U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

REPORT

ON

LAKE CHESDIN

AMELIA, CHESTERFIELD, AND DINWIDDIE

COUNTIES

VIRGINIA

EPA REGION III

WORKING PAPER No. 458

PACIFIC NORTHWEST ENVIRONMENTAL RESEARCH LABORATORY

An Associate Laboratory of the

NATIONAL ENVIRONMENTAL RESEARCH CENTER - CORVALLIS, OREGON

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REPORT
ON
LAKE CHESDIN
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WITH THE COOPERATION OF THE

VIRGINIA STATE WATER CONTROL BOARD

AND THE

VIRGINIA NATIONAL GUARD

JUNE, 1975

823

CONTENTS

F O R E W O R D

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the 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 Virginia State Water Control Board for professional involvement and to the Virginia National Guard for conducting the tributary sampling phase of the Survey.

Eugene T. Jensen, Executive Secretary of the State Water Control Board; Michael A. Bellanca, Director; Jean W. Gregory, Pollution Control Specialist; and Robert W. Pitchford, Pollution Control Technician; Bureau of Surveillance and Field Studies; 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.

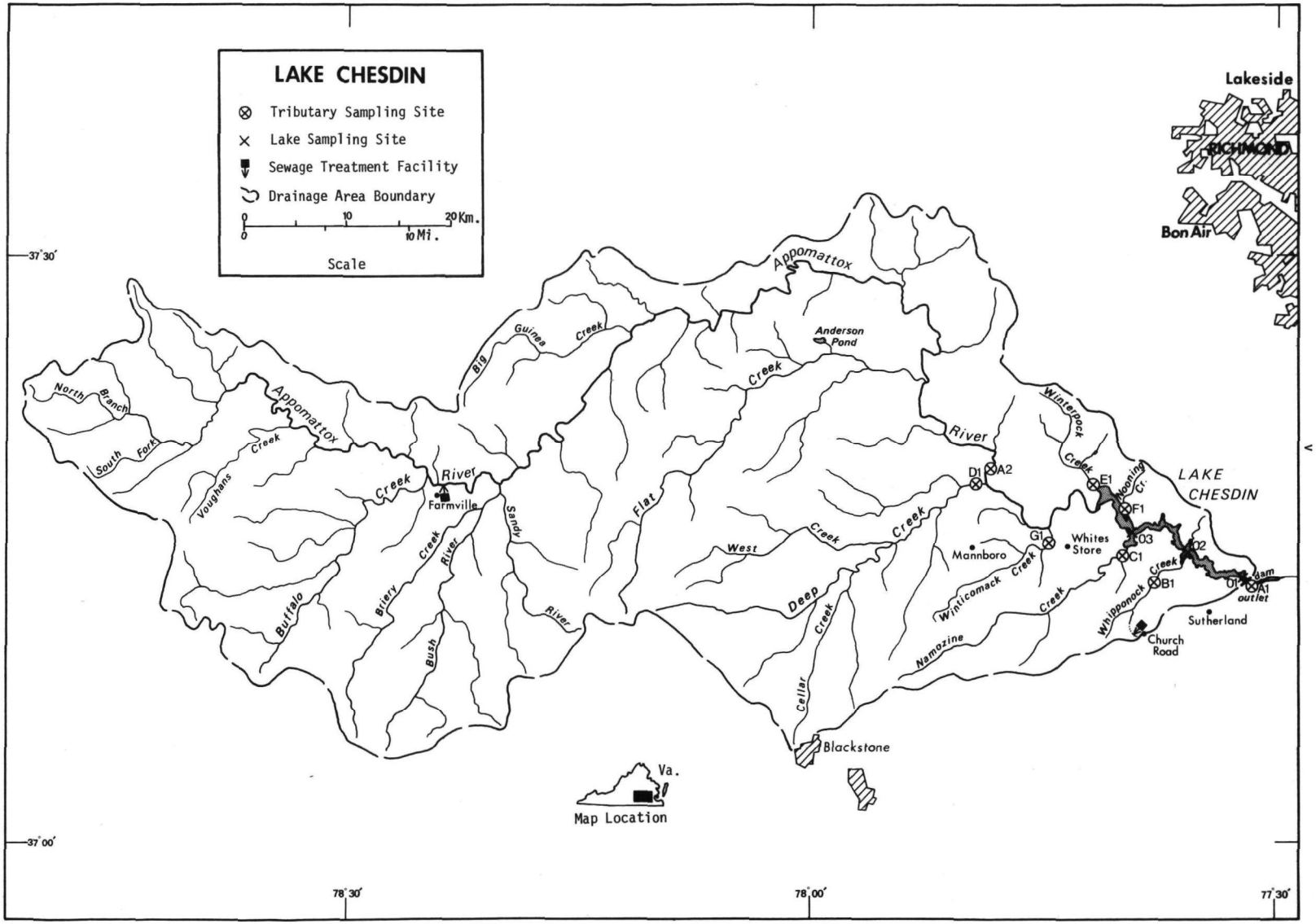
Major General William J. McCaddin, the Adjutant General of Virginia, and Project Officer Lt. Colonel James D. Manley, who directed the volunteer efforts of the Virginia National Guardsmen, also are gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF VIRGINIA

