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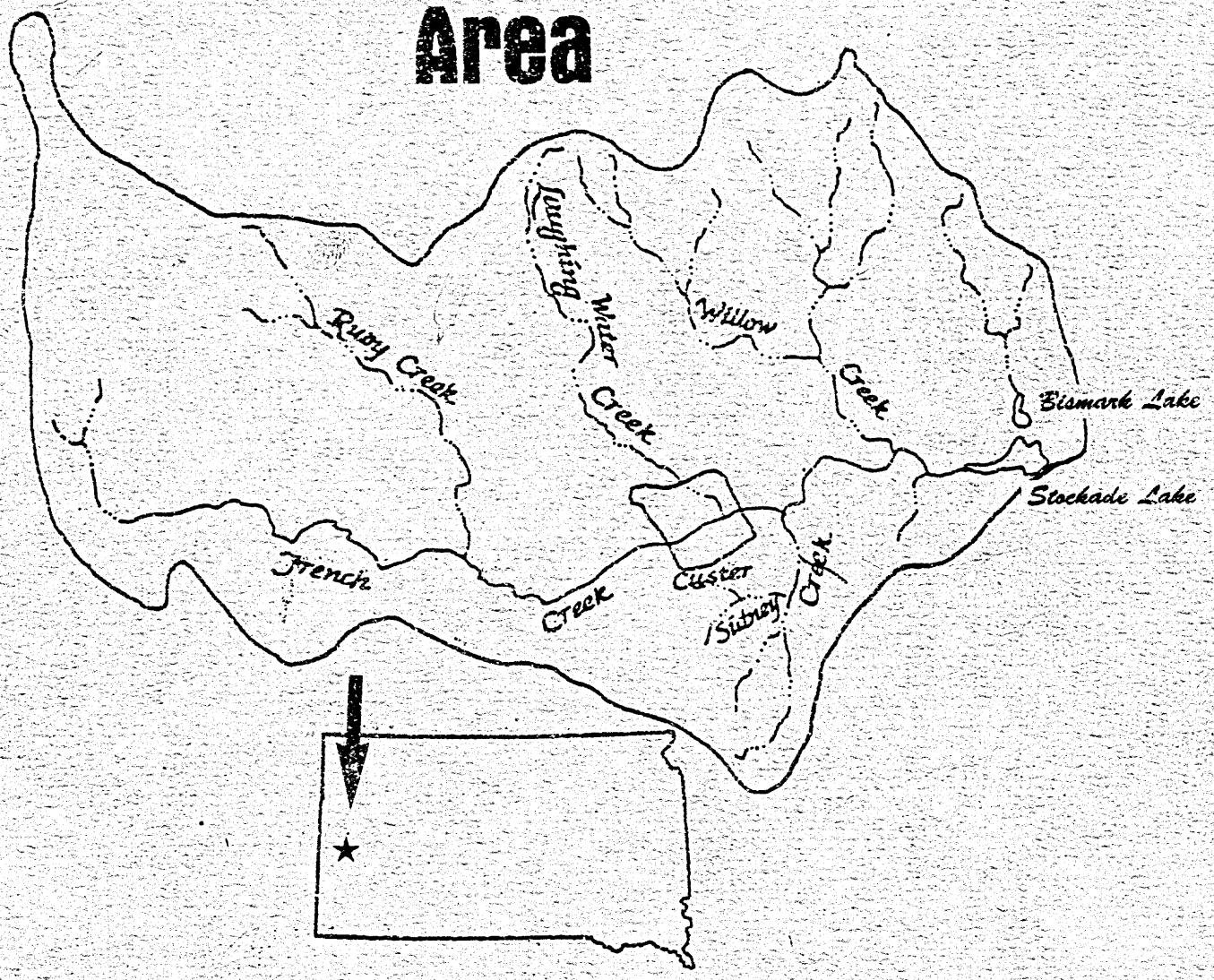
Stockade Lake Water Quality Study Area



Summary Report
1981

STOCKADE LAKE

WATER QUALITY STUDY AREA

SUMMARY REPORT

1981

Prepared by

Office of Water Quality

South Dakota Department of

Water and Natural Resources

Joe Foss Building

Pierre, South Dakota 57501

TABLE OF CONTENTS

Page

List of Tables i
List of Figures i
List of Appendices ii
Literature Cited iii

I. Stockade Lake Water Quality Study Area Summary 1

A. General Description 1
B. Beneficial Uses 3
C. Land Use 7
D. Topography/Geology/Climate 7

II. Stockade Lake Water Quality Study Area Selection 13

A. Criteria for Selection 13
B. WQSA Study Committees 14

III. Soil Loss - Sediment 16

IV. Water Quality Analysis of the Stockade Lake Watershed . . . 22

A. Description of Sites and Sampling Regime 22
B. Interpretation of Data 24

1. Water Quality Parameters 24

a. Phosphorus 24
b. Nitrogen 31
c. Dissolved Oxygen 32
d. Phytoplankton 32
e. Trophic State Index 35
f. Coliform Bacteria 35
g. Ammonia 38
h. Temperature 38
i. Miscellaneous Parameters 39

2. Nutrient Loadings 39

V. Stockade Lake Watershed Problems and Solutions 43

A. Watershed Problems and Recommendations 43

1. Custer Wastewater Treatment Plant 43
2. Individual Septic Tank/Drainfield Systems 47
3. Livestock Considerations 50
4. Sylvan Lake Wastewater System 51
5. Urban Runoff 53
6. Mining Activities 54
7. Silviculture 56

B. Inlake Problems and Recommendations 57

Tables

Page

1. Soil Erosion and Sediment Yield 20
2. Best Management Practices 21
3. Summary of Water Quality Violations 29
4. Beneficial Uses Assigned to Lakes and Streams in the Study Area . . . 30
5. Criteria for Lakes and Streams in the Study Area. 33
6. Mean Nutrient Concentration and Nutrient Ranges 34
7. Dissolved Oxygen Profile 36
8. Phytoplankton for Stockade Lake 41
9. Custer WWTP NPDES Limitations 45
10. Sylvan Lake WWTP NPDES Limitations. 52

Figures

1. Map of Stockade Lake Watershed 2
2. Stockade Lake Depth Contours 4
3. Map of Custer State Park With Stockade and Bismark Lakes. 6
4. Statewide Fishing, User-day, Surplus or Deficiency, ... Opportunity Map 8
5. Land Use Output - State Planning. 10
6. Average Annual Precipitation. 11
7. SCS Sediment Subareas . . . . . Producing Areas 18
8. Study Area Water Quality Sampling Sites 25
8. Stream and Lake Configuration 26
9. Watershed Mean Total PO_4 Configuration. 64
10. Watershed Mean Inorganic Nitrogen 65

Appendices

A. Selection Process

A1. Criteria for Selection of Stockade Lake as a WQSA
A2. Public Input into Selection of a WQSA
A3. Newspaper Articles

B. Management of Stockade Lake Study

B1. WQSA Workplan - Agency Responsibilities
B2. EPA - Stockade Lake Study Grant
B3. Technical Advisory Committee and Citizens Advisory Committee

C. Sedimentation Studies

C1. Soil Conservation Service Study
C2. 1972 Black Hills Conservancy Sub-district Sedimentation Study for Stockade Lake
C3. 1981 Study - Department of Water and Natural Resources and WQSA coordinator sedimentation results
C4. U.S. Forest Service Letter on Timber Harvest Sedimentation Rates
C5. Sedimentation, Pollution Sources - WQSA Coordinator Map and Narrative

D. Water Quality Graphs

E. Nutrient Data

E1. Calculations of Nutrient Loads to Stockade Lake
E2. Custer Wastewater Treatment Plant Effluent Data

F. Nutrient Pollution Sources - WQSA Coordinator Map and Narrative

G. Conceptual Plan for the Proposed Stockade Lake Watershed Improvement Project

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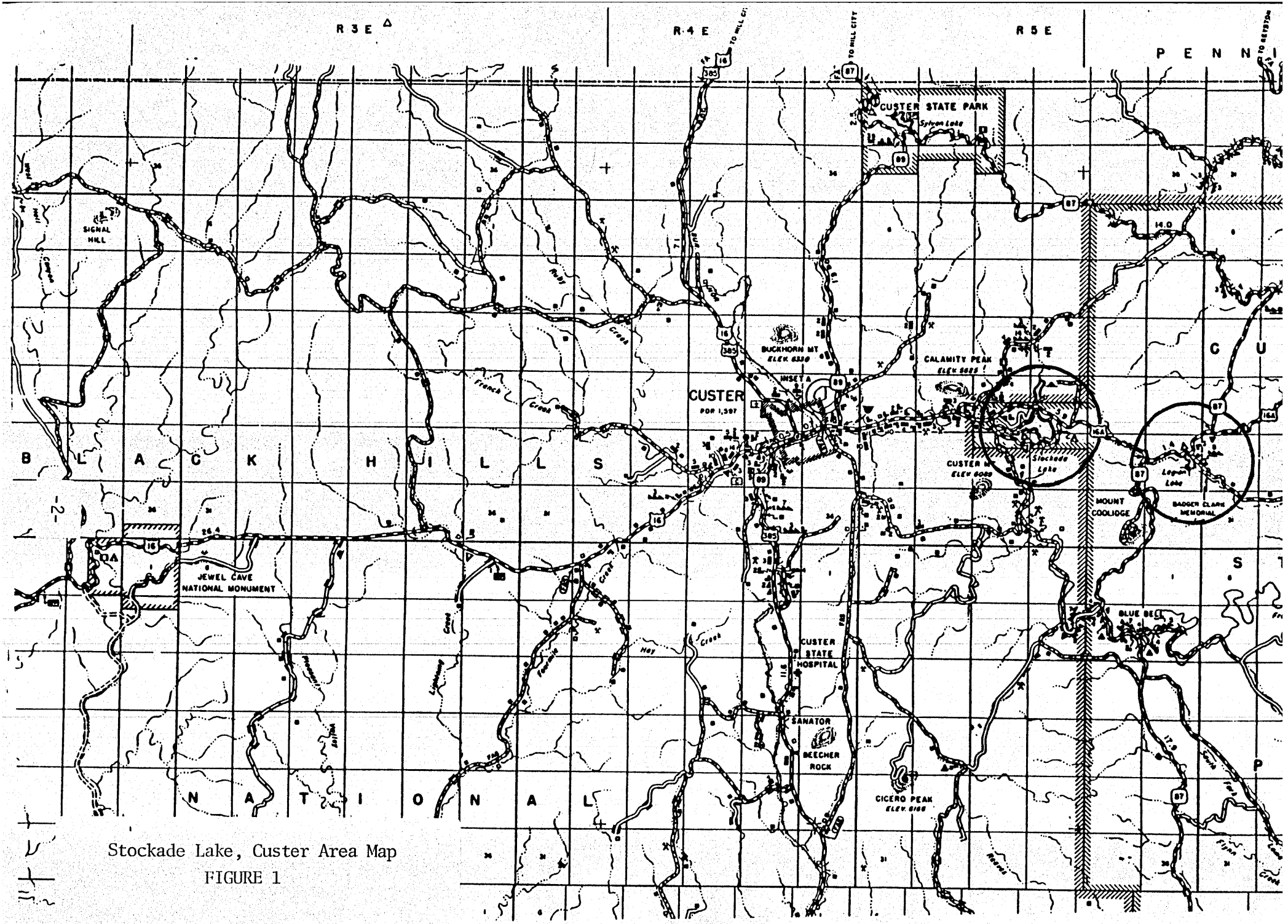
I. Stockade Lake - Water Quality Study Area Summary

A. General Description.

Stockade Lake is a manmade impoundment on French Creek, located in the southern Black Hills of South Dakota, four miles east of the City of Custer on U.S. Highway 16A (Figure 1). It was built in the mid 1930's by the Civilian Conservation Corps (CCC). The lake derives its name from its close proximity to the Gordon Stockade, a local historic landmark. The watershed for Stockade Lake is 25.8 km2 (66.8 square miles) of mostly mountainous, forested terrain. The lake has a surface area of 52.6 hectares (130 acres) and has a shoreline of 5.6 km (3.5 miles) making it the fourth largest lake in the Black Hills. The average depth of the lake is 5.5 meters (18 feet) with a maximum depth of 12.8 meters (42 feet) (Figure 2). The storage capacity of Stockade Lake is 3,040,000 m3 (2,470 acre feet). The lake is owned by the South Dakota Department of Game, Fish and Parks and is within the boundaries of Custer State Park.

The major water source for Stockade Lake is flow from French Creek with some additional flow from Bismark Lake, which was also built by CCC in the mid 1930's (Figure 3). Bismark Lake is located 164 m (150 yards) north of Stockade Lake. Bismark Lake is 8.9 hectares (22 acres) in surface area, has a maximum depth of 8.5 m (28 ft.) and a mean depth of 3 m (10 ft.). Surface runoff and groundwater feed Bismark Lake which has a drainage basin of 8.3 km2 (3.2 square miles). This lake suffers from poor water quality and has frequent fish kills. The discharge from Bismark Lake enters Stockade Lake during seasonal high flows. A small 0.2 hectare pool of water lies between the lakes during periods of no flow.



Stockade Lake, Custer Area Map

FIGURE 1

B. Beneficial Uses.

The local economy is dominated by tourism. As a result, Stockade Lake is heavily used for recreational purposes. Recreational uses include fishing, boating, picnicking, camping, and swimming. Stockade Lake is a heavily fished lake due to a lack of fishing opportunities in surrounding counties (Figure 4). The South Dakota Department of Game, Fish and Parks compiles a state inventory of fishing opportunity. Fishing opportunity is described as a user-day supply. Figure 4 lists user day fishing opportunity surpluses or deficiencies by county. Custer County lakes provide a fishing opportunity of 72,101 user days. After meeting Custer County fishing needs, a 37,955 user day surplus remains to make up the user day deficiencies of surrounding counties. Stockade Lake serves as a recreation resource for 5,854 Custer County residents. Rapid City is forty miles from Stockade Lake and has 46,340 of Pennington County's 73,375 population. Custer County has 11 lakes and impoundments including Stockade Lake. The additive surface acres of the 10 impoundments excluding Stockade Lake do not equal the 130 surface acres of Stockade Lake.

The Department of Game, Fish and Parks currently maintains a swimming area, a day use picnic area, a boat ramp and dock, and 3 camping areas with a 105 camper unit capacity on the shore areas of Stockade Lake. The camping areas around the lake are heavily used. Camping facilities are located on the north, southeast and on the south shores of the lake. The lake area is subject to moderate picnic and swimming use, and light to moderate boating and skiing use. The lake is surrounded by access roads.

STOCKADE LAKE

DEPTH CONTOURS

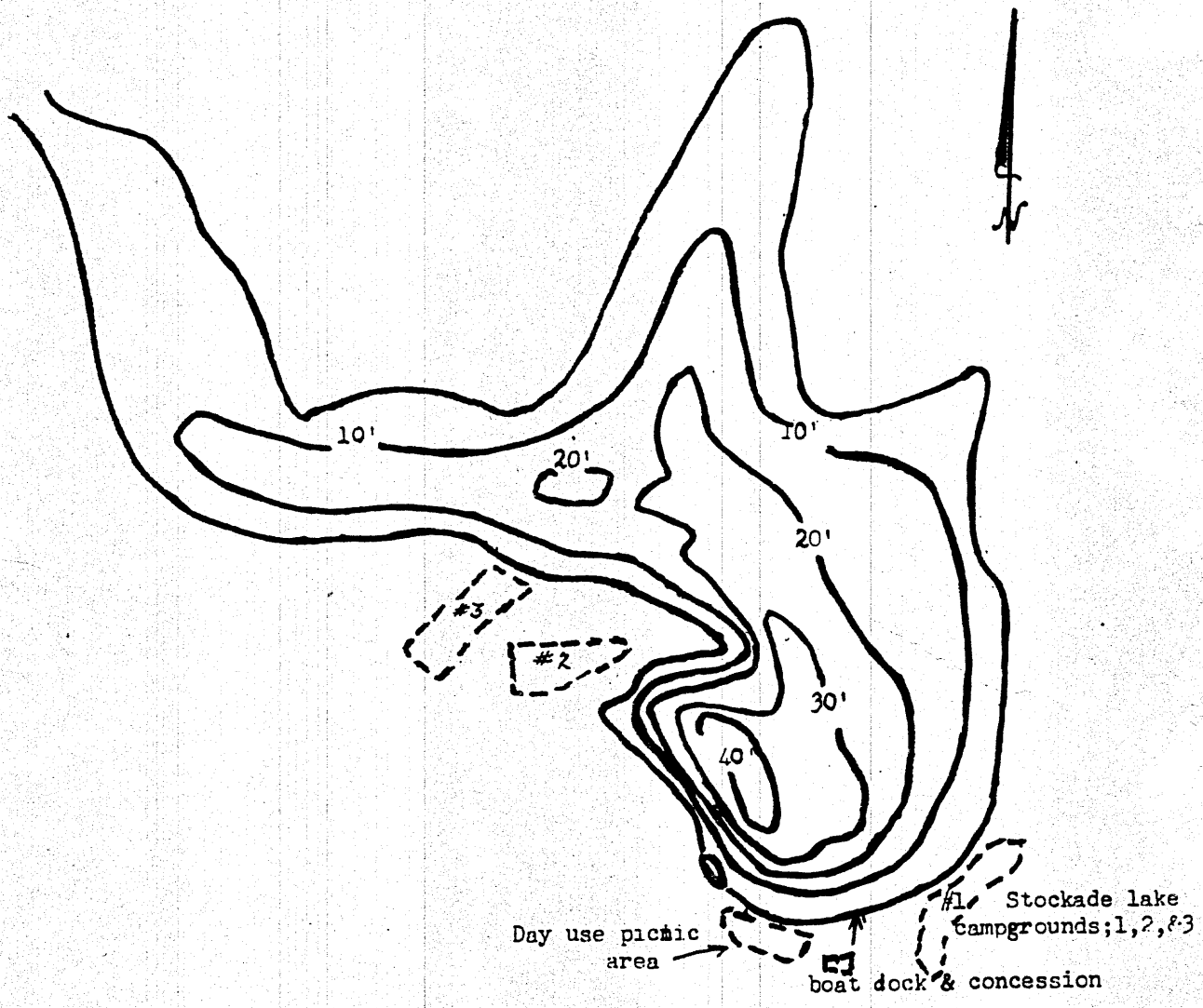


Figure 2

Stockade lake is assigned the following beneficial uses in South Dakota's "Surface Water Quality Standards" (ARSD 74:04:02): cold water marginal fish life propagation; immersion recreation; limited contact recreation; and wildlife propagation and stock watering.

Poor water quality impairs immersion recreation in Stockade Lake. At times, dense algal mats occur in the lake during the summer months. The lake had a safe bacteriological sample for the swimming area in 1980.

Stockade Lake is a cold water marginal fishery classification because of the occurrence of fish kills. The fish kills occur in both winter and summer. In July, 1970, a fish kill was halted by use of an aeration system that was installed by the South Dakota Department of Game, Fish and Parks. However, a lack of funding prevents continued use of the aeration system.

Stockade lake is a "put and take" fishery owing to the fishing demand and frequent fish kills. The cold water fishery is maintained by a stocking program of 39,000 rainbow trout fingerlings per year. The lake also supports a warm water fishery of yellow perch and bullheads. The lake has been stocked in the past with black crappies, yellow perch, large mouth bass, walleyes, northern pike, and bluegills. Green sunfish and black bullheads were introduced by anglers. The lake was chemically treated to remove stunted and undesirable fish in the early 1960's. However, less desirable fish such as carp suckers and black bullheads have found their way back into the lake.

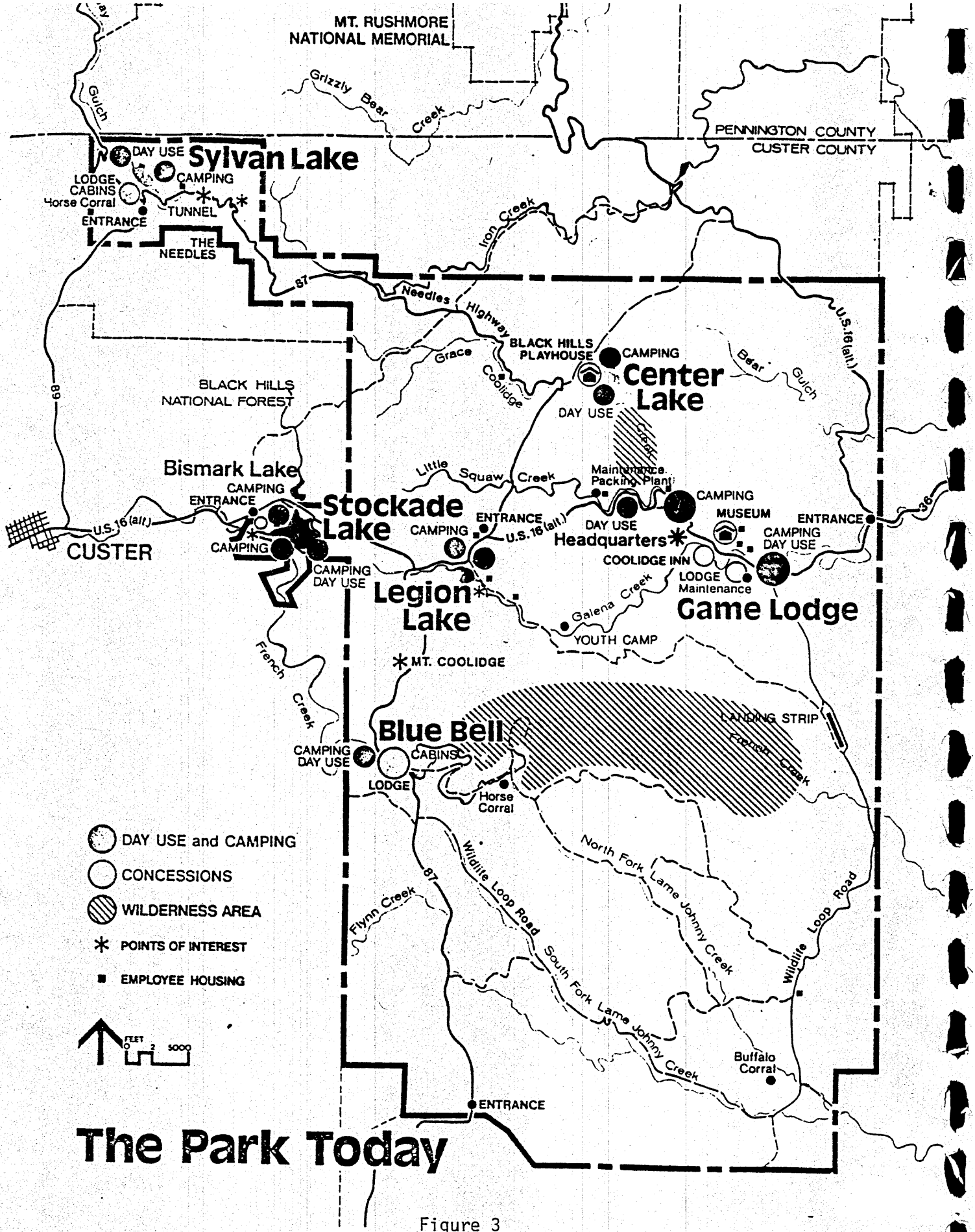

MT. RUSHMORE
NATIONAL MEMORIAL
Grizzly Bear Creek
PENNINGTON COUNTY
CUSTER COUNTY
DAY USE
Sylvan Lake
CAMPING
LODGE
CABINS
Horse Corral
TUNNEL
ENTRANCE
THE NEEDLES
Iron Creek
87
Needles Highway
U.S. 16 (alt.)
BLACK HILLS PLAYHOUSE
CAMPING
Center Lake
DAY USE
Grace Coolidge
Bear Gulch
BLACK HILLS NATIONAL FOREST
89
Bismark Lake
CAMPING
ENTRANCE
Little Squaw Creek
Maintenance
Packing Plant
CAMPING
Stockade Lake
ENTRANCE
DAY USE
MUSEUM
ENTRANCE
36
U.S. 16 (alt.)
CUSTER
CAMPING
CAMPING
U.S. 16 (alt.)
Headquarters
CAMPING
DAY USE
COOLIDGE INN
LODGE
Maintenance
CAMPING
DAY USE
Legion Lake
Galena Creek
Game Lodge
YOUTH CAMP
MT. COOLIDGE
French Creek
LANDING STRIP
Blue Bell
CAMPING
DAY USE
CABINS
LODGE
Horse Corral
French Creek
DAY USE and CAMPING
CONCESSIONS
WILDERNESS AREA
POINTS OF INTEREST
EMPLOYEE HOUSING
FEET
0
2
5000
Wildlife Loop Road
North Fork Lame Johnny Creek
Flynn Creek
87
Wildlife Loop Road
South Fork Lame Johnny Creek
Buffalo Corral
ENTRANCE
The Park Today

Figure 3

C. Land Use.

Landsat Remote Sensing (Figure 5) shows that 74% of the Stockade Lake watershed is covered by coniferous forest. The dominant tree of the forest is the ponderosa pine, with some aspen and birch also being present. Grasslands or meadows account for 24% of the watershed. Meadow areas are located along the stream flood plains in the watershed. The meadows support blue grasses and forbs in the grazed areas. Climax grass communities, although rare due to grazing, support tall and mid-height grasses such as: big bluestem, western wheatgrass, and switchgrass. Shrubs such as choke cherry, skunk bush, suma, and American plum are also found in the meadows.

The area classified as urban and built-up comprises 1.6% of the watershed area. The urban and built-up area is in and around the City of Custer. This area extends beyond the city boundaries of Custer west and east along U.S. Highways 16 and 16A. The urban land use classification is likely to increase in the future. From 1970 to 1980, population figures for Custer show an increase from 1,597 to 1,907.

D. Topography/Geology/Climate.

The soils in the northern portion of the watershed have developed from granitic and metamorphic rocks and are shallow on the ridges. The soils on the lower slopes and in the creek bottoms are deeper and have increased fertility. The general soil association in the Stockade watershed is the Pactola-Buska-Hisega Association. These soils are deep, well drained, sloping to very steep, silty and loamy soils formed in residuum from metamorphic rock.

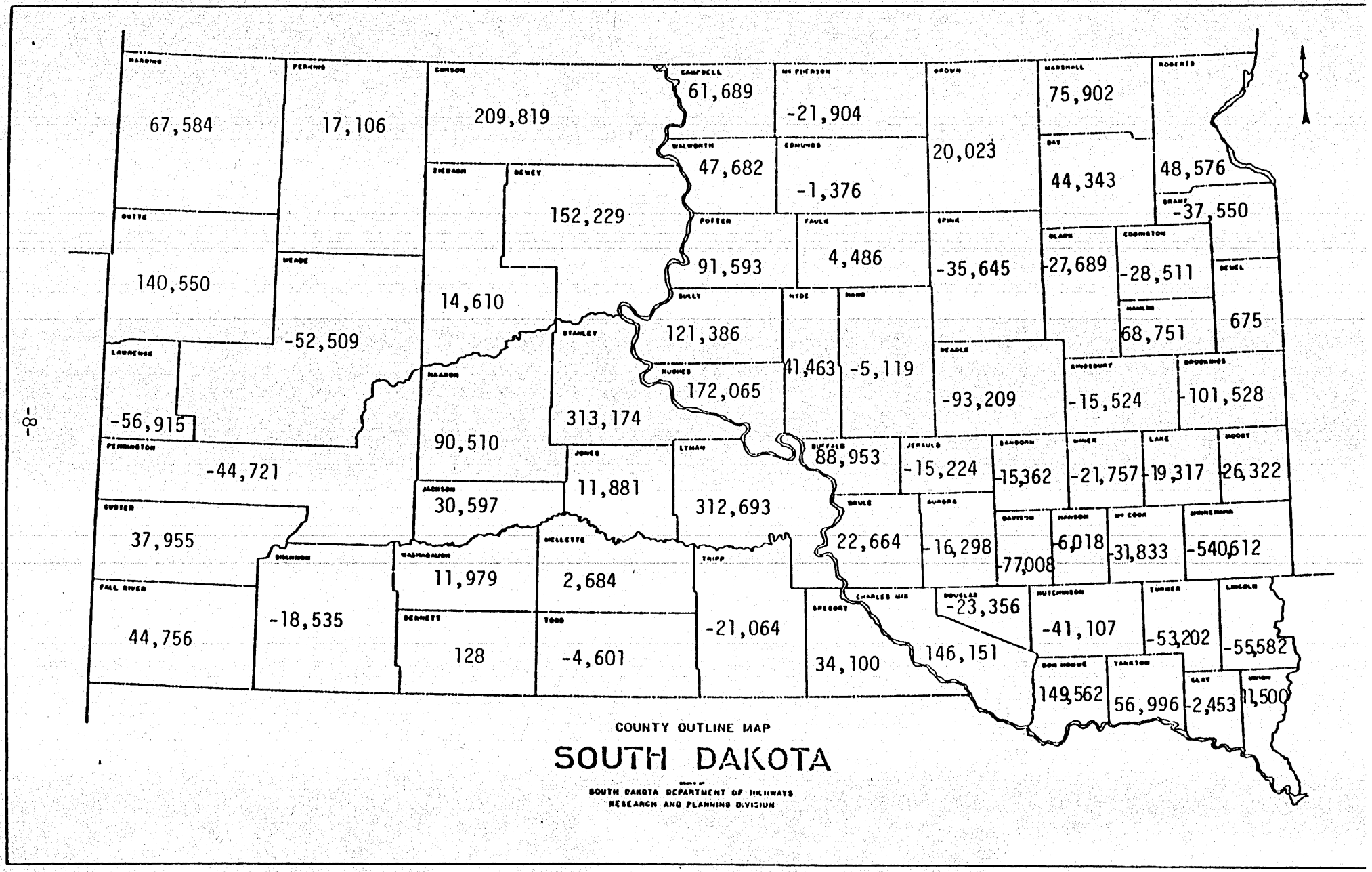


Figure 4 Statewide Fishing, User-day, Surplus or Deficiency, Opportunity Map.

The Pactola soils are the well drained soils, moderately deep over fractured bedrock formed in residuum weathered from metamorphic rocks. Slopes range from 6% to 60%.

The Buska series consist of deep, well drained soils formed in residuum from schist. Slopes range from 5% to 50%.

The Hisega series consist of deep, well drained soils formed from schist. Slopes range from 16% to 65%. Generally these soils tend to have little humus and are thin.

Detailed soil surveys are not complete for Custer County; however, general soil associations in the Stockade Lake watershed show soil depths ranging from 12 to 28 inches.

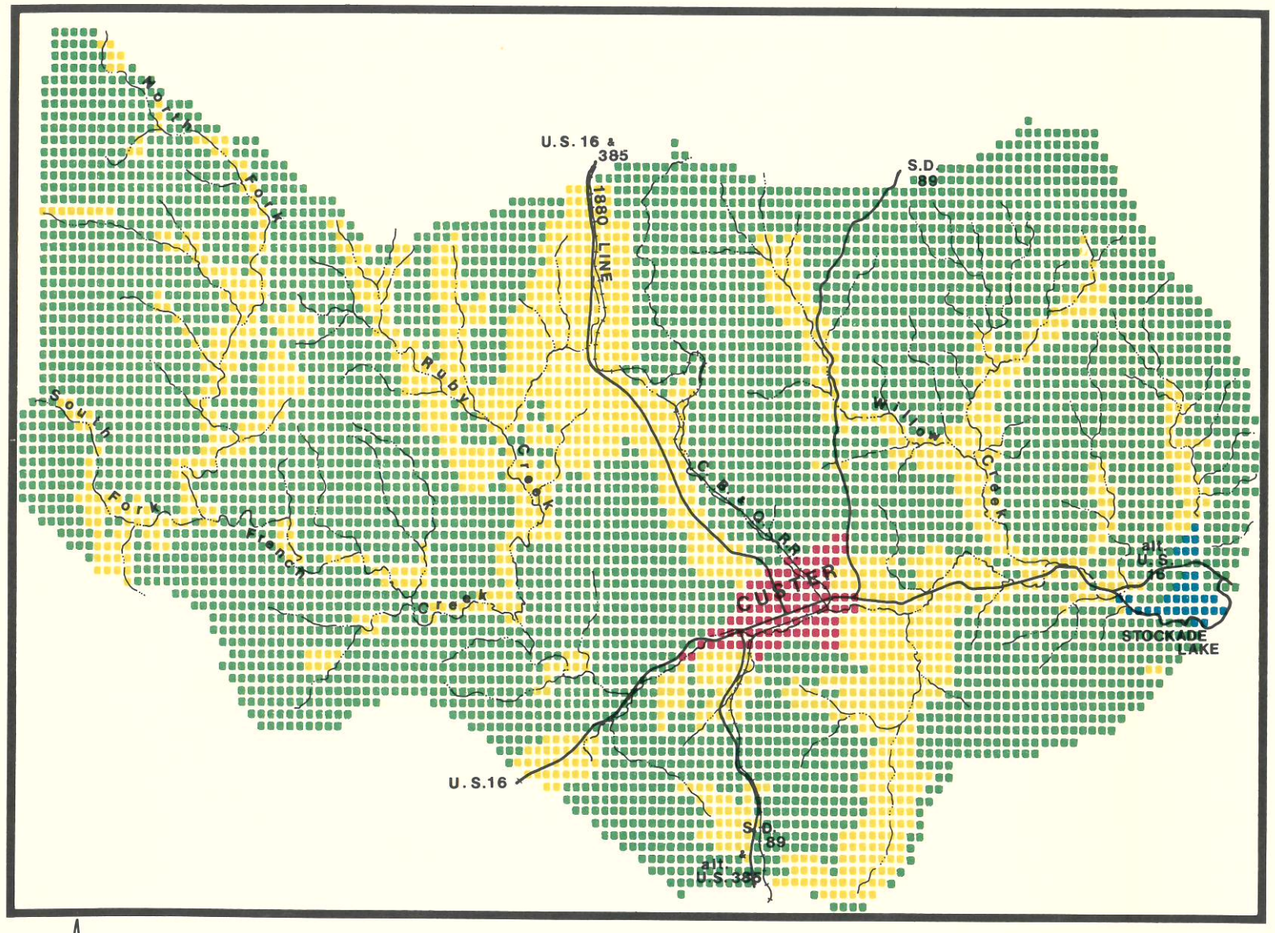
The northern portion of the Stockade Lake watershed lies in the Harney Peak Granite area and the southern portion in the metamorphic sheet mica pegmatites.

The Custer State Park portion of the watershed is closed to mining but mining is pursued in the area outside of the park. The watershed area is in an area of "zoned pegmatites". The size of the individual zoned pegmatites permits somewhat selective mining. Pegmatite is an uncommon granite rock with an abundance of large mineral crystals relative to common granite. These minerals range from several inches to several feet across. The chief mineral products of Custer County have been the pegmatite minerals. The deposits of minerals are found in discrete, recognizable zones. Many of the mines in the area have been in and out of production in the past. Mineral products of Custer County include: potash, feldspar, mica, beryl, and lithium. Mining of the pegmatite

Figure 5

Land Use Map

Stockade Lake Water Quality Study Area

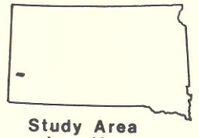




SCALE

0 1 2 3 4 Miles

0 1 2 3 4 Kilometers



Study Area Location

Land Cover - August 1979

CATEGORY	ACRES	HECTARES	%	ACCURACY
CONIFEROUS FOREST	35135	14219	73.5%	94%
MEADOWS	11670	4723	24.4%	89%
URBAN + BUILT-UP	740	299	1.6%	91%*
WATER	235	95	.5%	94%*
TOTALS	47780	19336	100%	93%

* 100% Sample

****

STOCKADE LAKE WATER QUALITY STUDY AREA

PRODUCED BY
SOUTH DAKOTA STATE PLANNING BUREAU

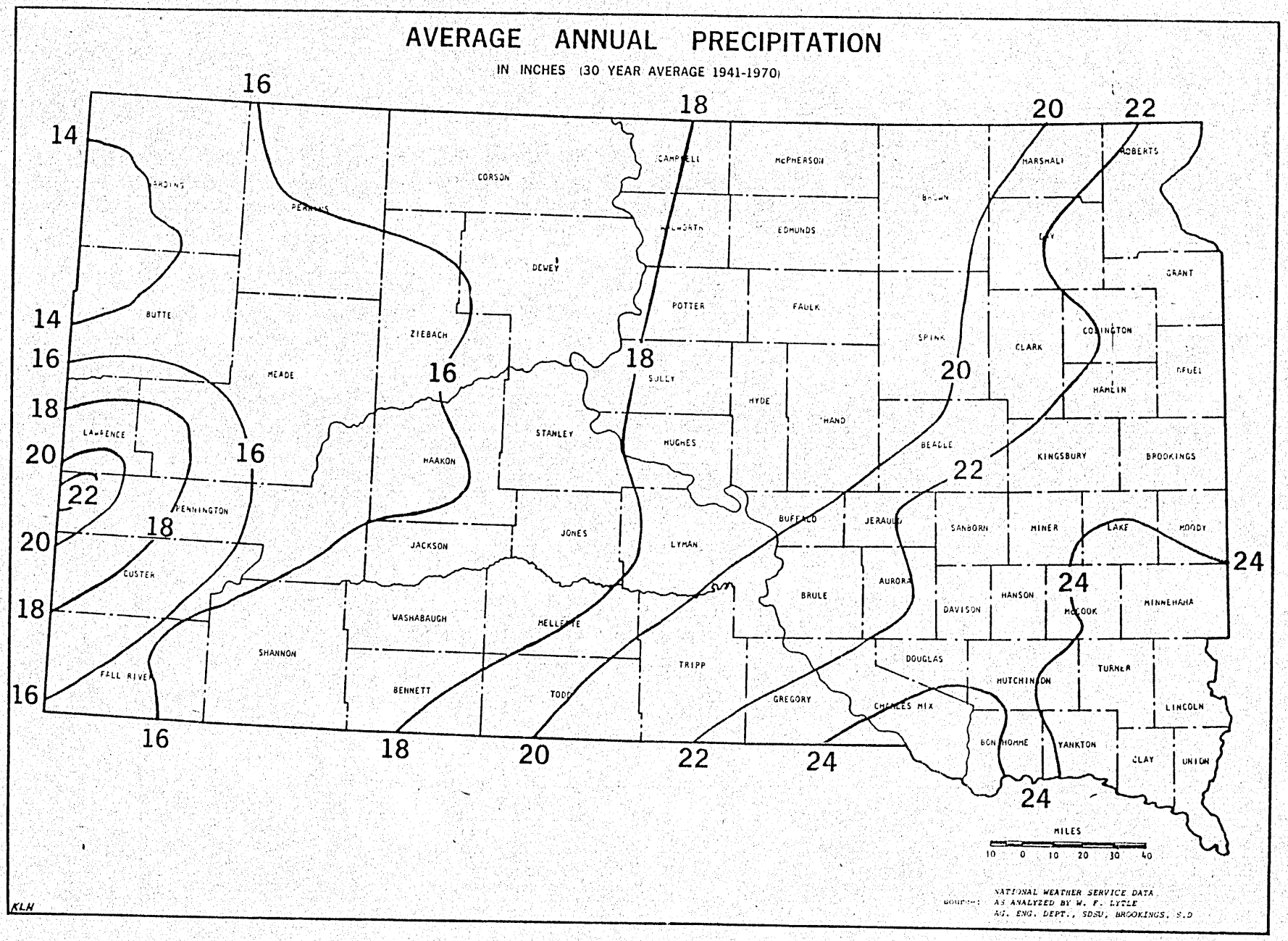
IN 1975, THE SOUTH DAKOTA STATE PLANNING BUREAU INITIATED A COMPREHENSIVE REMOTE SENSING MAPPING PROGRAM THOUGHOUT THE STATE. THIS STOCKADE LAKE WATER QUALITY STUDY AREA MAP WAS PART OF THAT PROGRAM, AND WAS PRODUCED THROUGH THE INTERPRETATION OF LANDSAT COLOR IMAGERY OF THE STUDY AREA. THE MAP HAS UNDERGONE A VERIFICATION PROCESS USING A 5% RANDOM SAMPLE, IN ORDER TO ASSESS THE ACCURACY OF THE REPRESENTED LAND COVER CATEGORIES.

SOIL EROSION CAN BE A MAJOR PROBLEM ON FORESTED LANDS, PARTICULARLY ON STEEP SLOPES AND DRAINAGE NETWORKS WHERE LOGGING AND HEAVY GRAZING OCCURS. CONSERVATION PRACTICES HAVE A SIGNIFICANT EFFECT IN REDUCING THE AMOUNT OF EROSION IN A FORESTED WATERSHED.

THE PREPARATION OF THIS MAP WAS FINANCED THROUGH A SECTION 208 WASTE TREATMENT MANAGEMENT GRANT FROM THE U.S. ENVIRONMENTAL PROTECTION AGENCY. FOR MORE INFORMATION CONTACT:

PLANNING INFORMATION SECTION
SOUTH DAKOTA STATE PLANNING BUREAU
CAPITOL BUILDING
PIERRE, SD 57501
605-773-3661

Figure 6


AVERAGE ANNUAL PRECIPITATION
IN INCHES (30 YEAR AVERAGE 1941-1970)
MILES
10 0 10 20 30 40
NATIONAL WEATHER SERVICE DATA
AS ANALYZED BY W. F. LYTLE
AG. ENG. DEPT., SDSU, BROOKINGS, S.D.
KLH

deposits changes from one pegmatite ore to another depending on the current market price for a particular mineral. The relative small-scale mining operations of the area do not lead to efficiencies of operation available to larger scale mining operations such as use of heavy equipment, large scale marketing, and large processing mills.

The climate of the Stockade Lake watershed, like the Black Hills in general, is significantly different than the surrounding plains area. The Black Hills have enough elevation and bulk to modify temperature and precipitation patterns. The temperatures are modified in winter by chinook winds in the eastern Black Hills. The Black Hills land mass also provides shelter from cold air masses. As a result, winter temperatures in the Black Hills average 6.5 degrees F warmer than the surrounding plains. There are also fewer days with temperatures of zero or lower than the surrounding plains. Precipitation patterns (Figure 6) show that the Stockade Lake watershed receives an average of 18 inches of precipitation per year. However, the area is prone to high precipitation accumulation in short but heavy rainfall events. This is due to upslope conditions where moist air is forced up against the Black Hills.

II. Stockade Lake Water Quality Study Area Selection

A. Criteria for selection.

Stockade Lake was selected as a Water Quality Study Area (WQSA) in early 1979 by the South Dakota Department of Water and Natural Resources (DWNR), formerly the Department of Environmental Protection (Appendix A).

Selection was made from three lakes nominated by the Sixth District Council of Local Governments. The two other nominated lakes were Sheridan Lake and Canyon Lake.

The nomination process was coordinated by the Sixth District Council of Governments and involved input from the following agencies: Agriculture Stabilization and Conservation Service, South Dakota Department of Game, Fish and Parks, the Soil Conservation Service, DWNR, the counties in the Sixth Planning and Development District, the US Forest Service and the local conservation districts.

Generally, the nominated lakes had high lake significance point rankings. Lake significance points are given to lakes based upon depth, surface area, fisheries classification, public accessibility, domestic water supply usage, publicly owned acreages adjoining lake shore, and public facilities present. The point total is designed to rank lakes for expenditures of State Lake Restoration Grant Funds. Stockade Lake had 63 out of a possible 78 significance points and ranked number 12 statewide. Public input was solicited in surveys conducted by Sixth District as well as public meetings (Appendix A). DWNR selected Stockade Lake for three reasons:

1. The Stockade Lake watershed is of a manageable size.

2. Stockade Lake has poorer water quality than Sheridan Lake according to the 1975 National Eutrophication Survey (NES). The NES ranked Stockade Lake 23 out of 31 South Dakota lakes studied in terms of water quality.

   Canyon Lake does not suffer from poor water quality to the extent of Stockade Lake, but does experience siltation. As a result, the lake has a lack of depth which was further aggravated by lowering the spillway elevation as a flood prevention measure.

3. Selection of the Stockade Lake watershed for study had the support of the US Forest Service and the South Dakota Department of Game, Fish and Parks which manage large portions of the land in the watershed.

B. WQSA Study Committees.

To direct the study on Stockade Lake and provide a forum for public input, two committees were formed; a Citizens Advisory Committee and a Technical Advisory Committee (Appendix B).

The Citizens Advisory Committee is composed of twelve members. The membership is broken down to include three citizens from each of four interest areas. These four interest areas are:

1. Private citizens
2. Public service groups
3. Economic interest groups
4. Public officials

The Technical Advisory Committee is composed of ten members, one member from each of the following government agencies:

1. U.S. Department of Agriculture, U.S. Forest Service - Black Hills National Forest
2. U.S. Department of Agriculture, Soil Conservation Service
3. U.S. Department of Agriculture, Agricultural Stabilization Conservation Service
4. S.D. Department of Game, Fish and Parks
5. S.D. Department of Game, Fish and Parks - Custer State Park
6. S.D. Department of Water and Natural Resources
7. City of Custer
8. Sixth District Council of Local Governments
9. Custer County, Planning Officer
10. Custer County, Cooperative Extension Service

III. Soil Loss - Sediment

Sediment surveys of Stockade Lake were conducted in 1972 and again in 1981. A private consulting firm conducted the 1972 survey. DWNR conducted the latest survey to check sedimentation rates since the 1972 study. The sedimentation yield rate was determined by plotting the cross-sectional area measured in the surveys. The cross-sectional sediment area multiplied by one side of the lake length yields the total lake sediment volume (figure the lake area as a square and use one side for calculations). The sedimentation rate was found by dividing the total volume by the number of years the lake has been in existance.

The Soil Conservation Service (SCS) conducted a Soil Erosion and Sediment Yield Study using the Universal Soil Loss Equation (USLE) on sheet and rill erosion (Appendix C1). The direct volume method, which is simply multiplying the area of erosion by an estimated rate of erosion and the volume weight of eroding soil, was used to estimate gully, streambank, and lake shore erosion. The direct volume method was also used to estimate sheet and rill erosion from construction sites, roads, and road banks. The SCS Study was done in 1980-81.

The results from these studies indicate sediment yields of 2.02 ac-ft/yr from 1935 to 1972 and 2.6 ac-ft/yr from 1972 to 1981 as measured at the lake inlets. The increase in inlet sediment yield from 1972 to 1981 may be due to a single event, such as the 1972 flood, having more influence in the shorter time period 1972-1981 than would occur in the longer period 1935-1972. The entire lake had a measured sediment yield of 6.97 ac-ft/yr from 1972 to 1981. The SCS study states that 0.94 ac-ft/yr soil erodes into Stockade Lake.

The SCS theoretical analysis results are low compared to the 1972 and 1981 Stockade Lake measurements. This indicates that additional sediments are being deposited from other sources. The main contributor of organic sediments is the Custer wastewater treatment facility. Sediment samples taken from Stockade Lake by DWNR in 1981 showed black ooze similar to sludge deposited on most of the lake bottom. Sediment samples from the French Creek Inlet area had soil particles and a slight anaerobic odor. The black ooze found in sediments elsewhere had a different consistancy and an anaerobic odor. The black sediment also contained decayed plant material and algae. In addition, another cause for the low sediment yield reported by SCS may be the type of land cover found in the watershed. Most of the watershed is forestland.

Little timber harvesting has been done in the watershed in the past. However, timber harvesting is due to start in the watershed this year. A study by the U.S. Forest Service indicates that over a 10 year period, timber cutting would yield only 930 ton/mi2 or 0.15 tons per acre (Appendix C4). This is well below the SCS guideline of 1 to 5 tons/acre/yr maximum erosion rate to sustain long term productivity.

The SCS studies identified two subareas of sediment yield in the Stockade Lake watershed. One subarea identified as sediment producing in Figure 8 is that portion of the watershed that contributed sediment directly to Stockade Lake. The majority of the watershed area is considered non-sediment producing to Stockade Lake (Figure 7). Custer Municipal Lake and Bismark Lake trap the sediment from the non-sediment producing areas. Of the five land uses listed in Table 1, gravel and/or dirt roads account for the largest single source of sediment yield to Stockade Lake,

STOCKADE LAKE
CUSTER COUNTY, SOUTH DAKOTA

FIGURE 7

contributing 771 tons/yr. Woodlands and grasslands account for the largest land area in the watershed (Figure 5). However, woodlands and grasslands account for a sediment yield of 61 and 96 tons/yr respectively to Stockade Lake, which is the lowest sediment yield per acre in the watershed.

The SCS selected best management practices for controlling sediment runoff for woodland and grassland areas in the watershed. SCS also estimated costs for these conservation measures (Table 2). Examples of conservation practices are: cover and green manure crop (plowing under), filter strips, lined and grassed waterways, diversions, mulching, sediment basins, streambank protection, and critical area planting. The total cost for application of best management practices (conservation practices) to both non-sediment and sediment contributing areas to Stockade Lake, amount to $781,380 or $16.30 per acre. The sediment contributing area accounts for $320,860 of the total.

Anaerobic odors and visual observations indicate that most of the sediment being deposited is of organic nature. The Custer wastewater treatment plant and septic tank problems are probably large contributors of nutrients. Calculations of nutrient loadings to Stockade Lake are found in Appendix E. Identification of septic tank problem areas by the City and the WQSA project coordinator are found in Appendix F. These nutrients are taken up by the algae and the plant material to form a new layer of sediment after the plants die. This fact was established when sediment samples were analyzed and found to have high phosphorus and nitrogen levels (Appendix C3).

TABLE 1

SOIL EROSION AND SEDIMENT YIELD
STOCKADE LAKE WATERSHED AREA

WQSA or Subwatershed		Wood-land	Grass-land	Sub Total	Chan-nels	Roads	Mine Spoils	Sub Total [1]	Total	Acre Feet Per Yr. [2]	Per-cent [3]
Non-Sediment Constributing Area	Erosion Tons/Yr.		1,927	3,449	1,617	2,581	261	4,459	7,908	-	-
	Sed. Yield Tons/Yr. [4]	0	0	0	0	0	0	0	0	0	0
Sediment Contributing Area	Erosion Tons/Yr.	405	642	1,047	483	771	60	1,314	2,361	-	-
	Sed. Yield Tons/Yr. [4]	61	96	157	242	771	60	1,073	1,230	0.94	.04
TOTAL	Erosion Tons/Yr.	1,927	2,569	4,496	2,100	3,352		5,773	10,269	-	-
	Sed. Yield Tons/Yr. [4]	61	96	157	242	771	60	1,073	1,230	0.94	.04

1/ No soil losses estimated for construction sites, however, planned developments should include a sediment control plan for before, during, and after construction.

2/ Tons converted to acre feet. Sediment in lake volume computed at 60 pounds per cubic foot due to sediment being submerged.

3/ Annual sediment yield expressed as a percent of total lake volume. Lake volume of Stockade Lake is 2,470 acre feet.

4/ Sediment deposited in Stockade Lake.

TABLE 2

BEST MANAGEMENT PRACTICES (Conservation Practices and Measures) 1/ 2/ 3/
STOCKADE LAKE WATERSHED AREA

Conservation Practices	Unit	Unit Cost 4/	Non-Sediment Contributing Area		Sediment Contributing Area		Total Watershed	
			Amount Needed	Cost	Amount Needed	Cost	Amount Needed	Cost
		(Dollars)		(Dollars)		(Dollars)		(Dollars)
GRASSLAND - 11,000 ACRES								
Proper Grazing Use	acres	-	8,275	-	2,725	-	11,000	-
Pasture & Hayland Planting	acres	20	140	2,800	60	1,200	200	4,000
Deferred Hayland Planting	acres	-	1,160	-	540	-	1,700	-
Planned Grazing Systems	acres	-	1,440	-	760	-	2,200	-
Livestock Water Stations	No.	1,000	3	3,000	2	2,000	5	5,000
Pasture & Hayland Management	acres	-	400	-	200	-	600	-
Waste Management Systems	No.	1,000	1	1,000	1	1,000	2	2,000
WOODLAND - 26,085 ACRES								
Livestock Exclusion (Fencing)	rods	5	2,000	10,000	1,200	6,000	3,200	16,000
Proper Grazing Use	acres	-	3,400	-	1,800	-	5,200	-
Access Roads	feet	7	10,560	73,920	5,280	36,960	15,840	110,880
Heavy Use Area Protection	acres	200	500	100,000	500	100,000	1,000	200,000
Grade Stabilization Structures	No.	1,000	4	4,000	6	6,000	10	10,000
Diversions	No.	1,000	-	-	2	2,000	2	2,000
Critical Area Planting	acres	200	2	400	3	600	5	1,000
Grass Filter Strip	acres	200	3	600	2	400	5	1,000
Woodland Improvement	acres	66	3,900	257,400	2,100	138,600	6,000	396,000
Tree Planting	acres	350	4	1,400	6	2,100	10	3,500
FARMSTEADS, URBAN & OTHER - 800 Acres								
Sediment Control Measures 5/	acres	2,000	3	6,000	12	24,000	15	30,000
TOTALS - Total Acres - 47,930 6/				460,520		320,860		781,380
								$16.30 per acre

1/ Needed to get "Land Adequately Treated."
2/ Refer to Soil Conservation Service Technical Guide for South Dakota 1981.
3/ On site investigation and planning are necessary to determine kinds, locations, sizes, extent & costs of practices (BMP's)
4/ Refer to Soil Conservation Service Cost-Return Handbook for South Dakota 1981.
5/ Examples of measures are: cover and green manure crop, filter strips, lined and grassed waterways, diversions, mulching, sediment basins, streambank protection, and critical area planting.
6/ Includes 10,045 acres of non-sediment producing land.

