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United States Department of the Interior

U.S. GEOLOGICAL SURVEY

Water Resources Division
6417 Normandy Lane
Madison, Wisconsin 53719-1133
608 274-3535 (Fax 608 276-3817)

July 30, 1996

Ms. Mary Platner
Alma-Moon Lake Protection and Rehabilitation District
N61 W29911 Rybeck Road
Hartland, Wisconsin 53029

Dear Ms. Platner:

This letter describes the progress on the evaluation of the water quality of Alma Lake according to the data collected from October 1994 to September 1995 as stated in our agreement. The format for this progress report is different from that of previous years, but it contains essentially the same type of information.

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 1995" and to Shaw and others (1994) "Understanding Lake Data."

Hydrologic conditions during water year 1995:

Annual variability in lake condition often reflects variability in climatic and hydrologic conditions. Air temperature in northcentral Wisconsin was, on the average, 3.6 °F warmer than normal for the period December 1994 through March 1995; April and May were 4.0 °F cooler than normal; and the period June through August was 3.2 °F warmer than normal (National Oceanic and Atmospheric Administration "Climatological Data--Wisconsin"). Precipitation during water year 1995 was 93 percent of normal precipitation for the northcentral division in Wisconsin (Pamela Naber-Knox, UW-Extension, Geological and Natural History Survey, written common., 1995). Watershed runoff in the region of Alma Lake was between 60 and 80 percent of long-term average runoff (Holmstrom and others, 1996, "Water Resources Data--Wisconsin").

Lake description and sampling locations:

Alma Lake is classified as a seepage lake, with no inlet or outlet. Alma Lake has a mean depth of 11 feet and a surface area of 55 acres (0.086 square miles). The water-quality monitoring site is located at the deepest point in the lake at a depth of about 17 feet. Lake stage was monitored along the southwest

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 0.011 mg/L on April 26 and August 16 to 0.016 mg/L on June 13, chlorophyll a ranged from <0.1 µg/L on July 19 to 5.4 µg/L on August 16, and Secchi depths ranged from 2.8 m on August 16 to 4.2 m on June 13 and July 19.[1]

Surface total-phosphorus and chlorophyll a concentrations, and Secchi depths for the 1992-95 period are shown in Figure 3. No general year to year or seasonal trends are apparent from the data. However, the surface total-phosphorus concentration appears to be slightly higher, on average, than the values from the previous three years.

Total-phosphorus concentrations 1.5 feet above the lake bottom ranged from 0.010 mg/L on August 16 to 0.012 mg/L on April 26 and July 19.

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, chlorophyll a concentrations, and Secchi depths. According to the index, surface total-phosphorus and chlorophyll a (using only the August value) concentrations in Alma Lake indicate "good" water quality, and Secchi depths indicate "very good" water quality.

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

1. The extremely low chlorophyll a values for July 19 is believed to be erroneous and the result of a laboratory error. Abnormally low chlorophyll a values were obtained for samples from numerous other lakes samples during a two week period in July. These low values for chlorophyll a were not accompanied by corresponding decreases in total phosphorus or increases in Secchi depth as would be expected.

	Parameter		Percentage distribution of lakes in northeast Wisconsin within parameter range
	Total-phosphorus (mg/L)		
	<0.010	best condition	22
Alma Lake values	0.010-0.020		41
	0.020-0.030		21
	0.030-0.050		12
	>0.050	worst condition	5
	Chlorophyll a (µg/L)		
	0-5	best condition	34
Alma Lake values	5-10		38
	10-15		11
	15-30		11
	>30	worst condition	5
	Secchi depth (feet)		
	>19.7	best condition	4
Alma Lake values	9.8-19.7		32
	6.6-9.8		22
	3.3-6.6		26
	<3.3	worst condition	16

Trophic status:

Another means of assessing the nutrient, or trophic, status of a lake is to use Carlson's Trophic State Index (TSI). The 1995 data is listed in Table 3. Figure 4 is a graphical illustration of the variation in Trophic State Indices for Alma Lake during the 4 year study period. The chlorophyll a value for July 1995 is not included in Figure 4. The data from 1995 show the lake to be mesotrophic to upper oligotrophic, or a lake with moderate to low nutrient levels.

