Waubeesee Lake at Wind Lake,WI
Water-Quality Data Summary 1988 through 1996

This summary covers the period October 1988 to September 1996, which is the period of water-quality monitoring of Waubeesee Lake by the U.S. Geological Survey. Emphasis in this summary is on data collected during 1996. All data collected during 1996 are included. Data from previous years are included in graphs to illustrate changes or trends.

In reviewing the data, it may be helpful to refer to the methods and explanations of physical and chemical characteristics sections in the USGS annual lake data report "Water-Quality and Lake-Stage Data for Wisconsin Lakes, Water Year 1996" and to Shaw and others (1994) "Understanding Lake Data."

The data that have been collected for Waubeesee Lake from 1988-96 are useful for understanding the lake's water quality, and for managing the lake. These data define the present water quality of the lake and provide a basis for assessing trends or changes in water quality in the future.

Lake description and sampling locations:

Waubeesee Lake is classified as a drainage lake, with one inlet from Long Lake and one outlet. The average depth of Waubeesee Lake is 19 feet, the surface area is 129 acres (0.20 square miles), and the lake's watershed area is 5.2 square miles. The water-quality sampling site is located at the deepest point in the lake at a depth of about 72 feet. Lake stage was monitored at the outlet, which is located on the east side of the lake and also at the Anschutz property. The locations of the monitoring sites are shown in Figure 1.

Hydrologic conditions during water year 1996:

Annual variability in lake condition often reflects variability in climatic and hydrologic conditions. Air temperature in southeastern Wisconsin was, on the average, 2.2 °F colder than normal for the period December 1995 through March 1996; April and May was 4.0 °F colder than normal; and the period June through August was 1.3 °F colder than normal (National Oceanic and Atmospheric Administration "Climatological Data--Wisconsin"). Precipitation during water year 1996 was 103 percent of normal precipitation for southeastern Wisconsin (Pamela Naber-Knox, UW-Extension, Geological and Natural History Survey, written commun., 1996). Watershed runoff in the region of Waubeesee Lake was

between 100 and 120 percent of long-term average runoff (Holmstrom and others, 1997, "Water Resources Data--Wisconsin").

Lake Data for 1996:

The following summarizes some highlights of data given in the tables and shown in the figures.

Lake-stage fluctuations:

Lake stages were measured by the USGS on sampling dates. The stages ranged from 4.88 feet on August 13 to 5.76 feet on July 16. This range of fluctuation is similar to recent years, but less than average fluctuation for the 8 years of monitoring. However, total fluctation may not have been observed due to the few number of measurements taken during the year. Stage values are shown in the table on the top half of Figure 2. Stage fluctuations for the period of 1988 through 1996 range from 3.38 to 5.76 feet.

Lake-depth profiles:

Vertical profiles of water temperature, dissolved oxygen, pH, and specific conductance exhibit no abnormalities and are similar to those from the previous years. These profiles, which were measured over the deepest point in the lake, are listed in Table 2 and shown in Figure 2. During the February through August sampling period, complete water-column mixing was observed on April 10. The lake became thermally stratified through the summer. As was observerved in previous years, there were sharp increases and decreases in dissolved oxygen concentrations in the late summer profiles. These fluctuations indicate that there were layered zones of biological activity in the water column. No anoxic regions developed in June, but by August the lower 23.5 feet were anoxic. The anoxic zone is unable to support fish. The pH, which ranged between 7.5 and 8.6, is common for southeastern Wisconsin lakes and poses no problems for aquatic life.

Chemical constituents:

Analyses of water samples collected on April10 for selected chemical constituents for chemical characterization of the lake are shown in Figure 2. Samples collected at 1.5 and 71-foot depths show similar constituent concentrations, as would be expected under mixed water column conditions. The constituent values for color, chlorophyll a, chloride, calcium, magnesium, pH, alkalinity, total-nitrogen, and total-phosphorus are within regional values for this area as described by Lillie and Mason in "Limnological Characteristics of Wisconsin Lakes," 1983, Technical Bulletin No. 138, Department of Natural Resources.

The ratio of dissolved-nitrogen to dissolved-phosphorus was 115:1, based on the surface concentrations on April 10. This ratio suggests the lake is phosphorus limited, which means algal growth is dependent on the amount of available phosphorus rather than nitrogen.

Three common measures of water quality used as indices are concentrations of near-surface total-phosphorus and chlorophyll a, and Secchi depth. Total-phosphorus concentrations ranged from 0.008 mg/L on June 11 to 0.012 mg/L on July 16 and April 10, chlorophyll a ranged from 1.1 µg/L on June 11 to 3.4 µg/L on August 13, and Secchi depths ranged from 2.8 m on July 16 and August 13 to 5.7 m on June 11.

