A STUDY OF WATER QUALITY ON THE J. PERCY PRIEST RESERVOIR

MILDRED ELIZABETH BATEMAN PERRY

A STUDY OF WATER QUALITY ON THE J. PERCY PRIEST RESERVOIR

An Abstract

Presented to

the Committee on Graduate Studies

Austin Peay State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

in Biology

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by

Mildred Elizabeth Bateman Perry

August 1, 1969

ABSTRACT

Biophysical criteria including temperature, dissolved oxygen, pH, available chlorine, Secchi disc turbidity, biological oxygen demand (BOD), and hardness on the J. Percy Priest Reservoir are documented and evaluated.

The study began October 13, 1968 and extended to June 18, 1969. Throughout the investigation the lake was sampled monthly with the exceptions of December 1968 and February 1969 when inclement weather prevented field work.

The reservoir was found to meet minimum permissible criteria as established by the National Technical Advisory Committee in 1968 and the Tennessee Stream Pollution Control Board, 1967 with respect to data collected within the bounds of this investigation.

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To the Graduate Committee:

I am submitting herewith a thesis written by Mildred Elizabeth Bateman Perry entitled "A Study of Water Quality on the J. Percy Priest Reservoir." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science in Biology.

Haskell C. Phillips
Major Professor

We have read this thesis and recommend its acceptance:

Charles L. Boehms
Minor Professor

Durward S. Harris

Accepted for the Committee:

Wayne C. Stamper
Dean of Graduate School

ACKNOWLEDGEMENTS

I wish to gratefully acknowledge the assistance and continual encouragement of my major professor, Dr. Haskell Phillips. Further acknowledgement is extended to Mr. Charles N. Boehms for the reading of this manuscript and assistance throughout this investigation. The constructive criticism and contributions of Dr. Durward S. Harris are greatly appreciated.

I wish to express my sincere gratitude to James Clement Burdick III of the Sanitary Engineering Department of Vanderbilt University, who provided me with technical assistance and facilities throughout this study.

I wish also to thank Jerry Anderson of Vanderbilt University for his assistance in the determinations of hardness.

Appreciation is also extended to Mr. Lee C. Forrest, a graduate assistant at Austin Peay State University whose research was conducted in conjunction with mine.

I would like to thank Mr. Donald Harker for navigating the boat used, keeping field notes, and assisting in other field work. Appreciation is also extended to his wife Kay Sylvie Harker for assistance in the laboratory.

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Chapter I

INTRODUCTION

The quality of waterways has become a major concern in the United States. An approach to the study of water quality requires periodic reexamination.

Several biophysical criteria may be used in studying water quality; those used in this study are:

1. dissolved oxygen
2. temperature
3. pH
4. Secchi disc turbidity
5. available chlorine
6. biological oxygen demand
7. hardness

By using these criteria in conjunction with other studies I have described and interpreted the results of findings on the J. Percy Priest Reservoir in this study extending from October 13, 1968 through June 18, 1969.

Throughout the investigation the lake was sampled monthly with the exceptions of December 1968 and February 1969 when inclement weather prevented field work.

James Clement Burdick III, working in cooperation with the United States Army Corps of Engineers, and Lee C. Forrest of Austin Peay State University compiled separate systematic inquiries of the J. Percy Priest Reservoir, both of which were used to supplement this investigation.

This study is basic to any further research in the ecology of the J. Percy Priest Reservoir.

Chapter II

METHODS AND MATERIALS USED IN MEASURING BIOPHYSICAL CRITERIA

All data with the exceptions of biological oxygen demand and hardness were determined in the field immediately after sampling. These data include all readings for dissolved oxygen, temperature, pH, Secchi disc turbidity and available chlorine.

Surface samples were tested periodically from seventeen sites. At eleven locations bottom samples were also checked. At three locations F, J and Dam water columns were established early in the study in which samples were checked at five or ten-foot intervals for dissolved oxygen, pH and temperature. Bottom samples were brought to the surface for testing with the Matheson 65035-10 Water Sampler. Biological oxygen demand and hardness were determined in the laboratory.

In October dissolved oxygen was determined by the Azide Modification of the Iodometric Method (Standard Methods, 1966). This proved to be cumbersome in the field and readings were later taken by using the Matheson Precision Galvanic Cell Oxygen Meter No. 68850. This method is preferred by most limnologists who have a large number of samples to test.

Temperature was taken with an ordinary Centigrade thermometer in October. Subsequently, however with the adoption of the Galvanic Cell Oxygen Analyzer, the thermistor jack of this instrument was used for temperature. Readings were compared with a Centigrade thermometer at the beginning of each sampling period to assure standard values.

An orthotolidin comparator was used to determine available chlorine. Chloramines, compounds in which chlorine is loosely bonded, and residual chlorine give a positive quantitative response with orthotolidin.

The hydrogen ion concentration was determined by using the LaPine 203-92 Portable Battery Operated pH Meter.

Relative turbidity was determined with the Secchi disc (Tyler, 1968). Attempts at standardizing the Secchi disc (Tyler, 1968) have proved cumbersome. However, for the purposes of this investigation ease of use and precision desired warranted including it as standard field equipment.

Biological oxygen demand was determined by the procedures outlined in Standard Methods (1966). In May and June of 1969 the oxygen analyzer was substituted for the Azide Modification of the Iodometric Method for reading dissolved oxygen values. It was assumed that readings would be highest in summer due to less available nutrients and a lowering of metabolism in winter (Besselievre, 1952). Therefore, biological oxygen demands were determined in the spring and summer only.

The frequency for each test was established according to expected variation in values. With few exceptions dissolved oxygen, temperature, Secchi disc turbidity, and pH were determined at all stations during each sampling period. Available chlorine was determined at only a few stations during January, March and April; this was determined for all but two stations in November and June, and in October and May available chlorine was not checked.

Calcium hardness was determined by the use of Hexaver (CDTA) according to the procedure outlined by the Hach Chemical Company (1967). Hardness was checked at the Dam only in November, March and April. Samples from stations A, F, and Dam were checked in May and June.

Chapter III

DESCRIPTION OF THE STUDY AREA

At its northern shoreline J. Percy Priest Reservoir is approximately eight miles east of Nashville, Tennessee, longitude 86° 37', latitude 36° 10', and at its southern boundary it is approximately four miles north of Smyrna, Tennessee at longitude 86° 20', latitude 35° 59'.

Approximately 17,000 acres of land were acquired by the United States Army Corps of Engineers for the development of the reservoir. This included the lake area, park sites, and a minimum of 300 feet measured horizontally back from the high waterline which is under shoreline control by the United States Army Corps of Engineers. Access to the shoreline area is available, but no structures may be built in this area (Metropolitan Planning Commission, 1968). The land taken for the J. Percy Priest Reservoir development was formerly used largely for pasture or other low intensity agriculture and was only sparsely populated.

Eleven recreation areas in Metropolitan-Davidson County alone have been planned on the J. Percy Priest Project. Of these park sites, one is to be operated by the Metropolitan Government, one by the State of Tennessee, and the remaining sites, including the dam, will be operated by the Corps of Engineers.

The Planning Commission of the Metropolitan Government of Nashville and Davidson County (1968) has completed an Urban Design Study of approximately 20,000 acres surrounding the J. Percy Priest Reservoir area which was considered available for potential development. It is bounded by Interstate 40 to the north, the Wilson and Rutherford County lines to the east, Interstate 24 to the south, and Bell Road, Murfreesboro Road, and proposed Donelson Pike to the west (Metropolitan Planning Commission, 1968).

A slope analysis breaks the land into four different classifications with the largest percentage falling into the 6-15% or gentle slope category. The 0-5% group makes up the second largest area with the moderate slope group of 16-25% and the rough slope group, over 25%, being third and fourth, respectively (Metropolitan Planning Commission, 1968).

The three general categories of soil types of the study area are: (1) level to rolling, very rocky, clay soils, (2) level to rolling, deep, terrace bottom soils, and (3) rolling to hilly, deep loamy soils (Metropolitan Planning Commission, 1968).

