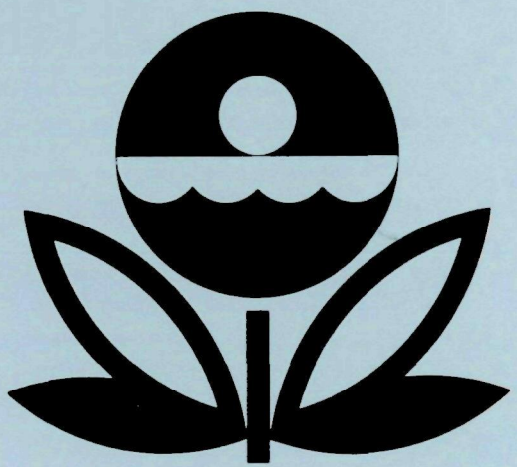
U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES



REPORT

ON

EL VADO RESERVOIR

RIO ARRIBA COUNTY

NEW MEXICO

EPA REGION VI

WORKING PAPER No. 822

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

REPORT

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WITH THE COOPERATION OF THE

NEW MEXICO ENVIRONMENTAL IMPROVEMENT AGENCY

AND THE

NEW MEXICO NATIONAL GUARD

JULY, 1977

REPORT ON EL VADO RESERVOIR

RIO ARRIBA COUNTY, NEW MEXICO

EPA REGION VI

by

National Eutrophication Survey

Water and Land Quality Branch
Monitoring Operations Division
Environmental Monitoring & Support Laboratory
Las Vegas, Nevada

and

Special Studies Branch
Corvallis Environmental Research Laboratory
Corvallis, Oregon

Working Paper No. 822

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

July 1977

CONTENTS

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 New Mexico Environmental Improvement Agency for professional involvement, to the New Mexico National Guard for conducting the tributary sampling phase of the Survey, and to those New Mexico wastewater treatment plant operators who provided effluent samples and flow data.

The staff of the Surveillance Section, Water Quality Division, New Mexico Environmental Improvement Agency 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.

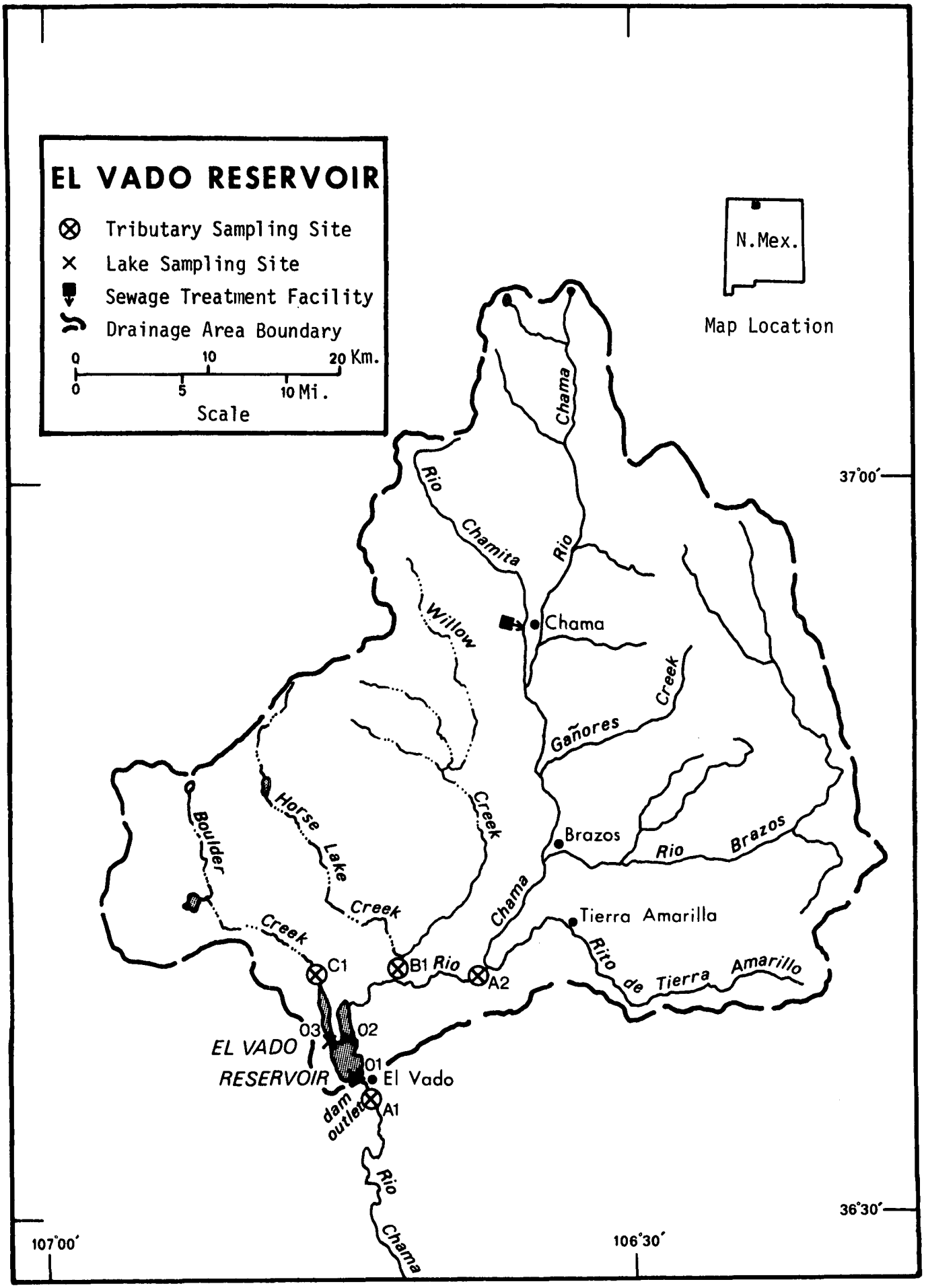
Brigadier General Franklin E. Miles, the Adjutant General of New Mexico, and Project Officer Colonel Marvin D. Bohannon, who directed the volunteer efforts of the New Mexico National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF NEW MEXICO

