U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

REPORT

ON

SHERMAN RESERVOIR

SHERMAN COUNTY

NEBRASKA

EPA REGION VII

WORKING PAPER No. 561

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

REPORT

ON

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WORKING PAPER NO. 561

WITH THE COOPERATION OF THE

NEBRASKA DEPARTMENT OF ENVIRONMENTAL CONTROL

AND THE

NEBRASKA NATIONAL GUARD

AUGUST, 1976

CONTENTS

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 nation-wide 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 water-shed 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 freshwater 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.

ACKNOWLEDGMENT

NATIONAL EUTROPHICATION SURVEY

STATE OF NEBRASKA

RESERVOIR NAME   COUNTY

Branched Oak   Lancaster
Harlan County   Harlan
Harry D. Strunk   Frontier
Hugh Butler   Frontier, Red Willow
Johnson   Dawson, Gosper
McConaughy   Keith
Pawnee   Lancaster
Sherman   Sherman
Swanson   Hitchcock

SHERMAN RESERVOIR

X Lake Sampling Site

Scale

0 1 2 3 4 5 Km.

0 1 2 3 Mi.

Oak

Creek

Sherman Feeder Canal
(From Middle Loup River
12.9 km. above Arcadia)

SHERMAN RESERVOIR

Nebraska

Map Location

X 02

X 5

dam
outlet

Farwell M. Canal

South Canal

Oak

Creek
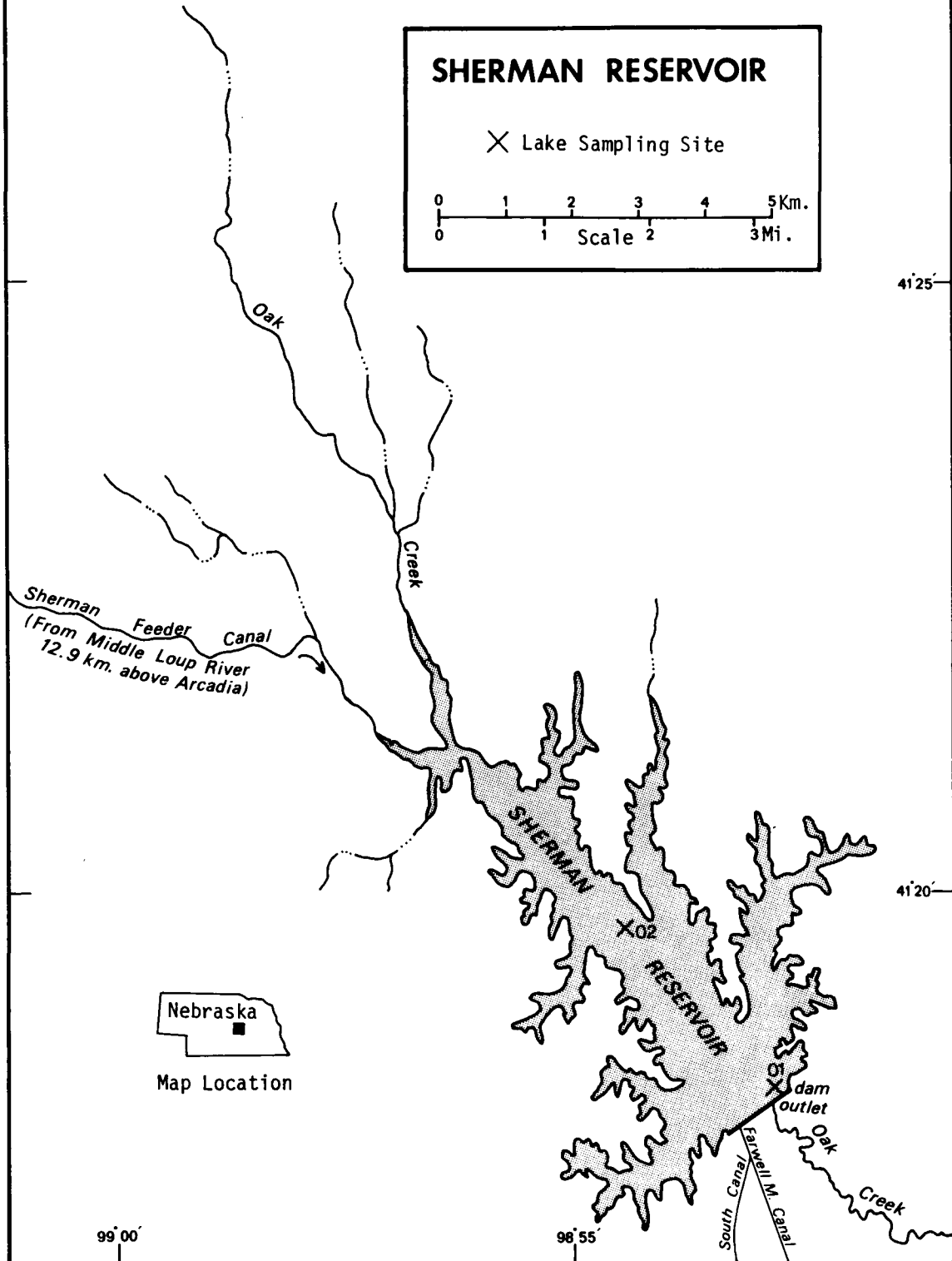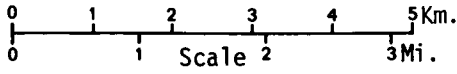
41°25′

