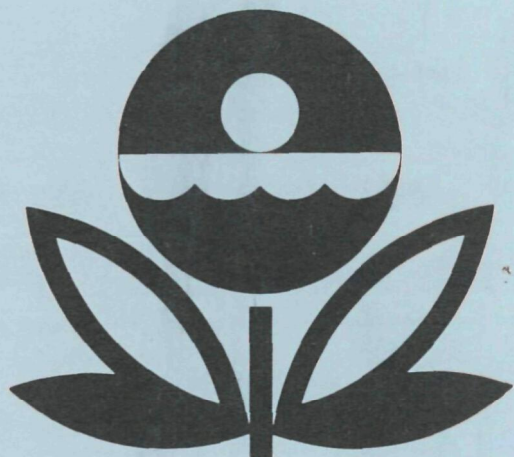


**U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY**

WORKING PAPER SERIES



REPORT
ON
OOLOGAH RESERVOIR
NOWATA AND ROGERS COUNTIES
OKLAHOMA
EPA REGION VI
WORKING PAPER No. 592

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

REPORT
ON
OOLOGAH RESERVOIR
NOWATA AND ROGERS COUNTIES
OKLAHOMA
EPA REGION VI
WORKING PAPER No. 592

WITH THE COOPERATION OF THE
OKLAHOMA DEPARTMENT OF POLLUTION CONTROL
AND THE
OKLAHOMA NATIONAL GUARD
MARCH, 1977

REPORT ON OOLOGAH RESERVOIR
NOWATA AND ROGERS COUNTIES, OKLAHOMA
EPA REGION VI

by

National Eutrophication Survey

Water and Land Monitoring Branch
Monitoring Applications Laboratory
Environmental Monitoring & Support Laboratory
Las Vegas, Nevada

and

Eutrophication Survey Branch
Corvallis Environmental Research Laboratory
Corvallis, Oregon

Working Paper No. 592

OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY

March 1977

CONTENTS

	<u>Page</u>
Foreword	ii
List of Oklahoma Study Lakes	iv
Lake and Drainage Area Map	v
<u>Sections</u>	
I. Conclusions	1
II. Lake and Drainage Basin Characteristics	4
III. Lake Water Quality Summary	6
IV. Nutrient Loadings	13
V. Literature Reviewed	19
VI. Appendices	20

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 nonpoint 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 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 the U.S. Environmental Protection Agency and to augment plans implementation by the states.

ACKNOWLEDGMENTS

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the Oklahoma Department of Pollution Control for professional involvement, to the Oklahoma National Guard for conducting the tributary sampling phase of the Survey, and to those Oklahoma wastewater treatment plant operators who provided effluent samples and flow data.

Dr. Denver Talley, Director, Oklahoma Department of Pollution Control; the staff of the Oklahoma Water Resources Board; and the staff of the Oklahoma State Department of Health reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper Series.

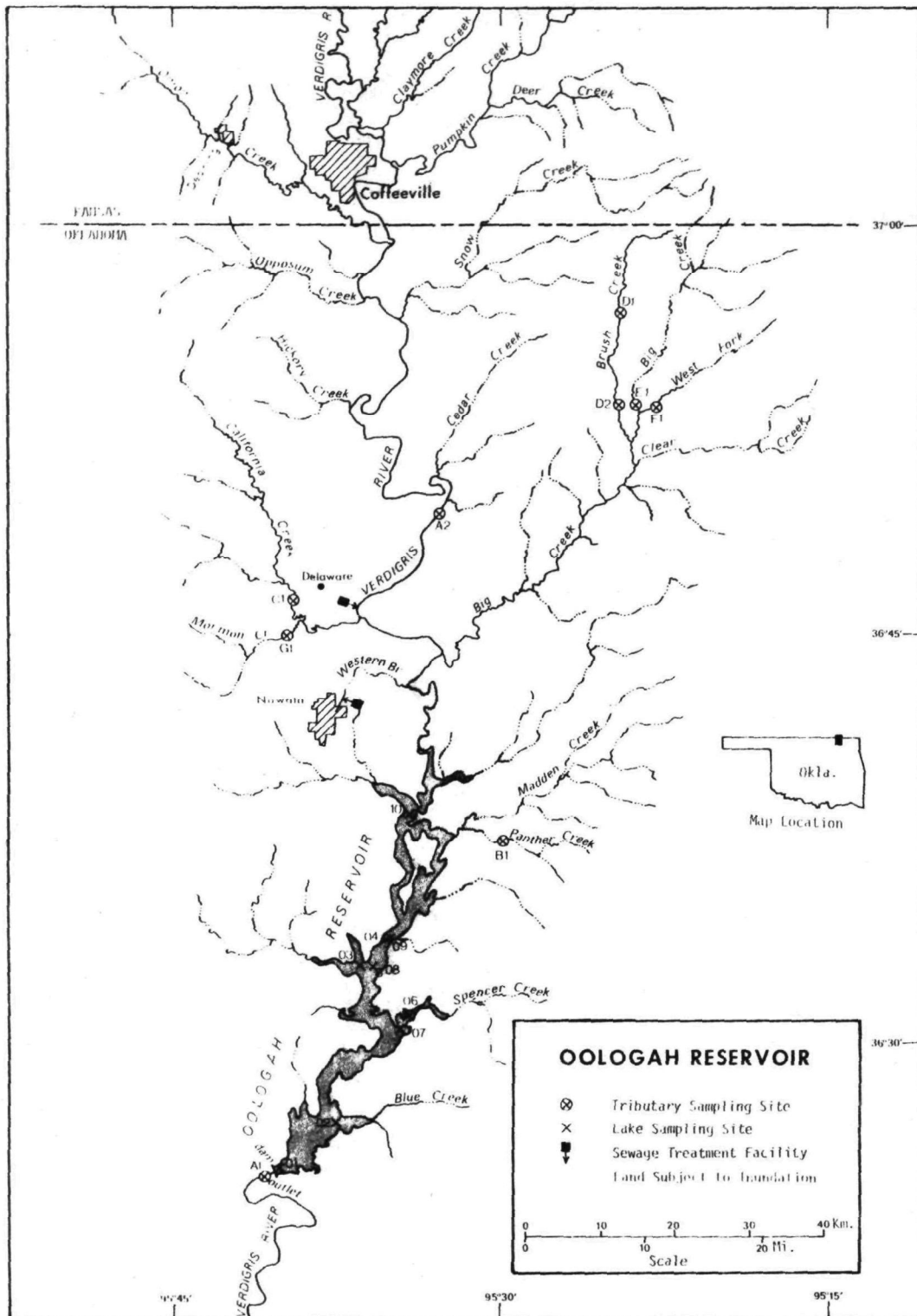
Major General John Coffey, Jr., the Adjutant General of Oklahoma, and Project Officers Colonel Curtis W. Milligan and Major James O. Haney, Jr., who directed the volunteer efforts of the Oklahoma National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF OKLAHOMA

<u>LAKE NAME</u>	<u>COUNTY</u>
Altus Reservoir	Greer, Kiowa
Arbuckle Lake	Murray
Lake Elsworth	Caddo, Comanche
Lake Eufaula	Haskell, McIntosh, Okmulgee, Pittsburg
Fort Cobb Reservoir	Caddo
Fort Supply Reservoir	Woodward
Foss Dam Reservoir	Custer
Lake Frances	Adair
Grand Lake O' The Cherokees	Mayes, Delaware, Craig, Ottawa
Lake Hefner	Oklahoma
Keystone Reservoir	Tulsa, Creek, Osage, Pawnee
Oologah Lake	Nowata, Rogers
Tenkiller Ferry Reservoir	Cherokee, Sequoyah
Lake Thunderbird	Cleveland
Wister Reservoir	LeFlore



REPORT ON OOLOGAH RESERVOIR, OKLAHOMA

STORET NO. 4012

I. CONCLUSIONS

A. Trophic Condition:*

On the basis of field observations and Survey data, Oologah Reservoir is considered eutrophic, i.e., nutrient rich and productive. Whether such nutrient enrichment is to be considered beneficial or deleterious is determined by the actual or potential impact upon designated beneficial water uses of each lake.

Chlorophyll a levels in the lake ranged from 0.3 $\mu\text{g/l}$ to 15.5 $\mu\text{g/l}$, with a mean of 5.1 $\mu\text{g/l}$. Potential for primary productivity as measured by algal assay control yield was high, and Secchi disc visibility was very low. Of the 16 Oklahoma lakes sampled in 1974 (including Lake Texoma), 6 had higher median total phosphorus levels, 3 had higher median inorganic nitrogen values, and 4 had higher median orthophosphorus levels than Oologah Reservoir.

