U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY
WORKING PAPER SERIES

REPORT
ON
HARRIMAN RESERVOIR
WINDHAM COUNTY
VERMONT
EPA REGION I
WORKING PAPER NO. 20

PACIFIC NORTHWEST ENVIRONMENTAL RESEARCH LABORATORY

An Associate Laboratory of the

NATIONAL ENVIRONMENTAL RESEARCH CENTER - CORVALLIS, OREGON

and

NATIONAL ENVIRONMENTAL RESEARCH CENTER - LAS VEGAS, NEVADA

☆GPO—697-032

REPORT

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EPA REGION I

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WITH THE COOPERATION OF THE

VERMONT AGENCY OF ENVIRONMENTAL CONSERVATION

AND THE

VERMONT NATIONAL GUARD

SEPTEMBER, 1974

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 fresh water lakes and reservoirs.

OBJECTIVES

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

ANALYTIC APPROACH

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

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

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

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

LAKE ANALYSIS

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

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

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Vermont Agency of Environmental Conservation for professional involvement and to the Vermont National Guard for conduct of the tributary sampling phase of the Survey.

Martin L. Johnson, Secretary of the Vermont Agency of Environmental Conservation; Gordon R. Ryper, Commissioner of the Water Quality Division; David L. Clough, Director, James W. Morse II, Biologist, and Wally McLean, Sanitary Engineer, of the Water Quality Division, provided invaluable lake documentation and counsel during the study. Reginald A. LaRosa, Director of the Water Supply and Pollution Control Division, and James F. Agan, Chief of the Operations Section, Environmental Engineering Division, were most helpful in arranging for the sampling of wastewater treatment plants involved in the Survey.

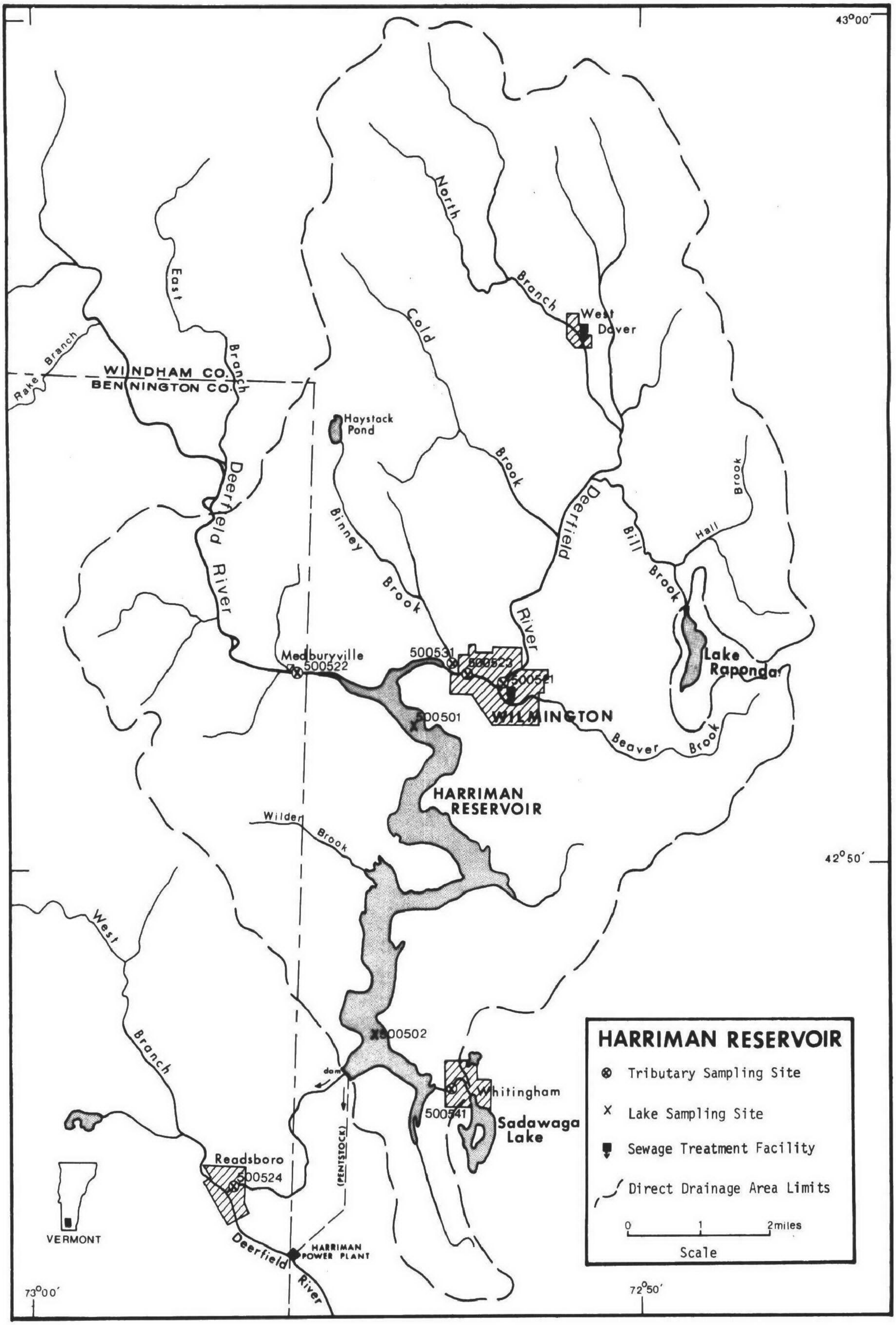
Major General Reginald M. Cram, the Adjutant General of Vermont, and Project Officer Major Howard Buxton, who directed the volunteer efforts of the Vermont National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF VERMONT