IV. Water Quality Analysis of the Stockade Lake Watershed

A. Description of sites and sampling regime

To determine water quality and identify water quality problems within the Stockade Lake watershed, a water quality monitoring plan was developed. Monitoring sites (Figure 8) were selected to determine in-lake water quality and water quality of Stockade Lake tributaries. The monitoring scheme included some tributaries to French Creek, the main source of water for Stockade Lake. Water quality data used for the water quality analysis were collected from April, 1979, to June, 1980. Data were collected during both dry and wet periods that produced watershed runoff.

Additional sources of data used for water quality analysis included DWNR flow and water quality data on French Creek collected as part of the Custer/French Creek wasteload allocation survey. Data used from this source was collected in February, 1980.

The Sixth District Council of Local Governments collected mean flows and water quality data in the watershed at a site on French Creek about two miles west of Custer. This site is upstream of Custer Municipal Lake. These data were used as one approach to determine nutrient loading into Stockade Lake. Custer wastewater self-monitoring data were also used for nutrient loading calculations.

Stockade Lake Water Quality Study Area Sample Site Locations included:

Site 1. French Creek, west of Custer, downstream of Custer Municipal Lake. T3S, R4E, NE Section 27.

Site 2. Laughing Water Creek, north of Custer. T3S, R4E, NE Section 23.

Site 3. French Creek, east of Custer, upstream of confluence with Sidney Creek. T3S, R5E, NW Section 30.

Site 4. French Creek at the east US Highway 16 Creek crossing. T3S, R5E, SE Section 20.

Site 5. French Creek, off US Highway 16 on a road to the NE, at a stream crossing in extreme east portion of section. T3S, R5E, SE Section 20.

Site 6. Inlet to Stockade Lake from Bismark Lake, located at US Highway 16. T3S, R5E, SW Section 22.

Site 7. Bismark Lake in-lake site on the east side of lake. T3S, R5E, NW Section 22.

Site 8. Bismark Lake Creek upstream of Bismark Lake. T3S, R5E, SW Section 15.

Site 9. Stockade Lake, in-lake site on the east side of the lake. T3S, R5E, SW Section 22.

Site 10. French Creek downstream of Stockade Lake. T3S, R5E, NW Section 27.

Site 11. Stockade Lake, in-lake site on the north side of lake. T3S, R5E, SE Section 21.

Unnamed. Custer municipal wastewater discharge at the outfall to French Creek on the road to the sewage treatment plant off US Highway 16, T3S, R5E, SW Section 19.

Site 87. French Creek upstream of Custer Municipal Lake about 2 miles west of Custer city limits. T3S, R4E, SE Section 28. (Site monitored by Sixth District Council of Local Governments.)

B. Interpretation of Data

Table 3 summarizes water quality in Stockade Lake and its tributaries. These waters are classified according to use as cold-water marginal fisheries, limited contact recreation, wildlife propagation and stock watering (Table 4 and Figure 9). The parameters shown in Table 3 were evaluated with respect to the standards established for these uses (Table 5). In addition, the watershed was evaluated for trophic status.

The most significant problem in Stockade Lake is its highly eutrophic or over-productive state, which is evidenced by high nutrient levels and high phytoplankton concentrations.

1. Water Quality Parameters

a. Phosphorus

Phosphorus was high at every station (Table 6). It showed a fourfold increase between sites 3 and 4 (Figure 10). The highest single reading, 2.92 mg/l total phosphorus (PO_4) occurred at site

FIGURE 8

STOCKADE LAKE WATER QUALITY STUDY AREA
WATER QUALITY SAMPLING SITES

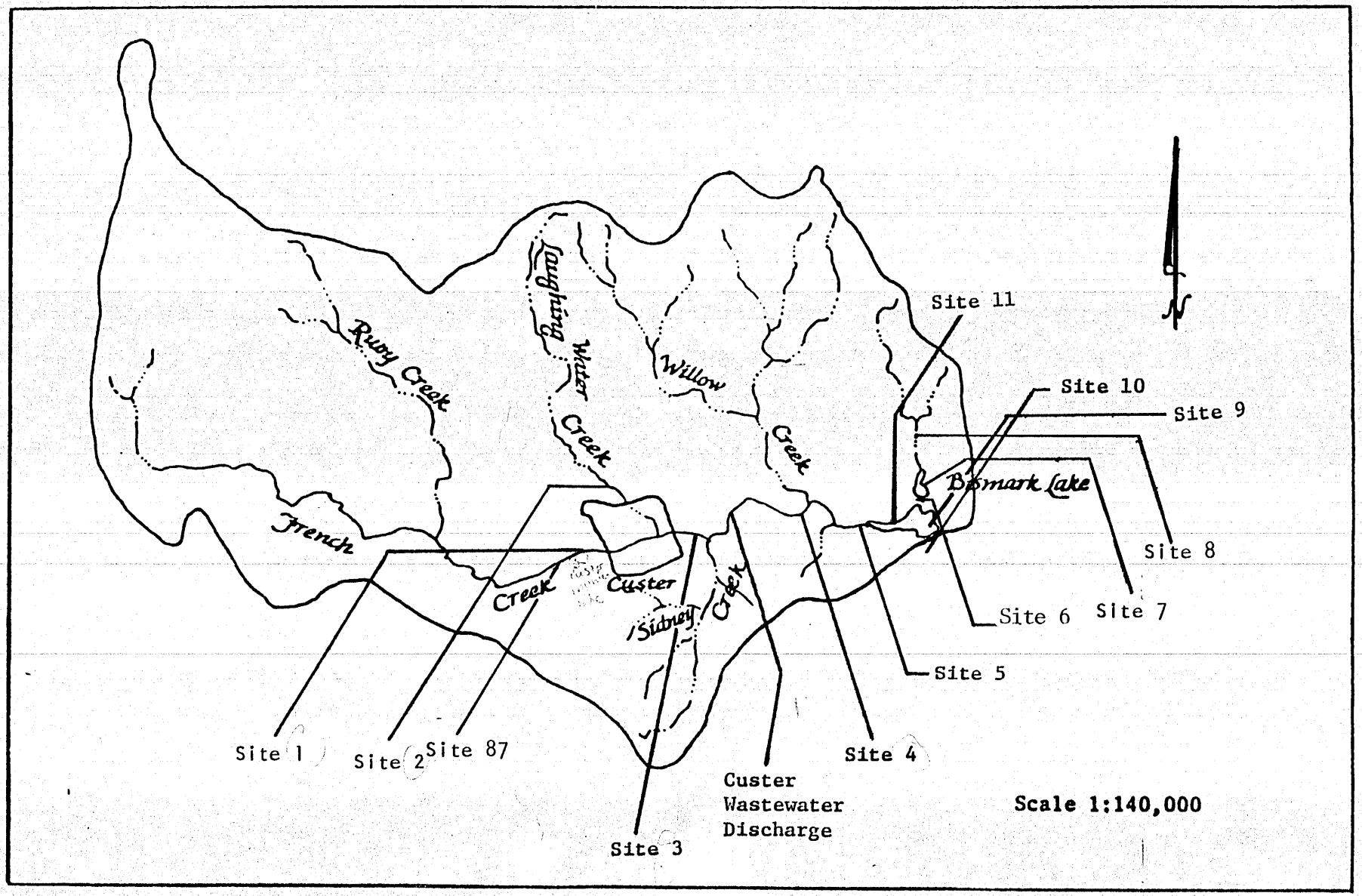
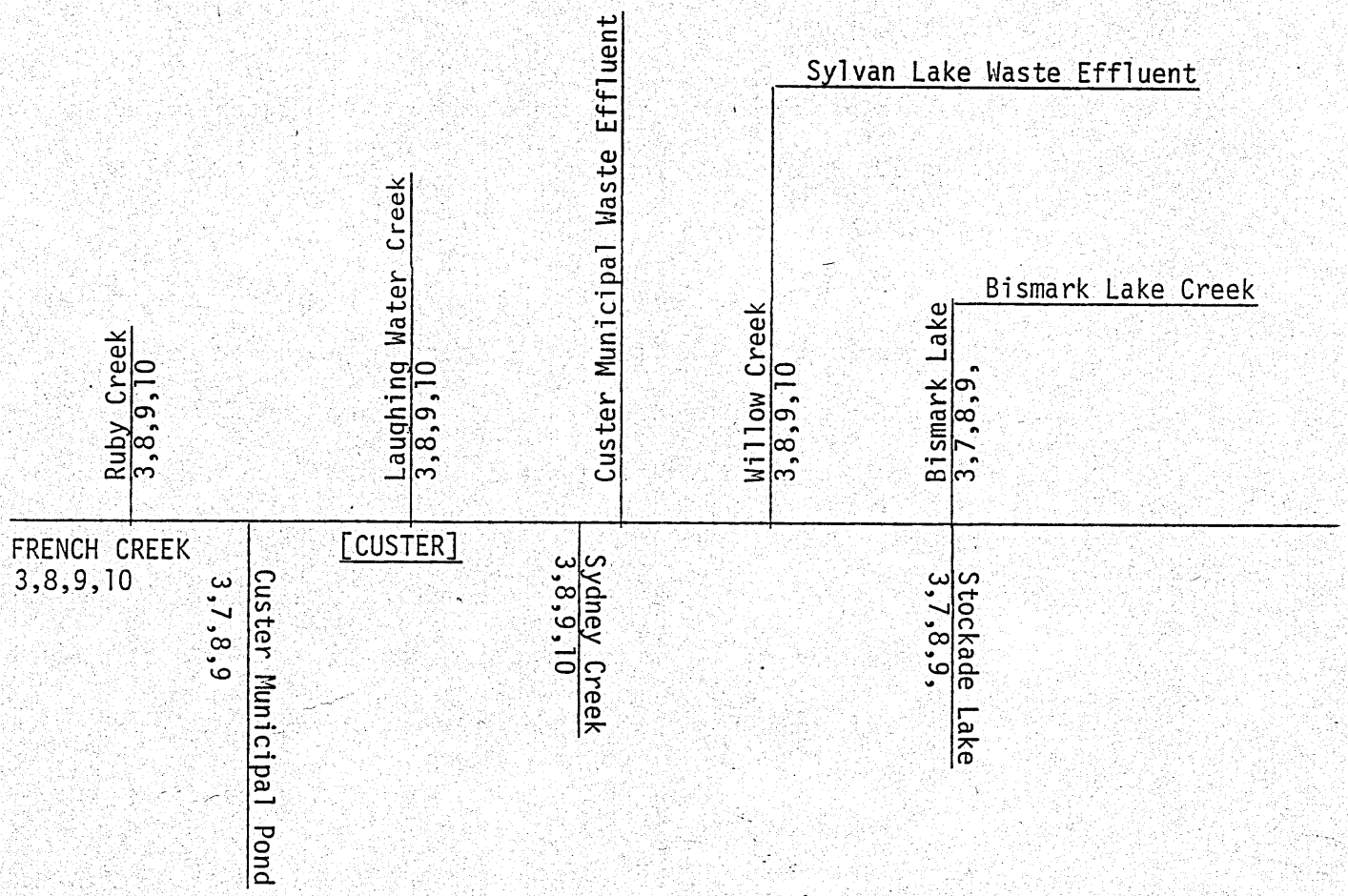


Figure 9

STREAM AND LAKE CONFIGURATION FOR STOCKADE WATERSHED

WITH ASSIGNED BENEFICIAL USES



4. Phosphorus levels declined from site 4 to site 5, indicating assimilation by organisms and sedimentation losses. A lack of flow data for Bismark Lake Creek precluded calculation of phosphorus loadings to Stockade Lake from Bismark Lake Creek (Appendix E).

Vollenweider's eutrophication scale classifies phosphorus levels of over 0.100 mg/l as hypereutrophic. Eutrophic is defined as phosphorus concentrations of 0.0300 to 0.100 mg/l. With the exception of stations 1 and 2, mean total PO_4 levels instream were high enough that lake waters with comparable levels would be considered hypereutrophic. At instream sites 1 and 2, the PO_4 levels would be considered eutrophic. Within the lake, at sites 6, 9, and 11, the waters were clearly hypereutrophic. The mean phosphorus value (.231 mg/l) at the outflow (site number 10) was far higher than any of the in-lake stations. All in-lake samples were taken at the surface. The lake discharge is from the surface of the lake.

Another major source of PO_4 is the contamination of French Creek upstream of the wastewater treatment plant. The sources of contamination are less readily identifiable than the treatment plant. A more complete discussion of these sources of contamination is deferred to the "Problems and Recommendations" section of this report.

In addition to the data collected in 1979 and 1980, samples were taken monthly at site 5 under the DWNR ambient water quality monitoring program from 1975 to the present. Although the data

covers only one site and samples were not analyzed for all parameters, some trends are evident.

Total PO_4 levels increased regularly throughout this time period, with mean annual concentrations from 1975 to 1980 of .164, .153, .386, .404, .758, and 1.105 mg/l.

TABLE 3

Stockade Lake, 1974-80

Summary of Water Quality Violations

a a = # of violations found.

b b = % of samples violating standard.

	Site										
	1	2	3	4	5	6	7	8	9	10	11
Water T°	1/5	1/5	0	0	0	0	0	0	0	0	2/12
Susp. Solids	0	0	1/5	1/4.5	1/5	0	0	1/6	0	0	1/6
Total Solids	0	0	0	0	0	0	0	0	0	0	0
Nitrates	0	0	0	0	0	0	0	0	0	0	0
Alkalinity	0	0	0	0	0	0	0	0	0	0	0
Diss. O_2	0	0	0	0	0	1/6	1/6	0	0	2/11	0
Fecal Coliform	0	1/5	8/42	3/14	3/16	0	0	3/18	0	0	0
Ammonia	0	0	0	2/20	0	0	0	0	0	1/11	1/11
pH	1/9	0	0	0	0	1/10	3/38	0	8/100	8/80	9/100

TABLE 4

Beneficial uses assigned to Lakes and Streams in the Stockade Lake Watershed from ARSD 74:03:02 "Surface Water Quality Standards"

Streams

French Creek
Ruby Creek
Laughing Water Creek
Sydney Creek
Willow Creek
Bismark Lake Creek

Stream Beneficial Uses

(3) Cold water marginal fish life propagation waters
(8) Limited contact recreational waters
(9) Wildlife propagation and stock watering waters
(10) Irrigation waters and
(11) Commerce and Industry waters

Lakes

Custer Municipal Lake
Bismark Lake
Stockade Lake

Lake Beneficial Uses

(3) Cold water lake marginial fish life propagation waters
(7) Immersion recreational waters
(8) Limited contact recreational waters
(9) Wildlife propagation and stock watering waters

This increase in phosphorus levels may be due to increased population pressures, declining efficiency of the Custer wastewater treatment plant lagoons, or both. There may also be alternative explanations, including a rise in non-point contribution. This rising trend in concentration levels indicate increased loadings of phosphorus are being discharged into Stockade Lake.

b. Nitrogen

The same patterns are seen in inorganic nitrogen (Table 6) levels as in phosphorus, although overall levels were not as high. Site 1 through 3 showed mean inorganic nitrogen levels in the oligotrophic to oligo-mesotrophic range. At site 4, the mean level jumped by a factor of four (Figure 11). This is attributable to the nutrient input from the wastewater treatment plant. Inorganic nitrogen levels decreased at site 5, and were relatively low at sites 6, 9, and 11, the in-lake stations. Again, inorganic nitrogen levels at the outflow were 2 to 3 times higher than in-lake surface values. In this case, inputs from Bismark Lake were quite low.

Organic nitrogen levels were moderate to high at all sites (Table 6). Organic nitrogen levels were highest in Stockade Lake during periods of algal blooms. The levels at the outflow (site 10) were also high, indicating high levels of organic nitrogen throughout the water column.

The trends evident in these nutrient readings clearly indicate the problem of nutrient enrichment from the Custer wastewater treatment plant. It is most clearly seen in the phosphate and inorganic nitrogen levels.

c. Dissolved Oxygen

Dissolved oxygen levels were generally acceptable during the study period. The only violations occurred once in Bismark Lake, once at the inflow of Bismark Lake into Stockade Lake, and twice at the outflow of Stockade lake.

While oxygen levels were not a problem at the sample sites, all samples were taken at the water surface. A study of the oxygen profile of Stockade Lake was performed in 1979 (Harms et. al., 1981) (Table 7). not cited in Lit cit. sect.

Results of the study, Table 7, indicate a severe oxygen depletion zone below 3 meters depth by late summer. This corresponds well with the dissolved oxygen violations noted at site 10, the lake outflow. As noted earlier, the outflow is taken from the bottom? of the lake. The severe oxygen depletion is indicative of a eutrophic lake.

d. Phytoplankton

Table 8 shows Stockade Lake phytoplankton levels and supports the conclusion that the lake is eutrophic. The large algal biomass and dominance of a few species (Anabaena flos-aque in June and Oscillatoria tennis in August) indicate severe eutrophication.

TABLE 5

Criteria for lakes and streams in the Stockade Lake watershed

Parameter mg/l unless specified	Criteria for Lakes	Criteria for Stream
Nitrates (as N)	50	50
Total Cyanide	0.02	0.02
Free Cyanide	0.002	0.005
Hydrogen Sulfide	0.002	0.005
Suspended Solids	90	90
Temperature (F)	75	75
Fecal Coliform (ave. #/100 ml)	200	1.000
Total Alkalinity	750	750
Conductivity Micromho	4000	2500
Dissolved Oxygen	5.0	5.0
Total Dissolved Solids	2500	2500
Total Chlorine Residual	0.02	0.02
Ammonia (un-ionized (as N)	0.02	0.02
Sodium Adsorption Ratio		10
Polychlorinated Biphenyls	0.000001	0.0000001
pH (standard units)	6.5-8.3	6.5-8.8

Table 6
Stockade Lake, 1979-80
Mean Nutrient Concentrations and Nutrient Ranges

Site #	Total PO_4	Org N.	Inorg N.
1	.041-.312 .085	.14 - 1.52 .709	.12 - .35 .17
2	.044-.214 .098	.21 - 1.69 .499	.13 - .25 .22
3	.041-.811 .165	.17 - 1.31 .53	.13 - .42 .22
4	.224-2.92 .703	.04 - 1.94 .656	.37 - 2.11 .438
5	.081-2.310 .522	.44 - 2.17 .703	.17 - .66 .475
6	.054-.482 .115	.07 - 2.44 .964	.14 - .94 .24
7	.044-.624 .177	.14 - 1.70 .815	.13 - .34 .16
8	.061-.441 .164	.10 - 2.05 .781	.13 - .37 .197
9	.027-.858 .129	.5 - 1.83 .9172	.13 - .60 .2378
10	.068-1.360 .231	.21 - 3.33 1.03	.14 - 3.43 .64
11	.064-.397 .128	.34 - 5.22 1.09	.13 - .74 .27

Above Values Represent:
Concentration Range in mg/l
Mean Concentration in mg/l

e. Trophic State Index (TSI)

The Trophic State Index is a scale designed to classify lakes according to their trophic status. Trophic status is a measure c a lake's productivity. The index is based on a logarithmic scale with zero corresponding to an extremely oligotrophic lake. Each increment of 10 indicates a doubling of algal biomass or a halvin of secchi depth. Other parameters, such as phosphorus levels, ma also be incorporated.

Depending on the parameter used, Stockade lake shows a TSI of between 65 and 75, values which correlate with highly eutrophic waters. The Secchi disk reading, for example, gives a TSI of 67.3, corresponding to an average secchi depth of less than 1m. Stockade Lake phosphorus levels correspond to a TSI of 74.5, agai highly eutrophic. Chlorophyll a levels in the lake yield a TSI o 67.0.

f. Coliform Bacteria

Violations of the water quality standard for fecal coliform bacteria indicate two major pollution problems in the watershed (Appendix D). The single anomalously high reading at site 2, jus upstream of Custer, may be due to low flows combined with a singl influx of contaminated material. However, the pattern at site 3, downstream from Custer, indicates gross contamination of the Creek. The high coliform levels from June through October of 197 indicate probable contamination from septic systems, singly, or i combination with exfiltration from broken sewerage lines and a

TABLE 7 Dissolved oxygen-temperature profile for Stockade Lake.

	June 22, 1979						August 17, 1979					
	Location						Location					
	1		2		3		1		2		3	
Depth (m)	DO mg/l	Temp °C	DO mg/l	Temp °C	DO mg/l	Temp °C	DO mg/l	Temp °C	DO mg/l	Temp °C	DO mg/l	Temp °C
0	9.3	19	9.5	19	9.9	19		19		19		19
½							11.2	19	8.3	18	9.3	18.5
1			8.1				10.2	18.5	7.1	18	8.7	18
1½			7.7	17			6.9	17.5	5.9	17.5	7.6	18
2							5.0	17			5.8	17.5
2½							2.2	16.5			4.1	17
3					8.5		1.0	16			2.4	16.5
3½							TRACE	15.5			0.3	15.5
4							TRACE	14.5			0.3	14
4½							TRACE	13.5			0.4	13
5							TRACE	12.5			0.5	12
5½					5.9	16	TRACE	11			0.5	11.5
6	5.5						TRACE	10.5				
7							TRACE	9.5				
8							TRACE	9				
9							TRACE	8.5				
10							TRACE	8				
11							TRACE	8				
12							TRACE	8				
13							TRACE	8				
14	1.2	11					TRACE	8				

periodic overflow of raw sewage from a bypass to French Creek. The raw sewage bypass occurred throughout the study during wet periods and during periods of heavy seasonal use of the East Custer Sanitary District sewer collection system. The East Custe Sanitary District sewage bypass was corrected in 1980. The rapid fluctuations in coliform levels may in part be due to urban runof problems in Custer.

At site 4, downstream from site 3, coliform contamination was les frequently a problem, although the site was in violation from mid-June through August of 1979. A comparison of the coliform graphs of the sites (see Appendix D) shows the relative duration of severity of coliform violations.

An additional factor influencing coliform levels at site 4 is the presence of the Custer wastewater treatment plant effluent discharge between sites 3 and 4. In 1979, the initial date of pond drawdown was June 18. As the graph shows, coliform levels a site 4 were already rising by that time. Pond drawdown continued until early December, while coliform levels declined markedly by mid-September. This indicates that the wastewater effluent is probably not a major coliform source, at least under conditions similar to those prevailing in 1979.

Additional coliform violations occurred at site 8, north of Bismark Lake. The coliforms were probably due to a nearby barnyard or stable (Kujala, Appendix F).

During the sampling period there were no violations of the coliform standard in the lake itself.

g. Ammonia

In contrast to coliforms, un-ionized ammonia levels increased between sites 3 and 4, with 2 violations at site 4. French Creek ammonia cencentrations are graphed in Appendix D. Mean un-ionized ammonia levels were .0015 mg/l at site 3 and .0097 mg/l at site 4, a sixfold increase. This increase in ammonia was probably due to the wastewater effluent from the Custer plant and the East Custer Sanitary District raw sewage bypass.

h. Temperature

Water temperature was generally within the limit (75°F) imposed by the standards. Two exceptions occurred in the upstream reach of French Creek (Sample Sites 1 and 2) in mid July, 1979. At these points, flow was quite low and air temperature was high (90°F). Water temperature at these sites had declined to acceptable levels by the next sampling date, one week later. The other violations of the temperature standard occurred at site 11, in Stockade Lake. At that site, the water is relatively shallow (less than 10 feet deep). Also, the French Creek flow reduces speed as it enters the lake. The coincidence of slow moving shallow water with high insolation characteristic of mid-summer conditions results in excessive heating of the waters. It is likely the effect of this on fish life was marginal, as temperature in other, deeper portions of the lake are lower.

1. Miscellaneous Parameters

Table 3, shows that the standards for total dissolved solids, nitrates, and alkalinity were never exceeded. Suspended solids violations were infrequent, with a maximum of one exceedance at each sampling site.

2. Nutrient Loadings

Although flow data is not available for each site or for many periods enough information has been gathered to allow some calculation of loadings to Stockade Lake (Appendix E).

The Sixth District Council of Local Governments sponsored a program o recording flows and taking samples periodically from September, 1975 through November, 1979. The sampling station was 2 miles west of Custer, upstream of all sites previously discussed. Their figures show an average flow of 3.1 cfs at this point, which drains 31 mi2 or 46% of the watershed. With this flow and the median total phosphorus concentration at the site (0.15 mg/l), total phosphorus loadings from this portion of the watershed alone were 0.79 g/m2/y. According to Vollenweider (in Wetzel, 1975, p. 245), dangerous total phosphorus loading for a lake with a mean depth of 5 meters is 0.13 g/m2/yr.21 Thus, loadings from the western, undeveloped half of the watershed alone supplied over six times the "dangerous" levels of phosphorus to the lake.

Assuming that the watershed is uniform, the 3.1 cfs measured by the Sixth District extrapolates to 6.7 cfs flow for the entire watershed.

Assuming that this entire average flow is in French Creek and using the nutrient levels found at station 5, phosphorus loadings of 5.94 g/yr/m2 and total nitrogen (organic and inorangic N) loadings of 13.41 g/m2/yr are indicated. This exceeds the dangerous loadings for a 5 m deep lake by a factor of 45 for phosphorus and 6 for nitrogen. As noted earlier, effluent from the Custer wastewater treatment plant supplies large amounts of nutrients to Stockade Lake. Data from summer of 1979 (8-24-79) indicate an effluent flow of 0.40 cfs. Nutrient values on that date were as follows: PO_4 - 2.44 mg/l; TKN - 2.32 mg/l, NO_3 - 0.1 mg/l, NO_2 - 1.2 mg/l, ammonia 2.05 mg/l. This leads to the following loading values: Total PO_4 - 1.66 g/m2/yr, ammonia 1.393 g/m2/yr, TKN - 1.58 g/m2/yr. These calculations do not distinguish between periods when the East Custer Sanitary District raw sewage overflow was bypassed to French Creek and when it was not.

Nutrient loadings to Stockade lake from the Custer wastewater treatment plant effluent, exclusive of any other source, are excessive. Past records (to 1978) indicate the wastewater treatment plant discharges for at least 6 months per year, at a flow not greater than .25 mgd. Using these limits and the nutrient levels above, loadings are as follows: Total phosphorus - .799 g/m2/yr, ammonia - .671 g/m2/yr, TKN - .759 g/m2/yr.

A set of water samples and flows taken Februry 21, 1980, indicate loadings during winter months. At an effluent flow of .26 cfs and total phosphorus level of 4.50 mg/l, the loading is 1.0449 x 106 g PO_4/yr, or 1.986 g/m2/yr. At this rate of loading, the "excessive" loading level of 0.13 g/m2/yr will be reached in 24 days. This

TABLE 8 Phytoplankton for Stockade Lake.

Sampling Date		Genera	Species	Algal Units per ml
June 22, 1979	1.	*Anabaena*	*flos-aquae*	15,582
	2.	*Scenedesmus*	*spp.*	523
	3.	*Aphanizomenon*	*flos-aquae*	437
	4.	*Cryptomonas*	*erosa*	423
	5.	*Cryptomonas*	*ovata*	165
	6.	*Trachelomonas*	*spp.*	132
	7.	*Pediastrum*	*spp.*	99
	8.	*Cyclotella*	*spp.*	53
	9.	*Ankistrodesmus*	*spp.*	20
	10.	*Cocconeis*	*placentula*	*
	11.	*Nitzschia*	*sigmoidea*	*
			Total	17,434
August 17, 1979	1.	*Oscillatoria*	*tenuis*	7,525
	2.	*Anabaena*	*spiroides*	1,589
	3.	*Aphanizomenon*	*flos-aquae*	920
	4.	*Closterium*	*spp.*	25
	5.	*Trachelomonas*	*spp.*	25
	6.	*Cyclotella*	*spp.*	17
	7.	*Ceratium*	*hirundinella*	8
	8.	*Cosmarium*	*spp.*	8
	9.	*Cryptomonas*	*erosa*	*
	10.	*Pediastrum*	*spp.*	*
	11.	*Staurastrum*	*spp.*	*
	12.	*Unidentified Desmid*		*
			Total	10,117

* Identified but not counted.

assumes a constant input from the effluent and no input from any other source.

Similarly, using the Sixth District data of mean flow of 3.1 cfs and median total PO_4 of 0.15 mg/l, 255 days are needed to reach "excessive" loadings.

V. Stockade Lake Watershed Problems and Solutions

Problems adversely affecting water quality in Stockade Lake are identified in the following discussion along with recommendations to alleviate these problems. The problems are identified in order of magnitude with the worst addressed first.

In-lake and watershed problems and recommendations are discussed separately. However, it must be mentioned that in-lake problems are symptoms of the problems occurring in the watershed. Therefore, actions to mitigate the in-lake problems cannot proceed without concurrent and coordinated work on the watershed problems. In-lake restoration efforts alone would be futile.

A. Watershed Problems and Recommendations

1. Custer Wastewater Treatment Plant

Problem:

The Custer wastewater treatment plant (WWTP) is, by itself, the main source of nutrient loading to Stockade Lake as calculations in the water quality analysis demonstrate.

The Custer wastewater treatment plant treats sewage from a population of 1,907 residents (1980 census) and additional domestic wastes from approximately 2,400 tourist accomodations. Wastewater is also received from the East Custer Sanitary District. The East Custer Sanitary District serves 132 permanent and 450 summer residents.

The WWTP consists of a barminutor, primary clarifier, trickling filter, final clarifier, anaerobic sludge digesters and sludge drying beds.

Additional treatment is provided by a 24.3 acre, three cell stabilization pond. The mechanical portion of the WWTP was constructed in 1948, while the stabilization ponds were constructed in 1973-74.

National Pollutant Discharge Elimination System (NPDES) permit limitations are summarized in Table 9 for the Custer WWTP effluent discharges to French Creek. Results of the Custer WWTP self-monitoring data indicate the plant generally meets permit conditions. However, based on the available data shown in the water quality analysis, the Custer WWTP is the major source of total phosphorous loading to Stockade Lake.

Currently Custer is in the Step I Facility Plan grant process and is number 32 on the South Dakota Construction Grants Priority List. Wastewater treatment alternatives including no discharge to French Creek/Stockade Lake are being considered in the Step I facility planning process. With Custer's position on the priority list, it may be another two years until grant monies are available to enable Custer to proceed through the Step 2 WWTP design and Step 3 construction phases.

The East Custer sewage collection line, combined with the Custer sewage interceptor line, was a source of raw sewage discharges to French Creek until modifications the raw sewage

TABLE 9

A SUMMARY OF NPDES EFFLUENT LIMITATION REQUIREMENTS AND EFFLUENT QUALITY OF THE EXISTING CITY OF CUSTER WASTEWATER TREATMENT FACILITY

Effluent Characteristics	NPDES Effluent Limitation Requirements		Quarterly Discharge Monitoring Reports*		
	Flow of French Creek is less than 10 times flow of WWTP	Flow of French Creek is greater than 10 times flow of WWTP	Minimum Value	Mean Value	Maximum Value
Five Day Biochemical Oxygen Demand (mg/l)	10	10	8.0	10.4	14.5
Total Suspended Solids (mg/l)	10	10	7.0	9.0	14.0
Fecal Coliform (#/100 ml)	400	4000	17	50	150
Ammonia Nitrogen (as N) (mg/l)	1.0	3.0	0.8	2.65	4.21
Total Residual Chlorine (mg/l)	0.02	0.2	0.0	0.0	0.0
pH (su)	6.5 - 8.8	6.0 - 9.0			
Dissolved Oxygen (mg/l)	6.0				

* Data through February, 1980

bypass from the East Custer Sanitary District line. The surcharged Custer sewer interceptor line's inability to handle the sewage from the East Custer Sanitary District at a point south of the treatment plant near French Creek resulted in frequent raw sewage overflows to French Creek. Modifications to the East Custer system in 1980 extended the collection line to a point near the headworks of the Custer wastewater treatment plant thereby solving the overflow problem from the East Custer Sanitary District.

However, the Custer sewer interceptor remains a problem. The line crosses French Creek in four places and follows the creek downstream through Custer to a point south of the wastewater treatment plant. The line receives infiltration from the alluvial groundwater near the creek. Therefore, it may also exfiltrate during dry periods when groundwater levels are down. During dry periods it could be the source of nutrient additions to French Creek, and one possible source for fecal coliform bacteria violations in French Creek above the Custer WWTP.

During wet periods surcharging in the interceptor causes the line to overload and creates a potential raw sewage by-pass to French Creek.

Recommendations:

Results of a smoke test conducted on the Custer sewage collection system are available through the City Engineer's office in Custer. These results should be obtained in order to

identify any exfiltration at or near French Creek. If problems are detected, steps should be taken to alleviate them. In addition, all raw sewage by-passes and overflows should be eliminated.

The 201, Step I, Facility Plan is slated for completion by October, 1981. Recommendations made in the Facility Plan should be carried through the design and construction steps as funds allow. DWNR strongly recommends the construction of a "no discharge" facility which would totally eliminate the addition of phosphorus and nitrogen to Stockade Lake from the treatment plant.

2. Individual Septic Tank/Drainfield Systems

Problem:

Infrared photo imagery by EPA and field investigations by the Stockade Lake Study Area Coordinator have identified 62 individual wastewater systems (septic tanks) with potential problems (Kujala, Appendix F).

The basic problem with septic tank/drainfield systems has been their placement in thin soils, underlain by granite. Septic tank systems installed without proper percolation and soil testing to determine system compatability with the soils have resulted in the failure of many existing septic tank systems.

Septic tank problems along French Creek occur within the Custer city limits and in the outlying areas. This is exemplified by

the pattern of fecal coliform bacteria violations and nutrient loadings on French Creek as explained in the water quality analysis.

An April 1980 DWNR inspection of Custer's sewage system identified three problem areas, one in the center of Custer between Lincoln and Montgomery, one in southeast Custer near 11th Avenue and Washington Street, and another in extreme southwest Custer.

Unfortunately the bond issue to provide for water and sewer improvements was turned down on September 16, 1980.

Recommendations:

The recomendations for this problem area have been divided into two sections, the first being installation of new systems. To be considered under this section are:

(1) Continual support of county sanitarians and the regulation/procedures they have been using for the installation of new systems.

(2) Consideration of alternative on-site disposal systems, to include:

a. Mound system: also known as evapotranspiration or NoDak system, where soils are mounded above the natural surface and effluent seeps more slowly into the natural soils or is evaporated or transpired through the mound surface.

b. Evaporation system: where effluent is prevented from entering the natural soil and is instead forced to evaporate or transpire. The system involves a ground liner covered with an artificial bed of sand, gravel or sandy loam.

c. Separation of household wastewater with subsequent reuse of the grey water portion (sink, shower, etc.) and reduction in treatment.

d. Composting toilets and/or recycling systems.

The remaining recommendations are concerned with existing systems with some crossover into new system installation.

(1) Homeowner Education/System Inspection - This recommendation may involve public meetings, explaining operation/maintenance, promotion of efficient systems through seminars and brochures, and on-site checking of systems to determine problem areas. After problems have been determined, officials can then assist in renovations.

(2) Enforcement of current regulations concerning installation and maintenance of individual wastewater systems, and review of applicable zoning regulations.

(3) Promotion of voluntary compliance in renovation of malfunctioning systems.

(4) Expansion of Step I planning area (WWTP) to include portions of the area designated as having septic tank problems.

3. Livestock Concentrations

Problem:

Livestock concentrations along tributaries to French Creek have been listed as potential sources of nutrients in the watershed (Kujala, Appendix F). As noted, large reaches of French Creek upstream of Ruby Creek and downstream to Stockade Lake have livestock concentrations or barnyards that may contribute nutrient loadings. Willow Creek and Bismark Lake Creek also have concentrations of livestock along most of their lengths.

It is likely much of the nutrient loadings from the Sixth District data mentioned in the water quality analysis originates from livestock wastes. Much of the land along the creeks in the watershed is meadow. Therefore, grazing animals are concentrated along the streams, particularly in winter. However, nutrient loadings from livestock sources have not been quantified.

Recommendations:

A quantitative evaluation of the impact on Stockade Lake of livestock concentrations in the watershed has not been made. It is, therefore, recommended that further investigation,

including problem area identification and water quality monitoring be conducted.

Since the U.S. Forest Service owns much of the land being used for grazing in the watershed, the Forest Service leasing agreement should be reviewed. Stipulations could be added to these leases which would minimize any adverse effects of livestock on the water quality of French Creek and Stockade Lake. Proper grazing management should be encouraged on both public and private land.

4. Sylvan Lake Wastewater System

Problem:

The Sylvan Lake facility operated by Game, Fish and Parks has a wastewater treatment facility which discharges to the Stockade Lake watershed.

The facility consists of a 2 cell, 10 acre stabilization pond which discharges to Willow Creek.

The facility serves approximately 1000 people for four months in the summer. Because of a lack of funding for facility upgrading an extension was granted until July 1, 1983. Until that date the facility must meet the discharge requirements in Table 10:

TABLE 10

SYLVAN LAKE WASTEWATER FACILITY NPDES EFFLUENT LIMITATIONS

Parameter	Average Effluent Concentration 30 Consecutive Day Period	7 Consecutive Day Period
Five Day Biochemical Oxygen Demand mg/l (BOD5)	30	45
Total Suspended Solids (TSS)	N/A	N/A
pH	Shall remain between 6.0 and 9.0	

After July 1, 1983 the Sylvan Lake facility must meet 10 mg/l BOD_5, 10 mg/l TSS and a pH of 6.0 to 9.0.

The Sylvan Lake facility has a 1981 priority ranking of 103 with a priority number of 49. However, State wastewater facilities are to be removed from the priority list and will not be grant eligible.

Work was recently completed on a project to divert spring flows from the lagoons. The spring was reducing the facility retention time, resulting in the discharge of effluent to Willow Creek.

Recommendations:

Sampling conducted by the South Dakota Department of Game, Fish and Parks (GFP) showed that diversion of the spring from the lagoon was successful and that there is no seepage of effluent into the spring water. The impact of the lagoon discharge on Willow Creek and ultimately French Creek and Stockade Lake is not known. It is recommended that this potential nutrient source be monitored at the lagoon outflow and at the confluence of French and Willow Creeks. In the event that high nutrient concentrations are detected, remedial action should be taken.

5. Urban Runoff

Problem:

Urban runoff in the Stockade Lake watershed may be divided into two types of sources. First, the City of Custer has eight miles of paved streets and twelve miles of gravel and dirt streets, with only a limited portion of the city served by storm sewers. Runoff thus carries large amounts of sediment from the gravel streets and sediment, together with oil, from the paved streets (Kujula, Appendix C3).

The second urban runoff problem is the disposal of snow from the streets to sites adjacent to French Creek. This snow contains sand and possibly other pollutants from the roads such as road salts and auto exhaust by-products (zinc, cadmium, nickel, sulfur oxides and hydrocarbons). Upon snow melt, these pollutants are readily washed into French Creek.

Recommendations:

Snow should be deposited at sites further removed from the Creek. Monitoring should be conducted to determine the extent of water quality degradation due to runoff from the streets. If found to be a significant problem suitable methods of dealing with this runoff would include construction of barriers, storm sewers with facilities for retention, and construction of curbs and gutters. All such improvements are expensive.

6. Mining Activities

Problem:

A placer mining operation located along French Creek east of the Custer city limits, was investigated by DWNR personnel in October, 1980. A stretch of the Creek has been rechannelized and two holes 15 to 18 feet deep have been dug in the new channel. The rechannelization may lead to increased erosion rates downstream from the site. Channel alteration from mining and other activities is also evident along many other reaches of French Creek. As development around Custer continues, the occurrence of this type activity will likely increase as well.

Pollution problems from mining activities or mine spoils other than placer mining are limited to a single site, less than a mile from Stockade Lake and a few hundred yards from French Creek. This is an abandoned mine, with an exposed face of spoils. The proximity of the spoils to French Creek and the exposed nature would allow the mine to contribute sediment to French Creek.

Recommendations:

The South Dakota Conservation Commission administers a $25,000 fund to rehabilitate abandoned mine sites. Agencies involved in the Stockade Lake Restoration Project should work with the Conservation Commission to develop a model rehabilitation project at the abandoned mine site. The estimated cost for reclamation of this site is $50,000 to $100,000 so additional funding sources must also be sought.

Zoning and regulations could also be used to control placer mining and sediment producing activity. A regulation should be adopted to protect against filling, lagooning, grading or dredging which would result in substantial detriment to natural waters by reason of erosion, sediment or impairment to fish and aquatic life.

Activity would be controlled through a permit similar to building permits.

7. Silviculture

Problem:

a. Sedimentation

The watershed is 75% forest land; and 15,000 acres, or 30% of the watershed will be harvested in the next five years (Appendix C3). Adverse effects from timber harvesting on water quality is a concern. The U.S. Forest Service has indicated the major pollutant arising from timber harvesting is sediment, derived from erosion of roads and logging trails. Slash and vegetation remaining on the land after timber harvesting are usually sufficient to prevent significant soil erosion.

The Forest Service calculated an erosion loss of about 0.15 tons per acre per year for logged areas in the French Creek watershed. This compares favorably with the Soil Conservation Service guideline of 1-5 tons per acre per

year as a maximum erosion rate to sustain long-term productivity.

b. Nutrient Loading

The U.S. Forest Service has determined that there is no evidence from a Forest Service water quality monitoring station on French Creek above Custer to indicate any sustained adverse change in water quality attributable to timber harvesting.

Recommendations:

At the present time, silvicultural activities in the Stockade Lake watershed appear to have a minimal impact on water quality. Predicted future increases in timber harvesting should be accompanied by water quality monitoring. Also, silvicultural best management practices (BMP's) to minimize erosion should be employed throughout the duration of timber harvesting activities in the watershed.

B. In-Lake Problems and Recommendations

Problems:

As discusssed in the water quality portion, watershed nutrient loadings to Stockade Lake are substantial. The lake is hypereutrophic based on nutrient values, secchi disk readings and phytoplankton populations. These three parameters are rated by two

methods; the Trophic State Index and Vollenweider's lake classification scheme.

Stockade Lake is assigned the following beneficial uses in South Dakota's "Surface Water Quality Standards" ARSD 74:04:02:

(3) Cold water marginal fish life propagation;

(7) Immersion recreation; and

(8) Limited contact recreation.

The cold water marginal fishery in Stockade Lake is a "put and take" fishery because of heavy fishing and frequent fish kills. Water quality degradation has added substantially to the fishery management problems in Stockade Lake.

Chemical rehabilitation of Stockade Lake by removal of undesireable fish, was attempted in 1960 and warm water fish species were introduced to the lake because of poor water quality. Reports of local sportsmen to Game, Fish and Parks as early as 1959 and 1960 indicated declines in the harvest of all fish.

Over-population of stunted fish resulted in another chemical rehabilitation in 1965. The lake was restocked with rainbow trout. Major summer fish kills have occurred in Stockade lake in July 1966, July 1970, and again in March 1971. Minor fish kills have occurred frequently since. Game, Fish and Parks attributed the kills to thermal stratification and low dissolved oxygen in the hypolimnion. Added fish stress is created by high surface

temperatures, dense algal blooms, and high pH. Thermal stratification develops in May and lasts through September.

Poor water quality intensifies the oxygen and pH problems in the hypolimnion. Algal blooms can attain a depth of five feet, limiting the lake area available for fish to between the 8 to 12 foot level in summer.

Aeration to alleviate the effects of thermal stratification and poor water quality in the lake was studied by Game, Fish and Parks. This study began in 1966 and continued through 1968. No fish kills occurred while the system was operating. The 1970 fish kill was abated when the system was used again. The system has not been used since 1970 due to a lack of funding.

The dense agal blooms consist mainly of Anabaena flos-aque in June, Ascillatoria tenuis and Ababaena spiroides in August. The algal blooms affect the immersion recreation use assigned to Stockade lake. Swimming in Stockade Lake is an activity which Custer State Park officials have not included in recreation development plans due to the poor water quality and resultant algal blooms. Watershed nutrient loadings to Stockade Lake result in algal blooms.

Also to be considered in the treatment of in-lake problems is sediment. The sediment surveys conducted on the Stockade Lake inlets in 1979 and 1981 indicates sediment deposits of 117,000 cubic yards from 1935 to 1972 and 44,000 cubic yards from 1972 to 1981. The total volume of sediments deposited in the Stockade Lake

inlets is 161,000 cubic yards. The SCS Soil Erosion and Sediment Yield Study (Appendix C1) indicates that 0.94 ac-ft/yr of soil erodes into Stockade Lake. The SCS sediment yield analysis results are low compared to the 1972 and 1981 Stockade Lake measurements of 2.02 ac-ft/yr from 1935 to 1972 and 2.6 ac-ft/yr from 1972 to 1981 (Appendix C). This indicates deposition of sediments from sources other than soil runoff. The main contributor of sediment other than soil is the Custer wastewater treatment facility. This is supported by sediment samples taken from Stockade Lake in 1981. These samples showed sludge-like ooze distributed on most of the lake bottom. Inlet sediment samples contained soil particles in the sludge, while elsewhere the sediment samples had a different consistancy and contained decayed plant material and algae.

Nutrient analysis on the sediment collected in Stockade Lake showed high phosphorus and nitrogen levels. The findings indicate that most of the sediment is organic in nature. As discussed in the water quality section of this report the Custer wastewater treatment facility and septic tank problems are the largest contributors to high nutrient loadings to Stockade Lake.

Recommendations:

Several measures for in-lake treatment have been considered for recommendation. The most prominent being a project combining lake drawdown/sediment consolidation with sediment removal by land based equipment. Additionally, there is the possibility of adding biomanipulation techniques after the lake has been refilled, to prevent future degradation.

Various factors should be considered when evaluating the costs of this procedure. Such items as sediment disposal, lost recreation potential, and the economic effects of biomanipulation must be covered. At this time, estimated construction costs for the above procedure would be $2,500,000. This figure has been derived using standard construction costs. The other factors mentioned have not been cost evaluated.

The lake drawdown/sediment removal process would take a minimum of two years to allow the sediment sufficient drying time. During this period, cuts may be made in the sediment to expedite drying.

Other methods of in-lake treatment that may be considered are as follows:

(1) Dredging to remove accumulated sediments. This procedure has been used in several areas of South Dakota and proposed in others. The primary factors associated with dredging have been the high cost and the release of nutrients into the water column from the disrupted sediment. Estimated costs to remove the accumulated sediments through dredging are $1,078,000. Other procedures may have to be incorporated with dredging to reduce the effects of nutrient release.

(2) Lake bottom sealing. Several methods to seal the bottom are explained in the literature. The only one considered here is the use of a PVC liner to cover the lake bottom. Estimated costs are $1,040,000. This treatment should be effective for

a minimum of 10 years or longer depending on the materials used.

(3) Chemical nutrient precipitation. This methods involves the application of a chemical such as aluminum sulfate (alum) to the lake surface to tie up the phosphorus that is in solution, forming a precipitate (floc) which settles and forms a partial bottom seal. Cost estimates are $100,000 per treatment. This treatment's effectiveness is dependent on the loadings coming into Stockade Lake. It may have to be repeated annually.

(4) Biomanipulation. This is the process of changing the species present in the lake to control the nutrients and/or algae. In Stockade Lake this would involve stocking warm water species such as pike, walleye and bass in place of the trout now stocked. The intent of this would be adding another level to the food chain to decrease the forage on the zooplankton which in turn feed on the algae. There is also the possibility of a decrease in total fish biomass.

(5) Aeration/Circulation. Various methods of artificial aeration are described in the literature although no specific method is recommended here. Several types are now in use in South Dakota and the system that was used previously on Stockade Lake should be considered since, according to GFP data, it was effective in eliminating several fish kills. Costs of aeration are reported to be prohibitive; however a system installed in Lake Herman near Madison, South Dakota to aerate

the 1,350 acre lake cost $1,300 for the initial 5 month period of operation. Installation costs were $20,000.

All the recommendations listed in this section must be viewed as temporary treatments or treatment of symptoms when the nutrient/sediment inflow from the watershed is considered.

Figure 10

Stockade Lake Watershed, 1979-80, Mean Total PO_4 as P (mg/l)

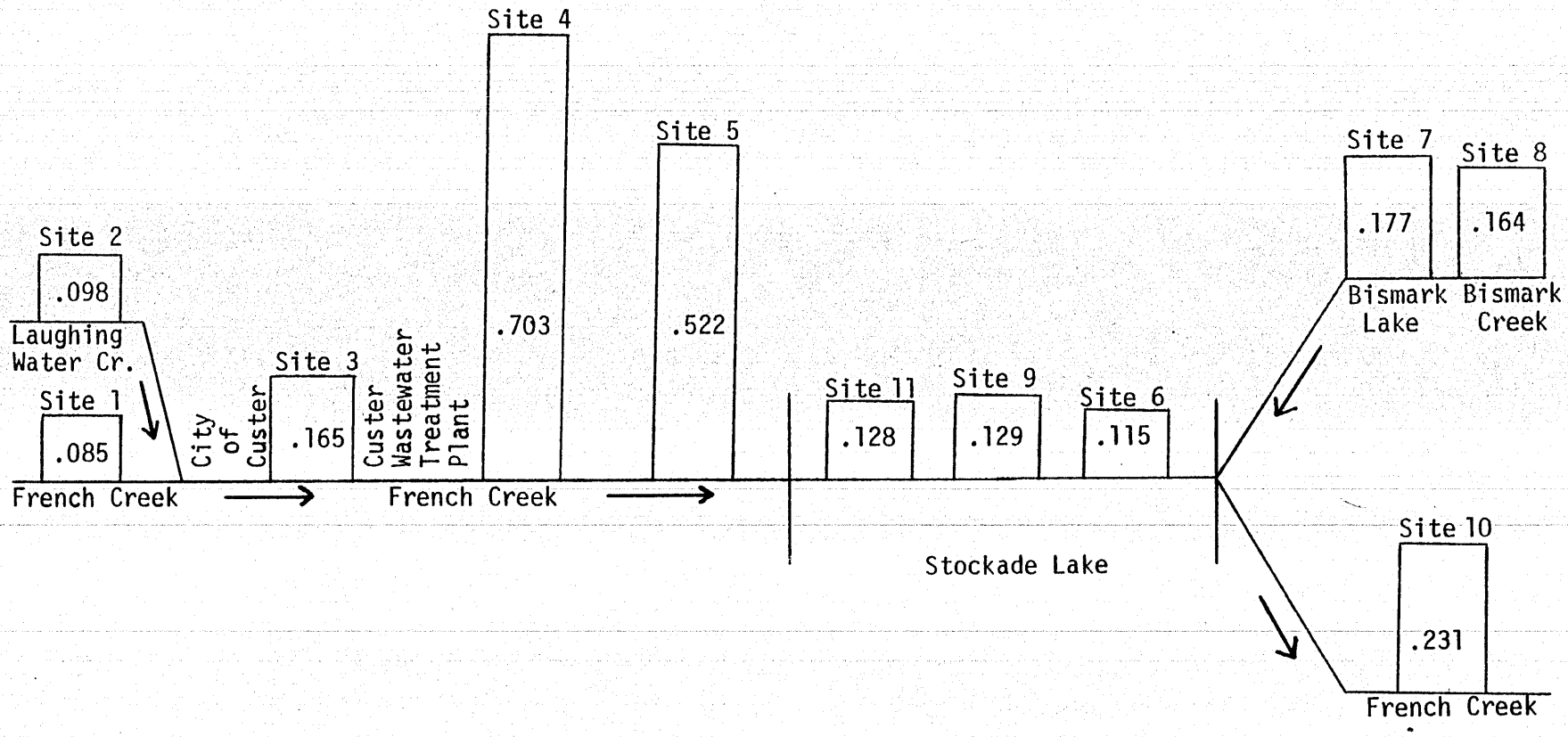
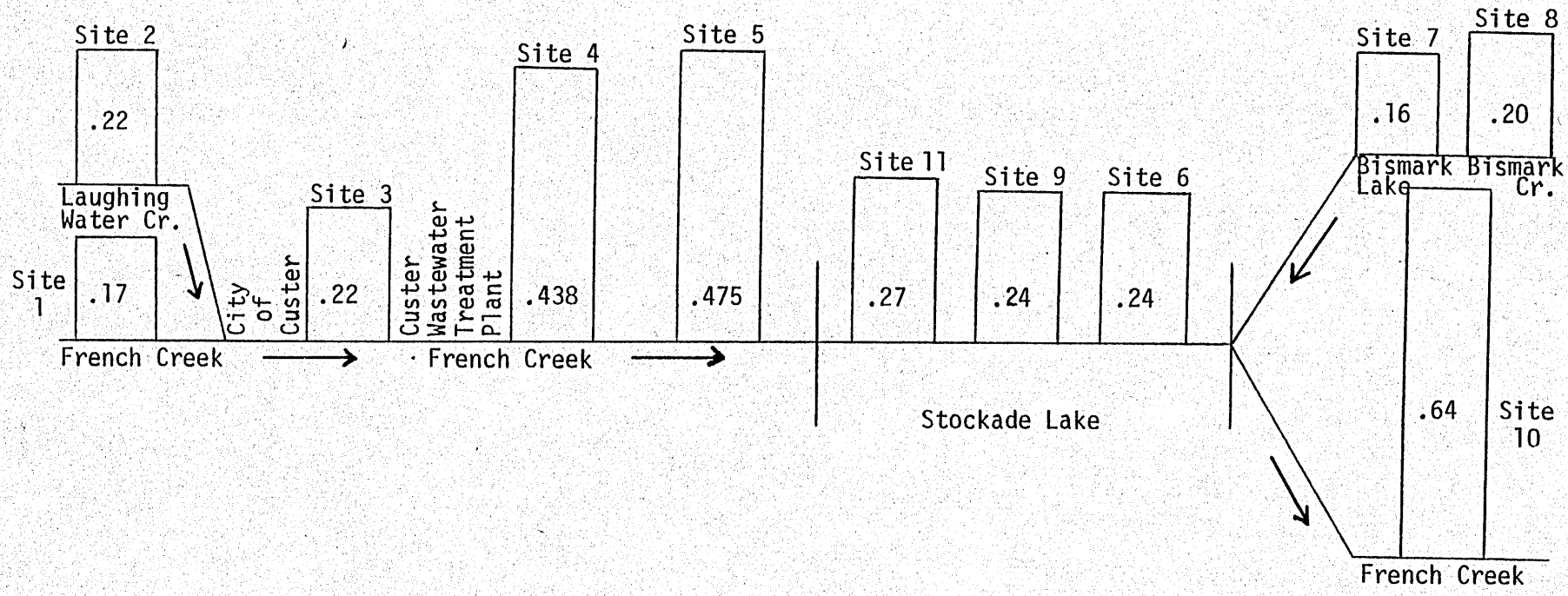


Figure 11

Stockade Lake Watershed, 1979-80, Mean Inorganic Nitrogen (mg/l)



APPENDICES

Appendix A1.