LAKE NAME	COUNTY
Alamogordo Reservoir (Sumner Lake)	De Baca, Guadalupe
Bluewater Lake	Valencia, McKinley
Conchas Reservoir	San Miguel
Eagle Nest Lake	Colfax
Elephant Butte Reservoir	Sierra
El Vado Reservoir	Rio Arriba
Lake McMillan	Eddy
Ute Reservoir	Quay


EL VADO RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
Drainage Area Boundary
0 10 20 Km.
0 5 10 Mi.
Scale
N.Mex.
Map Location
Chama
Rio Chamita
Rio Chama
Willow Creek
Chama
Gañores Creek
Brazos
Rio Brazos
Tierra Amarilla
Rito de Tierra Amarillo
Boulder Creek
Horse Lake Creek
Chama
Rio Chama
C1
B1
A2
03
02
01
EL VADO RESERVOIR
El Vado
dam outlet
A1
37°00'
36°30'
107°00'
106°30'

REPORT ON EL VADO RESERVOIR, NEW MEXICO

STORET NO. 3506

I. CONCLUSIONS

A. Trophic Condition:*

Based upon field observations, El Vado Reservoir is considered early eutrophic although biological response, as measured by chlorophyll a levels, is more typical of that observed in mesotrophic water bodies. Of the nine New Mexico lakes (including Navajo Reservoir) sampled in 1975, four had higher median total phosphorus levels (0.034 mg/l), none had higher median inorganic nitrogen values (0.140 mg/l) and two had higher median orthophosphorus levels (0.014 mg/l) than El Vado Reservoir. Chlorophyll a values ranged from 1.2 µg/l to 3.7 µg/l with a mean of 2.2 µg/l. Potential for primary productivity as measured by algal assay control yield was high during the May sampling and moderately low during October.

Survey limnologists reported an algal bloom on the October sampling date and noted that the lake was highly turbid throughout the sampling year; low Secchi disc readings (range of 0.4 to 1.5 m) suggest primary production might be light-limited in the reservoir during much of the year.

*See Appendix E.

B. Rate-Limiting Nutrient:

The algal assay results suggest colimitation by nitrogen and phosphorus during the spring sampling period (05/05/75) and phosphorus limitation during the fall (10/01/75). The reservoir data suggest primary limitation by nitrogen throughout the sampling year.

C. Nutrient Controllability:

1. Point sources -

During the sampling year, point sources were calculated to contribute 3.9% of the total phosphorus load to El Vado Reservoir. The city of Chama contributed the entire load.

The present phosphorus loading of 2.67 g $P/m^2/yr$ is three times that proposed by Vollenweider (1975) as "eutrophic" for a lake of such volume and retention time. Elimination of the known point source would still leave high nutrient inputs in excess of Vollenweider's proposed levels. Although Vollenweider's model may not be applicable on highly turbid water bodies, further examination of surrounding land uses and identification of additional point sources may provide answers to further nutrient reductions.

2. Nonpoint sources -

Nonpoint sources, including precipitation, contributed 96.1% of the total phosphorus input during the sampling year.

Rio Chama contributed 69.2%, Boulder Creek contributed 13.5%, Willow Creek contributed 9.6% and minor tributaries and immediate drainage contributed an estimated 3.1%.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

Lake and drainage basin characteristics are itemized below. Lake morphometry data were provided by Martin and Hanson (1966) and Tony Drypolcher (personal communication). Tributary flow data were provided by the New Mexico 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: 13.07 km^2.
2. Mean depth: 18.3 meters.
3. Maximum depth: 43.3 meters.
4. Volume: 239.914 x 10^6 m^3.
5. Mean hydraulic retention time: 326 days.

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

1. Tributaries -

Name	Drainage area (km^2)	Mean Flow (m^3/sec)
A-2 Rio Chama	1,243.2	6.18
B-1 Willow Creek	499.9	1.94
C-1 Boulder Creek	188.8	0.13
Minor tributaries and immediate drainage -	67.4	0.28
Total	1,999.3	8.53
2. Outlet - A-1 Rio Chama	2,012.4	8.53

C. Precipitation:

1. Year of sampling: 32.5 cm.
2. Mean annual: 35.6 cm.

III. LAKE WATER QUALITY SUMMARY

El Vado Reservoir was sampled three times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from three stations on the lake and from a number of 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 sampled were 38.1 meters at Station 01, 23.2 meters at Station 02, and 14.6 meters at Station 03. For a more detailed explanation of NES methods, see NES Working Paper No. 175.