The data that have been collected for Alma Lake from 1992 through 1995 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. Continued monitoring will help to build on this valuable data base.

If you have questions regarding this evaluation, please contact me at (608) 276-3834.

Sincerely,

William J Rose

William Rose
Hydrologist

Enclosures

cc: Bob Young, DNR, Rhinelander

Table 1. Lake stages for Alma and Moon Lakes, near St. Germain, Wisconsin, 1995 water year

LOCATION.--Lat 45°54'26", long 89°25'47", in NE 1/4 sec.36, T.40 N., R.8 E., Vilas County, Hydrologic Unit 07070001, 3 mi east of St. Germain.

LAKE-STAGE RECORDS

PERIOD OF RECORD.--October 1984 to September 1990, May 1992 to current year.

GAGE.--Staff gage read by Douglas Pagel.

EXTREMES FOR PERIOD OF RECORD.--Maximum gage height observed, 12.35 ft, Apr. 11, 12, 1986; minimum observed, 8.98 ft, Oct. 26, 27, 1989.

EXTREMES FOR CURRENT YEAR.--Maximum gage height observed, 10.91 ft, May 19, 29; minimum observed, 10.55 ft, Sept. 27.

GAGE HEIGHT, FEET, WATER YEAR OCTOBER 1994 TO SEPTEMBER 1995

DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	---	---	---	---	---	---	---	---	---	---	---	---
2	---	---	---	---	---	---	---	---	---	10.69	---	---
3	---	---	---	---	---	---	---	---	---	---	---	---
4	---	---	---	---	---	---	---	---	10.87	---	---	10.77
5	---	---	---	---	---	---	---	---	---	---	---	---
6	---	---	---	---	---	---	---	10.73	---	---	10.61	---
7	---	---	---	---	---	---	---	---	---	---	---	---
8	---	---	---	---	---	---	---	---	---	---	---	10.71
9	---	---	---	---	---	---	---	---	---	10.67	---	---
10	---	---	---	---	---	---	---	---	---	---	---	---
11	---	---	---	---	---	---	---	10.81	---	---	---	---
12	---	---	---	---	---	---	---	---	10.83	---	---	---
13	---	---	---	---	---	---	---	---	10.82	---	10.77	---
14	---	---	---	---	---	---	---	---	---	---	---	---
15	---	---	---	---	---	---	---	---	---	---	---	---
16	---	---	---	---	---	---	---	---	---	10.71	10.87	---
17	---	---	---	---	10.72	---	---	---	10.74	---	---	10.63
18	---	---	---	---	---	---	---	---	---	---	---	---
19	---	---	---	---	---	---	---	10.91	---	10.72	---	---
20	---	---	---	---	---	---	---	---	---	---	10.83	---
21	---	---	---	---	---	---	---	---	---	---	---	---
22	---	---	---	---	---	---	---	---	---	---	---	---
23	---	---	---	---	---	---	---	---	10.73	10.71	---	---
24	---	---	---	---	---	---	---	---	---	---	---	---
25	---	---	---	---	---	---	---	---	---	---	---	---
26	---	---	---	---	---	---	10.76	---	---	---	---	---
27	---	---	---	---	---	---	---	---	---	---	10.85	10.55
28	---	---	---	---	---	---	---	---	---	10.73	---	---
29	---	---	---	---	---	---	---	10.91	---	---	---	---
30	---	---	---	---	---	---	---	---	---	---	---	---
31	---	---	---	---	---	---	---	---	---	---	---	---

Table 2. Lake depth profiles for Alma Lake near St. Germain, Wisconsin, 1995 water year