Surface total-phosphorus and chlorophyll a concentrations, and Secchi depths for the 1988 -96 period are shown on Figure 3. The year-to-year trend for the 1988-96 show little variability. However, in most years, there is a seasonal trend of declining total-phosphorus concentrations from April through August.

Total-phosphorus concentration 1.5 feet above the lake bottom at the center site ranged from 0.013 mg/L on April 10 to 0.217 mg/L on August 13. The total-phosphorus concentrations observed during anoxic periods are indicative of a moderate phosphorus release from the bottom sediments.

Lake condition:

Water-quality index:

Lillie and Mason (1983) classified all Wisconsin lakes using a random data set collected in the summer (July and August). The index, shown on page 12 of "Water-Quality and Lake-Stage data for Wisconsin Lakes, Water Year 1995," is based on surface total-phosphorus and chlorophyll a concentrations, and Secchi depths. According to the index, surface total-phosphorus concentrations in Waubeesee Lake indicate "good" water quality, while chlorophyll a concentrations and Secchi depths indicate "very good" water quality.

Lillie and Mason (1983) also provided a means of comparing the condition of Waubeesee Lake with other lakes in southeastern Wisconsin. The comparison on page 4 shows the percentage distribution of southeastern Wisconsin lakes within each condition group and the relative position of Waubeesee Lake.

	Parameter		Percentage distribution of lakes in southeast Wisconsin within parameter ranges
	Total-phosphorus (mg/L)		
	<0.010	best condition	7
Waubeesee Lake values	0.010-0.020		21
	0.020-0.030		15
	0.030-0.050		21
	0.050-0.100		21
	0.100-0.150		3
	>0.150	worst condition	12
	Chlorophyll a (µg/L)		
Waubeesee Lake values	0-5	best condition	22
	5-10		31
	10-15		14
	15-30		12
	>30	worst condition	22
	Secchi depth (feet)		
	>19.7	best condition	1
Waubeesee Lake values	9.8-19.7		9
	6.6-9.8		26
	3.3-6.6		31
	<3.3	worst condition	33

Trophic status:

Another means of assessing the nutrient, or trophic, status of a lake is to use Carlson's Trophic State Index (TSI). The 1996 TSI data is listed in Table 2. Figure 4 is a graphical illustration of the variation in Trophic State Indices for Waubeesee Lake during the 9 year study period. The data from 1996 show the lake to be lower mesotrophic, or a lake with moderate nutrient levels.

Table 1. Lake-depth profiles for Waubeesee Lake at Wind Lake, Wisconsin, 1996 water year

DATE	SAMPLING DEPTH (FEET) (00003)	TEMPERATURE WATER (DEG C) (00010)	SPECIFIC CONDUCTANCE (US/CM) (00095)	PH WATER WHOLE FIELD (STANDARD UNITS) (00400)	OXYGEN, DISSOLVED (MG/L) (00300)
		WATER-QUALITY DATA			
FEB 1996					
06...	3.00	2.5	464	7.9	11.9
06...	6.00	2.5	460	7.9	11.5
06...	9.00	3.0	457	7.9	11.0
06...	12.0	3.0	459	7.9	11.6
06...	15.0	3.0	456	8.0	11.7
06...	18.0	3.0	456	8.0	11.2
06...	21.0	3.5	454	8.0	10.7
06...	24.0	3.5	455	7.9	10.3
06...	27.0	3.5	455	7.9	10.0
06...	30.0	3.5	456	7.9	10.0
06...	33.0	3.5	455	7.9	10.0
06...	36.0	3.5	458	7.9	10.0
06...	39.0	3.5	457	7.9	9.9
06...	42.0	3.5	460	7.9	9.9
06...	45.0	3.5	457	7.9	9.8
06...	48.0	3.5	459	7.9	9.6
06...	51.0	3.5	461	7.8	9.1
06...	54.0	3.5	462	7.8	9.0
06...	57.0	3.5	463	7.8	8.5
06...	60.0	3.5	464	7.8	8.4
06...	63.0	3.5	467	7.7	7.4
06...	66.0	3.5	468	7.7	7.3
06...	69.0	3.5	474	7.7	6.5
06...	71.0	--	--	--	--
APR					
10...	1.50	6.0	444	8.1	11.7
10...	3.00	6.0	445	8.1	11.7
10...	6.00	6.0	443	8.1	11.5
10...	9.00	6.0	444	8.1	11.6
10...	12.0	5.5	444	8.1	12.4
10...	15.0	5.5	443	8.1	12.4
10...	18.0	5.5	444	8.1	11.8
10...	21.0	5.5	445	8.1	11.5
10...	24.0	5.5	441	8.1	11.5
10...	27.0	5.5	443	8.1	11.4
10...	30.0	5.5	444	8.1	11.4
10...	33.0	5.5	445	8.1	11.4
10...	36.0	5.5	444	8.1	11.3
10...	39.0	5.5	446	8.1	11.4
10...	42.0	5.5	444	8.0	11.3
10...	45.0	5.5	445	8.0	11.3
10...	48.0	5.5	444	8.0	11.3
10...	51.0	5.5	446	8.0	11.4
10...	54.0	5.5	446	8.0	11.4
10...	57.0	5.5	444	8.0	11.4
10...	60.0	5.5	445	8.0	11.4
10...	63.0	5.5	447	8.0	11.4
10...	66.0	5.5	446	8.0	11.4
10...	71.0	5.5	446	8.0	11.4
10...	72.5	--	--	--	--