LAKE NAME	COUNTY
Bluestone	Giles, VA; Mercer, Monroe, Summers, WV
Chesdin	Amelia, Chesterfield, Dinwiddie
Chickahominy	Charles City, New Kent
Claytor	Pulaski
J. H. Kerr	Charlotte, Hallifax, Micklenburg, VA; Granville, Vance, Warren, NC
J. W. Flannagan	Dickenson
Occoquan	Fairfax, Prince William
Rivanna	Albemarle
Smith Mountain	Bedford, Franklin, Pittsylvania


LAKE CHESDIN
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
Drainage Area Boundary
0 10 20 Km.
0 10 Mi.
Scale
Lakeside
RICHMOND
Bon Air
37°30'
37°00'
78°30'
78°00'
77°30'
Appomattox
Anderson Pond
Guinea Creek
Big Creek
North Branch
South Fork
Appomattox River
Vaughans Creek
Farmville
Buffalo Creek
Briery River
Bush River
Sandy Flat Creek
West Creek
Deep Creek
Cellar Creek
Blackstone
Winterpock Creek
Mooning Cr.
LAKE CHESDIN
Dam
outlet
Whites Store
Mannboro
Winticomack Creek
Namozine Creek
Whipponock Creek
Church Road
Sutherland
D1
A2
E1
F1
G1
C1
03
02
B1
01
A1
Va.
Map Location

LAKE CHESDIN

STORET NO. 5111

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Lake Chesdin as eutrophic. It ranked fifth in overall trophic quality when the eight Virginia lakes sampled in 1973 were compared using a combination of six parameters*. Three lakes had less and one had the same median total phosphorus, two had less and one had the same median dissolved phosphorus, one had less median inorganic nitrogen, six had less mean chlorophyll a, and seven had greater mean Secchi disc transparency.

Survey limnologists reported algal scums in small coves and submerged and emergent vegetation along the shore near stations 1 and 2 in September.

B. Rate-Limiting Nutrient:

The algal assay results indicate that Lake Chesdin was phosphorus limited when the sample was collected (04/07/73). The lake data indicate phosphorus limitation at the other sampling times as well, except for station 3 in September.

C. Nutrient Controllability:

1. Point sources--The phosphorus contribution of known point sources amounted to 14.9% of the total input to Lake Chesdin during

* See Appendix A.

the sampling year. Contributing point sources included the wastewater treatment facilities of Farmville #1 (12.3%), Farmville #2 (2.3%), and the Correctional Field Unit #27 (0.3%).

The present phosphorus loading of 3.89 $g/m^2/yr$ is more than twice that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 13). However, Vollenweider's model probably does not apply to water bodies with short hydraulic retention times, and the mean retention time of Lake Chesdin is a relatively short 31 days.

While even complete removal of phosphorus at the listed point sources would only reduce the overall loading to 3.31 $g/m^2/yr$, in view of the questionable applicability of the model, and because Lake Chesdin primarily is phosphorus limited, all phosphorus inputs should be minimized to the greatest practicable extent to slow the present rate of eutrophication.

2. Non-point sources--Non-point sources accounted for about 85% of the total phosphorus input to Lake Chesdin during the sampling year. After point-source loads were subtracted, the Appomattox River contributed 64.5%, and Whipponock Creek contributed 0.4% of the total. Other gaged tributaries were Deep Creek which contributed 10.2%; Namozine Creek, 3.2%; and Winterpock Creek, 1.2% of the total load. Ungaged tributaries were estimated to have contributed 5.1% of the total phosphorus input.

The phosphorus export of the Appomattox River alone was large enough to produce an overall loading of 2.51 $g/m^2/yr$; i.e., well

above a eutrophic loading. However, the phosphorus export rate of the river was not much higher than the export rates of the other Lake Chesdin tributaries (see page 12), but the relatively large drainage-area to lake-area ratio of 188 to 1 would ensure a significant non-point phosphorus load to the lake even if the export rate could be reduced by one-third.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Lake Morphometry††:

1. Surface area: 12.95 kilometers^2.
2. Mean depth: 7.0 meters.
3. Maximum depth: >14.0 meters.
4. Volume: 90.650 x 10^6 m^3.
5. Mean hydraulic retention time: 31 days.

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

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Appomattox River	2,439.8	24.1
Whipponock Creek	26.4	0.2
Namozine Creek	151.8	1.5
Deep Creek	530.9	5.3
Winterpock Creek	53.9	0.5
Minor tributaries & immediate drainage -	241.8	2.5
Totals	3,444.6	34.1

2. Outlet -

Appomattox River	3,457.6**	34.1

C. Precipitation***:

1. Year of sampling: 103.6 centimeters.
2. Mean annual: 108.9 centimeters.

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† Table of metric conversions--Appendix B.
†† Bellanca, 1975.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of lake.
*** See Working Paper No. 175.