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.

EL VADO RESERVOIR
STORET CODE 3506

PHYSICAL AND CHEMICAL CHARACTERISTICS

PARAMETER	(5/ 5/75) S*** = 3 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	(8/19/75) S*** = 3 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	(10/ 1/75) S*** = 3 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)
TEMPERATURE (DEG CENT)												
0.-1.5 M DEPTH	6	6.8- 8.1	7.9	0.0- 1.5	6	18.0- 18.8	18.2	0.0- 1.5	6	16.9- 17.3	17.2	0.0- 1.5
MAX DEPTH**	3	6.2- 7.9	6.8	10.7- 34.1	3	6.3- 11.2	8.2	14.6- 38.1	3	12.5- 16.5	14.0	12.5- 31.4
DISSOLVED OXYGEN (MG/L)												
0.-1.5 M DEPTH	6	8.6- 9.2	8.8	0.0- 1.5	6	5.2- 6.4	6.0	0.0- 1.5	6	6.2- 7.0	6.9	0.0- 1.5
MAX DEPTH**	3	8.6- 9.2	9.2	10.7- 34.1	3	2.4- 5.6	2.4	14.6- 38.1	3	4.3- 6.8	5.0	12.5- 31.4
CONDUCTIVITY (UMHOS)												
0.-1.5 M DEPTH	6	280.- 329.	305.	0.0- 1.5	6	170.- 172.	172.	0.0- 1.5	6	149.- 155.	153.	0.0- 1.5
MAX DEPTH**	3	280.- 344.	328.	10.7- 34.1	3	106.- 178.	110.	14.6- 38.1	3	105.- 155.	115.	12.5- 31.4
PH (STANDARD UNITS)												
0.-1.5 M DEPTH	6	7.9- 8.2	8.0	0.0- 1.5	6	7.8- 8.6	8.0	0.0- 1.5	6	7.9- 8.2	8.2	0.0- 1.5
MAX DEPTH**	3	8.0- 8.1	8.0	10.7- 34.1	3	7.3- 7.8	7.5	14.6- 38.1	3	7.7- 8.3	7.8	12.5- 31.4
TOTAL ALKALINITY (MG/L)												
0.-1.5 M DEPTH	6	88.- 96.	92.	0.0- 1.5	6	59.- 66.	64.	0.0- 1.5	6	77.- 87.	84.	0.0- 1.5
MAX DEPTH**	3	89.- 96.	95.	10.7- 34.1	3	52.- 78.	54.	14.6- 38.1	3	58.- 80.	72.	12.5- 31.4
TOTAL P (MG/L)												
0.-1.5 M DEPTH	6	0.030-0.053	0.034	0.0- 1.5	6	0.018-0.039	0.023	0.0- 1.5	6	0.023-0.030	0.028	0.0- 1.5
MAX DEPTH**	3	0.030-0.091	0.052	10.7- 34.1	3	0.120-0.168	0.131	14.6- 38.1	3	0.028-0.067	0.065	12.5- 31.4
DISSOLVED ORTHO P (MG/L)												
0.-1.5 M DEPTH	6	0.010-0.023	0.013	0.0- 1.5	6	0.003-0.007	0.005	0.0- 1.5	6	0.006-0.012	0.007	0.0- 1.5
MAX DEPTH**	3	0.010-0.019	0.010	10.7- 34.1	3	0.031-0.054	0.050	14.6- 38.1	3	0.006-0.036	0.034	12.5- 31.4
NO2+NO3 (MG/L)												
0.-1.5 M DEPTH	6	0.100-0.130	0.110	0.0- 1.5	6	0.020-0.020	0.020	0.0- 1.5	6	0.020-0.030	0.025	0.0- 1.5
MAX DEPTH**	3	0.100-0.130	0.130	10.7- 34.1	3	0.140-0.230	0.200	14.6- 38.1	3	0.020-0.180	0.160	12.5- 31.4
AMMONIA (MG/L)												
0.-1.5 M DEPTH	6	0.040-0.060	0.045	0.0- 1.5	6	0.020-0.020	0.020	0.0- 1.5	6	0.020-0.020	0.020	0.0- 1.5
MAX DEPTH**	3	0.040-0.070	0.040	10.7- 34.1	3	0.020-0.020	0.020	14.6- 38.1	3	0.020-0.020	0.020	12.5- 31.4
KJELDAHL N (MG/L)												
0.-1.5 M DEPTH	6	0.200-0.700	0.550	0.0- 1.5	6	0.300-0.500	0.400	0.0- 1.5	6	0.200-0.500	0.200	0.0- 1.5
MAX DEPTH**	3	0.200-0.600	0.300	10.7- 34.1	3	0.200-0.500	0.400	14.6- 38.1	3	0.200-0.400	0.200	12.5- 31.4
SECCHI DISC (METERS)												
	3	0.4- 0.6	0.4		3	0.9- 1.5	1.5		3	0.6- 0.9	0.9	