Survey limnologists noted the lake was extremely turbid, and did not report any problem algal blooms or aquatic macrophyte growths.

*See Appendix E.

B. Rate-Limiting Nutrient:

The algal assay results indicate that Oologah Reservoir was limited by available phosphorus at the times of assay sample collection (04/02/74, 10/21/74). The lake data indicate primary limitation by phosphorus at the other sampling times as well. However, the low productivity estimated from chlorophyll a levels is most likely limited by light penetration rather than nutrient availability.

C. Nutrient Controllability:

1. Point sources -

During the sampling year, about 2.0% of the total phosphorus load to Oologah Reservoir was contributed by point sources. The city of Nowata contributed 2.0%, and the city of Delaware contributed <0.1%.

The calculated annual phosphorus loading of $3.45 \text{ g P/m}^2/\text{yr}$ is approximately four times greater than Vollenweider's (1975) "eutrophic" loading for lakes with such volume and retention time. However, Vollenweider's model may not be applicable to lakes in which epilimnetic light penetration is severely reduced by the presence of suspended sediments in the surface waters. If, in fact, the nutrient contributions of the Verdigris River are largely nonpoint in nature, it does not appear likely that point source phosphorus control would result in any appreciable change in the trophic condition of the lake.

2. Nonpoint sources -

The total annual phosphorus load not attributable to nearby point sources accounted for 98% of the loading reaching the impoundment. The Verdigris River contributed 94.5%, and Walt Creek contributed 0.4% of the total. Ungaged tributaries were estimated to have contributed 2.5%.

The Verdigris River had a phosphorus export of $41 \text{ kg/km}^2/\text{yr}$. This rate is much higher than the rates of other unimpacted tributaries to Oologah Reservoir, or to nearby Grand Lake o' the Cherokees.* Such inflation of background nutrient loading is probably due to unknown point sources upstream in Kansas rather than actual nonpoint contributions, but further investigation is needed to determine the location and significance of these possible sources.

*See Working Paper No. 589, "Report on Grand Lake o' the Cherokees".

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

Lake and drainage basin characteristics are itemized below. Lake surface area and mean depth were provided by the Oklahoma Department of Pollution Control; maximum depth was provided by the Oklahoma Water Resources Board. Tributary flow data were provided by the Oklahoma District Office of the U.S. Geological Survey (USGS). Outlet drainage area includes the lake surface area. Mean hydraulic retention time was obtained by dividing the lake volume by mean flow of the outlet. Precipitation values are estimated by methods as outlined in National Eutrophication Survey (NES) Working Paper No. 175. A table of metric/English conversions is included as Appendix A.

A. Lake Morphometry:

1. Surface area: 119.22 km².
2. Mean depth: 5.7 meters.
3. Maximum depth: 24.4 meters.
4. Volume: 679.554 x 10⁶ m³.
5. Mean hydraulic retention time: 109 days.

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

1. Tributaries -

<u>Name</u>	<u>Drainage area(km²)</u>	<u>Mean flow (m³/sec)</u>
A-2 Verdigris River	9,585.6	62.50
C-1 Wolf Creek	238.0	1.33
Minor tributaries and immediate drainage -	<u>1,294.9</u>	<u>7.91</u>
Totals	11,118.5	71.74
2. Outlet - A-1 Verdigris River	11,237.7	72.21

C. Precipitation:

1. Year of sampling: 129.4 cm.
2. Mean annual: 99.4 cm.

III. LAKE WATER QUALITY SUMMARY

Oologah Reservoir was sampled four 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 ten stations on the lake* and from one or more depths at each station (see map, page v). During each visit, depth-integrated samples were collected from each station for chlorophyll a analysis and phytoplankton identification and enumeration. During the first and last visits, 18.9-liter depth-integrated samples were composited for algal assays. Maximum depths (expressed in meters) sampled are listed below:

<u>Station Number</u>	<u>Maximum Depth</u>
01	21.6
02	12.2
03	9.1
04	9.1
05	1.5
06	6.7
07	10.7
08	12.2
09	9.4
10	2.4

The results obtained are presented in full in Appendix C and are summarized in III-A for waters at the surface and at the maximum depth for each site. Results of the phytoplankton counts and chlorophyll a determinations are included in III-B. Results of the limiting nutrient study are presented in III-C.

*At the June sampling, Station 07 replaced Station 06, 08 replaced 03, 09 replaced 04, and 10 replaced 05.

ODOUGAH LAKE
STREET CODE 4012

PHYSICAL AND CHEMICAL CHARACTERISTICS

PARAMETER	N*	(4/ 2/74)			N*	(6/13/74)			N*	(8/29/74)		
		RANGE	MEDIAN	MAX DEPTH RANGE (METERS)		RANGE	MEDIAN	MAX DEPTH RANGE (METERS)		RANGE	MEDIAN	MAX DEPTH RANGE (METERS)
TEMPERATURE (DEG CENT)												
0.-1.5 M DEPTH	12	11.5- 14.0	11.7	0.0- 1.5	11	21.9- 24.1	23.4	0.0- 1.5	6	25.0- 26.8	25.0	0.0- 0.0
MAX DEPTH**	6	9.5- 14.0	11.6	1.5- 21.3	6	21.7- 23.1	22.6	2.4- 21.6	6	24.7- 25.5	25.1	2.4- 18.3
DISSOLVED OXYGEN (MG/L)												
0.-1.5 M DEPTH	6	8.8- 9.6	9.4	1.5- 1.5	5	5.6- 7.2	7.2	1.5- 1.5	6	5.2- 6.4	6.0	0.0- 0.0
MAX DEPTH**	6	8.4- 9.8	9.2	1.5- 21.3	6	5.3- 6.8	5.5	2.4- 21.6	6	0.4- 6.2	4.6	2.4- 18.3
CONDUCTIVITY (UMHOS)												
0.-1.5 M DEPTH	12	10.- 514.	112.	0.0- 1.5	11	219.- 381.	342.	0.0- 1.5	6	309.- 356.	332.	0.0- 0.0
MAX DEPTH**	6	157.- 308.	202.	1.5- 21.3	6	222.- 417.	316.	2.4- 21.6	6	335.- 377.	341.	2.4- 18.3
PH (STANDARD UNITS)												
0.-1.5 M DEPTH	12	7.4- 7.7	7.5	0.0- 1.5	11	6.6- 8.1	7.7	0.0- 1.5	6	7.7- 8.0	7.9	0.0- 0.0
MAX DEPTH**	6	7.3- 7.5	7.4	1.5- 21.3	6	6.9- 8.0	7.4	2.4- 21.6	6	7.6- 7.9	7.7	2.4- 18.3
TOTAL ALKALINITY (MG/L)												
0.-1.5 M DEPTH	12	67.- 95.	81.	0.0- 1.5	11	84.- 134.	117.	0.0- 1.5	6	116.- 132.	122.	0.0- 0.0
MAX DEPTH**	6	65.- 94.	79.	1.5- 21.3	6	79.- 164.	116.	2.4- 21.6	6	120.- 132.	124.	2.4- 18.3
TOTAL P (MG/L)												
0.-1.5 M DEPTH	12	0.055-0.119	0.099	0.0- 1.5	11	0.048-0.196	0.087	0.0- 1.5	6	0.038-0.185	0.056	0.0- 0.0
MAX DEPTH**	6	0.004-0.119	0.091	1.5- 21.3	6	0.059-0.219	0.117	2.4- 21.6	6	0.044-0.110	0.060	2.4- 18.3
DISSOLVED ORTHO P (MG/L)												
0.-1.5 M DEPTH	12	0.015-0.061	0.051	0.0- 1.5	11	0.030-0.048	0.039	0.0- 1.5	5	0.006-0.030	0.014	0.0- 0.0
MAX DEPTH**	6	0.019-0.053	0.046	1.5- 21.3	6	0.031-0.057	0.035	2.4- 21.6	6	0.013-0.031	0.017	2.4- 18.3
NO2+NO3 (MG/L)												
0.-1.5 M DEPTH	12	0.460-0.550	0.500	0.0- 1.5	11	0.630-0.830	0.710	0.0- 1.5	6	0.210-0.390	0.280	0.0- 0.0
MAX DEPTH**	6	0.460-0.550	0.490	1.5- 21.3	6	0.660-0.790	0.715	2.4- 21.6	6	0.170-0.460	0.330	2.4- 18.3
AMMONIA (MG/L)												
0.-1.5 M DEPTH	12	0.060-0.160	0.150	0.0- 1.5	11	0.030-0.130	0.040	0.0- 1.5	6	0.030-0.140	0.060	0.0- 0.0
MAX DEPTH**	6	0.070-0.170	0.140	1.5- 21.3	6	0.030-0.140	0.080	2.4- 21.6	6	0.030-0.100	0.055	2.4- 18.3
KJELDAHL N (MG/L)												
0.-1.5 M DEPTH	12	0.400-0.900	0.750	0.0- 1.5	11	0.200-0.700	0.500	0.0- 1.5	6	0.400-1.200	0.600	0.0- 0.0
MAX DEPTH**	6	0.500-0.800	0.700	1.5- 21.3	6	0.200-0.600	0.400	2.4- 21.6	6	0.200-0.600	0.400	2.4- 18.3
SECCHI DISC (METERS)												
	6	0.2- 0.3	0.2		6	0.1- 0.7	0.3		6	0.3- 0.9	0.5	