Table 1. Lake-depth profiles for Waubeesee Lake at Wind Lake, Wisconsin, 1996 water year - continued

WATER-QUALITY DATA

DATE	SAMPLING DEPTH (FEET) (00003)	TEMPERATURE WATER (DEG C) (00010)	SPECIFIC CONDUCTANCE (US/CM) (00095)	PH WATER WHOLE FIELD (STANDARD UNITS) (00400)	OXYGEN, DISSOLVED (MG/L) (00300)
JUN 1996					
11...	1.50	17.5	452	8.3	9.6
11...	3.00	17.5	452	8.3	9.4
11...	6.00	17.5	452	8.3	9.7
11...	9.00	17.5	452	8.3	10.0
11...	12.0	17.5	452	8.3	10.2
11...	15.0	16.5	450	8.2	9.1
11...	18.0	14.5	454	8.1	8.9
11...	21.0	13.5	454	8.1	8.4
11...	24.0	12.0	451	8.0	8.2
11...	27.0	11.0	449	8.0	8.4
11...	30.0	10.5	447	8.0	8.4
11...	33.0	9.5	449	8.0	8.3
11...	36.0	9.0	449	8.0	8.0
11...	39.0	8.5	449	7.9	7.9
11...	42.0	8.0	448	7.9	7.8
11...	45.0	7.5	449	7.8	7.0
11...	48.0	7.0	452	7.7	6.3
11...	51.0	7.0	450	7.7	6.5
11...	54.0	7.0	447	7.7	6.1
11...	57.0	6.5	449	7.7	5.3
11...	60.0	6.5	450	7.6	4.5
11...	63.0	6.5	450	7.6	4.4
11...	66.0	6.5	450	7.6	4.0
11...	69.0	6.5	451	7.6	3.2
11...	72.0	6.5	453	7.6	2.7
11...	73.5	--	--	--	--
JUL					
16...	1.50	25.0	433	8.5	9.3
16...	3.00	25.0	433	8.5	9.3
16...	6.00	25.0	430	8.5	9.5
16...	9.00	24.0	434	8.5	9.2
16...	12.0	23.0	442	8.4	8.9
16...	15.0	18.0	462	8.2	9.5
16...	18.0	16.0	456	8.1	8.3
16...	21.0	14.0	459	7.9	5.4
16...	24.0	12.0	456	7.8	5.5
16...	27.0	11.0	455	7.9	6.0
16...	30.0	10.5	453	8.0	6.6
16...	33.0	9.5	451	8.0	6.8
16...	36.0	9.0	452	8.0	6.7
16...	39.0	8.0	449	7.9	6.5
16...	42.0	8.0	449	7.9	6.0
16...	45.0	7.5	451	7.8	4.8
16...	48.0	7.5	451	7.8	4.6
16...	51.0	7.0	451	7.7	3.8
16...	54.0	7.0	451	7.7	2.6
16...	57.0	6.5	451	7.6	1.7
16...	60.0	6.5	452	7.6	0.8
16...	63.0	6.5	453	7.6	0.3
16...	66.0	6.5	453	7.6	0
16...	68.0	6.5	453	7.6	0
16...	69.5	--	--	--	--

Table 1. Lake-depth profiles for Waubeesee Lake at Wind Lake, Wisconsin, 1996 water year - continued