455426089254700 - ALMA LAKE NEAR ST. GERMAIN, WI

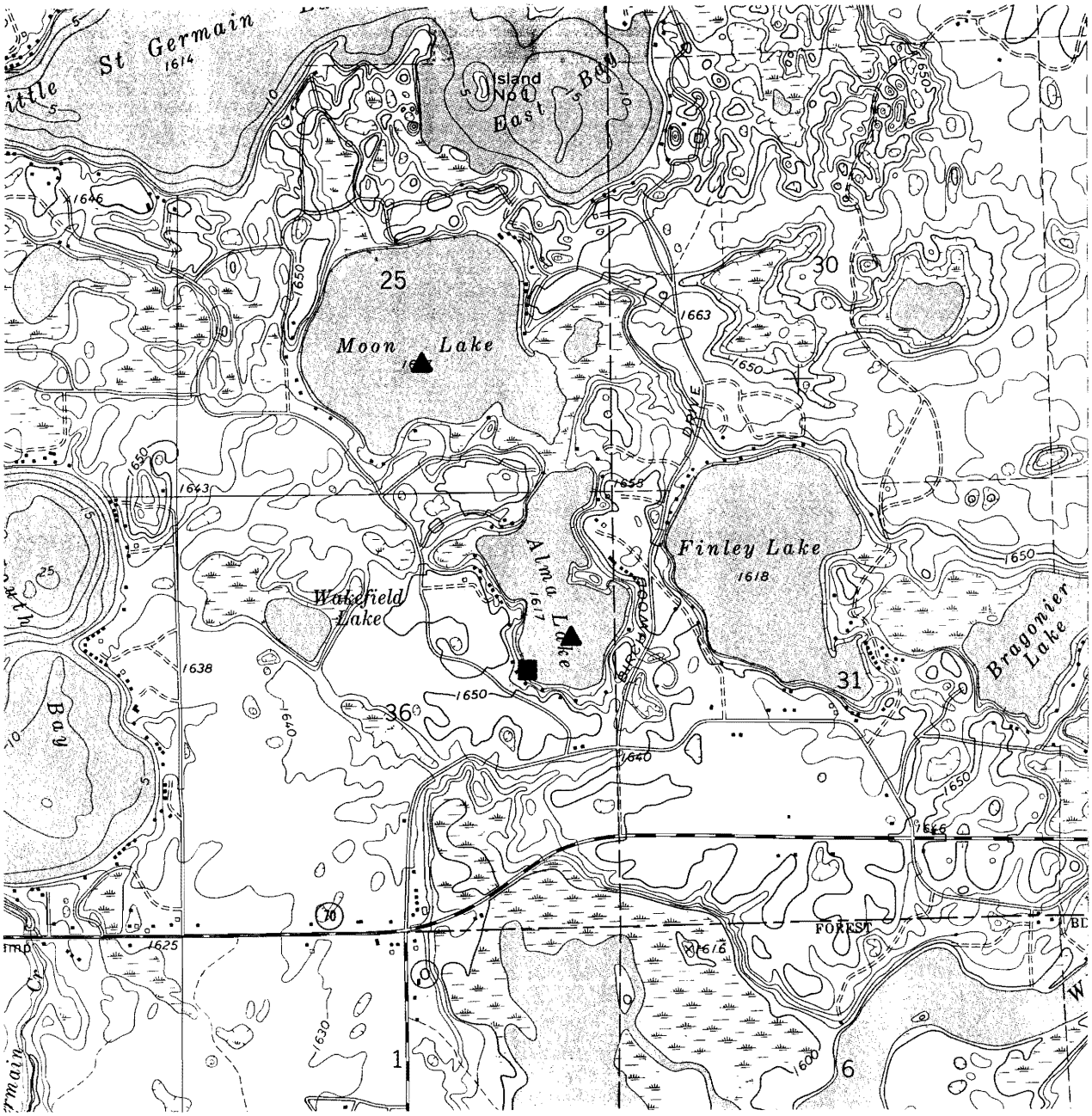
WATER-QUALITY DATA

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)
FEB 1995					
17...	3.00	2.0	31	6.0	7.2
17...	5.00	4.0	31	6.1	6.6
17...	7.00	4.0	30	5.8	6.6
17...	9.00	4.0	30	5.7	6.6
17...	11.0	4.0	28	5.7	6.6
17...	13.0	4.0	28	5.7	6.6
17...	15.0	4.0	28	5.7	6.6
17...	17.0	4.0	28	5.7	6.5
17...	18.0	--	--	--	--
APR					
26...	1.50	7.0	25	6.5	11.6
26...	3.00	7.0	25	6.4	11.6
26...	5.00	7.0	25	6.3	11.6
26...	7.00	6.5	24	6.3	11.6
26...	9.00	6.5	24	6.3	11.6
26...	11.0	6.5	24	6.3	11.6
26...	13.0	6.5	24	6.3	11.6
26...	15.0	6.5	24	6.3	11.6
26...	17.0	6.0	24	6.2	11.6
26...	18.5	--	--	--	--
JUN					
13...	1.50	20.0	24	5.9	9.0
13...	3.00	20.0	24	5.9	9.0
13...	5.00	19.5	23	5.9	9.0
13...	7.00	19.5	22	5.9	9.0
13...	9.00	19.0	22	5.9	9.1
13...	11.0	18.5	22	6.0	9.2
13...	13.0	18.5	22	5.9	9.1
13...	15.0	18.5	22	5.9	9.1
13...	17.0	18.0	22	5.9	8.3
13...	18.5	--	--	--	--
JUL					
19...	1.50	23.0	25	6.4	8.1
19...	3.00	23.0	24	6.4	8.0
19...	5.00	23.0	24	6.4	8.0
19...	7.00	23.0	23	6.4	8.0
19...	9.00	23.0	23	6.4	8.0
19...	11.0	23.0	23	6.2	8.0