LAKE NAME	COUNTY
Arrowhead Mountain Lake	Chittenden, Franklin
Clyde Pond	Orleans
Harriman Reservoir	Windham
Lake Champlain	Addison, Chittenden, Franklin
Lake Lamoille	Lamoille
Lake Memphremagog	Orleans
Waterbury Reservoir	Washington, Lamoille


43°00′
42°50′
73°00′
72°50′
North Branch
West Dover
East Branch
Rake Branch
WINDHAM CO.
BENNINGTON CO.
Haystack Pond
Cold Brook
Deerfield River
Binney Brook
Hall Brook
Bill Brook
Lake Raponda
Medburyville
500522
500531
500523
500521
500501
WILMINGTON
Beaver Brook
HARRIMAN RESERVOIR
Wilder Brook
West Branch
500502
dam
Whitingham
500541
Sadawaga Lake
Readsboro
500524
(PENSTOCK)
HARRIMAN POWER PLANT
VERMONT
HARRIMAN RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
Direct Drainage Area Limits
0
1
2miles
Scale

HARRIMAN RESERVOIR

STORET NO. 5005

I. CONCLUSIONS

A. Trophic Condition:

Harriman Reservoir is mesotrophic as evidenced by low chlorophyll a values, relatively good Secchi disc transparency, minimal occurrences of algal blooms and rooted aquatic vegetation, and some depression but no depletion of dissolved oxygen in the hypolimnion.

Nutrient concentrations in the reservoir were relatively low with total phosphorus not exceeding 0.017 mg/l and inorganic nitrogen not exceeding 0.520 mg/l in any of the samples (to 135 feet in depth). The algal assay tests indicate the potential primary productivity in Harriman Reservoir was quite low.

B. Rate-Limiting Nutrient:

The algal assay test indicates the rate-limiting nutrient in Harriman Reservoir was phosphorus at the time the assay sample was collected. The nitrogen-to-phosphorus ratios observed during lake sampling indicate phosphorus limitation at the other sampling times as well.

C. Nutrient Controllability:

1. Point sources--During the sampling year, Harriman Reservoir received a total phosphorus load at a rate less than that proposed by Vollenweider (in press) as "dangerous" but greater

than his "permissible" rate (i.e., a mesotrophic rate; see page 18). Of this load, it is estimated that the communities of Wilmington and West Dover collectively contributed about 26%.

At this time, West Dover is converting to a spray irrigation disposal system, and the waste treatment facilities of Wilmington are under review by the Vermont Agency of Environmental Conservation.

It is calculated that the removal of the West Dover phosphorus load by spray irrigation will reduce the phosphorus loading rate from the existing 0.88 $g/m^2/yr$ to 0.78 $g/m^2/yr$ and thus will provide some protection of the mesotrophic condition of Harriman Reservoir.

While it does not appear that there will be an urgent need for phosphorus removal facilities at Wilmington once the West Dover irrigation system becomes operational, it is likely that such facilities will eventually be needed to protect the reservoir because of the near-certain future expansion of recreational uses and facilities in the drainage.

2. Non-point sources--The mean annual phosphorus export of the Sadawaga Lake outlet was significantly higher than the exports of the other Harriman Reservoir tributaries. This is probably due to discharges from private disposal systems in the unincorporated community of Whitingham, and a need for further study is indicated.

The phosphorus exports of the Deerfield River and Binney Brook compare favorably with the exports of other unimpacted Vermont streams studied.

II. INTRODUCTION

Harriman Reservoir is located in the southernmost portion of Vermont, just north of the Vermont-Massachusetts state line, in Windham County (see map, page v). Harriman Reservoir is owned and operated by the New England Power Company and is used as a water storage basin for hydroelectric power generation, but access is provided to the public for recreational use. The outflow from the reservoir depends upon the demands for electricity, and this results in major fluctuations of reservoir water levels. The variability of water level is said to be the greatest hindrance to developing the full sport-fishing and recreational potential of Harriman Reservoir (Biggins, 1971).

Sport fish present in Harriman Reservoir include brown trout, rainbow trout, lake trout, smallmouth bass, chain pickerel, and panfish. Biggins (op. cit.) indicated that despite the variable water levels, Harriman Reservoir is a productive fishery resource and has good water quality.

Thermal stratification develops in the summer; however, dissolved oxygen is not depleted in the hypolimnion. Planktonic algae blooms are not at the nuisance level, and aquatic macrophyte growths do not occur to a great extent in the littoral zone (possibly because of the fluctuations in water level).

The watershed consists of rolling hills to mountainous terrain, and the vegetative cover is mixed soft and hardwood forests and farmlands. The area receives very heavy recreation use, particularly in the wintertime when from 8,000 to 12,000 week-end visitors crowd the area to ski and participate in other winter sports.

III. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry:

1. Surface area: 2,184 acres.
2. Mean depth: 34 feet.
3. Maximum depth: 170 feet.
4. Volume: 74,256 acre/feet.
5. Mean hydraulic retention time: 78 days.