* N = NO. OF SAMPLES
** MAXIMUM DEPTH SAMPLED AT EACH SITE
*** S = NO. OF SITES SAMPLED ON THIS DATE

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
05/05/75	1. Cryptomonas	154
	2. Chroomonas ?	92
	3. Cyclotella	31
	4. Nitzschia	31
	Other genera	--
	Total	308
08/19/75	1. Chroomonas ?	490
	2. Aphanizomenon	31
	Other genera	--
	Total	521
10/01/75	1. Aphanizomenon	234
	2. Chroomonas	176
	3. Cryptomonas	79
	Other genera	--
	Total	489

2. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll *a* (µg/l)
05/05/75	01	1.2
	02	2.2
	03	2.6
08/19/75	01	1.9
	02	1.6
	03	2.4
10/01/75	01	1.0
	02	3.7
	03	3.1

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.)
a. 05/05/75			
Control	0.020	0.090	2.4
0.05 P	0.070	0.090	2.3
0.05 P + 1.0 N	0.070	1.090	24.0
1.00 N	0.020	1.090	2.0
b. 10/01/75			
Control	0.005	0.100	0.3
0.05 P	0.055	0.100	7.6
0.05 P + 1.0 N	0.055	1.100	20.1
1.00 N	0.005	1.100	0.2

2. Discussion -

The control yields of the assay alga, Selenastrum capricornutum, indicate that the potential for primary productivity in El Vado Reservoir was high during the spring sampling (05/05/75) and moderately low during the October sampling (10/01/75). In the May assay, no growth response beyond that of the control was noted with the addition of either nitrogen or phosphorus alone, but was observed with the simultaneous addition of both nutrients, suggesting colimitation by nitrogen and phosphorus. In the October assay, the addition of phosphorus alone and in combination with nitrogen produced a significant increase in yield over that of the control, indicating phosphorus limitation at this time. Spikes of only nitrogen did not increase growth beyond the control yield in this assay.

The mean inorganic nitrogen to orthophosphorus ratios (N/P) in the lake data were 11/1 in the spring and 5/1 in the summer and fall suggesting primary limitation by nitrogen (a mean N/P ratio of 14/1 or greater generally reflects primary limitation by phosphorus).

IV. NUTRIENT LOADINGS
(See Appendix D for data)

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

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the New Mexico 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 $kg/km^2/year$, in Willow Creek and Boulder Creek, at Stations B-1 and C-1 and multiplying the means by the ZZ area in km^2.

The operator of the Chama wastewater treatment plant provided monthly effluent samples and corresponding flow data.

A. Waste Sources:

1. Known municipal -

Name	Pop.* Served	Treatment*	Mean Flow ($m^3/d \times 10^3$)	Receiving Water
Chama	2,000	Trickling Filter	0.333	Chamanita River to Chama River

2. Known industrial - None

*Provided by treatment plant operator.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source		kg P/yr	% of total
a.	Tributaries (nonpoint load) -		
	A-2 Rio Chama	24,175	69.2
	B-1 Willow Creek	3,345	9.6
	C-1 Boulder Creek	4,710	13.5
b.	Minor tributaries and immediate drainage (nonpoint load) -	1,080	3.1
c.	Known municipal STP's -		
	Chama	1,375	3.9
d.	Septic tanks* -	5	<0.1
e.	Known industrial - None		
f.	Direct precipitation** -	230	0.7
	Total	34,920	100.0%

2. Outputs - A-1 Rio Chama 16,285

3. Net annual P accumulation - 18,635

*Estimate based on 11 lakeshore residences.
**Estimated (See NES Working Paper No. 175).

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (nonpoint load) -		
A-2 Rio Chama	189,920	74.6
B-1 Willow Creek	29,805	11.7
C-1 Boulder Creek	13,590	5.3
b. Minor tributaries and immediate drainage (nonpoint load) -	4,450	1.7
c. Known municipal STP's -		
Chama	3,000	1.2
d. Septic tanks* -	115	<0.1
e. Known industrial - None		
f. Direct precipitation** -	14,110	5.5
Total	254,990	100.0%

2. Outputs - A-1 Rio Chama 269,615

3. Net annual N export*** - 14,625

*Estimate based on 11 lakeshore residences.
**Estimated (See NES Working Paper No. 175).
***Export probably due to unknown sources and/or sampling error.

D. Mean Annual Nonpoint Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
Rio Chama	19	153
Willow Creek	7	60
Boulder Creek	25	72

E. 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" and "oligotrophic".

Note that Vollenweider's model may not apply to lakes with short hydraulic retention times or in which light penetration is severely restricted by high concentrations of suspended solids in the surface waters.

	Total Yearly Phosphorus Loading (g/m^2/yr)
Estimated loading for El Vado Reservoir	2.67
Vollenweider's "eutrophic" loading	0.86
Vollenweider's "oligotrophic" loading	0.43

V. LITERATURE REVIEWED

Drypolcher, Tony. 1975. Personal communication (lake morphometry). New Mexico Environmental Improvement Agency, Santa Fe, New Mexico.