19...	13.0	23.0	23	6.1	8.0
19...	15.0	23.0	24	6.0	7.8
19...	16.0	22.5	24	5.7	7.0
19...	17.5	--	--	--	--
AUG					
16...	1.50	25.0	17	6.1	8.0
16...	3.00	25.0	17	6.1	8.0
16...	5.00	25.0	16	6.1	7.9
16...	7.00	25.0	15	6.2	7.9
16...	9.00	25.0	15	6.2	7.9
16...	11.0	25.0	14	6.2	7.9
16...	13.0	25.0	15	6.1	7.7
16...	15.0	24.5	15	6.0	7.5
16...	16.5	24.5	14	5.9	7.3
16...	18.0	--	--	--	--

Table 3.--Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Alma Lake, 1995 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)
04/26/95	3.8	12.5	41	1.5	0.011	11	47	3.20	44	<0.002
	-	-	-	17	0.012	12	-	-	-	<0.002
06/13/95	4.2	13.8	39	1.5	0.016	16	50	1.4	37	--
	-	-	-	17	0.011	11	-	-	-	--
07/19/95	4.2	13.8	39	1.5	0.013	13	48	<0.1	17	--
	-	-	-	16	0.012	12	-	-	-	--
08/16/95	2.8	9.2	45	1.5	0.011	11	47	5.4	48	--
	-	-	-	16	0.010	10	-	-	-	--



EXPLANATION

▲ Water-quality monitoring site

■ Lake-stage monitoring site

Figure 1. Locations of water-quality and lake-stage monitoring sites on Alma and Moon Lakes near St. Germain, Wisconsin.

WATER-QUALITY RECORDS

PERIOD OF RECORD.--October 1984 to September 1990 secchi depth only; February 1992 to current year.