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

1. Tributaries -

Name	Drainage area**	Mean flow**
Deerfield River	97.7 mi^2	250.3 cfs
North Branch, Deerfield River	50.4 mi^2	129.1 cfs
Binney Brook	3.6 mi^2	9.3 cfs
Sadawaga Lake outlet	2.8 mi^2	7.3 cfs
Minor tributaries & immediate drainage -	29.9 mi^2	85.2 cfs
Totals	184.4 mi^2	481.2 cfs

2. Outlet -

Deerfield River	187.8 mi^2†	481.2 cfs†

C. Precipitation††:

1. Year of sampling: 58.0 inches.
2. Mean annual: 35.9 inches.

* At maximum pool level.
** Drainage areas are accurate within ±1%; gaged flows are accurate within ±15%; and ungaged flows are accurate within ±20%.
† Includes area of lake; outflow adjusted to equal sum of inflows.
†† See Working Paper No. 1, "Survey Methods".

IV. LAKE WATER QUALITY SUMMARY

Harriman Reservoir was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the reservoir and from a number of depths at each station (see map, page v). During each visit, a single depth-integrated (15 feet or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the last visit, a single five-gallon depth-integrated sample was collected from station 1 for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 135 feet at station 1 and 13 feet at station 2.

The results obtained are presented in full in Appendix B, and the data for the fall sampling period, when the lake was essentially well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix B.

A. Physical and chemical characteristics:

Parameter	Minimum	Mean	Median	Maximum
		FALL VALUES (10/04/72)		
Temperature (Cent.)	5.0	12.5	15.5	16.8
Dissolved oxygen (mg/l)	3.6	6.6	7.1	8.1
Conductivity (µmhos)	50	50	50	50
pH (units)	5.6	6.3	6.3	6.8
Alkalinity (mg/l)	10	10	10	10
Total P (mg/l)	0.005	0.008	0.008	0.012
Dissolved P (mg/l)	0.003	0.006	0.006	0.008
NO_2 + NO_3 (mg/l)	0.110	0.210	0.165	0.430
Ammonia (mg/l)	0.010	0.081	0.070	0.200
		ALL VALUES		
Secchi disc (inches)	108	111	108	120

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
05/30/72	1. Dinobryon	922
	2. Anabaena	63
	3. Stephanodiscus	50
	4. Tabellaria	23
	5. Ankistrodesmus	14
	Other genera	31
	Total	1,103
07/31/72	1. Dinobryon	213
	2. Merismopedia	184
	3. Gloeocapsa	98
	4. Oocystis	22
	5. Cryptomonas	18
	Other genera	44
	Total	579
10/04/72	1. Dinobryon	93
	2. Merismopedia	88
	3. Cryptomonas	46
	4. Stephanodiscus	16
	5. Chroococcus	15
	Other genera	37
	Total	295

2. Chlorophyll *a* -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll *a* (μg/l)
05/30/72	01	0.7
	02	1.3
07/31/72	01	2.6
	02	1.8
10/04/72	01	1.9
	02	2.3

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	0.002	0.200	0.1
0.006 P	0.008	0.200	0.1
0.012 P	0.014	0.200	0.2
0.024 P	0.026	0.200	3.4
0.060 P	0.062	0.200	3.8
0.060 P + 10.0 N	0.062	10.200	22.6
10.0 N	0.002	10.200	0.1

2. Discussion -

The control yield of the test alga, *Selenastrum capricornutum*, indicates that the productivity of Harriman Reservoir was quite low at the time the sample was collected.

The response to spikes of phosphorus indicates that Harriman Reservoir productivity was limited by phosphorus at the time of sampling (note the lack of response when only nitrogen was added). This conclusion is substantiated by field data, collected at the same time, which indicate that the nitrogen-phosphorus ratio was greater than 14 to 1 (i.e., phosphorus limitation would be expected).

D. Trophic Condition:

The Survey data indicate that Harriman Reservoir is mesotrophic. The EPA field limnologists did not observe any algal blooms or significant amounts of emergent aquatic vegetation. They noted that the reservoir appearance was good.

Chlorophyll _a_ values were low (mean of 1.8 μg/l), Secchi disc readings were relatively good, and nitrogen and phosphorus concentrations were quite low (this was reflected in the low numbers of phytoplankton). Phytoplankton populations were dominated by the Chrysophycean genus _Dinobryon_, although Myxophycean (blue-green) genera were present during each sampling.

Dissolved oxygen concentrations in the hypolimnion remained high (6.9 mg/l at 135 feet) during stratification.

V. NUTRIENT LOADINGS
(See Appendix C for data)

For the determination of nutrient loadings, the Vermont 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, and the colder months when ice cover prevented sampling at some of the stations. National Guard sampling was begun in July, 1972, and was completed in July, 1973. However, the sizable portion of the outflow of Harriman Reservoir that passes through the Harriman Power Plant of the New England Power Company was not sampled during the above sampling year. Consequently, personnel of the Vermont Department of Water Resources made arrangements with the Company for the collection of a series of twice-monthly grab samples of the flows through the plant. This sampling was begun in January and was completed in April, 1974 (the results are included in Appendix C, but the mean outlet total phosphorus concentration is the same, and the mean outlet total nitrogen concentration is essentially the same, whether the results of the power plant sampling are included or not; consequently, the mean nutrient concentrations obtained during the year of sampling were used in loading calculations).