41°20′

99°00′

98°55′

SHERMAN RESERVOIR

STORET NO. 3108

I. INTRODUCTION

Sherman Reservoir was included in the National Eutrophication
Survey as a water body of interest to the Nebraska Department of Environ-
mental Control. This report relates only to reservoir sampling data.

II. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Sherman Reservoir is eutrophic.
It ranked fourth in overall trophic quality when the nine
Nebraska reservoirs sampled in 1974 were compared using a com-
bination of six parameters*. Five of the reservoirs had less
median total phosphorus, seven had less median dissolved phosphorus,
one had less and two had the same median inorganic nitrogen, none
had less mean chlorophyll a, and one had greater mean Secchi
disc transparency. Depression of dissolved oxygen with depth
occurred at sampling station 1 in July.

Survey limnologists did not observe macrophytes or surface
concentrations of algae during sampling visits.

B. Rate-Limiting Nutrient:

The algal assay results indicate that Sherman Reservoir was
limited by nitrogen at the time the assay sample was collected
(04/17/74). The reservoir data indicate nitrogen limitation in
September as well.

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* See Appendix A.

III. LAKE AND DRAINAGE BASIN CHARACTERISTICS[†]

    A. Lake Morphometry[††]:

        1. Surface area: 11.51 kilometers^2.

        2. Mean depth: 7.3 meters.

        3. Maximum depth: 28.7 meters.

        4. Volume: 84.023 x 10^6 m^3.

    B. Precipitation*:

        1. Year of sampling: 56.3 centimeters.

        2. Mean annual: 58.9 centimeters.

[†] Table of metric equivalents--Appendix B.
[††] Martin and Hanson, 1966; maximum depth from Hartung, 1974.
* See Working Paper No. 175, "...Survey Methods, 1973-1976".

IV. LAKE WATER QUALITY SUMMARY

Sherman Reservoir was sampled three times during the open-
water season of 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 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 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 17.1 meters at station
1 and 7.6 meters at station 2.