III. LAKE WATER QUALITY SUMMARY

Lake Chesdin 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 three stations on the lake and from one or more depths at each station (see map, page v). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first visit, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 12.8 meters at station 1, 13.1 meters at station 2, and 1.2 meters at station 3.

The sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR LAKE CHESDIN
STORET CODE 5111

PARAMETER	1ST SAMPLING (4/ 7/73) 3 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (7/13/73) 3 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (9/26/73) 3 SITES RANGE	MEAN	MEDIAN
TEMP (C)	13.6 - 14.9	14.2	14.1	18.8 - 29.4	26.3	27.2	21.2 - 24.4	23.0	23.3
DISS OXY (MG/L)	8.2 - 9.5	8.8	8.8	0.2 - 7.6	3.6	2.8	0.2 - 8.4	4.1	3.8
CNDCTVY (MCROMO)	70. - 80.	73.	71.	85. - 114.	92.	88.	82. - 170.	93.	85.
PH (STAND UNITS)	7.2 - 7.5	7.4	7.5	6.8 - 7.8	7.2	7.3	6.5 - 7.3	6.7	6.7
TOT ALK (MG/L)	26. - 28.	27.	27.	33. - 56.	42.	42.	29. - 53.	35.	35.
TOT P (MG/L)	0.042 - 0.052	0.048	0.048	0.022 - 0.087	0.041	0.035	0.026 - 0.092	0.047	0.040
ORTHO P (MG/L)	0.007 - 0.011	0.008	0.007	0.005 - 0.016	0.008	0.007	0.008 - 0.024	0.012	0.011
NO2+NO3 (MG/L)	0.140 - 0.180	0.157	0.160	0.060 - 0.160	0.094	0.085	0.030 - 0.090	0.051	0.050
AMMONIA (MG/L)	0.060 - 0.090	0.078	0.080	0.070 - 1.500	0.322	0.140	0.060 - 2.590	0.419	0.240
KJEL N (MG/L)	0.300 - 0.600	0.418	0.400	0.500 - 1.900	0.870	0.650	0.500 - 3.300	0.991	0.800
INORG N (MG/L)	0.200 - 0.260	0.235	0.240	0.130 - 1.580	0.416	0.245	0.110 - 2.650	0.470	0.270
TOTAL N (MG/L)	0.470 - 0.760	0.575	0.560	0.560 - 1.980	0.964	0.795	0.550 - 3.360	1.042	0.850
CHLRPYL A (UG/L)	3.0 - 5.6	4.7	5.6	9.4 - 25.0	14.9	10.2	3.4 - 30.1	18.1	20.7
SECCHI (METERS)	0.5 - 0.6	0.5	0.5	0.8 - 1.8	1.2	1.0	0.3 - 1.5	0.9	0.9

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
04/07/73	1. Flagellates	291
	2. Dinobryon sp.	230
	3. Stephanodiscus sp.	182
	4. Pennate diatoms	109
	5. Asterionella sp.	73
	Other genera	255
	Total	1,140
07/13/73	1. Melosira sp.	4,630
	2. Anabaena sp.	694
	3. Cyclotella sp.	537
	4. Flagellates	442
	5. Ankistrodesmus sp.	189
	Other genera	673
	Total	7,165
09/26/73	1. Anabaena sp.	284
	2. Melosira sp.	213
	3. Cyclotella sp.	142
	4. Flagellates	124
	5. Pennate diatoms	71
	Other genera	197
	Total	1,031

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
04/07/73	01	3.0
	02	5.6
	03	5.6
07/13/73	01	9.4
	02	10.2
	03	25.0
09/26/73	01	3.4
	02	30.1
	03	20.7

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	0.150	2.8
0.050 P	0.060	0.150	5.7
0.050 P + 1.0 N	0.060	1.150	12.2
1.0 N	0.010	1.150	3.5

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Lake Chesdin was moderately high at the time the sample was collected (04/07/73). A significant increase in yield resulted from the addition of only phosphorus, indicating that the lake was limited by phosphorus at that time. Note that no such increase occurred when only nitrogen was added.

The lake data substantiate these findings. The mean inorganic nitrogen/orthophosphorus ratios were 23/1 or greater at all stations and sampling times, with the exception of station 3 in September when the N/P ratio was about 9/1 (nitrogen limitation would be expected).

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Virginia National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v). Sampling was begun in July, 1973, and was completed in May, 1974.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Virginia District Office of the U.S. Geological Survey for the tributary sites nearest the lake except for Nooning and Winticomack Creeks (stations F-1 and G-1). The drainage areas and flows of these tributaries are included in "minor tributaries and immediate drainage". Monthly samples were taken at these stations, and the data are included in Appendix E for the record.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loads shown are those measured minus point-source loads, if any.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the means of the nutrient loads, in $kg/km^2/year$, at stations C-1, D-1, and E-1 and multiplying the means by the ZZ area in km^2.