Because reservoirs are commonly used for recreation and public water supply, all data originating with the author was taken from the reservoir and its main tributaries, the East Fork and West Fork of Stones River. This area is approximately 35 miles long when measured along the original Stones River channel. The reservoir covers 20,720 acres at full flood control elevation of 504.5 feet. During summer elevation of 490 feet it occupies 14,230 acres, and during the lowest pool elevation of 480 feet in winter the area is only 10,570 acres. The irregular shoreline encompasses many small bays, lagoons and islands. Milage on the Stones River channel measures zero where it empties into the Cumberland River approximately seven miles below the dam. The original channel meanders through the reservoir and milage measures approximately 37 at the merge of the East and West Forks of Stones River. The sequence of testing at each station establishes a longitudinal profile of the reservoir. The stations are:

A -West Fork of Stones River, 300 yards from the merge of the East and West Forks of Stones River

A'-Bottom

B -East Fork of Stones River, 300 yards from the merge of the East and West Forks of Stones River

C -Channel at mile 30 S.W. of Smyrna Road

Z -Bay at mile 33 near the mouth of Fall Creek

Z'-Bottom

D -100 ft. from Sewart Air Force Base

E -Mouth of bay at Sewart Air Force Base, 100 ft. from the river channel

F -Channel at mile 28, selected as a column

G -Channel at mile 25 near Hollandale Road

X -Bay N.W. of Sewart Air Force Base near the mouth of Hurricane Creek

Y -Channel, northeast at mile 22

Y'-Bottom

I -Channel at the fifteen mile marker near Mt. View Road; a bridge is now under construction here

I'-Bottom

J -Bay near Spring Creek at mile 14, selected as a column

K -Bay at the mouth of North and Wright Creeks

L -Channel at mile 12 near the mouth of Bay K

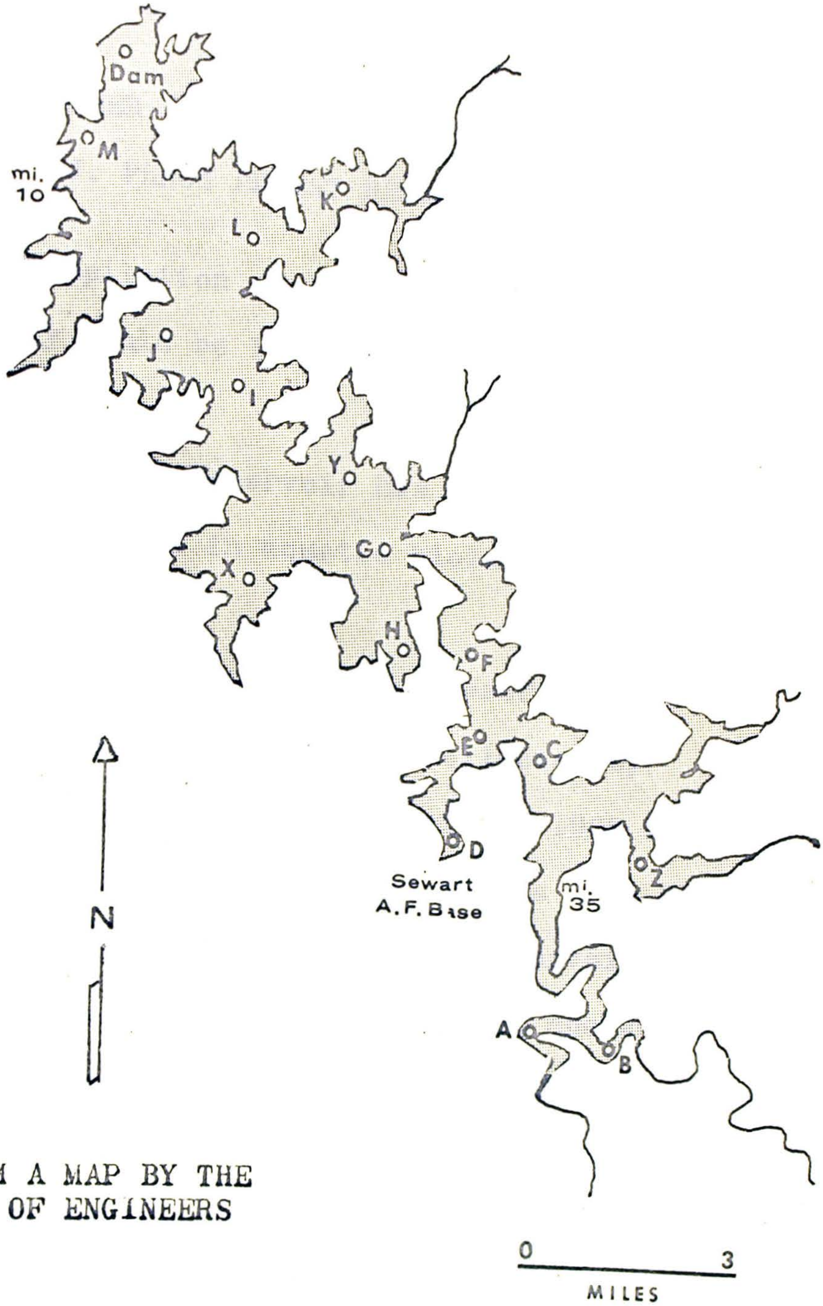
L'-Bottom

M -Small bay and recreation area 3/4 mi. S.W. of Dam

Dam -Samples were taken 400 feet south of the Dam; selected as a column

(') denotes a bottom sample throughout the manuscript when in connection with stations

These sites were selected because of their location near a proposed recreation area, because they were situated where contaminating effluents could be entering the reservoir through tributaries or because the location was such as to make it of limnological interest. Figure 1.



ADAPTED FROM A MAP BY THE
U.S. CORPS OF ENGINEERS

Figure 1. The J. Percy Priest Reservoir showing the location of sampling stations.

Chapter IV

OTHER INVESTIGATIONS ON THE J. PERCY PRIEST RESERVOIR

A complete compilation of literature pertaining to this type of study would be lengthy and largely superfluous to this study.

The J. Percy Priest Reservoir has stimulated interest among students interested in aquatic biology since its official opening in 1968.

Apparently the first study on the reservoir was temperature and dissolved oxygen data collected by J. Clement Burdick III beginning in April of 1968 at mile 9. He was employed by the United States Army Corps of Engineers to periodically examine the reservoir for certain data they needed to insure efficient operation. This was supplemented with additional physical and chemical analyses in preparation for a doctoral dissertation, still unpublished, for the Sanitary Engineering Department at Vanderbilt University.
Temperature, inflow and outflow, and elevation data have been collected daily by the United States Army Corps of Engineers since October of 1968.

In conjunction with the present study, Lee C. Forrest has conducted a bacteriological survey of the reservoir and its tributaries. Mr. Forrest, a master's degree candidate at Austin Peay State University, presently has not published these data.

Chapter V

RESULTS AND DISCUSSION

Dissolved Oxygen and Temperature

The J. Percy Priest Reservoir is a eutrophic lake as defined by Bennett (1962), in that it is almost always thermally stratified in summer and loses its supply of oxygen in the deeper water. Figures 2, 3, and 4. All three water columns F, J, and Dam exhibit summer stratification with a resulting oxygen deficient hypolimnion.

During the study extending from October of 1968 to June of 1969 turnover occurred once beginning late in September. Circulation was relatively complete until March of 1969 when some stratification was observed and surface waters were supersaturated with dissolved oxygen (Table 4). The lake remained thermally stratified throughout the remaining study period.