Criteria for Selection

[illegible] — 505 East St. Joe Street
Rapid City, South Dakota 57701
Phone (605) [illegible]-8211

Dear

As part of the new 208 Water Quality Management Planning activities, the South Dakota Department of Environmental Protection (DEP) has requested that Sixth District submit three priority ranked nominations for a Water Quality Study Area (WQSA). These study areas can be a lake, stream segment, or some other surface water, but it is anticipated that a lake will be preferable. The intent of this project is to study the selected area in order to determine the exact water quality problem, the reason for the problem, and the required restorative measures. The study will be conducted over a one-year period by DEP utilizing various governmental agencies, such as the State Planning Bureau and the Soil Conservation Service. Once this study has been completed, it is anticipated that DEP will strongly encourage the local sponsoring group to implement those restorative measures which are needed. These measures might consist of raising funds for implementation measures, implementing best management practices which are designed to reduce pollution from runoff, or controlling land use within the basin through proper zoning.

DEP is asking that Sixth District submit its nominations as soon as possible because they wish to make the final selection prior to snow melt so that this can be sampled. If your organization would wish to make a nomination, please submit the name of the lake (s) to this office by March 6, 1979. The nominations will be compiled and presented to the Council at the March 6, 1979 meeting for final selection and prioritization.

It should be pointed out that the final selection criteria to be used by DEP will be based upon technical feasibility and demonstrated public support. Therefore, the area which has the most public support (in terms of letters, etc.) will definitely have an advantage in the selection process.

If you should require any additional information concerning the selection of a Water Quality Study Area, please do not hesitate to contact Steve Richard at our office.

Sincerely,

Van A. Lindquist
Executive Director

SENT TO:

CONSERVATION [illegible]

William Kelly - [illegible]
Richard Westall - [illegible]
Vernon Seger - [illegible]
Gary Tennant - [illegible]
Stanton Selway - [illegible]
Darrell Giesler - [illegible]
Harold Cox - [illegible]

James Mathers - US Forest Service [illegible]

Jack Merwin - Wildlife, Parks and [illegible]

Warren Jackson - Custer State [illegible]

Jim Larson - RC & D

Terry Dimock - Community Development, Rapid City

NOMINATIONS FOR 208 WATER QUALITY STUDY AREA

NAME OF LAKE AND COUNTY	NOMINATED BY	DEP SIGNIFICANCE POINTS	SOUTH DAKOTA BENEFICIAL USE CLASSIFICATION	DESCRIPTION
SHERIDAN LAKE/PENNINGTON COUNTY	RAPID CITY (B.L.) - 1st CHOICE, RC & D - 1st CHOICE, U.S. FOREST SERVICE - 3rd CHOICE, WILDLIFE, PARKS AND FORESTRY - 2nd CHOICE	69	COLD WATER PERMANENT FISHERY, IMMERSION RECREATION, LIMITED CONTACT RECREATION, WILDLIFE PROPAGATION AND STOCK WATERING	SURFACE AREA - 378 ACRES, MAXIMUM DEPTH - 96 FEET, DRAINAGE BASIN - 142 SQ. MILES, TRIBUTARIES - SPRING CREEK AND HORSE CREEK
CENTER LAKE/CUSTER COUNTY	RAPID CITY (B.L.) - 2nd CHOICE, CUSTER STATE PARK - 4th CHOICE	63	COLD WATER PERMANENT FISHERY, IMMERSION RECREATION, LIMITED CONTACT RECREATION, WILDLIFE PROPAGATION AND STOCK WATERING	SURFACE AREA - 25 ACRES, MAXIMUM DEPTH - 40 FEET, DRAINAGE BASIN - 8 SQ. MILES TRIBUTARY - GRACE COOLIDGE CREEK
STOCKADE LAKE/CUSTER COUNTY	RAPID CITY (B.L.) - 3rd CHOICE, RC & D - 3rd CHOICE, U.S. FOREST SERVICE - 1st CHOICE, WILDLIFE, PARKS AND FORESTRY - 1st CHOICE CUSTER STATE PARK - 2nd CHOICE	63	COLD WATER MARGINAL FISHERY, IMMERSION RECREATION, LIMITED CONTACT RECREATION, WILDLIFE PROPAGATION AND STOCK WATERING	SURFACE AREA - 130 ACRES, MAXIMUM DEPTH - 42 FEET, DRAINAGE BASIN - 67 SQ. MILES, TRIBUTARY - FRENCH CREEK
SYLVAN LAKE/CUSTER COUNTY	CUSTER STATE PARK - 1st CHOICE	60	COLD WATER PERMANENT FISHERY, IMMERSION RECREATION, LIMITED CONTACT RECREATION, WILDLIFE PROPAGATION AND STOCK WATERING	SURFACE AREA - 19 ACRES, MAXIMUM DEPTH - 36 FEET, DRAINAGE BASIN - 1.5 SQ. MILES, TRIBUTARY - UNNAMED
IRON CREEK LAKE/LAWRENCE COUNTY	LAWRENCE COUNTY CONSERVATION DISTRICT - 2nd CHOICE	54	DOMESTIC WATER SUPPLY, COLD WATER PERMANENT FISHERY, IMMERSION RECREATION, LIMITED CONTACT RECREATION, WILDLIFE PROPAGATION AND STOCK WATERING	SURFACE AREA - 24 ACRES, MAXIMUM DEPTH - 35 FEET, DRAINAGE BASIN - 1.5 SQ. MILES, TRIBUTARY - IRON CREEK
BISMARK LAKE/CUSTER COUNTY	U.S. FOREST SERVICE - 2nd CHOICE	53	COLD WATER MARGINAL FISHERY, IMMERSION RECREATION, LIMITED CONTACT RECREATION, WILDLIFE PROPAGATION AND STOCK WATERING	SURFACE AREA - 25 ACRES, MAXIMUM DEPTH - 26 FEET, DRAINAGE BASIN - 3 SQ. MILES, TRIBUTARY - UNNAMED
LEGION LAKE/CUSTER COUNTY	CUSTER STATE PARK - 3rd CHOICE	52	COLD WATER MARGINAL FISHERY, IMMERSION RECREATION, LIMITED CONTACT RECREATION, WILDLIFE PROPAGATION AND STOCK WATERING	SURFACE AREA - 9 ACRES, MAXIMUM DEPTH - 20 FEET, DRAINAGE BASIN - 2 SQ. MILES, TRIBUTARY - GALENA CREEK
CANYON LAKE/PENNINGTON COUNTY	MAYOR OF RAPID CITY - 1st CHOICE, RC & D - 2nd CHOICE, WESTERN SD DEVELOPMENT - 1st CHOICE WILDLIFE, PARKS AND FORESTRY - 3rd CHOICE	39	COLD WATER PERMANENT FISHERY, IMMERSION RECREATION, LIMITED CONTACT RECREATION, WILDLIFE PROPAGATION AND STOCK WATERING	SURFACE AREA - 25 ACRES, MAXIMUM DEPTH - 8 FEET, DRAINAGE BASIN - 65 SQ. MILES, TRIBUTARY - RAPID CREEK
REAUSAW LAKE/LAWRENCE COUNTY	LAWRENCE COUNTY CONSERVATION DISTRICT - 1st CHOICE	30	COLD WATER MARGINAL FISHERY, IMMERSION RECREATION, LIMITED CONTACT RECREATION, WILDLIFE PROPAGATION AND STOCK WATERING	SURFACE AREA - 5 ACRES, MAXIMUM DEPTH - 8 FEET, DRAINAGE BASIN - 4 SQ. MILES, TRIBUTARY - HAY CREEK
SPEARFISH CREEK BETWEEN SPEARFISH AND BELLE FOURCHE/LAWRENCE AND BUTTE COUNTY	BELLE FOURCHE - 1st CHOICE, U.S. FOREST SERVICE - 4th CHOICE		DOMESTIC WATER SUPPLY, COLD WATER PERMANENT FISHERY, IMMERSION RECREATION, LIMITED CONTACT RECREATION, WILDLIFE PROPAGATION AND STOCK WATERING, IRRIGATION	STREAM SEGMENT - 10 MILES

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Black Hills National Forest
Custer, South Dakota 57730

2540

March 8, 1979

Mr. Van Lindquist
Executive Director
Sixth District Council of Local Governments
P.O. Box 1586
Rapid City, SD 57701

Dear Van:

The Black Hills National Forest endorses the concept of a water quality study unit within the Sixth District area. No matter which site is chosen, the Forest Service will cooperate as much as possible. Our data files will be available for use by the study team and we will consider action on any restorative recommendations that apply to Forest Service administered lands.

There are probably many areas within the Black Hills that may qualify for a study area. However, the Forest Service has selected three areas which we feel qualify best as a water quality study unit. The first area, in order of priority, is Stockade and Bismark Lakes. They are located in and adjacent to Custer State Park. These reservoirs are prime examples of eutrophic lakes. Fish kills have been recorded in both lakes, and algae "blooms" are perennial reoccurrences. The city of Custer and many acres of private land influence the upstream watersheds. These lakes are also centers of attraction for many thousands of Park visitors each year. A complete cause-effect study with recommended restorative measures would not only benefit the aquatic habitat but help preserve a primary recreation area.

The second recommended area is Sheridan Lake located north of Hill City, SD. Sheridan reservoir is also a eutrophic lake. It is influenced by Spring Creek and Newton Fork which flow through a considerable amount of private land. Sheridan Lake is an important recreation area. Uses include fishing, boating, swimming, picnicing, camping and summer homes. It is also located on a major travel artery used by the many visitors that come to the Black Hills annually.

Our third choice is Spearfish Creek. Spearfish Creek flows through many acres of private land including the city of Spearfish. Forest Service uses on the watersheds include recreation, timber harvesting and grazing.

JAMES R. MATHERS
Forest Supervisor

6th district council of local governments

P. O. Box 1586 – 306 East St. Joe Street
Rapid City, South Dakota 57709
Phone: (605) 394-2681

March 13, 1979

Mr. Howard, Acting Secretary
Department of Environmental
Protection
Joe Foss Building
Pierre, SD 57501

RE: 208 Water Quality Study Area

Dear Mr. Howard:

This letter is to convey Sixth District's selection for a 208 Water Quality Study Area. This matter was considered by the Sixth District Council on March 8, 1979. Contiguous issues were raised during the discussion of this action which illustrates several specific concerns. A special concern that was raised is whether or not the South Dakota Department of Environmental Protection (DEP) is attempting to dictate those areas of water quality planning to be addressed in Sixth District, and doing so without local motivation. In conjunction with this concern, discussion also centered upon whether or not the DEP is attempting to supercede the Sixth District 208 Plan through this program, particularly in view of the fact that lake water quality was not a priority item in the Sixth District 208. However, because of the potential for implementation funds, the Council did decide to nominate three lake watersheds from ten (10) areas that had been nominated as follows:

a) First Choice: Either Stockade or Sheridan Lake

b) Second Choice: Canyon Lake

These areas are being submitted in order for consideration as a 208 Water Quality Study Area, but only with the following understanding:

a) No study will be made unless there is demonstrated support for the study from the public within the basin.

b) DEP must realize that this action of submitting these areas for consideration cannot be construed to imply that Sixth District as a designated 208 Areawide Water

Quality Planning area is subjecting itself to the Statewide 208 Water Quality Plan.

c) Upon completion of the one year study, DEP will provide to Sixth District a report containing all necessary information required for application for a 314 Phase II Grant (as per the 314 Grant regulations published in the Federal Register) and for a South Dakota Lake Protection Grant.

d) It is requested that DEP notify Sixth District in writing of their selection, and that the rationale for their selection be presented.

e) It must be understood that any implementation which might result from this study must proceed in a manner that is consistent with the management structure as presented in the Sixth District 208 Water Quality Management Plan.

If any questions concerning this matter arise, please do not hesitate to call.

Sincerely,

Steven Pirner
208 Consultant

SP:fp

cc: Sixth District Council Members
Warren Jackson, Custer State Park
Toby Kirkpatrick, Custer State Park
Mr. Stan Selway, Lawrence County Conservation District
Dan Lindbloom
Lee Leffert, U.S. Forest Service
Mayor Art LaCroix, Rapid City
James Larsen, R.C. and D
Hoadly Dean, Western South Dakota Development

April 12, 1979

Van Lindquist, Director
Sixth District Council of Local Governments
P. O. Box 1586
Rapid City, South Dakota 57709

Re: 208 Water Quality Study Area

Dear Van:

This letter is in reference to Steve Pirner's letter of March 13, 1979 regarding the selection of a Water Quality Study Area (WQSA) in the Sixth District Council of Local Governments. After technically reviewing the three watersheds selected by the District - Stockade Lake, Sheridan Lake, and Canyon Lake, DEP is of the opinion that at this time Stockade Lake appears to be the best choice to study and has the best potential to develop a rehabilitation program. The reasons for this selection are the following:

1. Stockade Lake Watershed is approximately half the size of the Sheridan Lake Watershed and, therefore, should be more manageable;

2. According to available data, Stockade was determined to be of poorer water quality than Sheridan, (Stockade was 23rd on the 1975 National Eutrophication Survey while Sheridan ranked 9th); and

3. The South Dakota Department of Wildlife, Parks and Forestry as well as the U.S. Forest Service both of which manage land in this watershed, support this selection.

There are several reasons we feel that a WQSA approach can be useful:

1. WQSAs have been successful in other parts of the State. The Lake County Conservation District is coordinating the implementation of the Lake Herman WQSA. The Edmunds, McPherson and Brown County Conservation Districts have joined together to begin implementation of the Mina Lake WQSA. Other WQSAs such as Poinsett and Oakwood Lakes are begining to organize for implementation.

2. In the other Planning Districts, five new WQSAs have been selected. At Lake Kampeska a public meeting was held and over 400 people showed up to voice their support for the project.

3. In order to have a WQSA that can apply for implementation grants such as the Rural Clean Water Program, ASCS special projects, 314 Clean Lakes, State Lake Protection Grants, etc., a WQSA must have local support from the people in the watershed, county government, conservation districts, lake associations, etc.

4. If the WQSA approach is adopted, the duties of the 208 contractors in the WQSA are the following: 6th District would coordinate any activities at the local level to keep the public informed, conduct public meetings and hearings, assist the local units of government in any planning activities, and make sure that all planning activities comply with the Sixth District 208 Water Quality Management Plan. The Division of Conservation would keep the Conservation Districts informed of all planning activities. The U.S. Soil Conservation Service will provide sediment yield statistics for the lake and will recommend best management practices to be used in the watershed. The State Planning Bureau will provide land utilization maps. DEP will coordinate and compile the technical data from the above contractors and prepare a final report to be used by the District and potential local management agencies. DEP would monitor non-point source pollution to the lakes, and develop in-lake restoration recommendations.

We believe WQSAs are a useful approach to water quality planning. However, I would like to reaffirm DEP's position with regard to the designated status of the area covered by the Sixth District Council of Local Governments. DEP has no intention of negating the Sixth District 208 Water Quality Plan by forcing WQSAs on the District. The District may develop any planning programs it believes are applicable to the continuation of the 208 planning process.

In conclusion, it must be stated that the WQSA approach is strictly a voluntary approach to water quality management. No single individual, group of individuals, or unit of government will be required to comply with the findings of the study. Voluntary cost share programs will be used in the event the WQSA is implemented by a local unit of government.

I hope that this answers any questions you may have about our position on the Sixth District 208 Water Quality Management Plan, the Water Quality Study Areas, and the selection of Stockade Lake as a WQSA. Please contact me if you have any questions. Thank you.

Sincerely,

Bill Markley

Bill Markley
Statewide "208" Coordinator
Office of Water Quality

cc: Richard Howard, Acting Secretary
S.D. Department of Environmental Protection
Jim Nelson, Acting Office Administrator
Office of Water Quality
Roger Dean, US EPA - Region VIII

A3/39

Appendix A2.

Public Input Into Selection of a WQSA

6th district council of local governments

P. O. Box 1586 — 306 East St. Joe Street
Rapid City, South Dakota 57701
Phone: (605) - 342 - 8241

AUG 1979
RECEIVED

July 13, 1979

This letter was sent to the people on the attached sheet:

On July 24, 1979 at 7:00 p.m., a public meeting will be held at the County Courthouse in Custer to explain a proposed project to improve the water quality of Stockade Lake. Another purpose of the meeting is to determine if there is public support to begin and complete this project.

Utilization of your agencies' programs and resources are possible during this study. Therefore, your comments and questions are greatly needed. If support at the local level is not evident, another lake will be chosen and another meeting will be held, again to determine public support.

A brief summary of the project and a map are enclosed. If you have any questions, please contact me at 394-2681.

Thank you for taking the time to show your interest.

Sincerely,

Steven G. Richard

Steven Richard
Environmental Engineer
208 Water Quality Management Program

SR:fp

Enclosures

Dave Lehmkuhl
Custer County Extension Service
420 Mount Rushmore Road
Custer, SD 57730

Ed Glassgow
Black Hills Conservancy Sub-District
P.O. Box 1692
Rapid City, SD 57709

Conrad Hillman
Fish & Wildlife Service
515 Ninth Street
Rapid City, SD 57701

Jim Larson, RC & D
Federal Building - Room 224
P.O. Box 1692
Rapid City, SD 57709

William Sager
Custer County Commission
North 1
Custer, SD 57730

Jack Lintz
Custer County Commission
Hermosa, SD 57744

James Stender
Custer County Commission
Sylvan Lake Road
Custer, SD 57730

Edward Galles, Mayor
311 Harney
Custer, SD 57730

Stanton Selway
Lawrence Conservation District
Box A
Deadwood, SD 57732

Kerry Steiner
Soil Conservation Service
703 Mount Rushmore North
Custer, SD 57730

Jim Mathers
Black Hills National Forest
Box 792
Custer, SD 57730

Clare Mae Clay
ASCS
14 and Galveston
Hot Springs, SD 57747

Ed Artz
Soil Conservation Service
515 Ninth Street
Rapid City, SD 57701

Sam Kirk
Custer Conservation District
Pringle, SD 57773

Jack Markitan
Custer Conservation District
Fairburn, SD 57738

Helen Peterson
Custer Conservation District
Sylvan Lake Road
Custer, SD 57730

Joe Marsh
Custer Conservation District
1104 Needles Drive
Custer, SD 57730

Darwin Pierce
Custer Conservation District
Buffalo Gap, SD 57722

Harry Evans, Vice Chairman
Custer Conservation District
Pringle, SD 57773

Richard Westall, Chairman
Custer Conservation District
Edgemont, SD 57735

July 6, 1979

NOTICE OF PUBLIC MEETING CONCERNING PROPOSED
STOCKADE WATER QUALITY STUDY AREA

On July 24, 1979, a public meeting will be held at the County Courthouse in Custer to explain a proposed project to improve the water quality of Stockade Lake. Another purpose of the meeting is to determine if there is public support to begin and complete this project.

As a citizen living in the Black Hills area, your comments and questions are greatly needed. If support at the local level is not evident, another lake will be chosen and another meeting will be held, again to determine public support.

A brief summary of the project and a map are enclosed. If you have any questions, please contact me at 1-800-742-8908 or 394-2681.

Thank you for taking the time to show your interest.

Sincerely,

Steven G. Richard

Steve Richard
Environmental Engineer
208 Water Quality Management Program

SR:fp

Enclosures

MAY 01 1981

PROPOSED STOCKADE LAKE
WATER QUALITY STUDY AREA

PUBLIC MEETING

A G E N D A

1. Background on Proposed Study:
   Steve Pirner: Consultant, Sixth District

2. History of Stockade Lake:
   South Dakota Department of Game, Fish and Parks

3. Objectives of Proposed Study:
   Jim Seyfer: South Dakota Department of Water and Natural Resources

4. Question and Answer Session

N O T I C E

Written comments concerning this proposed study will be accepted until August 7, 1979. Mail to the Sixth District Council of Local Governments, P.O. Box 1586, Rapid City, SD 57709.

MEETING HELD AT: Custer County Courthouse
Custer, South Dakota
7:00 P.M.
July 24, 1979

STOCKADE LAKE WATER QUALITY

STUDY AREA (WQSA)

In early 1979, the Sixth District nominated Stockade Lake as an area to be studied for methods to improve the water quality of the lake. As a result of this nomination and subsequent Department of Natural Resources - Office of Water Quality (DNR) determinations, a public meeting will be held by water quality coordinators from the Sixth District to determine public interest for the project. If support for the project is voiced, the study will be completed by DNR before the end of 1979.

The study (Phase I) will be accomplished and funded by DNR and will include:

1. A literature review of the environmental problems of the Stockade Watershed.

2. On-site work
   a. water quality monitoring
   b. identification of critical sources of water pollution
   c. preparation of material to be used in developing applications for future funding
   d. sediment loss and yield

3. Development of potential Best Management Practices to reduce the pollution load.

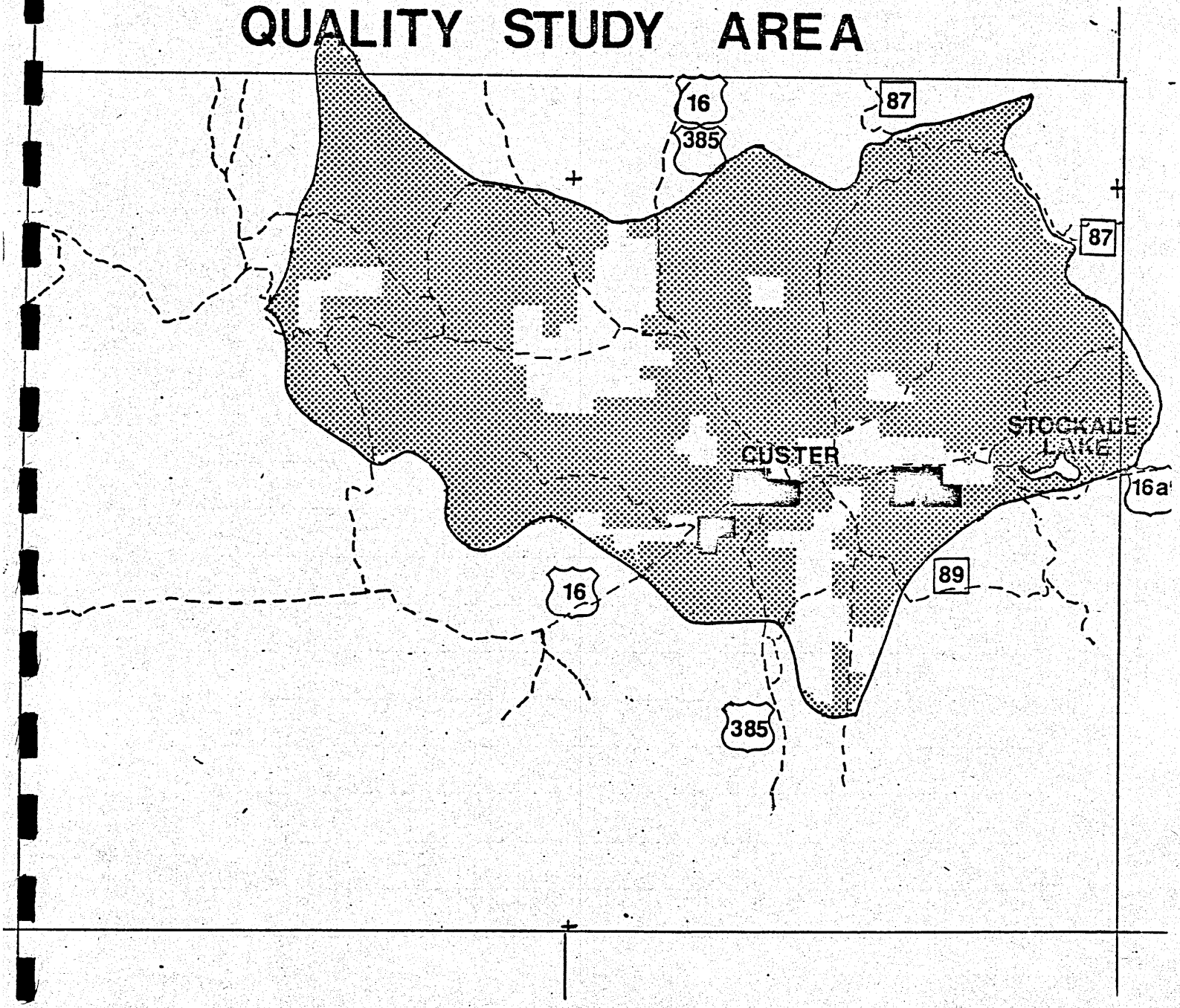
4. Final recommendations.

After accomplishment of Phase I, a public meeting will again be held to review the study and to determine support for Phase II, Implementation Of Approved Recommendations. If Phase II is supported, local steering committees and a sponsor will be slected to carry out the water quality improving suggestions. Phase II will be funded by 50% Federal and 50% State and local money.

Involved Agencies or Groups (Proposed)

Sixth District
Custer Conservation District
Soil Conservation Service
Agricultural Stabilization and Conservation Service
South Dakota Department of Game, Fish and Parks
United States Forest Service
Department of Natural Resources
Local Concerned Groups

PROPOSED STOCKADE LAKE WATER QUALITY STUDY AREA



LAND USE

- FOREST
- RANGE LAND
- URBAN & BUILT UP
- ROADS & HIGHWAYS
- WATER SHED BOUNDARY

LAKE AREA = .2046 MILES^2
131 ACRES

LAKE AVERAGE DEPTH = 19 FEET

WATER SHED DRAINAGE AREA = 78.0 MILES^2
49,915 ACRES

PRECIPITATION = 17 INCHES/YEAR/AVERAGE

HYDRAULIC RETENTION TIME OF LAKE = 274 DAYS

VOLUME OF WATER IN LAKE = 811,000,000 GAL.

PLEASE RETURN TO: Sixth District Council of Local Governments
P.O. Box 1586
Rapid City, SD 57709

SHOULD A PROJECT BE UNDERTAKEN TO IMPROVE THE WATER QUALITY OF STOCKADE LAKE?

YES_____

NO_____

COMMENTS: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(OPTIONAL)

NAME:_____

ADDRESS:_____

SIXTH DISTRICT COUNCIL OF LOCAL GOVERNMENTS

208 ADVISORY GROUP MEETING

Location: West River Electric
East Highway 44 (Rapid Valley)
Rapid City, South Dakota 57701

Time: 7:30 p.m.

Date: July 18, 1979

- AGENDA -

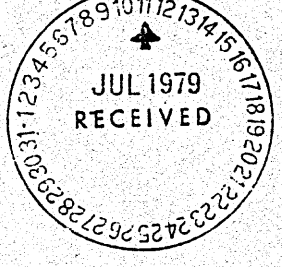
1. Introduction to 208 Program.
2. Purpose and structure of 208 Committee.
   a. election of chairman
   b. possible organization of sub-committees
3. Review of Work Plan.
4. Water Quality Study Area.
5. Action regarding non-response to letters of cooperation.
6. Feedback mechanism from management agencies.
7. Set meeting dates.

ENCLOSURES

Workplan Summary - Items which will be addressed during 1979 by the Sixth District 208 staff. See enclosure #1.

Water Quality Study Area (WQSA). See enclosure #2.

List of 208 Advisory Group Members. See enclosure #3.



Six District Council of Local Governments

208 ADVISORY GROUP

Private Citizens

Dan Lindblom
Hermosa, SD 57744
343-0580

Chuck Jordan
Box 1530
Rapid City, SD 57701
343-7799

Unfilled

John Staben
Box 43
Oral, SD 57766
424-2955

George Blair
Hereford Route
Sturgis, SD 57785
347-3165

Mr. Don Neugebauer
Hermosa, SD 57785
255-4462

Mr. Ken Nelson
Ladner, SD 57753
375-3592

Dean Curry
Cleghorn Canyon
Rapid City, SD 57701
343-7149

Public Interest

Norm Nelson
Sierra Club
P.O. Box 1624
Rapid City, SD 57701
348-1348

Jim Bell
SD Water Congress
Bell-Galyardt & Wells
1026 Jackson Blvd.
Rapid City, SD 57701
343-5282

Kit Kimbal
League of Women Voters
810 Roubaix Dr.
Rapid City, SD 57701
342-7741

Dennis Pfitzer
SD Engineering Soc.
414 7th St.
Rapid City, SD 57701
342-3420

Guy Edwards
Chamber of Commerce
P.O. Box 747
Rapid City, SD 57701
341-4465

Steve Paulson
Black Hills Energy Coalition
824½ 6th St.
Rapid City, SD 57701
348-9537

Economic Interest

Jack McCulloh
SD Stockgrowers Ass.
426 St. Joe St.
Rapid City, SD 57701
343-2660

Lawrence Jeffries
Environmental Affairs
Homestake Mining Co.
Lead, SD 57754
584-1020

Wayne Evenhuis
Associated General Contractors
P.O. Box 1917
Rapid City, SD 57701
343-6665

P.J. Cook
SD Sheepgrowers
1106 12th St.
Belle Fourche, SD 57717
892-2425

Kenneth Lee
Stauter Lumber Co.
Hill City, SD 57745
574-2949

Bob Schurger
RR 8, Box 819
Rapid City, SD 57701
342-8893

Dennis Catron
Catron Corp.
4715 Copper Hill
Rapid City, SD 57701
348-1731

Public Officials

Ed Glassgow
Black Hills Conservancy
Subdistrict
P.O. Box 1692
Rapid City, SD 57701
394-2529

William Carpenter
Forest Supervisor's Office
330 Mt. Rushmore Rd.
Custer, SD 57730
673-2641

Mike Madden
2401 Hoefer
Rapid City, SD 57701
348-2498

Vernon Seger
SD Conservation
District
Box 95
Oelrichs, SD 57763
535-2045

Bill Markley
Dept. of Environmental
Protection
Joe Foss Bldg.
4th Floor
Pierre, SD 57501
224-3351

A. C. Anderson
Piedmont, SD 57769
787-4516

Lee Vanderbush
SD Dept. of Game,
Fish & Parks
3305 W. South
Rapid City, SD 57701
394-2391

Ed Ensz
Soil Conservation
Service
515 9th St.
Room 239
Rapid City, SD 57701
343-1643

SIXTH DISTRICT COUNCIL OF LOCAL GOVERNMENTS

208 ADVISORY GROUP MEETING
September 5, 1979

MEMBERS PRESENT: Mike Madden, Ed Ensz, Kenneth Lee, P.J. Cook, William Carpenter, Dan Lindblom, Ken Nelson, Dennis Pfitzer, Lee Vanderbush, Charles Jordan, Jim Bell, A.C. Anderson, Jack McCulloh, Norman Nelson, Steve Paulson, Bill Markley

MEMBERS ABSENT: John Staben, Deane Curry, Kit Kimbal, Wayne Evenhuis, Bob Schurger, Don Neugebauer, Dennis Catron, Vernon Seger, George Blair, Guy Edwards, Lawrence Jeffries, Ed Glassgow

OTHERS PRESENT: Roger Dean: Environmental Protection Agency - Denver; Van A. Lindquist, Lee Harms, Steve Richard, Steve Pirner and Stewart Steele: Sixth District Council of Local Governments; Dean Flage: Northern Hills Environment - Health Department; Basil Bolyan: Meade Planning Commission; Jack Lintz: Custer County Commissioner.

The regular meeting of the 208 Advisory Group was called to order by Chairman Michael Madden at 7:30 p.m. at West River Electric.

A motion was made by Dan Lindblom, seconded by William Carpenter to approve the minutes of the July 18, 1979, meeting as mailed. The MOTION CARRIED.

STOCKADE LAKE WATER QUALITY STUDY AREA

Steve Pirner, in briefing the Advisory Group on the Stockade Lake Water Quality Study, said one of the criteria required before this study could be undertaken was public support. A public hearing was scheduled and held in Custer on July 24, 1979, and was advertised in two newspapers and through the news media. The results received by the Sixth District Council as a result of that meeting have all been favorable. Mr. Pirner requested the Advisory Group's approval or disapproval of the project.

A lengthy discussion ensued with the following questions raised: who would conduct the study; how much would the study cost; what was the purpose of the study; would this project be assured of State funding; and, who determined the choice of Stockade Lake?

Bill Markley responded, saying the State would conduct the study and he estimated the total cost to be approximately $12,000. The purpose of the study would be to determine what the problems are and to find solutions for those problems and do the things that would be worthwhile. The State would pay 100 percent of Phase I of the project and also made the selection of Stockade Lake from the list of lakes that was presented to them.

It was asked if this program did not fall into the Rural Clean Water Program and if it could be funded through this program. The reply was that the Rural Clean Water Program had not been funded by Congress; also the program was designed to look at only one project. The 314 Clean Lakes Program looks at several projects and consequently would not be able to use that money.

It was asked that if the Advisory Group disapproves Stockade Lake, would the State go to Sheridan Lake as an alternative? The answer was the State would probably go to some other lake in South Dakota where there was public support.

> A motion was made by Jack McCulloh, seconded by Norman Nelson to have this item continued until the next meeting. The motion was withdrawn.

Mr. Markley said this is a feasibility study; the money has been set aside to conduct the study, if not at Stockade Lake then some other lake in South Dakota; and he needed to know if they should proceed with the study at Stockade Lake.

> A motion was made by Norman Nelson, seconded by Jim Bell to approve the study for Stockade Lake. The MOTION CARRIED.

SYLVAN LAKE 314 GRANT

Steve Pirner reported that the Department of Game, Fish and Parks approached the Sixth District Council and is interested in applying to the Department of Water and Natural Resources for a 314 Clean Lakes Grant for Sylvan Lake. Sylvan Lake is in Custer State Park and the watershed lies completely within Custer State Park. The match ratio would be 50 percent federal and 50 percent State. The State can pick up 50 percent if it has been supported by local government. Mr. Pirner asked if the Advisory Group would like to take action.

Mr. Pirner said that Sylvan Lake is one of the best water quality lakes in this area. The 314 Rural Clean Water Program grant would be used to conduct a study to preserve the quality or prevent Sylvan Lake from going bad. The Department of Water and Natural Resources approves or disapproves the grants and there would be no 208 money used. There are no priority lists and this project would have to compete with the entire State for State funding. Public hearings would also be required.

The question of why the Advisory Group was being requested to approve a 314 Grant was answered: "to make the Group aware and to see if it would be a good project. Also, it is part of the 208 planning process to review and comment on projects of this nature." Mr. Pirner said if the Group approves this grant, it would not be received by the Environmental Protection Agency until November and it would probably take three or four months before the Department of Game, Fish and Parks received approval.

A motion was made by Dennis Pfitzer, seconded by A.C. Anderson to recommend approval of the Sylvan Lake 314 Grant. The MOTION CARRIED with 3 NO votes recorded.

BLACK HILLS WASTEWATER REUSE

Steve Pirner briefed the Advisory Group on the Black Hills Wastewater Reuse Report, which was the first activity on the workplan that had been discussed at the previous meeting. The report deals with a number of water quality and quantity problems and the objectives would be to improve water quality in the Sixth District area. This could be accomplished by eliminating the major point sources; creating a usable water supply source for agricultural and/or industrial use in western South Dakota or the energy developing areas of Wyoming; and, eliminating the need and the high costs associated with upgrading existing wastewater treatment plants to meet increasingly stringent federal and state water criteria. The report tried to determine if alternatives could be found for the areas of agriculture, silviculture, recreational impondments (recreational lakes - wetlands), governmental, groundwater recharge and industrial reuse. Of the various reuse alternatives, recreational lakes and groundwater recharge were found to have the least potential for implementation in the Sixth District area. Agriculture, silviculture, wetlands, governmental and industrial reuse were found to be potential alternatives for implementation on a localized basis. The only alternative that could be considered viable on a regional basis was the industrial reuse.

Steve Pirner said that in the conceptual design, the main pipeline would be approximately 148 miles long and would generally follow Interstate 90. It would start at Box Elder and continue along Ellsworth, Rapid City, Sturgis, Whitewood, and Spearfish. The construction, operation, and maintenance costs have been estimated at a total cost of $182,000,000, with the current annual operation and maintenance costs estimated at $3,780,000. By the year 2000, the operation and maintenance costs are estimated to incease to $7,150,000. Discussion followed and concerns were expressed concerning the significance of the impacts downstream due to the wastewater reuse.

Mr. Pirner asked the Advisory Group if the report was satisfactory or if there were areas which could be improved on. If the report is satisfactory, a public meeting could then be held. Mr. McCulloh suggested that the report be presented to the legislative task force on water development before it goes anywhere else.

Mr. Pirner said that if anyone had comments on the report, they should submit them to the Sixth District office by September 19, 1979, so they could be incorporated in the report. The final report would then be presented at the next meeting.

SIXTH DISTRICT COUNCIL OF LOCAL GOVERNMENTS

208 WATER QUALITY

REPORT FOR APRIL, 1980

During the month of April, the following tasks were addressed or accomplished by the Sixth District Council of Local Governments' 208 Water Quality staff.

National Urban Runoff Program (RC NURP):

Final approval was received from EPA headquarters for the proposed sampling sites and on April 24, a meeting of the Technical Advisory Group was held to discuss final changes in the detailed workplan. South Dakota Department of Water and Natural Resources staff placed the biological monitoring apparatus, and United States Geological Survey placed all flow measuring devices at the sampling sites. South Dakota School of Mines & Technology anticipates that some sampling will be accomplished during May.

Stockade Lake:

On April 3, a meeting was held in Custer with cooperating agencies and private landowners to discuss the possibility of a project on the Stockade Lake watershed. The results of this meeting were favorable, and the Custer County Conservation District supervisors agreed to sponsor the project. At a conservation district meeting on April 7, the Board of Supervisors discussed the proposed project and determined that a coordinator should be hired to develop a detailed workplan if the watershed survey report being prepared by the South Dakota Department of Water and Natural Resources indicated a need for implementation. On April 25, the Conservation District Board of Supervisors interviewed prospective candidates for the position of coordinator and discussed the scheduling of a public meeting to be held in May.

Small Wastewater Flow Treatment Workshop:

In cooperation with the Custer County Planning staff, a workshop was presented in Custer on April 16. There were approximately 20 people in attendance and presentations were made by the Soil Conservation Service, the Meade County Sanitarian, and 208 staff.

FY'78 Contract:

EPA has reported that the computer analysis of water quality monitoring data is nearly complete and should be sent soon.

FY'79 Contract:

The 1979 workplan has been submitted to the South Dakota Department of Water and Natural Resources for comment.

APR 17 1980

During the month of March, the following tasks were addressed or accomplished by the Sixth District Council of Local Governments' staff.

NATIONAL URBAN RUNOFF

A meeting with all cooperating agencies was held March 27, 1980, at the Sixth District offices. Discussion included a review of the Urban Hydrology Workshop attended by Harms and Strub in Denver, March 10-14, 1980. Further site selection work was accomplished. The detailed workplan is being adjusted to meet final qualifications resulting from discussions with EPA headquarters.

STOCKADE LAKE

A meeting has been planned for early April to address the Stockade Lake project implementation. The meeting will be in Custer and all coordinating agencies have been notified.

FY' 78 CONTRACT

EPA is assisting in a computer analysis of water quality monitoring data in storet. After receiving this report, evaluation of problem areas will begin.

FY' 79 WORKPLAN

The first draft is complete. Suggested FY'80/81 projects are now being written for submittal.

SMALL WASTEWATER TREATMENT WORKSHOP

A Small Wastewater Treatment Workshop will be held in Custer on April 16-17, 1980, at the Black Hills Cooperative Building, from 7:00 - 10:00 p.m.

208 ADVISORY GROUP

A new 208 Advisory Group was formed, consisting of 16 members. The first meeting has been scheduled for April 29, 1980, at the Sixth District Council of Local Governments' Conference Room at 7:30 p.m.

Other areas addressed are summarized as follows:

Technical assistance was provided to Sturgis in filling out their Phase II 201 grant.

Technical assistance was provided to area consultants in applying for alternate energy grants.

Staff continued to monitor the ETSI project.

SIXTH DISTRICT COUNCIL OF LOCAL GOVERNMENTS

208 WATER QUALITY MANAGEMENT PROGRAM

MONTHLY REPORT FOR MAY, 1980

During the month of May, 1980, the following areas were addressed or accomplished by the Sixth District Council of Local Governments' 208 staff.

NATIONAL URBAN RUNOFF PROGRAM (RAPID CITY NURP)

During the month of May, the detailed workplan was revised and completed, per conditions agreed upon with EPA. The sites all have flow gauging devices, and monitoring station shelters are approximately 90 percent complete. USGS is taking baseline flow data and SDSM&T is conducting baseline lab analyses. The first report to EPA will be sent on June 30, 1980.

STOCKADE LAKE

A water shed survey was completed by DWNR and received by the Sixth District Council of Local Governments on May 21, 1980. A public hearing is scheduled for June 3, 1980, at 7:30 p.m. at the Custer County Courthouse, Custer, South Dakota. The purpose of this meeting is to gauge public support for a water shed project.

208 ADVISORY COMMITTEE

The new 208 Advisory Committee met on May 7 and May 28, 1980. The group consists of 16 members, per EPA regulations: 25 percent from each of four (4) citizen groups. Fifty percent of the group (8) are veteran members and 50 percent are new members. Presently there are 3 vacancies due to transfers and conflicts. These positions will be filled as soon as possible. (See enclosed list.)

FY'78 CONTRACT

208 staff received the computer report on the Forest Service water quality monitoring data and staff is now prioritizing areas for possible further field investigation.

FY'79 CONTRACT

The FY'79 contract and workplan have been submitted to DWNR for their approval.

FY'81 PROJECTS

Five (5) possible projects will be submitted to DWNR for their consideration on June 2, 1980.

NATIONAL URBAN RUNOFF PROGRAM (RAPID CITY NURP)

NURP, initiated last year, is one of 30 such projects in the nation. The objectives of the study are to determine what effects urban runoff in the City of Rapid City are having on Rapid Creek, to characterize those effects, and where and when are detrimental pollutants being put into the Creek. The City would like to know if they are contributing by runoff to the problem in the creek, what effects are they having on the biological habitat and they are interested in knowing about the quality changes taking place in the Creek as it passes through the City. We are the only NURP studying a water quality stream model. The other 29 projects are studying a specific hydrologic water shed.

STOCKADE LAKE

This project is presently in its infant stages; nothing is finalized. The Conservation District made a request one year ago to study the possibility of cleaning up the lake. Since that time the Soil Conservation Service has conducted a basic quality assessment of the water shed and now has an inventory of the problems, i.e., the Lake is euthrophic. We are presently undertaking project development. The State has received funding for a coordinator to begin writing a detailed workplan on the eventual rehabilitation of the water shed and the Lake itself. There will be a public meeting in Custer on June 3, to update the public on what has transpired in the past year. A meeting was held approximately 3 weeks ago with all the involved agencies and affected private land owners which proved highly favorable. The agreement will be between the State and Sixth District Council and the Conservation District.

A subcommittee on the Stockade Lake Project, represented by members of the public from Custer and representatives from the 208 Advisory Group will be formed at an appropriate date.

OTHER BUSINESS

It was the consensus of the group to meet monthly on the last Wednesday, unless there would not be enough agenda items to warrant a meeting. The next meeting will be held May 28, 1980. The agendas will be sent out at least a week in advance of the meeting.

There being no further business, the meeting was adjourned.

_____
Chairman

OTHER BUSINESS

Mr. Leffert informed the group that the Corps of Engineers is currently conducting a study on groundwater recharge. Mr. Strub added that the Corps is studying the possibility of artificially recharging aquifers.

The public meeting for Stockade Lake is scheduled for June 3, 1980.

There will be a meeting on May 29, 1980, with the technical advisory committee for NURP.

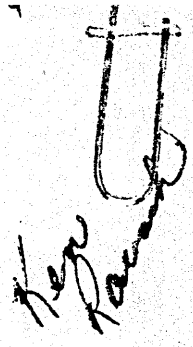
There being no further business, the meeting was adjourned.

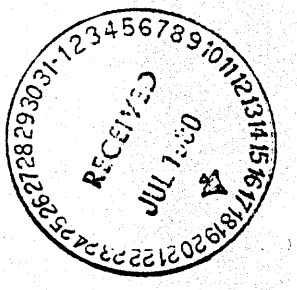
_____

Chairman

Keep Rand

RECEIVED JUL 1980





SIXTH DISTRICT COUNCIL OF LOCAL GOVERNMENTS

208 WATER QUALITY MANAGEMENT PROGRAM

MONTHLY REPORT FOR JUNE, 1980

During the month of June, 1980, the following areas were addressed or accomplished by the Sixth District Council of Local Governments' 208 staff.

NATIONAL URBAN RUNOFF PROGRAM (RAPID CITY NURP)

Two sets of baseline data, including flow measurements, have been collected to date. Although all analytical work has not been completed, available data was reported to the Environmental Protection Agency in the June 30, 1980 Quarterly Report.

STOCKADE LAKE

A public hearing was held in Custer on June 3, 1980. Approximately 20 people were present to hear about the history and proposed action on the project. Public support proved to be unanimous at the meeting. Following the meeting, the Department of Water and Natural Resources, Sixth District Council of Local Governments, and the Custer Conservation District discussed a contract which will probably be completed in July. The work plan will be completed 30 days after the contract is signed.

FY'78 CONTRACT

A meeting was held with Dr. Leland Harms, South Dakota School of Mines and Technology, and representatives of Bell-Galyardt Associates to discuss the computer report on Forest Service data collected for the 208 program. Tentatively, four problem areas were identified. The consultant will investigate these areas and begin work on the report in July.

FY'79 CONTRACT

The Department of Water and Natural Resources has approved the contract and work plan. Work is being scheduled to complete the work plan items. Subsequent reports will be illustrative of progress.

FY'81 PROJECTS

Six projects were submitted to the Department of Water and Natural Resources in June, 1980, for FY'81 funding. They include:

Canyon Lake Project
Piedmont/Black Hawk Valley Project
Streamflow Project
Spearfish Creek Project
Belle Fourche River Project
Construction BMP Project

The following narrative briefly describes the major tasks performed by Sixth District in the 208 Water Quality Planning process during June 1, 1979 through August 31, 1979.

Nominations were sought for a Water Quality Study Area in the Sixth District. These nominations were reviewed and presented to the Sixth District Council. The Council selected three prioritized areas and submitted those to DEP for their selection. DEP selected Stockade Lake as their choice for the Study Area. A substantial effort was made to secure public participation by doing the following: placing a public notice in area newspapers, making a personal presentation to the Custer County Conservation District, mailing notices to local organizations and units of government, preparing news releases, requesting television interviews, and placing questionnaires in area newspapers. A public meeting was then organized and held in Custer. Twenty-two people were present representing several local units of government, private citizens, Custer businesses, and possible implementing agencies. At this meeting, and in all correspondence received, there has not been any opposition raised to the proposed study.

Work has continued on the Regional Wastewater Reuse Study. Final conceptual design data has been gathered with the cost estimates for transportation nearing finalization. Correspondence has been sent advising various industrial firms of the project and attempting to secure some form of potential implementation. Meetings have been held with manufacturing representatives to gain technical input on the project feasibility. Two companies who are proposing to construct coal slurry pipelines have replied that they are interested in the concept. A number of meetings have been held with a representative from one of these companies, with coordination on the conceptual design taking place. This company has narrowed its potential sources of water down to three, with the wastewater pipeline concept being one of them. Hopefully, the final draft of the entire wastewater reuse report will be completed by the end of August, 1979.

The new federal public participation regulations were analyzed, and a new 208 advisory group was nominated in accordance with these regulations. These nominations were approved by the Sixth District Council and the people were contacted to see if they would serve on the group. The final listing was developed, and the first meeting was held on July 17, 1979.

At the request of the Lawrence County Commissioners, the proposed Lawrence County Soil Erosion and Sediment Control Ordinance, as developed by the Conservation District, was reviewed.

Discussion has taken place with the Sixth District EPA project officer concerning EPA approval of the Sixth District 208 Water Quality Management Plan. However, to date, all discussions have been only verbal in nature with nothing formal in writing yet received from EPA.

Monitoring of the start-up operations of the Lead-Deadwood Sanitary District wastewater treatment plant was accomplished. A report summarizing the results of the sampling program was prepared, and the data interpretation was discussed in detail with the District Manager and the plant superintendent.

Preliminary planning was completed for the Black Hawk/Piedmont task, with the objectives of the task further defined and the methodology to be used outlined. In addition, the task has been explained to representatives of the Black Hawk/Piedmont Association.

In order to represent the Sixth District Areawide 208, the July meeting of the South Dakota Rural Clean Water Committee was attended. Also, in an attempt to gain a better understanding of what is involved in a lake restoration project, the Lake Herman Model Implementation Project was toured. The implementation of both land treatment practices and structural controls to reduce the pollutant loading entering the lake were observed.

A meeting was organized between DEP and Rapid City to discuss the preliminary wasteload allocations that have been prepared by DEP. A number of options were discussed with a consensus finally reached on the present and future effluent limitations to be drafted into the proposed NPDES discharge permit renewal.

A meeting was attended between the Department of Water and Natural Resources (DWNR), the Conservation Commission, the Planning Districts, and others concerning the implementation of Senate Bill 65. There has been some confusion statewide on this subject. The debate centers on exactly how the cities and counties are to obtain the authority needed to implement the ordinance adopted by the local Conservation District. The issue was not settled, but the following consensus was reached:

1. At this time, cities and counties may adopt an ordinance which follows the guidelines presented by the local Conservation District, but they do not have to do so.

2. The Conservation Commission will request an Attorney General's Opinion on this matter.

Work continued on the Regional Wastewater Reuse Study. The final draft has been completed and is currently being reviewed by the 208 Group. It is anticipated that these comments will be incorporated into the report, and the final report will then be presented to the Water Resources Legislative Task Committee and to the local public.

It was learned that $12 million is available at the national level which is to be used to fund demonstration projects for water quality control of urban runoff. Rapid City personnel were contacted and agreed that a proposal should be submitted for the Meade Street drainage basin in southeastern Rapid City. This proposal was consequently completed and submitted to EPA, Washington, D.C.

AUG 06 1980

SIXTH DISTRICT COUNCIL OF LOCAL GOVERNMENTS

208 WATER QUALITY MANAGEMENT PROGRAM

MONTHLY REPORT FOR JULY, 1980

During the month of July, 1980, the following areas were addressed or accomplished by the Sixth District Council of Local Governments 208 staff.

NATIONAL URBAN RUNOFF PROGRAM (RAPID CITY NURP)

A meeting was held with Dr. Leland Harms and Marsha Smith, South Dakota School of Mines and Technology, and representatives of EPA from Denver. The Quality Assurance Plan was discussed and the lab was approved. In later August, representatives from EPA Headquarters and Region VIII will meet in Rapid City to finalize the detailed work plan. It is anticipated that the USGS project director will be on board by the end of August. Biological data was collected on July 31 by the South Dakota Department of Water and Natural Resources and 208 staff.

Stockade Lake

On July 23, 1980, the 208 staff met with Kerry Steiner and Arvo Kujala in Custer and assisted in the drafting of the work plan. Jim Seyfer, Department of Water and Natural Resources - Pierre and 208 staff, met with Steiner and Kujala on August 1, 1980 to discuss and coordinate project plans.

FY'78 Contract

The four problem areas have been investigated and work has begun on the project. Data is being reviewed and correlated with field investigations.

FY'79 Contract

The Department of Water and Natural Resources approved the work plan and the contract has been signed. Work is scheduled to begin September 1, 1980.

FY'80

Six projects were submitted to the Department of Water and Natural Resources in June, 1980, and are now pending. They include: Canyon Lake Project; Piedmont/Black Hawk Valley Project; Streamflow Project; Spearfish Creek Project; Belle Fourche River Project; and Construction BMP Project.

U.S. Corps of Engineers

The 208 Advisory Group passed a motion to continue their involvement in the Corps of Engineers' water study in order to support our water interests.

determine what the Act does require. After the meeting the group may be able to delete the whole thing if the cities and counties do not have to pass their own ordinance to be a permit issuing authority.

Vernon Seger said he thought it was to be voluntary but there was nothing said that they had to pass an ordinance.

Steve Pirner said the original intent was to put together a model for the cities and counties to implement if the need should arise.