* N = NO. OF SAMPLES

** MAXIMUM DEPTH SAMPLED AT EACH SITE

*** S = NO. OF SITES SAMPLED ON THIS DATE

(10/21/74)

S*** = 6
MAX
DEPTH
RANGE
(METERS)

PARAMETER	N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)
TEMPERATURE (DEG CENT)				
0.-1.5 M DEPTH	11	17.0- 17.9	17.8	0.0- 1.5
MAX DEPTH**	6	17.0- 17.8	17.2	0.0- 19.8
DISSOLVED OXYGEN (MG/L)				
0.-1.5 M DEPTH	11	8.2- 9.4	8.6	0.0- 1.5
MAX DEPTH**	6	4.8- 9.0	8.7	0.0- 19.8
CONDUCTIVITY (UMHOS)				
0.-1.5 M DEPTH	11	282.- 302.	294.	0.0- 1.5
MAX DEPTH**	6	282.- 431.	297.	0.0- 19.8
PH (STANDARD UNITS)				
0.-1.5 M DEPTH	11	7.6- 8.2	7.9	0.0- 1.5
MAX DEPTH**	6	7.3- 8.0	7.9	0.0- 19.8
TOTAL ALKALINITY (MG/L)				
0.-1.5 M DEPTH	11	104.- 113.	107.	0.0- 1.5
MAX DEPTH**	6	100.- 111.	106.	0.0- 19.8
TOTAL P (MG/L)				
0.-1.5 M DEPTH	11	0.037-0.129	0.052	0.0- 1.5
MAX DEPTH**	6	0.034-0.129	0.054	0.0- 19.8
DISSOLVED ORTHO P (MG/L)				
0.-1.5 M DEPTH	11	0.009-0.036	0.021	0.0- 1.5
MAX DEPTH**	6	0.008-0.036	0.015	0.0- 19.8
NO2+NO3 (MG/L)				
0.-1.5 M DEPTH	11	0.360-0.500	0.480	0.0- 1.5
MAX DEPTH**	6	0.300-0.500	0.465	0.0- 19.8
AMMONIA (MG/L)				
0.-1.5 M DEPTH	11	0.020-0.070	0.020	0.0- 1.5
MAX DEPTH**	6	0.020-0.070	0.020	0.0- 19.8
KJELDAHL N (MG/L)				
0.-1.5 M DEPTH	11	0.300-0.600	0.400	0.0- 1.5
MAX DEPTH**	6	0.200-0.700	0.350	0.0- 19.8
SECCHI DISC (METERS)				
	6	0.2- 0.7	0.6	

* N = NO. OF SAMPLES

** MAXIMUM DEPTH SAMPLED AT EACH SITE

*** S = NO. OF SITES SAMPLED ON THIS DATE

B. Biological Characteristics:

1. Phytoplankton -

<u>Sampling Date</u>	<u>Dominant Genera</u>	<u>Algal Units per ml</u>
04/02/74	1. <u>Chroomonas</u>	494
	2. <u>Chryptomonas</u>	380
	3. <u>Melosira</u>	228
	4. <u>Dactylococcopsis</u>	76
	5. <u>Skeletonema</u>	76
	Other genera	<u>39</u>
	Total	1,293
06/13/74	1. <u>Melosira</u>	86
	2. <u>Nitzschia</u>	86
	3. <u>Scenedesmus</u>	29
	Other genera	<u>--</u>
	Total	201
08/28,29/74	1. <u>Melosira</u>	567
	2. <u>Cryptomonas</u>	177
	3. <u>Stephanodiscus</u>	142
	4. <u>Chroomonas</u>	71
	5. <u>Skeletonema</u>	71
	Other genera	<u>142</u>
	Total	1,170
10/21/74	1. <u>Chroomonas</u>	3,783
	2. <u>Cyclotella</u>	408
	3. <u>Cryptomonas</u>	190
	4. <u>Melosira</u>	163
	5. <u>Skeletonema</u>	163
	Other genera	<u>327</u>
	Total	5,034

2. Chlorophyll a -

<u>Sampling Date</u>	<u>Station Number</u>	<u>Chlorophyll <u>a</u> ($\mu\text{g/l}$)</u>	<u>Sampling Date</u>	<u>Station Number</u>	<u>Chlorophyll <u>a</u> ($\mu\text{g/l}$)</u>
04/02/74	01	1.7	08/29/74	01	1.4
	02	1.6		02	4.1
	03	2.0		03	---
	04	1.2		04	---
	05	4.5		05	---
	06	15.1		06	---
	07	---		07	10.5
	08	---		08	7.2
	09	---		09	7.4
	10	---		10	8.0
06/13/74	01	0.3	10/21/74	01	3.0
	02	1.5		02	8.8
	03	---		03	---
	04	---		04	---
	05	---		05	---
	06	---		06	---
	07	0.5		07	13.8
	08	0.4		08	6.8
	09	0.4		09	7.1
	10	0.5		10	15.5

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>
--------------------	--------------------------------	------------------------------------	---

a. 04/04/74 - Stations 01-03

Control	0.035	0.610	13.4
0.05 P	0.085	0.610	18.4
0.05 P + 1.0 N	0.085	1.610	32.9
1.00 N	0.035	1.610	11.1

Stations 04-06

Control	0.015	0.549	6.0
0.05 P	0.065	0.549	14.7
0.05 P + 1.0 N	0.065	1.549	24.0
1.00 N	0.015	1.549	7.5

b. 10/21/74 - Stations 01,02,07

Control	0.025	0.439	1.8
0.05 P	0.075	0.439	12.8
0.05 P + 1.0 N	0.075	1.439	20.3
1.00 N	0.025	1.439	1.4

2: Discussion -

The control yields of the assay alga, Selenastrum capricornutum, indicate that the potential primary productivity in Oologah Reservoir was high at the times assay samples were collected (04/02/74, 10/21/74). Highly turbid lake conditions severely restricted light penetration and are the likely reason that chlorophyll a values noted (page 10) did not reflect the high yield potential noted under assay conditions where light limitation is not a factor. There was a significant increase in yield over that of the control when orthophosphorus was added but a lack of yield response when nitrogen alone was added. The maximum increase in yield over that of the control was achieved with the simultaneous addition of both nutrients. Based on these results, phosphorus limitation is indicated.

The mean inorganic nitrogen to orthophosphorus ratios (N/P) in the lake data were 14/1 or greater on all sampling occasions, further suggesting primary limitation by phosphorus (a mean N/P ratio of 14/1 or greater generally indicates phosphorus limitation).

IV. NUTRIENT LOADINGS (See Appendix D for data)

For the determination of nutrient loadings, the Oklahoma 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 September 1975.

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

In this report, nutrient loads for sampled tributaries were determined by using a modification of a USGS computer program for calculating stream loadings. Nutrient loads indicated for tributaries are those measured minus known point source loads, if any.

Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of USGS) were estimated by using the mean annual nutrient loads, in $\text{kg}/\text{km}^2/\text{yr}$, in Wolf Creek at Station C-1, and multiplying the means by the ZZ area in km^2 .

The operators of the Delaware and Nowata wastewater treatment plants provided monthly effluent samples and corresponding flow data.

A. Waste Sources:

1. Known municipal -

<u>Name</u>	<u>Pop.* Served</u>	<u>Treatment*</u>	<u>Mean Flow (m³/d x 10³)</u>	<u>Receiving Water</u>
Delaware	510	Stabilization pond	0.108	Verdigris River
Nowata	3,500	Trickling filter	1.813	Western Branch/ Verdigris River

2. Known industrial -

<u>Name</u>	<u>Product</u>	<u>Treatment**</u>	<u>Mean Flow** (m³/d x 10³)</u>	<u>Receiving Water**</u>
Peabody Coal #1	Coal	None	0.189	Madden Creek
Peabody Coal #2	Coal	Settling basin	0.189	Spencer Creek

*Treatment plant questionnaires.