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

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR SHERMAN COUNTY RESERVOIR
STORET CODE 3108

	1ST SAMPLING (4/17/74) 2 SITES				2ND SAMPLING (7/ 1/74) 2 SITES				3RD SAMPLING (9/27/74) 2 SITES			
PARAMETER	RANGE		MEAN	MEDIAN	RANGE		MEAN	MEDIAN	RANGE		MEAN	MEDIAN
TEMP (C)	7.4 -	7.7	7.6	7.7	18.0 -	23.3	22.1	22.8	16.2 -	16.4	16.3	16.2
DISS OXY (MG/L)	10.2 -	10.6	10.5	10.6	3.2 -	8.0	7.2	7.8	7.8 -	9.2	8.8	9.0
CNDCTVY (MCROMO)	14. -	121.	58.	46.	212. -	228.	224.	227.	168. -	170.	169.	169.
PH (STAND UNITS)	******	-************************			8.2 -	8.6	8.5	8.6	8.1 -	8.8	8.6	8.8
TOT ALK (MG/L)	104. -	107.	105.	105.	******	-***********************			103. -	108.	105.	105.
TOT P (MG/L)	0.062 -	0.067	0.065	0.065	******	-***********************			0.099 -	0.130	0.111	0.106
ORTHO P (MG/L)	0.046 -	0.054	0.050	0.050	******	-***********************			0.026 -	0.066	0.043	0.028
NO2+NO3 (MG/L)	0.030 -	0.120	0.059	0.055	******	-***********************			0.020 -	0.070	0.043	0.030
AMMONIA (MG/L)	0.030 -	0.060	0.044	0.045	******	-***********************			0.020 -	0.060	0.034	0.030
KJEL N (MG/L)	0.300 -	0.700	0.400	0.350	******	-***********************			0.200 -	0.500	0.300	0.300
INORG N (MG/L)	0.060 -	0.180	0.102	0.100	******	-***********************			0.050 -	0.090	0.077	0.090
TOTAL N (MG/L)	0.330 -	0.820	0.459	0.405	******	-***********************			0.260 -	0.530	0.343	0.330
CHLRPYL A (UG/L)	2.7 -	3.2	2.9	2.9	2.3 -	2.5	2.4	2.4	13.4 -	16.2	14.8	14.8
SECCHI (METERS)	0.6 -	0.7	0.7	0.7	1.8 -	2.1	2.0	2.0	1.1 -	1.1	1.1	1.1

4

B. Biological characteristics:

    1. Phytoplankton -

Sampling Date	Dominant Genera		Algal Units per ml
04/17/74	1.	Asterionella sp.	503
	2.	Flagellates	457
	3.	Fragilaria sp.	183
	4.	Stephanodiscus sp.	137
	5.	Cymbella sp.	91
		Other genera	229
		Total	1,600
07/01/74	1.	Merismopedia sp.	461
	2.	Flagellates	423
	3.	Cryptomonas sp.	269
	4.	Schroederia sp.	154
	5.	Stephanodiscus sp.	154
		Other genera	76
		Total	1,537
09/27/74	1.	Stephanodiscus sp.	2,198
	2.	Fragilaria sp.	244
	3.	Flagellates	153
	4.	Cyclotella sp.	122
	5.	Melosira sp.	122
		Other genera	244
		Total	3,083

    2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
04/17/74	1	3.2
	2	2.7
07/01/74	1	2.3
	2	2.5
09/27/74	1	16.2
	2	13.4

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.045	0.029	2.0
0.050 P	0.095	0.029	2.6
0.050 P + 1.0 N	0.095	1.029	28.1
1.0 N	0.045	1.029	19.4

2. Discussion -

The control yield of the assay alga, _Selenastrum capricornutum_, indicates that the potential primary productivity of Sherman Reservoir was high at the time the assay sample was collected (04/17/74). Also, the significant increase in yield with the addition of nitrogen alone indicates that the reservoir was limited by nitrogen at that time. Note that the addition of phosphorus alone resulted in a yield not significantly greater than that of the control.

The reservoir data also indicate nitrogen limitation in September as well (the mean inorganic nitrogen/orthophosphorus ratio was 2/1).

V. LITERATURE REVIEWED

Hartung, Ray, 1974. Personal communication (reservoir mor-
     phometry). NE Dept. of Env. Control, Lincoln.

Martin, R. O. R., and Ronald C. Hanson, 1966. Reservoirs in the
     United States. Water Supply Paper #1838, U.S. Geol. Surv.,
     Wash., DC.