The operator of the Farmville #1 wastewater treatment plant provided monthly effluent samples and corresponding flow data. The operators of the Correctional Field Unit #27 and Farmville #2 wastewater treatment

* See Working Paper No. 175.

plants did not participate in the Survey, and nutrient loads were estimated at 1.134 kg P and 3.401 kg N/capita/year.

A. Waste Sources:

1. Known municipal† -

Name	Pop. Served	Treatment	Mean Flow (m^3/d)	Receiving Water
Farmville #1	3,780	stab. pond	2,074.4	Appomattox River
#2*	1,000	stab. pond	378.5**	Appomattox River
Correctional Field Unit #27	125	stab. pond	47.3**	Whipponock Creek

2. Known industrial - None

† Gregory, 1973.
* Anonymous, 1971.
** Estimated at 0.3785 m^3/capita/day.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Appomattox River	32,510	64.5
Whipponock Creek	225	0.4
Namozine Creek	1,630	3.2
Deep Creek	5,120	10.2
Winterpock Creek	610	1.2
b. Minor tributaries & immediate drainage (non-point load) -	2,585	5.1
c. Known municipal STP's -		
Farmville #1	6,205	12.3
#2	1,135	2.3
Correctional Field Unit #27	140	0.3
d. Septic tanks* -	<5	<0.1
e. Known industrial - None	-	-
f. Direct precipitation** -	225	0.5
Total	50,385	100.0

2. Outputs -

Lake outlet - Appomattox River 47,240

3. Net annual P accumulation - 3,145 kg.

* Estimate based on six lakeshore dwellings; see Working Paper No. 175.
** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
Appomattox River	426,805	68.9
Whipponock Creek	6,950	1.1
Namozine Creek	26,215	4.2
Deep Creek	78,170	12.6
Winterpock Creek	10,515	1.7
b. Minor tributaries & immediate drainage (non-point load) -	41,515	6.7
c. Known municipal STP's -		
Farmville #1	11,190	1.8
#2	3,400	0.6
Correctional Field Unit #27	425	0.1
d. Septic tanks* -	65	<0.1
e. Known industrial - None	-	-
f. Direct precipitation** -	13,980	2.3
Total	619,230	100.0

2. Outputs -

Lake outlet - Appomattox River 888,095

3. Net annual N loss - 268,865 kg.

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

Tributary	kg P/km^2/yr	kg N/km^2/yr
Appomattox River	13	175
Whipponock Creek	9	263
Namozine Creek	11	173
Deep Creek	10	147
Winterpock Creek	11	195

* Estimate based on six lakeshore dwellings; see Working Paper No. 175.
** See Working Paper No. 175.

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 Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	3.89	0.24	47.8	loss*

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Lake Chesdin:	
"Dangerous" (eutrophic loading)	1.74
"Permissible" (oligotrophic loading)	0.87

* There was an apparent loss of nitrogen during the sampling year. This may have been due to nitrogen fixation in the lake, solubilization of previously sedimented nitrogen, recharge with nitrogen-rich ground water, or unknown and unsampled point sources discharging directly to the lake. Whatever the cause, a similar nitrogen loss has occurred at Shagawa Lake, Minnesota, which has been intensively studied by EPA's former National Eutrophication and Lake Restoration Branch (Malueg et al., 1975).

V. LITERATURE REVIEWED

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VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
5103	CLAYTOR LAKE	0.031	0.450	439.500	5.642	14.900	0.008
5105	JOHN W. FLANNAGAN DAM	0.011	0.320	415.700	5.955	14.800	0.004
5106	JOHN H. KERR RESERVOIR	0.044	0.290	458.937	8.833	15.000	0.009
5108	OCCOQUAN RESERVOIR	0.098	0.525	459.750	12.417	15.000	0.037
5110	SMITH MOUNTAIN LAKE	0.016	0.410	419.667	11.593	15.000	0.005
5111	LAKE CHESDIN	0.044	0.240	465.778	12.556	14.800	0.008
5112	CHICKAHOMINY LAKE	0.066	0.125	455.333	13.600	9.400	0.017
5113	RIVANNA (SOUTH FORK) RES	0.079	0.475	460.222	6.667	13.000	0.022

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
5103	CLAYTOR LAKE	71 (5)	29 (2)	71 (5)	100 (7)	43 (3)	64 (4)	378
5105	JOHN W. FLANNAGAN DAM	100 (7)	57 (4)	100 (7)	86 (6)	64 (4)	100 (7)	507
5106	JOHN H. KERR RESERVOIR	43 (3)	71 (5)	43 (3)	57 (4)	14 (0)	43 (3)	271
5108	OCCOQUAN RESERVOIR	0 (0)	0 (0)	29 (2)	29 (2)	14 (0)	0 (0)	72
5110	SMITH MOUNTAIN LAKE	86 (6)	43 (3)	86 (6)	43 (3)	14 (0)	86 (6)	358
5111	LAKE CHESDIN	57 (4)	86 (6)	0 (0)	14 (1)	64 (4)	64 (4)	285
5112	CHICKAHOMINY LAKE	29 (2)	100 (7)	57 (4)	0 (0)	100 (7)	29 (2)	315
5113	RIVANNA (SOUTH FORK) RES	14 (1)	14 (1)	14 (1)	71 (5)	86 (6)	14 (1)	213

