U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

REPORT

ON

DUHERNAL LAKE

MIDDLESEX COUNTY

NEW JERSEY

EPA REGION II

WORKING PAPER No. 365

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

☆G.P.O. 699-440

REPORT

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WITH THE COOPERATION OF THE

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

AND THE

NEW JERSEY NATIONAL GUARD

MAY 1976

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 Jersey Department of Environmental Protection for professional involvement and to the New Jersey National Guard for conducting the tributary sampling phase of the Survey.

Douglas Clark, Chief of the Bureau of Water Quality Planning and Management, Mr. Frank Takacs, New Jersey National Eutrophication Survey Coordinator, Principal Environmental Specialist, and Robert Kotch, Senior Environmental Engineer, provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

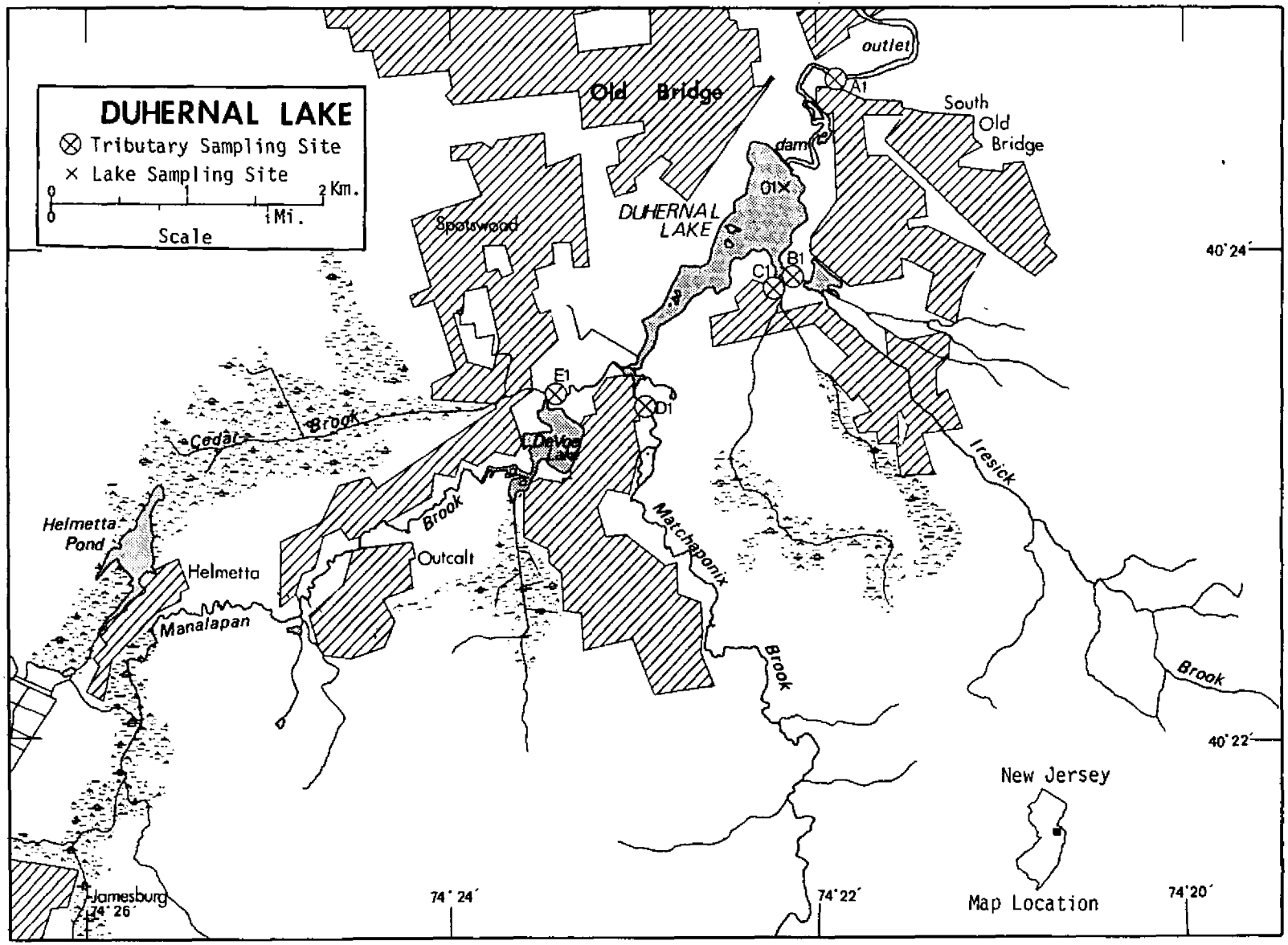
Major General William R. Sharp, Former Chief of Staff, Major General Wilfred G. Menard, Jr., Chief of Staff, and Project Officer Colonel Herbert D. Ruhlin, who directed the volunteer efforts of the New Jersey National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