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
3101	BRANCHED OAK	0.044	0.070	456.444	17.033	9.400	0.013
3102	HARLAN COUNTY RESERVOIR	0.112	0.365	476.111	27.822	12.200	0.061
3103	HARRY D. STRUNK (MEDICIN	0.064	0.460	470.500	14.367	14.200	0.009
3104	HUGH BUTLER (RED WILLOW)	0.061	0.090	468.875	16.612	14.400	0.014
3105	JOHNSON RESERVOIR	0.075	0.340	477.667	26.133	8.600	0.009
3106	LAKE MCCONAUGHY	0.027	0.585	409.555	8.644	11.400	0.004
3107	PAWNEE LAKE	0.060	0.175	453.000	15.367	8.800	0.020
3108	SHERMAN COUNTY RESERVOIR	0.067	0.090	451.167	6.717	11.800	0.050
3110	SWANSON RESERVOIR	0.067	0.090	466.333	14.450	11.000	0.016

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
3101	BRANCHED OAK	88 (7)	100 (8)	63 (5)	25 (2)	75 (6)	63 (5)	414
3102	HARLAN COUNTY RESERVOIR	0 (0)	25 (2)	13 (1)	0 (0)	25 (2)	0 (0)	63
3103	HARRY D. STRUNK (MEDICIN	50 (4)	13 (1)	25 (2)	75 (6)	13 (1)	81 (6)	257
3104	HUGH BUTLER (RED WILLOW)	63 (5)	75 (5)	38 (3)	38 (3)	0 (0)	50 (4)	264
3105	JOHNSON RESERVOIR	13 (1)	38 (3)	0 (0)	13 (1)	100 (8)	81 (6)	245
3106	LAKE MCCONAUGHY	100 (8)	0 (0)	100 (8)	88 (7)	50 (4)	100 (8)	438
3107	PAWNEE LAKE	75 (6)	50 (4)	75 (6)	50 (4)	88 (7)	25 (2)	363
3108	SHERMAN COUNTY RESERVOIR	38 (3)	75 (5)	88 (7)	100 (8)	38 (3)	13 (1)	352
3110	SWANSON RESERVOIR	25 (2)	75 (5)	50 (4)	63 (5)	63 (5)	38 (3)	314

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	3106	LAKE MCCONAUGHY	438
2	3101	BRANCHED OAK	414
3	3107	PAWNEE LAKE	363
4	3108	SHERMAN COUNTY RESERVOIR	352
5	3110	SWANSON RESERVOIR	314
6	3104	HUGH BUTLER (RED WILLOW)	264
7	3103	HARRY D. STRUNK (MEDICIN	257
8	3105	JOHNSON RESERVOIR	245
9	3102	HARLAN COUNTY RESERVOIR	63

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 x 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

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 75/12/23

310801
41 19 30.0 098 54 00.0
SHERMAN COUNTY RESERVOIR
31163   NEBRASKA

11EPALES   2111202
3   0056 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
74/04/17	09 35	0000	7.6		28	29		107	0.060	0.700	0.120	0.054
	09 35	0005	7.6	10.6		25		106	0.050	0.400	0.070	0.050
	09 35	0015	7.6	10.6		72		105	0.050	0.400	0.060	0.051
	09 35	0050	7.4	10.2		121		105	0.050	0.500	0.060	0.050
74/07/01	15 25	0000	22.6	8.0	84	226	8.60					
	15 25	0005	22.8	7.8		227	8.60					
	15 25	0020	21.7	7.2		222	8.50					
	15 25	0035	20.8	6.8		219	8.40					
	15 25	0056	18.0	3.2		212	8.20					
74/09/27	14 20	0000	16.2	8.8	42	169	8.85	106	0.040	0.500	0.030	0.028
	14 20	0005	16.2	9.0		169	8.79	108	0.060	0.300	0.030	0.028
	14 20	0015	16.2	9.0		169	8.79	103	0.020	0.300	0.030	0.026
	14 20	0045	16.2	8.6		170	8.82	106	0.040	0.300	0.020K	0.026