Norman Nelson said it would simplify things if the group would go back to the proposed workplan under IV. Program Outputs (a-i) and have staff identify which items would be staff oriented and which items the committee would enter into.

Steve Pirner said items c, d, f, and g would be strictly staff time. Items a, b, e, h, and i would involve both staff and the group. Mr. Pirner said a priorty task for the group will be to show that the 208 Plan is acceptable, that it is working, and the management agencies as stated in the Plan are aware of their rsponsibilities as stated in the Plan.

IV. WATER QUALITY STUDY AREA

Deane Curry requested the history of going into the study at Stockade Lake.

Steve Pirner said the background regarding the study of Stockade Lake was that under the first 208 program, the Statewide 208 took some of their money and established what they call water quality study areas. They looked at lakes that had water quality problems, tried to determine what was causing those problems and recommended things that should be done to correct those problems. The program became very successful, with a large degree of local support and participation. This year the State said they would do six more of these studies and would include one in the Sixth District. Mr. Pirner said that after being notified of this program, he wrote to all of the management agencies in the 208 Plan and the Sixth District Council members, and received ten nominations from them. The nominations were submitted to the Sixth District Council members and they selected three lakes (Stockade, Sheridan and Canyon Lakes) and submitted those lakes to DEP. The Department of Environmental Protection then made the final tentative selection of Stockade Lake as being the water quality study area in this area. It is anticipated that final implementation of the recommendations made in the study will be through the 314 Clean Lakes Program.

The 314 Clean Lakes Program is federally funded through EPA to do lake management work to improve the water quality or preserve the water quality of lakes. It is set up in two steps: Phase I, where you do a diagnostic feasibility study and has a 70% federal and a 30% local match; Phase II is the implementation of the feasibility study to correct the problems and it is a 50% federal and 50% local match. Mr. Pirner continued that because the program became so popular in the State on a statewide basis, the legislature passed a State Clean Lakes program two years ago which provides 25%

of funding for the Phase II portion if you have federal dollars, 60% State dollars if you do not have federal funding or 100% State dollars for the project if the lake is principally surrounded by State owned land. It appears that Stockade Lake may fall into that category. Stockade Lake was only tentatively selected because before we can do this study, local support is needed. To gauge this support, a public meeting has been advertised to be held in Custer on July 24, 1979. The meeting will determine if the study will proceed and whether the public thinks Stockade Lake is worth a project like this. If not, Sheridan Lake would probably be the next alternative.

V. ACTION REGARDING NON-RESPONSE TO LETTERS OF COOPERATION

Steve Pirner said he wrote the management agencies that were identified by the 208 Plan and asked them if they would accept responsibilities as stated in the 208 Plan. Mr. Pirner said the response was good to the letters. He received letters from 8 of the 9 Conservation Districts. The Tri-County was the 9th and they are submitting their letter to the Statewide Plan. He received letters from all of the counties with the exception of Fall River and Custer Counties. Letters were received from all cities with the exception of Deadwood, and all of the State and Federal Agencies have responded favorably with the exception of the Department of Natural Resources. Mr. Pirner concluded by asking the group for suggestions to secure letters of cooperation from those agencies which have not responded.

VI. FEEDBACK MECHANISM FROM MANAGEMENT AGENCIES

Dr. Lee Harms said the 208 Group would be required to keep track of the management structure and how the local people are reacting with the plan. The Group will need something that is simple but effective and something that will be able to be documented. A suggestion that he presented, was to supply everyone with a report form that would identify the water quality problem being addressed at that particular time. He also said the 208 Advisory Group meeting will be advertised ahead of time, so at the end of the agenda time will be allowed for interested people to have the opportunity to express their views.

ELECTION OF CHAIRMAN

Dr. Harms said the responsibility of the Chairman is primarily to run the meeting. The staff, with assistance from the Group, will prepare the agenda. The Advisory Group will also be required to adopt some type of By-Laws.

A motion was made by Dan Lindblom, seconded by Robert Schurger to nominate Mike Madden as Chairman. Vernon Seger motioned that nominations cease. The MOTION CARRIED.

SIXTH DISTRICT COUNCIL OF LOCAL GOVERNMENTS
208 WATER QUALITY MANAGEMENT PROGRAM
MONTHLY REPORT FOR AUGUST, 1980

During the month of August, 1980, the following areas were addressed or accomplished by the Sixth District Council of Local Governments' 208 staff.

NATIONAL URBAN RUNOFF PROGRAM (RAPID CITY NURP)

During the week of August 18 - August 20, 1980, 208 staff attended conferences in Silverthorne, Colorado - Urban Runoff - and Denver, Colorado - Technology Transfer, where staff reported on the progress of the Rapid City NURP program.

A meeting was held on August 28, 1980, with representatives from USGS: Department of Game, Fish and Parks; South Dakota Department of Water and Natural Resources; EPA - Region VIII; EPA consultants; Rapid City Engineering Department; South Dakota School of Mines and Technology; and 208 staff.

Specific sites 3, 4, 5, 6 and equipment were inspected. Workplan revision comments were discussed and clarified - priority pollutent constituents defined, interpretive analysis of data suggested for the quarterly report, wet fall/dry fall sampler locations, and BMP's.

FOREST SERVICE - DEPARTMENT OF WATER AND NATURAL RESOURCES - SIXTH DISTRICT

A meeting was held on August 27, 1980, between the Forest Service, Department of Water and Natural Resources, and 208 staff to discuss and approve a preliminary draft of the interagency agreement. The agreement or memorandum of understanding assures cooperation between each organization in the implementation of the 208 Water Quality Management Program on the National Forest System lands. A second draft should be available early in September for final approval.

ELLSWORTH AIR FORCE BASE/RAPID CITY WASTEWATER INTERTIE

A meeting was held at the Sixth District Council conference room on August 27, 1980, to discuss the proposed intertie system and stream reclassification.

In attendance were representatives from Utility Engineers, Rapid City; EPA; Department of Game, Fish and Parks; Ellsworth Air Force Base; and the 208 staff. It was decided that another public meeting should be held to provide further information on the effects of the two proposals and the different scenarios proposed. Those citizens expected to be directly affected will be encouraged to attend.

STOCKADE LAKE

The first draft of the Stockade Lake Workplan has been submitted to our office and is being reviewed.

STOCKADE LAKE

208 staff and a representative of the Department of Water and Natural Resources attended the first organizational meeting of the TAC and CAC on Stockade Lake in Custer. Officers were elected and the workplan was reviewed.

PITTSBURG - PACIFIC MINING CLAIMS

On September 15, 16, and 17, 208 staff attended meetings and field trips on the proposed taconite patents for Pittsburg - Pacific. Representatives from the Forest Service, Department of Water and Natural Resources, Air Quality Department, Health Department, the Attorney General's Office, and 208 staff discussed the impacts on the environment of such a mining process - strip mining. A coordination meeting will be held again on October 20, 1980, with the Federal and State Attorneys to compile the information generated and to prepare for their appearance before a judge, at which time they will attempt to solicit more information from Pittsburg - Pacific.

SIXTH DISTRICT COUNCIL MEETING

At the Sixth District Council meeting, held September 11, 1980, 208 staff presented a synopsis of the Rapid City National Urban Runoff Program and briefed the Council on the meeting in Pierre concerning the task force on Water Resource Projects.

BELLE FOURCHE RIVER EROSION PROBLEM

Herman Stark, a rancher near Vale, South Dakota, contacted staff concerning the Belle Fourche River erosion situation. Several acres per year are lost to the erosion process and in some instances, buildings are endangered. A tentative meeting is scheduled for October 15, 1980, at 7:00 p.m., in the Vale firehall, to confer with Mr. Stark and other affected landowners.

TECHNICAL ASSISTANCE

1. Technical assistance was given to Midland Heights on securing funds to repair their NODAK system.

Resource Projects has prioritized the project: "Analysis of the Suspended Sediment Problem in the Belle Fourche River" and has submitted it to the Missouri River Basin Commission and the State.

WATER RESOURCES ADVISORY GROUP (WRAG)

At the October 29, 1980 WRAG meeting, Jerry Marsh (Rapid Valley Irrigators) and Paul Jones (Private Citizen Sector) were elected to serve on the WRAG. A motion was passed that each member is to select a proxy to serve in his/her absence and the proxy will have voting privileges.

SIXTH DISTRICT COUNCIL MEETING

At the October 2, 1980 Sixth District Council meeting, staff briefed the Council on the State Water Project Prioritization Plan and the Task Force representing this area.

SOLID WASTES PUBLIC HEARING

On October 17, 1980, staff attended a public hearing regarding the South Dakota State Solid Waste Management Plan (draft). The plan discussed the solid waste management program activities which will be undertaken during the period of 1980 - 1985 by the South Dakota Department of Health, Division of Environmental Health, Office of Solid Waste Management and their perceived goals for the program.

SIXTH DISTRICT COUNCIL OF LOCAL GOVERNMENTS, DEPARTMENT OF WATER AND NATURAL RESOURCES, AND DEPARTMENT OF GAME, FISH AND PARKS MEETING

On October 7, 1980, staff attended a meeting in Pierre with DWNR, Department of Game, Fish and Parks, and Cecil Armstrong, the Forest Service EPA liaison. The purpose of the meeting was to define the Sixth District's and DWNR's role in the management of State Forest Service lands.

STOCKADE LAKE PROJECT

On October 8, 1980, 208 and DWNR staff accompanied Cecil Armstrong (Forest Service, EPA) in surveying the Stockade Lake Watershed and pinpointing known pollutant contributors. Project Coordinator, Arvo Kujala, met with Mr. Armstrong to discuss the progress thus far on the project.

FY'78 CONTRACTS

Staff met with the consultants and a preliminary outline is expected soon.

FY'79 CONTRACTS

The Department of Water and Natural Resources approved the workplan and the contract has been signed. Work is scheduled to begin in October.

FY'81

Six projects were submitted to the Department of Water and Natural Resources in June, 1980, and are now pending.

Belle Fourche River Erosion

Staff is in the process of coordinating a meeting between the Department of Water and Natural Resources, the Soil Conservation Office, and 208 staff to field inspect and survey the extent of the erosion situation and possible abatement procedures.

Stockade Lake TAC Meeting

Staff and a representative from the Department of Water and Natural Resources attended the Technical Advisory Committee meeting in Custer on November 12, 1980. The TAC is in the final stages of organizing their brochure and slide show. Project Director, Arvo Kujala, and Jack McBride had completed some field inspection of septic systems. The TAC reviewed the conceptual plan and discussed establishment of ideal baseline data for Stockade Lake and the prioritization of pollution sources.

Public Hearing and Citizens Advisory Committee Meeting in Spearfish

Staff and representatives from the Department of Water and Natural Resources attended a public hearing on the Environmental Impact Statement concerning Spearfish's sewage needs. Major comments and testimony were made with respect to exorbitant costs (Spearfish sewage being only a minor proportion of the contributing pollution), floodway land, and alternative above ground facilities. Staff also attended the Citizens Advisory Committee in the afternoon, at which time the above comments were reviewed.

Sixth District Council Meeting

At the November 13, 1980, Sixth District Council Meeting, staff reported to the Council on the progress of the Task Force on Water Resource Projects. Staff also presented the work completed to date on the matrix of water-oriented groups represented in South Dakota.

FY'78 Contracts

Staff is expecting the final draft report from consultants within the next 30 days.

FY'79 Contracts

The Department of Water and Natural Resources approved the workplan and the contract has been signed. Work is in progress.

FY'81

Staff is in the process of drafting workplans for two FY'81 projects: 1) construction BMP's, and 2) Septic System Failures in the Piedmont Valley, for submittal to the Department of Water and Natural Resources.

SIXTH DISTRICT COUNCIL OF LOCAL GOVERNMENTS JAN 15 1981

208 WATER QUALITY MANAGEMENT REPORT

December, 1980

Rapid City National Urban Runoff Project (NURP)

At the last Water Resources Advisory Group Meeting, Dr. Lee Harms, South Dakota School of Mines, and Kim Goddard, United States Geological Survey reviewed the locations of the six (6) stations, the sampling techniques, and monitor mechanisms. Dr. Harms presented some preliminary data that showed surprisingly high amounts of heavy metals, especially lead. The detection of such concentrations at stations one and two gives rise to some concern. Dr. Harms reiterated however, that this was preliminary data and that more data must be compiled before conclusions can be drawn. During the winter months, the project is relatively dormant as far as sampling is concerned and will resume in the spring.

Water Projects

A public hearing was held at the Rapid City Civic Center on December 10, 1980, to review those projects submitted by the Task Force on Water Resource Projects. The sponsors of each project presented a brief explanation of their project to the Board of Water and Natural Resources representatives and State Water Policy representatives. Projects presented were: New Underwood Dam, Sylvan Lake Restoration, Stockade Lake Restoration, Belle Fourche Erosion Problem, Belle Fourche Irrigation Project, Model Study on the Hydrology of Rapid Creek, West River Aqueduct, Expansion of Federal Programs to aid municipalities in need of water. On December 17, 1980, staff attended the board of Water and Natural Resources meeting in Pierre where the State's list of projects was narrowed down and approved. Those projects from the Sixth District not approved by the board were: New Underwood Dam (currently exploring alternative funding), Sylvan Lake Restoration (funding already approved), and Expansion of Federal Programs Project. The list of approved projects will be submitted to the Legislature for support and/or funding.

Stockade Lake Project

Work is being completed on the slide show presentation and the brochure has been completed and distributed.

ETSI Environmental Impact Statement (EIS)

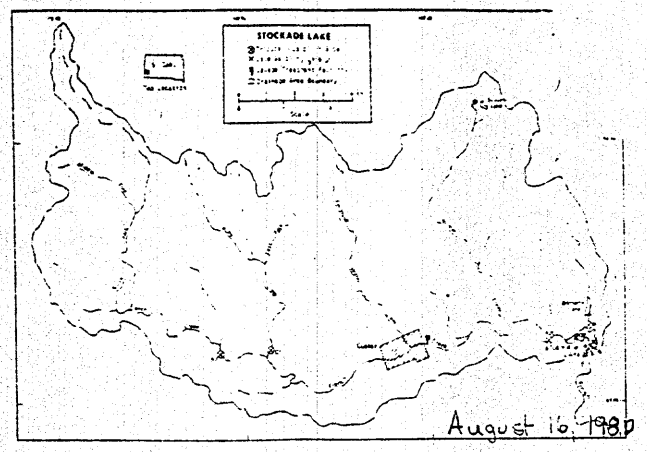
Staff met with Southern Hills Water Users on December 3, 1980, to discuss and coordinate testimony to be presented at the Public Hearings. Staff attended the three public hearings on the EIS. Following the Council's direction, staff presented testimony that suggests an inadequacy in the EIS:

1. lack of worst case analysis;

Appendix A3.

News Articles

Study underway to restore Stockade Lake



Kerry Stiner, Arvo Kujala and Joe Marsh review a grant proposal for restoration of Stockade Lake. *(CHRONICLE photo)*

A study is underway to develop a plan to restore Stockade Lake. Charged with engineering a conceptual plan to free the lake from pollution and sedimentation is Arvo Kujala, project coordinator.

The first phase of the plan, locating the sources of pollution, is funded by a grant from the Environmental Protection Association matched 75-25% by the Custer County Soil Conservation District. The $22,000 funding is the result of three public meetings, participants of which were largely in favor of cleaning up the lake for recreational and environmental improvements. Attendants of the public meetings were residents of the city and county considered to be representative of the county as a whole.

The grant is a contract between the State Department of Water and Natural Resources and the Soil Conservation District. Initially, the grant gives Kujala, along with District Soil Conservation supervisor Kerry Stiner, and board member Joe Marsh, 30 days to complete a work plan as to how the study will proceed, who will conduct various parts of the study, and when the various data will be collected. Marsh is the district representative for the SCS on the project.

Cooperation of the Soil Conservation Service, the Agricultural Stabilization Conservation Service, the Forest Service, Custer State Park, the City of Custer and Custer County will be a part of the project. Sixth District Council of Local Governments will assist in an advisory capacity.

The State of South Dakota directed the Soil Conservation districts to set up sedimentation and control guidelines which have now been established. The district is responsible for agricultural land; the county, for construction activities; the city, for any problem occurring within the city. All of their efforts and those of any landowner involved are cooperative in nature. For this reason, Stiner and Marsh indicated public participation is extremely important although the cooperation, so far, has been very good.

Kujala's first action will be to name a citizens' advisory committee and a technical advisory committee. They will then proceed to identify and pinpoint sources of pollution. Sampling and testing of Stockade Lake has been going on for over a year by the Department of Water and Natural Resources. Previously, the State Department of Health did some sampling and a sedimentation survey. EPA in May of this year made low-altitude color infrared photographs of the areas which will help in the study when they become available in about a month.

One requirement of the grant is that the SCS continue to meter sampling and testing now being conducted. The sampling will be a part of the grant funds for the project.

Previous reports have indicated the sources of pollution to be: natural pollution; runoff from roads, highways and streets, agricultural tillage (a slight amount); domestic and industrial wastes throughout the watershed; and some effect from commercial spraying, some of which clears up within a 24-hour period.



The watershed includes three forks of French Creek, Laughing Water Creek, Ruby Creek, and Willow Creek and Bismarck Lake.

Stockade Lake is a 131-acre lake with an average depth of 19 feet. It has a hydraulic retention time of 274 days per year which is a long retention time for a small lake and does not permit flushing out of the nutrients which cause a heavy growth of algae in it. The volume of water in the lake is 811,000,000 gallons.

The watershed area includes French creek and its tributaries, named above, in a 78 square-mile area covering nearly 50,000 acres.

The primary benefit of the study, which is Phase I of the program, and the restoration which will be Phase II, will be improved recreational activities such as fishing and swimming, picnicking and camping in the area. Restoration will also improve the quality of water downstream.

Once the study (Phase I) is completed, various means of funding the restoration will be explored.

Past measures at pollution and sedimentation control have been a draw-down of the lake level but the nutrients from which algae grow remain in the sediment and grow again as soon as the lake is refilled.

The Soil Conservation District hopes to use in-kind (volunteer and professional services) as part of the district's match for funding.

Outdoors

Custer citizens try to save Stockade Lake

Paul Schneider
Staff Writer

CUSTER — When he was a kid during the depression years of the 1930s, Civilian Conservation Corps worker Joe Marsh poured concrete for a dam on French Creek to form Stockade Lake, the largest lake in Custer State Park.

And up until a few years ago, he and other Custer residents and tourists splashed in the waters of Stockade. They boated and fished there, too.

Now Stockade stinks during the summer. Few serious boaters launch their crafts there and anglers say the fish from the green water aren't worth catching. Only a fool would drink the water.

By July, 1981, Marsh and other Custer area citizens and officials hope to have a plan that will save the lake from a range of ravages: erosion at homebuilding sites and street runoff to leaky septic tanks and Custer's municipal sewage.

The plan will be submitted to the state Department of Water and Natural Resources, completing the first phase of a community project that will restore the lake to its original quality.

An improved Stockade Lake would benefit local recreation and make the state park more attractive to tourists. But the pollution sources are varied and cleanup will require changes in both waste treatment and land use practices to make the water clean again, changes that may be expensive or inconvenient, according to Custer County extension agent Dave Lehmkuhl and Arvo Kujala, Stockade Lake restoration project coordinator.

They identify the Stockade Lake pollutants in two categories; nutrients, or the chemicals that promote the growth of aquatic weeds and algae, and sediments, which wash down from the watershed to fill in the lake.

In an undisturbed setting, the weeds and algae die and settle on the bottom of the lake along with the sediments, slowly filling in the lake in a sort of maturing process known as eutrophication. It ends when the lake fills in, becomes a wetlands or perhaps, even dries up.

However, construction, grazing, farming, mining, pollution and other human pursuits accelerate the eutrophication process, cutting a lake's life from thousands of years to perhaps a few decades, and fouling the water during the shortened lifespan.

French Creek and its tributaries drain some 78 square miles in the Custer area and the runoff which eventually flows into Stockade Lake carries the chemicals and sediments speeding up Stockade's dying process.

Officials say most of the nutrients in the lake, primarily phosphates and nitrates, are a result of the effluent, or liquid waste discharge, from Custer's municipal wastewater treatment plant, individual septic tanks at homes in the growing developments around Custer and the wastes from livestock.

Late last summer and during other dry periods the effluent from the city's only flow in French Creek between Custer and Stockade Lake.

Because of leaks in the city's sewage collection system, up to 40 percent extra liquid seeps into the pipes and overtaxes the wastewater plant, city officials say. The city has applied for an Environmental Protection Agency grant to correct the problem.

The city has also applied for a Housing and Urban Development grant to install sewer lines in southwest and southeast Custer to replace some septic tanks believed to be polluting French Creek.

Septic tanks in developments throughout the watershed are adding to Stockade Lake pollution problems. In areas of concentrated housing, the seepage from the tanks is concentrated and flows together through drainage areas. The problem is aggravated when the tanks malfunction or aren't pumped and maintained periodically, said Lehmkuhl.

Officials say cattle concentrated along French Creek and its tributaries add to the nutrient pollution. The cattle would have to be moved out of the watershed or separated from the creek by a "buffer" area to protect the water, a proposal likely to be unpopular with the landowners.

Like the nutrients, the sediments filling in the lake also originate from several sources. Officials blame runoff from streets and roads, housing construction sites, and areas where livestock mill in the creek mud for increasing sediment.

Cutting back urban runoff would require paving, curb, gutter and storm sewer construction. The city now dumps snow cleaned from the streets on a vacant lot near French Creek, which aggravates the runoff problem. The pollutants from the street could be filtered through the ground at another dump site, but hauling the snow farther costs more money.

Developers need to properly design and lay out building sites to minimize soil disturbance and erosion, officials say. Dikes, terraces and revegetation and protection of slope areas will retard fast runoff. Occasional efforts at placer mining along French Creek add to the sediment load flowing to Stockade.

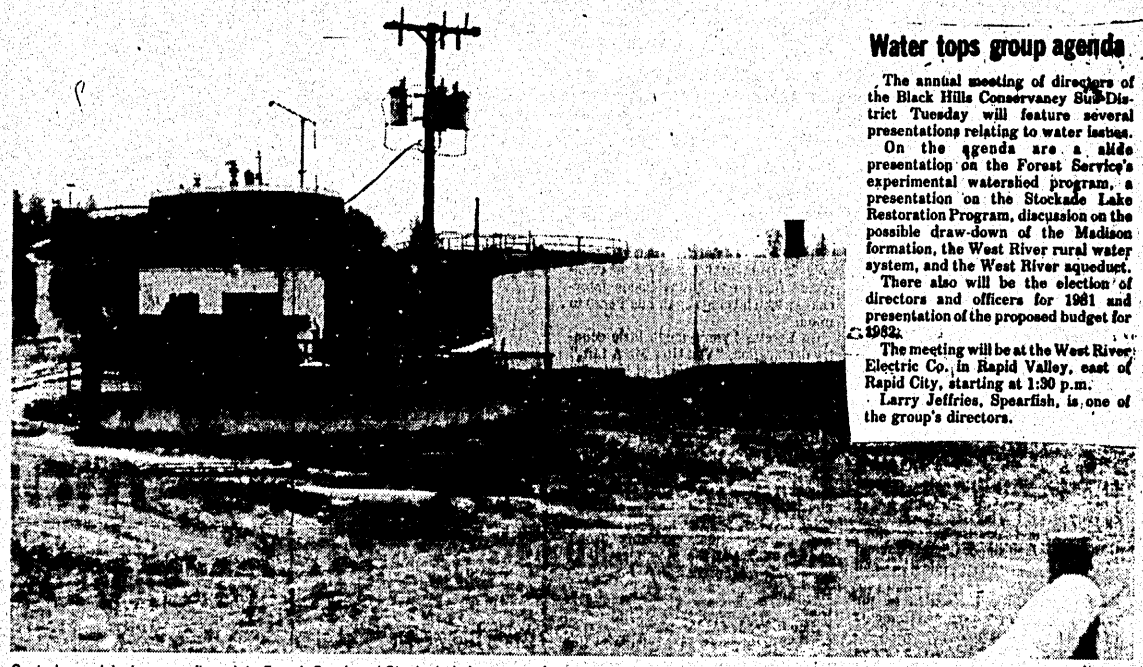
According to Kujala's calculations sediments totalling 117,000 cubic yards have poured into Stockade since its construction, the equivalent of a 15-ton truck dumping its load there every day since it was built.

The Sixth District Council of Local Governments picked Stockade as the top leak restoration priority in the Black Hills. Funds for restoration are available through the Clean Lakes Program, under the Federal Water Pollution Control Act of 1972.

From the program funding, administered through the state Department of Water and Natural Resources, $30,000 of the costs of the study and plan to be furnished in July have been paid by the federal government. Kujala is exploring other sources for correcting the pollution problem.

There are steps that could provide an the nutrient and sediment pollution in Stockade. The lake could be dredged to remove the sediments and embedded nutrients and the water could be treated with chemicals to control algae and plant growth. Also, the lake bottom could be sealed to stop the recycling of plant nutrients, and dissolved oxygen could be added to the lake to slow the eutrophication process.

However, those measures are treatment of the symptoms, not the sources, causing the pollution, officials say. The only real solution, they say, is control of the quality of what flows from the watershed.



Custer's municipal sewage flows into French Creek and Stockade Lake



Water tops group agenda

The annual meeting of directors of the Black Hills Conservancy Sub-District Tuesday will feature several presentations relating to water issues.

On the agenda are a slide presentation on the Forest Service's experimental watershed program, a presentation on the Stockade Lake Restoration Program, discussion on the possible draw-down of the Madison formation, the West River rural water system, and the West River aqueduct.

There also will be the election of directors and officers for 1981 and presentation of the proposed budget for 1982.

The meeting will be at the West River Electric Co. in Rapid Valley, east of Rapid City, starting at 1:30 p.m.

Larry Jeffries, Spearfish, is one of the group's directors.

GOALS FOR PROJECT

The water quality objectives are dictated by the necessity to protect the natural water courses and lakes from further pollution and contamination by human activities. The primary goal of the South Dakota Statewide "208" Water Quality Management Plan is to improve and maintain water quality for the maximum beneficial uses by present and future generations of South Dakotans. The objectives to achieve this goal are as follows:

To eliminate or reduce underground seepage from septic tank systems into the lakes and streams within the watershed.

To prevent contamination of underground water supplies by infiltration of waste-water effluents.

To eliminate or reduce above ground accumulations of unabsorbed effluents, plant nutrients or other pollutants which ultimately are washed into the streams and lakes.

To eliminate or reduce erosion caused by human activities which are contributing sediments to the streams and lakes.

To restore and improve the water quality of Stockade Lake by elimination or reduction of pollutants, including sediments, presently in the lake.

To increase recreational opportunities and economic benefits to the area.

****

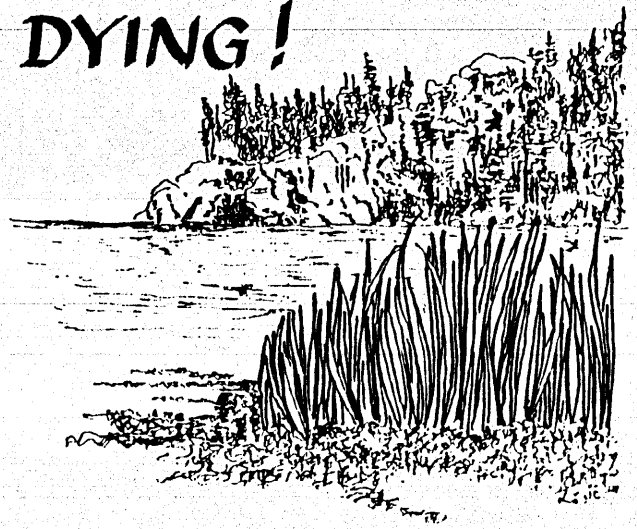
WE ENCOURAGE YOUR COMMENTS AND IDEAS WHICH CAN BE DIRECTED TO:

Mr. Arvo Kujala
Project Coordinator
Box 31
Custer, South Dakota 57730

TELEPHONE: 673-4429

Return Address:
CUSTER COUNTY SOIL CONSERVATION DISTRICT
P.O. BOX 31
CUSTER, SOUTH DAKOTA 57730

A LAKE IS DYING!



STOCKADE LAKE
WATERSHED IMPROVEMENT PROJECT

Sponsored By
CUSTER COUNTY SOIL CONSERVATION DISTRICT

INTRODUCTION

STOCKADE LAKE is located on the western edge of Custer State Park. Until the early 1970's this lake was used extensively by many residents and tourists as a recreational area. This is still true, to an extent people still fish the lake, in spring and early summer. The campgrounds around the lake are utilized too, but few people swim or fish there after mid-summer.

SOMETHING HAS HAPPENED TO STOCKADE LAKE and the area around it. The lake has quite an odor during the warmer summer season, the lakes color turns green, and dead fish are occasionally found around the edge.

In July, 1980, efforts were initiated by the Custer County Soil Conservation District to find solutions and correct the problems of Stockade Lake.

WITH YOUR HELP AND SUPPORT this declining trend can be REVERSED and the Lake RESTORED!

THE PROBLEM

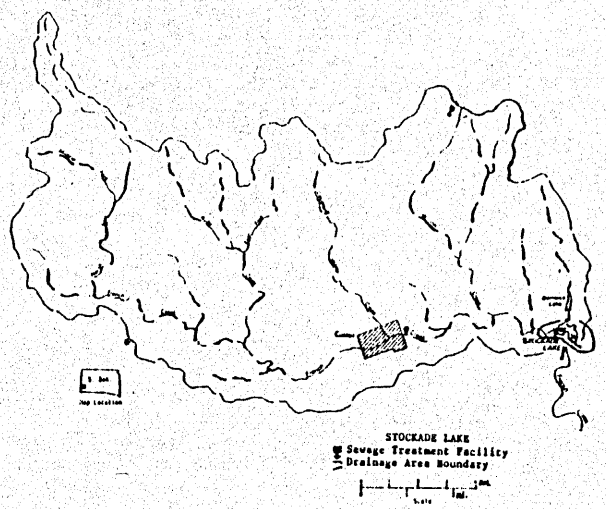
There presently exists *excessive pollution* and sedimentation (in the form of phosphates, nitrates and silt) in Stockade Lake and the tributary creeks.

THIS POLLUTION IS PRIMARILY CAUSED BY:

- *Domestic and municipal sewage wastes.*
- *Runoff from roads, streets, highways, campgrounds, and land developments and other soil disturbing activities adjacent to water courses.*
- *Other pollutants such as litter, oil from streets and roads, eroded soil, animal wastes and many other sources.*

THE RESULTS OF THIS POLLUTION ARE:

- *Serious deterioration of water quality.*
- *Adverse effects to water related recreation such as swimming, boating and water skiing due to objectionable odors and excessive growth of algae and aquatic vegetation.*
- *Deterioration of trout habitat.*
- *Reduction of the local recreation oriented revenues.*



AREA DESCRIPTION

STOCKADE LAKE is a 131-acre lake with an average depth of 19 feet and a maximum depth of 42 feet. The volume of water in the lake is 2,492 acre feet.

The watershed area includes French Creek and its tributaries, shown above, in a 78 square-mile area covering nearly 50,000 acres.

PLAN OF ACTION

PHASE I -

- *IDENTIFY* and quantify the various sources of nutrient *POLLUTION* and sedimentation.
- *ANALYZE AND EVALUATE* alternative *CORRECTIVE MEASURES* for social, environmental and economic feasibility.
- *RECOMMEND* most feasible and cost-effective *COURSE OF ACTION.*
- *EXPLORE* possible *FUNDING* sources for implementation.

PHASE II -

- *PREPARATION* of the detailed *PLANS* and specifications for the selected corrective measures.
- *IMPLEMENTATION* of these restoration measures.

PHASE III -

- *MONITOR* recreational *USE* and economic benefits on the local area.
- *MONITOR RESTORATION* of area resources.

HOW CAN WE HELP?

AS AN INDIVIDUAL:

- *Keep informed of the environmental issues and problems concerning Stockade Lake and its watershed.*
- *Inspect and correct faulty septic tank systems.*
- *Do not over-fertilize lawns, gardens or croplands.*
- *Properly dispose of litter, garbage and other wastes. Do not dump soil, debris or agricultural wastes adjacent to creeks or within the flood plain.*
- *Use phosphate-free detergents for washing clothes and other cleaning projects. Limit dishwasher detergents to those with less than 8.8% phosphates.*
- *Minimize soil disturbing activities and livestock concentrations adjacent to lakes and streams.*

AS A COMMUNITY:

- *Support the efforts of local agencies and the Citizens Advisory Committee which are already working out the problems.*

Custer, South Dakota

JUL 09 1981

STOCKADE LAKE WATERSHED IMPROVEMENT PROJECT PROGRESS REPORT

Following is a summary of tasks performed by the Project Coordinator during June, 1981:

1. Group Meetings:

   Conservation District Board of Supervisors - 6/1/81
   Joint CAC/TAC meeting 6/17/81 (to decide final recommended course of action)

2. Other contacts made

   Field review with National Guard officials 6/4/81
   Field review with RC&D ID team 6/9/81
   Custer State Park & U.S. Forest Service
   Black Hills Conservancy Sub-district re. status of request to EPA re. Septic Tank survey (by phone) 6/10/81

3. Press Releases

   Interview with Rob Keller of KEVN-TV 6/11/81
   Interview with Bob Van Cleave of KEVN-TV 6/17/81
   Custer County Chronicle 6/25/81
   Radio & KOTA TV reports of CAC/TAC meeting 6/17/81 & 6/18/81

4. Other tasks done

   Prepared cost estimate for sediment removal
   Prepared draft of Conceptual Plan
   Preliminary review of Conceptual Plan with CAC & TAC chairmen
   Prepared letters of recommendation re. State Water Plan to Congressional delegation & Cathy Warnke
   Discussed potential of using sediments as fertilizer with Orfaco and Wycon 6/12/81 & 6/17/81
   Field review of possible "wetlands" site below Stockade Lake 6/15/81

Arno Kuzala
7/7/81



Chronicle

purveyors of the printed word since 1879

JUL 09 1981

20¢
volume101
number 26
June 25, 1981
Custer, S.D. 57730
(USPS 141-020)

$tockade re$toration expensive

It will come as no surprise to area residents that the draft final findings and recommendations of the Technical and Citizens Advisory committees for the watershed and Stockade Restoration project indicate that serious pollution has and continues to occur in the area. "The problem is generally caused by excessive nutrients and sediments entering French Creek and subsequently being carried into Stockade Lake," the report reveals.

Recommendations included:

eliminating or reducing nutrients being discharged into French Creek from the Custer Sanitary Sewer System;

identifying and correcting malfunctioning septic tank systems;

providing corrective measures within the watershed to reduce the amount of sediment and nutrients being deposited into the lake; and

preventing the recycling of nutrients within Stockade Lake.

The City of Custer has taken action on the first two recommendations through their retention of an engineering company to develop a facility plan for the renovation of the city outfall sewer system and the sewage disposal plant. Also, application has been made to the Environmental Protection Agency for approval and funding to expand the facility study to include a survey of septic tank systems located within the Stockade Lake watershed. The latter project has not been funded yet.

Other recommendations include:

reducing and improving roads and recreation facilities in the Stockade Lake and French Creek areas;

constructing sediment basins in the tributary streams;

providing streambank protection where erosion occurs;

providing buffer zones at sites contributing sediments and nutrients to the streams (including mine spoil dumps, land developments, snow disposal areas, mill sites, landfills, barnyards and corrals);

reducing concentrations of livestock along the streams by alternate watering stations and rotating grazing systems; and

recommending that the U. S. Forest Service drain Bismarck Lake, remove sediments and establish fish populations similar to those in Stockade Lake. For in-lake treatment, it is recommended that Stockade Lake be drained and the sediments be removed; and that the lake be restocked with fish with the objective of minimizing forage fish. (The last recommendation almost stalemated the approval of the draft report earlier because of a controversy over whether warmwater or cold-water fish should be stocked; however, that decision is too far in the future for immediate consideration.)

The kicker in the report is that corrective measures were to be completed in a time frame depending on when and how much funding is available. It was agreed that there is no point in taking corrective measures in the lake until the Custer Wastewater Treatment Plant is corrected. It was also agreed that Bismarck Lake should be drained and cleaned before Stockade Lake is drained and cleaned.

At a meeting June 17 Harold Stoltenberg of Rapid City of the Recreation, Conservation and Development office said that his staff will explore funding for irrigation, wetlands, roads, recreational facilities, sediment basins, streambank stabilization, mine spoil dumps and livestock stability as some funds may become available for those projects. Having some of the work done by the National Guard was explored with little likelihood that Guardsmen can work long enough at any single project in one year to create much improvement.

The June 17 meeting drew the largest crowd of any of the Stockade Lake project meetings. Those present generally agreed that the draft report is acceptable and it is to be prepared in its final form by project director Arvo Kujala and Citizens Advisory Committee chairman Art Richardson.

Attending the meeting for the Technical Advisory Committee were Ron Walker, Tom Champion, Dick Ford, Bill Carpenter, Oakley Hoy, Tim Bjork, Jack McBride and consultants Dave Linde, Linda Yocum, Leon Fager and Lee Loffert. They represent the City of Custer, Custer County, Soil Conservation Service, South Dakota Department of Water and Natural Resources, Forest Service and other agencies. Attending from the Citizens Advisory Committee were Richardson, Warren Jackson, Dick Eide, Don Delicate and Bruce Bitz. Soil Conservation District officials present were Joe Marsh, Dotty Ramsey and Kujala; RC&D, Stoltenberg. Gary Tschetter also attended and offered to help in any way he could.

Any of the minor projects for which funding can be obtained and which will not be out of order in the restoration steps will be undertaken as soon as possible. The major corrective measures, are perhaps as far as 10 years down the road and could run into a cost of millions of dollars, with Champion remarking that city taxpayers in no way can afford to finance such a project. With federal funding being decreased or eliminated it appears that the major problems in the watershed and lake will continue, for the most part, as is.

Custer County Chronicle

purveyors of the printed word since 1879

20¢
volume 101
number 19
May 7, 1981
Custer, S.D. 57730
(USPS 141-020)

It rained!



Custer county residents revelled in weekend rains Friday and Saturday which netted 0.81 hundredths of an inch of moisture that soaked into the parched and dried sagebruch-covered hills, grasslands and timber lands [illegible]

Annella Wright takes office



When Annella Wright took her oath of office, becoming the first woman mayor in Custer's history, she brought with her six council members, each chosen by her. Since Wright was the only person to file a petition of nomination for mayor and no citizens filed for positions on the council, she was able to appoint the members of the council.

The new council consists of veteran members Gordon Dretsch, Ward 1; Richard Eide, Ward 2; Lee Sutton, Ward 3; former mayor William Young, Sr., Ward 3 and new members Shanna Utecht, Ward 2 and Frank Hendrickson, Ward 1.

The appointments of Robin Monzelowsky as finance officer, Dan Kelley as city attorney, Tom Champion as maintenance supervisor and Gordon Fluke as city engineer were all approved by the new council.

Gordon Dretsch was voted to be council president and Lee Sutton as vice-president. Committee members will be appointed at a later date.

Members of the parks and recreation board were approved by the council. They are Terry Reetz, Chuck Hazlett, Dan Custis, Dan Hutt and Susan Svoboda.

Precaution is necessary to prevent fires

[illegible]

taken off enough granite to gravel a road three inches deep and 30 feet wide half way across the United States. Seven million tons also means Korczak is getting closer to having the massive sculpture in the round roughed out. When fully blocked out, however, the massive equestrian still will be encased in a protective layer of granite from eight to 12 feet thick.

Removing that last rock, about one and one half million tons, from two thousand miles of surface, will be the slowest, most difficult, dangerous and costly part of carving Crazy Horse. Korczak says, "Now, it costs me less than 40 cents to remove one ton of rock, but when we move into the finishing stage it will cost about $1,000 a ton." To date, Korczak single-handedly has raised and spent more than four million dollars on the project.

The Boston-born sculptor of Polish descent who was orphaned at age one began Crazy Horse 34 years ago living in a tent. He had only $174 left to his name. Since 1947 Crazy Horse has become virtually a small town, with all the services and expenses of any city that served upward of 25,000 people a day in the summer—and which stays open year round in spite of the usually harsh winters at 6,240 feet above sea level.

From the beginning he has refused any federal or state money for Crazy Horse, feeling the interested public should finance the work, not tax dollars. Twice he has turned down 10 million dollars from the federal government because he does not believe the government would either finish the work on the mountain carving or carry out the project's humanitarian goals. An admission charge of $5 a carload plus revenue from souvenir purchases and contributions have been the primary source of revenue for Korczak's non-profit, humanitarian project. In the 34 years at Crazy Horse, Korczak has never taken a salary or

Stockade Lake input sought

A meeting to receive public input concerning alternative corrective measures for the proposed Stockade Lake Watershed Improvement Project has been announced by Art Richardson, chairman of the Citizens Advisory Committee. The meeting is scheduled for May 11, at the VFW hall beginning at 7:30 p.m.

The purpose of the meeting is to get suggestions and recommendations from local citizens and landowners within the watershed to assure that the final plan best meets the needs of the local area.

Since there is a very wide range of human activities that contribute to the pollution of Stockade Lake and since numerous alternative corrective treatments are possible, the Citizens Advisory Committee requested that the Technical Advisory Committee develop a tentative recommended course of action. According to Richardson, this tentative recommendation will serve as a starting point for obtaining suggestions from the public at the May 11 meeting. Following the meeting, the two committees will develop a final plan to be submitted to the Custer County Conservation District for approval by the Board of Supervisors.

The tentative recommendation of the Technical Advisory Committee is based on rather limited input received from the public to date, suggestions from various local and state agencies, plus the recommendations of Dr. Lois Haertel, Associate Professor in the Biology Department of SDSU who has analyzed the current conditions of Stockade Lake and has evaluated treatments for the lake.

The tentative recommendation included many aspects of pollution control.

(Related story on page 4)

(As the CHRONICLE goes to press Wednesday morning, a fire has destroyed the chipping plant about three miles north of Custer alongside the railroad on property owned by Zielkowskis. The fire is under investigation by the Custer Volunteer Fire Department and Custer County Sheriff's deputies. The two and one half story building was uninsured and burned to the ground in a light rain.)

Protect homes from wildfire

The image of wildfire burning in heavy timber—billowing smoke, flames spreading through treetops, and blackened snags—is bad enough. But insert people's homes in the same picture, and one has devastating loss.

Throughout the Black Hills, the trend toward suburban living is on the increase. Most private land within a 10-mile radius of towns and cities has been subdivided for housing developments. Many homes lie in secluded, wooded locations, and this is what has fire control personnel worried.

The ponderosa pine forest in the Black Hills is highly flammable, with an average of 210 forest fires reported yearly. During dry weather periods, even with federal, state, county, and private fire control forces

Like a mother, she taught her students we



and a friend.

She is remembered by many Custer County residents as their teacher in area rural schools. Though she has lived and worked in the Custer area for many years, she was born and raised in Plankinton.

During her last two years of high school in Plankinton, Mrs. Griffiths took a course that was offered for those who wanted to enter the teaching profession. Her teaching career began shortly after high school when she became the teacher of a rural school just a few miles from Plankinton. During those first years of teaching, one of the most vivid

approximately six miles from the State Game Lodge. After that, she moved to a school about 30 miles northwest of Custer in the limestone country. There she taught at a school for the children of sawmill workers.

Mrs. Griffiths then taught in Pennington county schools; before returning to teach in Custer County at the Park country school. She taught there for about 11 years, after which she taught at the Spring Creek school near Hermosa.

In the 1960's Mrs. Griffiths took on a new assignment, becoming the teacher for the children of Korczak Ziolkowski at Crazy Horse. The two

IGINAL ECLIPSE
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Your Choice
OSEMILK
1.19
Rose Milk
IC LIGHTERS
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AIR CURL
ZLER
HAIR SETTER
9.98
Plus 2.00 Rebate From Conair
H PARTICIPATING STORES
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PRICES

and rocking streets and roads impassable, and leaving heaps must join if a solution is to be reached. (CHRONICLE photos)

Public input sought for Stockade Lake project

Continued from page 1

Sources of nutrient and sediment pollution which have been identified within the tributary watershed are listed in order of significance based on the evaluation and judgment of the T.A.C.

Under each source of pollution are the tentative recommended corrective measures or course of action listed in order of priority.

A. Nutrient Sources of Pollution

1. Municipal WWTP (Waste Water Treatment Plant) Effluent

Recommended course of action: Recommend to the City of Custer that the City analyze and evaluate the following alternatives:

a. Prevent groundwater and storm water from entering the sewer collection and outfall system.

b. Use effluent from WWTP for irrigation of hayland, timber land and possibly of a wetlands system.

c. Provide advanced treatment of effluent using a rapid infiltration system.

d. Renovate or upgrade WWTP.

2. Individual Septic Tank Systems

Recommended course of action:

a. Use proper operation and maintenance procedures.

b. Based on the findings of a detailed septic tank survey, repair or replace malfunctioning systems or utilize a different system.

3. Recycling of nutrients within lake

Recommended action:

a. Drain the lake and remove sediments to the extent it is economically feasible.

b. Refill lake and stock with optimum populations of predatory fish and forage fish to increase the population of zoo plankton for increased grazing of green algae.

c. Monitor water quality and animal and plant life populations to maintain proper balance.

(Note: Other options, such as aeration, would be available if further improvement of water quality were still needed.)

4. Agricultural Wastes (from barnyards or corrals)

Recommended action: With landowner concurrence and cooperation:

a. Construct dikes, barriers or terraces

b. Provide buffer zone along creek

c. Relocate facilities away from creeks

5. Toxic Materials

Recommended action:

a. Proper disposal of solid wastes

b. Conservative and proper use of fertilizers

c. Proper use of insecticides and herbicides

B. Sediment Sources of Pollution

1. Urban Runoff

Recommended action:

a. Select snow-disposal sites more remote from live streams

b. Construct dikes, barriers or terraces

c. Construct sedimentation basins or traps

d. Erosion protection (Paving, curb and gutters or storm sewers)

2. Land Development and High-use Areas:

Recommended action:

a. Construct sedimentation basins or traps

b. Slope protection and revegetation

c. Construct dikes, terraces or buffer zones

d. Relocate facilities

3. Mining and Milling - Stream Channel Changes:

Recommended action:

a. Slope protection and revegetation

b. Dikes or buffer zones at mine spoil disposal areas

c. Streambed protection (gradient reduction structures, etc.)

4. Livestock Concentrations Adjacent to Streams:

Recommended action:

a. Reduce use (Greater distribution by alternate salting areas and watering facilities)

b. Streambank protection

c. Streamside fencing (with water gaps)

5. Miscellaneous:

Recommended action:

a. Increase water yield through intensive forest management

b. Proper location, construction, maintenance and management of roads

c. Slope protection and revegetation of landfills adjacent to creeks

It was announced at [illegible] ing that a bridge luncheon be held at the home of Baldwin, assisted by [illegible] gers, on May 12 as a fund event for Cottey Colle[illegible]

A report was given luncheon held at the [illegible] Lucy Roudebush for loc school girls at which Smedley spoke about Colleee.

Chapter AW furnishe vidual table decorations nial Manor all through Macy Cullum and Trudy prepared the Easter items McNeil and Trudy with them for Mother's Day.

The Chapter celebra 43rd anniversary this having been organized 1938, at the home of M Winters with Mrs. Maud well elected to serve as president.

President Macy Cullu the meeting with a rea Ogden Nash entitled Comes to Baltimore or mas Comes More P[illegible]

Mary Ellen McCall a review of the book *The End of the Rainbow* story about Mary Ann C selling a successful s recovering from drug a

Custer local

Mrs. Lorraine Heidep Mrs. Jim (Karla) Lyn in Chamberlain Apr. where they attended services Friday for Mr priem's stepfather wh Mrs. Lyndoe's step-gr

Stockade cleanup simple, cost the problem

Dick Rebbeck
Staff Writer

CUSTER — Stockade Lake cleanup seemed simple enough, as outlined Monday in a public review of watershed improvement recommendations. Dig out the accumulated gunk. And stop Custer sewers from pouring in new pollution.

Paying for it is something else, considering Reagan administration stop orders on federal funds for such work.

A long list of tentative recommendations were explained by Art Richardson, chairman of a Stockade Lake cleanup citizen's advisory committee, and Arvo Kujala, the project's coordinator for the Custer County Soil Conservation District.

But the issues boiled down to two — remove sediment that coats the lake bottom in greasy black jelly up to seven feet thick, and filter nitrogen and phosphorus out of Custer waste water treatment plant effluent.

The nitrogen and phosphorus overfertilize the lake and stimulate heavy growth of algae and other aquatic life. The algae not only turn the water a sickly, odorous green but, along with weeds and other plant and animal forms, sink to the bottom when they die and in decomposing use up oxygen needed by trout.

Tim Bjork, with the Department of Water & Natural Resources at Pierre, told about 30 Custer area residents at the public review session that the city's sewage treatment plant is the place to start in cleaning up the watershed.

"Unless something is done with the waste water treatment plant, all the other treatments won't do much good, or any good," Bjork said.

Although several sources of soil erosion may aggravate the lake's problems, Bjork said much of the sedimentation probably comes from the algae, stimulated by sewer plant nutrients, settling to the bottom and decomposing.

With a shutoff of federal construction grant money, however, there's little hope the sewage system can be improved to solve the nutrient problem, said Gordon Fluke of Great Plains Engineering in Custer.

A major part of the sewer problem is heavy infiltration of groundwater into the mains. This overloads the treatment plant and flushes nitrogen and phosphorus nutrients into French Creek above the lake. But federal money to correct infiltration problems is "practically non-existent," Fluke said.

After raising several questions about the recommendations, Fluke concluded, "Funding is the real tough problem."

Some money could be raised by selling the sediment as fertilizer. Linda Yocum, Department of Water & Natural Resources, Pierre, said the lake-bottom muck contains 23 percent nitrogen and "a lot of phosphorus."

Kujala mentioned that the lake holds enough sediment now to cover a 20-acre field six feet deep.

Ironically, the lake's problem became serious after Custer installed a modern sewage treatment facility. Bjork explained that raw sewage escaping the old system tied up much of the nitrogen and phosphorus. Eliminating the raw sewage left nitrogen and phosphorus free to flow on into the lake.

Other recommendations drew a few questions from the crowd.

Livestock were not rated as a serious pollution source in the French Creek drainage, and fencing to control pollution livestock on streambanks was considered prohibitively expensive.

Richardson said livestock pollution in French Creek is not nearly the problem it is on some other Black Hills streams.

Recommendations that a restored lake be stocked with a blance of warmwater predator fish and trout were challenged by Game, Fish & Parks Department fisheries biologist Dick Ford, Rapid City. He said there are easier ways to manage aquatic populations with just trout.

Kujala said public comments on what people want most in Stockade Lake cleanup will help the committee refine its project recommendations before estimating costs and identifying sources of money.

3/12/74 RC. Source

Three Hills lakes nominated for water quality study

The 6th District Council of Local Governments has nominated Stockade, Sheridan and Canyon Lakes for a water quality study.

The Department of Environmental Protection will select one of these lakes on the basis of technical feasibility and public support for a lake restoration program, explained Steve Pirner, 208 water quality planner, at the council's meeting Thursday.

Phase I of the project, which is part of the new 208 water quality management planning activities, is a study of present water quality and steps necessary for improvement. This is a 70/30 match of federal funds to local.

Phase II is implementation of that plan, which would be a 50/50 match of federal funds to local.

"We have to have the cooperation of the people in the area selected because they're going to have to do best management practices for that area," said Pirner.

Leo Hamm, a new member of the 6th District Council, questioned the value of the project, particularly since it was an outside effort and not locally motivated.

He said that participation in the DEP program would supercede all the local work done in two years of 208 water quality planning.

"We're not that interested in providing employment for state agencies who need to justify their existence," said Hamm.

Speaking in favor of the nomination of Stockade Lake was Warren Jackson, director of Custer State Park.

Appendix B1.

WQSA Workplan - Agency Responsibilities

STOCKADE LAKE

WATERSHED IMPROVEMENT PROGRAM

WORK PLAN

November 1980
(Revised 11/17/80)

PREPARED BY

CUSTER COUNTY CONSERVATION DISTRICT

Goal II (continued)

Stockade Lake drainage area so that land and activities contributing most directly to water quality problems are adequately treated with Best Management Practices.

OBJECTIVES

1. Identify land areas that, when treated with Best Management Practices, will provide the most cost effective contribution to water quality improvement

2. Provide planning and technical assistance to land users in areas that will help improve water quality through the use of practical resource management systems or pollution abatement measures.

ACTIVITY	RESPONSIBILITY	TARGET DATE	REMARKS
1. Identify sources of nutrient and loading to Stockade Lake	DWNR - SCS	Feb. 1981	
a. Determine areas that have a high delivery rate of sediment or nutrient potential by the use of all available data - such as soil maps, RSI data, aerial photography and topographic maps	SCS	Dec. 1980	
b. Field observation of land within watershed to determine critical areas needing treatment	SCS - CCCD - PC	Dec. 1980	
c. Survey critical areas to determine % impact from designated areas	SCS - DWNR - PC*	Dec. 1980	
d. Correlate delivery rates with suspended solid analysis of water reaching Stockade Lake	DWNR	Feb. 1981	

* Visual observation only

Goal I-1 (Continued)

to improve the water quality in Stockade Lake.