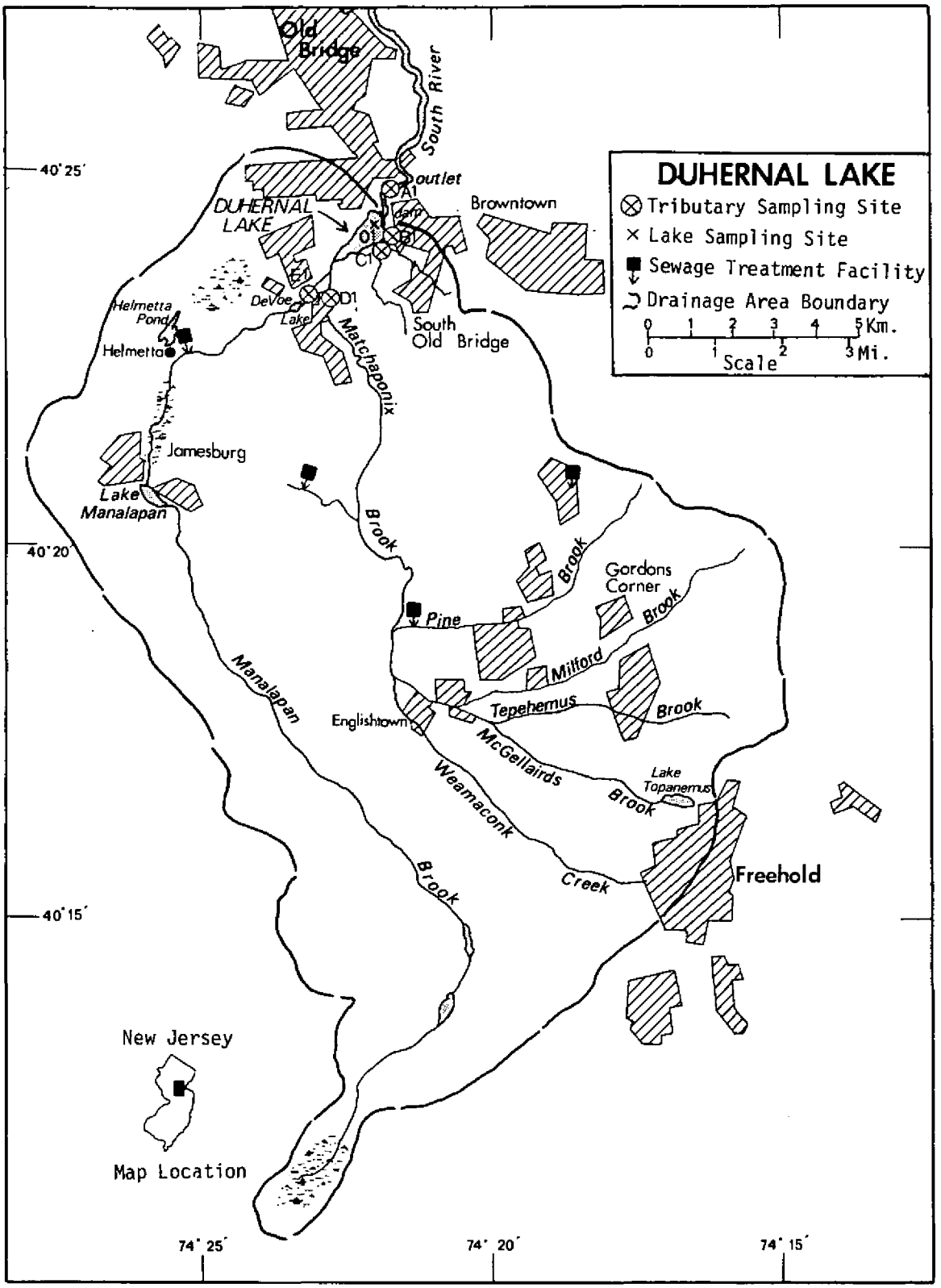
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF NEW JERSEY

LAKE NAME	COUNTY
Budd Lake	Morris
Duhernal Lake	Middlesex
Farrington Lake	Middlesex
Greenwood Lake	Passaic, N.J.; Orange, N.Y.
Lake Hopatcong	Morris, Sussex
Lake Musconetcong	Morris, Sussex
Oradell Reservoir	Bergen
Paulinskill Lake	Sussex
Pinecliff Lake	Passaic
Pompton Lakes	Passaic
Spruce Run Reservoir	Hunterdon
Union Lake	Cumberland
Wanaque Reservoir	Passaic


DUHERNAL LAKE
Tributary Sampling Site
Lake Sampling Site
0 2 Km.
0 1 Mi.
Scale
Old Bridge
outlet
A1
South Old Bridge
dam
01
DUHERNAL LAKE
Spotswood
B1
C1
E1
D1
Cedar Brook
Helmetta Pond
Helmetta
Outcalt
Brook
Manalapan
Matchaponix Brook
Iresick Brook
40°24'
40°22'
74°24'
74°22'
74°20'
74°26'
Jamesburg
New Jersey
Map Location


DUHERNAL LAKE
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
Drainage Area Boundary
0 1 2 3 4 5 Km.
0 1 2 3 Mi.
Scale
Old Bridge
South River
outlet
DUHERNAL LAKE
Browntown
South Old Bridge
Helmetta Pond
Helmetta
DeVoe Lake
Matchaponix Brook
Jamesburg
Lake Manalapan
Manalapan Brook
Pine
Gordons Corner Brook
Milford
Tepehemus Brook
Englishtown
McGellairds Brook
Lake Topanemus
Weamaconk Creek
Freehold
New Jersey
Map Location
40° 25'
40° 20'
40° 15'
74° 25'
74° 20'
74° 15'

DUHERNAL LAKE, NEW JERSEY

STORET NO. 3412

I. CONCLUSIONS

A. Trophic Condition:

Duhernal Lake is classified as eutrophic based upon Survey data. The turbid, green lake is characterized by low Secchi disc transparency, moderately high nutrient levels and extensive growths of emerged and submerged vegetation. Potential for primary productivity as measured by algal assay control yield was low. Chlorophyll a values ranged from a low of 1.5 µg/l in the spring to a high of 10.3 µg/l in the fall.