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	5105	JOHN W. FLANNAGAN DAM	507
2	5103	CLAYTOR LAKE	378
3	5110	SMITH MOUNTAIN LAKE	358
4	5112	CHICKAHOMINY LAKE	315
5	5111	LAKE CHESDIN	285
6	5106	JOHN H. KERR RESERVOIR	271
7	5113	RIVANNA (SOUTH FORK) RES	213
8	5108	OCCOQUAN RESERVOIR	72

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR VIRGINIA 02/05/76

LAKE CODE 5111 LAKE CHESDIN

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 3457.6

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
5111A1	3457.6	47.57	59.47	59.47	49.55	33.98	21.24	18.97	24.35	18.69	18.12	24.07	35.11	34.07
5111A2	2439.8	33.70	41.91	42.48	34.55	23.79	15.29	13.88	17.56	13.59	12.46	16.42	24.35	24.06
5111B1	26.4	0.28	0.40	0.57	0.37	0.31	0.17	0.07	0.08	0.10	0.16	0.16	0.37	0.25
5111C1	151.8	1.98	2.66	2.55	2.18	1.47	0.85	0.68	0.88	0.71	0.85	1.30	1.70	1.48
5111D1	530.9	7.65	9.63	8.78	7.93	5.10	3.11	2.78	3.68	2.83	2.83	4.25	5.38	5.30
5111E1	53.9	0.62	0.82	0.99	0.74	0.54	0.31	0.19	0.22	0.23	0.31	0.40	0.68	0.50
5111ZZ	255.9	3.40	4.53	4.25	3.68	2.38	1.42	1.22	1.59	1.25	1.36	2.12	2.66	2.47

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 3457.6
SUM OF SUB-DRAINAGE AREAS = 3458.7
TOTAL FLOW IN = 410.63
TOTAL FLOW OUT = 410.59

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
5111A1	7	73	24.07	14	18.69				
	8	73	28.32	12	12.74				
	9	73	16.42	8	15.01				
	10	73	17.27	13	13.88				
	11	73	13.03	10	11.61	11	24.49		
	12	73	76.46	8	20.67				
	1	74	73.62	12	62.30	13	48.14		
	2	74	53.80	9	76.46				
	3	74	45.31	23	92.03				
	4	74	43.04	20	24.64				
	5	74	41.06	5	30.30				
5111A2	7	73	16.14	14	12.46				
	8	73	18.69	12	8.21				
	9	73	9.63	8	9.06				
	10	73	11.04	13	8.78				
	11	73	9.49	10	11.04	11	10.28		
	12	73	52.39	8	20.95				
	1	74	50.97	12	43.89	13	37.94		
	2	74	41.63	9	57.48				
	3	74	36.81	23	96.28				
	4	74	29.73	20	23.22				
	5	74	31.15	5	25.77				

TRIBUTARY FLOW INFORMATION FOR VIRGINIA 02/05/76

LAKE CODE 5111 LAKE CHESDIN

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
5111B1	7	73	0.08	14	0.06				
	8	73	0.06	12	0.03				
	9	73	0.06	8	0.03				
	10	73	0.04	13	0.03				
	11	73	0.15	10	0.13	11	0.15		
	12	73	0.37	8	0.08				
	1	74	0.42	12	0.40	13	0.28		
	2	74	0.28	9	0.45				
	3	74	0.22	23	0.45				
	4	74	0.23	20	0.14				
	5	74	0.18	5	0.16				
5111C1	7	73	0.65	14	0.48				
	8	73	0.59	11	0.25				
	9	73	0.40	8	0.34				
	10	73	0.34	13	0.25				
	11	73	0.74	10	0.65	11	0.74		
	12	73	0.25	8	0.57				
	1	74	2.72	12	2.41	13	1.78		
	2	74	2.01	9	2.92				
	3	74	1.59	23	3.45				
	4	74	1.47	20	0.93				
	5	74	1.25	5	1.08				
5111D1	7	73	2.72	14	2.07				
	8	73	2.83	12	1.13				
	9	73	1.73	8	1.53				
	10	73	1.59	13	1.25				
	11	73	2.10	10	1.76	11	1.61		
	12	73	10.11	8	2.41				
	1	74	10.34	12	8.01	13	5.95		
	2	74	7.79	9	10.25				
	3	74	7.36	23	18.69				
	4	74	5.66	20	3.17				
	5	74	3.68	5	3.40				
5111E1	7	73	0.20	14	0.14				
	8	73	0.17	12	0.06				
	9	73	0.11	8	0.08				
	10	73	0.09	13	0.07				
	11	73	0.28	10	0.25	11	0.28		
	12	73	0.82	8	0.18				
	1	74	0.93	12	0.82	13	0.62		
	2	74	0.65	9	0.96				
	3	74	0.48	23	1.05				
	4	74	0.48	20	0.31				
	5	74	0.40	5	0.34				