**Oklahoma Department of Pollution Control, 1976.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

<u>Source</u>	<u>kg P/yr</u>	<u>% of total</u>
a. Tributaries (nonpoint load) -		
A-2 Verdigris River	388,860	94.5
C-1 Wolf Creek	1,810	0.4
b. Minor tributaries and immediate drainage (nonpoint load) -	10,360	2.5
c. Known municipal STP's -		
Delaware	75	<0.1
Nowata	8,255	2.0
d. Septic tanks* -	15	<0.1
e. Known industrial -		
Peabody Coal #1	Unknown	---
Peabody Coal #2	Unknown	---
f. Direct precipitation** -	<u>2,085</u>	<u>0.5</u>
Totals	411,460	100.0
2. Output - A-1 Verdigris River	159,885	
3. Net annual P accumulation -	251,575	

*Estimate based on 35 lakeshore residences and 4 parks.

**Estimated (see NES 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 (nonpoint load) -		
A-2 Verdigris River	3,791,695	89.5
C-1 Wolf Creek	46,190	1.1
b. Minor tributaries and immediate drainage (nonpoint load) -	251,210	5.9
c. Known municipal STP's -		
Delaware	315	<0.1
Nowata	19,580	0.5
d. Septic tanks* -	515	<0.1
e. Known industrial-		
Peabody Coal #1	Unknown	---
Peabody Coal #2	Unknown	---
f. Direct precipitation** -	<u>128,710</u>	<u>3.0</u>
Totals	4,238,215	100.0

2. Output - A-1 Verdigris River 3,743,220
3. Net annual N accumulation - 494,995

*Estimate based on 35 lakeshore residences and 4 parks.

**Estimated (see NES Working Paper No. 175).

D. Mean Annual Nonpoint Nutrient Export by Subdrainage Area:

<u>Tributary</u>	<u>kg P/km²/yr</u>	<u>kg N/km²/yr</u>
Verdigris River	41	396
Wolf Creek	8	194

E. Mean Nutrient Concentrations in Ungaged Streams:

<u>Tributary</u>	<u>Mean Total P (mg/l)</u>	<u>Mean Total N (mg/l)</u>
B-1 Panther Creek	0.056	1.328
D-2 Brush Creek	0.044	1.296
E-1 Big Creek	0.083	1.416
F-1 East Fork Big Creek	0.040	1.303
G-1 Mormon Creek	0.048	1.396

F. Yearly Loadings:

In the following table, the existing phosphorus annual loading is compared to the relationship proposed by Vollenweider (1975). Essentially, his "eutrophic" loading is that at which the receiving waters would become eutrophic or remain eutrophic; his "oligotrophic" 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 "eutrophic" or "oligotrophic".

Note that Vollenweider's model may not be applicable to water bodies with very short retention times or in which light penetration is severely restricted from high concentrations of suspended solids in the surface waters.

Total Yearly Phosphorus Loading (g/m²/yr)	
Estimated loading for Oologah Reservoir	3.45
Vollenweider's "eutrophic" loading	0.83
Vollenweider's "oligotrophic" loading	0.42

V. LITERATURE REVIEWED

Oklahoma Department of Pollution Control. 1976. Water Quality Management Plan, Middle Arkansas River Basin. Oklahoma City, Oklahoma.

U.S. Environmental Protection Agency. 1975. National Eutrophication Survey Methods 1973-1976. Working Paper No. 175. National Environmental Research Center, Las Vegas, Nevada, and Pacific Northwest Environmental Research Laboratory, Corvallis, Oregon.

Vollenweider, R. A. 1975. Input-Output Models With Special Reference to the Phosphorus Loading Concept in Limnology. Schweiz. Z. Hydrol. 37:53-84.

VI. APPENDICES

APPENDIX A CONVERSION FACTORS

CONVERSION FACTORS

Hectares $\times 2.471 =$ acres

Kilometers $\times 0.6214 =$ miles

Meters $\times 3.281 =$ feet

Cubic meters $\times 8.107 \times 10^{-4} =$ acre/feet

Square kilometers $\times 0.3861 =$ square miles

Cubic meters/sec $\times 35.315 =$ cubic feet/sec

Centimeters $\times 0.3937 =$ inches

Kilograms $\times 2.205 =$ pounds

Kilograms/square kilometer $\times 5.711 =$ lbs/square mile

APPENDIX B
TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR OKLAHOMA

03/25/77

LAKE CODE 4012 DOLOGAH LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 11237.7

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS)												MEAN
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
4012A1	11237.7	31.43	36.53	73.62	143.00	144.98	147.25	111.57	20.67	52.10	55.22	28.03	21.24	72.21
4012A2	9585.6	27.47	30.87	66.54	129.12	117.51	111.57	107.32	19.54	47.86	49.84	23.50	17.84	62.50
4012C1	238.0	0.62	0.91	1.22	2.24	4.19	2.07	1.05	0.48	0.88	0.96	0.76	0.59	1.33
4012ZZ	1414.1	3.68	5.38	7.58	13.31	24.92	12.46	6.23	2.83	5.38	5.66	4.53	3.40	7.91

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 11237.7
SUM OF SUB-DRAINAGE AREAS = 11237.7

TOTAL FLOW IN = 859.81
TOTAL FLOW OUT = 865.65

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW
4012A1	11	74	421.071	2	59.749		
	12	74	211.810	15	206.713		
	1	75	184.060	19	166.786		
	2	75	212.376	16	183.493		
	3	75	214.075	16	171.034		
	4	75	209.545	19	163.955		
	5	75	42.475				
	6	75	275.240				
	7	75	78.154	29	2.067		
	8	75	1.501	28	0.595		
4012A2	9	75	3.964	29	0.0		
	10	75	1.982				
	11	74	444.574	2	603.149		
	12	74	99.109	14	161.689		
	1	75	92.879	18	45.307		
	2	75	137.620	15	215.774		
	3	75	175.281	16	168.485		
	4	75	97.693	20	41.059		
	5	75	70.226				
	6	75	237.862	13	58.333		
	7	75	12.799				
	8	75	18.576				
	9	75	4.078				
	10	75	1.557				

TRIBUTARY FLOW INFORMATION FOR OKLAHOMA

03/25/77

LAKE CODE 4012 DOLOGAH LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS (CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW
401201	11	74	9.911	2	14.153		
	12	74	1.699	14	1.982		
	1	75	1.699	17	0.850		
	2	75	4.243	15	1.416		
	3	75	3.631	16	1.133		
	4	75	1.416	20	1.699		
	5	75	1.133				
	6	75	4.248	13	0.566		
	7	75	0.283				
	8	75	0.340				
401222	9	75	0.085				
	10	75	0.028				
	11	74	70.792				
	12	74	16.141				
	1	75	15.008				
	2	75	33.980				
	3	75	28.317				
	4	75	15.857				
	5	75	11.327				
	6	75	36.812				
	7	75	1.982				
	8	75	2.832				
	9	75	0.566				
	10	75	0.283				

APPENDIX C
PHYSICAL AND CHEMICAL DATA

STWRET RETRIEVAL DATE 77/03/24

401201
36 25 23.0 C95 40 41.0 3
COLOGAN LAKE
40131 OKLAHOMA

100391

/TYP/AMBN/LAKE

11EPALES 04001002
0075 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 CONDUCTIV 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
74/04/02	10 30	0000	11.5		8	49	7.50	79	0.130	0.600	0.550	0.052
	10 30	0005	11.6	9.6		42	7.40	78	0.160	0.400	0.550	0.057
	10 30	0015	11.5	9.2		119	7.40	78	0.160	0.500	0.550	0.058
	10 30	0030	11.0	9.7		185	7.40	77	0.160	0.500	0.540	0.058
	10 30	0050	11.0	9.2		134	7.40	76	0.150	0.400	0.550	0.058
	10 30	0070	11.0	9.2		212	7.30	78	0.140	0.500	0.540	0.053
74/06/13	12 45	0000	24.0		26	381	7.70	134	0.050	0.500	0.630	0.039
	12 45	0005	23.2	7.2		373	7.70	131	0.030	0.200	0.650	0.035
	12 45	0015	23.1	7.0		374	7.90	137	0.030	0.200	0.640	0.035
	12 45	0030	23.1	7.4		376	7.80	146	0.040	0.200	0.680	0.034
	12 45	0050	23.0	7.0		378	7.60	132	0.040	0.200	0.680	0.033
	12 45	0071	23.0	6.8		378	7.60	134	0.030	0.200	0.660	0.034
74/08/29	09 20	0000	25.9	5.2	22	309	7.90	122	0.030	0.500	0.380	
	09 20	0015	25.9	5.2		312	7.90	122	0.020K	0.400	0.400	0.022
	09 20	0035	25.8	5.2		313	7.90	123	0.020K	0.300	0.420	0.026
	09 20	0050	25.6	3.2		375	7.80	121	0.020K	0.300	0.460	0.019
	09 20	0060	25.4	2.2		377	7.70	122	0.030	0.400	0.460	0.023
74/10/21	09 25	0000	17.8	8.2	25	302	7.78	113	0.030	0.800	0.500	0.022
	09 25	0005	17.8	8.2		299	7.90	112	0.020K	0.400	0.440	0.025
	09 25	0015	17.8	8.2		300	7.92	109	0.020K	0.300	0.430	0.021
	09 25	0030	17.8	8.2		300	7.94	109	0.020K	0.500	0.430	0.018
	09 25	0045	17.8	8.2		301	7.93	109	0.020K	0.300	0.430	0.016
	09 25	0065	17.8	8.2		302	7.78	111	0.020K	0.300	0.430	0.015

