



United States Department of the Interior

U.S. GEOLOGICAL SURVEY

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December 2, 1996

Mr. Tom Casper, Chairman
Pretty Lake Protection and Rehabilitation District
4818 Pretty Lake Drive
Dousman, Wisconsin 53118

Dear Mr. Casper:

This letter describes the progress on the evaluation of the water quality of Pretty 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 southeastern Wisconsin was, on the average, 3.2 °F warmer than normal for the period December 1994 through March 1995; April and May was 2.0 °F cooler than normal; and the period June through August was 3.8 °F warmer than normal (National Oceanic and Atmospheric Administration "Climatological Data--Wisconsin"). Precipitation during water year 1995 was 94 percent of normal precipitation for southeastern Wisconsin (Pamela Naber-Knox, UW-Extension, Geological and Natural History Survey, written commun., 1995). Watershed runoff in the region of Pretty Lake was between 80 and 100 percent of long-term average runoff (Holmstrom and others, 1996, "Water Resources Data--Wisconsin").

Lake description and sampling locations:

Pretty Lake is classified as a seepage lake, with no inlet or outlet. Pretty Lake has a surface area of 64 acres (0.1 square miles), and a watershed area 192 square miles. The water-quality sampling site is located at the deepest point in the lake at a depth of about 32 feet. Lake stage was monitored on the

southeast side of the lake. The locations of the monitoring sites are shown in Figure 1.

Lake Data for 1995:

Data collected during the year, as published in the lake data report are enclosed. The following summary presents some highlights from the tables and figures.

Lake-stage fluctuations:

Lake stages were only measured on two USGS sampling dates in the 1995 water year, and therefore do not show full range of stage fluctuation. The two observed stages only differed by 0.02 feet, while average fluctuation observed during the two previous years of monitoring was about 1.14 feet. Stage values are listed in the top half of Figure 2.

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 year. These profiles, which were measured over the deepest point in the lake, are listed in Table 1 and shown in Figure 2. During the February through August sampling period, complete water-column mixing was observed on April 4. The lake became thermally stratified through the summer. In June the lower 4.0 feet of water was anoxic (devoid of oxygen), and by August the lower 12.5 feet were anoxic. The anoxic zone is unable to support fish. The pH, which ranged between 7.1 and 8.6, is common for southeastern Wisconsin lakes and poses no problems for aquatic life.

Chemical constituents:

Analyses of water samples collected on April 4 for selected chemical constituents for chemical characterization of the lake are shown in Figure 2. Samples collected at 1.5 and 29-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 160:1, based on the surface concentrations on April 4. 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 0.010 mg/L on June 12 to 0.012 mg/L on July 6, chlorophyll *a* ranged from 1.2 µg/L on June 12 to 3.7 µg/L on August 17, and Secchi depths ranged from 2.7 m on August 17 to 5.6 m on June 12.

Surface total-phosphorus and chlorophyll *a* concentrations, and Secchi depths for the 1993 -95 period are shown in Figure 3. No year-to-year changes are apparent from these data.

Total-phosphorus concentration 1.5 feet above the lake bottom at the center site ranged from 0.015 mg/L on April 4 to 0.093 mg/L on July 6. The low total-phosphorus concentrations observed during anoxic periods are indicative of minor 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 and Secchi depths in Pretty Lake indicate "good" water quality, and chlorophyll *a* concentrations indicate "very good" water quality.

Lillie and Mason (1983) also provided a means of comparing the condition of Pretty 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 Pretty Lake.

Parameter	Percentage distribution of lakes in southeast Wisconsin within parameter ranges	
Total-phosphorus (mg/L)		
	best condition	7
Pretty 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
	worst condition	12

Parameter	Percentage distribution of lakes in southeast Wisconsin within parameter ranges	
Chlorophyll a (µg/L)		
Pretty Lake values	0-5	22
	5-10	31
	10-15	14
	15-30	12
	worst condition	22

Parameter	Percentage distribution of lakes in southeast Wisconsin within parameter ranges	
Secchi depth (feet)		
	best condition	1
	9.8-19.7	9
Pretty Lake values	6.6-9.8	26
	3.3-6.6	31
	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 1995 TSI data is listed in Table 2. Figure 4 is a graphical illustration of the variation in Trophic State Indices for Pretty Lake during the 3 year study period. The data from 1995 show the lake to be lower mesotrophic, or a lake with moderate to low nutrient levels.