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/02/05

511101
37 13 15.0 077 31 34.0
LAKE CHESDIN
51041 VIRGINIA

11EPALES
3

2111202
0037 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/04/07	15 45	0000	14.9		24	75	7.50	26	0.080	0.600	0.160	0.009
	15 45	0006	14.9	8.7		71	7.50	26	0.080	0.400	0.160	0.008
	15 45	0015	14.6	8.7		71	7.50	28	0.080	0.400	0.160	0.007
	15 45	0022	14.4	8.5		72	7.50	27	0.080	0.400	0.160	0.007
	15 45	0033	13.9	8.2		70	7.50	26	0.090	0.400	0.160	0.008
73/07/13	16 15	0000	29.4		72	87	7.50	44	0.130	1.200	0.090	0.005
	16 15	0006	29.3	6.7		86	7.50	42	0.110	0.600	0.090	0.005
	16 15	0015	26.5	0.2		85	6.80	42	0.240	0.600	0.130	0.008
	16 15	0028	23.0	0.2		88	6.80	45	0.400	0.900	0.070	0.015
	16 15	0042	18.8	0.8		114	6.90	56	1.500	1.900	0.080	0.016
73/09/26	14 10	0000	23.5	3.8	60	84	6.70	35	0.260	0.800	0.040	0.010
	14 10	0015	23.4	2.6		85	6.70	36	0.250	0.600	0.030	0.009
	14 10	0020	23.3	2.8		85	6.70	35	0.240	0.700	0.030	0.009
	14 10	0025	23.0	0.8		90	6.60	37	0.340	0.900	0.040	0.008
	14 10	0035	22.4	2.4		88	6.60	38	0.280	0.800	0.060	0.008
	14 10	0042	21.2	0.2		170	6.50	53	2.590	3.300	0.060	0.011

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/04/07	15 45	0000	0.049	3.0
	15 45	0006	0.046	
	15 45	0015	0.042	
	15 45	0022	0.043	
	15 45	0033	0.046	
73/07/13	16 15	0000	0.025	9.4
	16 15	0006	0.022	
	16 15	0015	0.035	
	16 15	0028	0.031	
	16 15	0042	0.087	
73/09/26	14 10	0000	0.028	3.4
	14 10	0015	0.026	
	14 10	0020	0.026	
	14 10	0025	0.033	
	14 10	0035	0.040	
	14 10	0042	0.077	

STORET RETRIEVAL DATE 76/02/05

511102
37 14 47.0 077 35 23.0
LAKE CHESDIN
51041 VIRGINIA

11EPALES 2111202
3 0024 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/04/07	16 15	0000	14.1		18	70	7.40	28	0.080	0.500	0.140	0.008
	16 15	0006	14.2	9.3		70	7.50	28	0.070	0.400	0.150	0.011
	16 15	0015	13.9	8.9		70	7.50	27	0.060	0.400	0.140	0.007
	16 15	0024	13.9	9.0		70	7.50	28	0.090	0.400	0.150	0.007
73/07/13	15 30	0000	29.3		40	87	7.80	33	0.070	0.600	0.060	0.005
	15 30	0006	28.4	7.3		85	7.40	34	0.070	0.500	0.060	0.005
	15 30	0012	27.2	4.7		88	7.20	42	0.150	0.500	0.120	0.007
	15 30	0020	25.2	1.0		93	6.80	48	0.450	0.700	0.160	0.007
	15 30	0024	23.9			109						
73/09/26	13 45	0000	24.4	8.4	34	82	7.30	29	0.090	0.800	0.050	0.015
	13 45	0010	24.1	7.8		82	6.90	29	0.060	0.800	0.050	0.013
	13 45	0015	22.9	4.2		86	6.70	30	0.170	0.500	0.050	0.011
	13 45	0043	21.4	5.2		84	6.50	35	0.180	0.500	0.090	0.014

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/04/07	16 15	0000	0.051	5.6
	16 15	0006	0.052	
	16 15	0015	0.048	
	16 15	0024	0.051	
73/07/13	15 30	0000	0.031	10.2
	15 30	0006	0.035	
	15 30	0012	0.036	
	15 30	0020	0.052	
73/09/26	13 45	0000	0.037	30.1
	13 45	0010	0.041	
	13 45	0015	0.045	
	13 45	0043	0.069	