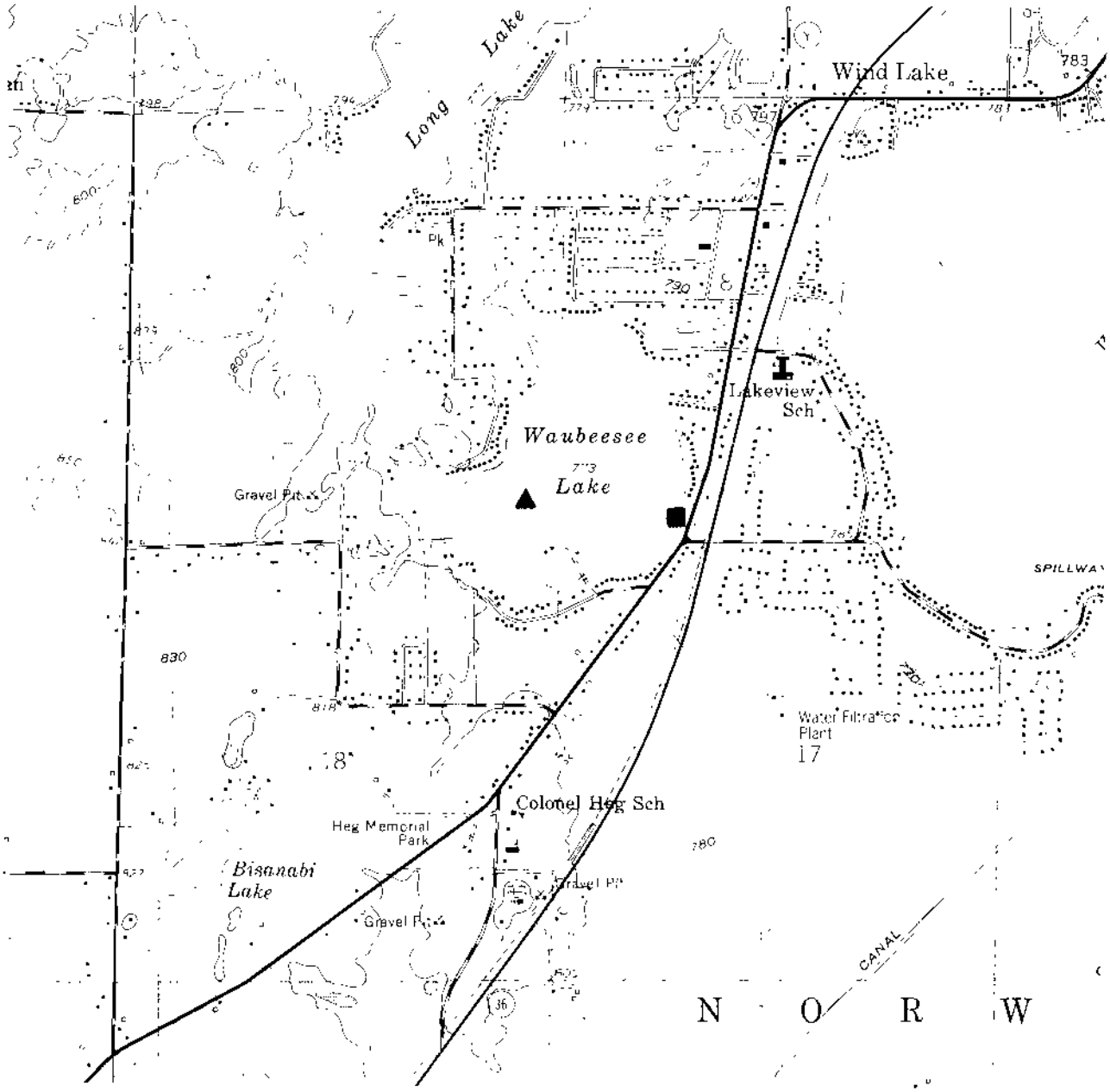
WATER-QUALITY DATA

DATE	SAMPLING DEPTH (FEET) (00003)	TEMPERATURE WATER (DEG C) (00010)	SPECIFIC CONDUCTANCE (US/CM) (00095)	PH WATER WHOLE FIELD (STANDARD UNITS) (00400)	OXYGEN, DISSOLVED (MG/L) (00300)
AUG 1996					
13...	1.50	26.0	423	8.6	8.4
13...	3.00	25.5	423	8.6	8.4
13...	6.00	25.0	422	8.6	8.1
13...	9.00	24.5	428	8.5	8.2
13...	12.0	23.0	444	8.5	8.0
13...	15.0	20.0	456	8.3	7.6
13...	18.0	16.5	468	8.0	6.7
13...	21.0	13.5	465	7.6	1.1
13...	24.0	12.0	458	7.7	2.6
13...	27.0	11.0	459	7.8	3.8
13...	30.0	10.0	457	7.8	4.1
13...	33.0	9.5	454	7.8	4.7
13...	36.0	8.5	452	7.8	4.5
13...	39.0	8.0	453	7.8	4.5
13...	42.0	7.5	454	7.7	3.3
13...	45.0	7.5	453	7.7	2.9
13...	48.0	7.0	452	7.7	2.2
13...	51.0	7.0	452	7.6	0.2
13...	54.0	6.5	453	7.6	0
13...	57.0	6.5	453	7.6	0
13...	60.0	6.5	455	7.6	0
13...	63.0	6.5	457	7.6	0
13...	66.0	6.5	458	7.6	0
13...	69.0	6.5	460	7.6	0
13...	73.0	6.5	461	7.5	0
13...	74.5	--	--	--	--

Table 2.--Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Waubeesee Lake, 1996 water year

[- indicates not applicable; -- indicates no data available]

Date	Secchi Disk			Sampling	Total Phosphorus			Chlorophyll a		Dissolved Ortho-phosphate Phosphorus
	Depth (meters)	Depth (feet)	T.S.I.	Depth (feet)	Conc. (mg/L)	Conc. (µg/L)	T.S.I	Conc. (µg/L)	T.S.I.	Conc. (mg/L)
04/10/96	4.7	15.4	38	1.5	0.012	12	47	2.4	41	<0.002
	-	-	-	71	0.013	13	-	-	-	0.002
06/11/96	5.7	18.7	35	1.5	0.008	8	44	1.3	37	--
	-	-	-	72	0.111	111	-	-	-	--
07/16/96	2.8	9.2	45	1.5	0.012	12	47	2.6	42	--
	-	-	-	68	0.113	113	-	-	-	--
08/13/96	2.8	9.2	45	1.5	0.010	10	46	3.4	44	--
	-	-	-	73	0.217	217	-	-	-	--



EXPLANATION

▲ Water-quality monitoring site

■ Lake-stage monitoring site

Figure 1. Locations of water-quality and lake-stage monitoring sites on Waubeesee Lake at Wind Lake, Wisconsin.

LOCATION.--Lat 42°48'57", long 88°10'15", in SE 1/4 SE 1/4 sec.7, T.4 N., R.20 E., Racine County, Hydrologic Unit 07120006, at Wind Lake.
DRAINAGE AREA.--5.16 mi^2.
PERIOD OF RECORD.--February 1988 to August 1989, February 1991 to current year.
REMARKS.--Lake sampled near southwest end at the deep hole. Lake ice-covered during February measurements. Water-quality analyses done by Wisconsin State Laboratory of Hygiene.