Dissolved oxygen and temperature data were taken most consistently. The interrelationship between these two physical properties of water is, at least, very delicate assuming minimum interference from other factors which might alter otherwise predictable values. By discovering interference with this relationship, one is able to investigate the responsible agents. These agents may be physical, chemical or biological in nature. Only through thorough examination can one determine which phenomena

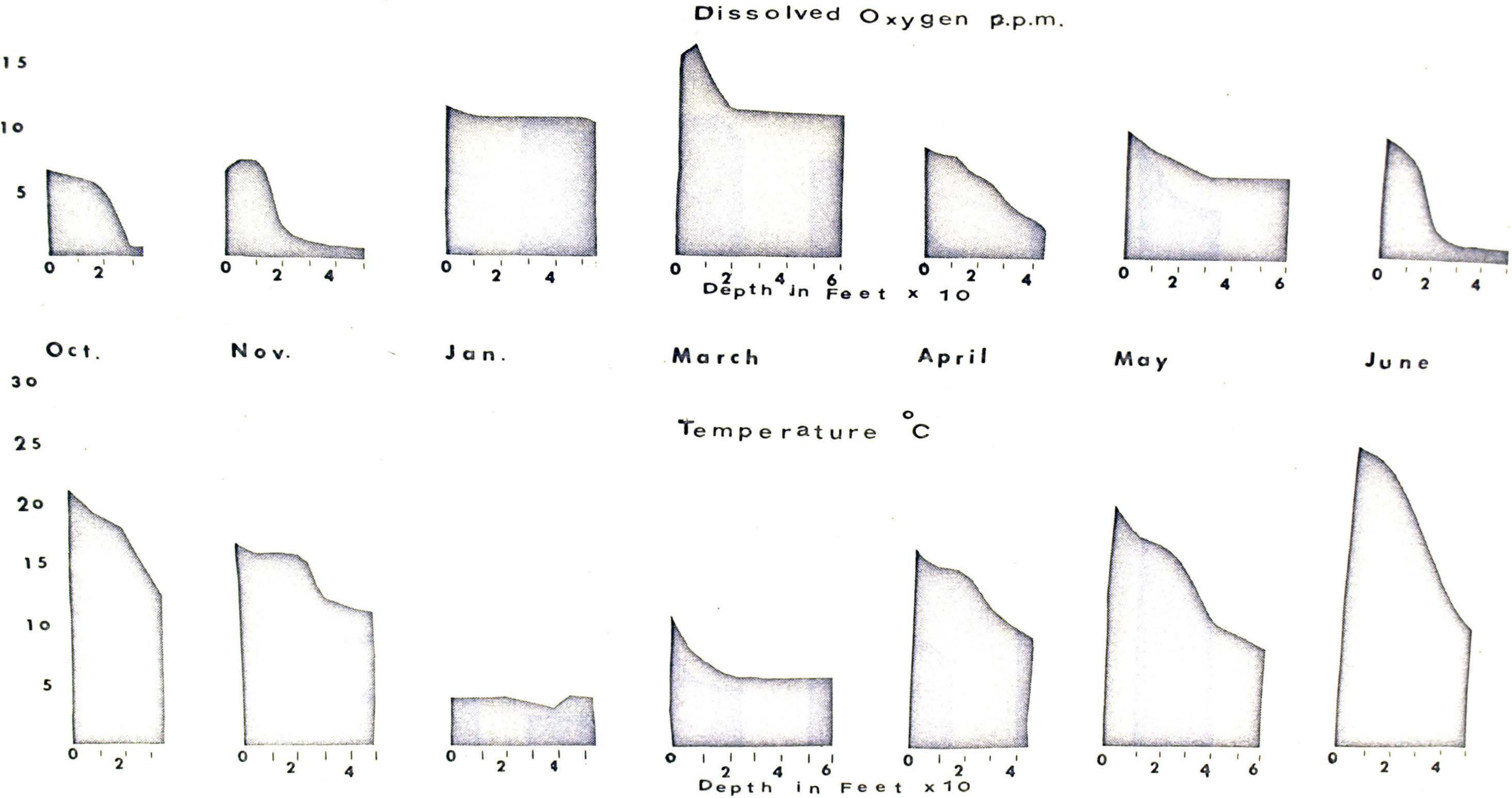


Figure 2. Monthly Profiles of Temperature and Dissolved Oxygen at Station Dam showing Inverse Seasonal Relationship Between these two Factors.

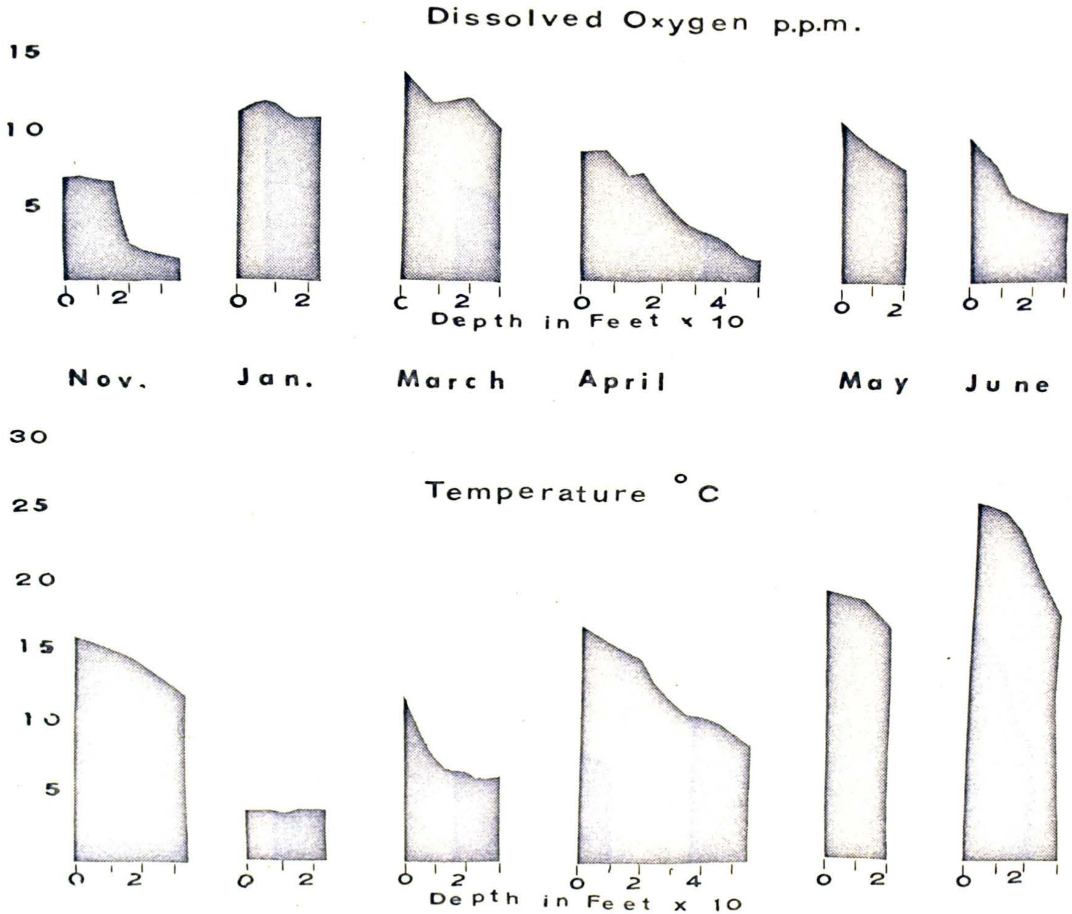


Figure 3. Monthly Profiles of Temperature and Dissolved Oxygen at Station F showing Inverse Seasonal Relationship between these factors.