REMARKS.--Lake sampled near center of southern lobe of lake at the deep hole. Lake ice-covered during February measurements. Water-quality analyses done by Wisconsin State Laboratory of Hygiene.

WATER-QUALITY DATA, FEBRUARY 17 TO AUGUST 16, 1995
(Milligrams per liter unless otherwise indicated)

	Feb. 17		Apr. 26		June 13		July 19		Aug. 16	
Depth of sample (ft)	3.0	17	1.5	17	1.5	17	1.5	16	1.5	16
Lake stage (ft)	10.72		10.76		10.82		10.72		10.87	
Specific conductance (µS/cm)	31	28	25	24	24	22	25	24	17	14
pH (units)	6.0	5.7	6.5	6.2	5.9	5.9	6.4	5.7	6.1	5.9
Water temperature (°C)	2.0	4.0	7.0	6.0	20.0	18.0	23.0	22.5	25.0	24.5
Color (Pt-Co. scale)	---	---	5	10	---	---	---	---	---	---
Turbidity (NTU)	---	---	<0.50	0.50	---	---	---	---	---	---
Secchi-depth (meters)	---		3.8		4.2		4.2		2.8	
Dissolved oxygen	7.2	6.5	11.6	11.6	9.0	8.3	8.1	7.0	8.0	7.3
Hardness, as CaCO3	---	---	9	8	---	---	---	---	---	---
Calcium, dissolved (Ca)	---	---	2.4	2.0	---	---	---	---	---	---
Magnesium, dissolved (Mg)	---	---	0.7	0.7	---	---	---	---	---	---
Sodium, dissolved (Na)	---	---	0.7	0.7	---	---	---	---	---	---
Potassium, dissolved (K)	---	---	<0.3	0.3	---	---	---	---	---	---
Alkalinity, as CaCO3	---	---	6	6	---	---	---	---	---	---
Sulfate, dissolved (SO4)	---	---	4.0	5.0	---	---	---	---	---	---
Chloride, dissolved (Cl)	---	---	0.2	1.0	---	---	---	---	---	---
Fluoride, dissolved (F)	---	---	<0.1	<0.1	---	---	---	---	---	---
Silica, dissolved (SiO2)	---	---	<0.0	<0.0	---	---	---	---	---	---
Solids, dissolved, at 180°C	---	---	16	18	---	---	---	---	---	---
Nitrogen, NO2 + NO3, diss. (as N)	---	---	0.06	0.05	---	---	---	---	---	---
Nitrogen, ammonia, dissolved (as N)	---	---	0.03	<0.03	---	---	---	---	---	---
Nitrogen, organic, total (as N)	---	---	0.47	0.50	---	---	---	---	---	---
Nitrogen, amm. + org., total (as N)	---	---	0.50	0.50	---	---	---	---	---	---
Nitrogen, total (as N)	---	---	0.56	0.55	---	---	---	---	---	---
Phosphorus, total (as P)	---	---	0.011	0.012	0.016	0.011	0.013	0.012	0.011	0.010
Phosphorus, ortho, dissolved (as P)	---	---	<0.002	<0.002	---	---	---	---	---	---
Iron, dissolved (Fe) µg/L	---	---	20	10	---	---	---	---	---	---
Manganese, dissolved (Mn) µg/L	---	---	16	7	---	---	---	---	---	---
Chlorophyll a, phytoplankton (µg/L)	---	---	3.2	---	1.4	---	<0.1	---	5.4	---