ACTIVITY	RESPONSIBILITY	TARGET DATE	REMARKS
1. Prepare work plan to identify tasks and completion target dates			
a. Prepare tentative work plan	PC	9/1/80	Submitted to DWNR on 8/22/80
b. Review tentative work plan	All agencies	10/30/80	Done: 10/15/80
c. Assign agency personnel to tasks necessary to meet WIP objectives	All agencies	10/30/80	Done: 10/15/80
d. Finalize tentative work plan	PC DWNR	11/30/80	Submitted to DWNR 11/1/80
2. Identify current situation			
a. Complete survey of condition of Stockade Lake	DWNR C S Park	Nov. 80	
b. Complete survey of tributary watershed	SCS USFS PC	Dec. 80	
c. Prepare description and map to identify sources of sediments and nutrients	SCS DWNR PC TAC	Dec. 80	
3. Establish ideal baseline data for Stockade Lake	DWNR GF&P	Dec. 80	
4. Investigate possible sediment and nutrient control alternatives. Recommend plan			
a. Conduct tributary surveys	DWNR PC SCS USFS	Dec. 80	
b. Prepare preliminary survey maps for possible corrective treatments. Investigate cost effectiveness, recommend plan	PC (Map) DWNR (Cost effectiveness investigations)	Apr. 81	
c. Review survey maps and recommended plan	TAC CAC	Apr. 81	

Goal III (Continued)

ACTIVITY	RESPONSIBILITY	TARGET DATE	REMARKS
d. Solicit landowner response	CCCD CAC PC	May. 81	
e. Investigate funding sources	PC 6th Dist DWNR	Jan. 81	
f. Complete selected watershed improvement plan	CCCD PC	July 81	

GOAL IV

Develop a monitoring program to determine the effectiveness of the various land treatment and pollution control measures that have been applied.

OBJECTIVES

Establish a system of monitoring runoff and lake water that will provide data for evaluation and justification of structures and practices.

ACTIVITY	RESPONSIBILITY	TARGET DATE	REMARKS
1. Select location of monitoring sites	DWNR PC	Completed	
2. Sample selected sites			
a. In lake	PC	*Bi-monthly	(1)
b. Continuous flow streams	PC	Bi-monthly	(1)
c. Non-continuous flow streams	PC	Runoff events	(1)
3. Organize and interpret sampling and testing date	DWNR	As required	
4. Prepare documents detailing evaluation	DWNR	As required	

(1) DWNR advised on 8/27/80 not to sample until further notice due to lack of funds.

* monthly after ice up

Nov. 18,1980

NOV 25 1980

Rich Whitston
DWNR
Joe Foss Bldg.
Pierre, SD 57501

Dear Rich:

Enclosed are copies of pages 8,10, and 11 of the Work Plan which have been revised as you, Tim Bjork and I agreed on Nov. 17.

Also enclosed for your information are copies of reports by the various T.A.C. members which were submitted last month in response to my request on Sept. 10, together with copies of my work sheets relating to flow at sampling sites #3 and #4 as well as at sites #5 and #6 indicating the total inflow into Stockade Lake.

Sincerely,

Arvo Kujala

Arvo Kujala
Project Coordinator

AEK/dr

Encl:

> RICH W.

TO: TAC Members

I would appreciate your help in identifying the various sources of pollution and sedimentation within the Stockade Lake watershed. This information needs to be as comprehensive as possible so that the extent of the problem can be analized and that alternative pollution abatement measures or land treatments can be evaluated.

Attached is suggested format for your use in supplying the needed information. I suggest that this first report be compiled based on presently available data and your knowledge of the watershed. Field varification of the significant sources of pollution will probably be necessary this fall, therefore we need your report on, or preferably before, our next TAC meeting.

Thanks,

Steve 9/10/80

Arno - I looked at some of the places I thought had erosion problems but [illegible] they were as serious as I thought so want even mention them

[illegible] 10/9/80

AGENCY REPORTS FOR T.A. COMMITTEE

STOCKADE LAKE WATERSHED IMPROVEMENT PROJECT

I. Description *of Pollution or Erosion

A. On your agency administered lands:

—

B. Elsewhere within watershed:

Bob Marshall Camp and Outlaw Ranch both have erosion problems in the watershed but sediment from both go into Bismarck lake.

II. Corrective measures

A. Presently underway :

District has a plan with Outlaw ranch and Bismarck Lake has requested assistance throug Lowell Pierce at Brookings. Caretaker is Gary Holtz - 673-2730

B. Proposed in near future :

—

C. Recommendations for further corrective measures together with possible funding sources :

Critical area seedings along with some form of water control.

Keep in mind possible RCD assistance [illegible] State and County land for measures to control erosion

* Identify type, such as domestic sewage, agricultural wastes or fertilizers, etc., map location or Sec., Township & Range and your estimate of the seriousness of the problem.

DAD:

I. Description of Pollution or Erosion:

A. The primary activity on Forest Service administered lands, in the Stockade Lake Watershed, is timber harvesting. The prime source of pollution resulting from the harvesting of timber is the construction of access roads and skid trails. There are currently no timber sales adjacent to French Creek waters. As a result, erosion is restricted to natural background rates that would be normally found in second-growth timber stands (about 0.15 tons per acre per year). Grazing is a secondary activity within the French Creek Watershed. Most of the livestock grazing is located on relatively flat bottom lands. The meadows along French Creek, on Forest Service administered lands, are in good to excellent condition. As a result, the erosion rate is low, with little sediment finding its way to the Creek. Further, water quality monitoring by the Forest Service has detected little evidence of bacteriological or nutrient pollution in French Creek waters flowing from Forest Service administered lands.

B. It appears that the most significant source of pollution to French Creek, and subsequently Stockade Lake, is from the city of Custer itself. Runoff from city streets, improperly installed septic systems, sewer treatment plant overloads, and streamside grazing on private lands all seem to make contributions to Stockade Lake pollution.

II. Corrective Measures:

A. In order to prevent or reduce potential pollution from present or future Forest Service administered timber sales, Best Management Practices (BMP's) have been developed. These practices consist of common-sense methods of timber sale administration that are known to have a significant effect on reducing the pollution that is normally associated with the activity. Using the guidelines, the amount of pollution that could potentially find its way to a major waterway (such as French Creek) is reduced.

B. Other than the use of BMP's for silvicultural activities, there are no major watershed restoration measures projected to be employed on Forest Service administered lands within the French Creek drainage above Stockade Lake.

C. At the present time, there are no proposed corrective measures for watershed restoration on Forest Service administered lands. Corrective measures for other sources of pollution from non-Federally administered lands will be offered on request by the TA Committee.

BHH:F 11/14/80

10/15/80

AGENCY REPORTS FOR T.A. COMMITTEE

STOCKADE LAKE WATERSHED IMPROVEMENT PROJECT

I. Description *of Pollution or Erosion

A. On your agency administered lands: C.S.P.

problems not too serious

Siltation - gravel road to [illegible] picnic area next to water, gullys from [illegible] lake.

B. Elsewhere within watershed:

?

II. Corrective measures

A. Presently underway :

none

B. Proposed in near future :

?

C. Recommendations for further corrective measures together with possible funding sources :

1. Hard surface road to beach, [illegible] road past beach.
2. Move picnic area away from [illegible], access from existing [illegible] road, [illegible] picnic [illegible].
3. Mend gullys from [illegible], [illegible] lake [illegible].

* Identify type, such as domestic sewage, agricultural wastes or fertilizers, etc., map location or Sec., Township & Range and your estimate of the seriousness of the problem.

(N) Also check [illegible]

[illegible]

[illegible]

AGENCY REPORTS FOR T.A. COMMITTEE

STOCKADE LAKE WATERSHED IMPROVEMENT PROJECT

I. Description *of Pollution or Erosion

A. On your agency administered lands:

B. Elsewhere within watershed:
French Creek - Jim Kemp ranch a new house being built close to creek - across the road from Kemps. Ag waste from Kemp's such as manure, fertilizer. Erosion & sedimentation from new house.

II. Corrective measures

A. Presently underway :

B. Proposed in near future :

C. Recommendations for further corrective measures together with possible funding sources :
potential help by use of audio-visual work, educational programs to make people aware of erosion and pollution problems. Work with Landowners to help make them aware of problems they are creating.

* Identify type, such as domestic sewage, agricultural wastes or fertilizers, etc., map location or Sec., Township & Range and your estimate of the seriousness of the problem.

(Coop. Ext. Service)

AGENCY REPORTS FOR T.A. COMMITTEE

STOCKADE LAKE WATERSHED IMPROVEMENT PROJECT

I. Description of Pollution or Erosion

A. On your agency administered lands:
HIGHLY TREATED EFFLUENT FROM POLISHING POND.
CONTAMINATION FROM OVERFLOWING SEPTIC TANKS IN AND OUT OF TOWN, SOUTHWEST AND WEST.

B. Elsewhere within watershed:
LIVESTOCK PASTURED ON FRENCH CREEK ON PRIVATE + NATIONAL FOREST SERVICE LANDS
RECHANNELIZATION OF FRENCH CREEK ON EAST SIDE OF TOWN. SEVERE SILTING POSSIBLE - NO EFFORT MADE TO CORRECT IT.

II. Corrective measures

A. Presently underway:
APPLYING FOR N.D. GRANT TO CORRECT THOSE SITUATIONS WITHIN CITY.

B. Proposed in near future:
STUDY NOW UNDER WAY FOR RENOVATION OR REPLACEMENT OF EXISTING PLANT UNDER 201 GRANT.

C. Recommendations for further corrective measures together with possible funding sources:
A SANITARY SEWER DISTRICT WEST OF TOWN TO ELIMINATE SEPTIC TANK DISCHARGING IN SHALLOW TOPSOILS BASED ON REVENUE BONDING.
REQUIRE MINING OPERATIONS FOR ANY PURPOSE TO RESTORE AREAS DISTURBED. GOLD MINING A LARGE CONTRIBUTOR.

* Identify type, such as domestic sewage, agricultural wastes or fertilizers, etc., map location or Sec., Township & Range and your estimate of the seriousness of the problem.

DOMESTIC SEWAGE, AGRI WASTES IN THE AREA KNOWN AS LITTLE ITHAY AND UP FRENCH CREEK TO ITS HEADWATERS.

SEC 26 3S 4E
SEC 25 3S 4E

(City of Custer)

This is a non scientific, laymens review of one of the many problems facing the restoration of Stockade Lake.

In a trip involving basically time, Upper French Creek and Tompkins subdivision was surveyed for potential pollution problems.

Tompkins Subdivision:

From Highway 16 to the last residence in this area of one and two tenths miles there are nineteen homes. If these dwellings were spaced out there would be an average of three hundred thirty-three feet between sewer systems. This spacing in itself is not toobad when you consider that this meets all of the state codes. However, this is not the case. There are three clusters of homes that add to the impact of the systems on absorbation rate in these areas. The water from septic tanks will creat a balloon effect in the movement away from the drainfield system.

The rate of movement of nutrients (on an average) is five to seven feet a year away from the septic system. From this one can easily see that a cluster of sanitation systems can join together and form a system of cells that will act as a carrier for water and thus speed up the absorption system action.

The following diagram will give an idea of the chain of events that could take place, and in turn create drainage and pollution problems.

The balloon effect will in turn create a "ponding situation" that will sometimes surface and cause health problems and in general an un-pleasant community problem.

Upper French Creek:

In this area of one and one-half miles there are thirty-one homes, eleven mobile homes, two trailer courts, one bar and lounge, one feed store and gasoline sales and a golf course.

Here again the same thing can and will happen, given enough time and the impact of the homes, mobile homes and businesses in this area.

The only solution that is practical but at the same time quite expensive is a sanitary sewer district for these areas.

I am not a health officer or Sanitary Engineer, but it does not take a professional to see what has developed in these two small areas and what can happen if further development takes place here and in other places of the Stockade Lake Watershed.

The facts on Upper French Creek Are:

Thirty-one homes for an average of one-hundred and eighty nine feet between sewer systems, however here again, these homes and mobile homes are "grouped" and the impact on the land is greater and problems develope faster. Not included in these averages are the business places listed above.

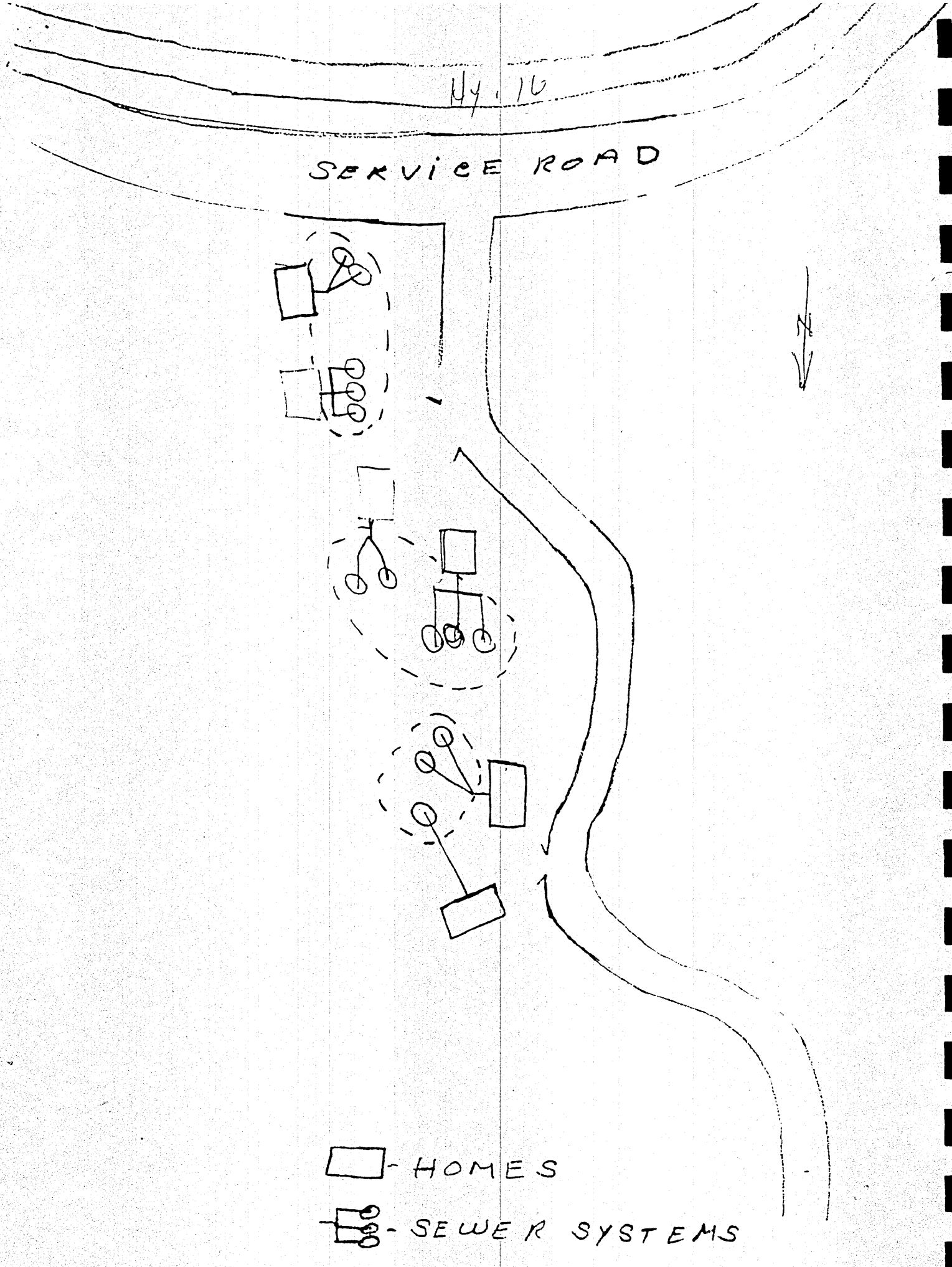
The subdivisions referred to in this report, were not singled out on purpose, but rather to show the effect of sewer systems that are along drainage ways. There are many more sources of potential pollution from

West of Custer to Stockade Lake.

This is Part I of a series of reports that will cover all of the drainage ways and streams that are tributaries that empty into French Creek.

Jack McBride

Planning Coordinator
Custer Planning Office.


Hy. 16
SERVICE ROAD
N
- HOMES
- SEWER SYSTEMS

November 7, 1980

On Thursday afternoon, November 6th, Arvo Kujala and I made our survey of French Creek, below east city limits of Custer.

I personally was rather surprised as to the difference in this area as opposed to Upper French Creek and Tomkins Subdivision. One problem and it is a big one is the city sewer plant located in the upper section of this area.

The numbers of homes along the stream are not as numerous as the congested sections West of Custer. There may be as many; however two or three clusters of buildings are back far enough from the waterway and probably not cause any pollution problem. There is one spot where public accomodations and homes are directly across the stream from each other and no doubt will create problems sooner or later.

The City sewer plant located above the lake may pose more problems for this area than the greater number of homes further up French Creek.

One spot East of Custer has several trailers on a small area. Pipes (drain type) come from two of these trailers and the whole thing looks suspicious. These pipes are very visible from a road that is below the trailer parking site. More investigation will probably have to be done to determine just what is going on out there.

Summary:

From what I have seen in the watershed above and below Custer City, it appears that the upper area might be a priority. With pollution from Custer City, streets and other non-point sources, as a second area to work.

Remedy:

One thing that would probably be as big help is for the County to zone and set up guidelines for numbers of individual trailers or homes per acre or on lot size basis. Being in the Planning business, I know that people will resist zoning as far as residential is concerned. However, the fact is that in many cases there are too many sewer systems on too small an acreage to work properly. When this happens these systems start to breakdown and pollution begins.

Sincerely,

Jack McBride
Planning Coordinator

CONCEPTUAL PLAN
FOR
THE PROPOSED
STOCKADE LAKE WATERSHED IMPROVEMENT PROJECT

Near

Custer, South Dakota

_____1981

Prepared By

CUSTER COUNTY CONSERVATION DISTRICT
P.O. Box 31, Custer, S.D. 57730

TABLE OF CONTENTS

I. SUMMARY, CONCLUSIONS & RECOMMENDATIONS

- A. General
- B. Conclusions
- C. Recommendations

II. INTRODUCTION

- A. Contract Authorization
- B. Purpose of Report
- C. Planning Area Description
- D. Planning Participation and Cooperation

III. WATER RESOURCES AND WATER QUALITY OBJECTIVES

- A. Existing Water Resources
- B. Water Quality Objectives

IV. SUMMARY OF POLLUTION SOURCES

- A. Domestic and Municipal Sources
- B. Industrial Sources
- C. Agricultural Sources

V. ALTERNATIVES CONSIDERED

- A. Preliminary Alternatives
- B. Screening of Preliminary Alternatives
- C. Description of Proposed Alternatives
  - Alternative 1
  - Alternative 2
  - Alternative 3
  - Alternative 4
  - Alternative 5
  - Alternative 6

VI. EVALUATION OF ALTERNATIVES AND ENVIRONMENTAL ASSESSMENT

- A. Views of Public and Concerned Interest
- B. Alternative Evaluation Method
- C. Evaluation of Alternatives
  - Alternative 1
  - Alternative 2
  - Alternative 3
  - Alternative 4
  - Alternative 5
  - Alternative 6

VII. SELECTION OF PREFERRED ALTERNATIVE

VIII. FLOOD PROTECTION CONSIDERATIONS

IX. COORDINATION WITH UTILITIES, PUBLIC AGENCIES & OTHER ENTITIES

X. PROJECT PHASING & SCHEDULE

XI. ESTIMATED PROJECT COSTS

APPENDIX

A. REFERENCES
B. PUBLIC INPUT
C. WATER QUALITY TESTS
D. SEDIMENTATION SURVEYS

LIST OF TABLES

A. DRAINAGE AREA FLOW DATA
B. ESTIMATED PROJECT COSTS
C. PRELIMINARY SCREENING OF ALTERNATIVES

LIST OF FIGURES

A. PROJECT LOCATION MAP
B. MAP OF SIGNIFICANT POLLUTANT SOURCES
C. RECOMMENDED PROJECT SCHEDULE

SECTION I

I. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

A. General

The fundings of this report indicate that serious pollution has occurred, and is occurring, within the Stockade Lake watershed. The problem is generally caused by excessive nutrients and sediments entering French Creek and subsequently being carried into Stockade Lake.

In order to reduce the pollution occurring in the lake and tributary stream beds it will be necessary to:

Plains Engineering Co. of Hot Springs, S.D. has been retained by the City of Custer, SD to develop a conceptual plan for the renovation of the city outfall sewer system and the sewage disposal plant. While this project is being developed separately from the Stockade Lake WIP the successful implementation of the city project will directly effect the degree of reduction of pollution in French Creek and Stockade Lake. Therefore the planning of the two projects is being coordinated to assure that the proposed corrective measures of each are fully compatible.

SECTION II

II. INTRODUCTION

B. The purposes of this report are to:

1. Identify and analize existing non-point and point source pollution within the Stockade Lake watershed
2. Define and evaluate the areas within the watershed requiring corrective treatments
3. Evaluate alternative methods of treatment and develop a conceptual plan for implementation of corrective measures or construction of required facilities on a cost effective basis
4. Analize and evaluate the effects of alternate treatment methods on the physical and biological environment.

C. Planning Area Description

D. Planning Participation and Cooperation

The boundary of the watershed and the relationship to governmental boundaries is shown on Plate No. _____.

A number of federal, state and local agencies,, as shown on the following organizational chart, are involved in the planning processes for the implementation of corrective &practices and facilities. Elimination of pollution of lakes and streams has been a common goal of these agencies for several years and cooperative effort has been very much in evidence.

SECTION III

III WATER RESOURCES AND WATER QUALITY OBJECTIVES

A. Existing Water Resources

1. General

2. Groundwater Supplies

3. Surface Water Supplies

(a) Streams and Creeks

(b) Lakes and Ponds

B. Water Quality Objectives

The water quality objectives are dictated by the necessity to protect the natural water courses and lakes from further pollution and contamination by human activities. The primary goal of the South Dakota Statewide "208" Water Quality Management Plan is to improve and maintain water quality for the maximum beneficial uses by present and future generations of South Dakotans. The objectives to achieve this goal are as follows:

1. To eliminate or reduce underground seepage from septic tank systems into the lakes and watersources within the watershed.
2. To prevent contamination of underground water supplies by infiltration of wastewater effluents.
3. To eliminate or reduce above ground accumulations of unabsorbed effluents, plant nutrients or other pollutants which ultimately are washed into the streams and lakes.
4. To eliminate or reduce erosion caused by human activities which are contributing sediments to the streams and lakes.
5. To restore and improve the water quality of Stockade Lake by the elimination or reduction of pollutants presently in the lake.

SECTION IV

IV SUMMARY OF POLLUTION SOURCES

A. Domestic and Municipal Sources

B. Industrial Sources

C. Agricultural Sources

SECTION V

V. ALTERNATIVES CONSIDERED

A. Preliminary Alternatives

A number of alternative methods of treatment have been considered and table "Preliminary Screening of Alternatives" indicates in tabular form all of the alternatives considered and their relative ranking based on the evaluation criteria shown. A numerical value was assigned, indicating the degree to which each alternative satisfies the particular criteria as follows:

Fully meets the criteria -	3
Partially meets the criteria	2
Probably does not meet the criteria	1
Does not meet the criteria	0

The numerical sum of the assigned values for each alternative indicates the relative acceptability of each alternative with the highest number indicating the greatest acceptability.

B. Screening of Alternatives:

Based on the preliminary evaluation of alternatives shown in table are considered unacceptable and are removed from further consideration.

TABLE C

PRELIMINARY SCREENING OF ALTERNATIVES

EVALUATION CRITERIA	ALTERNATIVES 1	2	3	4	5	6	7	8
a. Environmentally acceptable								
b. Technically practical								
c.. Economically feasible								
d. Socially feasible								
e. Can be implemented on available land								
f. Energy consumption is acceptable								
TOTAL POINTS								
RELATIVE RANKING								

C. Description of Proposed Alternatives

V. EVALUATION OF ALTERNATIVES & ENVIRONMENTAL ASSESMENT

A. Views of Public and Concerned Interests

Appendix B contains copies of notices of public hearings, letters and documents resulting from public hearings and reviews, together with a summary of comments.

Evaluation of public input and comments indicates that public acceptance is (low, medium, high?)

B. Alternative Evaluation Method

Alternatives have been considered in the final evaluation based on the evaluation criteria listed below. While each of these criteria is considered pertinent some are more important than others therefore a weighted value has been subjectively assigned to each criteria to indicate its relative importance.

	Value
1. Initial cost and cost effectiveness	5
2. Public acceptance	5
3. Environmental considerations	5
4. Reliability	5
5. Flexibility	3
6. Energy Requirements	3
7. Implementation Capability	5
8. Accomplishment of overall abatement of pollution	5

Appendix B2.

EPA - Stockade Lake Study Grant

COST OR PRICE SUMMARY FORMAT FOR SUBAGREEMENTS UNDER U.S. EPA GRANTS

(See accompanying instructions before completing this form)

Form Approved OMB No. 158-R0144

PART I - GENERAL

1. GRANTEE	2. GRANT NUMBER
South Dakota Department of Water & Natural Resources	P-008151
3. NAME OF CONTRACTOR OR SUBCONTRACTOR	**4. DATE OF PROPOSAL**
Custer County Conservation District	7/30/80 - 7/30/81
5. ADDRESS OF CONTRACTOR OR SUBCONTRACTOR *(Include ZIP code)*	**6. TYPE OF SERVICE TO BE FURNISHED**
	"208" Water Quality Planning

PART II - COST SUMMARY

7. DIRECT LABOR *(Specify labor categories)*	ESTIMATED HOURS	HOURLY RATE	ESTIMATED COST	TOTALS
Project Coordinator (Part time)	1144	$ 15.00	$17,160 -	
Secretary (Part time)	340	6.00	2,040 -	
Survey Technician (Part time)	255	6.00	1,530 -	
Conservation District Supervisors	40*	25.00	1,000* -	
Technical Advisory Committee	70*	25.00	1,750 -	
Citizens Advisory Committee	66*	25.00	1,650* -	25,130 -
DIRECT LABOR TOTAL:				$

8. INDIRECT COSTS *(Specify indirect cost pools)*	RATE	× BASE =	ESTIMATED COST	
none		$	$	
INDIRECT COSTS TOTAL:				$

9. OTHER DIRECT COSTS				
a. TRAVEL			ESTIMATED COST	
(1) TRANSPORTATION	2,200 miles @ 20¢		$ 440 -	
(2) PER DIEM	4 days @ $27.50		$ 110 -	
TRAVEL SUBTOTAL:			$ 550 -	
b. EQUIPMENT, MATERIALS, SUPPLIES *(Specify categories)*	QTY	COST	ESTIMATED COST	
Supplies & materials		$	$ 240	
EQUIPMENT SUBTOTAL:			240 -	
c. SUBCONTRACTS			ESTIMATED COST	
			$	
SUBCONTRACTS SUBTOTAL:			$	
d. OTHER *(Specify categories)*			ESTIMATED COST	
Audit ($500.) office space ($2,880*) postage ($80.)			$ 3,460 -	
Tele. ($160) Brochure & Printing ($200) Mail Water			360 -	
samples ($40) Mtg. Room ($220) OTHER SUBTOTAL:			$ 260 -	
e. OTHER DIRECT COSTS TOTAL:			$ 4,080 -	$ 4,870
10. TOTAL ESTIMATED COST				$ 30,000
11. PROFIT				$ N/A
12. TOTAL PRICE				$ 30,000 -

Form Approved
OMB No. 158-R0144

PART III - PRICE SUMMARY

13. COMPETITOR'S CATALOG LISTINGS, IN-HOUSE ESTIMATES, PRIOR QUOTES (Indicate basis for price comparison)	MARKET PRICE(S)	PROPOSED PRICE
		$

PART IV - CERTIFICATIONS

14. CONTRACTOR

14a. HAS A FEDERAL AGENCY OR A FEDERALLY CERTIFIED STATE OR LOCAL AGENCY PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER FEDERAL GRANT OR CONTRACT WITHIN THE PAST TWELVE MONTHS?

☐ YES ☐ NO *(If "Yes" give name address and telephone number of reviewing office)*

14b. THIS SUMMARY CONFORMS WITH THE FOLLOWING COST PRINCIPLES

40 CFR 30,710

14c.

This proposal is submitted for use in connection with and in response to *(1)* "208" Water Quality Planning Contract. This is to certify to the best of my knowledge and belief that the cost and pricing data summarized herein are complete, current, and accurate as of

(2) August 1, 1980 and that a financial management capability exists to fully and accurately account for the financial transactions under this project. I further certify that I understand that the subagreement price may be subject to downward renegotiation and/or recoupment where the above cost and pricing data have been determined, as a result of audit, not to have been complete, current and accurate as of the date above.

(3) Nov. 5, 1980
DATE OF EXECUTION

Vera E. Kupala
SIGNATURE OF PROPOSER

Project Officer
TITLE OF PROPOSER

14. GRANTEE REVIEWER

I certify that I have reviewed the cost/price summary set forth herein and the proposed costs/price appear acceptable for subagreement award.

11/06/80
DATE OF EXECUTION

Nancy Potts
SIGNATURE OF REVIEWER

Accountant
TITLE OF REVIEWER

16. EPA REVIEWER *(If applicable)*

DATE OF EXECUTION

SIGNATURE OF REVIEWER

TITLE OF REVIEWER

Office Space
In-Kind Contribution Computations

A. Office being used:

(1) Location - Kujala private office, 3 miles NE of Custer
(2) Size: 17' x 24' office space and 5' x 10' storage area for equipment & supplies (total 458 sq. ft.) ~~plus use of vehicle storage space in garage~~. NP

B. Property used as value comparison:

(1) Location - SCS office, 703 Mt. Rushmore Rd., Custer
(2) Size 612 sq. ft.
(3) Rental cost $325/mth = $3900/year
$3900 - 612 sq. ft. = $6.37/sq. ft./ year

C. Computation of In-Kind Contribution value:
458 sq. ft. x $6.37/sq ft./year = $2917./ year
or ($243.08 rounded to:) $240/month

Appendix B3.

Technical Advisory Committee and
Citizens Advisory Committee

RESPONSIBILITIES FOR PLANNING

STOCKADE LAKE WATERSHED IMPROVEMENT PROJECT

Primary responsibilities associated with the development of a conceptual plan (feasibility study) for the Stockade Lake W.I.P. are as follows:

DWNR Provide overall direction and consultation to assure that development of the proposed plan complies with all applicable federal and state laws and regulations. Provide technical assistance and services as needed.

CCCD Solicit input from landowners concerning agricultural problems and needs related to water quality and provide this data for consideration in the conceptual plan.

Advise landowners of potential funding possibilities for appropriate land treatment measures.

Monitor progress and accomplishments related to development of the conceptual plan.

PROJECT COORDINATOR

Provide coordination with and between the various agencies, committees, and individuals having responsibilities and involvement in the project.

Develop conceptual plan in accordance with the terms of the contract between DWNR and CCCD dated 7/30/80.

Assure that landowners and the public are kept informed of the progress and significant events of the plan by press releases, slide show, brochures, etc.

TAC Provide input to the plan regarding sediment and pollution problems within the watershed.

Provide technical assistance and consultation in the analysis and evaluation of alternative corrective measures to assure that the final plan is technically, environmentally, and economically feasible.

Recommend preferred alternative for implementation.

CAC At appropriate stages during development of the plan conduct reviews to assure that the plan is financially and socially acceptable to the public and the landowners.

Solicit input from individuals and groups to provide data concerning the needs, wishes, and desires of these citizens for consideration in the preparation of the plan.

Assist in the development and presentation of slide shows and the preparation of brochures and news releases.

Mailing List

TECHNICAL ADVISORY COMMITTEE

	NAME/TITLE	ADDRESS	BUSINESS PHONE
1	Oakley Hoy Dist. Cons. Soil Conservation Service	Box 31 Custer, SD	673-4429
2	Bill Carpenter (1) Program Officer	Black Hills Nat'l Forest Box 792, Custer, SD 57730	673-2251
3	Claire Harris ASCS (Located in Hot Sprs.)	SE of City Custer, SD 57730	745-4106
4	Rich Whitson Nat. Res. Engr.	DWNR Joe Foss Bldg. Pierre, SD 57501	773-3296
5	Ron Walker	Custer State Park Hermosa, SD 57744	255-4515
6	Richard Ford Fisheries Biologist SD GF&P	3305 W. South St. Rapid City, SD 57701	394-2391
7	Mike Strub 208 Project Director	Sixth Dist. COLG Box 1586 306 East St. Joe Rapid City,SD 57701	394-2681
8	Dave Lehmkuhl County Agent	Cooperative Extension Serv. Custer County Courthouse Custer, SD 57730	673-2372
9	Jack McBride Planning Coordinator	Custer County Courthouse Custer, SD 57730	673-2552
10	Tom Champion Maintenance Supervisor	City Hall Custer, SD 57730	673-4824

COORDINATORS:

Joe Marsh, Board of Supervisors Project Representative 673-2884
Custer County Soil Conservation District 1104 Needles Dr. Custer, SD

Arvo Kujala Project Coordinator Stockade Lake Project WIP 673-4294 or
Box Box 227 673-4429
Custer, SD 57730

(1) Lee Leffert, Hydralogist Alternate Member

(2) Lee Vanderbush, Ass't. Regional Supr. and Ron Glover, Fisheries Biol.- Alternate Members

Mailing List

B2 10/7/80

CITIZENS' ADVISORY COMMITTEE

NAME/TITLE	ADDRESS	PHONE
a. Private Citizens		
Lila Van Wie	Rt. 3 Custer, SD 57730	673-4172
Don Delicate	Box 272 Custer, SD	673-2058
Tal Lockwood	Box 726 Custer, SD	673-4496
b. Public Interest		
Art Richardson (1) Chamber of Commerce	214 Mt. Rushmore Road Custer, SD	673-4672 (Home) 673-4011 (Bus.)
Dan Lantaff Jaycees	Rt 1, Box 9? Custer, SD	673-4056 (Home) 673-2521 (Bus.)
Linda Johnson Jaycettes	Box 213 Custer, SD	673-2030 (Home) 673-2011 (Bus.)
c. Economic Interest		
Margaret Ballantyne	Box 352, Custer, SD	673-4278 (Home) 673-2286 (Bus.)
Joe McFarland	120 Mt. Rushmore Rd Custer, SD	673-2318 (Home)
Steve Baldwin	210 Rushmore Rd. Custer, SD	673-2764 (Home) 673-4433 (Bus.)
d. Public Officials		
William Sager County Commissioner	505 Belle Aire Dr. Custer, SD	673-4032 (Home) 673-2424 (Bus.)
Richard Eide (2) City Councilman	Box 338 Custer, SD	673-4036 (Home)
Warren Jackson (3) Park Supt. Custer St Park	Rt. 3 Box 21 Hermosa, SD 57744	255-4636 (Home) 255-4515 (Bus.)
ALTERNATES		
(1) Wayne Saukerson		673-2409 (Home)
(2) Ed Galles		673-4824 (Bus.)
(3) Tom LeFaive		673-4515 (Bus.)

9/30/80

STANDARD OPERATING PROCEDURES

(Stockade Lake W.I.P. Advisory Committees)

A. SCHEDULING OF ADVISORY COMMITTEE MEETINGS

(1) Regular meetings of the TAC and CAC will be held monthly until the conceptual plan is completed on or before as follows:

The T.A.C. meetings on the _____of each month at _____,

The C.A.C. meetings on the _____of each month at _____.

(2) Special meetings of either advisory committee may be called as needed by the chairman of the respective committees

(3) Notice of committee meetings will be provided by the secretary to the Custer Chronicle for inclusion in the calendar of events one week prior to the meeting.

B. CONDUCT OF THE MEETINGS

(1) The chairman shall conduct the meetings using standard parliamentary procedures. In the absence of the chairman, the vice chairman will conduct the meeting.

(2) The secretary will keep minutes of each meeting; recording the results of all motions and significant items of business. A copy of the minutes will be made for the CCCD.

(3) The P.C. will coordinate with the secretary of the Advisory Committee to prepare press releases within one week following the committee meetings.

(4) A tentative agenda will be prepared by the chairman of each committee after consultation with the P.C. and shall be provided to the committee members at least one week prior to the meeting.

DEC 01 1980

11/26/80

TO: CAC & TAC MEMBERS

NOTICE OF MEETING

DATE: Dec. 3, 1980 (Wednesday)

PLACE: REA Building
Custer

TIME: 9:00 AM

PURPOSE: Review by CAC AND TAC of proposed brochure and make final decision on layout and content. Attached is tentative wording for your prior review. The section headings will be prepared by Julie Carpenter as previously agreed.

OTHER AGENDA ITEMS for TAC members (CAC is welcome to participate also):

- Prioritize pollution problems
- List possible corrective measures or treatments

Hope to see you Wednesday,

Proj. Coord.

Encl.

INTRODUCTION

Stockade Lake, as most area residents know, is beautifully located on the west edge of Custer State Park. Not too long ago this lake was used by many residents and tourists as a recreational source. This is still true, to an extent people still fish the lake, in spring and early summer. The campgrounds around the lake are utilized, too, but not many people ever swim or fish there after mid-summer.

Something has happened to Stockade Lake and the area around it. The lake has quite an odor during the warmer summer season, and the lakes color turns to green, and dead fish are occasionally around the edge.

THE PROBLEM

There presently exists excessive pollution and sedimentation (in the form of phosphates, nitrates and silt) in Stockade Lake and the tributary creeks. This pollution is primarily caused by:

- Domestic and municipal sewage wastes.
- Runoff from roads, streets, highways, campgrounds, and land developments and other soil disturbing activities adjacent to water courses.
- Other pollutants, such as litter, oil from streets and roads, eroded soil, animal wastes and many other sources all contribute to the deterioration of Stockade Lake's water quality.

The results of this pollution are:

- Serious deteriation of water quality.
- Adverse effects to water related recreation such as swimming, boating and water skiing due to objectionable odors and excessive growth of algae and water weeds.
- Lowered oxygen levels to the point where cold-water fish are unable to survive.

PROJECT DESCRIPTION

Stockade Lake is a 131-acre lake with an average depth of 19 feet. It has a hydraulic retention time of 274 days ~~per year~~ which is a long retention time for a small lake and does not permit flushing out of the nutrients which cause a heavy growth of algae in it. The volume of water in the lake is 811,000,000 gallons.

The watershed area includes French Creek and its tributaries, named above, in a 78 square-mile area covering nearly 50,000 acres.

PLAN OF ACTION

The first phase of this project consists of preparation of a conceptual plan to include the following items:

- Identify and quantify the various sources of nutrient pollution and sedimentation
- Analize and evaluate possible alternative corrective measures for social, environmental and economic feasibility
- Recommend most feasible and cost-effective course of action
- Propose schedule for implementation
- Explore possible funding sources for implementation

Phase II of the program will consist of preparation of the detailed plans and specifications for the selected corrective measures and the implementation of these restoration measures.

GOALS FOR PROJECT

The water quality objectives are dictated by the necessity to protect the natural water courses and lakes from further pollution and contamination by human activities. The primary goal of the South Dakota Statewide "208" Water Quality Management Plan is to improve and maintain water quality for the maximum beneficial uses by present and future generations of South Dakotans. The objectives to achieve this goal are as follows:

- To eliminate or reduce underground seepage from septic tank systems into the lakes and watersources within the watershed.
- To prevent contamination of underground water supplies by infiltration of wastewater effluents.
- To eliminate or reduce above ground accumulations of unabsorbed effluents, plant nutrients or other pollutants which ultimately are washed into the streams and lakes.
- To eliminate or reduce erosion caused by human activities which are contributing sediments to the streams and lakes.
- To restore and improve the water quality of Stockade Lake by the elimination or reduction of pollutants presently in the lake.
- To increase recreational opportunities and economic benefits to the area.

PROJECT DESCRIPTION

Stockade Lake is a 131-acre lake with an average depth of 19 feet. It has a hydraulic retention time of 274 days which is a long retention time for a small lake and does not permit flushing out of the nutrients which cause a heavy growth of algae in it. The volume of water in the lake is 811,000,000 gallons.

The watershed area includes French Creek and its tributaries, named above, in a 28 square-mile

HOW CAN WE HELP?

First of all, keep informed of the environmental issues and problems concerning Stockade Lake and its watershed.

Identify and correct malfunctioning septic tank systems. Do not over-fertilize lawns, gardens or croplands.

Properly dispose of litter, garbage and other wastes. Do not dump soil, debris or agricultural wastes adjacent to creeks or within the flood plain.

For washing clothes, use detergents and cleaning agents that are phosphate-free. Limit dishwaher detergents to those with less than 8.8% phosphates. (The phosphate content is indicated on the label)

Minimize soil disturbing activities and livestock concentrations adjacent to streams and lakes.

STOCKADE LAKE PROJECT

CAC-TAC MEETINGS

NOV 24 1981

TAC Date	CAC Date	PURPOSE
9/17/80	9/17/80	Organizational Structure, TAC & CAC Duties Election of officers, discuss tentative Work Plan including need for a brochure and slide show
10/15/80	10/16/80	Commitee reports of pollution and erosion sources, Questions re. tentative Work Plan
11/12/80	11/19/80	Revise work plan - Brochure review, Conceptual plan - comments or recommendations Prioritize pollution sources, slide show
12/19/80	12/19/80	Showing of slides/tape - Brochure reviewed and report of dispersing same Comments on approach of Conceptual Plan - Publicity prepared - Journal etc.
12/3/80	12/3/80	Final decision on layout and content of brochure - Prioritize pollution problems List possible corrective measures on treatments
1/14/81		Sediment Survey results - slide show narrative work - Review preliminary mapping of sources of pollution - Explore funding sources - Recommend individual projects for implementation
	1/22/81	Slide show, titles & narrative changes. Projects recommended for implementation by TAC. Reviewed funding sources as listed in State "208" plan.
2/18/81	2/18/81	Public Relations Efforts - Nitrogen & phosphorus levels established by GF&P Review of plan of action. RC&D "Critical Funds" discussed - fill out application Slide show review - Sediment survey - waiting for results from lab.
3/18/81	3/19/81	Baseline data for the lake - Results of sediment survey. Funding sources & outlook - Preliminary mapping of alternative treatments. (Review & recommendations)
4/15/81	4/22/81	Landowner contacts - Public meeting proposal, format of Public meeting Final results of sediment survey - RC&D Application. Septic tank survey - Status report of landowner contacts. Report of Tech. Assistance available. Conceptual Plan (Preliminary analysis & screening of alternatives by TAC
5/11/81	5/11/81	Public meeting for citizen input RC&D ID team reveiwed (field exam) slide show.
6/17/81	6/17/81	Joint meeting to decide final recommended course of action and discuss Public mtg. Review of Conceptual Plan - Discussed potential of using sediments as fertilizer

STOCKADE LAKE PROJECT

CAC-TAC MEETINGS (continued)

TAC Date	CAC Date	PURPOSE
7/1/81	7/1/81	Discussion on joint meeting 6/17 - Forest Service - Bismarck Lake drainage discussed. Getting local citizens behind project Review final draft Report on RC&D field exam Look at wetlands system Follow up of sediment analysis
9/3/81	9/3/81	Review draft addendum to Work Plan Sediment sampling with DWNR, CSP, Co. Agent & FS Conceptual Plan revisions Biomanipulation research w/Dr. Haertel Letter to make recommendations on proposed placer operation

Appendix C1.

Soil Conservation Service Study

SECTION 208 - WATER QUALITY STUDY AREAS

SOIL EROSION AND SEDIMENT YIELD STUDY

IN

STOCKADE LAKE WATERSHED

CUSTER COUNTY, SOUTH DAKOTA

SOIL CONSERVATION SERVICE
U. S. DEPARTMENT OF AGRICULTURE
HURON, SOUTH DAKOTA

ASSISTED BY
SOUTH DAKOTA DEPARTMENT OF WATER AND NATURAL RESOURCES
PIERRE, SOUTH DAKOTA

February 1981

SOIL EROSION AND SEDIMENT YIELD

IN

STOCKADE LAKE WATER QUALITY STUDY AREA

IN

CUSTER COUNTY, SOUTH DAKOTA

Introduction

Intense use of our natural resources over the years has caused a general deterioration of our environment. Some of our air, soil, and water resources have become polluted. Increased public awareness of this situation helped to bring about the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500). Section 208 of P.L. 92-500 addresses water pollution problems as it calls for management practices "...(to) be developed and implemented to assure adequate control of sources of pollutants in each state."

The South Dakota Department of water and Natural Resources has responsibility for formulating a section 208 water quality management plan for South Dakota. The watershed was one of six selected in 1980 for study to facilitate formulation of the plan. (See Figure 1.)

It is generally thought that sediment and nutrients are the principal pollutants in South Dakota lakes and streams. 1/, 2/, 3/

This report outlines more detailed information on soil erosion, sediment sources and quantities, management practices to control sediment, and costs for those practices. This information was developed by the Soil Conservation Service (SCS) for the South Dakota Department of Water and Natural Resources.

1/ Mathew, F.L., "Water Pollution in South Dakota, Part I: Natural Water Quality and Pollution Sources," 1970, South Dakota Water Resources Institute, South Dakota State University, Brookings, South Dakota, 34 pages.

2/ "Development Components of the South Dakota Water Plan, Volume II-B" 1977, Division of Resources Management, South Dakota Department of Water and Natural Resources, Pierre, South Dakota.

3/ "A plan for the Classification-Preservation-Restoration of Lakes in Northeastern South Dakota" 1977, State Lakes Preservation Committee, State of South Dakota and the Old West Regional Commission, Pierre, South Dakota.

Summary

This study has determined relative percentages of erosion and sediment yield from forestland, grassland, gullies, streambanks, and other sources. The Universal Soil Loss Equation and direct volume methods were used to estimate gross erosion which was multiplied by estimated sediment delivery ratios developed by watershed shape analysis 1/ to obtain estimated sediment yields.

Sediment was determined to be a pollutant in the Stockade Lake Water Quality Study Area (WQSA). Best management practices (BMP's) for this state section 208 water quality management plan thus became those management practices that reduced sediment yield.

A review of the Technical Guide for South Dakota (available at offices of the Soil Conservation Service) indicated soil and water conservation practices (management practices) that are potential BMP's. The relationships between runoff, sediment yield, and management practices, were outlined and, coupled with views of SCS district conservationists, a number of BMP's were selected for the WQSA. Costs for BMP's were generally abstrated from the SCS Cost-Return Handbook.

No quantification of reductions in sediment yield due to application of BMP's was attempted. The reasons for this are twofold:
1. The technical data base was inadequate.
2. The potential combinations of BMP's were too great.

Definition and Outline of Study Methods

Erosion

Sheet erosion occurs as water flows overland and moves layers of soil particles loosened by raindrop impact. Rill erosion is movement of soil particles as overland flow concentrates into small channels, or rills, 2 to 12 inches deep. Soil particles are loosened in rills by shear force exerted on the bottom and banks of the rill by the channelized water. Bank sloughing, or miniature landslides, occur as the bottom and lower banks are eroded.

The Universal Soil Loss Equation (USLE), 2/, 3/ was used to estimate sheet and rill erosion in the WQSA's. SCS personnel familiar with each WQSA derived the data needed for the USLE from their field experience, Section III of the South Dakota Technical Guide and detailed soils maps.

1/ "Sediment yield was Gross Erosion in Minnesota" by O.M. Finkelson, Geologist, SCS, St. Paul, Minnesota 1978.

2/ Wischmeir, W.H., and Smith, D.D., "Prediction Rainfall Erosion Looses, A Guide to Conservation Planning", Agricultural Handbook, No. 537, December 1978, Science & Education Administration.

3/ "Estimating Soil Loss Resulting from Water and Wind Erosion in South Dakota," June 1977, South Dakota Technical Guide III-1, USDA, SCS, Huron, South Dakota.

Sheet and rill erosion from construction sites, roads and roadbanks was estimated using a direct volume method (multiplying the area of erosion by an estimated rate of erosion and the volume weight of the eroding soil. 1/ Sample areas were observed in each WQSA and county highway maps were used to expand the sample data.

Gully and streambank erosion is soil moved by water flowing in channels that are greater than 12 inches deep. The mechanisms of loosening and moving soil particles are the same as in rill erosion except for the larger scale. Lake shore erosion occurs as wave action loosens and moves soil particles. The direct volume method was used to estimate gully, streambank, and lake shore erosion. The effects of ice were also considered in the erosion rate. Sample areas were observed in each WQSA and aerial photographs were used to expand the sample data.

Sediment Yield

Sediment yield is the amount of soil removed from a drainage basin. 2/, 3/ It is measured (or estimated) at a point at a stream channel cross section and only represents a fraction of the total soil eroded in the basin above that point.

In this study, gross erosion was estimated and then multiplied by an estimated sediment delivery ratio to obtain sediment yield. This ratio is expressed as a percent and represents the amount of soil removed from a watershed (sediment) divided by the amount of soil moved in the watershed (erosion). It is thus inversely proportional to the amount of deposition occurring between points of erosion and the point where sediment yield is measured.

Many factors affect sediment yield - watershed size, shape, hydrology, channel density, land use, vegetative cover, geology and topography, soil structure, texture, and permeability. The interaction between all of these factors was subjectively analyzed after a delivery ratio was selected from a drainage area versus delivery ratio curve. This analysis resulted in raising or lowering the curve ratio and the adjusted ratio was used to estimate sediment yield from all sources of sheet and rill erosion. Much higher ratios were used to estimate sediment yield from gully, streambank, and lakeshore erosion.

1/ Method is outlined in the "Erosion and Sediment Inventory Handbook," USDA-SCS, Syracuse, New York (1972) and in "Guide to Sedimentation Investigations," Technical Guide 12, South Technical Service Center, USDA-SCS, Fort Worth, Texas (1976).

2/ "Sedimentation," 1975 National Engineering Handbook, Section 3, USDA, SCS, Washington, D.C.

3/ "Predicting Sediment Yields," in "Proceedings of the National Symposium on Soil Erosion and Sedimentation by Water," 1977, American Society of Agricultural Engineers, Publication 4-77, St. Joseph, Michigan.

Best Management Practices

The Environmental Protection Agency (EPA) has defined best management practices, as published in the Federal Register, as follows:

> "The term, best management practices (BMP), means a practice, or combination of practices, that is determined by a State (or designated areawide planning agency) after problem assessment, examination of alternative practices, and appropriate public participation to be the most effective, practicable (including technological, economic, and institutional considerations) means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality goals (40 CFR Part 130)."

Thus best management practices in section 208 water quality management plans are primarily those management practices that are believed to have a beneficial impact on water quality. 1/ Since sediment yield affects water quality adversely in these study areas, management practices that reduce sediment yield will be BMP's. Best management practices were selected from Section III of the South Dakota Technical Guide and costs were taken from the SCS Cost-Return Handbook.

Narrative Comments

The Soil Conservation Service completed a study of the Stockade Lake Watershed. The purpose of this study was to identify the water erosion and sedimentation problems relative to Stockade Lake which is located 3 miles east of Custer, South Dakota. The watershed was divided into two sub-areas. Studies showed that the larger sub-area was contributing little or no sediment to Stockade Lake. All of the sediment entering the lake was from the area within the dashed line (see watershed map).

Table 1 shows the present "Land Uses and Estimated Acres Needing Treatment" of the Stockade Lake Watershed Area. Figures are given for each sub-area and a total for watershed. Stockade Lake Watershed contains 47,930 acres. Figures are given for the following uses: forestland, grassland (both tame and native included), farmsteads, and urban, and non-sediment contributing areas. Estimated acres are listed for acres adequately treated, and acres needing treatment with recommended Best Management Practices (conservation practices) which will contribute to water quality improvement as well as erosion control on the land in the watershed area.

1/ "Environmental Impact of Land Use on Water Quality, Final Report on the Black Creek Project (Summary," 1977, U.S. Environmental Protection Agency 905/9-77-007-A, Great Lakes National Program Office, Chicago, Illinois.

Narrative Comments (cont.)

Table 2 - "Soil Erosion and Sediment Yield Estimates" lists erosion and sediment yield information. The figures are given by sub-areas. They are further broken down by land use, sheet and rill erosion, and other erosion and sediment yields. A final total column shows estimated total tons of sediment per year for the watershed.

This study contains no "Sheet and Rill Erosion Map", since there is no land in the watershed which has over 5 tons per acre per year soil losses.

No figures were developed showing the extent of soil losses from erosion by wind. It was felt that there is no significant wind erosion in this watershed.

Table 3 - "Estimates of Best Management Practices (Conservation Practices and Measures) needed for Land Adequately Treated, Including Costs" shows the major land treatment needed in this watershed area. The chart also shows estimated amounts and probable costs to get the land in this watershed "adequately treated". It must be kept in mind, that these are "Estimates" only, and that specific practices, and accurate amounts together with precise costs can only be obtained in a planning process with the owners and operators of each tract of land, based on their decisions on how each field is to be used and treated. This study does not show this sort of detailed information.

The information from Table 2 shows that the amount of sediment reaching Stockade Lake is relatively small. The major problem with water quality in this lake may be pollution from an inadequate city sewer system, or from a lack of adequate sewer systems properly serving this entire area around Custer and Stockade Lake, or both. This potential source of pollution should be thoroughly investigated to determine the extent of this problem and recommendations made for the solution.

