

WATER QUALITY OF LAKE THUNDERBIRD, JUNE-NOVEMBER 1973

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A study of the water quality of Lake Thunderbird, from June to November, 1973, showed that this impoundment had no major persistent pollution problem. Weekly chemical and biological analyses of surface and deep water samples indicated that a limited number of heavy metals were above normal concentrations for surface water, and that, in a few areas and samples, the number of coliform organisms was above accepted standards. Erosion and misuse of shorelines are the major causes of water quality deterioration. A properly operating water treatment should be sufficient to satisfy U. S. Public Health Service drinking water standards.

Lake Thunderbird is an impoundment which serves as the drinking water supply for Del City, Midwest City, and Norman, and also as a recreational site for central Oklahoma. Concern for the water quality of the lake has been great in Norman ever since the impoundment was completed. With the influx of people increasing each year, it is necessary to monitor the lake with regard to Oklahoma water quality standards. The purpose of the present study, conducted by the University of Oklahoma School of Civil Engineering and Environmental Science, was to determine the water quality of Lake Thunderbird from June to November, 1973.

METHODS

In order to evaluate Lake Thunderbird as a whole, it was necessary to establish sampling stations throughout the lake. Figure 1 is a map of the lake with sampling station numbers enclosed in circles. Stations were divided into four categories representing inflows (stations 10 and 11), the upper end of the lake (stations 1 and 9), its main body (stations 2A, 4, 6, and 8), and shoreline-use areas (stations 2, 3, 4A, and 7). A total of 13 stations were used at one time or another throughout the study. Table 1 contains a description of the location of each station. Surface water samples were collected at all stations; samples from depths of 10 ft, 20 ft, and 30 ft were collected periodically from stations 2, 6 and 8. Occasionally samples from a 40-ft. depth were collected at station 6.

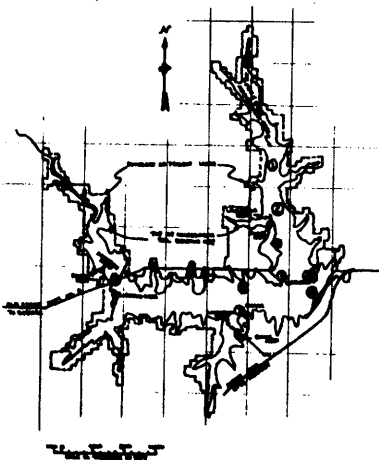


FIGURE 1. Map of Lake Thunderbird with collecting stations indicated by circled numbers.

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Temperature, total dissolved solids, pH, and dissolved oxygen were determined in the field. Samples were collected and returned to the laboratory for analysis for chlorides, iron, lead, manganese, nitrates, phosphate, hardness, turbidity, total number of coliform bacilli and number of fecal coliforms, and algae. The analyses were performed according to the techniques outlined in *Standard Methods* (1). Microscopic analysis of a 1:10 dilution of the water sample was used for algal determination. Algae were counted by using the membrane filter techniques given in *Standard Methods* (1, pp. 729-30). When specific information concerning a particular genus was required *Fresh-Water Algae of the United States* (2) was used as a reference.

TABLE 1. Composite evaluation of Lake Thunderbird water quality

Parameter	Standard ^a	Average Lake Values				Evaluation
		Inflow stations	Alameda St. bridge	Main body stations	Shoreline stations	
Physical						
Temperature (C)	30	24-25	24	23-28	24-28	Good
Turbidity (JTU)	10-250	69-149	61	14-18	11-29	Good
Total dissolved solids ^b	500	332-401	239	200-222	207-237	Good
Chemical						
pH	6.5-8.5	8.0-8.1	8.2	8.3-8.5	8.4-8.5	Good
Dissolved oxygen ^b	4.0	4.4-5.5	6.5	6.2-6.4	5.7-7.0	Good
Chlorides ^b	250	14-46	24	20-24	21-22	Good
Iron ^b	a	0.9-1.6	1.9	0.7-1.3	0.4-0.8	Good
Phosphates ^b	a	0.7-2.0	0.6	0.003-0.5	0.03-0.8	Fair
Nitrates ^b	45	1.6-2.6	1.2	1.0-1.8	1.0-2.1	Good
Manganese ^b	a	0.8-1.8	1.4	0.3-1.6	0.3-2.2	Good
Hardness ^c	500	300-301	159	133-158	118-162	Good
Lead ^b	0.05	0.06	0.06	0.04	0.04-0.05	Good

^a See explanation of standards in Results and Discussion.

^b mg/l.

^c mg/l as CaCO₃.

RESULTS AND DISCUSSION

Table 1 contains a summary of the data collected. The following generalizations can be made. Temperature, turbidity, total dissolved solids, and hardness were found to be within standard limits. The pH did not

exhibit wide variations. Dissolved oxygen, as expected, decreased with depth. Chlorides were at a low level. Iron and manganese were present in concentrations above the standards. The lake was rated "fair" in its content of phosphates, while nitrate concentration was low, but the concentrations

TABLE 2. Fecal and total coliforms in Lake Thunderbird, July 1973 - October 1973.