WATER-QUALITY DATA, FEBRUARY 06 TO AUGUST 13, 1996

(Milligrams per liter unless otherwise indicated)

	Feb. 06		Apr 10		June 11		July 16		Aug 13	
Depth of sample (ft)	3.0	69	1.5	71	1.5	72	1.5	68	1.5	73
Lake stage (ft)	4.93		4.90		5.32		5.76		4.88	
Specific conductance (µS/cm)	464	474	444	446	452	453	433	453	423	461
pH (units)	7.9	7.7	8.3	8.0	8.3	7.6	8.5	7.6	8.6	7.5
Water temperature (°C)	2.5	3.5	6.0	5.5	17.5	6.5	25.0	6.5	26.0	6.5
Color (Pt-Co. scale)	---	---	25	29	---	---	---	---	---	---
Turbidity (NTU)	---	---	0.60	1.2	---	---	---	---	---	---
Secchi-depth (meters)	---		4.7		8.7		2.8		2.8	
Dissolved oxygen	11.9	6.5	11.7	11.4	9.6	2.7	9.3	0.0	8.4	0.0
Hardness, as CaCO3	---	---	210	210	---	---	---	---	---	---
Calcium, dissolved (Ca)	---	---	42	42	---	---	---	---	---	---
Magnesium, dissolved (Mg)	---	---	25	25	---	---	---	---	---	---
Sodium, dissolved (Na)	---	---	13	13	---	---	---	---	---	---
Potassium, dissolved (K)	---	---	3	3	---	---	---	---	---	---
Alkalinity, as CaCO3	---	---	170	170	---	---	---	---	---	---
Sulfate, dissolved (SO4)	---	---	29	29	---	---	---	---	---	---
Chloride, dissolved (Cl)	---	---	27	27	---	---	---	---	---	---
Fluoride, dissolved (F)	---	---	0.1	0.1	---	---	---	---	---	---
Silica, dissolved (SiO2)	---	---	1.0	1.0	---	---	---	---	---	---
Solids, dissolved, at 180°C	---	---	268	264	---	---	---	---	---	---
Nitrogen, NO2 + NO3, diss (as N)	---	---	0.20	0.20	---	---	---	---	---	---
Nitrogen, ammonia, dissolved (as N)	---	---	<0.03	<0.03	---	---	---	---	---	---
Nitrogen, organic, total (as N)	---	---	0.80	0.80	---	---	---	---	---	---
Nitrogen, amm. + org., total (as N)	---	---	0.80	0.80	---	---	---	---	---	---
Nitrogen, total (as N)	---	---	1.0	1.0	---	---	---	---	---	---
Phosphorus, total (as P)	---	---	0.012	0.013	0.008	0.111	0.012	0.113	0.010	0.217
Phosphorus, ortho, dissolved (as P)	---	---	<0.002	0.002	---	---	---	---	---	---
Iron, dissolved (Fe) µg/L	---	---	<10	<10	---	---	---	---	---	---
Manganese, dissolved (Mn) µg/L	---	---	<0.4	1	---	---	---	---	---	---
Chlorophyll a, phytoplankton (µg/L)	---	---	2.4	---	1.1	1.3	2.6	---	3.4	---