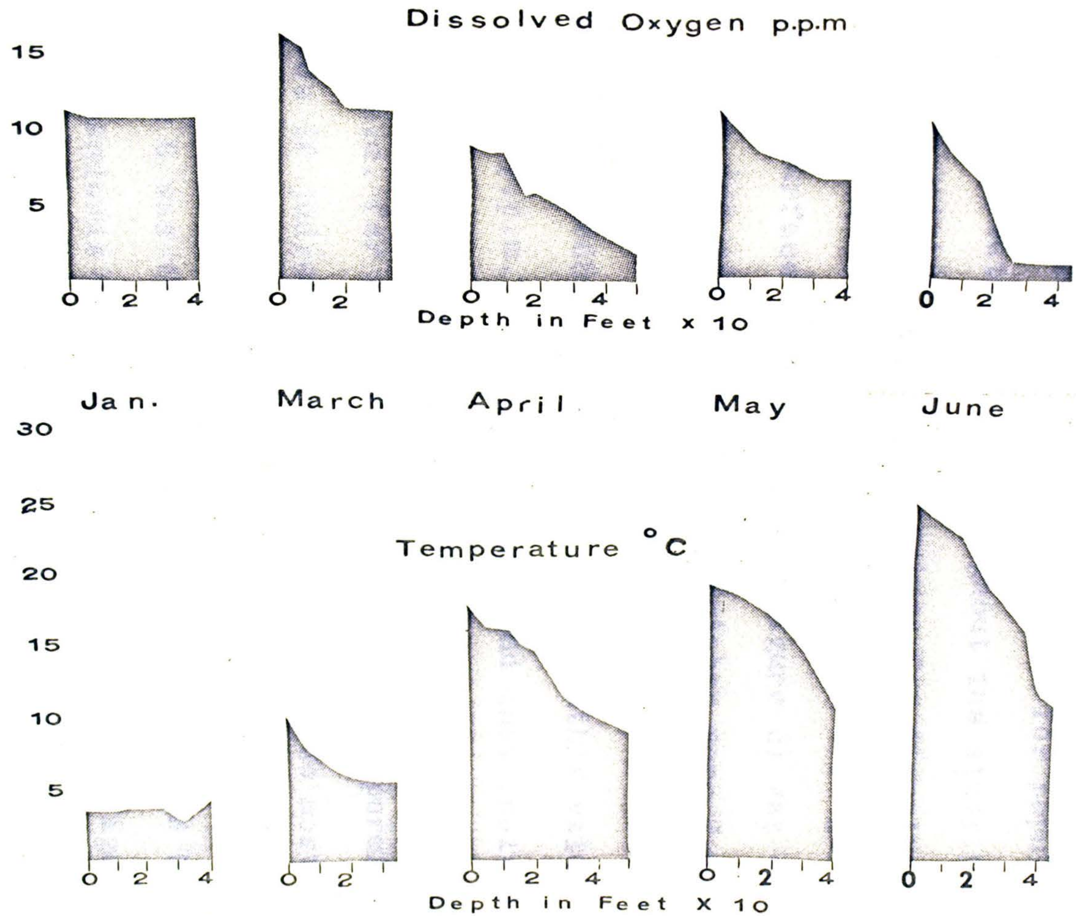


Figure 4. Monthly Profiles of Temperature and Dissolved Oxygen at Station J showing Inverse Seasonal Relationship Between these Factors

is responsible

Based on criteria established by the National Technical Advisory Committee (1968) and the Tennessee Stream Pollution Control Board (1967), J. Percy Priest Reservoir was found to contain sufficient oxygen for public water supply, for recreational and aesthetic purposes, and for populations of local fresh water fishes throughout the study period.

During October the lowest values for dissolved oxygen were obtained (Table 1). At this time an average of values taken from surface determinations (Figure 6) was 4.9 p.p.m. The maximum and minimum values in October were 7.4 p.p.m. at Station B and 2.2 p.p.m. at Station G respectively. The N.T.A.C. (1968) recommends a mean monthly value of not less than 4 p.p.m. dissolved oxygen and that individual samples should not contain less than 3 p.p.m. A mean value of 4.9 p.p.m. for October 13, 1968 is within permissible standards if judged by this criterion. Since most surface determinations were well above 3.0 p.p.m. and the 2.2 p.p.m. at Station G was the only surface value obtained below minimum standards for individual samples this figure should not be viewed as completely unsatisfactory.

Paul S. Welch, (1952) states "Dissolved oxygen at levels of 3 p.p.m. or lower should be regarded as hazardous to lethal under average stream and lake conditions; and that 5 p.p.m. or more of dissolved oxygen should be present in waters, if conditions are to be favorable for freshwater fishes." If one follows the criteria presented by Welch it is then permissible to be more critical of values obtained in October and to propose that even lower values may have existed during the previous summer months of July, August and September of 1968 before this study began. Burdick (1969) recorded surface values of 7.8 and 7.9 p.p.m. dissolved oxygen July 12 and 27, 1968, 8.0 and 7.6 p.p.m. August 8 and 23, 1968, and 7.1, 7.2, 6.5, 4.8 and 7.0 p.p.m. September 13, 18, 18 (mile 20), 18 (mile 30), and 28, 1968. All values were determined at mile 9 unless otherwise indicated. Except for values at mile 30 of September 1968, oxygen was extinguished to values below 5 p.p.m. only at depths approximating 15 feet and below during this time (Burdick, 1969).

Station G' at 16 ft. was depleted of oxygen beyond measurement, a value of zero p.p.m. in October (Table 1). One explanation for oxygen depletion in a recently impounded reservoir is the rapid decay of flooded organic materials. It was reported by Besselievre (1952) that temperatures below 50^{o}F will inhibit bacterial life and stop all action temporarily. Burdick (1969) recorded surface temperature at 8.5^{o}C in December 1968. During this investigation the average surface temperatures in March was 11.2^{o}C (52.2^{o}F). Therefore, bacterial action should have been nominal during most of the time between December 1968 and March 1969. As the water temperature began to rise in March bacterial decay of the debris and rooted vegetation on the bottom soon depleted the available oxygen in the hypolimnion in deeper portions of the reservoir. Thermal stratification prevents oxygen being replenished to the benthic zone until fall turnover occurs. Turnover was not complete in the reservoir until some time after October 13, 1968; however, oxygen was reappearing in the benthic regions by November 3, 1968 (Table 2). Evidence for lack of oxygen in October in benthic zones was indicated by a strong odor of hydrogen sulfide in bottom samples, particularily at the dam. According to Howmiller (1969) sulfides are oxidized rapidly by oxygen; therefore, concentrations of hydrogen sulfide high enough to be detected by odor should not exist in the presence of oxygen. During most of the summer and through October most degradation of bottom material occurred by anaerobic processes.

Considering minimum standards for dissolved oxygen for the maintenance and survival of freshwater fishes as stated by Welch (1952), one concludes that fishes having a high oxygen requirement tend to orient themselves according to regions satisfying this requirement, assuming the water at that level is at sufficiently low temperatures. Bennett (1962) observed that summerkills of fish occurred after periods of several days during which skies were cloudy or partly cloudy, temperatures ranged in the 80's and 90's both day and night, and winds were calm or nearly calm. Under these weather conditions, dissolved oxygen that may be abundant during the daytime may disappear entirely during calm, hot nights resulting in large kills of fishes. Fishkills have not been reported at the study area. However, with the rapid depletion of dissolved oxygen in the hypolimnion, a clinograde distribution (Hurchinson, 1957) during summer months could result in lethal conditions for less tolerant species such as the smallmouth bass. The highest temperature recorded in October was 21.5^{o}C which is within the requirements of even the least tolerant of local species of fish.

The Tennessee Stream Pollution Control Board (1967) recommends for all water uses other than fish and aquatic life, that dissolved oxygen should be present in sufficient quantities to prevent odors of decomposition and other offensive conditions. For waters reserved for fish and aquatic life the dissolved oxygen shall be maintained at 5.0 p.p.m. at a depth of 5 feet except in limited sections of the stream receiving treated effluents. In these limited sections, a minimum of 3.0 p.p.m. shall be allowed. A minimum dissolved oxygen content of 6.0 p.p.m. shall be maintained in recognized trout streams.

Secchi Disc Turbidity

Secchi Disc values for the research period are summarized in Figure 5. A Secchi Disc reading represents the depth at which five per-cent of solar radiation is transmitted (Hutchinson, 1957). Many factors can however alter values obtained with the Secchi Disc. At best, such readings give relative values for turbidity or rate of absorption of light.