Station	Fecal coliforms/100 ml			Total coliforms/100 ml			
	Station No.	No. of samples	Range	Geometric mean ^a	No. of samples	Range	Geometric mean ^a
Little River	10	12	0-TMTC ^b	230(6)	13	0-TMTC	1290(5)
	End	9	12	0-16	4(5)	13	0-4800
Hog Creek	11	4	0-120	27(2)	5	2000-5000	2260(5)
	End	1	6	0-1	1(1)	7	180-TMTC
Main body							
Hog Creek	4	4	0-8	8(1)	5	0-630	420(4)
Surface	2A	6	0	0	6	0-220	80(3)
10 ft deep	2A	6	0-10	3(2)	6	0-400	100(3)
Dam							
Surface	6	11	0-10	4(5)	12	0-1000	260(8)
10 ft deep	6	5	0-8	3(3)	5	0-180	50(4)
Water intake							
Surface	8	11	0-10	2(3)	12	0-460	170(10)
10 ft deep	8	5	0	0	5	0-390	260(3)
Shoreline							
Marina	3	12	0-TMTC	5(4)	13	0-1000	160(12)
Boat launch	2	6	0-2	1(2)	7	20-2450	330(7)
Swimming areas							
—Beach	4A	8	0-18	10(4)	8	0-1300	190(6)
—Picnic	5	12	0-8	3(3)	13	0-900	300(10)
—Picnic	7	11	0-16	3(5)	12	0-1200	150(11)

^a Numbers in parentheses = number of samples on which geometric mean is based. Samples which gave zero and TMTC results were not included in calculation of the geometric mean.

^b TMTC = too many to count.

of both phosphates and nitrates were sufficient to cause algal blooms. The amount of lead was fairly constant throughout the lake and within that expected for surface water. The number of fecal coliform bacilli did not exceed the standard, but in certain samples the total number of coliforms did exceed the standard (Table 2).

Total coliform counts varied widely from week to week and at different locations on Lake Thunderbird. It was difficult to filter enough water to get statistically accurate values for fecal coliforms owing to the amount of clay in the water. Although total coliform values throughout the lake were higher than desirable for a public drinking water supply, the fecal coliform values were generally quite low, even at heavily used areas. Water at the intake tower gave relatively low total coliform counts and very low fecal coliform counts. The total coliform population in the lake may have been higher than usual during this 1973 study due to exceedingly heavy rainfalls and resulting increase in storm run-off into the lake. The low fecal coliform counts indicated that fecal pollution of Lake Thunderbird was either distant or slight. The lake has good bacteriological quality in terms of public health and safety for recreational use, even for primary contact sports. There is a lack of epidemiological data to prove that recreation in water with high coliform values causes enteric disease. Epidemiological studies should be made locally when setting coliform standards for recreational use.

No algal problems existed during the testing period. Total numbers of algae were low and species were diverse. The predominant algae found throughout the project were *Melosira*, *Cyclotella*, *Trichodesmium lacustre*, and *Navicula* (2). The number of algae decreased with depth of the water.

In predicting whether the state of the impoundment is good or bad, data on water volume is needed. Measurements of the water volume during the project were: June, 1039.34 elevation at 123,600 acres ft; July, 1039.65 elevation at 123,600 acres ft; August, 1039.03 elevation at 101,000 acres ft; September, 1039.32 elevation at 105,500 acres ft; October, 1039.89 elevation at 124,000 acres ft of water.

Explanation of standards (Table 1)

Temperature. Applicable values are 30 C for primary contact reaction waters (3) and 34 C according to Oklahoma water quality standards (4). (These standards apply to surface water.)

Turbidity. Surface waters with turbidity values between 10 and 150 JTU are considered to be good sources for a water supply; only filtration and disinfection would be required prior to use (5). The U. S. Public Health Service drinking water standards (6) of 5 JTU can be met with treatment at the Norman, Midwest City, and Del City plants (7).

Total dissolved solids. The U. S. Public Health Service drinking water standard of 500 mg/l (6) is applicable. Lake Thunderbird water meets this standard prior to treatment.

pH. Oklahoma water quality standards (4) indicate as desirable a range of pH 6.5-8.5. (This standard applies to surface water.)

Dissolved oxygen. Oklahoma water quality standards (4) indicate that the dissolved oxygen should be greater than 4 mg/l. (This standard applies to surface water.)

Chlorides. The U. S. Public Health Service drinking water standard of 250 mg/l (6) is applicable. Lake Thunderbird water meets this standard prior to treatment.

Iron. The U. S. Public Health Service drinking water standard of 0.3 mg/l (6) is applicable to the treated water at Norman, Midwest City, and Del City. The treatment plants at the three cities are considered sufficient to reduce the marginal iron concentrations to U. S. Public Health Service standard based on treatment requirements (7).

Phosphates. Algal blooms can occur with phosphate concentrations as low as 0.03 mg/l. Lake Thunderbird water is considered "fair" owing to its potential for algal growth.

Nitrates. The U. S. Public Health Service drinking water standard of 45 mg/l (6) is applicable. Algal blooms can occur with nitrate concentrations as low as 1.3 mg/l. Lake Thunderbird water is marginal in this respect.

Manganese. The U. S. Public Health Service drinking water standard of 6.05 mg/l (6) is applicable to the treated water at Norman, Midwest City, and Del City. The treatment at the three cities' plants is considered sufficient to reduce the manganese concentration to drinking water standard (7).

Hardness. There is no U. S. Public Health Service standard for drinking water (6). CaCO₃ content greater than 500 mg/l is considered unsuitable for general domestic purposes.

Lead. The U. S. Public Health Service standard for drinking water is 0.05 mg/l. Lake Thunderbird water meets this standard prior to treatment.

CONCLUSIONS

In general, Lake Thunderbird met current quality standards (3, 4) at the time of the study. There are possibilities for future decreases in water quality due to uncontrolled watershed land use for recreational and residential purposes. Agricultural uses and erosion may increase nutrients and solids in the water, and increased algal levels may occur due to the increase in nutrients. Del City, Midwest City and Norman currently have no problems with their water supply, but continuous care should be exercised in their water treatment operations.

ACKNOWLEDGMENTS

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