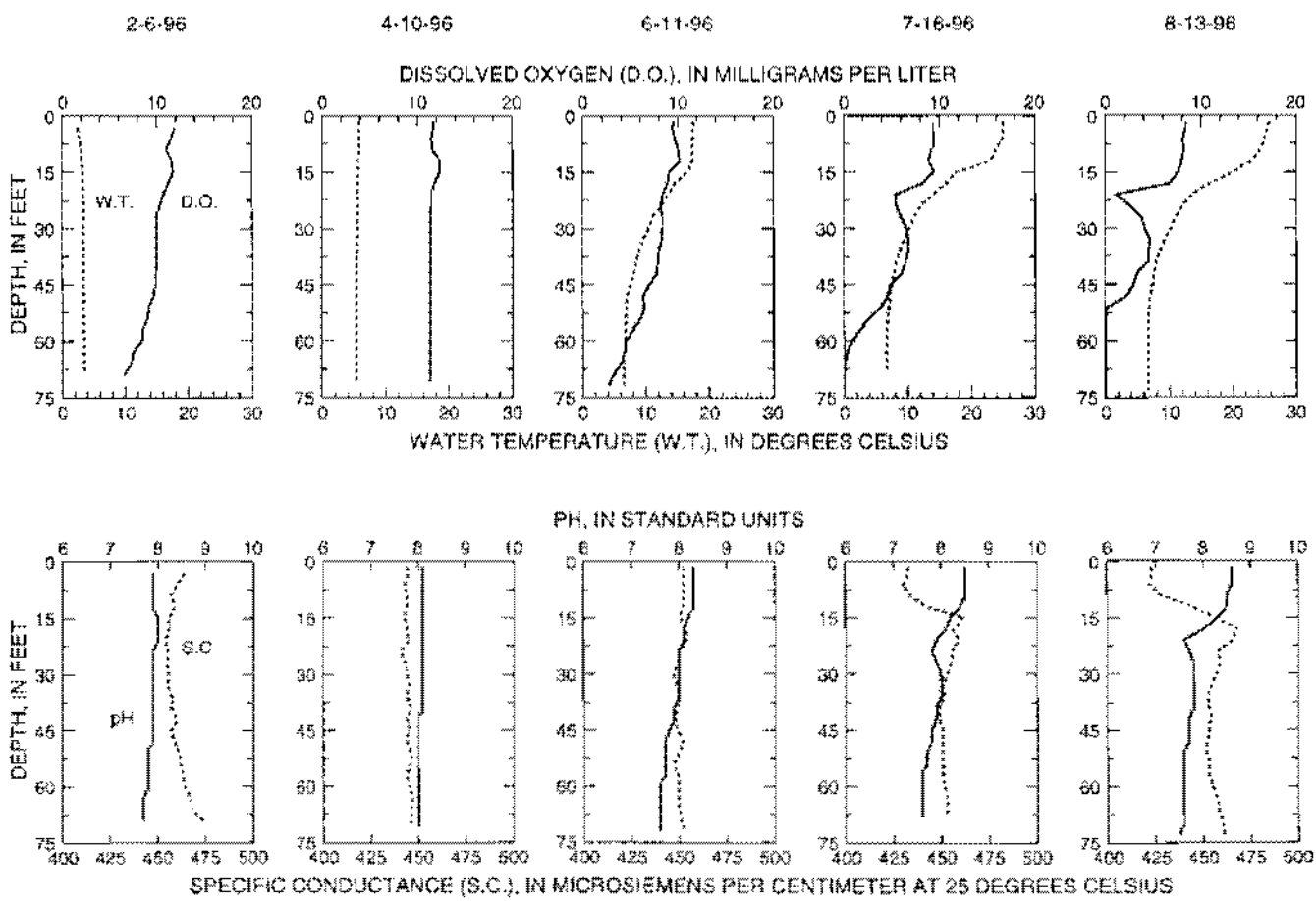


Figure 2. Water-quality data and depth profiles for Waubeesee Lake at Wind Lake, Wisconsin, 1996 water year