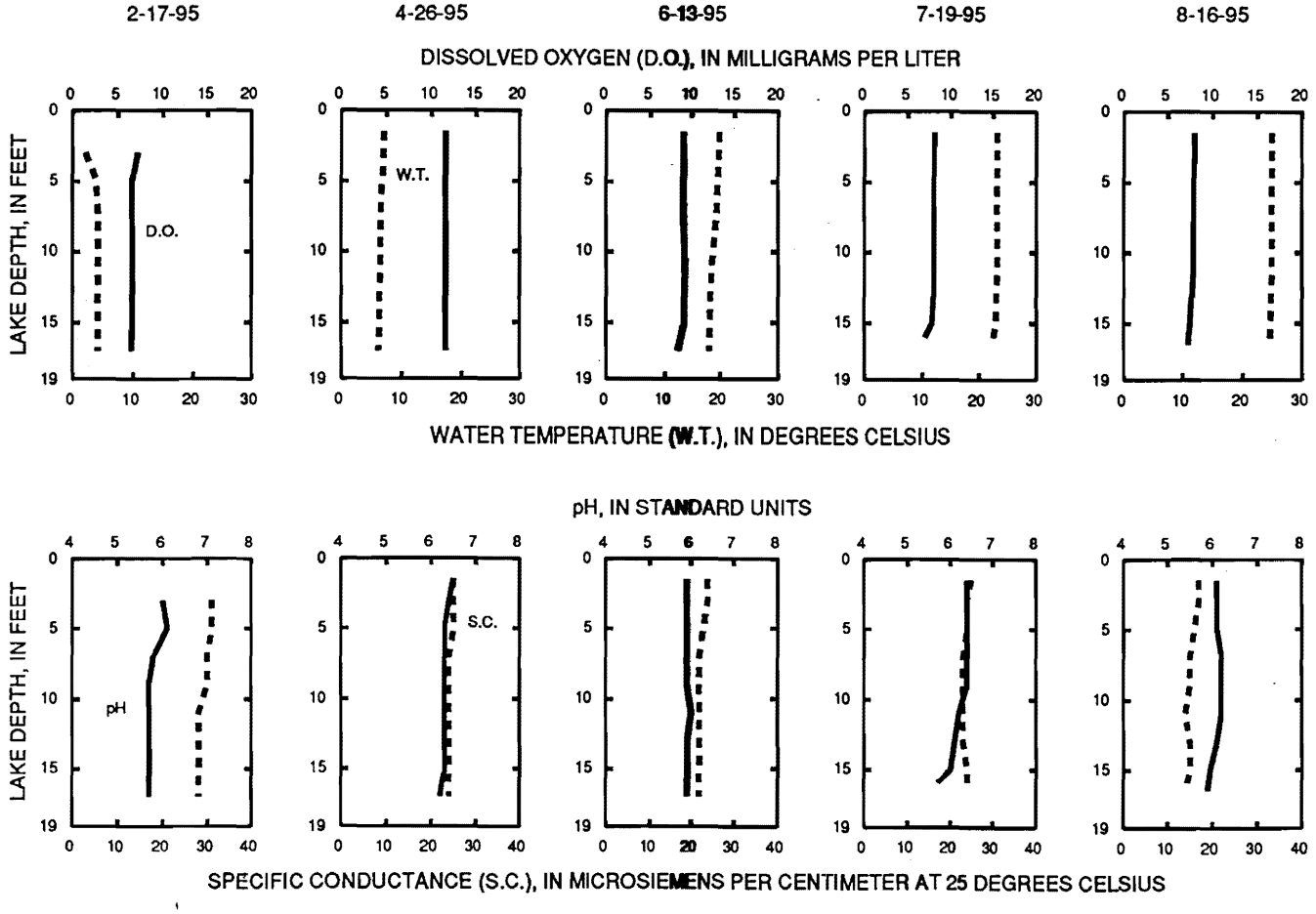