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 77/03/24

401201
36 25 23.0 095 40 -1.0 3
OOLUGAH LAKE
40131 OKLAHOMA

100391

/TYPE/AMBT/LAKE

11EPALES 04001002
0075 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCR LT PENNING PERCENT
74/04/02	10 30	0000	0.099	1.7	
	10 30	0005	0.099		
	10 30	0015	0.099		
	10 30	0030	0.097		
	10 30	0050	0.094		
	10 30	0070	0.100		
74/06/13	12 45	0000	0.048	0.3	
	12 45	0005	0.050		
	12 45	0006			1.0
	12 45	0015	0.052		
	12 45	0030	0.053		
	12 45	0050	0.054		
	12 45	0071	0.059		
74/08/29	09 20	0000	0.057	1.4	
	09 20	0015	0.049		
	09 20	0035	0.060		
	09 20	0050	0.067		
	09 20	0060	0.098		
74/10/21	09 25	0000	0.051	3.0	
	09 25	0004			5.0
	09 25	0005	0.037		
	09 25	0009			1.0
	09 25	0015	0.037		
	09 25	0030	0.034		
	09 25	0045	0.038		
	09 25	0065	0.034		

STORED RETRIEVAL DATE 77/03/24

401202
36 27 00.0 095 37 24.0 3
OOLAGAH LAKE
40131 OKLAHOMA

100391

/T/PA/ABNT/LAKE

11EPALES 04001002
0044 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSF SECCHI INCHES	00094 CONDUCTVY 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
74/04/02	10 20	0000	11.5		8	76	7.50	78	0.150	0.500	0.550	0.055
	10 20	0005	11.5	9.2		78	7.50	79	0.150	0.400	0.550	0.053
	10 20	0015	11.5	9.8		165	7.50	79	0.130	0.400	0.540	0.052
	10 20	0030	11.5	9.4		173	7.50	81	0.150	0.400	0.570	0.051
	10 20	0040	11.4	9.8		191	7.40	79	0.140	0.500	0.550	0.046
74/06/13	13 20	0000	24.1		19	379	7.70	131	0.040	0.300	0.670	0.032
	13 20	0005	23.9	7.2		377	8.00	131	0.040	0.200	0.670	0.030
	13 20	0015	23.6	7.4		375	8.00	149	0.040	0.200	0.680	0.031
	13 20	0030	23.1	6.6		375	7.90	137	0.040	0.200	0.660	0.031
	13 20	0040	22.8	5.6		417	7.80	164	0.050	0.200	0.700	0.031
74/08/28	15 10	0000	25.1	6.0	36	324	7.70	120	0.060	0.400	0.390	0.014
	15 10	0015	25.9	6.0		326	7.70	117	0.040	0.200	0.380	0.010
	15 10	0023	25.7	6.0		329	7.65	118	0.090	0.300	0.400	0.010
	15 10	0029	25.3	4.2		340	7.60	120	0.050	0.200	0.430	0.018
74/10/21	10 20	0000	17.8	9.0	29	302	8.01	113	0.020K	0.600	0.370	0.009
	10 20	0005	17.8	8.6		301	8.06	112	0.020	0.400	0.360	0.009
	10 20	0015	17.8	9.0		302	8.17	111	0.020K	0.200	0.360	0.009
	10 20	0031	17.8	9.0		316	7.96	110	0.020K	0.200	0.380	0.009

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 77/03/24

401202
35 27 00.0 095 37 24.0 3
COLUMBIAN LAKE
40131 OKLAHOMA

100391

/TYPE/AMBIENT/LAKE

11EPALES 04001002
0.44 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00465 PHOS-TOT MG/L F	32217 CHLOROPHYL A UG/L	00031 INCH T LT REMARKS PERCENT
74/04/02	10 20	0000	0.098	1.6	
	10 20	0005	0.054		
	10 20	0015	0.091		
	10 20	0030	0.090		
	10 20	0040	0.092		
74/06/13	13 20	0000	0.053	1.5	
	13 20	0031			50.0
	13 20	0035	0.053		
	13 20	0036			1.0
	13 20	0015	0.055		
	13 20	0030	0.055		
	13 20	0040	0.063		
74/08/28	15 10	0000	0.043	4.1	
	15 10	0015	0.039		
	15 10	0023	0.040		
	15 10	0029	0.052		
74/10/21	10 20	0000	0.040	8.8	
	10 20	0005	0.037		
	10 20	0015	0.040		
	10 20	0031	0.042		

STORET RETRIEVAL DATE 77/03/24

401203
36 32 59.0 095 37 59.0 3
COLOGAN LAKE
40131 OKLAHOMA

100391

7/7/84/AGENT/LAKE

11EPALES 04001002
0044 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 CONDUCTIVITY FIELD MICROMHO	00400 PH SU	00410 T ALK CACU3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT N MG/L	00630 NO2+NO3 N-TOTAL MG/L	00671 PHOS-PIS ORTHO MG/L P
74/04/02	11 15	0000	11.5		8	514	7.50	70	0.160	0.800	0.490	0.061
	11 15	0005	11.5	9.4		105	7.50	67	0.160	0.800	0.490	0.053
	11 15	0015	11.5	8.8		123	7.45	68	0.160	0.800	0.500	0.058
	11 15	0030	9.5	8.4		172	7.30	65	0.170	0.800	0.460	0.047

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/02	11 15	0000	0.111	2.0	
	11 15	0005	0.103		
	11 15	0015	0.100		
	11 15	0030	0.090		

SECRET RETRIEVAL DATE 77/03/24

401204
36 33 53.0 045 35 43.0 3
OJLOGAN LAKE
40101 OJLAHOMA

100391

ZTYP/AMANT/LAKE

11EPALES 04001002
0030 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECTHI INCHES	00094 CONDUCTVY FIELD MIC-OMHO	00400 PH SU	00410 T ALK CAC03 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT NJEL N MG/L	00630 NO2S+O3 N-TOTAL MG/L	00671 PHOS-DIS ORTHOP MG/L P
74/04/02	14 00	0000	11.4		6	136	7.60	83	0.160	0.900	0.480	0.050
	14 00	0005	11.4	9.4		102	7.60	43	0.140	0.700	0.480	0.045
	14 00	0015	11.4	9.4		235	7.50	80	0.160	0.700	0.490	0.049
	14 00	0030	11.4	9.4		236	7.40	79	0.140	0.700	0.470	0.046

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCOIT LT REMPING PERCENT
74/04/02	14 00	0000	0.099	1.2	
	14 00	0005	0.092		
	14 00	0015	0.089		
	14 00	0030	0.089		

STORET RETRIEVAL DATE 77/03/28

401205
36 39 00.0 095 35 00.0 4
Oologah Lake
40105 OKLAHOMA

100391

/TYPE/AMNT/LAKE

11EPALES 04001002
0010 FEET DEPTH CLASS 00

DATE	TIME	DEPTH	00010 WATER	00300 DO	00077 TRANSP	00094 CONDUCTVY	00400 PH	00410 T ALK	00610 NH3-N	00625 TOT KJEL	00630 NO2&NO3	00671 PHOS-DIS
FROM	OF		TEMP		SECCHI	FIELD		CACO3	TOTAL	N	N-TOTAL	ORT-HO
TO	DAY	FEET	CENT	MG/L	INCHES	MICROMHO	SU	MG/L	MG/L	MG/L	MG/L	MG/L P
74/04/02	14 30	0000	14.0		8	118	7.50	95	0.160	0.800	0.500	0.047
	14 30	0005	14.0	8.8		157	7.40	94	0.120	0.700	0.460	0.043

DATE	TIME	DEPTH	00665 PHOS-TOT	32217 CHLRPHYL	00031 INCDT LT
FROM	OF		A	REMNING	
TO	DAY	FEET	MG/L P	UG/L	PERCENT
74/04/02	14 30	0000	0.118		4.5
	14 30	0005	0.119		