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the New

England District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

Except for the North Branch of the Deerfield River, nutrient loads for sampled tributaries were calculated using mean annual concentrations and mean annual flows. Nutrient loadings for the North Branch and the unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated by using the mean of the nutrient loads, in lbs/mi^2/year, at stations 22, 31, and 41 and multiplying the means by the North Branch and ZZ areas in mi^2.

As noted before, the Harriman area is a highly popular winter recreation area; and on winter week-ends, as well as during the weeks of Christmas and Washington's birthday (50 days total), 8,000 or more winter sports-enthusiasts crowd the area. The additional nutrient loads to municipal and private wastewater treatment systems or direct discharges from these influxes of visitors were not measured by Survey sampling, since both the wastewater treatment plant samples and the tributary samples were routinely collected once a month <u>on week days</u> (as was done at the other water bodies studied during 1972-73).

Because of the unmeasured seasonal loads, the non-representative waste treatment plant and North Branch tributary sampling, and the direct discharges in Dover Township, point-source nutrient loads to Harriman Reservoir had to be estimated. Also, because of hydraulic overloads, the treatment plant loads were calculated at 3.5 lbs P and 9.4 lbs N/capita/yr, as were the direct discharge loads.

The following table shows the estimates of permanent and seasonal contributing populations provided by personnel of the Vermont Department of Water Resources.

ESTIMATES OF CONTRIBUTING POPULATIONS,
HARRIMAN RESERVOIR DRAINAGE*

PERMANENT RESIDENTS	NUMBER SERVED
West Dover waste treatment system	100
Wilmington waste treatment system	700
Estimated number of persons discharging directly in Dover Township	150
Estimated number of persons using septic tanks	1,360

ADDITIONAL WINTER RESIDENTS (50 days)	NUMBER SERVED	FULL-YEAR EQUIV.
West Dover waste treatment system	200	27
Wilmington waste treatment system	250	34
Estimated number of persons discharging directly in Dover Township	2,000	274
Estimated number of persons using septic tanks	6,750	925

The operators of the Wilmington and West Dover (North Branch Fire District #1) wastewater treatment plants provided once-a-month effluent samples and corresponding flow data; and, though not used in estimating loadings, the results are included in Appendix C.

* McLean, 1974.

A. Waste Sources:

1. Known municipal -

Name	Pop. Served*	Treatment	Mean Flow (mgd)	Receiving Water
Wilmington	700	Clarigester	0.058	North Branch, Deerfield River
West Dover	100	trickling filter	0.016	North Branch, Deerfield River

2. Known industrial - None

* Estimated permanent population.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	lbs P/ yr	% of total
a. Tributaries (non-point load) -		
Deerfield River	4,430	25.8
N. Br., Deerfield River	4,220	24.6
Binney Brook	200	1.2
Sadawaga Lake outlet	420	2.4
b. Minor tributaries & immediate drainage (non-point load) -	2,500	14.6
c. Known municipal -		
Wilmington	2,570	15.0
West Dover	1,930	11.2
d. Septic tanks* -	570	3.3
e. Known industrial - None	-	-
f. Direct precipitation** -	340	1.9
Total	17,180	100.0

2. Outputs -

Lake outlet - Deerfield River 14,210

3. Net annual P accumulation - 2,970 pounds

* Estimated 2,285 (equivalent) residents on septic tanks in drainage; see Working Paper No. 1.

** Estimated; see Working Paper No. 1.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	lbs N/ yr	% of total
a. Tributaries (non-point load) -		
Deerfield River	420,310	50.9
N. Br., Deerfield River	204,960	24.8
Binney Brook	11,300	1.4
Sadawaga Lake outlet	13,350	1.6
b. Minor tributaries & immediate drainage (non-point load) -	121,590	14.7
c. Known municipal STP's -		
Wilmington	6,900	0.8
West Dover	5,180	0.6
d. Septic tanks* -	21,480	2.6
e. Known industrial - None	-	-
f. Direct precipitation** -	21,040	2.6
Total	826,110	100.0

2. Outputs -

Lake outlet - Deerfield River 686,800

3. Net annual N accumulation - 139,310 pounds

* Estimated 2,285 (equivalent) residents on septic tanks in drainage; see Working Paper No. 1.
** Estimated; see Working Paper No. 1.

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

Tributary	lbs P/mi^2/yr	lbs N/mi^2/yr
Deerfield River	45	4,293
Binney Brook	56	3,139
Sadawaga Lake outlet	150	4,768

E. Yearly Loading Rates:

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

	Total Phosphorus		Total Nitrogen	
Units	Total	Accumulated	Total	Accumulated
lbs/acre/yr	7.9	1.4	378.3	63.8
grams/m^2/yr	0.88	0.15	42.4	7.1

Vollenweider loading rates for phosphorus (g/m^2/yr) based on mean depth and mean hydraulic retention time of Harriman Reservoir:

"Dangerous" (eutrophic rate)	1.32
"Permissible" (oligotrophic rate)	0.66

F. Controllability of Nutrients:

1. Point sources--During the sampling year, Harriman Reservoir received a total phosphorus load at a rate of 7.9 lbs/acre/yr or 0.88 g/m^2/yr (a mesotrophic rate). Of this load, it is estimated that the communities of Wilmington and West Dover contributed about 26%.