BEST MANAGEMENT PRACTICES (Conservation Practices and Measures) 1/ 2/ 3/

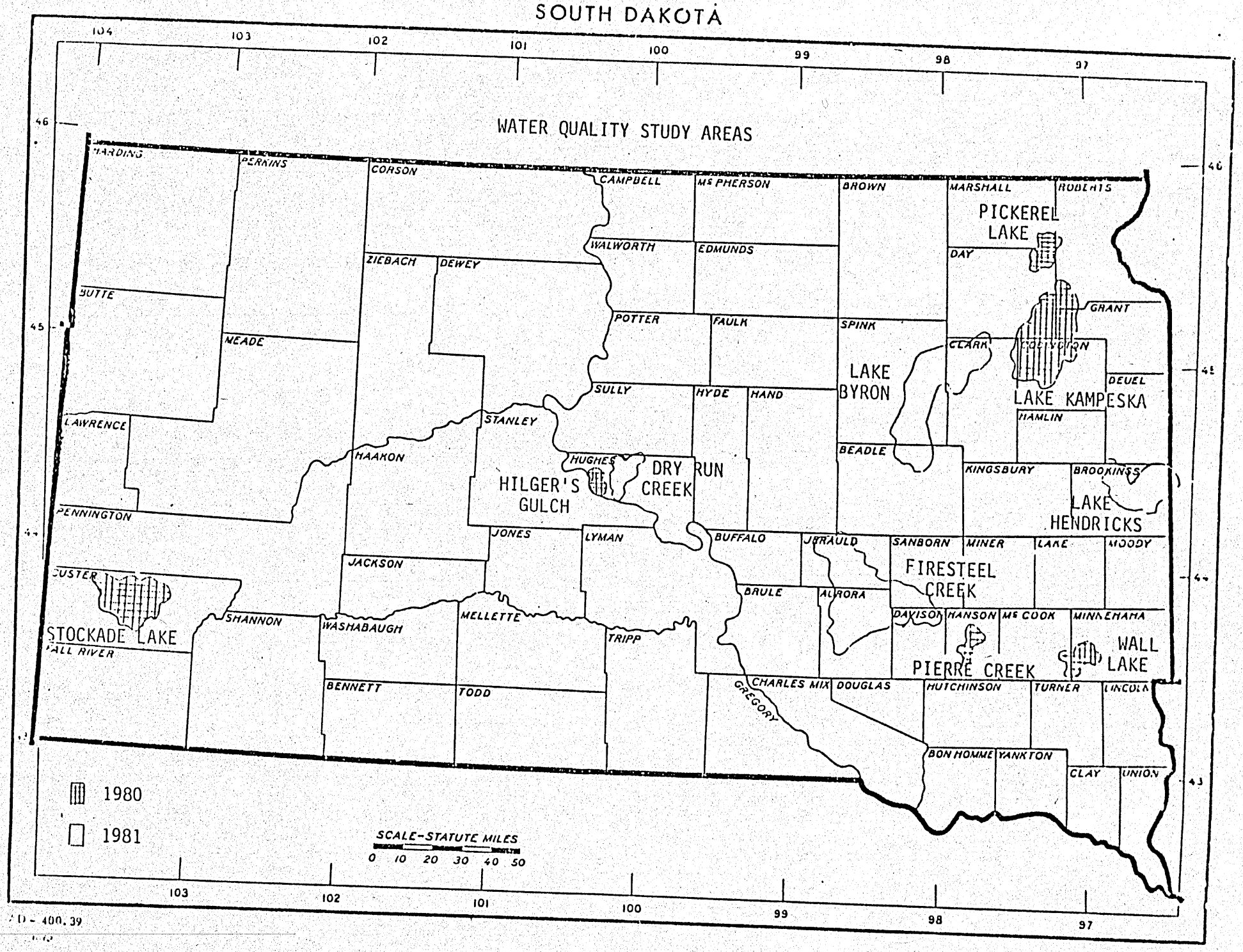
STOCKADE LAKE WATERSHED AREA

Conservation Practices	Unit	Unit Cost 4/	Non-Sediment Contributing Area		Sediment Contributing Area		Total Watershed	
			Amount Needed	Cost	Amount Needed	Cost	Amount Needed	Cost
		(Dollars)		(Dollars)		(Dollars)		(Dollars)
GRASSLAND - 11,000 ACRES								
Proper Grazing Use	acres	-	8,275	-	2,725	-	11,000	-
Pasture & Hayland Planting	acres	20	140	2,800	60	1,200	200	4,000
Deferred Hayland Planting	acres	-	1,160	-	540	-	1,700	-
Planned Grazing Systems	acres	-	1,440	-	760	-	2,200	-
Livestock Water Stations	No.	1,000	3	3,000	2	2,000	5	5,000
Pasture & Hayland Management	acres	-	400	-	200	-	600	-
Waste Management Systems	No.	1,000	1	1,000	1	1,000	2	2,000
WOODLAND - 26,085 ACRES								
Livestock Exclusion (Fencing)	rods	5	2,000	10,000	1,200	6,000	3,200	16,000
Proper Grazing Use	acres	-	3,400	-	1,800	-	5,200	-
Access Roads	feet	7	10,560	73,920	5,280	36,960	15,840	110,880
Heavy Use Area Protection	acres	200	500	100,000	500	100,000	1,000	200,000
Grade Stabilization Structures	No.	1,000	4	4,000	6	6,000	10	10,000
Diversions	No.	1,000	-	-	2	2,000	2	2,000
Critical Area Planting	acres	200	2	400	3	600	5	1,000
Grass Filter Strip	acres	200	3	600	2	400	5	1,000
Woodland Improvement	acres	66	3,900	257,400	2,100	138,600	6,000	396,000
Tree Planting	acres	350	4	1,400	6	2,100	10	3,500
FARMSTEADS, URBAN & OTHER - 800 Acres								
Sediment Control Measures 5/	acres	2,000	3	6,000	12	24,000	15	30,000
TOTALS - Total Acres - 47,930 6/				460,520		320,860		781,380
								$16.30 per acre

1/ Needed to get "Land Adequately Treated."
2/ Refer to Soil Conservation Service Technical Guide for South Dakota 1981.
3/ On site investigation and planning are necessary to determine kinds, locations, sizes, extent & costs of practices (BMP's).
4/ Refer to Soil Conservation Service Cost-Return Handbook for South Dakota 1981.
5/ Examples of measures are: cover and green manure crop, filter strips, lined and grassed waterways, diversions, mulching, sediment basins, streambank protection, and critical area planting.
6/ Includes 10,045 acres of non-sediment producing land.

FIGURE 1

SOUTH DAKOTA



AD - 400.39

LAND USE AND ESTIMATED ACRES NEEDING TREATMENT
STOCKADE LAKE WATERSHED AREA

WQSA or SUBWATERSHEDS	LAND USE (Acres) and TREATMENT (Acres and Percent)											
	CROPLAND		GRASSLAND		WOODLAND		FARMSTEAD AND URBAN		NON SEDIMENT CONTRIBUTING		TOTAL	
	AC	%	AC	%	AC	%	AC	%	AC	%	AC	%
Non-sediment Contributing Area	-	-	8,275	100	20,611	100	60	100	7,786 1/	100	36,732	-
Adequately Treated	-	-	6,620	80	16,489	80	54	90	7,786	100	30,949	-
Needs Treatment	-	-	1,655	20	4,122	20	6	10	0	-	5,783	
Sediment Contributing Area	-	-	2,725	100	5,474	100	740	100	2,259 2/	100	11,198	-
Adequately Treated	-	-	2,180	80	4,379	80	666	90	2,259	100	9,484	-
Needs Treatment	-	-	545	20	1,095	20	74	10	0	-	1,714	-
TOTAL FOR WATERSHED	-	-	11,000	100	26,085	100	800	100	10,045	100	47,930	-
Adequately Treated	-	-	8,800	80	20,868	80	720	90	10,045	100	40,433	-
Needs Treatment	-	-	2,200	20	5,217	20	80	10	0	-	7,497	-

1/ Rock outcrop
2/ Rock outcrop and Stockade Lake (130 acres)

United States
Department of
Agriculture

Soil
Conservation
Service

Federal Building
200 Fourth Street S. W.
Huron, South Dakota 57350

May 21, 1981

Mr. Herbert R. Davis
Soil Conservationist
Department of Water and
Natural Resources
Joe Foss Building
Pierre, South Dakota 57501

Dear Herb,

Enclosed you find a copy of James Hyland's comments on the review of Stockade Lake sediment survey and a copy of Section 3, Sedimentation, Chapters 1, 2, and 7, of the National Engineering Handbook (on reservoir sediment surveying).

Sincerely,

Lawrence M. Nieman acting

R. D. Swenson
State Conservationist

Enclosures

cc: Lawrence Nieman, ASC, SCS, Huron (w/survey)
Ralph Stensland, Conservation Agronomist, SCS, Huron (w/survey)
James Hyland, Geologist, SCS, Huron (w/survey)

The following are my thoughts from a brief review of the sediment survey data Herb Davis, Department of Water and Natural Resources, sent me:

1. The sediment survey of 1972, sediment delivered "from mid 1930's to early 1972 is 117,000 cubic yards or approximately 3,250 cubic yards per year." This is approximately 2 ac.ft/yr.

2. The sediment survey of 1981 addresses the sediment deposited in the inlet of Stockade Lake "37,000 cubic yards." This would be 84 percent of the total (44,000 cu yd) for Stockade and Bismark Lakes.
   84% of 4,890 cu.yd/yr = 5,821 cu.yd/yr = 3.6 ac.ft/yr.
   37,000 cu.yd ÷ 9 yr. = 2.6 ac.ft/yr.

   My sediment calculations were for sediment delivered to Stockade Lake for the contributing area. The drainage area above Bismark Lake was considered as non-contributing to Stockade Lake due to the very high trap efficiency of Bismark Lake.

3. I'm not sure if the jump from 2 ac.ft/yr (1972 survey) to 2.6 ac.ft/yr can be attributed to the high flow of 1972 or not. It is possible and I would tend to believe it due to two things. One is from observations of erosion which occurred during the '72 flood and two is that I believe the conservation management of the forest land in the last ten years has been more effective in controlling erosion than during the earlier years and thus should show a decrease in sediment delivered. This would indicate some unusual event had occurred. A major event could be a "building boom" as well as a flood but I do not believe this has been the case to the extent it would provide the additional sediment measured.

4. There is also the fact that since we are working with a much shorter period of time the effect of a single event will have more influence than it would have over a longer period of time.

5. Sediment Contributing Area to Stockade Lake = 11,198 ac. = 17.5 mi^2

   Sediment Contributing Area to Bismark Lake = 4 mi^2

   Sediment contributing drainage area of Bismark is approximately 20 percent of that of Stockade. The sediment measured in the inlet of Bismark is approximately 20 percent of that of Stockade. This is closer than I would expect since the delivery ratio on the smaller drainage areas should be higher than on the larger contributing area, other factors being equal. Here is the rub. The other factors are not equal. The sediment contributing drainage area of Bismark has a much higher percent of forest land than Stockade's contributing area has. Public to private land ratio is different between the two. Development and use of the two areas is different. The list can go on and on; i.e, stream density, watershed shape, roads, etc.

6. It does not surprise me to see measured sediment volumes in a lake considerably different than the estimated sediment delivery using a mixture of estimating procedures. The variety is too extensive to discuss in this correspondence. We need a couple of hours to discuss them. I would be happy to do this at our next meeting if you feel it will be useful. At best, using the estimating procedures available in the study of Stockade Lake, I would say we are fortunate to be in the same order of magnitude.

   Reservoir sediment surveys have been conducted for years and the SCS has adopted a set of standards for conducting these surveys. These are based upon experience and considerable study. I am including a copy of the National Engineering Handbook Section 3, which covers these standards for your consideration. I do not know whether varying from these will give a bigger or lower total sediment volume.

7. If the sediment density is not corrected for bulking due to submergence, one can not relate the volume measured in the pool to a volume produced (erosion) per square mile in the sediment contributing drainage area. A cubic foot of sediment deposited in a position above the pool can be equal to 1.5 cubic feet of the same material in the pool if the unit weight of the dry sediment is 90 lbs/cu.ft. and the submerged unit weight is 60 lbs/cu.ft. The only way to know what this ratio is, is to to actually measure the in-place density of the two conditions. This is done either manually by sampling and weighing or by the use of geophysical nuclear density meter.

   If the aerated sediment weighs 90 lbs/cu.ft. and the same material weighs 60 lbs/cu.ft., the 6.97 ac.ft/yr. measured in the pool would be 4.6 ac.ft/yr. or 7,421 cu.yd/yr. The average submerged sediment can be more or less than 60 lbs/cu.ft. This has been used only as an illustration.

I will be available to discuss these things with you further at our next meeting.

James B. Hyland

James B. Hyland
Geologist
Soil Conservation Service

Appendix C2.

Black Hills Conservancy Sub-District
Sedimentation Study for Stockade Lake



COMPREHENSIVE WATER QUALITY MANAGEMENT PLAN FOR THE BLACK HILLS REGION

APPENDIX A

LAKE MANAGEMENT DATA

OCTOBER, 1973

PREPARED BY
BLACK HILLS CONSERVANCY SUB-DISTRICT
RAPID CITY, SOUTH DAKOTA

TABLE 57 BACTERIOLOGICAL DATA FOR Stockade Lake

SAMPLING AGENCY SOUTH DAKOTA HEALTH DEPARTMENT YEAR SAMPLED 1971

SAMPLE LOCATION	MAY		JUNE		JULY		SEPTEMBER	
	FC #/100 ml	FS #/100 ml	FC #/100 ml	FS #/100 ml	FC #/100 ml	FS #/100 ml	FC #/100 ml	FS #/100 ml
By Swimming Beach	6	24	20	4	3	4	3	4

TABLE 56 WATER QUALITY DATA FOR Stockade Lake - B

SAMPLING AGENCY BLACK HILLS CONSERVANCY SUB-DISTRICT STATION Shallow Station - See Figure 62
LATITUDE 43 46 02 LONGITUDE 103 31 33 STATION CODE SKL-B

PARAMETER			DATE AND SAMPLE DEPTH				
STORET NUMBER	NAME	UNITS	2/12/72 Composite	2/12/72 5 feet			
00010	Water temperature	°C		4			
00095	Conductivity @ 25°C	µmhos/cm		232			
00300	Dissolved oxygen	mg/l		3.4			
00077	Transparency--Secchi Disk	in.					
00500	Residue--total	mg/l	208				
00505	Residue--total volatile	mg/l	78				
00515	Residue--filtrable	mg/l	202				
00520	Residue--volatile filtrable	mg/l	76				
00530	Residue--non-filtrable	mg/l	6				
00535	Residue--volatile non-filt.	mg/l	2				
00070	Turbidity	Jtu	8				
00900	Hardness--total as $CaCO_3$	mg/l	127				
00901	Hardness--Carbonate as $CaCO_3$	mg/l	127				
00902	Hardness--Non-carb. as $CaCO_3$	mg/l	0				
00915	Calcium as Ca	mg/l	33				
00925	Magnesium as Mg	mg/l	11				
00930	Sodium as Na	mg/l	13				
00935	Potassium as K	mg/l	6				
01045	Iron as Fe	µg/l	100				
01055	Manganese as Mn	µg/l	350				
00430	Alkalinity--Carbonate as $CaCO_3$	mg/l	0	0			
00410	Alkalinity--Total as $CaCO_3$	mg/l	136	118			
00940	Chloride as Cl	mg/l	11.5				
00945	Sulfate as SO_4	mg/l	14				
00955	Silica as SiO_2	mg/l	18				
01145	Selenium as Se	µg/l	0				
00400	pH		8.6	6.8			
00630	Nitrite plus nitrate as N	mg/l	0.34	2.25			
00660	Phosphate--Ortho as PO_4	mg/l	1.6	1.8			
00650	Phosphate--total as PO_4	mg/l	3.3	3.3			

TABLE 56 WATER QUALITY DATA FOR Stockade Lake - B

SAMPLING AGENCY BLACK HILLS CONSERVANCY SUB-DISTRICT STATION Shallow Station - See Figure 62
LATITUDE 43 46 02 LONGITUDE 103 31 33 STATION CODE SKL - B

PARAMETER			DATE AND SAMPLE DEPTH				
STORET NUMBER	NAME	UNITS	6/10/71 Composite	6/10/71 3 feet	6/10/71 7 feet	8/19/71 Composite Day/Night	8/19/71 5 feet Day/Night
00010	Water temperature	°C		19	14		22/21
00095	Conductivity @ 25°C	µmhos/cm		167	162		196/181
00300	Dissolved oxygen	mg/l		8.9	4.0		13.1/11.6
00077	Transparency--Secchi Disk	in.	36			37/	
00500	Residue--total	mg/l	196			188/178	
00505	Residue--total volatile	mg/l	72			90/78	
00515	Residue--filtrable	mg/l	118			182/172	
00520	Residue--volatile filtrable	mg/l	54			84/78	
00530	Residue--non-filtrable	mg/l	78			6/6	
00535	Residue--volatile non-filt.	mg/l	18			6/0	
00070	Turbidity	Jtu	59			22/26	
00900	Hardness--total as $CaCO_3$	mg/l	77			94/98	
00901	Hardness--Carbonate as $CaCO_3$	mg/l	77			94/84	
00902	Hardness--Non-carb. as $CaCO_3$	mg/l	0			0/14	
00915	Calcium as Ca	mg/l	21			28/27	
00925	Magnesium as Mg	mg/l	6			6/8	
00930	Sodium as Na	mg/l	7			4/4	
00935	Potassium as K	mg/l	4			6/6	
01045	Iron as Fe	µg/l	270			16/6	
01055	Manganese as Mn	µg/l	130			0/50	
00430	Alkalinity--Carbonate as $CaCO_3$	mg/l	0	0	0	0/0	38/38
00410	Alkalinity--Total as $CaCO_3$	mg/l	80	64	64	104/84	90/88
00940	Chloride as Cl	mg/l	17.5			8/8	
00945	Sulfate as SO_4	mg/l	17			13/12	
00955	Silica as SiO_2	mg/l	8			13/14	
01145	Selenium as Se	µg/l	0			20/10	
00400	pH		7.5	8.3	7.2	8.5/8.4	9.8/9.6
00630	Nitrite plus nitrate as N	mg/l	2.4	0.2	0.6	0.77/0.95	1.0/1.0
00660	Phosphate--Ortho as PO_4	mg/l	0.9	0.3	0.7	1.3/1.4	1.3/1.3
00650	Phosphate--total as PO_4	mg/l	1.4	1.5	1.9	2.6/2.6	2.6/2.7

TABLE 56 WATER QUALITY DATA FOR Stockade Lake - A

SAMPLING AGENCY BLACK HILLS CONSERVANCY SUB-DISTRICT STATION Deep Station - Off dam face
LATITUDE 43 45 57 LONGITUDE 103 30 47 STATION CODE SKL - A

PARAMETER			DATE AND SAMPLE DEPTH				
STORET NUMBER	NAME	UNITS	8/19/71 Composite Day/Night	8/19/71 5 feet Day/Night	8/19/71 10 feet Day/Night	8/19/71 25 feet Day/Night	
00010	Water temperature	°C		21/21	19/19	12/12	
00095	Conductivity @ 25°C	µmhos/cm		192/200	201/232	232/264	
00300	Dissolved oxygen	mg/l		13.7/11.7	2.5/3.2	0/0	
00077	Transparency--Secchi Disk	in.	36/				
00500	Residue--total	mg/l	278/238				
00505	Residue--total volatile	mg/l	168/92				
00515	Residue--filtrable	mg/l	220/192				
00520	Residue--volatile filtrable	mg/l	116/86				
00530	Residue--non-filtrable	mg/l	58/46				
00535	Residue--volatile non-filt.	mg/l	52/6				
00070	Turbidity	Jtu	61/54				
00900	Hardness--total as $CaCO_3$	mg/l	102/98				
00901	Hardness--Carbonate as $CaCO_3$	mg/l	102/98				
00902	Hardness--Non-carb. as $CaCO_3$	mg/l	0/0				
00915	Calcium as Ca	mg/l	27/27				
00925	Magnesium as Mg	mg/l	9/8				
00930	Sodium as Na	mg/l	4/4				
00935	Potassium as K	mg/l	7/7				
01045	Iron as Fe	µg/l	11/11				
01055	Manganese as Mn	µg/l	0/90				
00430	Alkalinity--Carbonate as $CaCO_3$	mg/l	0/0	40/42	18/14	0/0	
00410	Alkalinity--Total as $CaCO_3$	mg/l	104/100	90/90	96/96	110/112	
00940	Chloride as Cl	mg/l	7/7				
00945	Sulfate as SO_4	mg/l	13/11				
00955	Silica as SiO_2	mg/l	15/14				
01145	Selenium as Se	µg/l	10/10				
00400	pH		8.5/8.3	9.6/9.6	8.7/8.6	6.7/6.8	
00630	Nitrite plus nitrate as N	mg/l	1.4/1.5	1.8/2.2	0.82/0.84	2.0/2.2	
00660	Phosphate--Ortho as PO_4	mg/l	3.5/3.5	1.2/1.2	1.4/1.3	3.7/3.6	
00650	Phosphate--total as PO_4	mg/l	4.4/4.9	2.3/2.6	2.6/4.2	5.1/5.1	

TABLE 56 WATER QUALITY DATA FOR Stockade Lake - A

SAMPLING AGENCY BLACK HILLS CONSERVANCY SUB-DISTRICT STATION Deep Station - Off dam face
LATITUDE 43 45 57 LONGITUDE 103 30 47 STATION CODE SKL - A

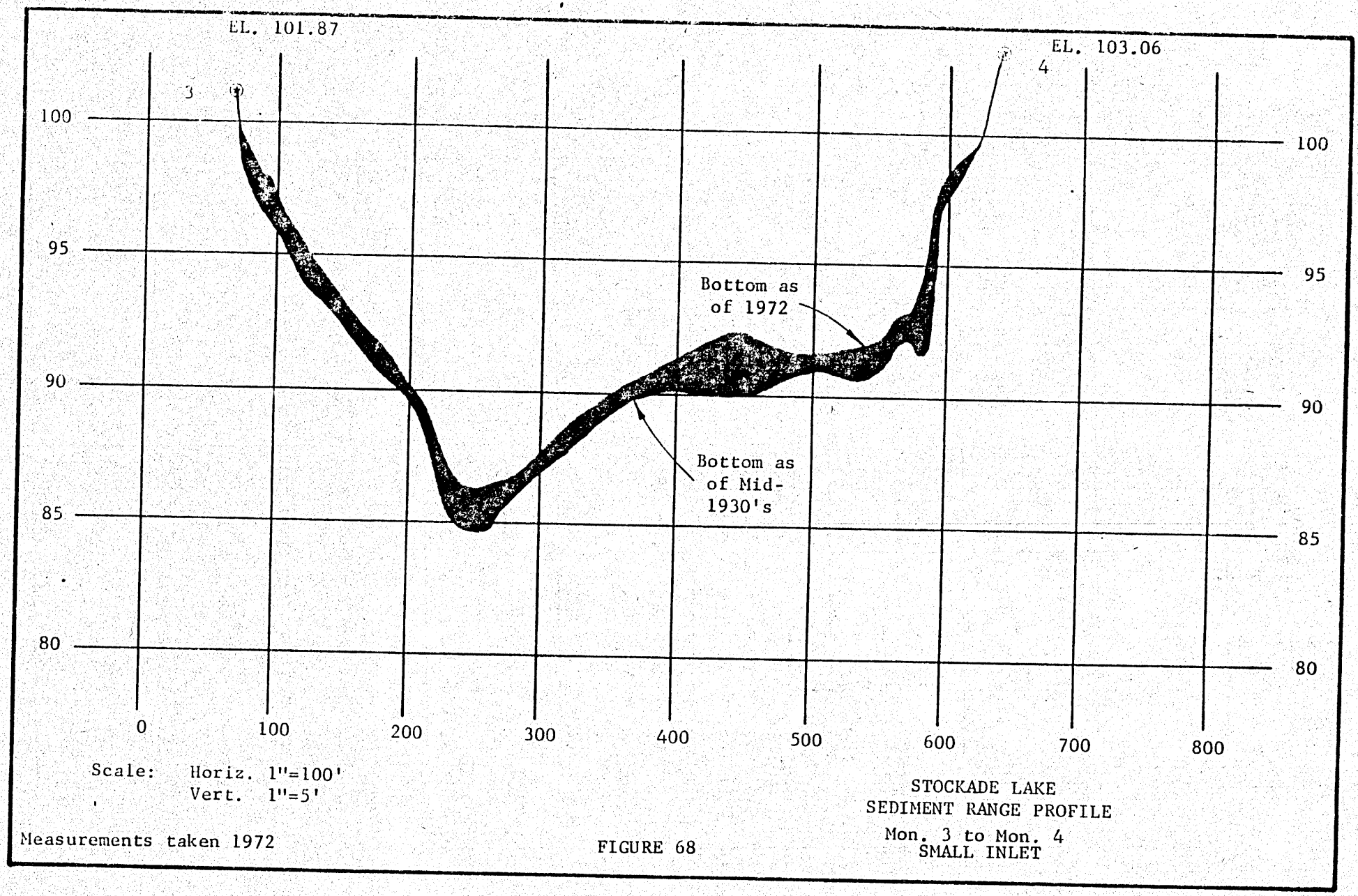
PARAMETER			DATE AND SAMPLE DEPTH				
STORET NUMBER	NAME	UNITS	6/10/71 Composite	6/10/71 5 feet	6/10/71 10 feet	6/10/71 30 feet	
00010	Water temperature	°C		16	12	6	
00095	Conductivity @ 25°C	µmhos/cm		192	217	439	
00300	Dissolved oxygen	mg/l		6.7	3.1	0	
00077	Transparency--Secchi Disk	in.	36				
00500	Residue--total	mg/l	172				
00505	Residue--total volatile	mg/l	64				
00515	Residue--filtrable	mg/l	152				
00520	Residue--volatile filtrable	mg/l	64				
00530	Residue--non-filtrable	mg/l	20				
00535	Residue--volatile non-filt.	mg/l	0				
00070	Turbidity	Jtu	49				
00900	Hardness--total as $CaCO_3$	mg/l	85				
00901	Hardness--Carbonate as $CaCO_3$	mg/l	32				
00902	Hardness--Non-carb. as $CaCO_3$	mg/l	53				
00915	Calcium as Ca	mg/l	24				
00925	Magnesium as Mg	mg/l	6				
00930	Sodium as Na	mg/l	10				
00935	Potassium as K	mg/l	6				
01045	Iron as Fe	µg/l	400				
01055	Manganese as Mn	µg/l	200				
00430	Alkalinity--Carbonate as $CaCO_3$	mg/l	0	0	0	0	
00410	Alkalinity--Total as $CaCO_3$	mg/l	32	62	66	130	
00940	Chloride as Cl	mg/l	40				
00945	Sulfate as SO_4	mg/l	18				
00955	Silica as SiO_2	mg/l	8				
01145	Selenium as Se	µg/l	10				
00400	pH		7.4	7.2	7.1	7.1	
00630	Nitrite plus nitrate as N	mg/l	2.8	0.7	0.4	1.4	
00660	Phosphate--Ortho as PO_4	mg/l	1.9	0.3	0.6	4.6	
00650	Phosphate--total as PO_4	mg/l	3.9	1.8	1.8	6.2	

TABLE 56 WATER QUALITY DATA FOR Stockade Lake - A

SAMPLING AGENCY BLACK HILLS CONSERVANCY SUB-DISTRICT STATION Deep Station - Off dam face

LATITUDE 43 45 57 LONGITUDE 103 30 47 STATION CODE SKL - A

PARAMETER			DATE AND SAMPLE DEPTH				
STORET NUMBER	NAME	UNITS	2/12/72 Composite	2/12/72 5 feet	2/12/72 15 feet	2/12/72 30 feet	
00010	Water temperature	°C		3	4	4	
00095	Conductivity @ 25°C	umhos/cm		290	290	351	
00300	Dissolved oxygen	mg/l		2.9	1.2	0	
00077	Transparency--Secchi Disk	in.					
00500	Residue--total	mg/l	--				
00505	Residue--total volatile	mg/l	218				
00515	Residue--filtrable	mg/l	--				
00520	Residue--volatile filtrable	mg/l	214				
00530	Residue--non-filtrable	mg/l	8				
00535	Residue--volatile non-filt.	mg/l	4				
00070	Turbidity	Jtu	16				
00900	Hardness--total as $CaCO_3$	mg/l	123				
00901	Hardness--Carbonate as $CaCO_3$	mg/l	123				
00902	Hardness--Non-carb. as $CaCO_3$	mg/l	0				
00915	Calcium as Ca	mg/l	33				
00925	Magnesium as Mg	mg/l	10				
00930	Sodium as Na	mg/l	15				
00935	Potassium as K	mg/l	6				
01045	Iron as Fe	µg/l	185				
01055	Manganese as Mn	µg/l	510				
00430	Alkalinity--Carbonate as $CaCO_3$	mg/l	0	0	0	0	
00410	Alkalinity--Total as $CaCO_3$	mg/l	140	118	116	138	
00940	Chloride as Cl	mg/l	13				
00945	Sulfate as SO_4	mg/l	15				
00955	Silica as SiO_2	mg/l	18				
01145	Selenium as Se	µg/l	10				
00400	pH		8.6	6.9	6.8	6.5	
00630	Nitrite plus nitrate as N	mg/l	0.25	1.95	1.9	3.15	
00660	Phosphate--Ortho as PO_4	mg/l	2.4	1.8	1.8	4.1	
00650	Phosphate--total as PO_4	mg/l	3.9	2.3	2.7	5.2	

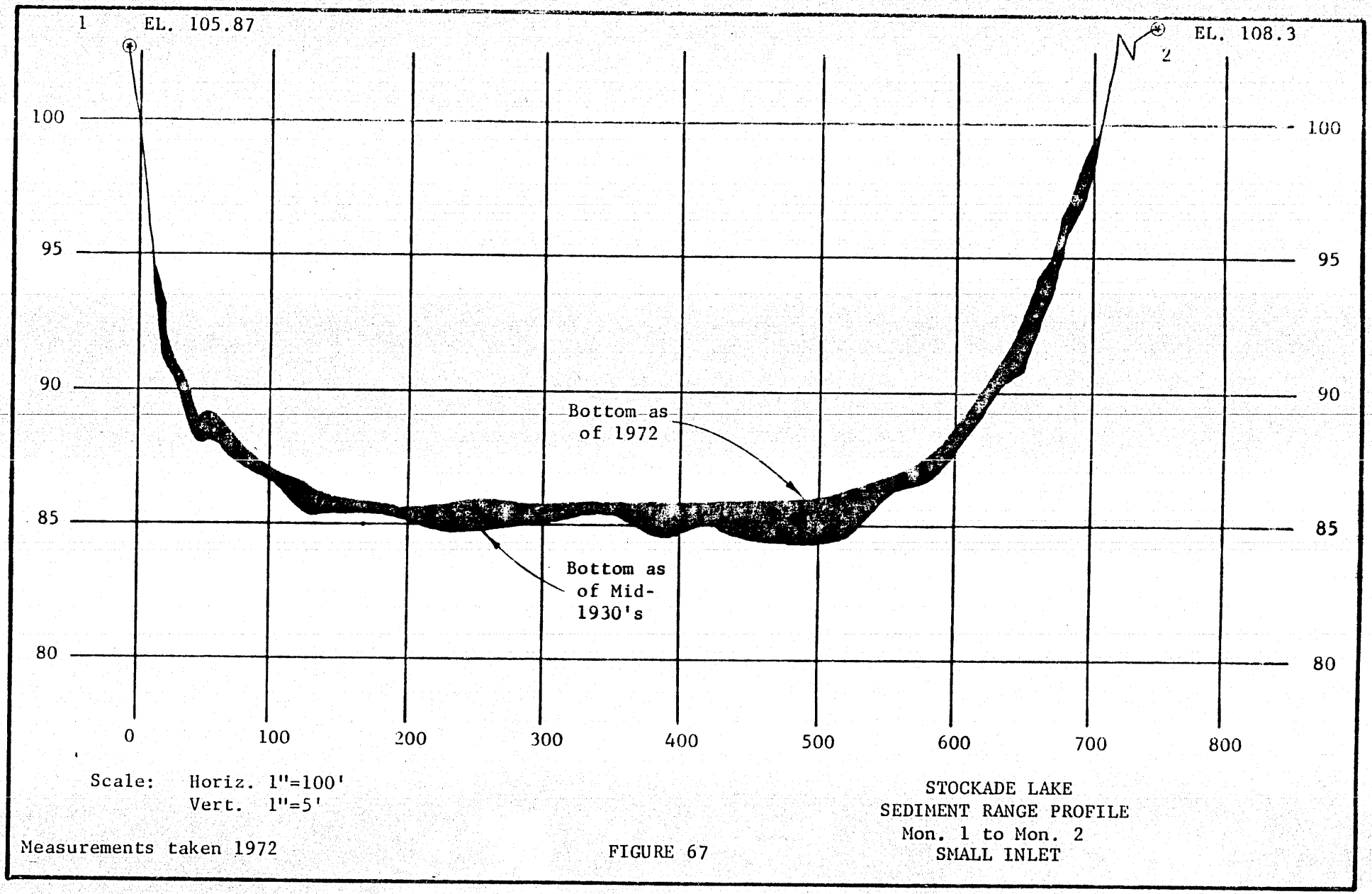


Scale: Horiz. 1"=100'
Vert. 1"=5'

Measurements taken 1972

FIGURE 68

STOCKADE LAKE
SEDIMENT RANGE PROFILE
Mon. 3 to Mon. 4
SMALL INLET



Scale: Horiz. 1"=100'
Vert. 1"=5'

Measurements taken 1972

FIGURE 67

STOCKADE LAKE
SEDIMENT RANGE PROFILE
Mon. 1 to Mon. 2
SMALL INLET

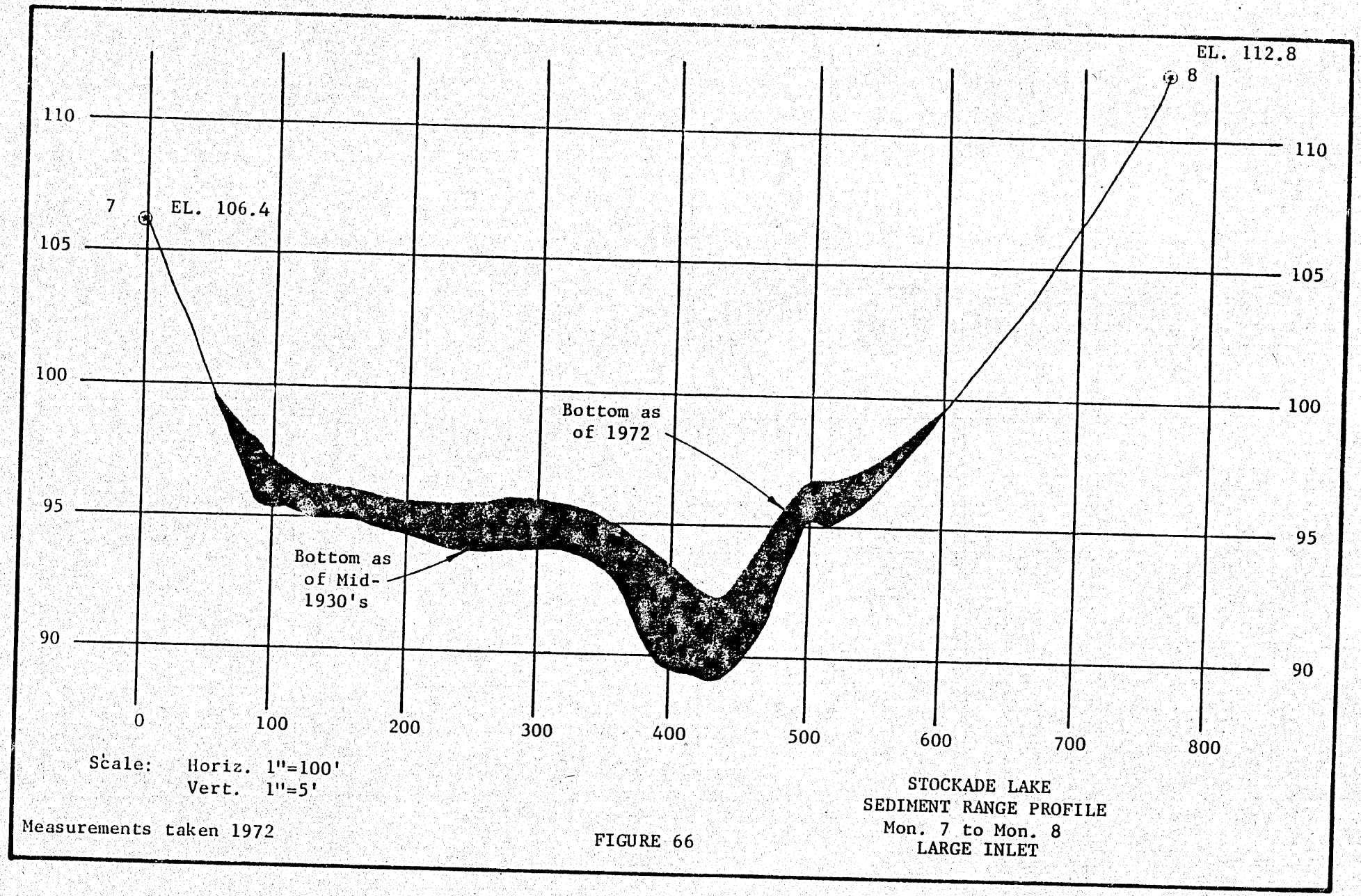
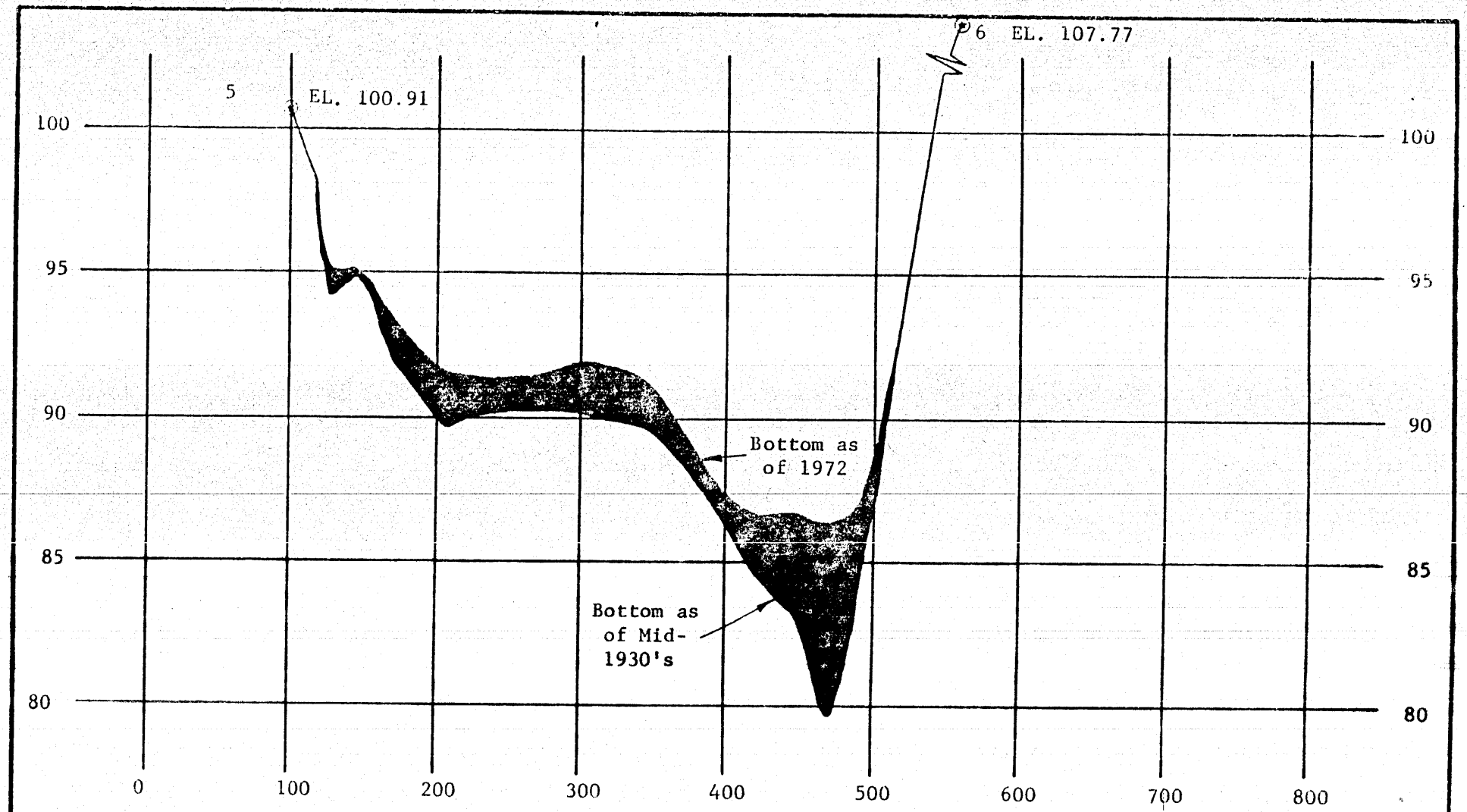


FIGURE 66

STOCKADE LAKE
SEDIMENT RANGE PROFILE
Mon. 7 to Mon. 8
LARGE INLET

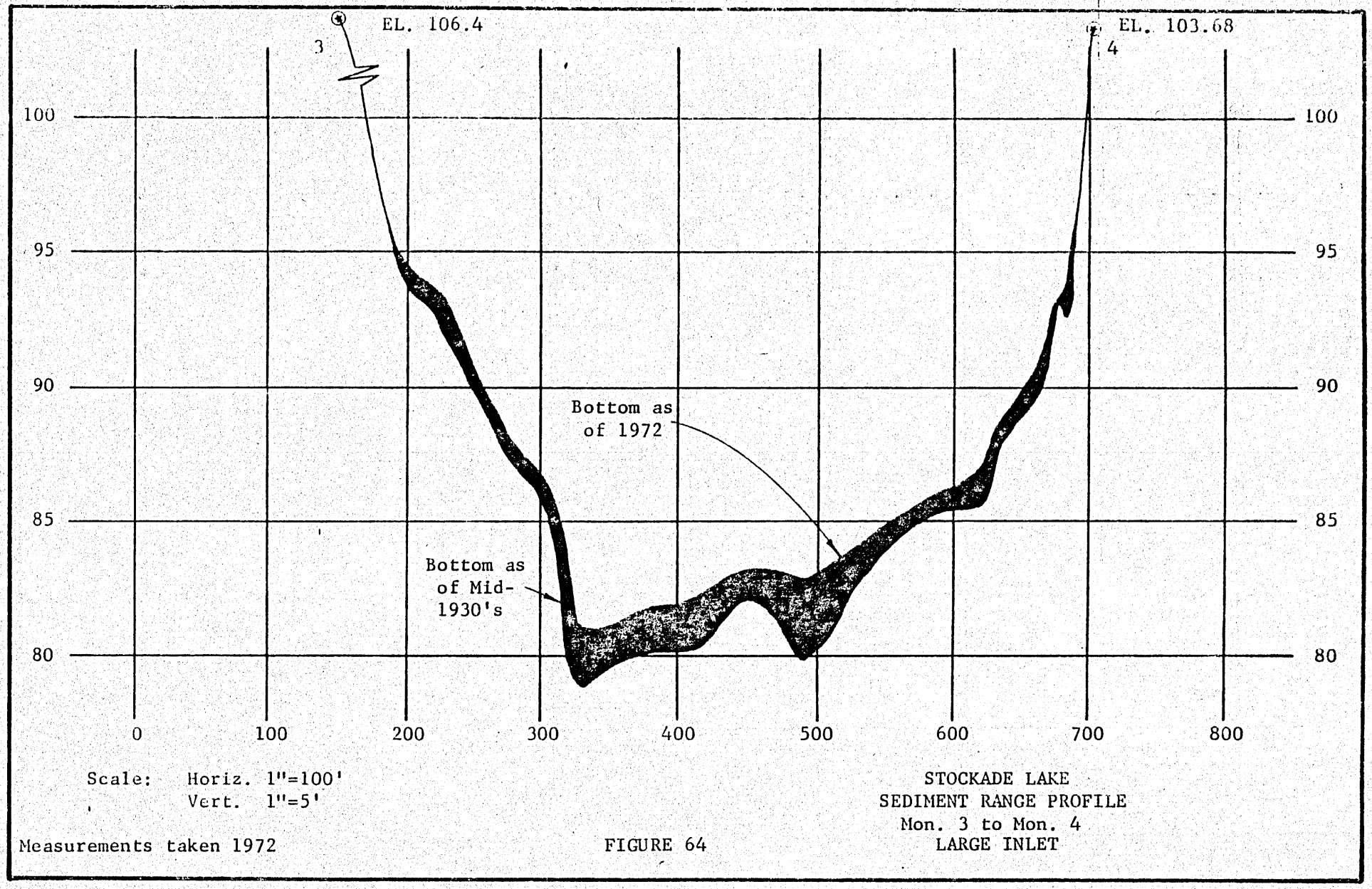


Scale: Horiz. 1"=100'
Vert. 1"=5'

Measurements taken 1972

FIGURE 65

STOCKADE LAKE
SEDIMENT RANGE PROFILE
Mon. 5 to Mon. 6
LARGE INLET



Scale: Horiz. 1"=100'
Vert. 1"=5'

Measurements taken 1972

FIGURE 64

STOCKADE LAKE
SEDIMENT RANGE PROFILE
Mon. 3 to Mon. 4
LARGE INLET

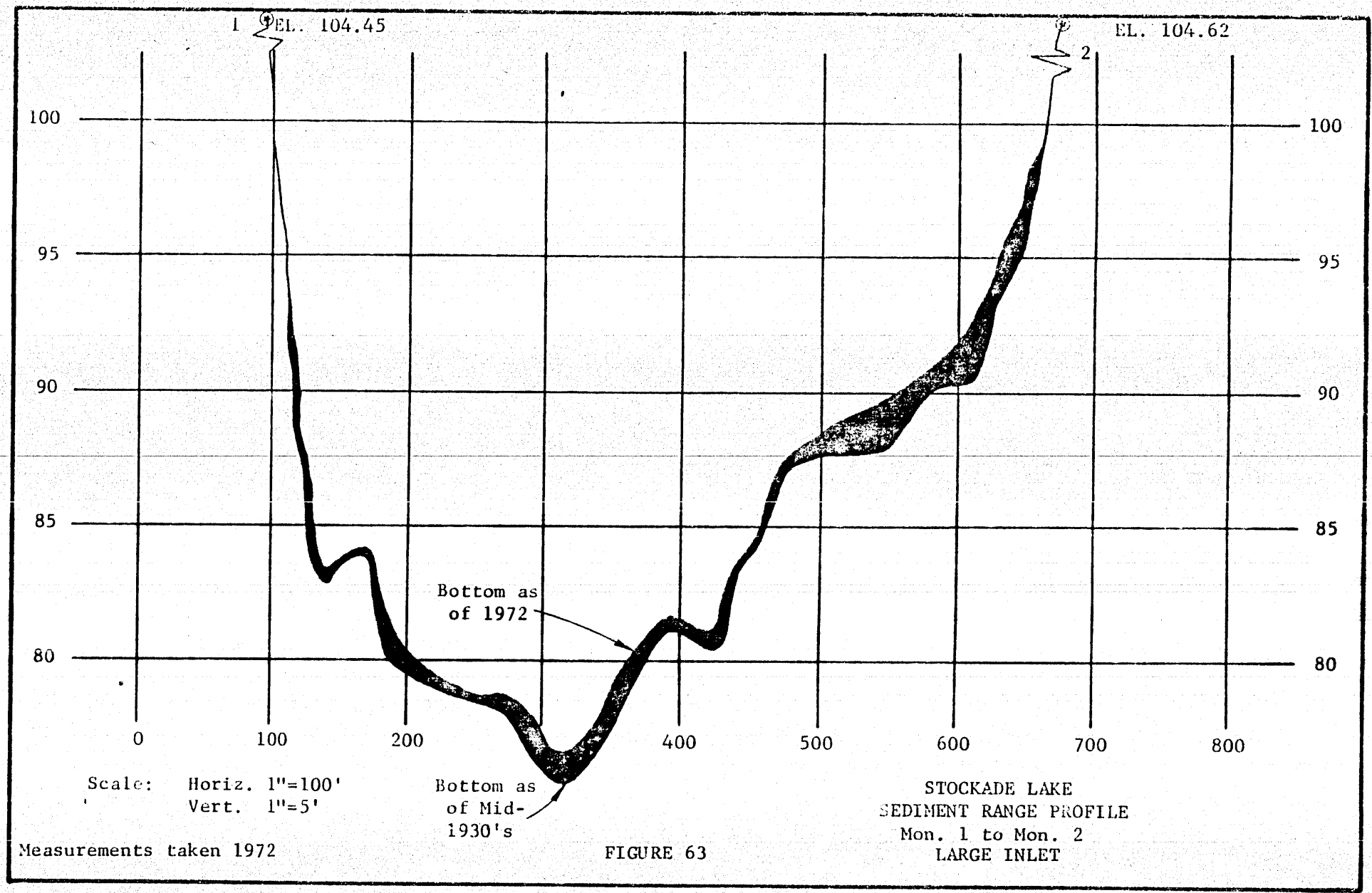

1
EL. 104.45
2
EL. 104.62
100
95
90
85
80
0
100
200
400
500
600
700
800
Bottom as of 1972
Bottom as of Mid-1930's
Scale: Horiz. 1"=100'
Vert. 1"=5'
Measurements taken 1972
STOCKADE LAKE
SEDIMENT RANGE PROFILE
Mon. 1 to Mon. 2
LARGE INLET

FIGURE 63

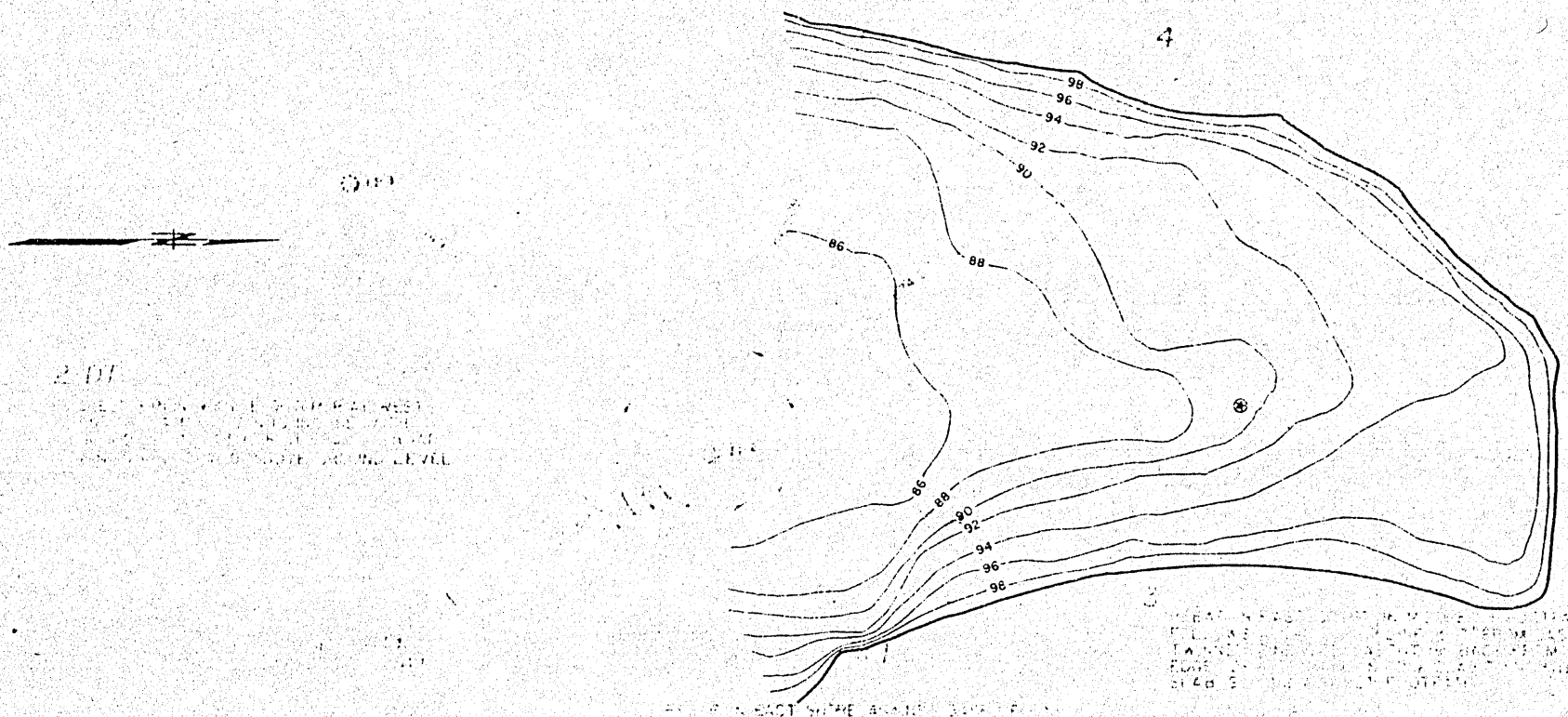


FIGURE 62

STOCKADE LAKE

SMALL INLET

SEDIMENT CONTOURS

100 / 0 100 200

scale feet

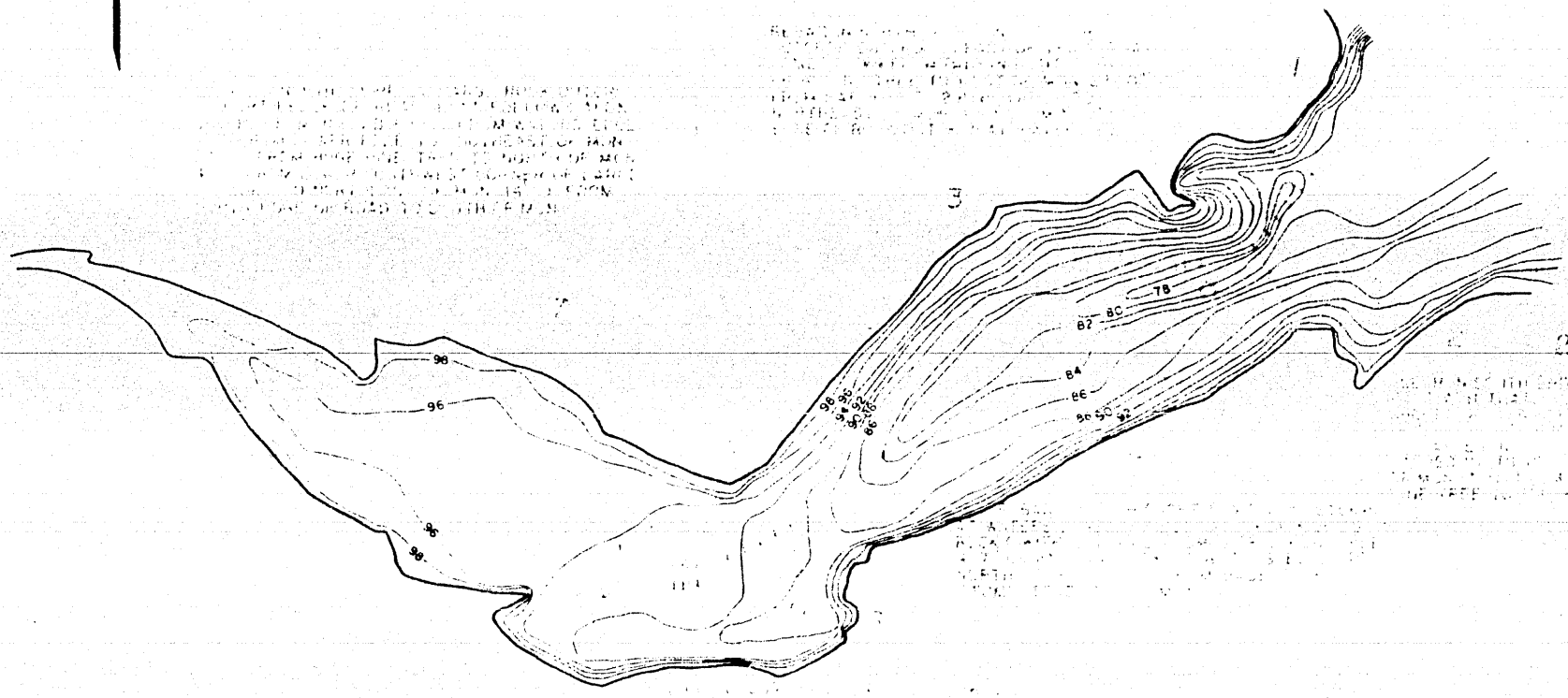


FIGURE 61

STOCKADE LAKE

LARGE INLET

SEDIMENT CONTOURS

200 0 200 400

scale feet

Influence of Pollution Problems on Beneficial Uses

Water quality restricts or adversely influences the following beneficial uses:

1. Fishlife propagation
2. Recreation

Pollution Sources

Source	Relative Magnitude
1. Natural	Major
2. Roads and highways	Moderate
3. Tilled soil agriculture	Moderate
4. Streamside grazing	Moderate
5. Domestic wastes	Minor

Management Recommendations

1. Promote good soil conservation practices.
2. Discourage streamside winter feeding.
3. Control sedimentation from roads and highways.
4. Summertime aeration.
5. Remove sediment.
6. Initiate a weed cutting and removal program.
7. Drain or draw-down periodically.
8. Fence selected sections of tributary streams.