STORET RETRIEVAL DATE 77/03/28

401206
36 31 19.0 095 33 38.0 3
OOLUJAH LAKE
40131 OKLAHOMA

100391

/TYP/AMNT/LAKE

11EPALES 04001002
0026 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	07077 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-JIS ORTHO MG/L P
74/04/02	15 00	0000	13.5		12	198	7.70	85	0.080	0.900	0.510	0.016
	15 00	0005	13.6	9.4		235	7.70	85	0.060	0.800	0.500	0.015
	15 00	0015	13.6	7.2		288	7.60	85	0.070	0.800	0.500	0.018
	15 00	0022	13.5	9.2		308	7.55	83	0.070	0.800	0.510	0.019

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCU LT REMNING PERCENT
74/04/02	15 00	0000	0.055	15.1	
	15 00	0005	0.065		
	15 00	0015	0.059		
	15 00	0022	0.004		

STORET RETRIEVAL DATE 77/03/28

401207
36 30 52.0 095 34 25.0 3
00LOGAN LAKE
40131 OKLAHOMA

100391

/TYPK/AMBNT/LAKE

11EPALES 04001002
0036 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
74/06/13	13 50	0000	23.7		13	344	8.10	121	0.040	0.500	0.760	0.036
	13 50	0005	23.6	7.2		342	8.10	117	0.040	0.300	0.730	0.036
	13 50	0015	23.3	7.0		340	8.00	114	0.030	0.300	0.760	0.036
	13 50	0032	23.1	6.8		362	8.00	159	0.050	0.300	0.780	0.035
74/08/28	14 15	0000	26.8	6.4	36	330	8.00	118	0.140	0.700	0.290	0.006
	14 15	0015	26.5	6.4		329	8.10	116	0.070	0.500	0.280	0.010
	14 15	0020	26.4	7.0		328	8.10	117	0.060	0.500	0.260	0.008
	14 15	0025	26.2	5.8		329	8.10	117	0.090	0.600	0.280	
	14 15	0030		2.0			8.00	120	0.060	0.200	0.260	0.012
	14 15	0035	25.5	0.4		338	7.70	128	0.100	0.500	0.360	0.031
74/10/21	10 55	0000	17.9	9.0	26	295	8.17	106	0.020K	0.400	0.400	0.009
	10 55	0005	17.8	9.4		294	8.20	104	0.020K	0.300	0.400	0.010
	10 55	0015	17.8	9.4		295	8.08	102	0.020K	0.300	0.410	0.009
	10 55	0030	17.2	4.8		431	7.29	100	0.070	0.400	0.300	0.008

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 77/03/26

401207
36 30 52.0 095 34 25.0 3
OOLOGAH LAKE
40131 OKLAHOMA

100391

/TYPE/AMHNT/LAKE

11EPALES 04001002
0036 FEET DEPTH CLASS 00

DATE	TIME	DEPTH	00665 PHOS-TOT	32217 CHLRPHYL	00031 INCOT LT
FROM	OF			A	REMNING
TO	DAY	FEET	MG/L P	UG/L	PERCENT
74/06/13	13 50	0000	0.037	0.5	
	13 50	0005	0.035		50.0
	13 50	0015	0.037		
	13 50	0025			1.0
	13 50	0032	0.034		
74/08/28	14 15	0000	0.058	10.5	
	14 15	0015	0.037		
	14 15	0020	0.040		
	14 15	0025	0.043		
	14 15	0030	0.047		
	14 15	0035	0.110		
74/10/21	10 55	0000	0.059	13.8	
	10 55	0005	0.054		5.0
	10 55	0009			1.0
	10 55	0015	0.049		
	10 55	0030	0.061		

STORET RETRIEVAL DATE 77/03/28

401208
36 32 31.0 095 37 24.0 3
OOLAGAH LAKE
40131 OKLAHOMA

100391

/TYP/AMENT/LAKE

11EPALES 04001002
0044 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
74/06/13	14 10	0000	23.1		10	308	6.60	112	0.040	0.600	0.710	0.044
	14 10	0005	22.6	6.4		304	6.80	107	0.090	0.400	0.790	0.042
	14 10	0015	22.4	6.4		297	6.80	104	0.100	0.400	0.800	0.043
	14 10	0025	22.1	5.8		265	6.80	95	0.140	0.500	0.810	0.042
	14 10	0040	22.1	5.4		270	6.90	98	0.120	0.500	0.790	0.036
74/08/28	12 15	0000	25.0	6.0	15	334	7.90	121	0.060	0.500	0.220	0.007
	12 15	0015	25.0	5.8		334	7.75	120	0.060	0.500	0.240	0.011
	12 15	0021	25.0	5.0		335	7.75	123	0.060	0.400	0.280	0.013
74/10/21	11 35	0000	17.2	8.6	27	285	7.91	104	0.020	0.300	0.480	0.020
	11 35	0005	17.3	9.0		285	7.93	107	0.020	0.400	0.500	0.024
	11 35	0015	17.2	8.8		285	8.00	105	0.020	0.300	0.500	0.016
	11 35	0020	17.2	9.0		284	7.94	106	0.020K	0.300	0.500	0.016

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 77/03/28

401205
35 32 31.0 095 37 24.0 3
OOLONGAH LAKE
40131 OKLAHOMA

100391

/TYPE/AGENT/LAKE.

11EPALES 04001002
0044 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/06/13	14 10	0000	0.113	0.4	
	14 10	0005	0.122		
	14 10	0015	0.127		
	14 10	0025	0.154		
	14 10	0040	0.151		
74/08/28	12 15	0000	0.038	7.2	
	12 15	0015	0.045		
	12 15	0021	0.044		
74/10/21	11 35	0000	0.046	6.8	
	11 35	0005	0.052		
	11 35	0015	0.046		
	11 35	0020	0.048		

STORET RETRIEVAL DATE 77/03/28

401209
36 33 48.0 095 35 35.0 3
OOLJGAH LAKE
40131 OKLAHOMA

100391

/TYPE/AMOUNT/LAKE

11EPALES 04001002
0035 FEET DEPTH CLASS 00

DATE	TIME	DEPTH	00010 WATER	00300 DO	00077 TRANSP	00094 CONDUCTVY	00400 PH	00410 T ALK	00610 NH3-N	00625 TOT KJEL	00630 NO2&NO3	00671 PHOS-DIS
FROM	OF		TEMP		SECCHI	FIELD		CACO3	TOTAL	N	N-TOTAL	ORTHO
TO	DAY	FEET	CENT	MG/L	INCHES	MICROMHO	SU	MG/L	MG/L	MG/L	MG/L	MG/L P
74/06/13	14 45	0000	23.4		9	260	7.30	107	0.120	0.500	0.830	0.039
	14 45	0005	21.9	5.6		226	7.30	84	0.070	0.500	0.710	0.039
	14 45	0015	21.8	5.4		229	7.20	81	0.100	0.400	0.670	0.040
	14 45	0031	21.7	5.3		224	7.20	79	0.110	0.500	0.730	0.041
74/08/28	11 45	0000	25.0	6.0	14	340	7.80	128	0.060	0.700	0.270	0.023
	11 45	0015	25.0	5.8		341	7.80	126	0.060	0.500	0.280	0.015
	11 45	0025	25.0	5.4		342	7.75	125	0.050	0.400	0.300	0.015
74/10/21	14 10	0000	17.4	8.6	25	290	8.05	107	0.030	0.600	0.490	0.023
	14 10	0005	17.2	8.6		290	7.92	107	0.020	0.400	0.500	0.021
	14 10	0015	17.1	8.6		291	8.02	107	0.020	0.400	0.500	0.019
	14 10	0024	17.1	8.6		291	7.93	106	0.020	0.400	0.500	0.020

STORET RETRIEVAL DATE 77/03/28

401209
36 33 48.0 095 35 36.0 3
OOLAGAH LAKE
40131 OKLAHOMA
100391

/TYPE/AMBT/LAKE

11EPALES 04001002
0035 FEET DEPTH CLASS 00

DATE	TIME	DEPTH	PHOS-TOT	CHLRPHYL	INCDT LT
FROM	OF			A	REMNING
TO	DAY	FEET	MG/L P	UG/L	PERCENT
74/06/13	14 45	0000	0.127	0.4	
	14 45	0001			1.0
	14 45	0005	0.161		
	14 45	0015	0.178		
	14 45	0031	0.193		
74/08/28	11 45	0000	0.056	7.4	
	11 45	0015	0.046		
	11 45	0025	0.062		
74/10/21	14 10	0000	0.060	7.1	
	14 10	0001			50.0
	14 10	0004			5.0
	14 10	0005	0.053		
	14 10	0007			1.0
	14 10	0015	0.057		
	14 10	0024	0.061		