Martin, R. O. R., and R. L. Hanson. 1966. Reservoirs in the United States. Geological Survey Water Supply Paper 1838. United States Department of Interior, Geological Survey, Washington, D.C.

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 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 B

TRIBUTARY FLOW DATA

LAKE CODE 3506 EL VADO RESERVOIR

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 2012.4

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
3506A1	2012.4	1.08	3.23	7.62	13.22	33.41	11.16	6.43	4.98	3.23	2.55	2.43	12.18	8.53
3506A2	1243.2	0.96	2.38	5.10	9.91	31.15	9.06	3.96	3.40	2.46	2.07	2.10	1.22	6.16
3506B1	499.9	0.034	0.651	2.124	2.549	0.793	1.756	1.982	1.019	0.623	0.218	0.425	10.902	1.94
3506C1	188.8	0.011	0.045	0.159	0.266	0.127	0.059	0.303	0.275	0.136	0.116	0.031	0.006	0.12
3506ZZ	80.5	0.042	0.108	0.246	0.481	1.359	0.396	0.207	0.181	0.119	0.105	0.093	0.051	0.28

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 2012.4
SUM OF SUB-DRAINAGE AREAS = 2012.4
TOTAL FLOW IN = 101.76
TOTAL FLOW OUT = 101.71

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
3506A1	12	74	7.929	8	1.076				
	1	75	0.793	11	0.765				
	2	75	0.821	9	0.765				
	3	75	0.878	9	1.076				
	4	75	22.370	5	0.850	19	2.718		
	5	75	65.412	3	27.467	17	91.180		
	6	75	18.406	7	2.662				
	7	75	9.345	8	10.194				
	8	75	7.362	9	9.911				
	9	75	2.464	7	0.736				
	10	75	4.446	5	6.201				
	11	75	10.930	2	0.963				
3506A2	12	74	1.019	8	0.991				
	1	75	0.708	11	1.274				
	2	75	0.595	9	1.416				
	3	75	0.595	9	2.265				
	4	75	14.442	5	6.654	19	9.543		
	5	75	69.093	3	26.788	17	111.002		
	6	75	35.113	7	55.218				
	7	75	9.061	8	8.778				
	8	75	2.265	9	2.209				
	9	75	2.039	7	1.812				
	10	75	1.161	5	1.189				
	11	75	1.331	2	1.784				

TRIBUTARY FLOW INFORMATION FOR NEW MEXICO

LAKE CODE 3506 EL VADO RESERVOIR

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
350631	12	74	17.556	8	29.166				
	1	75	0.0	11	0.0				
	2	75	0.0	2	0.0				
	3	75	29.506	9	0.0				
	4	75	23.503	5	1.133	19	18.010		
	5	75	1.388	3	1.133	17	1.274		
	6	75	0.793	7	0.425				
	7	75	0.736	8	1.133				
	8	75	0.227	9	0.0				
	9	75	0.085	7	0.0				
	10	75	0.167	5	0.0				
	11	75	0.0	2	0.0				
3506C1	12	74	0.004						
	1	75	0.008						
	2	75	0.012						
	3	75	0.018						
	4	75	0.453	5	0.210	19	0.651		
	5	75	0.249	3	0.096	17	0.396		
	6	75	0.099						
	7	75	0.453						
	8	75	0.396						
	9	75	0.311	7	0.0				
	10	75	0.176	5	0.0				
	11	75	0.201						
3506ZZ	12	74	0.034						
	1	75	0.031						
	2	75	0.028						
	3	75	0.028						
	4	75	0.821						
	5	75	2.662						
	6	75	0.651						
	7	75	0.311						
	8	75	0.269						
	9	75	0.133						
	10	75	0.076						
	11	75	0.085						

