	0.029		1.0
74/08/16	13 30	0000		7.1	
74/11/04	15 10	0000	0.020	3.2	
	15 10	0005	0.020		
	15 10	0010	0.024		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/02/11

480203
30 09 10.0 097 17 12.0
BASTROP LAKE
48021 TEXAS

11EPALES 2111202
3 0045 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/03/14	15 00	0000	25.7		60	770	8.65	149	0.020	0.500	0.020K	0.011
	15 00	0006	25.7	4.8		770	8.70	150	0.020K	0.500	0.020K	0.013
	15 00	0015	22.8	8.2		740	8.50	151	0.020	0.400	0.020K	0.011
	15 00	0027	20.4	6.8		695	8.10	150	0.080	0.400	0.030	0.007
	15 00	0041	17.9	3.0		660	7.90	153	0.240	0.600	0.040	0.013
74/05/23	10 10	0000	33.6		90	896	8.60	128	0.020	0.700	0.020	0.002
	10 10	0005	33.5	7.4		894	8.50	128	0.020	0.400	0.020	0.002
	10 10	0010	31.3	8.0		860	8.40	128	0.030	0.400	0.020K	0.002
	10 10	0020	29.6	4.8		830	8.00	129	0.020	0.400	0.030	0.003
	10 10	0035	22.5	1.0		747	7.25	151	0.360	0.700	0.020K	0.003
74/08/16	13 40	0000	33.3	7.2	90	900	8.70					
	13 40	0005	33.2	7.0		900	8.70					
	13 40	0020	30.4	3.6		849	8.00					
	13 40	0030	29.0	0.8		827	7.80					
	13 40	0041	22.1	0.0		755	7.30					
74/11/04	15 25	0000	24.4	6.8	48	7251	8.13	131	0.080	0.600	0.030	0.010
	15 25	0005	24.3	7.2		7253	8.10	130	0.080	0.500	0.030	0.007
	15 25	0015	24.3	7.0		7252	8.04	127	0.100	0.400	0.030	0.008
	15 25	0030	24.1	7.0		7252	7.98	127	0.110	0.500	0.040	0.016
	15 25	0044	24.1	6.0		7252	7.88	127	0.140	0.600	0.030	0.012

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/03/14	15 00	0000	0.024	5.9	
	15 00	0006	0.026		
	15 00	0015	0.023		
	15 00	0027	0.022		
	15 00	0041	0.019		
74/05/23	10 10	0000	0.015	49.8	
	10 10	0004			50.0
	10 10	0005	0.014		
	10 10	0010	0.015		
	10 10	0020	0.017		1.0
	10 10	0035	0.022		
74/08/16	13 40	0000		6.3	
74/11/04	15 25	0000	0.018	3.7	
	15 25	0005	0.020		
	15 25	0015	0.020		
	15 25	0030	0.022		
	15 25	0044	0.030		

K VALUE KNOWN TO BE

APPENDIX E

TRIBUTARY DATA

STORET RETRIEVAL DATE 76/03/10

4802A1
30 09 10.0 097 17 50.0 4
SPICER CREEK
48465 7.5 BASSTROP, TX
O/LAKE BASSTROP
BANK SAMP FROM DIRT RD .5 MI W OF 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
74/09/07	17 45		0.016		0.040	0.005K	
74/10/04	09 25		0.480	0.400	0.075	0.005	0.010K
74/11/01	09 35		0.032	0.900	0.065	0.005K	0.040
74/12/06	08 30		0.088	0.600	0.040	0.010	0.010
75/01/03	13 50		0.056	0.700	0.072	0.005	0.020
75/02/07	12 20		0.540	0.500	0.024	0.008K	0.010K
75/03/07	14 30		0.020	0.600	0.065	0.005K	0.010K
75/04/11	13 20		0.010	0.400	0.046	0.011	0.011
75/04/25	11 15		0.010	0.475	0.040	0.005K	0.010K
75/05/09	13 30		0.175	0.450	0.025	0.005K	0.030
75/05/23	16 00		0.025	0.850	0.025	0.005K	0.020
75/06/06	09 30		0.015	0.850	0.070	0.005K	0.010K
75/06/11	18 45		1.050	0.950	0.045	0.025	0.150

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/03/10

4802A2
30 10 40.0 097 15 00.0 4
SPICER CREEK
48 7.5 BASSTROP, TX
T/LAKE BASSTROP
BRDG ON SEC RD 1.5 MI SE OF CAMP SWIFT
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
74/11/01	09 20		0.160	0.600	0.030	0.030	0.035
74/12/06	08 45		0.048	0.400	0.032	0.010	0.020
75/01/03	13 30		0.064	0.500	0.032	0.010	0.030
75/02/07	12 00		0.060	0.600	0.032	0.016	0.020
75/03/07	14 15		0.045	0.850	0.075	0.005K	0.020
75/05/09	13 05		0.070	0.550	0.065	0.010	0.010
75/05/23	16 15		0.055	0.400	0.020	0.010	0.020

K VALUE KNOWN TO BE
LESS THAN INDICATED