Past studies (Ketelle and Uttormark, 1971) recommended complete dredging as possible weed control treatment in Duhernal Lake.

B. Rate-Limiting Nutrient:

Algal assay results indicate that Duhernal Lake was limited by available phosphorus levels. Spikes with phosphorus, and nitrogen and phosphorus simultaneously resulted in increases in assay yield. Additions of nitrogen alone did not stimulate a growth response. The mean total inorganic nitrogen to mean orthophosphorus ratio (N/P) in sampled waters substantiates phosphorus limitation.

C. Nutrient Controllability:

1. Point Sources -

During the sampling year, the mean annual phosphorus load from point sources was estimated to be 85.6% of the total load reaching Duhernal Lake. The Pine Brook sewage treatment plant contributed 42.5%, the Jamesburg plant contributed 22.7%, and the Central Jersey Sewer Company contributed 18.2%. The present loading of 60.18 g $P/m^2/yr$ is about 19 times that proposed by Vollenweider (Vollenweider and Dillon, 1974) as "dangerous" (eutrophic). However, Vollenweider's model may not apply to lakes with such short retention times.

While it is unlikely that practicable control of point and nonpoint nutrient sources would of itself eliminate the existing macrophyte problem in this shallow lake, other parameters of water quality would be expected to improve.

2. Nonpoint Sources -

The mean annual phosphorus load from nonpoint sources was 14.4% of the total load reaching Duhernal Lake. Measured tributaries accounted for 14.0% of the total, and ungaged tributaries accounted for 0.3%.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

Lake and drainage basin characteristics are itemized below. Lake surface area, mean depth and maximum depth were provided by the State of New Jersey. Tributary flow data were provided by the New Jersey 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: 0.38 km^2.
2. Mean depth: 1.4 meters.
3. Maximum depth: 3.0 meters.
4. Volume: 0.532 x 10^6 m^3.
5. Mean hydraulic retention time: 2 days.

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

1. Tributaries -

Name	Drainage area(km^2)	Mean flow (m^3/sec)
B(1) Iresick Brook	7.8	0.08
C(1) Unnamed	4.1	0.07
D(1) Matchaponix Brook	113.7	1.84
E(1) Manalapan Brook	113.7	1.92
Minor tributaries and immediate drainage -	5.3	0.09
Totals	244.6	4.00
2. Outlet - A(1) South River	245.0	3.50

C. Precipitation:

1. Year of sampling: 143.6 cm.

2. Mean annual: 109.8 cm.

III. LAKE WATER QUALITY SUMMARY

Duhernal Lake was sampled three times during the open-water season of 1973 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from one station on the lake and from one or more depths at that station (see map, page v). During each visit, a depth-integrated sample was collected at the station for chlorophyll a analysis and phytoplankton identification and enumeration. During the first visit, an 18.9-liter depth-integrated sample was composited for algal assays. Maximum depth sampled was 1.5 meters at Station 1. 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 the 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.