Turbid waters generally carry greater numbers of bacteria than clear waters. With the settling of suspended particles bacteria are carried to the bottom of the reservoir where the lower temperatures diminish action. Secchi Disc readings during this study show a clearing or increase of transparency as readings were taken along the lake profile progressing from the East Fork of Stones River toward the Dam at the northwest boundary of the reservoir.

Hydrogen Ion Concentration

Dissolved CO_2 combines with water to form carbonic acid, and this dissociates as follows:

$$CO_2 + H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^- \rightleftharpoons H^+ + CO_3^=$$

When H_2CO_3 dissociates, it releases hydrogen ions, or more properly, hydronium ion, H_3O^+. These affect the pH, which is the negative logarithm of the hydronium ion activity. If a strong acid is added to a water sample, the combined CO_2 will be converted to the free form. The amount of acid required to accomplish this conversion is a measure of

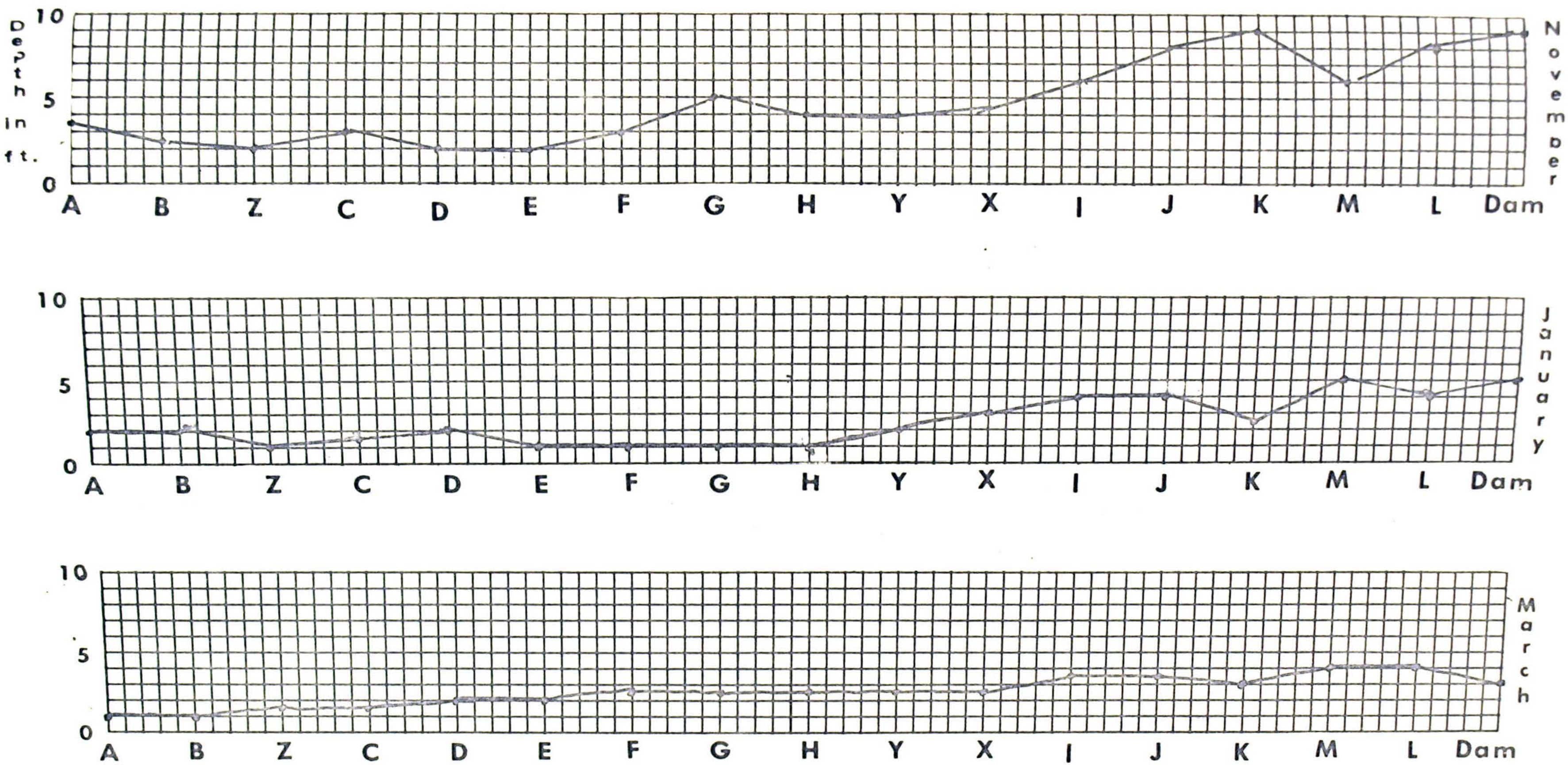


Figure 5. Profiles of the lake plotted against Secchi Disc Depth for each sampling date.

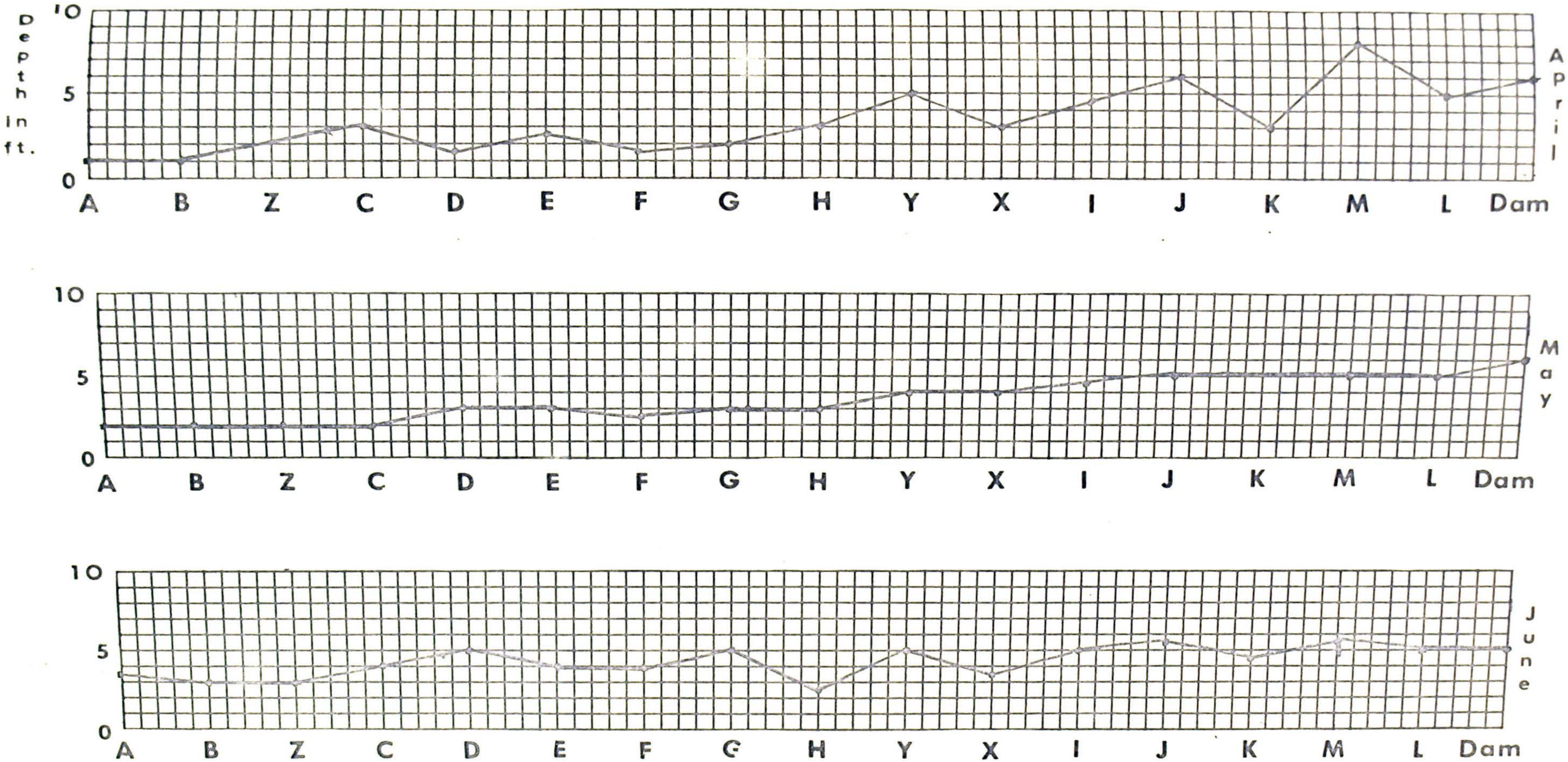
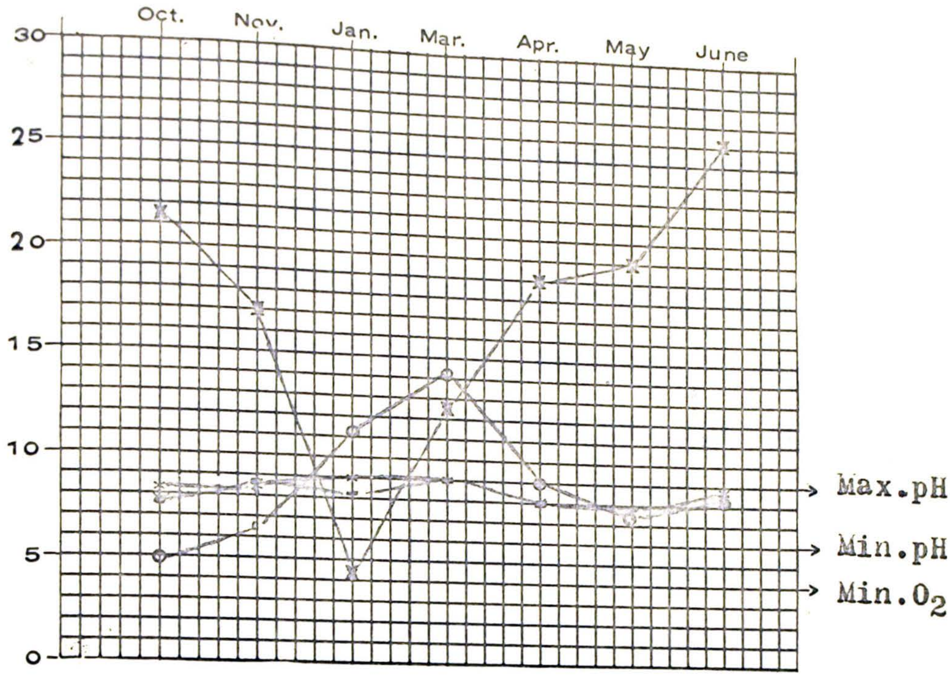