The data that have been collected for Pretty Lake from 1993 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 Rose
Hydrologist

Enclosures

cc: Bob Wakeman, DNR, Milwaukee

Table 1. Lake-depth profiles for Pretty Lake near Dousman, Wisconsin, 1995 water year

WATER-QUALITY DATA					
DATE	SAM- PLING DEPTH (FEET) (00003)	TEMPER- ATURE WATER (DEG C) (00010)	SPE- CIFIC CON- DUCT- ANCE (US/CM) (00095)	PH WATER WHOLE FIELD (STAND- ARD UNITS) (00400)	OXYGEN, DIS- SOLVED (MG/L) (00300)
FEB 1995					
21...	1.50	3.5	393	8.6	16.2
21...	3.00	4.0	393	8.6	15.8
21...	6.00	4.0	389	8.6	15.5
21...	9.00	4.0	389	8.6	15.0
21...	12.0	4.5	406	8.3	12.2
21...	15.0	4.5	416	8.0	5.7
21...	18.0	5.0	415	7.8	3.6
21...	21.0	5.0	415	7.8	2.6
21...	24.0	5.0	424	7.7	2.0
21...	27.0	5.0	433	7.7	1.7
21...	28.0	5.0	431	7.7	1.5
21...	29.5	--	--	--	--
APR					
04...	1.50	6.5	384	8.4	10.9
04...	3.00	6.5	384	8.4	10.8
04...	6.00	7.0	383	8.4	10.6
04...	9.00	7.0	383	8.4	10.6
04...	12.0	7.0	382	8.4	10.8
04...	15.0	7.0	381	8.4	10.8
04...	18.0	6.5	380	8.4	10.4
04...	21.0	6.5	379	8.4	10.3
04...	24.0	6.5	380	8.4	10.4
04...	27.0	6.5	381	8.4	10.4
04...	29.0	6.5	381	8.4	10.4
04...	30.5	--	--	--	--
JUN					
12...	1.50	21.5	365	8.2	10.2
12...	3.00	21.5	365	8.2	10.1
12...	6.00	21.5	364	8.1	10.1
12...	9.00	21.0	365	8.1	10.7
12...	12.0	20.5	366	8.1	10.7
12...	15.0	19.5	374	8.1	12.2
12...	18.0	17.0	385	7.9	10.1
12...	21.0	15.5	396	7.5	6.7
12...	24.0	13.5	404	7.3	2.5
12...	27.0	13.0	406	7.2	1.2
12...	30.0	12.0	410	7.1	0.3
12...	32.5	11.5	411	7.1	0.3
12...	34.0	--	--	--	--
JUL					
06...	1.50	23.0	354	8.5	9.4
06...	3.00	23.0	354	8.5	9.4
06...	6.00	23.0	354	8.5	9.6
06...	9.00	23.0	355	8.5	9.9
06...	12.0	23.0	355	8.5	10.0
06...	15.0	23.0	354	8.5	9.9
06...	18.0	22.0	361	8.4	7.8
06...	21.0	19.0	404	7.4	2.0
06...	24.0	16.0	414	7.5	0.5
06...	27.0	14.0	415	7.5	0.6
06...	30.0	12.5	426	7.4	0.0
06...	31.5	12.5	431	7.4	0
06...	33.0	--	--	--	--
AUG					
17...	1.50	27.5	322	8.5	8.3
17...	3.00	27.5	321	8.5	8.2
17...	6.00	27.5	319	8.5	8.2
17...	9.00	27.5	323	8.5	7.5
17...	12.0	27.0	328	8.4	7.8
17...	15.0	26.0	351	8.1	5.4
17...	18.0	24.5	396	7.5	0.3
17...	21.0	22.0	422	7.3	0.3
17...	24.0	19.0	425	7.3	0.2
17...	27.0	16.5	444	7.3	0.2
17...	29.0	15.5	456	7.2	0.2
17...	30.5	--	--	--	--

Table 2.--Water clarity and water-quality analyses and their associated Trophic State Indices (TSI) for Pretty Lake, 1995 water year