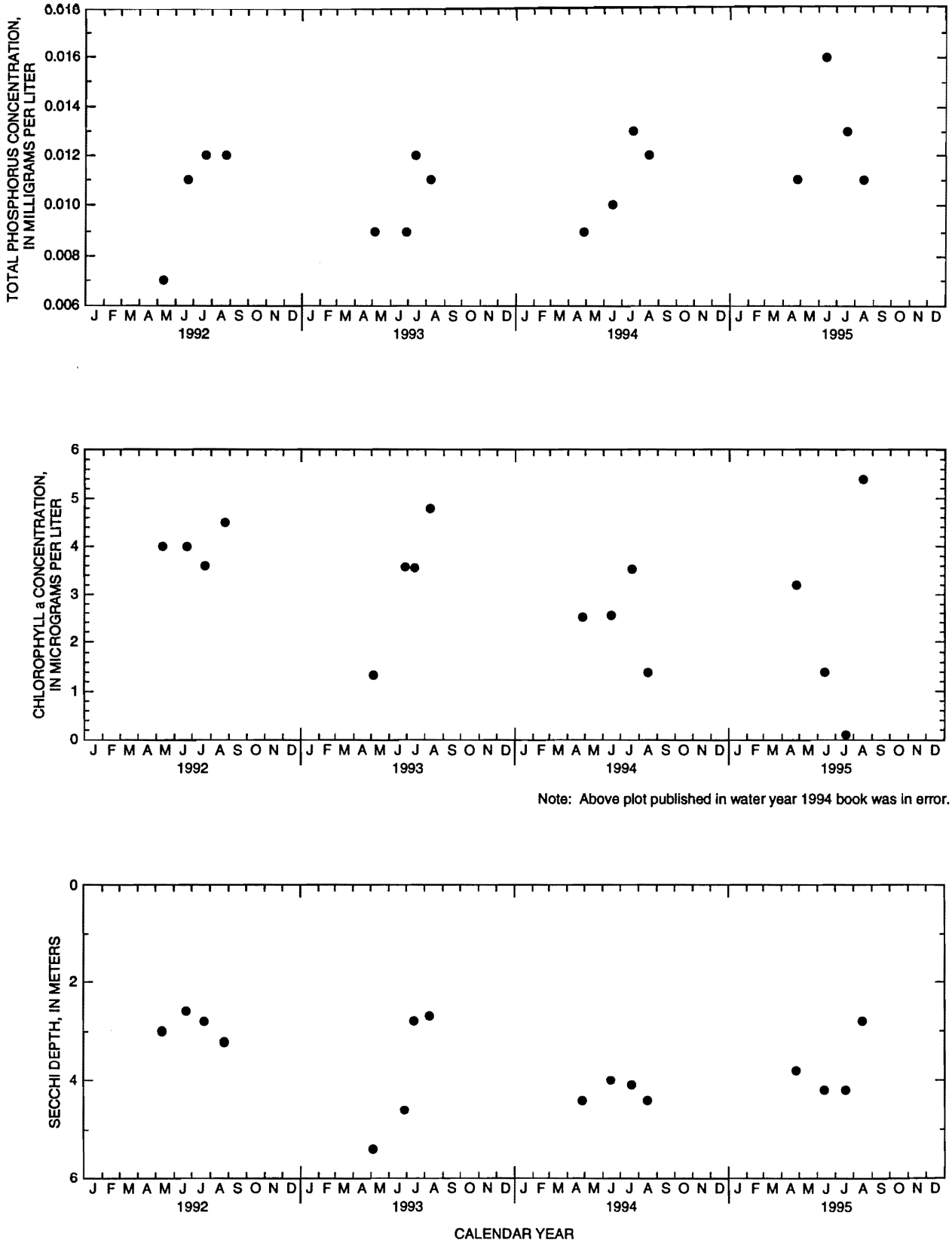