Figure 5. continued...

alkalinity. Alkalinity data for September 18, 1968 ranged from 145 p.p.m. to 220 p.p.m. as $CaCO_3$ (Burdick, 1969). This is within permissible criteria, below 400 to 500 p.p.m., recommended by N.T.A.C.(1968). The Tennessee Stream Pollution Control Board has set no recommended values for alkalinity (1967).

Average values for pH ranged from a minimum of 7.6 in October to a maximum of 8.9 in March 1969 (Figure 6). The T.S.P.C.B. (1967) requires that the pH value shall lie within the range of 6.0 to 9.0 and shall not fluctuate more than 1.0 unit in this range over a period of 24 hours. Values of pH are within this acceptable range, however fluctuations at an individual station were not examined daily. Hutchinson (1947) states that Paleozoic limestone basins yield pH values greater than 8.0. Limestone was flooded when the reservoir was impounded.

Average values for all months when sampling occurred revealed that only in March 1969 did the pH average over 8.5 (Figure 6). During this time surface samples were also supersaturated with dissolved oxygen. Probably during this month a phytoplankton bloom coupled with cool, windy nights was largely responsible for both the high concentration of dissolved oxygen and for the unusually high pH due to the utilization of available CO_2.



o– Mean Dissolved O_2 p.p.m.

x– Maximum Temperature ^{o}C

-– Average pH

*– Maximum pH

Figure 6. A comparison of data with acceptable standards. Temperatures above $37^{o}C$ are not acceptable

Available Chlorine

As chloride is used so much in our food, where chloride values run high there is usually a suspicion of sewage contamination (Mason, 1899).

Chloramines, residual chlorine and compounds in which chlorine is loosely bonded give a quantitative response to orthotolidin. Therefore, the chlorine measured with this test is actually available chlorine, and further investigation would be required to determine the exact chemical nature of the compounds responsible for these readings.

Available chlorine readings were always low, ranging from $<$0.1 p.p.m. to 0.3 p.p.m. (Tables 2,3,4,5 and 7). Because of the natural dissipation of residual chlorine, chlorine used in the treatment of wastewater at the wastewater treatment plants at Murfreesboro and Smyrna, Tennessee on the West and East Forks of Stones River, should not respond to orthotolidin in the reservoir (Blanton, 1969).

These values may be a result of chlorine in cleaning agents at Sewart Air Force Base. The chlorine measured may also be a result of degradation of residual fertilizers and/or herbicides and pesticides retained in the soil of previous farm and pastureland.

Biological Oxygen Demand

Biological Oxygen Demand is a test commonly used as an indicator of putrid or other materials requiring large amounts of dissolved oxygen for degradation. Raw sewage, decaying vegetable fiber, etc. may be responsible for a high oxygen demand; however, it is generally related with bacterial populations.

Readings for B.O.D. were all low. The highest value measured was 5.6 p.p.m. for undiluted samples May 10, 1969 (Table 6). It is evident (Tables 6 and 7) that frequently the highest values for B.O.D. were obtained in shallow bays or in the East and West Forks of Stones River. Dilution, settling, and depth or low temperatures, of the water in other locations on the reservoir have kept B.O.D. values low.

Hardness

Determinations for hardness were made by Jerry Anderson of Vanderbilt University and myself. Values obtained were:

Calcium Hardness as p.p.m. $CaCO_3$

Station	Date Collected	p.p.m.
Dam	Nov. 3, 1968	70
Dam	March 22, 1969	124
Dam	April 19, 1969	120
Dam	May 10, 1969	125
Dam'	May 10, 1969	142
A	May 10, 1969	124
F	May 10, 1969	143

Dam	June 18, 1969	114
Dam'	June 18, 1969	132
A	June 18, 1969	129
F	June 18, 1969	129

The N.T.A.C. (1968) states that hardness more than 300-500 p.p.m. as $CaCO_3$ is excessive for public water supplies. They also indicate that many consumers object to water harder than 150 p.p.m. A moderately hard water is sometimes defined as having hardness between 60 to 120 p.p.m. $CaCO_3$.

Data presented indicate that this water meets satisfactory requirements for hardness.