STORET RETRIEVAL DATE 76/02/05

511103
37 15 55.0 077 39 05.0
LAKE CHESDIN
51053 VIRGINIA

11EPALES 2111202
3 0008 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/04/07	15 50	0000	13.7		18	80	7.20	27	0.080	0.400	0.180	0.007
	15 50	0004	13.6	9.5		80	7.30	27	0.070	0.300	0.170	0.007
73/07/13	15 15	0000	27.9	7.6	30	89	7.50	38	0.100	1.200	0.080	0.008
73/09/26	13 30	0000	23.5	7.2	12	84	6.80	30	0.150	1.200	0.060	0.024

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/04/07	15 50	0000	0.052	5.6
	15 50	0004	0.047	
73/07/13	15 15	0000	0.058	25.0
73/09/26	13 30	0000	0.092	20.7

APPENDIX E

TRIBUTARY and WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 75/03/26

5111A1
37 13 12.0 077 31 30.0
APPOMATTOX RIVER
51019 7.5 SUTHERLAND
O/LAKE CHESDIN
AT DAM 2.5 MI NE OF SUTHERLAND
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
73/07/14	09 40		0.075	1.800	0.520	0.028	0.055
73/08/12	14 00		0.031	0.980	0.440	0.022	0.065
73/09/08	11 15		0.056	1.000	0.490	0.014	0.045
73/10/13	11 15		0.069	0.550	0.190	0.012	0.035
73/11/11	09 57		0.070	0.450	0.199	0.007	0.055
73/12/08	10 20		0.056	0.300	0.048	0.008	0.050
74/01/12	10 40		0.168	0.400	0.032	0.020	0.060
74/02/09	12 20		0.148	0.500	0.040	0.015	0.035
74/03/23	09 00		0.120	1.300	0.040	0.010	0.045
74/04/20	11 25		0.080	0.600	0.050	0.015	0.020
74/05/05	17 00		0.024	0.200	0.050	0.010	0.020

STORET RETRIEVAL DATE 75/03/26

511142
37 19 04.0 077 48 30.0
APPOMATTOX RIVER
51 7.5 MANNBORO
I/LAKE CHESDIN
RT 602 BEVILLS BRDG 1.2 MI E JCT RT 612
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
73/07/14	12 20		0.260	0.320	0.036	0.016	0.050
73/08/12	15 40		0.154	0.590	0.270	0.017	0.035
73/09/08	14 00		0.210	0.210	0.100	0.021	0.080
73/10/13	14 00		0.138	0.650	0.220	0.016	0.035
73/11/11	11 27		0.048	0.150	0.032	0.018	0.045
73/12/08	11 55		0.160	0.200	0.005K	0.016	0.090
74/01/12	10 20		0.216	0.300	0.020	0.024	0.065
74/02/09	13 20		0.184	0.800	0.045	0.020	0.070
74/03/23	11 40		0.044	1.000	0.040	0.020	0.060
74/04/20	12 25		0.112	0.200	0.020	0.010	0.010
74/05/05	18 00		0.168	0.200	0.020	0.010	0.040

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/03/26

5111B1
37 13 13.0 077 37 35.0
WHIPPENOCK CREEK
51 7.5 CHURCH RD
T/LAKE CHESDIN
RT 708 BRDG 4 MI NW OF SUTHERLAND
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
73/07/14	14 00		0.294	1.200	0.046	0.030	0.060
73/08/12	16 30		0.190	2.940	0.110	0.036	0.065
73/09/08	15 20		0.154	0.170	0.080	0.031	0.095
73/10/13	14 45		0.090	0.550	0.063	0.027	0.055
73/11/11	13 32		0.044	0.350	0.025	0.023	0.060
73/12/08	12 50		0.064	0.300	0.012	0.020	0.055
74/01/12	10 10		0.124	0.300	0.024	0.012	0.030
74/02/09	14 35		0.160	1.000	0.115	0.010	0.015
74/03/23	11 45		0.080	0.400	0.025	0.010	0.025
74/04/20	13 15		0.056	0.600	0.020	0.020	0.020
74/05/05	19 30		0.108	0.600	0.080	0.025	0.055

STORET RETRIEVAL DATE 75/03/26

5111C1
37 14 37.0 077 39 44.0
NAMOZINE CREEK
51 7.5 CHURCH RD
T/LAKE CHESDIN
RT 708 BRDG 3.5 MI ESE OF WHITES STORE
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
73/07/14	13 45		0.060	0.720	0.023	0.018	0.065
73/08/11	16 20		0.010K	0.900	0.022	0.009	0.055
73/09/08	15 10		0.010K	0.100K	0.039	0.008	0.035
73/10/13	14 35		0.017	0.700	0.120	0.010	0.035
73/11/11	13 58		0.010K	0.650	0.018	0.018	0.040
73/12/08	12 45		0.012	0.100	0.008	0.008	0.035
74/01/12	13 20		0.052	0.400	0.020	0.012	0.035
74/02/09	14 20		0.040	0.300	0.020	0.010	0.015
74/03/23	11 30		0.020	1.000	0.035	0.010	0.025
74/04/20	13 05		0.012	0.400	0.015	0.010	0.030
74/05/05	19 10		0.028	0.400	0.035	0.020	0.035