At this time, the waste treatment facilities of West Dover are being converted to a spray-irrigation system with no discharge to the North Branch of the Deerfield River, and the waste treatment facilities of Wilmington are being studied by the Vermont Agency of Environmental Conservation (Morse, 1974).

It is calculated that the removal of the West Dover phosphorus load will reduce the loading rate from the existing 7.9 lbs/acre/yr (0.88 g/m^2/yr) to 7.0 lbs/acre/yr (0.78 g/m^2/yr) and thus provide some protection of the mesotrophic condition of Harriman Reservoir.

When the West Dover irrigation system becomes operational, it appears there will not be an immediate need for phosphorus removal at Wilmington. However, it is likely that removal facilities eventually will be needed to protect Harriman Reservoir because of the near-certain expansion of recreational facilities and increased recreational uses in the drainage.

With existing nutrient loadings, it is calculated that the provision of 80% phosphorus removal at Wilmington would reduce the loading rate to 0.68 g/m^2/yr, or very near an oligotrophic rate.

2. Non-point sources--The mean annual phosphorus exports of the Deerfield River and Binney Brook compare favorably with the exports of unimpacted Vermont streams studied elsewhere in which the mean P-export was 52 lbs/mi^2/yr and the range was from 30 to 65 lbs/mi^2/yr. The much higher export of the Sadawaga Lake outlet is probably due to discharges from private disposal systems in the unincorporated community of Whitingham.

The favorable drainage area/lake area ratio of 55/1 diminishes the possible impact of non-point sources which may not be amenable to control.

VI. LITERATURE REVIEWED

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McLean, Wallace M., 1974. Personal communication (estimates of numbers of winter visitors; per-capita nutrient contributions). VT Dept. Water Resources, Montpelier.

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VII. APPENDICES

APPENDIX A

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR VERMONT 7/9/74

LAKE CODE 5005 HARRIMAN RESERVOIR

TOTAL DRAINAGE AREA OF LAKE 188.00

TRIBUTARY	SUB-DRAINAGE AREA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
		NORMALIZED FLOWS												
500521	33.20	70.40	55.10	129.00	284.00	136.00	51.80	22.90	18.30	34.90	45.80	92.30	82.30	85.15
500522	97.70	207.00	162.00	379.00	834.00	400.00	152.00	67.40	53.70	103.00	135.00	272.00	242.00	250.34
500523	50.40	107.00	83.70	196.00	430.00	206.00	78.60	34.80	27.70	52.90	69.60	140.00	125.00	129.14
500524	188.00	399.00	312.00	729.00	1610.00	769.00	293.00	130.00	103.00	197.00	259.00	523.00	466.00	482.00
500531	3.63	7.70	6.00	14.10	31.00	14.80	5.70	2.50	2.00	3.80	5.00	10.10	9.00	9.30
500541	2.84	6.00	4.70	11.00	24.30	11.60	4.40	2.00	1.60	3.00	3.90	7.90	7.00	7.28

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 188.00 TOTAL FLOW IN = 5780.26
SUM OF SUB-DRAINAGE AREAS = 187.77 TOTAL FLOW OUT = 5790.00

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
500521	7	72	44.00						
	8	72	19.80						
	9	72	22.40						
	10	72	59.10						
	11	72	181.00						
	12	72	184.00						
	1	73	139.00						
	2	73	97.00						
	3	73	215.00						
	4	73	196.00						
	5	73	143.00						
	6	73	60.10						
	7	73	44.40						
500522	7	72	129.00	15	139.00				
	8	72	58.00	12	81.00				
	9	72	66.10	8	53.30				
	10	72	174.00	16	164.00				
	11	72	533.00	4	378.00				
	12	72	540.00	12	482.00				
	1	73	408.00	10	204.00				
	2	73	285.00	1	216.00				
	3	73	633.00	2	151.00				
	4	73	575.00	23	404.00				
	5	73	420.00	4	241.00	14	234.00		
	6	73	176.00						
	7	73	131.00	24	86.50				

LAKE CODE 5005 HARRIMAN RESERVOIR

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
500523	7	72	66.80	15	71.60				
	8	72	29.90	12	41.80				
	9	72	34.00	8	27.50				
	10	72	89.80	16	84.70				
	11	72	274.00	4	195.00				
	12	72	279.00	7	877.00				
	1	73	211.00	10	105.00				
	2	73	147.00	1	111.00				
	3	73	327.00	2	78.10				
	4	73	296.00	23	209.00				
	5	73	216.00	4	124.00	14	121.00		
	6	73	91.20						
	7	73	67.50	24	43.70				
500524	7	72	250.00	15	267.00				
	8	72	111.00	12	156.00				
	9	72	126.00	8	103.00				
	10	72	334.00	16	316.00				
	11	72	1030.00	14	635.00				
	12	72	1040.00	12	927.00				
	1	73	786.00	10	393.00				
	2	73	549.00	1	415.00				
	3	73	1220.00	2	291.00				
	4	73	1109.00	6	887.00	23	778.00		
	5	73	807.00	4	464.00	14	451.00		
	6	73	340.00						
	7	73	252.00	24	163.00				
500531	7	72	4.80	15	5.20				
	8	72	2.20	12	3.00				
	9	72	2.40	8	2.00				
	10	72	6.40	16	6.10				
	11	72	19.80	14	12.30				
	12	72	20.10	12	17.90				
	1	73	15.20	10	7.60				
	2	73	10.60	1	8.00				
	3	73	23.50	2	5.60				
	4	73	21.40	6	17.10	23	15.00		
	5	73	15.50	4	9.00	14	8.70		
	6	73	6.60						
	7	73	4.80	24	3.20				
500541	7	72	3.80	15	4.00				
	8	72	1.70	12	2.40				
	9	72	1.90	10	1.60				
	10	72	5.00	16	4.80				
	11	72	15.50	14	9.60				
	12	72	15.60	12	14.00				
	1	73	11.80	10	5.90				
	2	73	8.30	1	6.30				
	3	73	18.40	2	4.40				
	4	73	16.70	6	13.40	23	11.80		
	5	73	12.20	4	7.00	14	6.80		
	6	73	5.10						
	7	73	3.90	24	2.50				