DUMERNAL LAKE
STORET CODE 3412

PHYSICAL AND CHEMICAL CHARACTERISTICS

PARAMETER	(4/16/73) S*** = 1 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	(7/22/73) S*** = 1 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	(10/ 2/73) S*** = 1 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)
TEMPERATURE (DEG CENT)												
0.-1.5 M DEPTH	2	13.4- 13.6	13.5	0.0- 1.5	2	22.8- 23.0	22.9	0.0- 1.5	1	20.5- 20.5	20.5	0.0- 0.0
MAX DEPTH**	1	13.4- 13.4	13.4	1.5- 1.5	1	22.8- 22.8	22.8	1.5- 1.5	1	20.5- 20.5	20.5	0.0- 0.0
DISSOLVED OXYGEN (MG/L)												
0.-1.5 M DEPTH	1	11.0- 11.0	11.0	1.5- 1.5	2	6.4- 6.6	6.5	0.0- 1.5	1	7.8- 7.8	7.8	0.0- 0.0
MAX DEPTH**	1	11.0- 11.0	11.0	1.5- 1.5	1	6.4- 6.4	6.4	1.5- 1.5	1	7.8- 7.8	7.8	0.0- 0.0
CONDUCTIVITY (UMHOS)												
0.-1.5 M DEPTH	2	122.- 135.	129.	0.0- 1.5	2	135.- 146.	141.	0.0- 1.5	1	280.- 280.	280.	0.0- 0.0
MAX DEPTH**	1	135.- 135.	135.	1.5- 1.5	1	146.- 146.	146.	1.5- 1.5	1	280.- 280.	280.	0.0- 0.0
PH (STANDARD UNITS)												
0.-1.5 M DEPTH	2	5.2- 5.3	5.2	0.0- 1.5	2	5.4- 5.5	5.4	0.0- 1.5	1	5.6- 5.6	5.6	0.0- 0.0
MAX DEPTH**	1	5.3- 5.3	5.3	1.5- 1.5	1	5.5- 5.5	5.5	1.5- 1.5	1	5.6- 5.6	5.6	0.0- 0.0
TOTAL ALKALINITY (MG/L)												
0.-1.5 M DEPTH	2	10.- 10.	10.	0.0- 1.5	2	10.- 10.	10.	0.0- 1.5	1	10.- 10.	10.	0.0- 0.0
MAX DEPTH**	1	10.- 10.	10.	1.5- 1.5	1	10.- 10.	10.	1.5- 1.5	1	10.- 10.	10.	0.0- 0.0
TOTAL P (MG/L)												
0.-1.5 M DEPTH	2	0.044-0.045	0.044	0.0- 1.5	2	0.140-0.218	0.179	0.0- 1.5	1	0.082-0.082	0.082	0.0- 0.0
MAX DEPTH**	1	0.044-0.044	0.044	1.5- 1.5	1	0.218-0.218	0.218	1.5- 1.5	1	0.082-0.082	0.082	0.0- 0.0
DISSOLVED ORTHO P (MG/L)												
0.-1.5 M DEPTH	2	0.004-0.008	0.006	0.0- 1.5	2	0.021-0.032	0.026	0.0- 1.5	1	0.010-0.010	0.010	0.0- 0.0
MAX DEPTH**	1	0.008-0.008	0.008	1.5- 1.5	1	0.021-0.021	0.021	1.5- 1.5	1	0.010-0.010	0.010	0.0- 0.0
NO2+NO3 (MG/L)												
0.-1.5 M DEPTH	2	1.100-1.100	1.100	0.0- 1.5	2	0.850-1.100	0.975	0.0- 1.5	1	1.220-1.220	1.220	0.0- 0.0
MAX DEPTH**	1	1.100-1.100	1.100	1.5- 1.5	1	1.100-1.100	1.100	1.5- 1.5	1	1.220-1.220	1.220	0.0- 0.0
AMMONIA (MG/L)												
0.-1.5 M DEPTH	2	0.300-0.320	0.310	0.0- 1.5	2	0.460-0.550	0.505	0.0- 1.5	1	0.310-0.310	0.310	0.0- 0.0
MAX DEPTH**	1	0.300-0.300	0.300	1.5- 1.5	1	0.550-0.550	0.550	1.5- 1.5	1	0.310-0.310	0.310	0.0- 0.0
KJELDAHL N (MG/L)												
0.-1.5 M DEPTH	2	0.600-0.600	0.600	0.0- 1.5	2	1.200-1.200	1.200	0.0- 1.5	1	0.600-0.600	0.600	0.0- 0.0
MAX DEPTH**	1	0.600-0.600	0.600	1.5- 1.5	1	1.200-1.200	1.200	1.5- 1.5	1	0.600-0.600	0.600	0.0- 0.0
SECCHI DISC (METERS)												
	1	1.0- 1.0	1.0		1	0.6- 0.6	0.6		1	0.9- 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
07/22/73	1.	Eunotia	54
	2.	Oscillatoria	54
	3.	Tabellaria	36
	4.	Fragilaria	36
	5.	Euglena	18
		Other genera	36
		Total	234
10/02/73	1.	Flagellates	3,068
	2.	Dinobryon	186
	3.	Eunotia	37
	4.	Dinoflagellates	19
	5.	Staurastrum	19
		Other genera	---
		Total	3,329

2. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll *a* (µg/l)
04/16/73	1	1.5
07/22/73	1	8.6
10/02/73	1	10.3

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	0.010	1.390	0.1
0.05 P	0.060	1.390	4.2
0.05 P + 1.0 N	0.060	2.390	8.0
1.00 N	0.010	2.390	0.1

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that potential for primary production in Duhernal Lake was low at the time of sampling. Increased yield with the addition of phosphorus as well as the lack of increase when only nitrogen was added indicates phosphorus limitation. Maximum growth potential was achieved with the simultaneous addition of both phosphorus and nitrogen.

The N/P ratios were about 235/1 in the spring field sample, 55/1 in the summer, and 153/1 in the fall, further suggesting phosphorus limitation in Duhernal Lake.

IV. NUTRIENT LOADINGS
(See Appendix D for data)

For the determination of nutrient loadings, the New Jersey National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page vi), except for the high runoff month of February when two samples were collected. Sampling was begun in July 1973, and was completed in February 1974.

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

In this report, nutrient loads for Iresick Brook, Station B(1), 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) and for Unnamed Stream, Matchaponix Brook, and Manalapan Brook at Stations C(1), D(1), and E(1), respectively, were estimated by using the mean annual concentrations in Iresick Brook at Station B(1) and the mean appropriate annual flow.

The operators of the Central Jersey Sewer Company, Pine Brook, New Jersey Training School for Boys, and Helme Products (Helmetta) wastewater treatment plants provided monthly effluent samples and corresponding data. Nutrient loads for the city of Jamesburg wastewater treatment plant were estimated at 1.134 kg P and 3.401 kg N/capita/year.

A. Waste Sources:

1. Known municipal -

Name	Population Served*	Treatment	Mean Flow ($m^3/d \times 10^3$)	Receiving Water
Central Jersey Sewer Company	4,800**	1.	1.878	Barkley Brook/ Matchaponix Brook
Pine Brook	15,000	2.	4.246	Matchaponix Brook
New Jersey Training School for Boys	500	1.	0.324	Matchaponix Brook
Helme Products (Helmetta)	300	3.	0.070	Manalapan Brook/Devoe Lake
Jamesburg***	4,584	3.	1.735	Manalapan Brook

Key: 1. Activated sludge
2. Trickling filter
3. Sand filter

*Treatment plant questionnaires.
**Population estimate based on 1,200 homes, 4 people/home.
***U.S. Environmental Protection Agency, 1971; population shown is 1970 census; flow estimate based on 0.3785 m^3/capita/day.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source		kg P/yr	% of total
a.	Tributaries (nonpoint load) -		
	B(1) Iresick Brook	65	0.3
	C(1) Unnamed Stream	55	0.2
	D(1) Matchaponix Brook	1,510	6.6
	E(1) Manalapan Brook	1,575	6.9
b.	Minor tributaries and immediate drainage (nonpoint load) -	70	0.3
c.	Known municipal STP's -		
	Jamesburg	5,200	22.7
	Central Jersey Sewer Company	4,165	18.2
	Pine Brook	9,715	42.5
	New Jersey Training School for Boys	350	1.5
	Helme Products (Helmetta)	160	0.7
d.	Septic tanks* -	<1	<0.1
e.	Known industrial - None		
f.	Direct precipitation** -	5	<0.1
	Total	22,870	100.0