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

Date	Secchi Disk			Sampling Depth (feet)	Total Phosphorus			Chlorophyll a		Dissolved Ortho-phosphate Phosphorus Conc. (mg/L)
	Depth (meters)	Depth (feet)	T.S.I.		Conc. (mg/L)	Conc. (µg/L)	T.S.I.	Conc. (µg/L)	T.S.I.	
04/04/95	5.0	16.4	37	1.5	0.011	11	47	2.1	40	<0.002
	-	-	-	29	0.015	15	-	-	-	<0.002
06/12/95	5.6	18.4	35	1.5	0.010	10	46	1.2	36	--
	-	-	-	32	0.042	42	-	-	-	--
07/06/95	2.9	9.5	45	1.5	0.012	12	47	1.3	37	--
	-	-	-	31	0.093	93	-	-	-	--
08/17/95	2.7	8.9	46	1.5	0.011	11	47	3.7	45	--
	-	-	-	29	0.062	62	-	-	-	--



EXPLANATION

- ▲ Water-quality monitoring site
- Lake-stage monitoring site

Figure 1. Locations of water-quality and lake-stage monitoring sites on Pretty Lake near Dousman, Wisconsin.

LOCATION.--Lat 42°57'22", long 88°29'50", in NE 1/4 NW 1/4 sec.28, T.6 N., R.17 E., Waukesha County, Hydrologic Unit 07090001, 4.1 mi south of Dousman.

PERIOD OF RECORD.--February 1993 to current year.

REMARKS.--Lake sampled at the deep hole which is near the northeast end of lake. Lake ice-covered during February measurements. Water-quality analyses done by Wisconsin State Laboratory of Hygiene.

WATER-QUALITY DATA, FEBRUARY 21 TO AUGUST 17, 1995
(Milligrams per liter unless otherwise indicated)

	Feb. 21		Apr. 04		June 12		July 06		Aug. 17	
Depth of sample (ft)	1.5	28	1.5	29	1.5	32	1.5	31	1.5	29
Lake stage (ft)	---		---		865.38		---		865.40	
Specific conductance (µS/cm)	393	431	384	381	365	411	354	431	322	456
pH (units)	8.6	7.7	8.4	8.4	8.2	7.1	8.5	7.4	8.5	7.2
Water temperature (°C)	3.5	5.0	6.5	6.5	21.5	11.5	23.0	12.5	27.5	15.5
Color (Pt-Co. scale)	---		<5		---		---		---	
Turbidity (NTU)	---		15		10.0		---		---	
Secchi-depth (meters)	---		5.0		5.6		2.9		2.7	
Dissolved oxygen	16.2	1.5	10.9	10.4	10.2	0.3	9.4	0.0	8.3	0.2
Hardness, as CaCO3	---		190		190		---		---	
Calcium, dissolved (Ca)	---		32		32		---		---	
Magnesium, dissolved (Mg)	---		27		27		---		---	
Sodium, dissolved (Na)	---		8.0		8.0		---		---	
Potassium, dissolved (K)	---		1		2		---		---	
Alkalinity, as CaCO3	---		170		170		---		---	
Sulfate, dissolved (SO4)	---		16		16		---		---	
Chloride, dissolved (Cl)	---		14		14		---		---	
Fluoride, dissolved (F)	---		0.1		0.1		---		---	
Silica, dissolved (SiO2)	---		0.9		0.9		---		---	
Solids, dissolved, at 180°C	---		216		218		---		---	
Nitrogen, NO2 + NO3, diss. (as N)	---		0.04		0.03		---		---	
Nitrogen, ammonia, dissolved (as N)	---		0.28		0.28		---		---	
Nitrogen, organic, total (as N)	---		0.62		0.72		---		---	
Nitrogen, amm. + org., total (as N)	---		0.90		1.0		---		---	
Nitrogen, total (as N)	---		0.94		1.0		---		---	
Phosphorus, total (as P)	---		0.011		0.015		0.012		0.0093	
Phosphorus, ortho, dissolved (as P)	---		<0.002		<0.002		---		---	
Iron, dissolved (Fe) µg/L	---		<10		<10		---		---	
Manganese, dissolved (Mn) µg/L	---		<0.4		<0.4		---		---	
Chlorophyll a, phytoplankton (µg/L)	---		2.1		---		1.2		3.7	