Beneficial Uses

Recreation is the primary beneficial use of Stockade Lake. The lake is used extensively for all types of water sports and as a focal point for camping and picnicking.

Present recreation facilities consist of 110 family camping units, a small picnic area, boat launching ramps, and a swimming beach. A marina concession services the lake. Toilet facilities consist of three comfort stations with flush toilets and showers. New campground development is tentatively scheduled for the spring of 1974. Plans are to redevelop two of the three existing camping areas and construct a new 70-unit campground on the north side of the lake. Vault toilets will be utilized at the new site.

A creel survey conducted at Stockade Lake by the South Dakota Game, Fish and Parks Department showed that anglers fished a total of 17,266 hours during the 112-day summer season in 1970.

Sediment Studies

A sediment survey conducted at Stockade Lake in July of 1972 showed 117,126 cubic yards or 72.6 acre-feet of sediment stored in the two major inlets of the lake. Contour maps of the bottoms of the two major inlets are shown in Figures 61 and 62, pages 203 and 204. Profiles of sediment ranges are shown in Figures 63 through 68, pages 205-210.

Water Quality Studies

Water samples were collected at two stations on Stockade Lake in June of 1971 (day), August of 1971 (night and day in one 24-hour period), and in February of 1972 (day). Test results are presented in Table 56, page 211.

Bacteriological samples were collected in May, June, July, and September of 1971 by South Dakota State Health Department personnel. Test results are presented in Table 57, page 212.

Pollution Problems

1. Sedimentation
2. Eutrophication
3. Oxygen depletion in winter and summer
4. pH
5. Turbidity

STOCKADE LAKE

General Information

Location: SW¼, S22, T3S, R5E

On U. S. Highway 16A about 4 miles east of Custer, South Dakota

Drainage Basin: French Creek

Date of Closure: Mid-1930's

Controlling Agency: South Dakota Game, Fish and Parks Department

Designated Uses: 2b, 3a, 3b, 4

Drainage Area Above Lake: 66.8 square miles

Surface Area: 130 acres

Storage Capacity: 2470 acre-feet

Maximum Water Depth: 42 feet

Stream Draining into Lake: French Creek

Watershed Characteristics

Approximately 60 percent of the watershed above Stockade Lake is public timberland administered by the U. S. Forest Service. The remaining land is privately owned and is used for livestock grazing and hay crops. The lake is located within the Custer State Park boundaries. Geology of the area consists primarily of Precambrian metamorphic formations. Some Precambrian granite is also present in the watershed. Hill slopes are moderately steep. The watershed receives an average of about 19 inches of precipitation per year. The city of Custer (population 1,597) is located about four miles upstream from Stockade Lake. Many permanent and summer homes are located in the watershed. Summer populations are considerably swelled by the influx of tourists into the area. The drainage above Stockade Lake is one of the most extensively developed areas in the Black Hills. Effluent from Custer's wastewater treatment plant has been a major source of nitrogen, phosphorus, and organic materials; but plant modifications scheduled for completion in late 1973 should alleviate this problem.

Appendix C3.

1981 Study
Department of Water and Natural Resources and
WQSA Coordinator Sedimentation Results

SEDIMENT SURVEY, 1981

Stockade Lake

A. Description

A sediment survey was conducted in January, 1981, of the inlet portions of Stockade Lake by measuring the elevation of the top of the sediment deposits along the same cross-sections as established by the survey in 1972 by Utility Engineering Co., Rapid City, SD. (See attached pages D-1 and D-2).

Utility Engineering Co. advised that their survey was made prior to the major flood of June 9-10, 1972.

B. Survey Results

(1) 1972 Survey: Total sediment deposition from mid-1930's to early 1972 was 117,000 cubic yards or approximately 3,250 c.y. average per year.

(2) 1981 Survey: Volume of sediment deposited in the French Creek inlet since early 1972 is 37,000 C.Y. and in the Bismark inlet is 7,000 c.y. for a total of 44,000 c.y. or 4,890 c.y. per year average.

The surveyed area covers 57 acres which represents 43% of the total surface area of the lake. A sediment survey of the main body of the lake has not been conducted.

Total volume of sediments deposited since the mid-1930's within the inlet areas is 161,000 c.y.

C. Analysis of 1981 Survey

(1) Sediment delivery rates: The 37,000 c.y. of sediments deposited in the French Creek inlet from 1972 to 1981 were derived from a tributary watershed of 74 square miles. The volume of sediment deposited therefore averaged 500 c.y. per square mile during this 9 year period.

In the Bismark inlet with a 4 square mile tributary drainage area and 7,000 c.y. of sediment indicates 1,750 c.y. of sediment per square mile of drainage area.

(2) Conclusion:

Since Bismark Lake, located immediately upstream of Stockade Lake, serves as a sedimentation basin for Stockade Lake it appears unlikely that the amount of sediment per square mile of drainage area would be 3½ times greater in the Bismark inlet than in the French Creek inlet. Therefore it appears that some of the finer sediments entering the French Creek inlet during high runoff is being de-

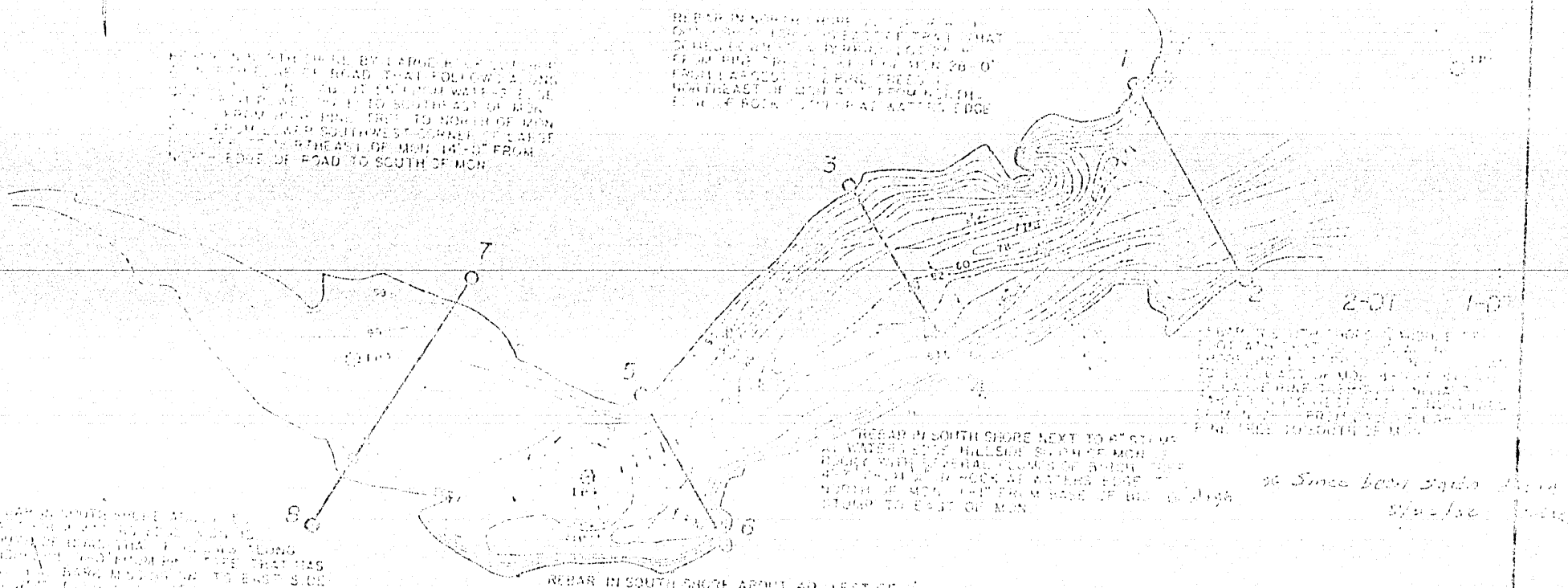
posited throughout the lake, including the Bismark inlet. Also a significant portion of the sediment volume may consist of organic deposits derived from decomposed algae, aquatic plants or other organic wastes

(3) Recommendation:

In order to determine the total volume and the composition of sediments in Stockade Lake I recommend that samples be taken and sediment thicknesses be measured at appropriate locations in the main body of the lake.

Project Coordinator

Attachments: Sediment Survey Plan Maps, D-1 and D-2 Cross-sections, D-3 through D-8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660
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780
840
900
960
1020
1080
1140
1200
1260
1320
1380
1440
1500
1560
1620
1680
1740
1800
1860
1920
1980
2040
2100
2160
2220
2280
2340
2400

REBAR IN WEST SHORE ON SLOPE ABOVE ROAD THAT RUNS ALONG SHORELINE. MON IS IN SMALL CLEARING 16'-0" FROM A 4" DIA PINE TREE TO WEST OF MON AND 5'-3" FROM SMALL PINE TREE TO NORTH OF MON. TREE HAS A 2" BRANCH GROWING ABOUT 6' ABOVE GROUND ON NORTH SIDE OF TREE 27'-10" FROM PINE TREE TO NORTHWEST OF MON.

REBAR IN WEST SHORE JUST EAST OF [illegible] ABOUT 6' FROM WEST EDGE OF ROAD. [illegible] IN ROCK SLAB. 3 METHOD OF MON'S FROM [illegible] POINT TO 5 SOUTHWEST OF MON. 7'-0" FROM WEST EDGE OF ROAD.

2-DT

STEEL PIN IN GRANITE OUTCROP AT WEST EDGE OF ROAD. TOP PIN IS IN LINE WITH GUARD POST ON SOUTH EDGE OF ROAD. PIN IS [illegible] ABOVE GROUND LEVEL.

1-DT

REBAR IN JAW TOP JUST SOUTH OF GRANITE OUTCROP AT NORTH EDGE OF ROAD. MON IS DIRECTLY IN LINE WITH GUARD RAIL POSTS 5'-0" FROM FARTHEST EAST GUARD POST. MON IS FARTHEST POINT ON GRANITE OUTCROP TO NORTH OF ROAD.

REBAR IN EAST SHORE AGAINST BASE OF PINE TREE GROWING ON ROCKY POINT AT FOOT OF INLET. MON. IS ABOUT 15'-0" BACK FROM WATERS EDGE. 7'-6" FROM "X" IN ROCK OUTCROP TO WEST OF MON. "X" IS LEVEL WITH GROUND 1'-8" FROM "X" IN SOUTH FACE OF BOULDER TO NORTH OF MON.

REBAR IN EAST SHORE IN MIDDLE OF FOOTPATH THAT FOLLOWS ALONG SHORE LINE. 4'-7" FROM BASE OF LARGE TWISTED PINE TREE ABOUT 18" BACK FROM WATERS EDGE. 12'-11" FROM "C" IN ROCK SLAB TO NORTH OF MON. SLAB IS LYING AGAINST FOOTPATH.

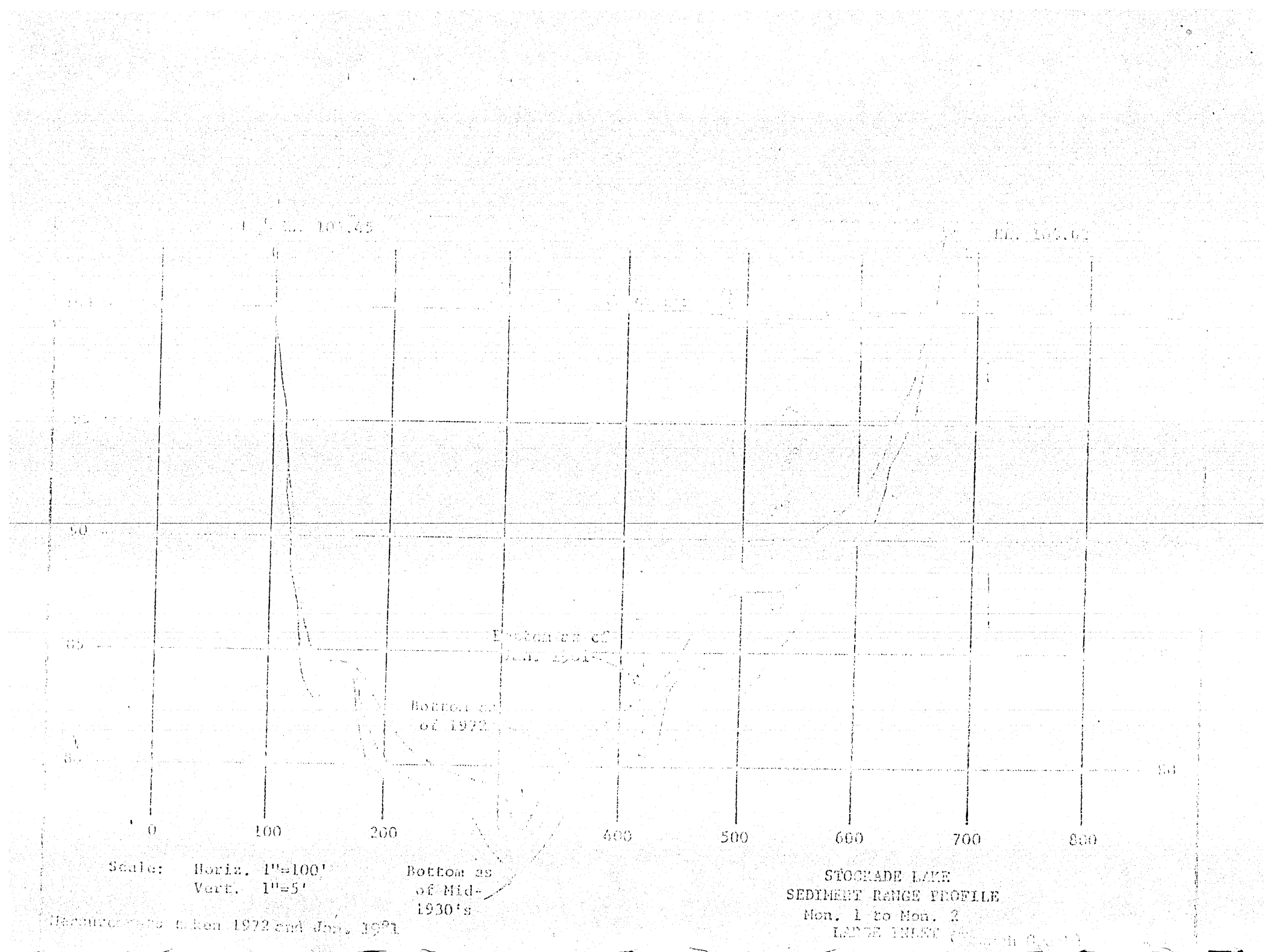
STOCKADE LAKE

SMALL INLET (Limerk)

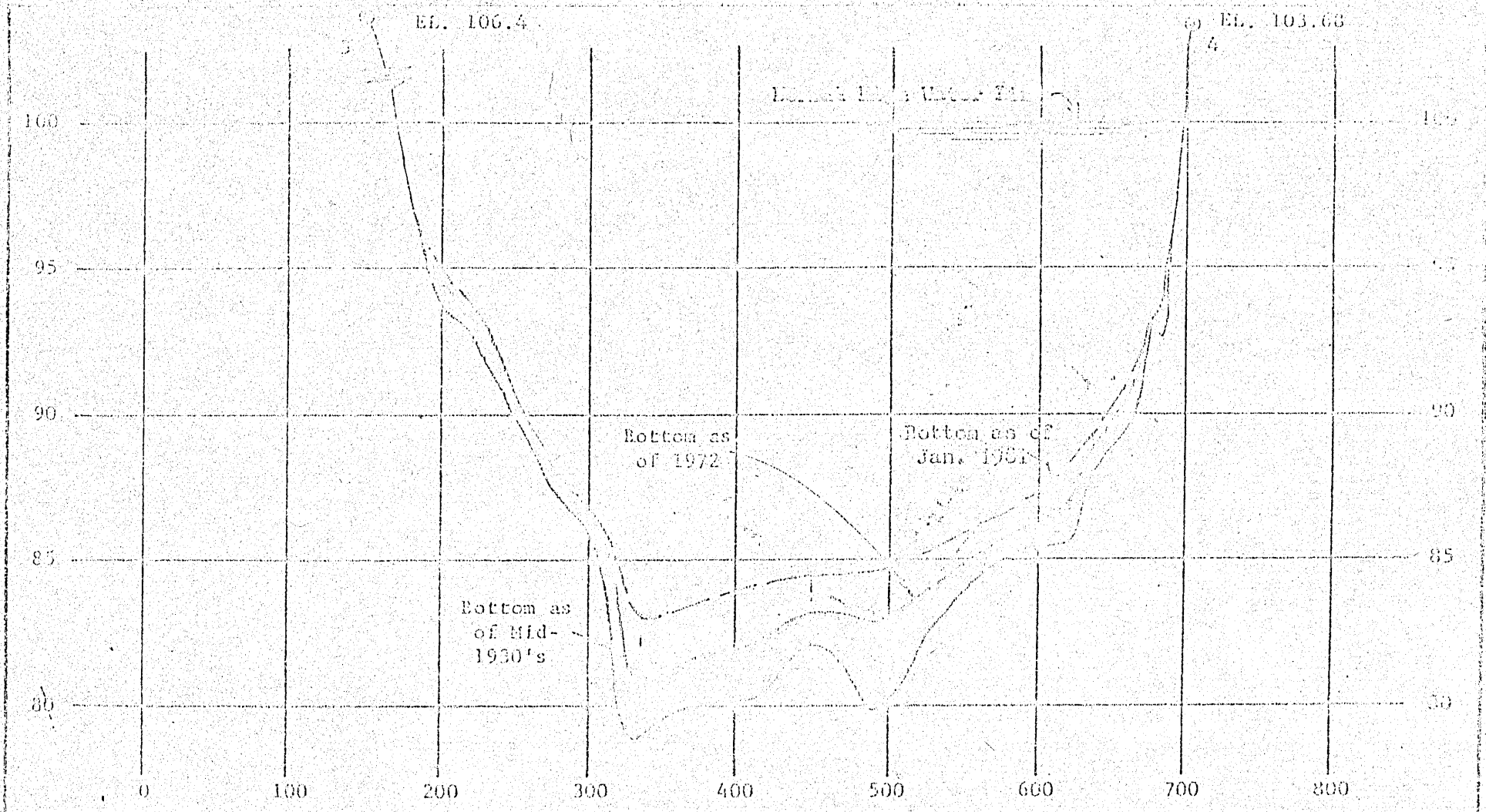
BATHYMETRIC CONTOURS

60 0 60 120

Feet (m)



STOCKADE LAKE
SEDIMENT RANGE PROFILE
Mon. 1 to Mon. 2

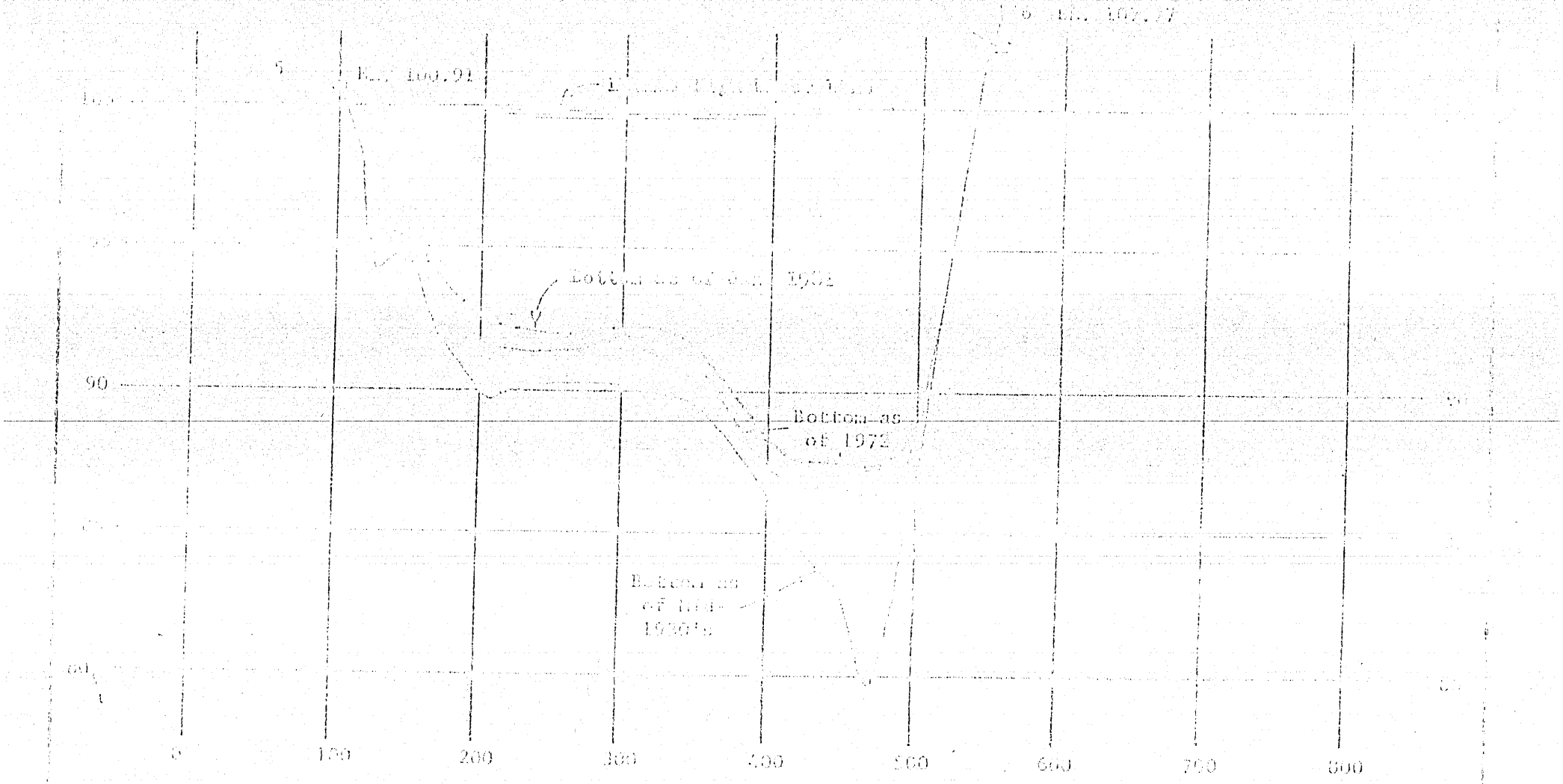


Scale: Horiz. 1"=100'
Vert. 1"=5'

Measurements taken 1972 and Jan. 1981

STOCKADE LAKE
SEDIMENT RANGE PROFILE
Mon. 3 to Mon. 4
LARGE INLET

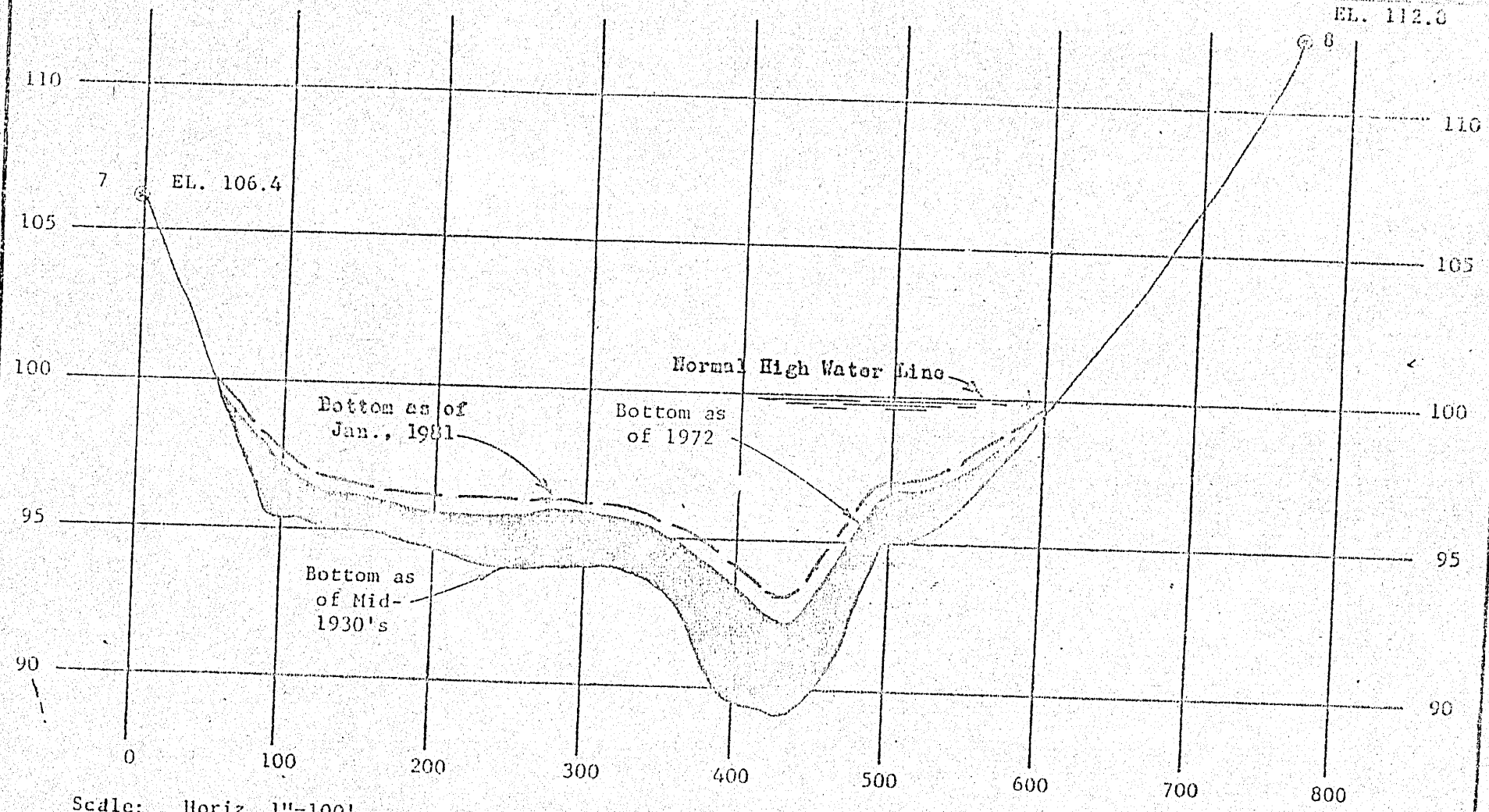
Fig. D.4



Scale: Horiz. 1"=100'
Vert. 1"=5'

Measurements taken 1972 and Jan./1983

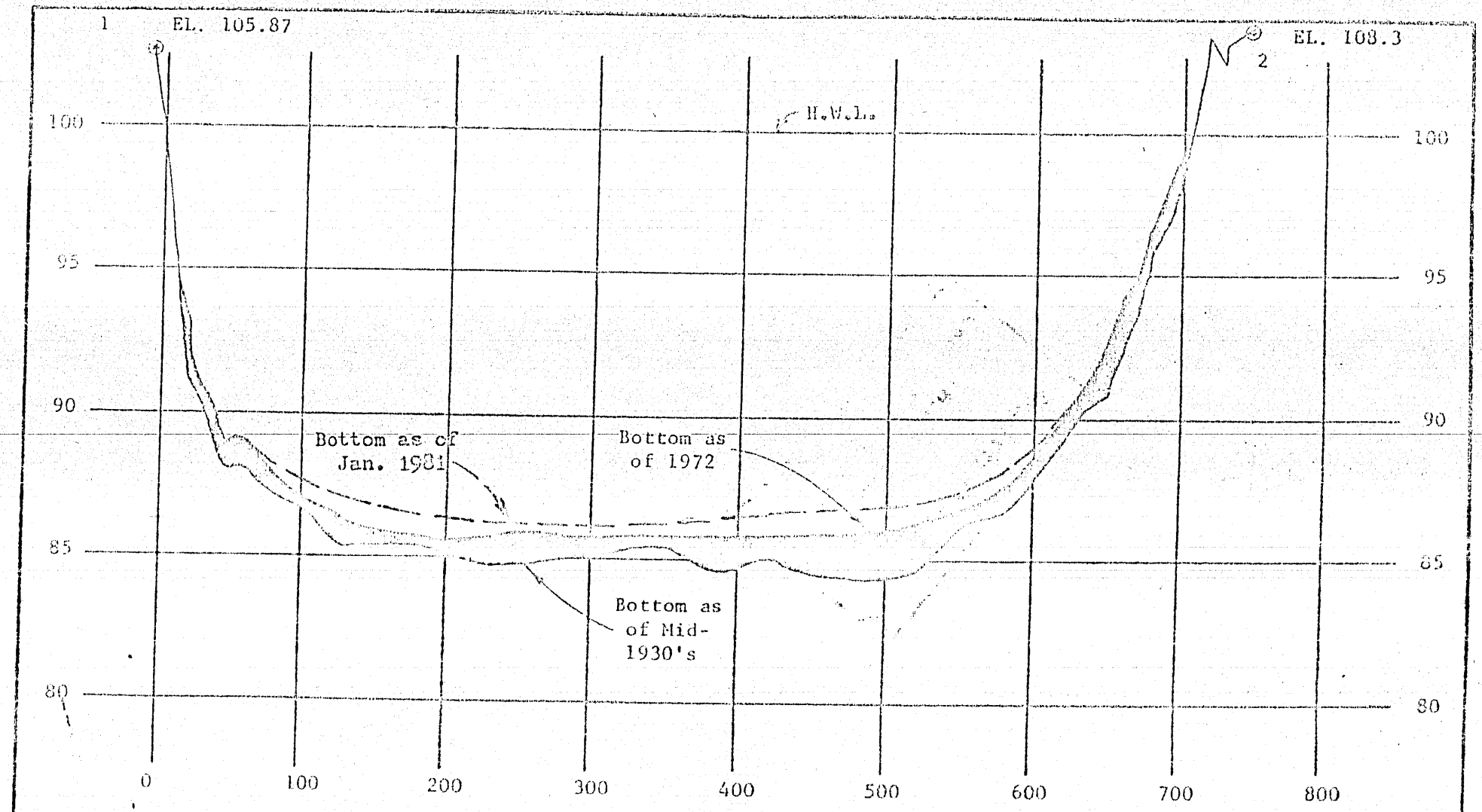
STOCKADE LAKE
SEDIMENT RANGE PROFILE
Mon. 5 to Mon. 6
LARGE INLET



Scale: Horiz. 1"=100'
Vert. 1"=5'

Measurements taken 1972 and Jan. 1981

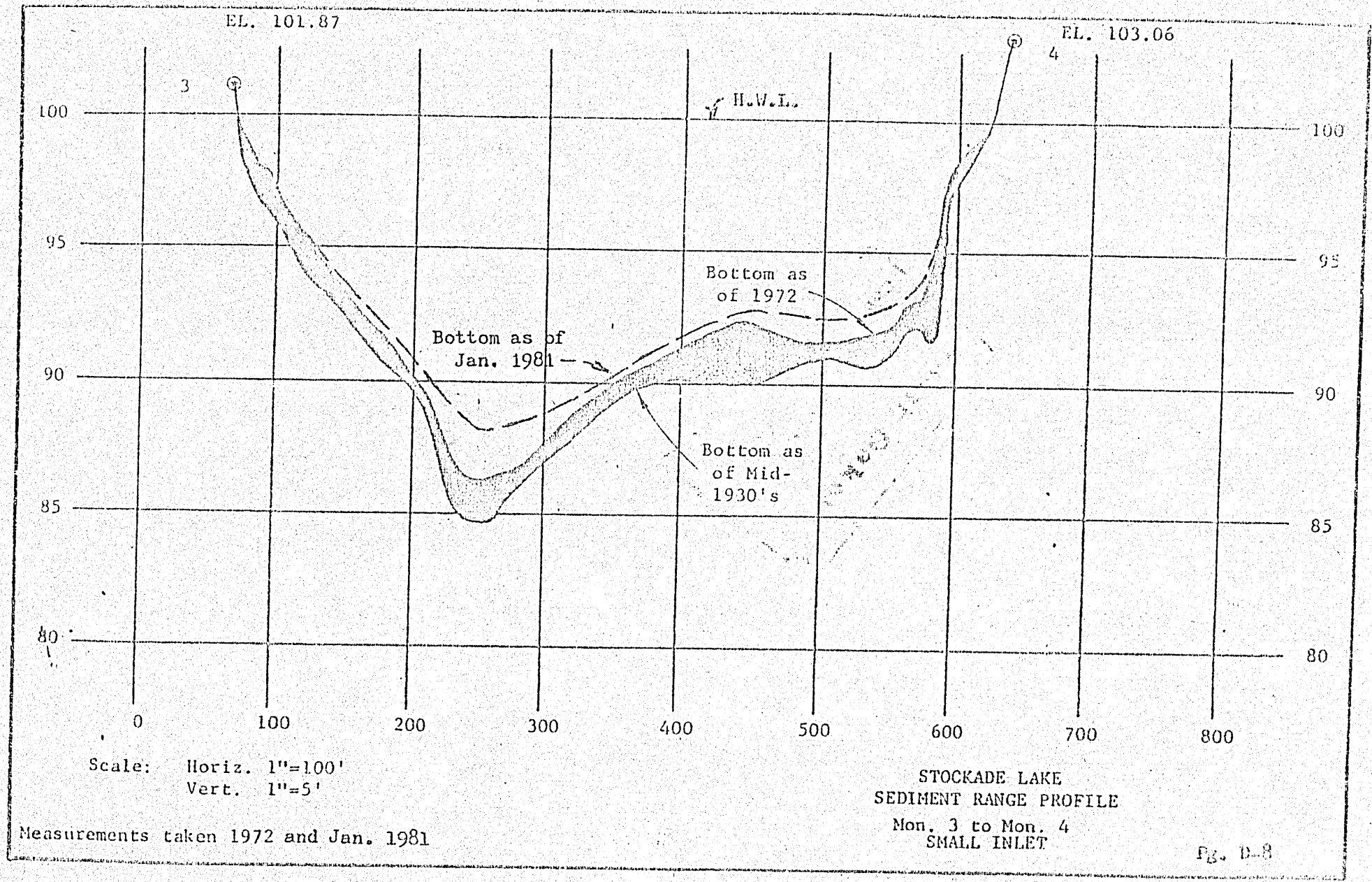
STOCKADE LAKE
SEDIMENT RANGE PROFILE
Mon. 7 to Mon. 8
LARGE INLET



Scale: Horiz. 1"=100'
Vert. 1"=5'

Measurements taken 1972 and Jan. 1981

STOCKADE LAKE
SEDIMENT RANGE PROFILE
Mon. 1 to Mon. 2
SMALL INLET (Bismark)



Scale: Horiz. 1"=100'
Vert. 1"=5'

Measurements taken 1972 and Jan. 1981

STOCKADE LAKE
SEDIMENT RANGE PROFILE
Mon. 3 to Mon. 4
SMALL INLET

Fig. D-8

Appendix C4.

U.S. Forest Service
Letter on Timber Harvest Sedimentation

United States Department of Agriculture
Forest Service
Black Hills National Forest
Custer, South Dakota 57730

Reply to: 2510

Date: March 27, 1981

APR 17 1981

Mr. Lee Baron
Department of Water and Natural Resources
Joe Foss Building
Pierre, S.D.

Dear Mr. Baron:

Reference is made to your telephone conversation with Lee Leffert concerning the relationship of timber harvesting to water quality and quantity within the French Creek watershed. Preliminary investigations concerning water quality and quantity within the drainage are described below. It should be remembered that Best Management Practices for the reduction of nonpoint pollution are employed for every timber sale throughout the entire forest, reducing potential water quality degradation.

Water Quality

Numerous National studies addressing the affects of timber harvesting on water quality, assert the major impact of timber harvesting on water quality is sedimentation. Further, these studies show the primary source of sediment is from road and skid trail erosion. The harvested slopes do not normally erode to significant degrees. This is because remaining slash and vegetation is sufficient to provide soil protection.

This trend also appears to be true in the French Creek watershed. Using calculated figures from the Universal Soil Loss Equation (USLE), it is projected that over a 10 year period, the background, or natural erosion from a square mile of timber covered lands, averaging 20% slopes, in the French Creek drainage is about 700 tons. This equates to about 0.11 tons per acre per year. USLE calculations showed no significant increase in erosion resulting from cutting timber, using a 3-step shelterwood method. Erosion from roads and skid trails accessing timber sale areas, have been calculated to erode an additional 225 tons per square mile over a ten year period. This additional volume, when combined with background rates, totals about 930 tons per square mile in 10 years. This equates to about 0.15 tons per acre per year from timber harvesting areas. This erosion rate is well below the Soil Conservation Service guideline of 1-5 tons per acre per year maximum erosion rate to sustain long term productivity.

The Forest Service is an agency of the Department of Agriculture
FS-6200-11 (10/79)

The above projections are pure erosion rates. They do not imply the actual amount of instream sediment. Once soil is eroded, it may simply be deposited several feet downslope, or be carried off site to a stream system. The amount "delivered" to a stream channel is termed delivery ratio. Delivery ratio is an extremely intangible figure, with values changing significantly with changes in topography, ground cover, climate and relative location of a stream channel to the erosion site.

In the French creek drainage, an estimated average delivery ratio is 0.05. This is because the valleys are "U" shaped and much of the eroded soil from the sideslopes is trapped in the wide, flat valley bottoms before it can reach a stream channel. Using the delivery ratio of 0.05, the 49,000 acre French Creek watershed above Stockade Lake delivers an estimated 300 tons of sediment from the forested watershed to the French Creek channel system per year. It is doubtful if even 10% of the 300 tons would reach Stockade Lake annually, since much of it would be trapped in various dams in French Creek and its tributaries above Stockade Lake.

Chemical affects of timber harvesting on water quality can include increased nutrients, phenols, temperature (from removing streamside shade trees) calcium, and manganese. Dissolved oxygen levels may also be depleted. Results from the Forest's water quality monitoring station on French Creek above Custer do not indicate any significant sustained change in any of these parameters, that can be attributed to timber harvesting.

Water Quantity

The long term average annual precipitation in Custer is 18 inches. About 80% falls during the summer months (April through September) with the remaining 20% generally occurring as snowfall. Because the majority of the precipitation falls during the warm summer months, evapotranspiration rates are high, resulting in a reduced runoff volume. As a result, the average amount of water available to streamflow is only about 1¼ inches of water per acre per year. If this volume were prorated over the 49,000 acre watershed above Stockade Lake, average streamflow would be about 6 cubic feet per second. This obviously is not the case, therefore it is assumed that the difference between available water and actual streamflow is ground water recharge.

Water availability in response to timber basal area has been modeled using a computer program, WET, accessable from the Ft. Collins computer center. At the present time, the Black Hills National Forest is using a 3-step shelterwood harvesting system. Program WET shows that once an entire watershed has been treated, and every tree stand is being managed in a 3-step shelterwood system, there is a potential increase in available water of 17%. This increase is projected from a watershed with an average pretreatment basal area of 100-120 cubic feet per acre, over the entire watershed. Actual amounts of water availability in the French Creek drainage, would then be dependent upon the percentage of the watershed that has been treated, and the treatment each stand receives in relation to the cutting cycle.

At the present time, about 15,000 acres, or about 30% of the Stockade Lake watershed is being, or is planned to be, harvested in the next five years. If a 17% increase is available water is realized in this area, there would be a total increase of about 255 acre feet per year. This is an increase in average flow of 0.35 cubic feet per second; assuming none of the available water is lost to evapotranspiration or groundwater recharge.

Summary

Using the above information as a base for evaluating the affects of timber harvesting on water quality and quantity in the French Creek watershed above Stockade Lake, the following assumptions can be made:

1. Timber harvesting does not significantly increase sedimentation rates over natural levels.

2. Timber harvesting does not significantly change the chemical quality of surface water.

3. Timber harvesting will increase the total volume of water available for streamflow, but that volume is almost immeasurable.

Sincerely,

JAMES R. MATHERS
Forest Supervisor

Appendix C5.

Sedimentation Pollution Sources -
WQSA Coordinator Map and Narrative

SEDIMENT POLLUTION

Description of Potential Sources of Significant Sediment Pollution

While all soil disturbing activities within the watershed have the potential for contributing sediment to the tributary creeks visual observations indicate that the following sources are the most significant.

1. Urban Runoff

French Creek and Laughing Water Creek run through the City of Custer for a total distance of two miles. There are approximately 8 miles of paved* streets within the city and 12 miles of gravel and/or dirt streets. A very limited portion of the city is served by storm sewers.

Runoff from the gravel streets is contributing a significant quantity of sand and silt into the tributary creeks. The runoff also washes dirt and oil together with sand and salt from the paved streets which are sanded during the winter. Snow removal and disposal to sites adjacent to French Creek add further quantities of sediment to the creek and lake.

2. Disturbance of Stream Channels

Moderate to significant amounts of sediments are being derived from placer mining and soil disturbing activities such as channel changes associated with these operations.

Two placer sites were being operated adjacent to French Creek in 1980.

The extent of placer mining operations can be expected to fluctuate proportionately with changes in the price of gold.

3. Raw Stream Banks and Livestock Concentrations Adjacent to Creeks

Sediment from this source is caused by exposed bare soil on steep stream banks and by livestock located in areas as described in item 3 under nutrient pollution. Livestock trampling and grazing along stream banks and exposed soils at barnyards, corrals and stables are the primary cause of moderate sedimentation under this item.

4. Gravel or Dirt Roads or trails

Several gravel and dirt roads exist from which sediment is washed into the tributary creeks due to the proximity of the roads to the creeks

* Includes 2.4 miles of light asphalt surface treatments

or to steep road grades. Also roads adjacent to the shore of Stockade Lake and foot trails within the picnic areas in Custer State Park are causing some sediments to be washed into the lake during heavy runoff periods.

5. Dirt Fill and Mine Spoil Encroachments

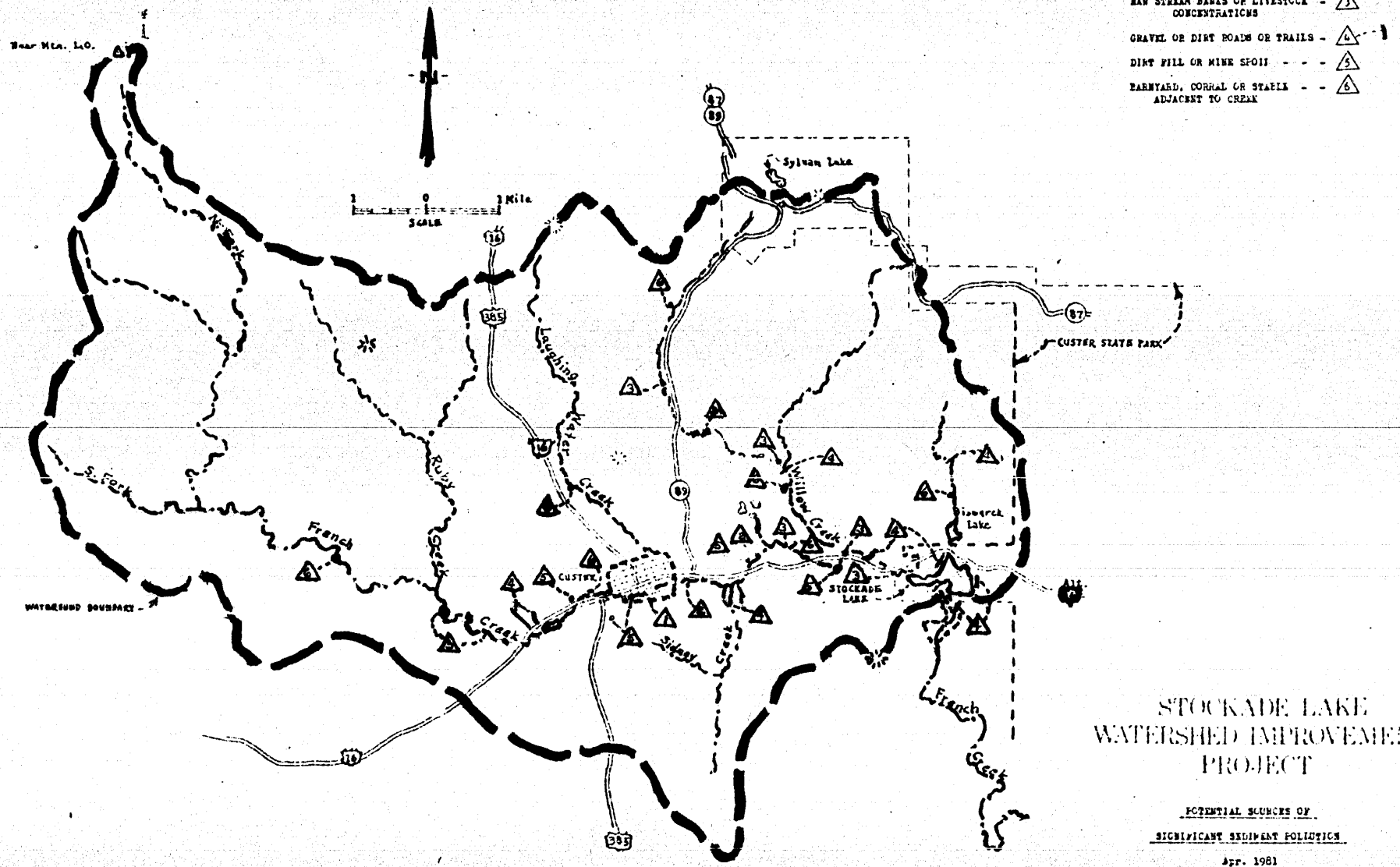
Approximately three locations along French Creek have been noted where site development and/or dumping of dirt to encroach into the waterway has occurred in recent years. Also one old mine spoil dump located immediately adjacent to French Creek still contributes some sediment to the creek due to the steep slopes and proximity of the spoil pile. Also some dust and sediment is derived from milling operations near the tributary creeks.

6. Barnyards, Corrals and Stables

At least six sites exist where livestock holding facilities are located within 100 feet of the tributary streams which creates the potential for sediments from the bare soils to be washed into the creeks. Since these areas are relatively small in size the amount of sediment is also estimated to be quite small.

7. Land Developments

Significant residential home development has occurred within the watershed during the past decade with most of the development occurring within a half mile of French Creek between Stockade Lake and a point about two miles west of Custer. The necessary disturbance of soil during site grading and the construction of roads, streets and utility services result in moderate amounts of erosion and sedimentation particularly during the first few years after the development work is begun. Since virtually none of these new developments have paved roads or streets sedimentation from this source is continuous and long term.