APPENDIX B

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/07/02

500501
42 48 00.0 072 54 24.0
HARRIMAN RESERVOIR
50 VERMONT

11EPALES 2111202
3 0052 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/05/30	11 15	0000	16.4	9.4	108	20	5.50	10K	0.270	0.050		0.010
	11 15	0015	8.3	10.6		20	5.30	10K	0.380	0.090	0.006	0.004
	11 15	0050	5.0	11.0		20	5.20	10K	0.380	0.070	0.011	0.009
72/07/31	11 35	0000				50K	6.70	10K	0.170	0.070	0.011	0.009
	11 35	0004	22.9	8.0		50K	6.50	10K	0.160	0.060	0.010	0.007
	11 35	0015	22.0	8.2		50K	6.20	10K	0.180	0.070	0.008	0.008
	11 35	0030	16.4	6.4		50K	5.90	10K	0.190	0.080	0.008	0.008
	11 35	0050	14.3	9.0		50K	5.80	10K	0.180	0.090	0.008	0.008
	11 35	0085	6.7	9.4		50K	5.80	10K	0.370	0.090	0.008	0.007
	11 35	0110	5.2	9.6		50K	5.70	10K	0.410	0.090	0.010	0.010
	11 35	0135	4.7	9.4		50K	5.60	10K	0.430	0.090	0.012	0.006
72/10/04	18 30	0000			120	50K	6.80	10K	0.110	0.200	0.006	0.003
	18 30	0004	16.8	8.1		50K	6.85	10K	0.170	0.100	0.005	0.004
	18 30	0015	16.4	6.8		50K	6.40	10K	0.160	0.070	0.006	0.008
	18 30	0030	16.0	5.6		50K	6.20	10K	0.160	0.080	0.006	0.004
	18 30	0060	15.0	4.2		50K	6.00	10K	0.170	0.120	0.009	0.004
	18 30	0080	11.6	3.6		50K	5.65	10K	0.180	0.100	0.008	0.005
	18 30	0100	5.7	7.6		50K	6.00	10K	0.290	0.050	0.006	0.008
	18 30	0115	5.3	7.4		50K	5.70	10K	0.380	0.010	0.010	0.006
	18 30	0135	5.0	6.9		50K	5.65	10K	0.430	0.050	0.012	0.007

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/05/30	11 15	0000	0.7J
72/07/31	11 35	0000	2.6J
72/10/04	18 30	0000	1.9J

K* VALUE KNOWN TO BE LESS THAN INDICATED

J* VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/07/02

500502
42 51 42.0 072 53 48.0
HARRIMAN RESERVOIR
50 VERMONT

11EPALES 2111202
3 0009 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/05/30	12 10	0000	19.5	8.8	108	30	5.90	10K	0.190	0.030	0.010	0.008
	12 10	0005	16.4	9.2		20	5.60	10K	0.170	0.030	0.009	0.005
72/07/31	11 10	0000			108	50K	6.30	10K	0.170	0.070	0.015	0.013
	11 10	0004	22.1	8.4		50K	6.30	10K	0.170	0.070	0.010	0.010
	11 10	0013	21.5	9.4		50K	6.30	10K	0.160	0.060	0.017	0.010
72/10/04	16 10	0000				50K	6.50	10K	0.160	0.070	0.010	0.007
	16 10	0004	16.5	7.6		50K	6.70	10K	0.160	0.060	0.010	0.006
	16 10	0010	16.5	7.8		50K	6.70	10K	0.150	0.060	0.008	0.006

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/05/30	12 10	0000	1.3J
72/07/31	11 10	0000	1.8J
72/10/04	16 10	0000	2.3J

K* VALUE KNOWN TO BE LESS THAN INDICATED

J* VALUE KNOWN TO BE IN ERROR

APPENDIX C

TRIBUTARY and WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 74/07/02

500521 LS500521
42 52 00.0 072 52 30.0
DEERFIELD RIVER (N BR)
50 15/WILMINGTON
I/HARRIMAN RES
RT 9 BRDG IN WILMINGTON
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/07/15			0.192	0.300	0.023	0.009	0.014
72/08/12	13 30		0.320	0.600	0.030	0.010	0.023
72/09/08	13 00		0.150	1.350	0.078	0.007	0.010
72/10/16	11 20		0.230	1.100	0.176	0.005K	0.015
72/11/14	10 50		0.330	0.300	0.048	0.005K	0.012
72/12/12	10 50		0.340	0.100K	0.024	0.005K	0.010
73/03/02	10 05		0.450	1.760	0.870	0.009	0.025
73/04/06	10 30		0.294	1.100	0.480	0.005K	0.010
73/04/23			0.252	1.050	0.430	0.005K	0.010
73/05/04	09 30		0.170	0.210	0.014	0.005K	0.010
73/05/14	09 40		0.180	0.690	0.250	0.005K	0.005K
73/07/24	16 20		0.190	0.180	0.024	0.005K	0.015