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/17	09 35	0000	0.067	3.2	
	09 35	0005	0.065		
	09 35	0015	0.065		
	09 35	0050	0.066		
74/07/01	15 25	0000		2.3	
74/09/27	14 20	0000	0.099	16.2	
	14 20	0005	0.106		
	14 20	0009			1.0
	14 20	0015	0.101		
	14 20	0045	0.104		

K VALUE KNOWN TO BE
LESS THAN INDICATED

310802
41 20 45.0 098 55 45.0
SHERMAN COUNTY RESERVOIR
31163   NEBRASKA

11EPALES   2111202
3   0033 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
74/04/17	10 00	0000	7.7		25	14		105	0.040	0.300	0.050	0.050
	10 00	0005	7.7	10.6		23		105	0.030	0.300	0.030	0.050
	10 00	0015	7.7	10.6		63		104	0.040	0.300	0.040	0.048
	10 00	0025	7.7	10.6		115		104	0.030	0.300	0.040	0.046
74/07/01	15 10	0000	23.2	7.8	72	227	8.60					
	15 10	0005	23.3	8.0		228	8.60					
	15 10	0015	23.2	7.8		228	8.60					
	15 10	0020	23.2	8.0		228	8.60					
74/09/27	14 50	0000	16.4	7.8	42	168	8.16	104	0.030	0.300	0.060	0.063
	14 50	0005	16.4	9.2		168	8.40	104	0.030	0.200K	0.060	0.065
	14 50	0010	16.4	9.2		168	8.10	105	0.020K	0.200K	0.070	0.066

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/17	10 00	0000	0.063	2.7	
	10 00	0005	0.065		
	10 00	0015	0.062		
	10 00	0025	0.066		
74/07/01	15 10	0000		2.5	
	15 10	0010			1.0
74/09/27	14 50	0000	0.114	13.4	
	14 50	0005	0.120		
	14 50	0010	0.130		

K VALUE KNOWN TO BE
LESS THAN INDICATED

APPENDIX D

TRIBUTARY DATA

3108A1
41 17 37.0 098 52 06.0
OAK CREEK
31109   7.5 LOUP CITY SE
O/SHERMAN RESERVOIR
BRDG ON SEC RD 1 M DWNSTRM SHERMAN DAM
11EPALES   2111204
4   0000 FEET DEPTH

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
74/08/25	14	55	0.470	0.500	0.075	0.490	0.610
74/09/08	14	35	0.470	0.550	0.060	0.480	0.620
74/10/06	14	55	0.660	0.800	0.050	0.550	0.630
74/11/24	17	25	0.768	0.500	0.064	0.490	0.610
74/12/24	16	30	0.910	1.000	0.165	0.360	0.615
75/01/25	11	00	0.830	2.300	0.256	0.320	1.390
75/02/21	16	00	0.915	1.750	0.114	0.497	1.000
75/03/25	14	00	0.681	1.100	0.055	0.485	0.600
75/04/20	14	20	0.510	1.300	0.050	0.530	0.660
75/05/04	17	15	0.390	0.750	0.158	0.575	0.645

STORET RETRIEVAL DATE 76/01/27

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
74/08/25	09	55	0.288	0.300	0.020	0.165	0.220
74/09/08	15	20	0.280	0.500	0.015	0.125	0.145
74/10/06	14	20	0.432	0.450	0.045	0.140	0.175
74/11/17	14	40	0.368	0.400	0.050	0.145	0.150
75/06/01	11	30	0.185	0.850	0.025	0.135	0.150
75/06/15	16	20	0.350	1.150	0.170	0.160	0.250
75/06/29	11	00	0.290	1.050	0.100	0.190	0.300
75/07/13			0.145	1.280	0.035	0.125	0.175
75/08/10	15	45	0.015	1.300	0.020	0.110	0.200