2. Output - A(1) South River 8,100

3. Net annual P accumulation 14,770

*Estimate based on one lakeside residence.
**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) -		
	B(1) Iresick Brook	3,550	1.4
	C(1) Unnamed Stream	3,225	1.2
	D(1) Matchaponix Brook	84,835	32.7
	E(1) Manalapan Brook	88,525	34.1
b.	Minor tributaries and immediate drainage (nonpoint load) -	4,150	1.6
c.	Known municipal STP's -		
	Jamesburg	15,590	6.0
	Central Jersey Sewer Company	15,920	6.1
	Pine Brook	40,640	14.6
	New Jersey Training School for Boys	2,005	0.8
	Helme Products (Helmetta)	845	0.3
d.	Septic tanks* -	10	<0.1
e.	Known industrial - None		
f.	Direct precipitation** -	410	0.2
	Total	259,705	100.0

2. Output - A(1) South River 251,560

3. Net annual N accumulation - 8,145

*Estimate based on one lakeside residence.
**Estimated (see NES Working Paper No. 175).

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
B(1) Iresick Brook	8	455
C(1) Unnamed Stream	13	787
D(1) Matchaponix Brook	13	746
E(1) Manalapan Brook	14	778

E. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Yearly Phosphorus Loading (g/m^2/yr)
Estimated loading for Duhernal Lake	60.18
Vollenweider's "dangerous" or eutrophic loading	3.18
Vollenweider's "permissible" or oligotrophic loading	1.59

V. LITERATURE REVIEWED

Ketelle, Martha J. and Paul D. Uttormark. 1971. Problem Lakes in the United States. U.S. Environmental Protection Agency Project #16010 EHR. University of Wisconsin, Madison, Wisconsin.

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_____. 1975. National Eutrophication Survey Methods 1973-1976. Working Paper No. 175. Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, and Corvallis Environmental Research Laboratory, Corvallis, Oregon.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

VI. APPENDICES

APPENDIX A

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

TRIBUTARY FLOW INFORMATION FOR NEW JERSEY 06/04/76

LAKE CODE 3412 DUHERNAL LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 245.0

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
3412A1	245.0	3.71	5.27	6.09	4.47	3.62	2.80	2.12	2.58	2.35	2.04	3.28	3.77	3.50
3412B1	7.8	0.130	0.176	0.207	0.153	0.074	0.017	0.028	0.025	0.023	0.025	0.045	0.082	0.082
3412C1	4.1	0.085	0.096	0.113	0.091	0.068	0.040	0.048	0.045	0.045	0.045	0.057	0.074	0.067
3412D1	113.7	2.32	2.63	3.09	2.49	1.90	1.10	1.30	1.27	1.22	1.25	1.59	1.98	1.84
3412E1	113.7	2.24	2.55	2.94	2.44	1.87	1.39	1.53	1.53	1.47	1.50	1.70	1.93	1.92
3412ZZ	5.7	0.116	0.133	0.156	0.125	0.093	0.057	0.065	0.065	0.062	0.062	0.079	0.099	0.093

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 245.0
SUM OF SUB-DRAINAGE AREAS = 245.0
TOTAL FLOW IN = 48.13
TOTAL FLOW OUT = 42.11

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
3412A1	7	73	7.108	21	2.747				
	8	73	1.501	19	1.586				
	9	73	1.501	16	6.938				
	10	73	2.633	13	1.218				
	11	73	2.577	17	1.642				
	12	73	9.571	15	5.720				
	1	74	6.711	20	4.927				
	2	74	4.559	24	3.964				
	3	74	7.164						
	4	74	7.447						
	5	74	3.511						
	6	74	2.690						
3412B1	7	73	0.215	21	0.062				
	8	73	0.018	19	0.017				
	9	73	0.011	16	0.091				
	10	73	0.045	13	0.007				
	11	73	0.045	17	0.020				
	12	73	0.261	15	0.212				
	1	74	0.198	20	0.110				
	2	74	0.099	24	0.068				
	3	74	0.204						
	4	74	0.212						
	5	74	0.079						
	6	74	0.042						