K VALUE KNOWN TO BE LESS
THAN INDICATED

STORET RETRIEVAL DATE 74/07/02

500522 LS500522
42 52 00.0 072 56 00.0
DEERFIELD RIVER
50 15/WILMINGTON
I/HARRIMAN RES
MEDBURYVILLE POWER PLANT
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/07/15			0.121	1.125	0.026	0.009	0.009
72/08/12	14 15		0.140	0.310	0.023	0.008	0.008
72/09/08	13 30		0.120	1.050	0.060	0.007	0.008
72/10/16	12 30		0.076	1.500	0.100	0.005K	0.010
72/12/12	10 15		0.350	0.150	0.020	0.005K	0.006
73/04/23			0.410	0.520	0.210	0.005K	0.005K
73/05/04	10 30		0.220	0.190	0.030	0.005K	0.005K
73/05/14			0.120	1.000	0.054	0.005K	0.015
73/07/24	16 25		0.066	0.210	0.022	0.005K	0.015

K VALUE KNOWN TO BE LESS
THAN INDICATED

STORET RETRIEVAL DATE 74/07/02

500523 LS500523
42 52 00.0 072 52 40.0
DEERFIELD RIVER (N BR)
50 15/WILMINGTON
I/HARRIMAN RES
TRANSFORMER BELO DAM AT WILMINGTON
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/07/15			0.192	0.575	0.022	0.012	0.024
72/08/12	13 55		0.312	0.500	0.038	0.011	0.029
72/09/08	13 05		0.140	0.900	0.058	0.008	0.018
72/10/16	12 35		0.071	0.750	0.120	0.005K	0.019
73/04/23			0.250	0.680	0.025	0.005K	0.015
73/05/04	09 50		0.176	0.340	0.018	0.005K	0.015
73/05/14	09 53		0.176	1.100	0.031	0.005K	0.010
73/07/24	15 50		0.025	0.150	0.023	0.005K	0.015

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 74/07/02

500524 LS500524
42 46 30.0 072 56 30.0
DEERFIELD RIVER
50 15/WILMINGTON
O/HARRIMAN RES
RT 100 BRDG IN READSBORO
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/07/15			0.042	0.350	0.026	0.009	0.016
72/08/12	12 30		0.063	0.475	0.055	0.008	0.023
72/09/08	12 37		0.032	0.300	0.046	0.007	0.025
72/10/16	10 00		0.054	1.750	0.150	0.005K	0.013
72/11/14	11 10		0.073	0.440	0.041	0.005K	0.009
72/12/12	11 50		0.096	1.200	0.042	0.005K	0.023
73/01/10	09 55		0.160	0.380	0.048	0.013	0.015
73/02/01	09 20		0.330	0.880			0.006
73/03/02	09 20		0.336	0.290	0.105	0.006	0.015
73/04/06	09 30		0.090	1.150	0.336	0.005K	0.010
73/04/23			0.039	0.580	0.015	0.005K	0.015
73/05/04	08 30		0.036	0.480	0.090	0.005K	0.030
73/05/14	09 00		0.030	0.320	0.071	0.005K	0.005K
73/07/24	16 35		0.066	0.192	0.035	0.005K	0.010

K VALUE KNOWN TO BE LESS
THAN INDICATED

STORET RETRIEVAL DATE 74/08/05

[illegible]
42 52 00.0 072 56 00.0
DEERFIELD RIVER
50 15 WILMINGTON
D/HARRIMAN RESERVOIR
HARRIMAN POWER PLANT 1 M SE OF READSBORO
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/01/21	10 20		0.460	0.100K	0.044	0.005K	0.010
74/02/04	11 16		0.528	0.150	0.044	0.005K	0.012
74/02/19	12 00		0.368	0.300	0.025	0.005K	0.015
74/03/04	[illegible]		0.350	0.200	0.025	0.005K	0.040
74/03/18	10 [illegible]		0.384	0.300	0.045	0.005K	0.020
74/04/09	[illegible]		0.364	0.500	0.020		0.005K
74/04/15	[illegible]		0.350	0.400	0.050	0.005K	0.005K