APPENDIX C

PHYSICAL AND CHEMICAL DATA

STORET RETRIEVAL DATE 76/12/16
NATL EUTROPHICATION SURVEY
EPA-LAS VEGAS

350601
36 35 43.0 106 44 00.0 3
EL VADO RESERVOIR
35039 NEW MEXICO
120991

/TYPA/AMBNT/LAKE

11EPALES 04001002
0116 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK 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
75/05/05	14 45	0000	6.8	8.8	16	301	8.00	92	0.050	0.600	0.110	0.014
	14 45	0005	7.6	8.8		309	7.90	92	0.040	0.500	0.110	0.013
	14 45	0015	7.6	8.6		301	8.10	91	0.050	0.500	0.120	0.014
	14 45	0045	6.9	9.2		308	8.10	93	0.080	0.500	0.130	0.017
	14 45	0080	7.4	7.2		308	8.00	93	0.050	0.500	0.120	0.014
	14 45	0112	6.2	8.6		344	8.00	96	0.070	0.600	0.130	0.010
75/08/19	07 30	0000	18.4	6.0	58	170	8.60	59	0.020K	0.300	0.020K	0.004
	07 30	0005	18.1	5.2		170	8.30	63	0.020K	0.300	0.020K	0.005
	07 30	0015	17.7	5.0		169	8.10	64	0.020K	0.400	0.020	0.005
	07 30	0040	11.5	5.0		113	7.95	51	0.020K	0.400	0.100	0.030
	07 30	0080	7.4	5.8		99	7.70	49	0.020K	0.300	0.160	0.036
	07 30	0125	6.3	2.4		110	7.50	54	0.020K	0.500	0.230	0.054
75/10/01	10 30	0000	17.3	7.0	36	149	8.20	87	0.020K	0.300	0.030	0.010
	10 30	0005	17.2	6.2		151	8.15	87	0.020K	0.200	0.030	0.012
	10 30	0015	17.1	5.2		147	8.00	84	0.020K	0.200	0.080	0.023
	10 30	0035	16.7	6.4		135	7.80	53	0.020K	0.400	0.160	0.036
	10 30	0070	13.8	4.8		108	7.70	55	0.020K	0.400	0.160	0.037
	10 30	0103	12.5	5.0		105	7.70	58	0.020K	0.400	0.180	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
75/05/05	14 45	0000	0.035	1.2	
	14 45	0005	0.032		
	14 45	0015	0.034		
	14 45	0045	0.031		
	14 45	0080	0.034		
	14 45	0112	0.091		
75/08/19	07 30	0000	0.018	1.9	
	07 30	0005	0.018		
	07 30	0015	0.019		
	07 30	0040	0.046		
	07 30	0080	0.053		
	07 30	0125	0.131		
75/10/01	10 30	0000	0.029	1.0	
	10 30	0005	0.030		
	10 30	0015	0.039		
	10 30	0035	0.062		
	10 30	0070	0.062		
	10 30	0103	0.065		

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 76/12/16
NATL EUTROPHICATION SURVEY
EPA-LAS VEGAS

350602
36 37 48.0 106 44 55.0 3
EL VADO RESERVOIR
35039 NEW MEXICO
120991

/TYPA/AMBNT/LAKE

11EPALES 04001002
0055 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK 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
75/05/05	15 30	0000	8.1	8.6	14	282	8.20	88	0.050	0.700	0.120	0.019
	15 30	0005	8.0	8.8		280	8.10	88	0.060	0.700	0.130	0.023
	15 30	0015	8.2	9.2		282	8.00	89	0.050	0.600	0.130	0.020
	15 30	0030	7.9	9.2		283	8.10	89	0.050	0.600	0.130	0.020
	15 30	0055	6.8	9.2		280	8.00	89	0.040	0.200	0.130	0.019
75/08/19	08 00	0000	18.6	6.4	58	171	8.00	61	0.020K	0.400	0.020K	0.007
	08 00	0005	18.8	6.4		172	8.00	64	0.020K	0.400	0.020K	0.005
	08 00	0015	17.4	4.8		175	7.80	69	0.020K	0.400	0.020K	0.005
	08 00	0030	13.0	4.4		134	7.70	63	0.020K	0.400	0.070	0.025
	08 00	0050	10.4	5.6		115	7.60	54	0.020K	0.400	0.110	0.031
	08 00	0076	8.2	5.6		106	7.30	52	0.020K	0.400	0.140	0.031
75/10/01	10 10	0000	17.2	7.0	36	155	8.20	82	0.020K	0.200K	0.020K	0.007
	10 10	0005	17.3	7.0		154	8.20	82	0.020K	0.200	0.020K	0.007
	10 10	0015	17.2	6.4		154	8.10	86	0.020K	0.300	0.040	0.016
	10 10	0040	16.9	5.6		155	7.90	77	0.020K	0.200	0.120	0.033
	10 10	0063	14.0	4.3		115	7.85	72	0.020K	0.200	0.160	0.034

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/05/05	15 30	0000	0.053	2.2	
	15 30	0005	0.051		
	15 30	0015	0.049		
	15 30	0030	0.048		
	15 30	0055	0.052		
75/08/19	08 00	0000	0.019	1.6	
	08 00	0005	0.028		
	08 00	0015	0.034		
	08 00	0030	0.055		
	08 00	0050	0.068		
	08 00	0076	0.120		
75/10/01	10 10	0000	0.023	3.7	
	10 10	0005	0.030		
	10 10	0015	0.031		
	10 10	0040	0.037		
	10 10	0063	0.067		

K VALUE KNOWN TO BE LESS
THAN INDICATED

STORET RETRIEVAL DATE 76/12/16
NATL EUTROPHICATION SURVEY
EPA-LAS VEGAS

350603
36 37 45.0 106 45 52.0 3
EL VADO RESERVOIR
35039 NEW MEXICO
120992

/TYPA/AMBNT/LAKE

11EPALES 04001002
0038 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK 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
75/05/05	16 35	0000	7.9	8.8	24	329	8.20	96	0.040	0.300	0.100	0.010
	16 35	0005	8.0	9.2		326	7.90	95	0.040	0.200	0.100	0.011
	16 35	0015	7.9	9.2		324	7.90	96	0.040	0.200	0.100	0.009
	16 35	0035	7.9	9.2		328	8.10	95	0.040	0.300	0.100	0.010
75/08/19	08 30	0000	18.0	5.6	36	172	7.85	65	0.020K	0.400	0.020	0.005
	08 30	0005	18.1	6.0		172	8.10	66	0.020K	0.500	0.020K	0.003
	08 30	0015	18.0	5.8		175	8.00	68	0.020K	0.500	0.020K	0.006
	08 30	0030	14.2	3.0		176	7.75	74	0.040	0.500	0.170	0.031
	08 30	0048	11.2	2.4		178	7.83	78	0.020K	0.200	0.200	0.050
75/10/01	09 45	0000	16.9	6.8	24	153	7.90	86	0.020K	0.500	0.030	0.006
	09 45	0005	17.0	6.6		153	8.20	77	0.020K	0.200K	0.020K	0.007
	09 45	0015	16.9	6.4		153	8.30	80	0.020K	0.200K	0.020K	0.006
	09 45	0041	16.5	6.8		155	8.30	80	0.020K	0.200	0.020K	0.006