Figure 2. Lake water-quality data and depth profiles for Alma Lake, near St. Germain, Wisconsin, 1995 water year



Note: Above plot published in water year 1994 book was in error.

Figure 3. Surface total phosphorus and chlorophyll a concentrations, and Secchi depths for Alma Lake near St. Germain, Wisconsin.

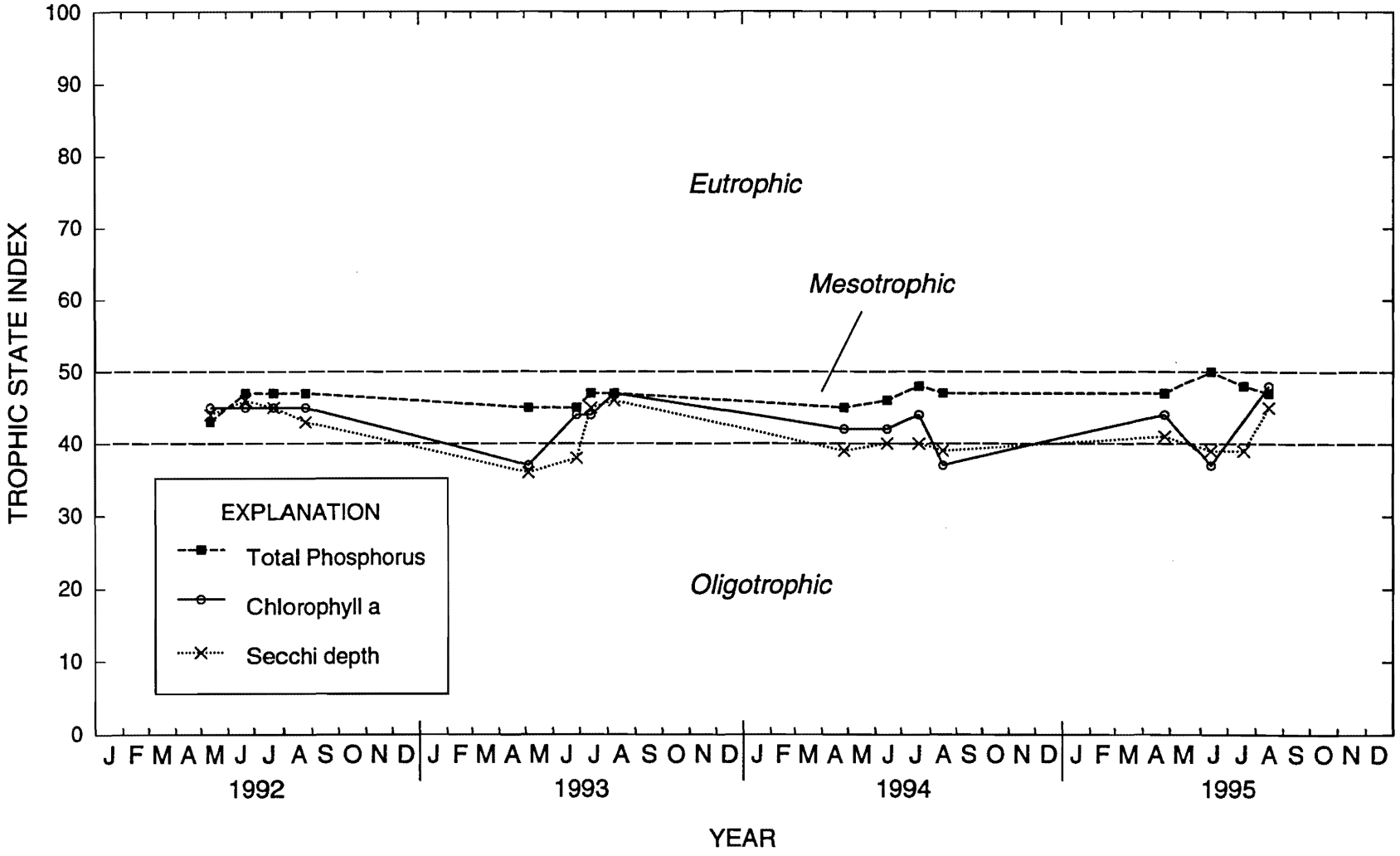


Figure 4. Trophic state indices for Alma Lake near St. Germain, Wisconsin