2-21-95

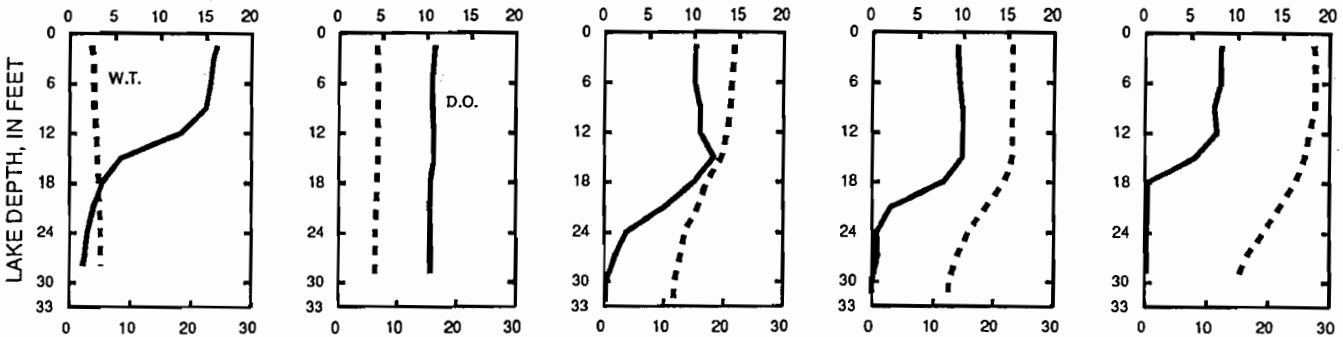
4-4-95

6-12-95

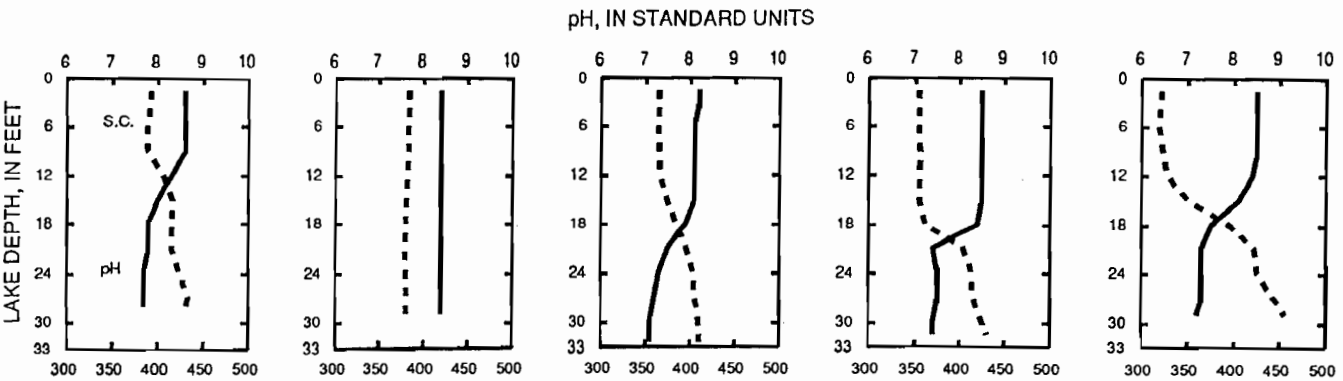
7-6-95

8-17-95

DISSOLVED OXYGEN (D.O.), IN MILLIGRAMS PER LITER



WATER TEMPERATURE (W.T.), IN DEGREES CELSIUS



SPECIFIC CONDUCTANCE (S.C.), IN MICROSIEMENS PER CENTIMETER AT 25 DEGREES CELSIUS

Figure 2. Water-quality data and depth profiles for Pretty Lake near Dousman, Wisconsin, 1995 water year