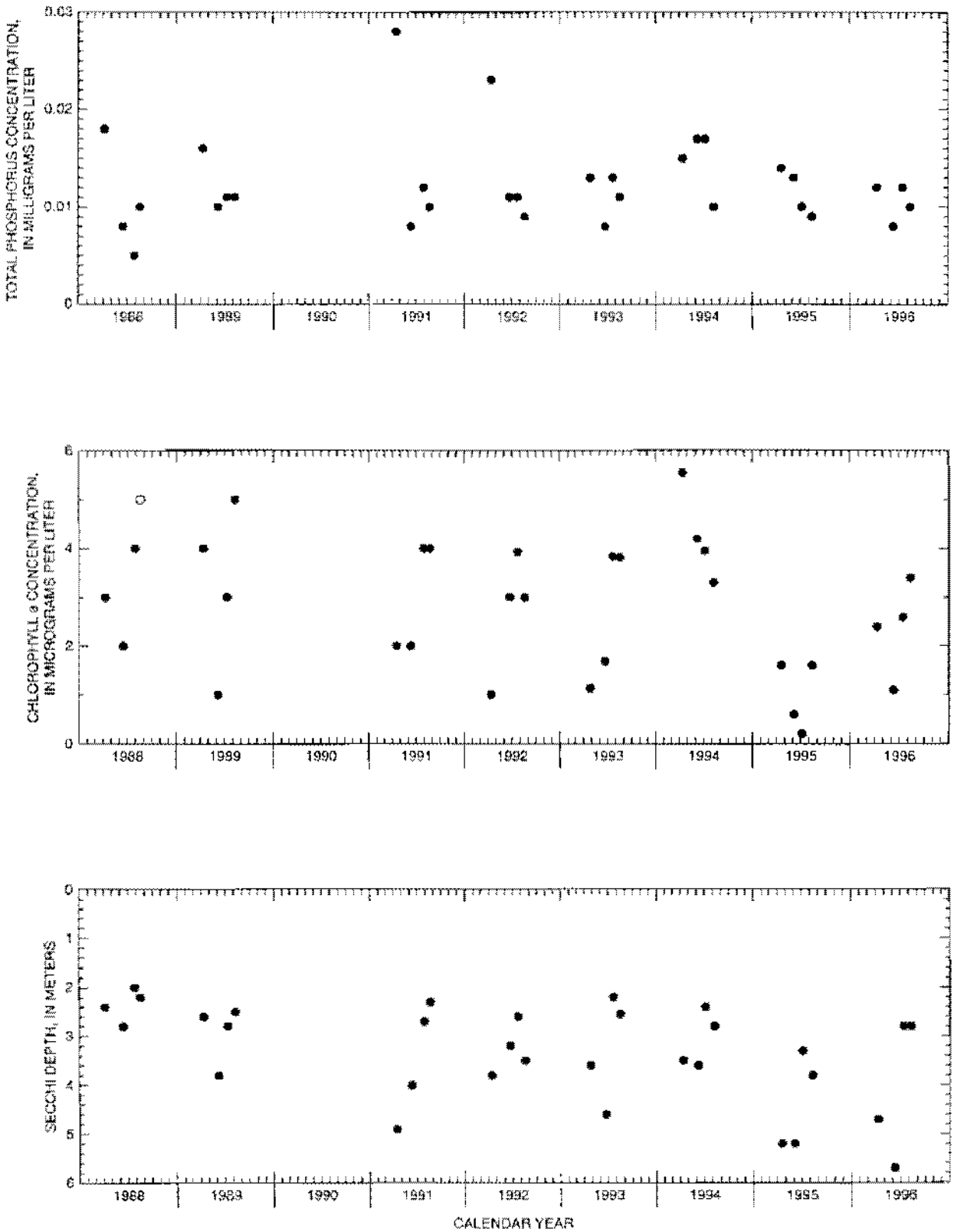


Figure 3. Surface total phosphorus and chlorophyll a concentrations, and Secchi depths for Waubeesee Lake at Wind Lake, Wisconsin.