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 74/07/02

500531 LS500531
42 52 00.0 072 53 00.0
BINNEY BROOK
50 15/WILMINGTON
T/HARRIMAN RES
RT 9 BRDG W OF WILMINGTON
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/08/12	14 00		0.140	1.012	0.026	0.011	0.027
72/09/08	13 10		0.100	0.200	0.040	0.007	0.007
72/10/16	12 25		0.068	0.200	0.075	0.005K	0.010
72/11/14	09 50		0.183	0.320	0.052	0.005K	0.017
72/12/12	10 18		0.189	0.160	0.035	0.005K	0.009
73/01/10	11 30		0.200	0.400	0.008	0.005K	0.010
73/02/01	11 40		0.220	1.050	0.730	0.005K	0.005K
73/03/02	10 55		0.220	0.205	0.063	0.005K	0.010
73/04/06	10 55		0.198	0.160	0.050	0.005K	0.005K
73/04/23			0.170	0.755	0.027	0.005K	0.005K
73/05/04	10 10		0.130	1.130	0.042	0.005K	0.020
73/05/14	10 05		0.120	0.240	0.044	0.005K	0.005K
73/07/24	16 30		0.063	0.190	0.040	0.005K	0.015

K VALUE KNOWN TO BE LESS
THAN INDICATED

STORET RETRIEVAL DATE 74/07/02

500541 LS500541
42 47 30.0 072 53 00.0
SADAWAGA LAKE OUTFLOW
50 15/WILMINGTON
T/HARRIMAN RES
RT 8 BRDG W OF WHITINGHAM
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/07/15			0.102	0.625	0.034	0.027	0.044
72/08/12	12 12		0.340	1.667	0.050	0.044	0.071
72/09/08	12 30					0.005K	
72/10/16	11 00		0.094	0.550	0.088	0.021	0.040
72/11/14	10 50		0.109	2.310	0.074	0.009	0.024
72/12/12	11 20		0.126	0.360	0.075	0.007	0.023
73/02/01	09 45		0.168	1.005	0.590	0.006	0.006
73/04/06	10 00		0.097	0.310	0.050	0.007	0.015
73/04/23			0.032	1.100	0.048	0.007	0.022
73/05/04	08 50		0.026	0.230	0.013	0.005K	0.020
73/05/14	09 20		0.018	0.420	0.022	0.007	0.025
73/07/24	16 00		0.210	0.320	0.045	0.021	0.035

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 74/07/02

5005S1 PR5005S1 P000700
42 51 30.0 072 52 30.0
WILMINGTON
50007 15 WILMINGTON
T/HARRIMAN RESERVOIR
N DEERFIELD RIVER
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
72/12/06	11 00								
CP(T)-			0.460	14.000	2.900	2.140	3.400	0.058	0.053
72/12/06	16 00								
73/01/15	11 00								
CP(T)-			0.375	24.000	7.825	3.625		0.090	0.075
73/01/15	16 00								
73/02/23	11 00								
CP(T)-			0.330	15.000	5.700	2.700	4.500	0.046	0.050
73/02/23	16 00								
73/04/30	11 00								
CP(T)-			0.395	17.200	5.500	2.300	4.800	0.077	0.075
73/04/30	16 00								
73/07/16	11 00								
CP(T)-			0.400	16.800	5.700	2.200	4.300	0.075	0.070
73/07/16	16 00								
73/08/16	11 00								
CP(T)-			0.140	22.600	9.070	3.460	5.800	0.045	0.050
73/08/16	16 00								
73/09/16	11 00								
CP(T)-			0.290	23.900	7.225	3.300	5.250	0.052	0.049
73/09/16	16 00								
73/10/22	11 00								
CP(T)-			0.115	40.000	15.000	6.050	14.000	0.047	0.047
73/10/22	16 00								
73/11/19	11 00								
CP(T)-			0.330	18.500	7.800	3.570	4.800	0.037	0.043
73/11/19	16 00								
73/12/19	11 00								
CP(T)-			0.600	23.000	5.500	2.600	4.800	0.081	0.073
73/12/19	16 00								
74/01/15	11 00								
CP(T)-			0.600	16.000	7.750	2.240	3.900	0.054	0.052
74/01/15	16 00								
74/02/25	11 00								
CP(T)-			0.480	11.000	4.300	1.750	3.200	0.058	0.056
74/02/25	16 00								

STORET RETRIEVAL DATE 74/07/02

500557 TF500557 P000300
42 56 30.0 072 51 00.0
DOVER
50 15 WILMINGTON
T/HARRIMAN RESERVOIR
NORTH BRANCH DEERFIELD RIVER
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
72/11/20	08 15		1.370	2.730	0.073	1.160	2.000	0.001	0.001
72/12/25	10 00		0.660	36.000	12.000	6.300	8.700	0.025	0.024
73/02/01	10 15		0.200	45.000	20.000	12.000	13.500	0.030	0.030
73/03/17	09 00		0.200	24.000	6.300	3.990	5.500	0.030	0.030
73/04/12	16 00		1.700	9.800	0.600	3.500	6.500	0.010	0.012
73/05/15	16 00		0.355	27.000	4.350	4.200	15.700	0.002	0.002
73/06/21	09 15		0.168	13.800	2.520	4.940	7.600	0.005	0.017
73/07/18	11 30		3.400	16.800	4.400	7.700	8.700	0.010	0.020
73/08/21	09 30		1.840	19.800	3.720	7.200		0.025	0.020
73/09/20	09 30		5.900	5.000	0.194		5.800	0.010	0.020
73/10/22	14 00		4.100	5.500	0.180	10.250	12.000	0.010	0.020
73/11/26	10 00		5.000	0.450	0.040K	2.560	2.900	0.002	0.005
73/12/25	11 00		1.600	3.700	0.083	3.200	3.850	0.025	0.010

K VALUE KNOWN TO BE LESS
THAN INDICATED