TRIBUTARY FLOW INFORMATION FOR NEW JERSEY 06/04/76

LAKE CODE 3412 OUHERNAL LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
3412C1	7	73	0.116	21	0.0				
	8	73	0.040	19	0.0				
	9	73	0.034	16	0.074				
	10	73	0.057	13	0.0				
	11	73	0.057	17	0.0				
	12	73	0.142	15	0.116				
	1	74	0.108	20	0.079				
	2	74	0.076	24	0.068				
	3	74	0.113						
	4	74	0.116						
	5	74	0.071						
	6	74	0.057						
3412D1	7	73	3.200	21	1.784				
	8	73	1.104	19	1.104				
	9	73	0.934	16	2.039				
	10	73	1.586	13	0.765				
	11	73	1.586	17	1.161				
	12	73	3.908	15	3.171				
	1	74	2.945	20	2.209				
	2	74	2.124	10	1.274	24	1.841		
	3	74	3.087						
	4	74	3.171						
	5	74	1.926						
	6	74	1.529						
3412E1	7	73	3.115	21	1.812				
	8	73	1.388	19	1.388				
	9	73	1.246	16	1.982				
	10	73	1.699	13	1.133				
	11	73	1.699	17	1.416				
	12	73	3.766	15	3.087				
	1	74	2.832	20	2.124				
	2	74	2.067	24	1.869				
	3	74	2.945						
	4	74	3.087						
	5	74	1.897						
	6	74	1.642						
3412Z2	7	73	0.161	21	0.088				
	8	73	0.057	19	0.054				
	9	73	0.045	16	0.102				
	10	73	0.079	13	0.040				
	11	73	0.079	17	0.059				
	12	73	0.195	15	0.159				
	1	74	0.147	20	0.110				
	2	74	0.108	24	0.091				
	3	74	0.156						
	4	74	0.159						
	5	74	0.096						
	6	74	0.076						

APPENDIX C

PHYSICAL AND CHEMICAL DATA

STORET RETRIEVAL DATE 76/06/04

341201
40 24 18.0 074 22 10.0 3
DUHERNAL LAKE
34023 NEW JERSEY
013391

11EPALES 2111202
0008 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
73/04/16	14 00	0000	13.6		40	122	5.20	10K	0.320	0.600	1.100	0.004
	14 00	0005	13.4	11.0		135	5.30	10K	0.300	0.600	1.100	0.008
73/07/22	14 10	0000	23.0	6.6	24	135	5.40	10K	0.460	1.200	0.850	0.032
	14 10	0005	22.8	6.4		146	5.50	10K	0.550	1.200	1.100	0.021
73/10/02	12 10	0000	20.5	7.8	36	280	5.60	10K	0.310	0.600	1.220	0.010

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/04/16	14 00	0000	0.045	1.5
	14 00	0005	0.044	
73/07/22	14 10	0000	0.140	8.6
	14 10	0005	0.218	
73/10/02	12 10	0000	0.082	10.3

K VALUE KNOWN TO BE
LESS THAN INDICATED

APPENDIX D

TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 76/06/04

3412A1
40 24 15.0 074 21 59.0 4
SOUTH RIVER
34 7.5 SOUTH AMBOY
0/DUBERNAL LAKE 013391
2NDRY RD #3514 BRDG N EDGE E SPOTSWOOD
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
73/07/21	10 24		1.100		0.370	0.042	0.120
73/08/19	10 55		1.060	0.480	0.390	0.035	0.125
73/09/16			0.950	1.760	0.625	0.018	0.100
73/10/13	09 35		2.100	2.200	0.860	0.024	0.125
73/11/17	10 30		1.300	0.700	0.470	0.009	0.080
73/12/15	10 15		0.840	0.900	0.340	0.005K	0.035
74/01/20	13 55		1.260	0.500	0.368	0.005K	0.010
74/02/24	15 15		1.040	0.900	0.310	0.005K	0.040
			1.520	0.800	0.390	0.005K	0.025

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/06/04

341281
40 23 55.0 074 22 10.0 4
IRESICK BROOK
34 7.5 SOUTH AMBOY
T/DUBERNAL LAKE 013391
2NDRY RD BRDG SE CORNER OF LAKE
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
73/07/21	11	00	0.315	0.750	0.150	0.013	0.040
73/08/19	11	10	0.290	3.000	0.115	0.010	0.025
73/09/16			0.056	2.500	0.880	0.010	0.035
73/10/13	10	10	0.850	1.300	0.023	0.010	0.025
73/11/17	10	45	0.170	0.950	0.060	0.005K	0.040
73/12/15	10	30	0.140	0.500	0.060	0.005K	0.020
74/01/20	14	05	0.252	0.100K	0.072	0.005K	0.005K
74/02/24			0.224	0.300	0.045	0.005K	0.015

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/06/04

3412D1
40 23 18.0 074 23 28.0 4
MATCHAPONIX BROOK
34 7.5 SOUTH AMBOY
T/DUBERNAL LAKE 013391
2NDRY RD BRDG NE EDGE OF MONROE
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
73/07/21	11	40	0.940	1.500	0.920	0.050	0.145
73/08/19	11	40	1.100	3.500	2.200	0.052	0.410
73/09/16			0.920	1.600	0.810	0.016	0.110
73/11/17			0.770	2.200	0.410	0.007	0.350
73/12/15	10	40	0.704	0.900	0.400	0.005K	0.130
74/01/20	14	10	1.090	0.800	0.590	0.005K	0.170
74/02/24			0.940	1.400	0.580	0.005K	0.120

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/06/04

3412E1
40 23 27.0 074 22 57.0 4
MANALAPAN BROOK
34 7.5 SOUTH AMBOY
T/DUBERNAL LAKE 013391
2NDRY RD BRDG AT DEVOE LAKE OUTLET
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
73/07/21	11 55		0.970	0.880	0.230	0.038	0.100
73/08/19	12 00		0.820	4.800	0.240	0.040	0.130
73/09/16			0.630	0.750	0.170	0.020	0.080
73/10/13	10 30		1.080	1.120	0.300	0.017	0.085
73/11/17	11 05		1.100	0.450	0.208	0.005K	0.063
73/12/15	11 48		0.950	0.900	0.192	0.005K	0.050
74/01/20	14 15		1.430	0.200	0.192	0.005K	0.020
74/02/24			1.280	0.900	0.070	0.005	0.027