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/05/05	16 35	0000	0.033	2.6	
	16 35	0005	0.030		
	16 35	0015	0.032		
	16 35	0035	0.030		
75/08/19	08 30	0000	0.039	2.4	
	08 30	0005	0.035		
	08 30	0015	0.034		
	08 30	0030	0.127		
	08 30	0048	0.168		
75/10/01	09 45	0000	0.027	3.1	
	09 45	0005	0.025		
	09 45	0015	0.022		
	09 45	0041	0.028		

K VALUE KNOWN TO BE LESS
THAN INDICATED

APPENDIX D

TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL OF 2 JUL 77 3
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

3506A1
36 35 39.0 106 44 30.0 4
RIO CHAMA
35 15 TIERRA AMRLLA
O/EL VADO RESERVOIR 120991
BELO DAM .5 MI S OF EL VADO CITY
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
74/12/08	12 31		0.080	0.300	0.015	0.010	0.030
75/01/11	13 40		0.096	1.000	0.012	0.009	0.017
75/02/09	10 45		0.064	0.300	0.008K	0.005	0.010
75/03/09	10 50		0.070	0.550	0.035	0.020	0.120
75/04/05	10 52		0.105	1.250	0.030	0.005K	0.020
75/04/19	10 55		0.085	2.500	0.035	0.010	0.020
75/05/03	11 45		0.110	1.800	0.040	0.013	0.040
75/05/17	11 45		0.120	0.400	0.025		0.050
75/06/07	14 35		0.120	0.650	0.030	0.035	0.080
75/07/08	13 30		0.125	0.650	0.020	0.025	0.080
75/08/09	10 45		0.180	0.850	0.025	0.050	0.090
75/09/07	13 22		0.085	0.400	0.010	0.030	0.130
75/10/05	11 00		0.195	0.900	0.015	0.040	0.120
75/11/02	14 15		0.075	0.300	0.030	0.035	0.100

K VALUE KNOWN TO BE LESS
THAN INDICATED

STORET RETRIEVAL DATE 76/12/16
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

3506A2
36 39 45.0 106 37 57.0 4
RIO CHAMA
35 15 TIERRA AMRLLA
T/EL VADO RESERVOIR 120991
ORT RD BRDG 3.5 MI WSW OF LAPUENTE
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
74/12/08	11	31	0.024	0.400	0.005	0.020	0.030
75/01/11	12	25	0.232	2.000	0.104	0.042	0.065
75/02/09	10	00	0.216	0.500	0.056	0.045	0.070
75/03/09	12	55	0.200	0.437	0.030	0.045	0.120
75/04/05	10	40	0.155	0.500	0.020	0.025	0.170
75/04/19	10	25	0.360	1.750	0.040	0.050	0.140
75/05/03	11	15	0.145	0.850	0.020	0.040	0.165
75/05/17	11	00	0.165	1.400	0.025	0.032	0.370
75/06/07	14	05	0.030	0.300	0.020	0.030	0.110
75/07/08	13	05	0.010	0.450	0.015	0.020	0.070
75/08/09	10	15	0.010	1.500	0.015	0.055	0.055
75/09/07	13	45	0.010	0.300	0.010	0.020	0.050
75/10/05	10	35	0.005	1.000	0.010	0.020	0.050
75/11/02	13	30	0.010	0.600	0.075	0.030	0.050

NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

350681
36 40 10.0 106 42 10.0 4
WILLOW CREEK
35 15 TIERRA AMRLLA
T/EL VADO RESERVOIR 120991
BNK 1500 FT S OF RT 95
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
74/12/08	13	44	0.048	0.300	0.007	0.005	0.020
75/01/11	16	45	0.236	2.150	0.084	0.027	0.062
75/03/09	13	00	0.190	3.800	0.030	0.040	0.160
75/04/05	11	50	0.140	0.800	0.035	0.010	0.050
75/04/19	11	45	0.095	0.650	0.270	0.020	0.095
75/05/03	12	40	0.090	0.250	0.015	0.015	0.040
75/05/17	12	45	0.080	0.200	0.020	0.015	0.050
75/06/07	13	25	0.045	0.350	0.020	0.030	0.100
75/07/08	14	25	0.090	0.250	0.005	0.005	0.040
75/08/09	12	00	0.055	0.750	0.020	0.035	0.040
75/09/07	14	45	0.025	0.400	0.015	0.005K	0.020
75/10/05	12	00	0.015	0.700	0.015	0.010	0.030
75/11/02	15	20	0.170	0.200	0.010	0.005	0.030