TABLE 1

Raw Data for October 13, 1968

Station	Depth ft.	Time	Secchi ft.	Temp. °C Air	Temp. °C H_2O	Dissolved O_2 p.p.m.	pH	Cl_2	BOD p.p.m. 5-Day
A	0	9:25	—	25	20.5	6.0	7.8	—	—
A'	—	—	—	—	—	—	—	—	—
B	—	9:40	—	24	20.5	7.4	7.9	—	—
B'	—	—	—	—	—	—	—	—	—
C	0	10:20	—	—	—	4.6	7.8	—	—
Z	0	—	—	—	—	—	—	—	—
Z'	—	—	—	—	—	—	—	—	—
D	0	11:55	—	28	22.0	3.0	7.4	—	—
E	0	12:55	—	—	—	3.4	7.5	—	—
F	0	—	—	—	—	3.2	7.0	—	—
F'	39	—	—	—	12.4	0.0	7.4	—	—
G	0	1:15	—	—	—	2.2	7.4	—	—
G'	16	1:15	—	—	19.5	0.0	7.4	—	—
H	0	—	—	—	—	4.5	7.5	—	—
X	0	—	—	—	—	—	—	—	—
Y	0	—	—	—	—	—	—	—	—
Y'	—	—	—	—	—	—	—	—	—
I	0	2:40	—	—	—	5.0	7.6	—	—
I'	32	2:40	—	—	14.0	0.0	7.5	—	—
J	0	—	—	—	—	6.1	7.8	—	—
J'	25	—	—	—	—	1.2	7.5	—	—
M	0	—	—	—	—	4.9	7.4	—	—
L	0	—	—	—	—	6.4	7.5	—	—
L'	2	—	—	—	—	6.3	7.4	—	—
K	0	—	—	—	—	5.3	7.9	—	—
Dam	0	4:30	—	—	21.5	6.3	8.1	—	—
Dam'	35	4:30	—	—	13.0	0.9	8.0	—	—

TABLE 2

Raw Data for November 3, 1968

Station	Depth ft.	Time	Secchi ft.	Temp. °C Air	Temp. °C H_2O	Dissolved O_2 p.p.m.	pH	Cl_2	BOD p.p.m. 5-Day
A	0	9:25	3.5	22	16.5	9.6	7.9	.15	—
A'									—
B	0	—	2.5	—	16.5	10.4	8.2	.2	—
B'	3	—		—	16.5	10.4			—
C	0	—	3.0	—	16.0	5.5	8.5	.1	—
Z	0	—	2.0	—	16.5	5.1	8.4	.1	—
Z'	5	—		—	16.5	4.9			—
D	0	—	2.0	—	16.0	8.2	8.0	.15	—
E	0	—	2.0	—	16.5	7.3	8.4	.1	—
F	0	—	3.0	—	16.0	6.0	8.3	.15	—
F'	32	—		—	12.5	1.5	8.2	.1	—
G	0	—	5.0	—	16.5	6.0	8.3	.15	—
G'	14	—		—	16.5	6.4	8.3	.15	—
H	0	—	4.0	—	15.5	4.9	8.2	.2	—
X	0	2:10	4.3	—	15.0	5.7	8.4	.15	—
Y	0	—	4.0	—	17.0	7.5	8.4	.15	—
Y'	26	—		—	16.5	2.0	8.3	.1	—
I	0	—	6.0	—	15.5	4.8	8.5	.15	—
I'	28	—		—	12.4	1.9	8.6	.2	—
J	0	—	8.0	—	15.5	4.2	8.8	.2	—
J'	27	—		—	12.3	1.3	8.6	.2	—
M	0	—	6.0	—	17.0	6.7	8.6	.15	—
L	0	—	8.0	—	16.0	4.7	8.7	.2	—
L'	50	—		—	11.5	0.8	7.5	.1	—
K	0	3:10	9.0	—	16.5	5.8	8.5	.15	—
Dam	0	4:30	9.0	—	17.0	6.7	8.5	.15	—
Dam'	50	4:30	—	—	11.5	0.8	8.4	.1	—

TABLE 3

Raw Data for January 11, 1969

Station	Depth ft.	Time	Secchi ft.	Temp. °C Air	H_2O	Dissolved O_2 p.p.m.	pH	Cl_2	BOD p.p.m. 5-Day
A	0	—	2.0	.5	3.5	12.0	7.7	—	—
A'	4	—	—	—	3.0	13.2	8.0	—	—
B	0	—	2.0	—	4.0	12.0	8.3	—	—
B'	18	—	—	—	4.0	10.8	8.2	—	—
C	0	—	1.5	—	3.8	11.1	8.2	—	—
Z	0	—	1.0	—	3.5	11.6	7.8	—	—
Z'	4	—	—	—	2.5	11.0	8.0	—	—
D	0	—	2.0	—	3.8	10.8	8.0	—	—
E	0	—	1.0	—	2.5	11.8	7.8	—	—
F	0	—	1.0	2.0	3.8	10.8	7.8	.1	—
F'	25	—	—	—	3.8	10.8	8.1	.1	—
G	0	—	1.0	—	4.3	12.5	8.0		—
G'	20	—	—	—	4.0	10.8	7.8	—	—
H	0	—	1.0	—	3.0	12.8	7.8	—	—
X	0	—	3.0	—	3.5	12.6	8.2	—	—
Y	0	—	2.0	—	3.5	12.2	7.8	—	—
Y'	38	—	—	—	4.0	10.8	7.8	—	—
I	0	—	4.0	—	3.5	13.1	7.8	—	—
I'	43	—	—	—	4.0	10.6	7.9	—	—
J	0	—	4.0	4.0	3.5	11.0	7.8	.1	—
J'	40	—	—	—	4.0	10.8	7.9		—
M	0	—	5.0	—	3.5	12.6	8.6	—	—
L	0	—	4.0	—	3.8	10.8	8.8	—	—
L'	—	—	—	—	3.0	10.7	8.7	—	—
K	0	—	2.5	—	3.3	12.2	8.6	—	—
Dam	0	—	5.0	.5	4.0	11.6	8.6	—	—
Dam'	55	—	—	—	4.0	10.6	9.0	—	—

TABLE 4

Raw Data for March 22, 1969

Station	Depth ft.	Time	Secchi ft.	Temp. °C Air	H_2O	Dissolved O_2 p.p.m.	pH	Cl_2	BOD p.p.m. 5-Day
A	0	7:50	1.0	9.0	12.5	8.0	8.1	0.1	1.2
A'	30	—	—	—	5.9	10.8	8.4	0.1	—
B	0	—	1.0	—	12.0	11.2	8.5	0.1	3.0
B'	20	—	—	—	6.0	12.0	8.6	0.1	—
C	0	—	1.5	—	12.0	12.0	8.4	—	—
Z	0	—	1.5	—	12.0	15.6	8.8	—	—
Z'	5	—	—	—	8.0	13.2	8.5	—	—
D	0	—	2.0	—	12.0	13.2	8.5	—	—
E	0	—	2.0	—	11.0	13.2	8.7	0.1	2.6
F	0	9:30	2.5	13.0	11.0	13.2	8.6	0.1	2.5
F'	28	—	—	—	5.9	11.1	8.4	0.1	—
G	0	—	2.5	—	11.0	15.6	8.8	—	—
G'	23	—	—	—	5.9	11.9	8.7	—	—
H	0	—	2.5	—	10.5	14.5	8.9	—	—
X	0	—	2.5	—	10.5	15.0	8.9	—	—
Y	0	—	2.5	—	10.5	14.8	9.0	—	—
Y'	30	—	—	—	5.9	11.4	8.8	—	—
I	0	—	3.5	—	9.5	15.8	9.0	—	—
I'	36	—	—	—	5.8	11.6	8.5	—	—
J	0	11:00	3.5	20.0	10.0	17.0	9.0	0.1	2.5
J'	35	—	—	—	5.9	11.0	9.0	0.15	—
M	0	—	4.0	—	10.5	15.6	9.0	—	—
L	0	—	4.0	—	10.0	15.8	8.8	—	—
L'	40	—	—	—	5.8	11.0	8.8	—	—
K	0	—	3.0	—	11.5	14.8	9.0	—	—
Dam	0	12:30	3.0	20.5	11.0	15.3	8.8	0.1	3.0
Dam'	60	—	—	—	5.8	11.0	9.0	0.1	—