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/06/04

3412DA TF3412DA P015000
40 19 00.0 074 22 00.0 4
PINE BROOK
34 MONMOUTH COUNTY
T/DUHERNAL LAKE 013391
MATCHAPONIX BROOK
11EPALES 2141204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/11/29	11 00								
CP(T)-			0.020	30.000	13.000	5.600	8.500	0.920	1.030
73/11/29	16 00								
73/12/28	11 00								
CP(T)-			0.160	26.000	10.000	3.300	6.000	1.100	1.080
73/12/28	16 00								
74/01/29	11 00								
CP(T)-			0.200	23.000	10.900	3.360	8.000	1.210	1.200
74/01/29	16 00								
74/02/27	11 00								
CP(T)-			0.080	21.000	11.000	3.450	6.500	1.200	1.190
74/02/27	16 00								
74/03/28	11 00								
CP(T)-			0.040	11.000	9.600	3.150	3.450	1.200	1.190
74/03/28	16 00								
74/04/29	12 00								
CP(T)-			0.080	31.000	14.000	4.200	6.700	1.210	1.200
74/04/29	15 30								
74/05/29	11 00								
CP(T)-			0.090	31.000	14.000	3.900	6.900	1.160	1.200
74/05/29	16 00								
74/06/28	11 00								
CP(T)-			0.060	29.000	14.500	3.900	5.700	1.160	1.170
74/06/28	16 00								
74/07/29	10 00								
CP(T)-			0.280	27.000	15.700	4.000	5.400	1.000	1.010
74/07/29	16 00								
74/08/29	10 00								
CP(T)-			0.040	30.000			5.600	1.100	1.010
74/08/29	16 00								
74/09/30	10 00		0.260	27.000		4.450	6.100	1.100	1.170
74/10/28	09 00								
CP(T)-			0.320	30.000	15.700	4.500	7.000	1.070	1.100
74/10/28	15 00								
74/11/25	09 00								
CP(T)-			0.160	25.000	16.300	4.700	5.900	1.010	1.030
74/11/25	15 00								

STORET RETRIEVAL DATE 76/06/04

3412DB AS3412DB P000500
40 20 58.0 074 23 45.0 4
NEw JERSEY TRAINING SCHOOL FOR B
34 7.5 JAMESBURG
T/DUHERNAL LAKE 013391
MATCHOPONIX BROOK
11EPALES 2141204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/12/06	11 00								
CP(T)-			0.890	11.000	6.400	1.380	2.000	0.010	0.005
73/12/06	16 00								
74/01/21	11 00								
CP(T)-			0.360	31.000	9.700	1.680	4.100	0.200	0.100
74/01/21	16 00								
74/03/12	11 00								
CP(T)-			0.040	6.100	3.300		1.650	0.050	0.050
74/03/12	16 00								
74/05/15	08 00								
CP(T)-			0.200	11.000	5.500	1.200	2.100	0.150	0.150
74/05/15	16 00								
74/06/14	11 00								
CP(T)-			0.440	14.000	10.000	2.300	2.900	0.175	0.160
74/06/14	16 00								
74/08/08	08 00								
CP(T)-			0.160	15.000	8.300	2.400	3.300	0.150	0.125
74/08/08	15 00								
74/09/09	11 00								
CP(T)-			2.160	6.400	2.300	1.650	2.300	0.040	0.050
74/09/09	16 00								
74/10/07	11 00								
CP(T)-			6.400	3.000	0.760	1.500	2.200	0.050	0.045
74/10/07	16 00								

STORET RETRIEVAL DATE 76/06/04

3412EA SF3412EA P000300
40 22 34.0 074 25 30.0 4
HELME PRODUCTS (HELMETTA)
34 7.5 NEW BRUNSWIK
T/DUBERNAL LAKE 013391
MANALAPAN BROOK/DEVOE LAKE
11EPALES 2141204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/11/30	11 30		1.300	22.000	13.000	5.900	7.200	0.023	0.020
74/01/08	13 00		0.720	30.000	17.600	3.840	4.800	0.018	0.018
74/02/05			6.600	36.000	24.000	4.600	5.950	0.020	0.018
74/03/06			3.100	38.000	24.000	7.000	9.400	0.021	0.018
74/04/02	08 00		1.240	34.000	25.000	4.700	6.800	0.021	0.018
74/05/01	09 00		7.400	29.000	18.000	5.750	7.100	0.017	0.018
74/06/25	09 30		4.600	26.000	14.000	3.800	4.400	0.024	0.019
74/07/24	09 00		3.840	29.000	18.000	4.300	5.500	0.021	0.018
74/08/27	13 00		0.080	23.000			5.450	0.019	0.019
74/09/26	12 45		0.720	34.000	17.300	4.700	6.600	0.020	0.019
74/10/24	10 00		1.760	29.000	17.300	7.400		0.022	0.020
75/01/17			0.351	33.500	21.000	4.650	5.200	0.021	0.018