K VALUE KNOWN TO BE LESS
THAN INDICATED

STORET RETRIEVAL DATE 76/12/16
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

3506C1
36 39 55.0 106 46 20.0 4
BOULDER CREEK
35 15 BOULDER LAKE
T/EL VADO RESERVOIR 120992
RT 95 BRDG 3 MI NE OF POUND RANCH
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
75/04/05	12	24	0.110	11.500	0.060	0.015	7.100
75/04/19	12	30	0.065	2.200	0.160	0.020	2.500
75/05/03	12	35	0.030	1.200	0.030	0.020	0.080
75/05/17	13	20	0.005	1.200	0.015	0.005	0.040

STORET RETRIEVAL DATE 77/02/1-
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

3506AA TF3506AA P002000
36 52 50.0 106 35 16.0 4
CHAMA
35 15 CHAMA
T/EL VADO RES. 110292
CHAMITA RIVER TO CHAMA RIVER
11EPALES 00001004
0000 FEET DEPTH CLASS 00

/AMMNT/STORAM

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
74/11/26	11	30							
CP(T)-			0.240	15.000	4.600	11.500	12.300	0.050	0.050
74/11/26	16	00							
74/12/26	10	00							
CP(T)-			0.240	29.000	14.500	15.000	17.000	0.040	0.040
74/12/26	15	00							
75/02/26	10	00							
CP(T)-			0.080	27.000	6.430		12.500	0.040	0.050
75/02/26	15	00							
75/03/28	16	00	0.080	14.000	4.700	6.400	7.700	0.050	0.050
75/04/30	15	00	5.100	25.000	0.062	0.610	1.600	0.060	0.050
75/06/02	15	00	0.550	7.300	0.077	2.900	4.600	0.050	0.050
75/06/28	11	30	0.125	8.200	0.055	5.450	6.000	0.070	0.060
75/07/30	16	00	0.050	11.500	0.575	7.400	7.850	0.060	0.070
75/08/29	15	00	0.069	13.000	0.130	8.400	9.600	0.070	0.070
75/09/29	16	00	0.075	17.500	2.700	9.600	11.000	0.050	0.050
75/10/30	16	00	0.200	22.000	4.600	10.500	17.000	0.050	0.050
75/12/01	15	00	0.050	30.000	11.500	12.600	13.000	0.050	0.055
75/12/30	16	00	0.040	33.000	20.000	12.000	13.500	0.500	0.500

APPENDIX E

PARAMETRIC RANKINGS OF LAKES SAMPLED BY NES IN 1975

STATE OF NEW MEXICO

Mean or median values for six of the key parameters evaluated in establishing the trophic conditions of New Mexico lakes sampled are presented to allow direct comparison of the ranking, by parameter, of each lake relative to the others. Median total phosphorus, median inorganic nitrogen and median dissolved orthophosphorus levels are expressed in mg/l. Chlorophyll a values are expressed in µg/l. To maintain consistent rank order with the preceding parameters, the mean Secchi disc depth, in inches, is subtracted from 500. Similarly, minimum dissolved oxygen values are subtracted from 15 to create table entries.

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
0812	NAVAJO RESERVOIR	0.025	0.130	420.928	2.164	11.200	0.009
3501	ALAMOGORDO	0.025	0.050	469.667	5.867	10.600	0.003
3502	BLUE WATER LAKE	0.036	0.140	480.125	3.867	11.400	0.012
3503	CONCHAS RESERVOIR	0.020	0.040	451.833	3.275	14.400	0.004
3504	EAGLE NEST LAKE	0.181	0.070	455.750	13.357	14.400	0.132
3505	ELEPHANT BUTTE RESERVOIR	0.083	0.110	475.750	6.758	14.200	0.052
3506	EL VADO RESERVOIR	0.034	0.140	466.444	2.189	12.600	0.014
3507	LAKE MACMILLAN	0.097	0.045	489.778	14.133	10.100	0.009
3509	UTE RESERVOIR	0.021	0.040	448.750	3.242	13.800	0.004

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
0812	NAVAJO RESERVOIR	63 (5)	25 (2)	100 (8)	100 (8)	75 (6)	56 (4)
3501	ALAMOGORDO	75 (6)	63 (5)	38 (3)	38 (3)	88 (7)	100 (8)
3502	BLUE WATER LAKE	38 (3)	6 (0)	13 (1)	50 (4)	63 (5)	38 (3)
3503	CONCHAS RESERVOIR	100 (8)	94 (7)	75 (6)	63 (5)	6 (0)	81 (6)
3504	EAGLE NEST LAKE	0 (0)	50 (4)	63 (5)	13 (1)	6 (0)	0 (0)
3505	ELEPHANT BUTTE RESERVOIR	25 (2)	38 (3)	25 (2)	25 (2)	25 (2)	13 (1)
3506	EL VADO RESERVOIR	50 (4)	6 (0)	50 (4)	88 (7)	50 (4)	25 (2)
3507	LAKE MACMILLAN	13 (1)	75 (6)	0 (0)	0 (0)	100 (8)	56 (4)
3509	UTE RESERVOIR	88 (7)	94 (7)	88 (7)	75 (6)	38 (3)	81 (6)