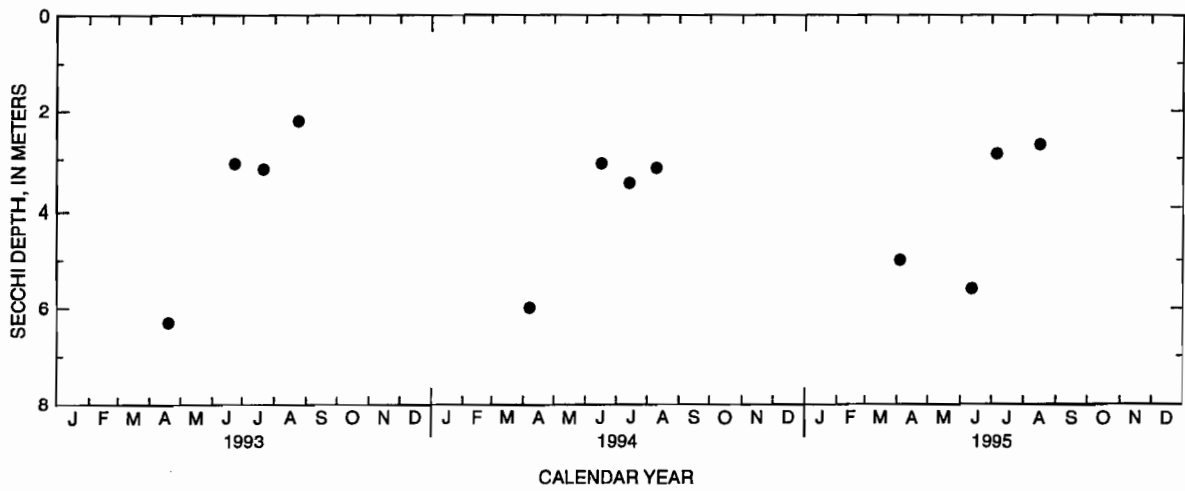
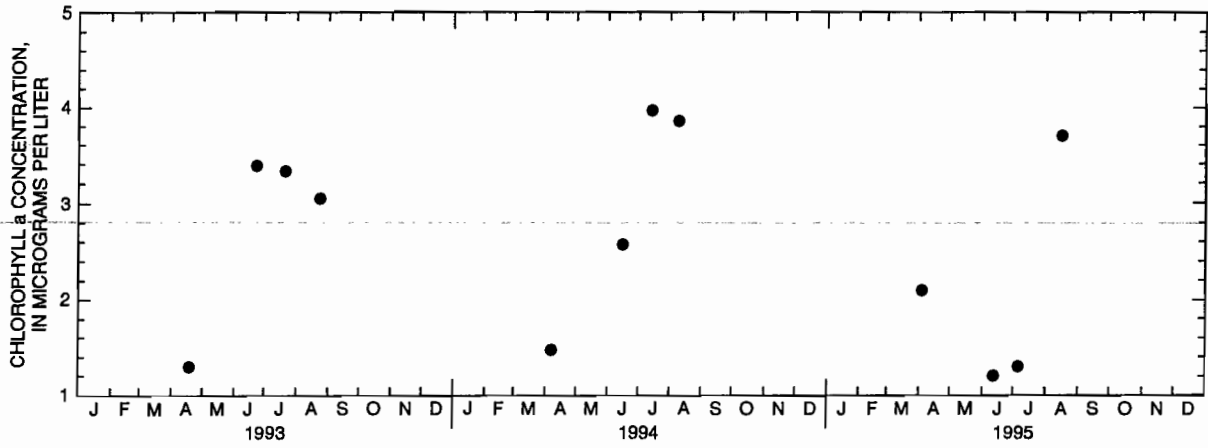
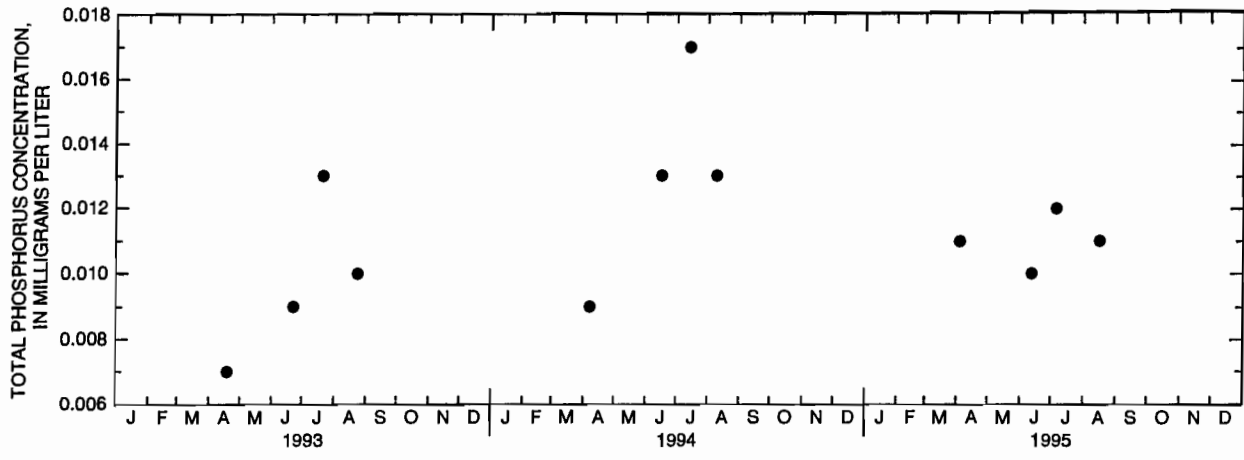


Figure 3. Surface total phosphorus and chlorophyll a concentrations, and Secchi depths for Pretty Lake, at Deep Hole, near Dousman, Wisconsin.