(Circles indicate laboratory detection limit for selected analyses. Actual concentrations for these particular analyses are less than the plotted circles.)

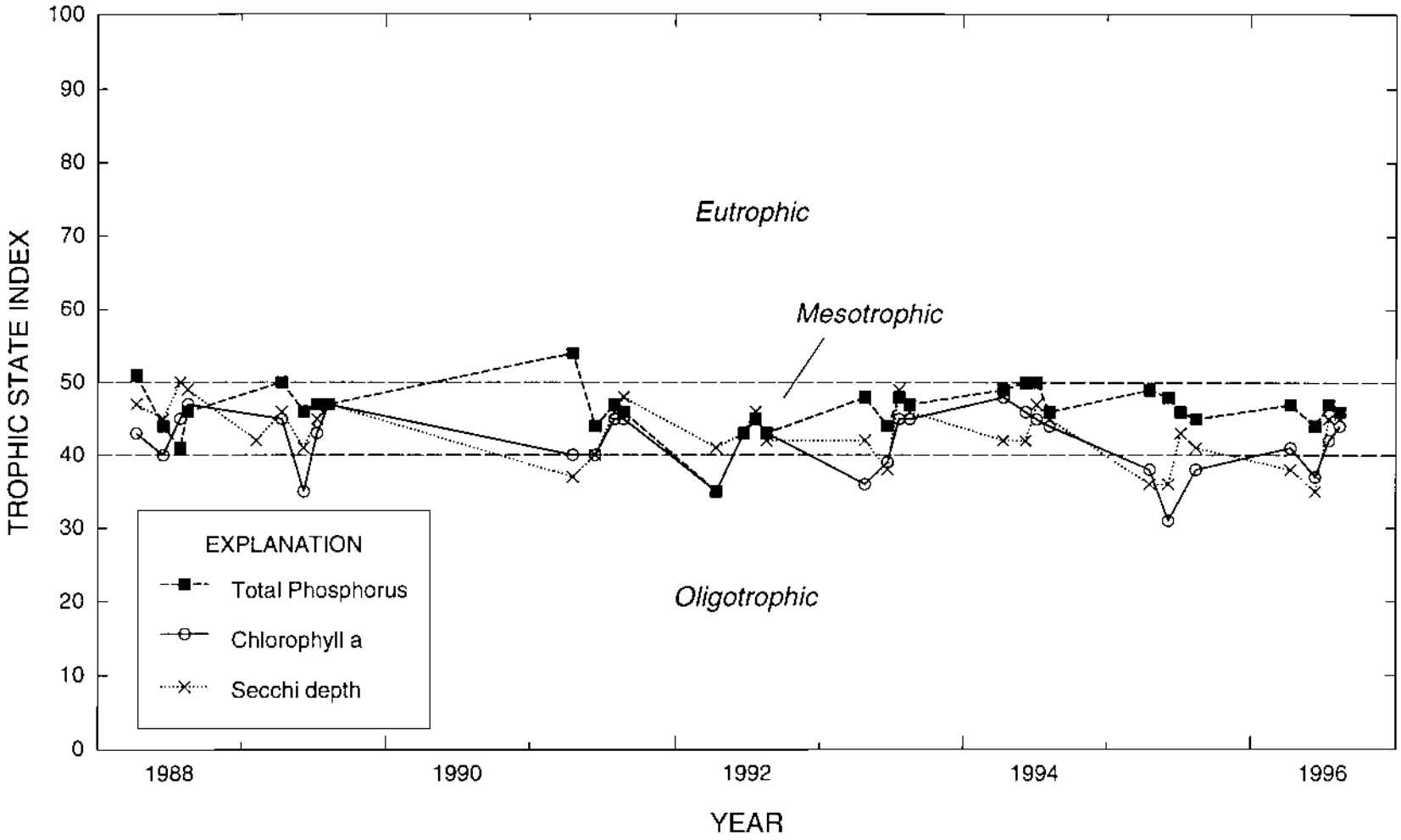


Figure 4. Trophic state indices for Waubeesee Lake at Wind Lake, Wisconsin