STORET RETRIEVAL DATE 76/06/04

3412XA AS3412XA P004800
40 20 53.0 074 18 54.0 4
CENTRAL JERSEY SEWER COMPANY
34 MONMOUTH COUNTY
T/DUNHERNAL LAKE 013392
BARKLEY BROOK
11EPALES 2141204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/12/04	08 00								
CP(T)-			19.000	4.700	1.000	6.500	7.200	0.450	0.450
73/12/04	20 00								
74/01/04	08 00								
CP(T)-			17.600	7.800	3.120	4.800	6.200	0.500	0.500
74/01/04	19 00								
74/02/05	08 00								
CP(T)-			19.000	4.600	0.096	4.500	6.100	0.500	0.500
74/02/05	19 00								
74/03/04	08 00								
CP(T)-			8.880	5.600	0.630	4.800	6.000	0.500	0.500
74/03/04	19 00								
74/04/03	08 00								
CP(T)-			18.000	5.000	1.050	3.600	5.500	0.500	0.500
74/04/03	19 00								
74/05/03	08 00								
CP(T)-			20.000	3.800	1.150	5.400	6.200	0.500	0.500
74/05/03	19 00								
74/06/04	08 00								
CP(T)-			15.200	11.500	5.200	5.800	6.700	0.500	0.500
74/06/04	19 00								
74/07/02	08 00								
CP(T)-			17.600	8.500	3.600	5.250	6.500	0.500	0.500
74/07/02	19 00								
74/08/05	08 00								
CP(T)-			15.000	15.000	6.500	6.300	7.400	0.500	0.500
74/08/05	19 00								
74/09/03	08 00								
CP(T)-			12.000	12.000	6.100	5.500	6.700	0.500	0.500
74/09/03	19 00								
74/10/04	08 00								
CP(T)-			18.400	7.100	1.200	4.625	5.290	0.500	0.500
74/10/04	19 00								
74/12/04	08 00								
CP(T)-			10.100	5.100	1.300	3.900	4.800	0.500	0.500
74/12/04	19 00								

STORET RETRIEVAL DATE 76/06/04

3412XA AS3412XA P004800
40 20 53.0 074 18 54.0 4
CENTRAL JERSEY SEWER COMPANY
34 MONMOUTH COUNTY
T/DUNHERNAL LAKE 013392
BARKLEY BROOK
11EPALES 2141204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
75/01/07	08	00							
CP(T)-			10.400	10.000	3.000		4.500	0.500	0.500
75/01/07	19	00							

APPENDIX E

PARAMETRIC RANKINGS OF LAKES SAMPLED BY NES IN 1973

STATE OF NEW JERSEY

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
3402	BUDD LAKE	0.082	0.205	474.000	48.500	7.400	0.012
3403	GREENWOOD LAKE	0.021	0.100	414.250	11.920	14.800	0.007
3406	ORADELL RESERVOIR	0.055	0.990	462.500	22.267	13.600	0.008
3409	PINECLIFF LAKE	0.070	0.175	465.500	38.960	11.000	0.011
3410	POMPTON LAKES	0.071	0.795	463.167	23.033	11.800	0.029
3412	DUHERNAL LAKE	0.082	1.420	466.667	6.800	8.600	0.010
3413	FARRINGTON LAKE	0.055	0.770	462.000	8.283	14.400	0.012
3415	LAKE HOPATCONG	0.022	0.120	416.333	13.627	14.900	0.007
3417	LAKE MUSCONETCONG	0.036	0.140	436.000	11.067	6.000	0.010
3419	PAULINS KILL LAKE	0.133	0.950	460.500	7.017	9.000	0.065
3420	SPRUCE RUN RESERVOIR	0.020	0.470	428.667	15.333	15.000	0.007
3422	UNION LAKE	0.063	1.150	463.200	22.080	12.800	0.018
3423	WANAQUE RESERVOIR	0.014	0.120	355.333	7.111	14.800	0.005

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
3402	BUDD LAKE	12 (1)	58 (7)	0 (0)	0 (0)	92 (11)	29 (3)	191
3403	GREENWOOD LAKE	83 (10)	100 (12)	92 (11)	58 (7)	21 (2)	83 (9)	437
3406	ORADELL RESERVOIR	54 (6)	17 (2)	42 (5)	25 (3)	42 (5)	67 (8)	247
3409	PINECLIFF LAKE	33 (4)	67 (8)	17 (2)	8 (1)	67 (8)	42 (5)	234
3410	POMPTON LAKES	25 (3)	33 (4)	33 (4)	17 (2)	58 (7)	8 (1)	174
3412	DUHERNAL LAKE	12 (1)	0 (0)	8 (1)	100 (12)	83 (10)	58 (7)	261
3413	FARRINGTON LAKE	54 (6)	42 (5)	50 (6)	75 (9)	33 (4)	29 (3)	283
3415	LAKE HOPATCONG	75 (9)	87 (10)	83 (10)	50 (6)	8 (1)	83 (9)	386
3417	LAKE MUSCONETCONG	67 (8)	75 (9)	67 (8)	67 (8)	100 (12)	50 (6)	426
3419	PAULINS KILL LAKE	0 (0)	25 (3)	58 (7)	92 (11)	75 (9)	0 (0)	250
3420	SPRUCE RUN RESERVOIR	92 (11)	50 (6)	75 (9)	42 (5)	0 (0)	83 (9)	342
3422	UNION LAKE	42 (5)	8 (1)	25 (3)	33 (4)	50 (6)	17 (2)	175
3423	WANAQUE RESERVOIR	100 (12)	87 (10)	100 (12)	83 (10)	21 (2)	100 (12)	491

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	3423	WANAQUE RESERVOIR	491
2	3403	GREENWOOD LAKE	437
3	3417	LAKE MUSCONETCONG	426
4	3415	LAKE HOPATCONG	386
5	3420	SPRUCE RUN RESERVOIR	342
6	3413	FARRINGTON LAKE	283
7	3412	DUHERNAL LAKE	261
8	3419	PAULINS KILL LAKE	250
9	3406	ORADELL RESERVOIR	247
10	3409	PINECLIFF LAKE	234
11	3402	BUDD LAKE	191
12	3422	UNION LAKE	175
13	3410	POMPTON LAKES	174