TABLE 5

Raw Data for April 19, 1969

Station	Depth ft.	Time	Secchi ft.	Temp. °C Air	Temp. °C H_2O	Dissolved O_2 p.p.m.	pH	Cl_2	BOD p.p.m. 5-Day
A	0	10:30	1.0	—	17.3	7.2	7.7	—	—
A'	40	—		—	10.2	3.2	7.7	—	—
B	0	—	1.0	—	15.0	8.6	7.8	—	—
B'	27	—		—	11.3	4.5	7.7	—	—
C	0	—	3.0	—	17.0	8.3	7.4	—	—
Z	0	—	—	—	—	—	—	—	—
Z'	—	—	—	—	—	—	—	—	—
D	0	—	1.5	—	16.0	7.9	7.8	—	—
E	0	—	2.5	—	16.5	7.3	7.8	—	—
F	0	11:50	1.5	—	16.5	8.5	7.8	0.1	—
F'	53	—		—	8.7	1.3	7.8	.1	—
G	0	—	2.0	—	17.5	8.5	7.8	—	—
G'	15	—		—	14.8	6.7	7.8	—	—
H	0	—	3.0	—	16.5	9.1	8.2	—	—
X	0	—	3.0	—	17.5	10.9	8.0	—	—
Y	0	1:50	5.0	—	17.5	10.3	8.2	—	—
Y'	36	—		—	10.3	3.9	7.9	—	—
I	0	—	4.5	—	17.0	11.5	8.1	—	—
I'	60	—		—	8.0	1.6	8.0	—	—
J	0	2:20	6.0	21.5	18.0	8.8	8.2	.1	—
J'	50				9.0	1.6	8.3	.1	—
M	0	7:45	8.0	—	15.0	9.2	7.7		—
L	0	—	5.0	—	18.5	10.3	8.3	—	—
L'	25	—		—	13.0	5.2	8.1	—	—
K	0	—	3.0	—	19.0	10.1	8.1	—	—
Dam	0	8:35	6.0	11.5	16.4	8.3	8.1	.1	—
Dam'	45	—	—	—	9.5	2.3	8.0	0.1	—

TABLE 6

Raw Data for May 10, 1969

Station	Depth ft.	Time	Secchi ft.	Temp. °C Air	Temp. °C H_2O	Dissolved O_2 p.p.m.	pH	Cl_2	BOD p.p.m. 5-Day
A	0	—	2.0	13.0	20.0	6.9	7.9	—	4.6
A'	15	—	—	—	17.0	8.0	7.8	—	—
B	0	—	2.0	—	20.0	7.1	8.3	—	5.0
B'	28	—	—	—	14.5	6.5	8.3	—	—
C	0	—	2.0	—	19.5	6.9	7.6	—	2.9
Z	0	—	2.0	—	20.0	6.9	7.9	—	5.6
Z'	10	—	—	—	18.0	8.5	7.6	—	—
D	0	—	3.0	—	18.5	7.4	8.0	—	4.4
E	0	—	3.0	—	20.0	6.7	7.8	—	5.1
E'	30	—	—	—	14.4	6.6	8.0	—	—
F	0	9:00	2.5	18.0	19.0	10.4	7.9	—	5.1
F'	20	—	—	—	16.7	7.8	7.6	—	—
G	0	—	3.0	—	19.5	6.3	7.7	—	5.6
G'	30	—	—	—	14.3	6.7	7.8	—	—
H	0	—	3.0	—	19.0	8.1	8.3	—	4.1
X	0	—	4.0	—	19.0	8.4	7.9	—	1.6
Y	0	—	4.0	—	19.5	7.6	8.0	—	3.1
Y'	35	—	—	—	12.2	6.7	7.9	—	—
I	0	—	4.5	—	19.0	8.6	8.3	—	3.7
I'	45	—	—	—	9.7	6.8	8.2	—	—
J	0	10:50	5.0	22.0	19.0	10.4	7.7	—	0.0
J'	40	—	—	—	16.7	7.8	6.9	—	—
M	0	—	5.0	—	19.5	7.9	—	—	1.1
L	0	—	5.0	—	20.0	8.1	—	—	1.2
L'	50	—	—	—	9.0	6.7	—	—	—
K	0	—	—	—	—	—	—	—	—
Dam	0	11:45	6.0	—	20.0	10.0	—	—	1.1
Dam'	60	—	—	—	8.7	6.7	—	—	—

TABLE 7

Raw Data for June 18, 1969

Station	Depth ft.	Time	Secchi ft.	Temp. °C Air	Temp. °C H_2O	Dissolved O_2 p.p.m.	pH	Cl_2	BOD p.p.m. 5-Day
A	0	12:15	3.5	25.0	25.0	8.9	7.9	.2	2.1
A'	44				11.0	.6	7.7	.15	2.6
B	0	—	3.0	—	25.0	8.7	7.8	.3	1.9
B'	40	—		—	12.0	.9	7.8	.2	3.1
C	0	—	4.0	—	25.0	9.4	7.9	.2	2.7
Z	0	—	3.0	—	24.5	8.8	7.9	.2	1.5
Z'	15	—		—	23.5	6.1	7.9	.2	2.5
D	0	—	5.0	—	25.5	8.7	7.8	.2	3.7
E	0	—	4.0	—	25.0	8.5	7.9	.2	2.1
E'	10	—		—	23.5	5.8	7.9	.2	2.5
F	0	1:45	4.0	17.0	25.0	8.6	8.0	.2	2.4
F'	28				17.0	1.1	7.8	.3	1.8
G	0	—	5.0	—	24.5	8.7	8.0	.2	1.7
G'	29	—		—	16.4	1.1	7.9	.2	1.9
H	0	—	2.5	—	25.5	8.4	8.1	.3	1.8
X	0	—	3.5	—	26.0	8.3	8.2	.2	2.5
Y	0	—	5.0	—	24.5	8.4	8.2	.2	.9
Y'	34	—		—	14.0	1.0	8.0	.1	1.0
I	0	—	5.0	—	25.0	8.5	8.2	.2	1.4
I'	58	—		—	9.5	.7	8.2		2.3
J	0	5:30	5.5	11.0	25.5	8.6	8.2	.1	1.8
J'	45			—	11.0	1.0	8.2		3.3
M	0	—	5.5	—	25.5	8.7	8.4	.2	1.4
L	0	—	5.0	—	25.0	8.4	8.5	.1	4.9
L'	50	—		—	10.5	.8	8.2	.1	3.4
K	0	—	4.5	—	25.5	8.6	8.4	.2	4.9
Dam	0	6:45	5.0	—	24.5	9.3	8.4	.2	1.5
Dam'	50	—	—	—	10.0	1.0	8.3	.3	.5

Chapter VI

SUMMARY

Biophysical criteria including temperature, dissolved oxygen, pH, available chlorine, Secchi disc turbidity, hardness, and biological oxygen demand at seventeen stations on the J. Percy Priest Reservoir have been documented and evaluated.

The study began October 13, 1968 and extended to June 18, 1969. During this period the reservoir was sampled monthly with the exceptions of December 1968 and February 1969.

J. Percy Priest reservoir was found to be a eutrophic lake; it is thermally stratified in summer and loses its supply of oxygen in the deeper water. The lowest mean monthly value for dissolved oxygen was 4.9 p.p.m. for surface determinations. This is greater than the minimum of 4 p.p.m. recommended by the National Technical Advisory Committee (1968) and the minimum 3 p.p.m. recommended by Welch (1952). The Tennessee Stream Pollution Control Board (1967) will allow a minimum of 3 p.p.m. of dissolved oxygen in limited sections.

Determinations of relative turbidity with the Secchi disc showed a definite clearing or settling in the reservoir as the water approached the reservoir. Standards for the Secchi disc readings are not available for making comparisons.

Average values for pH ranged from a minimum of 7.6 in October to a maximum of 8.9 in March 1969. The Tennessee Stream Pollution Control Board (1967) requires that the pH value shall lie within the range of 6.0 to 9.0.

Determinations of available chlorine were always low, ranging from < 0.1 p.p.m. to 0.3 p.p.m. Probably these readings are a result of degradation of residual fertilizers and/or herbicides and pesticides retained in the soil from previous land uses. The National Technical Advisory Committee (1968) allows 250 p.p.m. of chloride.

Readings for biological oxygen demand were always low. The highest value obtained was 5.6 p.p.m. for undiluted samples May 10, 1969. The highest values were obtained in shallow bays or in the East and West Forks of Stones River.

Determinations for hardness gave values ranging from 70 p.p.m. to 143 p.p.m. as $CaCO_3$, which are well below the 300-500 p.p.m. considered excessive for public water supplies by the National Technical Advisory Committee (1968).

The reservoir met minimum permissible criteria with respect to data collected within the bounds of this investigation.

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