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/03/26

511101
37 18 16.0 077 49 14.0
DEEP CREEK
51 7.5 MANNBORO
T/LAKE CHESUIN
RT 612 BRDG 4 MI N OF MANNBORO
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
73/07/14	12 30		0.168	0.520	0.025	0.019	0.035
73/08/12	15 50		0.076	0.930	0.042	0.021	0.030
73/09/08	14 30		0.079	0.160	0.083	0.019	0.035
73/10/13	14 05		0.019	0.550	0.040	0.011	0.020
73/11/10	10 13		0.010K	0.300	0.011	0.016	0.035
73/12/08	12 05		0.010K	0.300	0.032	0.005K	0.040
74/01/12	13 50		0.056	0.300	0.012	0.016	0.040
74/02/09	13 30		0.076	0.300	0.025	0.010	0.025
74/03/23	10 45		0.044	0.650	0.020	0.015	0.045
74/04/20	12 40		0.020	0.200	0.015	0.010	0.020
74/05/05	18 10		0.044	0.200	0.025	0.015	0.020

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/03/26

5111E1
37 18 17.0 077 41 17.0
WINTERPOCK CREEK
51 7.5 WINTERPOCK
T/LAKE CHESDIN
BANK NEAR MOUTH TRAIL AT END SEC RD
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
73/07/14	11 45		0.072	2.000	0.140	0.012	0.045
73/08/12	14 45		0.015	0.560	0.026	0.012	0.050
73/09/08	13 00		0.010K	0.250	0.040	0.012	0.055
73/10/13	12 20		0.012	0.725	0.025	0.010	0.050
73/11/11	12 18		0.010K	0.500	0.029	0.024	0.080
73/12/08	11 25		0.032	0.600	0.044	0.016	0.035
74/01/12	13 35		0.036	0.300	0.020	0.008	0.015
74/03/23	10 15		0.016	0.600	0.035	0.010	0.030
74/04/20	12 15		0.020	0.300	0.015	0.010	0.025
74/05/05	17 42		0.040	0.300	0.045	0.015	0.020

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/03/26

5111F1
37 17 20.0 077 39 30.0
NOONING CREEK
51 705 WINTERPOCK
T/LAKE CHESDIN
XING 2 MI SW PA HWY 602 & 657 JCT
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
73/07/14	10 30		0.072	0.290	0.019	0.012	0.030
73/08/12	15 10		0.085	1.600	0.294	0.031	0.080
73/09/08	12 00		0.075	0.370	0.360	0.033	0.095
73/10/13	11 55		0.014	0.150	0.026	0.012	0.020
73/11/10	12 47		0.037	0.750	0.310	0.022	0.045
73/12/08	11 00		0.028	0.300	0.056	0.008	0.065
74/01/12	14 20		0.024	0.400	0.056	0.008	0.025
74/03/23	09 45		0.040	1.000	0.035	0.015	0.035
74/04/20	11 15		0.016	0.400	0.015	0.020	0.025
74/05/05	17 20		0.020	0.400	0.035	0.020	0.055

STORET RETRIEVAL DATE 75/03/26

5111G1
37 15 13.0 077 44 20.0
WINTICOMACK CREEK
51 705 WINTERPOCK
T/LAKE CHESDIN
PA HWY 622 BRDG .75 MW PA HWY 708 JCT
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
73/07/14	11 05		0.160	0.980	0.064	0.030	0.080
73/08/12	16 00		0.096	2.400	0.270	0.031	0.080
73/09/08	14 30		0.022	1.300	0.035	0.019	0.075
73/10/13	14 15		0.023	0.700	0.052	0.016	0.060
73/11/11	10 51		0.010K	0.500	0.038	0.023	0.080
73/12/08	12 15		0.012	0.500	0.024	0.012	0.055
74/01/12	14 00		0.020	0.500	0.016	0.012	0.035
74/02/09	14 00		0.040	0.600	0.025	0.010	0.015
74/03/23	11 00		0.016	1.000	0.050	0.010	0.030
74/04/20	12 50		0.012	0.400	0.020	0.017	0.030
74/05/05	18 50		0.032	0.500	0.055	0.025	0.055

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/03/25

51111AA PD51111AA P003780
37 18 18.0 078 23 05.0
TOWN OF FARMVILLE
51019 7.5 FARMVILLE
T/LAKE CHESDIN
APPOMATTOX 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
73/11/29	14 00		0.090	24.000	6.050	8.700	11.000	0.555	0.540
73/12/28	14 00		0.320	15.500	3.500	4.900	5.750	0.540	0.500
74/01/24	15 30		0.280		3.400	6.200		0.597	0.500
74/02/20	14 00		0.320	14.000	4.500	5.900	7.700	0.720	0.600
74/03/22	09 30		0.200	13.000	4.500	6.600	8.800	0.565	0.600
74/04/12	10 30		0.200	6.700	2.800	5.400	7.800	0.575	0.500