STORET RETRIEVAL DATE 77/03/28

401210
36 38 30.0 095 34 10.0 4
00LOGAN LAKE
40105 OKLAHOMA

100391

/TYP/AMNT/LAKE

11EPALES 04001002
0012 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
74/06/13	15 15	0000	22.9		5	219	7.30	87	0.130	0.700	0.660	0.048
	15 15	0008	22.4	5.4		222	7.30	87	0.140	0.600	0.660	0.057
74/08/28	11 15	0000	25.0	5.8	12	356	7.90	132	0.100	1.200	0.210	0.030
	11 15	0008	24.7	6.2		352	7.90	132	0.090	0.600	0.170	0.016
74/10/21	14 40	0000	17.0	8.8	9	282	7.61	105	0.070	0.700	0.500	0.036

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/06/13	15 15	0000	0.196	0.5	
	15 15	0008	0.219		
74/08/28	11 15	0000	0.185	8.0	
	11 15	0008	0.058		
74/10/21	14 40	0000	0.129	15.5	

APPENDIX D

TRIBUTARY AND WASTEWATER
TREATMENT PLANT DATA

SECRET RETRIEVAL DATE 77/03/24

401241
 36 25 20.0 095 25 20.0 4
 VERDIGRIS RIVER
 40 7.5 OOLOGAH
 O/OOLOGAH RESERVOIR 100492
 HWY 88 2.4 MI SE OF JCT W US RTE 169
 11EPALES 04001004
 0000 FEET DEPTH CLASS: 00

/TYPE/AMNT/STREAM

DATE	TIME	DEPTH	00630 NO2-NH03 N-TOTAL MG/L	00625 TOT NOEL N MG/L	00610 NH4-N TOTAL MG/L	00671 PHOS-DIS ORTH0 MG/L P	00665 PHOS-TOT MG/L P
FROM	OF	FEET					
TO	DAY						
74/11/02	09 00		0.400	0.900	0.065	0.010	0.050
74/12/15	10 20		0.400	1.400	0.035	0.055	0.130
75/01/19	14 00		0.368	1.400	0.016	0.045	0.090
75/02/16	16 00		0.479	1.400	0.048	0.032	0.090
75/03/16	09 30		0.464	1.550	0.080	0.024	0.050
75/04/19	15 00		0.410	1.300	0.025	0.005	0.060
75/07/29	11 00		0.570	0.450	0.025	0.015	0.030
75/08/28	15 10		0.095		0.025	0.015	
75/09/29	09 50		0.230	0.500	0.012	0.017	0.070

STORET RETRIEVAL DATE 77/03/24

431242
 36 49 15.0 095 33 00.0 4
 VERMIGRIS RIVER
 40 NOWATA CO HWY 24
 T/OULOGAN RESERVOIR 100391
 2ND HY RD BRDG 0.5 MI W OF JCT W HWY 24
 11EPALES 0-001004
 0000 FEET DEPTH CLASS 00

/TYPE/AMOUNT/STREAM

DATE	TIME	DEPTH	00630 NUTRIENT N-TOTAL	00625 TOT KJEL N	00610 NH3-N TOTAL	00671 PHOS-DIB ORTHOP	00665 PHOS-TOT
FROM	OF		MG/L	MG/L	MG/L	MG/L P	MG/L P
TO	DAY	FEET					
74/11/02	13	30	0.264	1.900	0.090	0.060	0.480
74/12/14	10	00	0.416	2.300	0.097	0.052	0.270
75/01/18	10	00	0.432	1.200	0.144	0.040	0.060
75/02/15	09	15	0.640	0.300	0.032	0.032	0.100
75/03/16	14	40	0.576	2.100	0.070	0.032	0.070
75/04/20	09	55	0.400	1.350	0.020	0.025	0.120
75/06/13	12	00	0.490	1.350	0.055	0.050	0.300

STORET RETRIEVAL DATE 77/03/24

401281
 35 45 20.0 095 37 45.0 4
 PANTHER CREEK
 40 NOWATA CO MAY MO
 T/OOLOGAN RESERVOIR 100391
 2NDRY RD BRDG 1.0 MI N OF NEW ALLWE
 11EPALES 04001004
 0000 FEET DEPTH CLASS 00

/TYPAA/ABNT/STREAM

DATE	TIME	DEPTH	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT NOEL N MG/L	00610 NH4-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
FROM	OF						
TO	DAY	FEET					
74/11/02	11	00	0.136	3.000	0.045	0.070	0.080
74/12/14	09	23	0.120	2.000	0.040	0.020	0.040
75/01/18	09	20	0.015	0.300	0.040	0.010	0.010
75/02/15	08	45	0.025	0.300	0.024	0.008	0.030
75/03/10	08	30	0.155	1.100	0.048	0.035	0.160
75/04/20	09	15	0.015	1.200	0.025	0.005	0.020
75/06/13	14	10	0.080	0.850	0.035	0.020	0.050

STORET RETRIEVAL DATE 77/03/24

401201
36 46 20.0 095 39 40.0 4
*JLF CREEK
48 NJWATA COUNTY
T/OULOGAH RESERVOIR 100391
2NDRY RD BR03 1. MI N DELAWARE
11EPALES 04001004
0000 FEET DEPTH CLASS 00

/TYP/ANBNT/STREAM

DATE	TIME	DEPTH	00530 NO2-NH3 N-TOTAL MG/L	00625 TOT KjEL N MG/L	00610 NH3-N TOTAL MG/L	01671 PHOS-DIS ORTH0 MG/L P	00665 PHOS-TOT MG/L P
FROM	OF						
TO	DAY	FEET					
74/11/07	11 45		0.136	2.000	0.020	0.070	
74/12/14	12 40		0.200	1.900	0.040	0.015	0.070
75/01/17	11 30		0.064	0.400	0.016	0.010	0.010
75/02/15	11 15		0.168	0.300	0.020	0.008K	0.030
75/04/20	11 50		0.095	0.800	0.015	0.005K	0.030
75/06/13	15 00		0.165	0.850	0.045	0.020	0.040

K VALUE KNOWN TO BE
LESS THAN INDICATED

SIGMET RETRIEVAL DATE 77/03/24

401201
36 56 45.0 095 25 00.0 4
BRUSH CREEK
40 CRAIG CO HAY MAP
T/OOLOGAN RESERVOIR 100391
2NDRY RD BRDG E MI N OF JCT W HWY 10
11EPALES 04001004
0000 FEET DEPTH CLASS 00

/TYPE/AMNT/STREAM

DATE	TIME	DEPTH	00630 NO2&NO3 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					
74/11/02	15	30	0.204	2.400	0.035	0.100	
74/12/14	10	35	0.760	1.600	0.065	0.020	0.060
75/01/17	11	00	0.448	3.300	0.048	0.010	0.016
75/02/15	10	15	0.720	0.200	0.008	0.008	0.030
75/03/10	11	20	0.540	1.350	0.032	0.024	0.130
75/04/20	11	10	0.195	1.150	0.035	0.010	0.030
75/06/13	11	30	0.470	1.000	0.055	0.035	0.060

STORET RETRIEVAL DATE 77/03/24

401202
 36 53 20.0 095 25 00.0 4
 BRUSH CREEK
 40 CRAIG CO HWY 14P
 T/OLOGAN RESERVOIR 100391
 HWY 10 BRDG 1 MI E NOWATA/CRAIG CO LINE
 11EPALES 04001004
 3000 FEET DEPTH CLASS 00

/TYPE/AMBIENT/STREAM

DATE	TIME	DEPTH	00630 NO2-NH3 N-TOTAL MG/L	00625 TUT 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					
74/11/02	14	30	0.120	1.400	0.025	0.050	
74/12/14	12	30	0.312	0.700	0.010	0.010	0.030
75/01/17	10	30	0.128	0.550	0.012	0.005	0.010K
75/02/15	10	40	0.288	1.200	0.016	0.008K	0.020
75/03/10	10	15	0.272	1.700	0.064	0.088	0.090
75/04/20	10	30	0.650	0.900	0.020	0.005K	0.030
75/06/13	10	30	0.200	1.250	0.060	0.020	0.050

K VALUE KNOWN TO BE
 LESS THAN INDICATED

STORET RETRIEVAL DATE 77/03/24

4012E1
 36 53 20.0 095 23 40.0 4
 BIG CREEK
 40 CRAIG CO HWY MAP
 T/OOLJGAH RESERVOIR 100391
 HWY 10 BRDG 2 MI E HOWATA/CRAIG CO LINE
 11EPALES 04001004
 0000 FEET DEPTH CLASS 00