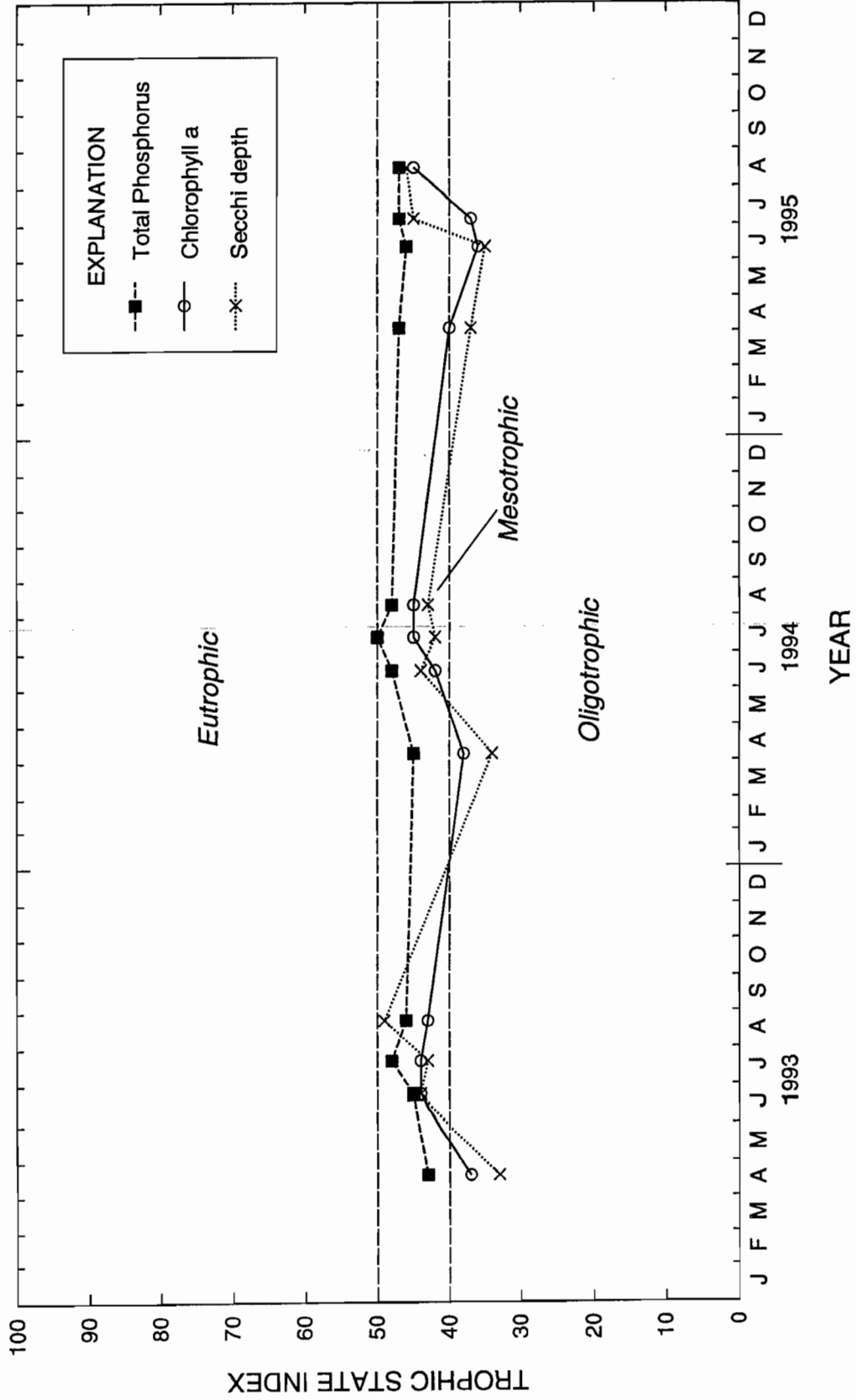


Figure 4. Trophic state indices for Pretty Lake near Dousman, Wisconsin