/TYP/AMBNT/STREAM

DATE	TIME	DEPTH	00630 NO2+N03 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
FROM	OF						
TO	DAY	FEET					
74/11/02	14 45		0.448	0.700	0.020	0.055	0.170
74/12/14	11 50		0.540	2.500	0.525	0.015	0.070
75/01/17	10 30		0.432	0.500	0.016	0.005K	0.010K
75/02/15	10 25		0.736	0.100	0.008	0.008K	0.030
75/03/10	10 40		0.552	1.500	0.048	0.08K	0.100
75/04/20	10 40		0.015	0.825	0.015	0.005K	0.030
75/06/13	10 45		0.390	0.675	0.050	0.025	0.095

K VALUE KNOWN TO BE
 LESS THAN INDICATED

STORET RETRIEVAL DATE 77/03/24

4012F1
 36 53 20.0 095 22 30.0 4
 E FORK BIG CREEK
 40 CRAIG CO FAY MUD
 T/OULOGAN RESERVOIR 100391
 HWY 10 BRDG 3 MI E NOWATA/CRAIG CO LINE
 11EPALES 04001004
 0000 FEET DEPTH CLASS 00

/TYPE/AMOUNT/STREAM

DATE	TIME	DEPTH	00530 0254003 N-TOTAL MG/L	00625 TOT KJEL N MG/L	01610 NH3-N TOTAL MG/L	00671 PHOS-DIS URTHO MG/L P	00655 PHOS-TOT MG/L P
74/11/02	15 00		0.112	2.500	0.025	0.090	
74/12/14	11 40		0.312	1.400	0.025	0.015	0.050
75/01/17	10 40		0.008	0.300	0.008	0.010	0.010
75/02/15	10 20		0.160	0.600	0.008	0.008K	0.040
75/03/10	11 00		0.296	1.600	0.024	0.024	
75/04/20	10 55		0.055	0.400	0.015	0.005K	0.020
75/06/13	11 00		0.150	0.750	0.050	0.025	0.080

K VALUE KNOWN TO BE
 LESS THAN INDICATED

STORET RETRIEVAL DATE 77/03/24

401231
 36 45 15.0 095 39 40.0 4
 MORMAY GREEN
 40 NW/4TH CO MAP
 T/OOLUGAH RESERVOIR 100391
 SEC RD BRDG 2.5 MI SW OF DELAWARE
 11EPALES W-001004
 0000 FEET DEPTH CLASS 00

/TYP/A/AMBT/ST/FAM

DATE	TIME	DEPTH	00630 NO23NO3 N-TOTAL MG/L	00625 TOT KOLL N MG/L	00610 N-T-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/02	12 30		0.152	3.100	0.025		
74/12/14			0.192	1.900	0.025	0.015	0.060
75/01/17	12 00		0.072	0.300	0.016	0.005	0.010
75/02/15	12 00		0.144	0.300	0.032	0.006K	0.010K
75/03/10	12 40		0.280	1.600	0.048	0.032	
75/04/20	12 10		0.010	0.750	0.015	0.005K	0.030
75/06/13	15 45		0.220	1.750	0.100	0.025	0.090

K VALUE KNOWN TO BE
 LESS THAN INDICATED

SIGNET RETRIEVAL DATE 77/03/24

4-12AA 004-12AA -000510
 36 48 30.0 095 38 00.0 4
 DELAWARE
 TO WYOMING COUNTY
 T/JOULIAN RESERVOIR 10-391
 VERDIEHS River
 11EPALES 00001004
 0000 FEET DEPTH CLASS 00

ZAMONT/STREAM

DATE	TIME	DEPTH	00630 NO2-NH3 TOTAL MG/L	00625 TOT AMFL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS UPPER MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
75/06/02	13 00		0.050	5.400	0.220	0.510	1.100	0.054	0.051
75/06/14	17 00		0.100	7.100	0.050K	1.450	2.200	0.049	0.050
75/07/06	12 15		0.275	2.900	0.025	1.300	1.600	0.035	0.042
75/07/25	14 00		0.225	3.400	0.075	0.640	1.100	0.025	0.030
75/08/14	11 15		0.250	11.500	0.044	1.725	1.600	0.037	0.039
75/09/04	14 40		0.325	8.450	0.130	0.925	1.400	0.028	0.029
75/10/06	15 25		0.450	10.550	0.025	1.100	2.200	0.020	0.022
75/10/20	15 00		0.550	16.000	0.025	1.150	2.300	0.016	0.017
75/11/05	13 45		0.450	10.050	0.170	1.300	2.000	0.017	0.014
75/12/03	14 00		0.725	7.100	0.100	1.880	3.800	0.016	0.018
76/01/06	09 20		0.450	9.550	0.240	2.100	2.925	0.019	0.017
76/01/20	09 45		0.950	8.000	0.100	2.100	3.000	0.018	0.019
76/02/02	15 30		0.700	7.800	0.350		2.700	0.019	0.018

K VALUE KNOWN TO BE
 LESS THAN INDICATED

APPENDIX E
PARAMETRIC RANKINGS OF LAKES
SAMPLED BY NES IN 1974
STATE OF OKLAHOMA

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
4001	ALTONS RESERVOIR	0.041	0.050	468.625	14.750	8.400	0.010
4002	ARBUCKLE LAKE	0.020	0.070	443.600	7.027	14.600	0.008
4003	LAKE ELLSWORTH	0.037	0.070	459.400	8.430	9.400	0.009
4004	LAKE EUPAULA	0.081	0.405	482.513	4.383	14.200	0.029
4005	FORT COBB RESERVOIR	0.038	0.110	454.667	14.967	8.400	0.012
4006	FORT SUPPLY RESERVOIR	0.070	0.135	485.167	9.733	7.800	0.014
4007	FOSS DAM RESERVOIR	0.027	0.090	463.857	4.862	8.400	0.006
4008	LAKE FRANCES	0.142	1.780	484.333	7.973	8.200	0.093
4009	GRAND LAKE OF THE CHEPOK	0.087	0.740	468.857	6.768	14.800	0.038
4010	LAKE HEFNER	0.057	0.250	461.000	5.667	9.000	0.036
4011	KEYSTONE RESERVOIR	0.136	0.690	484.303	21.427	14.900	0.096
4012	MOLOGAH LAKE	0.059	0.580	483.000	5.137	14.600	0.031
4013	TENKILLER FERRY RESERVOIR	0.039	0.550	435.500	6.646	15.000	0.016
4014	LAKE THUNDERBIRD	0.027	0.150	465.000	8.422	12.000	0.009
4015	WISTER RESERVOIR	0.080	0.230	478.500	4.812	15.000	0.016
4834	TEXOMA LAKE	0.045	0.160	460.875	12.325	14.600	0.016

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORGAN	500- MEAN SEC	MEAN CHLORA	15- MIN DO	MEDIAN DISS O2/HO P
4001	ALTON RESERVOIR	87 (4)	100 (15)	47 (7)	13 (2)	80 (11)	73 (11)
4002	ARBOGLE LAKE	1 (15)	93 (13)	93 (14)	53 (8)	33 (4)	93 (14)
4003	LAKE BUSHWYTH	43 (12)	40 (13)	86 (12)	33 (5)	60 (9)	87 (13)
4004	LAKE BURBANK	27 (3)	33 (5)	27 (4)	100 (15)	47 (7)	33 (5)
4005	FORT COCK RESERVOIR	73 (11)	73 (11)	87 (13)	7 (1)	80 (11)	67 (10)
4006	FORT SUPPLY RESERVOIR	33 (5)	67 (10)	0 (0)	27 (4)	100 (15)	60 (9)
4007	FOSS DAM RESERVOIR	93 (14)	80 (12)	60 (9)	87 (13)	80 (11)	100 (15)
4008	LAKE FRANCES	0 (0)	0 (0)	7 (1)	47 (7)	93 (14)	7 (1)
4009	GRAND LAKE OF THE CHEPOK	13 (2)	7 (1)	40 (6)	60 (9)	20 (3)	13 (2)
4010	LAKE HEFNER	47 (7)	40 (6)	67 (10)	73 (11)	67 (10)	20 (3)
4011	KEYSTONE RESERVOIR	7 (1)	13 (2)	13 (2)	0 (0)	13 (2)	0 (0)
4012	MOLOGAH LAKE	40 (6)	20 (3)	20 (3)	80 (12)	33 (4)	27 (4)
4013	TENKILLER FERRY RESERVOIR	67 (10)	27 (4)	100 (15)	67 (10)	3 (0)	50 (7)
4014	LAKE THUNDERBIRD	87 (13)	60 (9)	53 (8)	40 (6)	53 (8)	80 (12)
4015	WISTER RESERVOIR	27 (4)	47 (7)	33 (5)	93 (14)	3 (0)	40 (6)
4834	TEXOMA LAKE	53 (8)	53 (8)	73 (11)	20 (3)	33 (4)	50 (7)