STOCKADE LAKE WATERSHED IMPROVEMENT PROJECT

POTENTIAL SOURCES OF SIGNIFICANT SEDIMENT POLLUTION

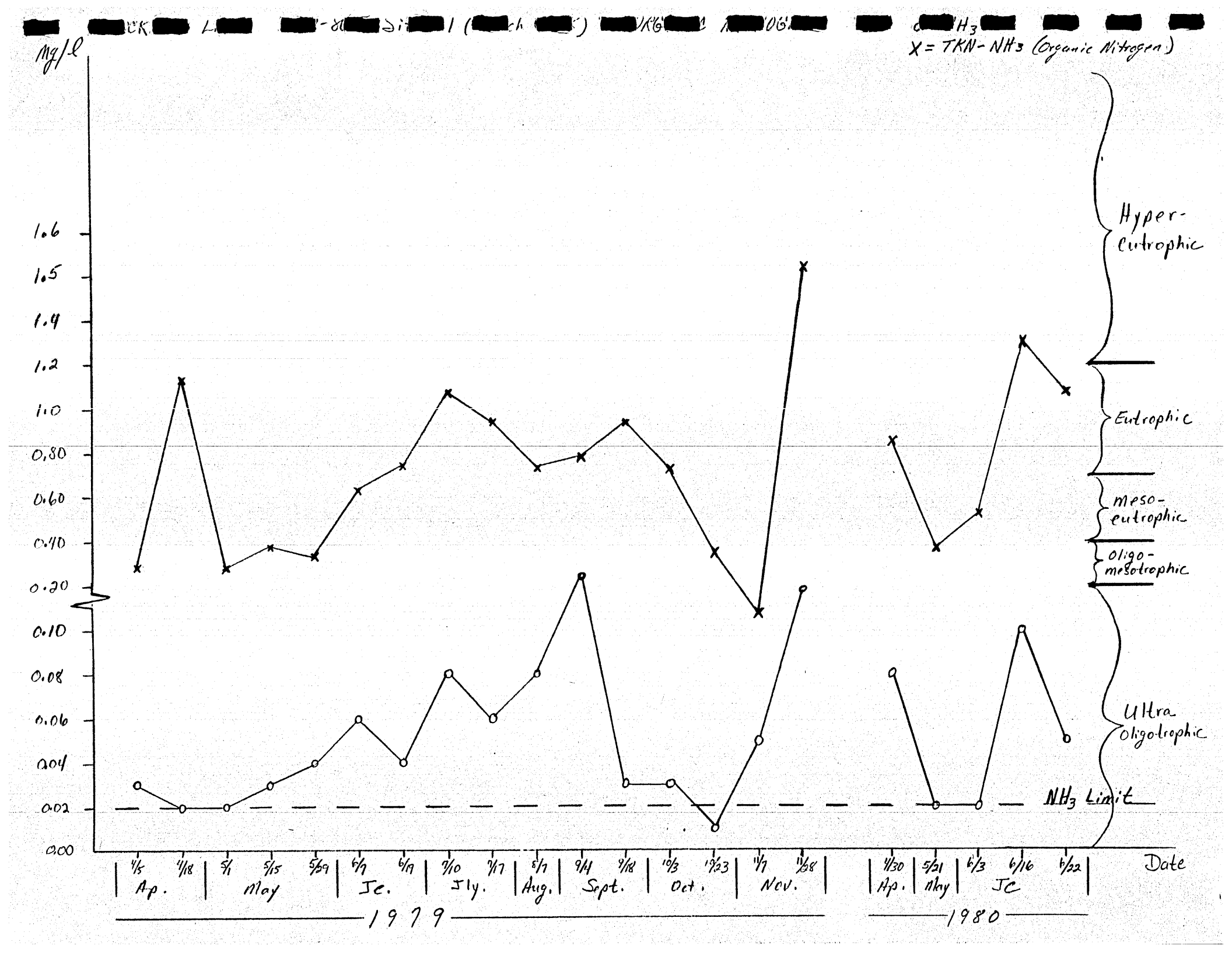
Apr. 1981

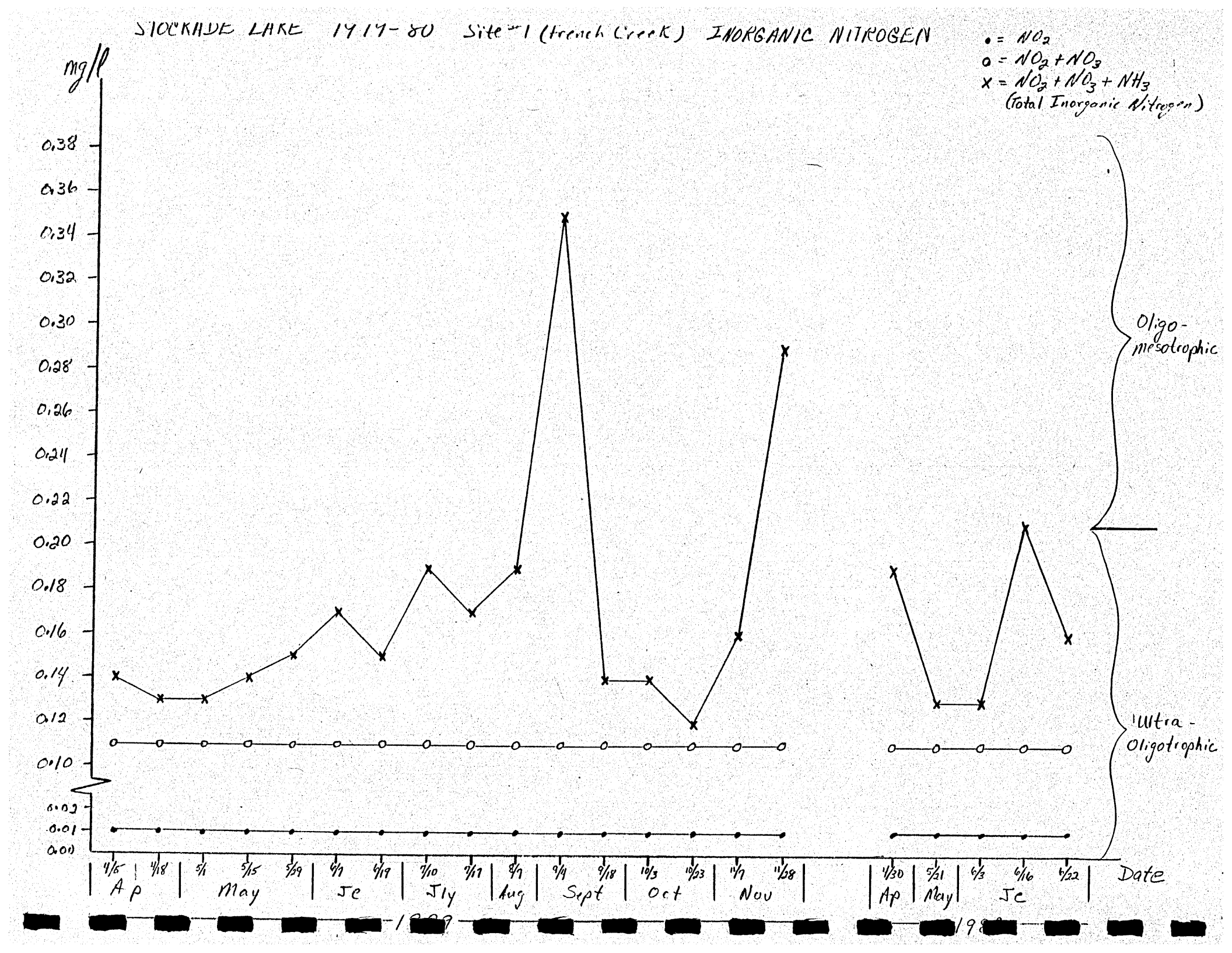
Appendix D.

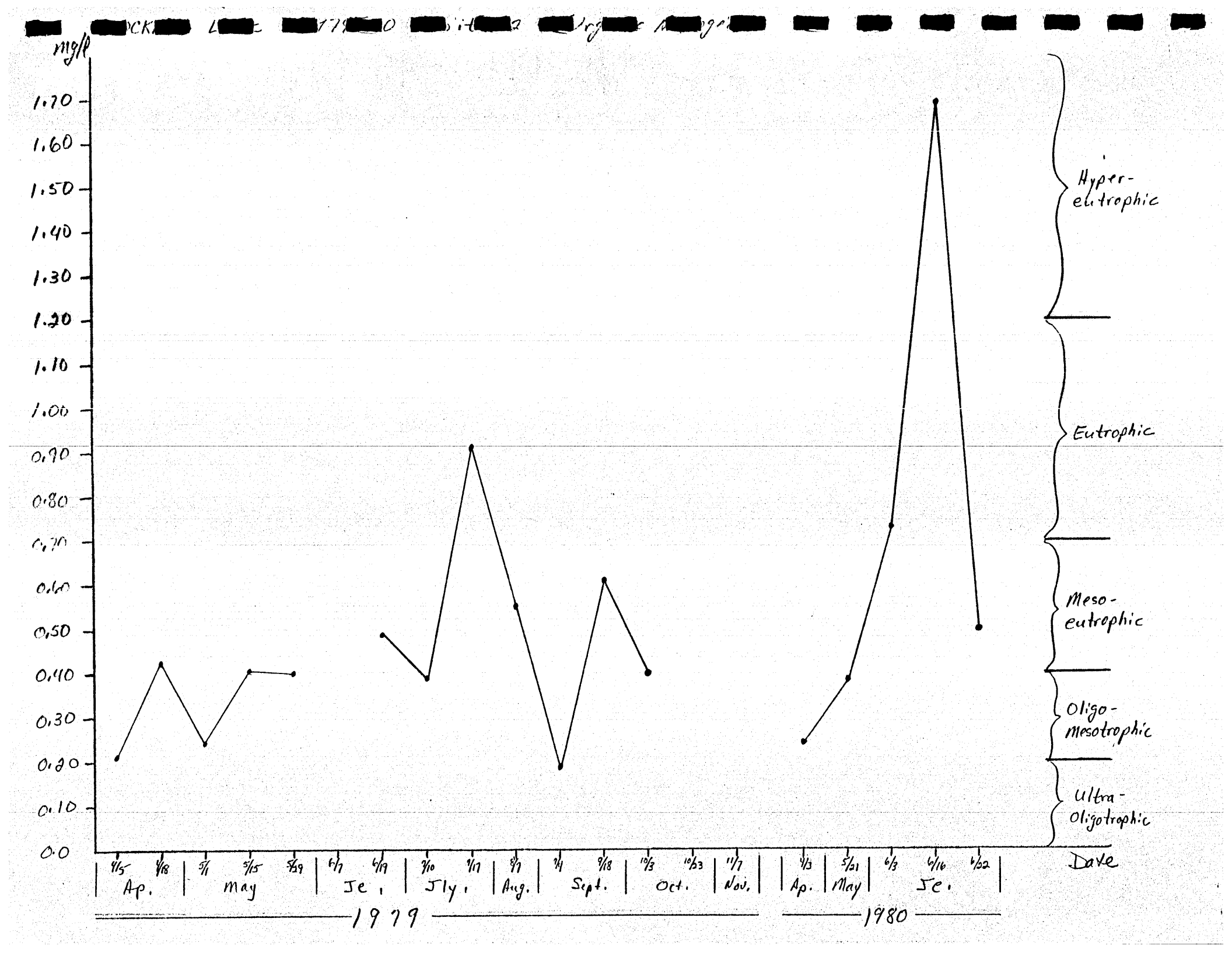
Water Quality Graphs

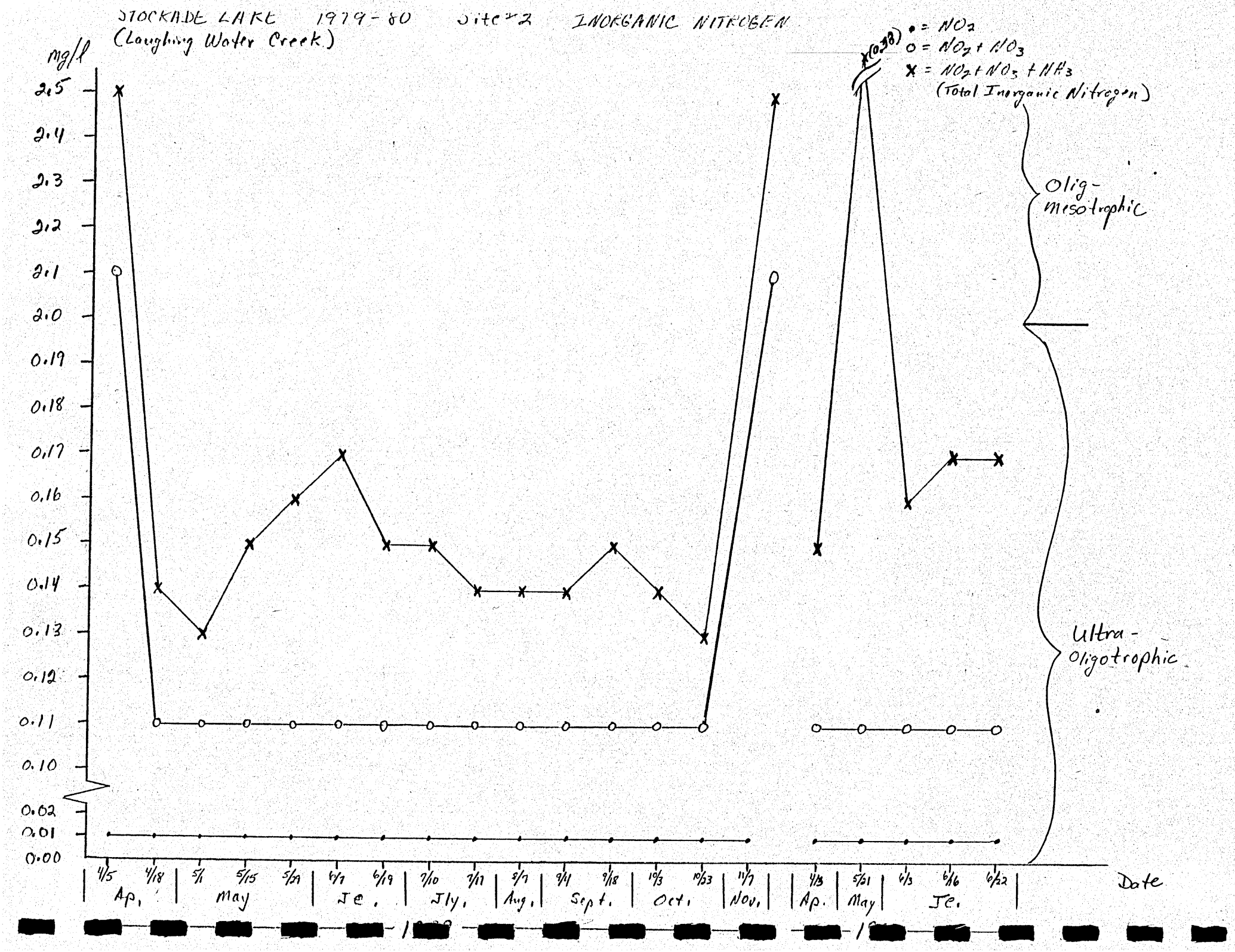
[redacted] NH_3 [redacted]

X = TKN - NH_3 (Organic Nitrogen)

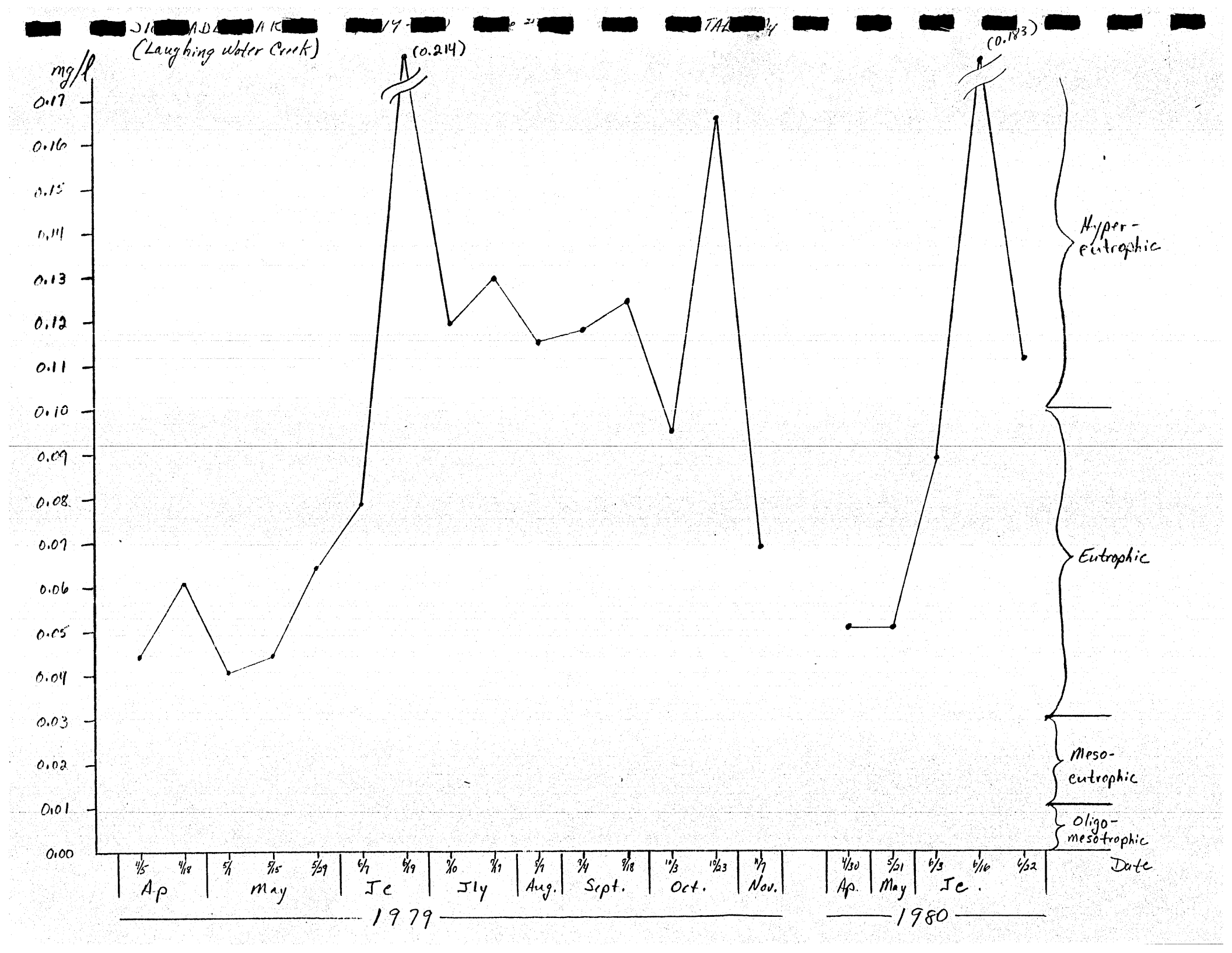


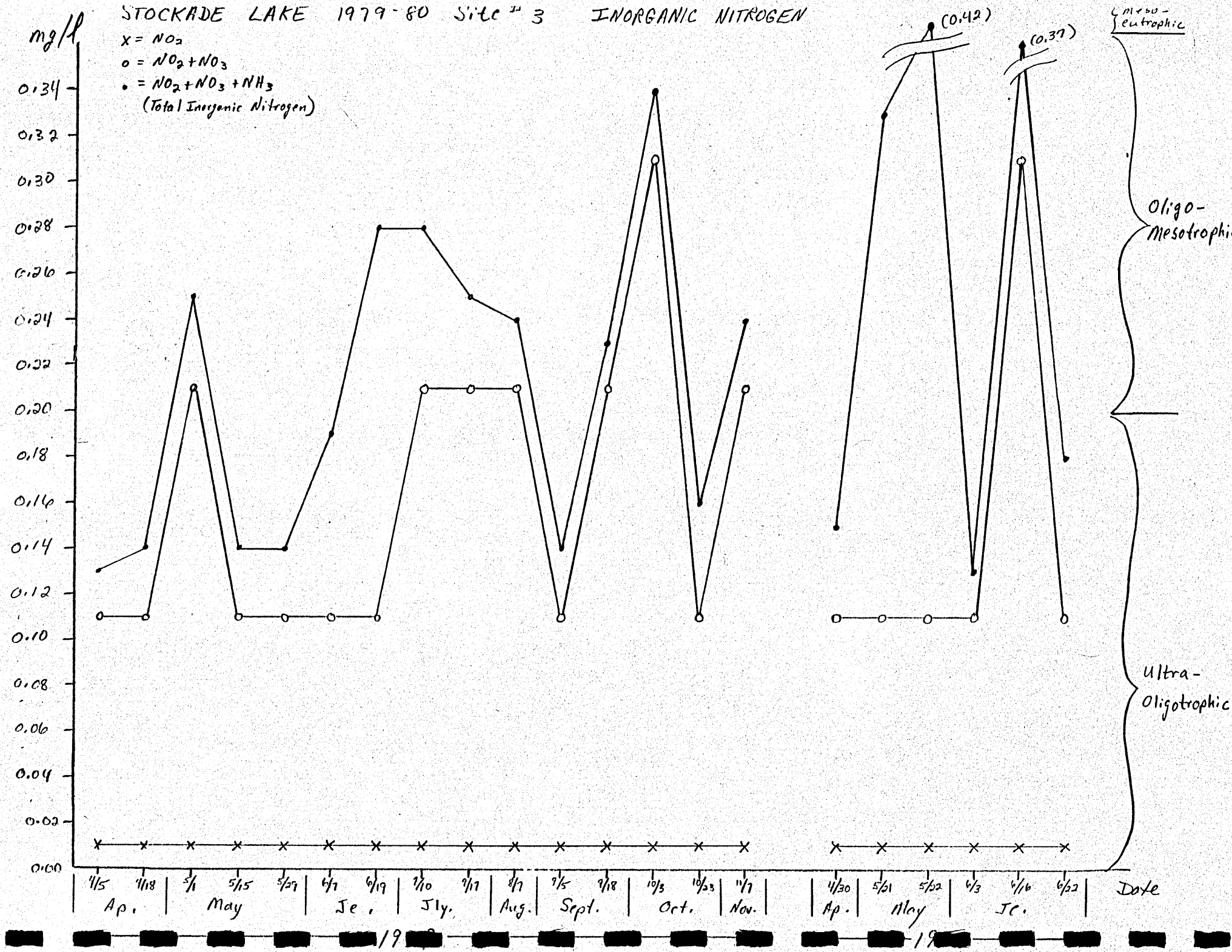

STOCKADE LAKE 1977-80 Site #1 (French Creek) INORGANIC NITROGEN
• = NO2
o = NO2 + NO3
x = NO2 + NO3 + NH3
(Total Inorganic Nitrogen)
mg/l
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.03
0.01
0.00
Oligo-mesotrophic
Ultra-Oligotrophic
4/6 4/18 5/1 5/15 5/29 6/1 6/19 7/10 7/17 8/9 9/11 9/18 10/3 10/23 11/7 11/28 4/30 5/21 6/3 6/16 6/22
Ap May Je Jly Aug Sept Oct Nov Ap May Je
Date
1977
1978

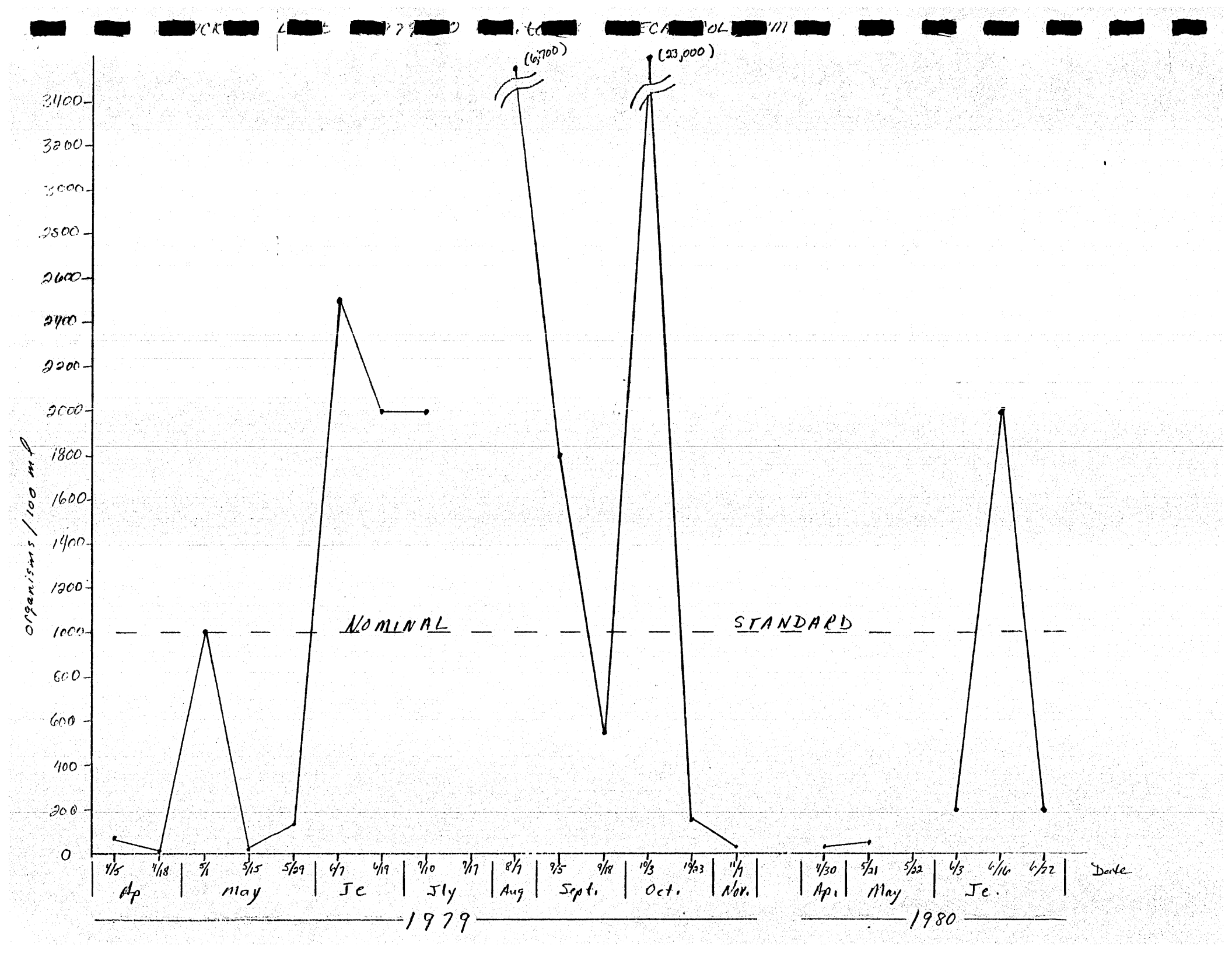

mg/l
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.0
Hyper-eutrophic
Eutrophic
Meso-eutrophic
Oligo-mesotrophic
Ultra-oligotrophic
4/5
4/18
5/1
5/15
5/29
6/7
6/19
7/10
7/17
8/7
9/4
9/18
10/3
10/23
11/7
4/3
5/21
6/3
6/16
6/22
Ap.
May
Je.
Jly.
Aug.
Sept.
Oct.
Nov.
Ap.
May
Je.
Date
1979
1980


STOCKADE LAKE 1979-80 Site #2 INORGANIC NITROGEN
(Laughing Water Creek)
mg/l
• = NO2
o = NO2 + NO3
x = NO2 + NO3 + NH3
(Total Inorganic Nitrogen)
x(0.38)
2.5
2.4
2.3
2.2
2.1
2.0
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.02
0.01
0.00
Olig-
mesotrophic
Ultra-
Oligotrophic
4/5 4/18 5/1 5/15 5/29 6/7 6/19 7/10 7/17 8/7 9/1 9/18 10/3 10/23 11/7 4/13 5/01 6/3 6/16 6/22
Ap. May Je. Jly. Aug. Sept. Oct. Nov. Ap. May Je.
Date

[redacted] (Laughing Water Creek) [redacted] TA[redacted]




STOCKADE LAKE 1979-80 Site # 3 INORGANIC NITROGEN
mg/l
x = NO2
o = NO2 + NO3
• = NO2 + NO3 + NH3
(Total Inorganic Nitrogen)
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
(0.42)
(0.37)
Meso-eutrophic
Oligo-Mesotrophic
Ultra-Oligotrophic
4/5 4/18 5/1 5/15 5/29 6/7 6/19 7/10 7/17 8/7 9/5 9/18 10/3 10/23 11/7
Ap. May Je. Jly. Aug. Sept. Oct. Nov.
4/30 5/21 5/22 6/3 6/16 6/22
Ap. May Jc.
Date


(6,700)
(23,000)
3100
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
600
400
200
0
Organisms / 100 ml
NOMINAL
STANDARD
4/5
4/18
5/1
5/15
5/29
6/7
6/19
9/10
9/17
8/1
9/5
9/18
10/3
10/23
11/1
4/30
5/21
5/22
6/3
6/16
6/22
Date
Ap
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Je
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Aug
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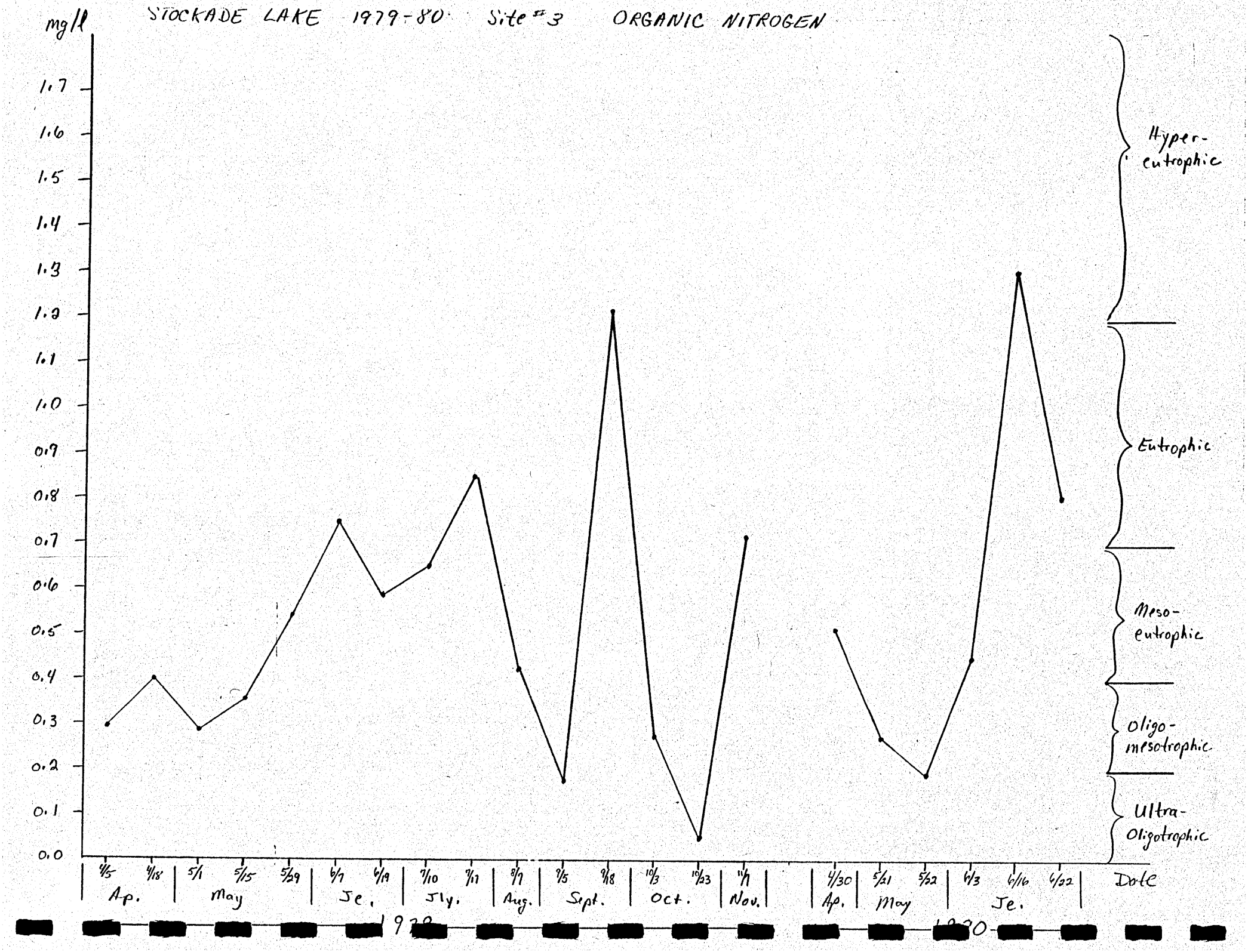
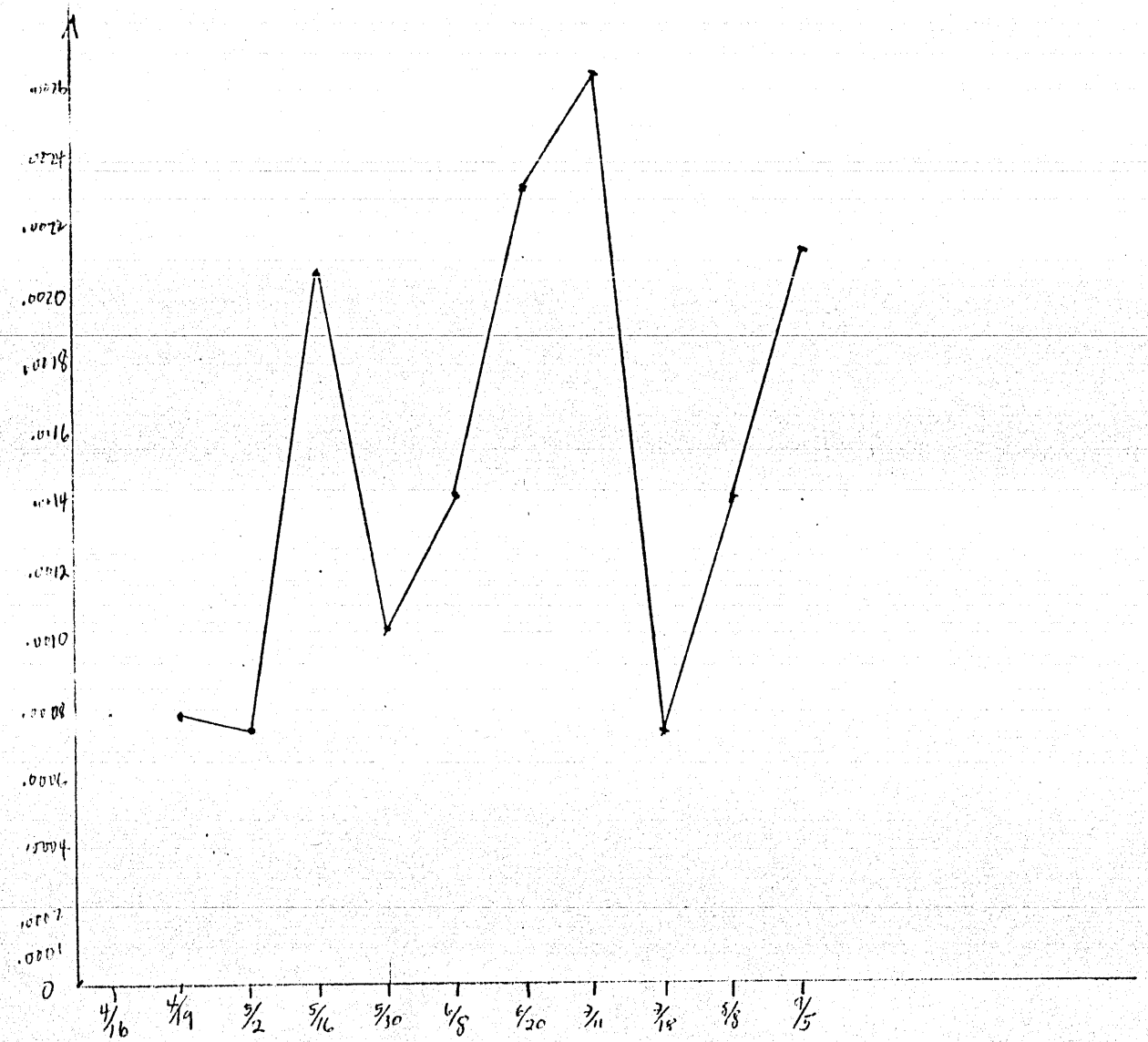
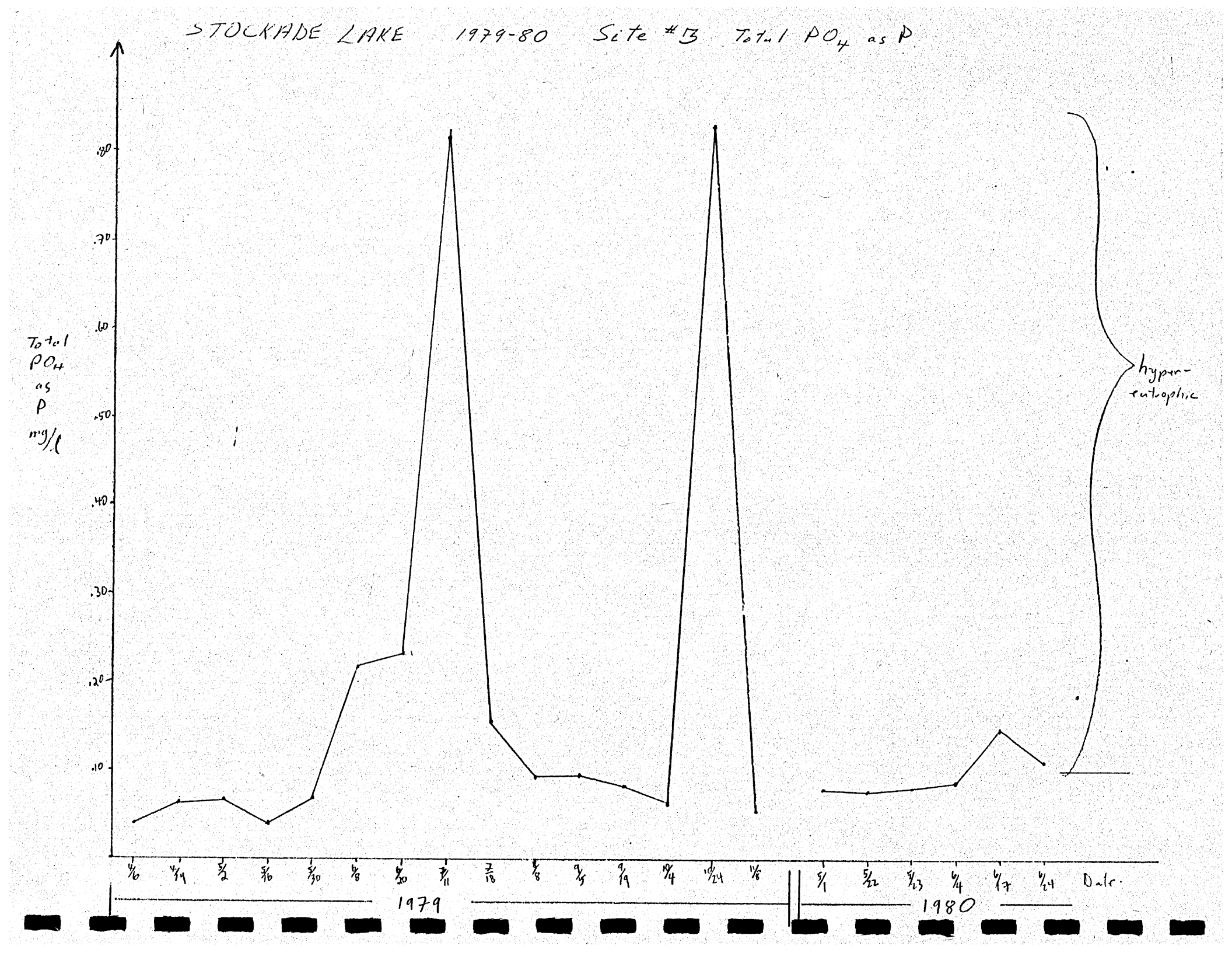
Oct.
Nov.
Ap.
May
Je.
1979
1980


mg/l
STOCKADE LAKE 1979-80 Site #3 ORGANIC NITROGEN
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Hyper-eutrophic
Eutrophic
Meso-eutrophic
Oligo-mesotrophic
Ultra-Oligotrophic
4/5
4/18
5/1
5/15
5/29
6/7
6/19
7/10
7/11
8/7
9/5
9/18
10/3
10/23
11/7
4/30
5/21
5/22
6/3
6/16
6/22
Date
Ap.
May
Je.
Jly.
Aug.
Sept.
Oct.
Nov.
Ap.
May
Je.
1979
1980

STOCKADE LAKE 1979-80 Sta #3 UNIONIZED AMMONIA

Standard: 0.02 mg/l.




STOCKADE LAKE 1979-80 Site #3 Total PO_4 as P
Total PO_4 as P mg/l
.80
.70
.60
.50
.40
.30
.20
.10
hyper-eutrophic
4/6
4/19
5/2
5/16
5/30
6/8
6/20
7/11
7/28
8/8
9/5
9/19
10/4
10/24
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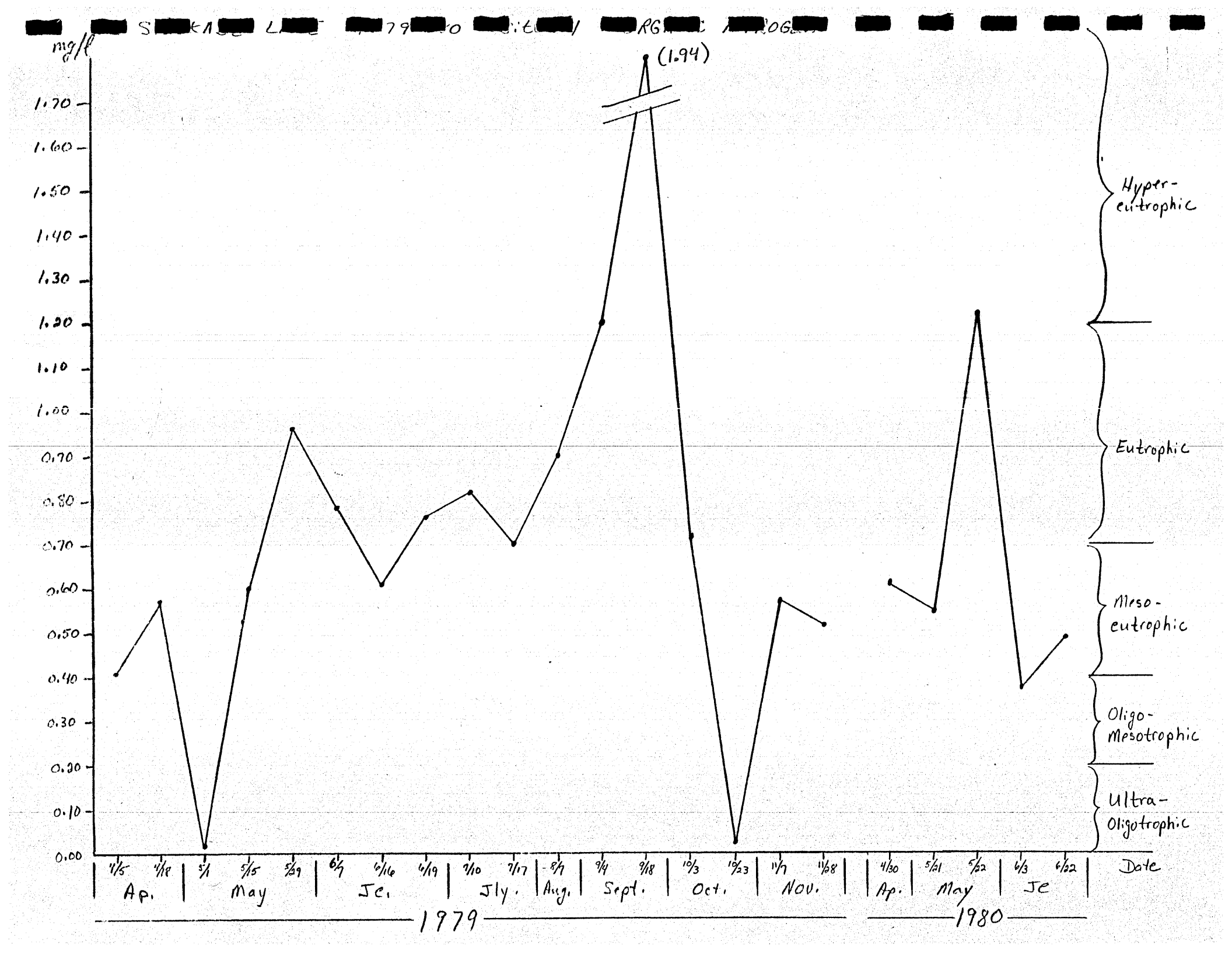
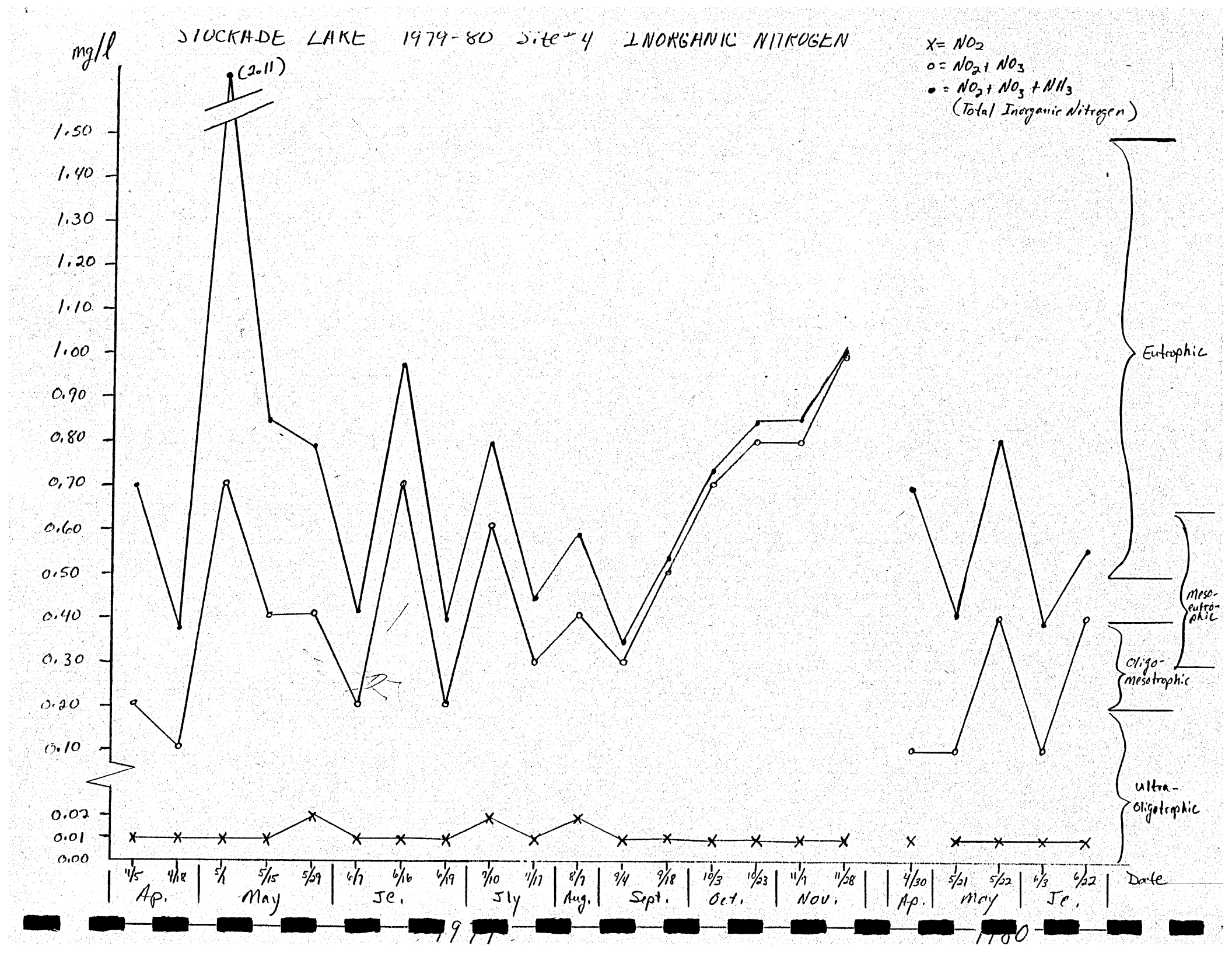
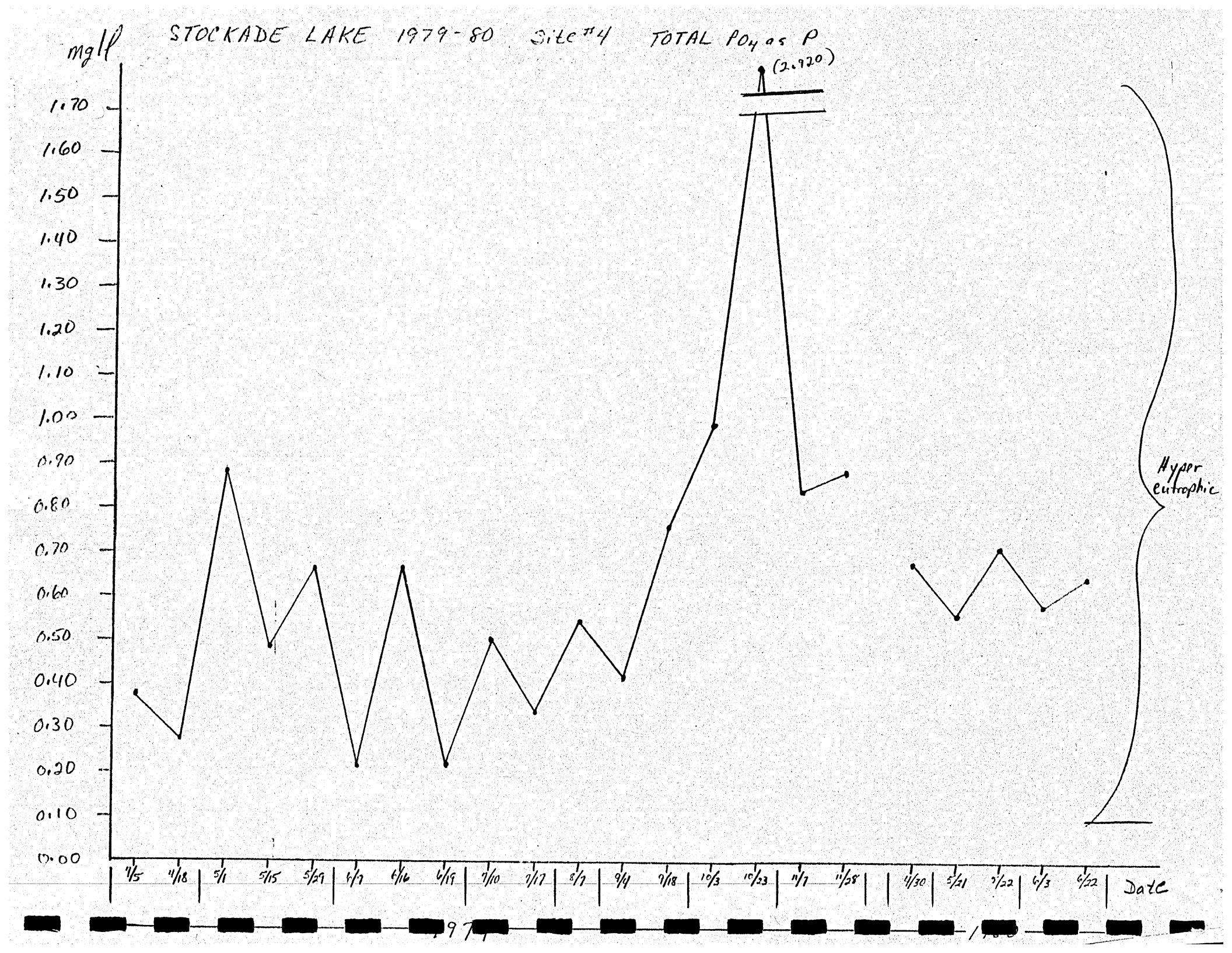
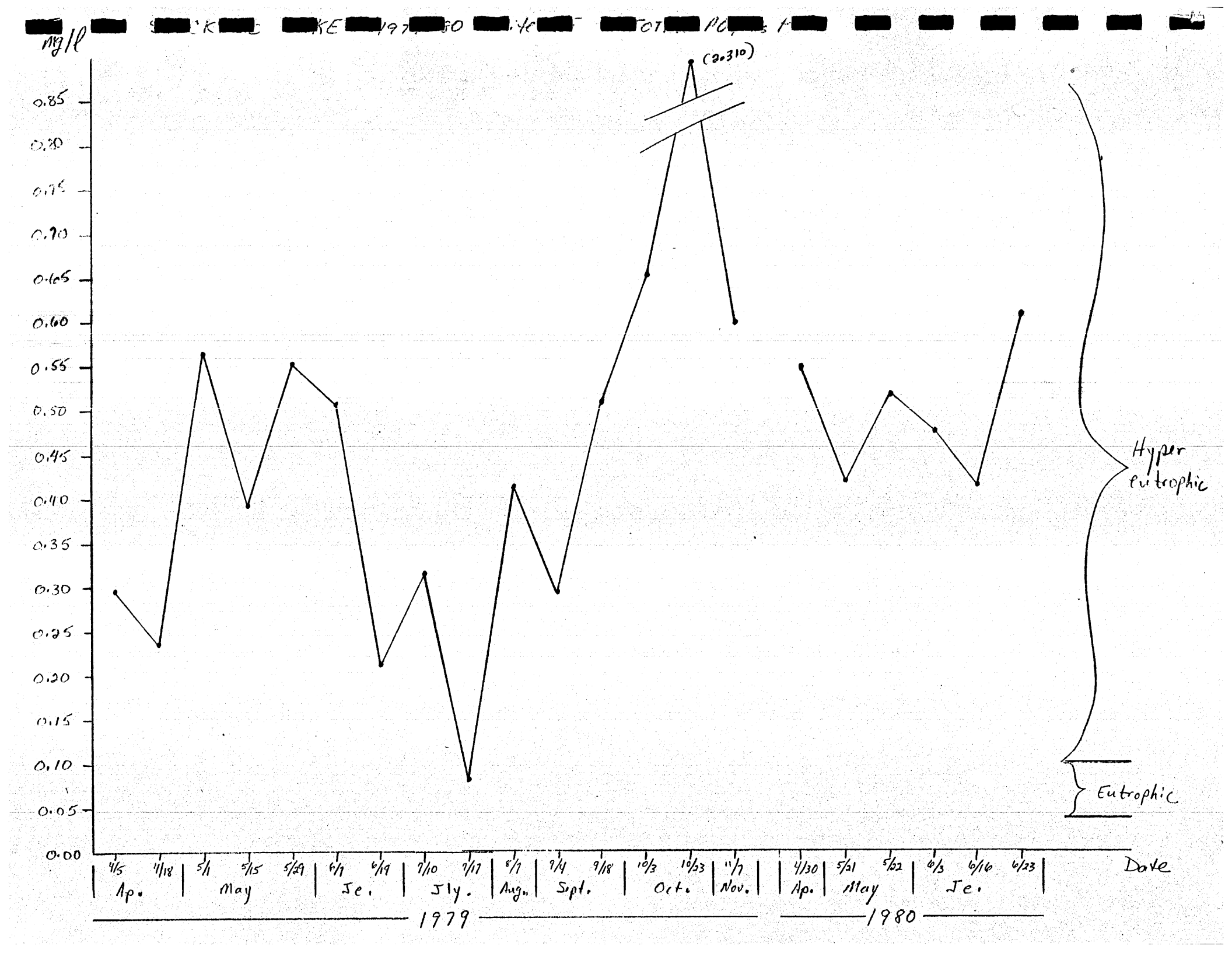
5/22
5/23
6/4
6/17
6/24
Date
1979
1980

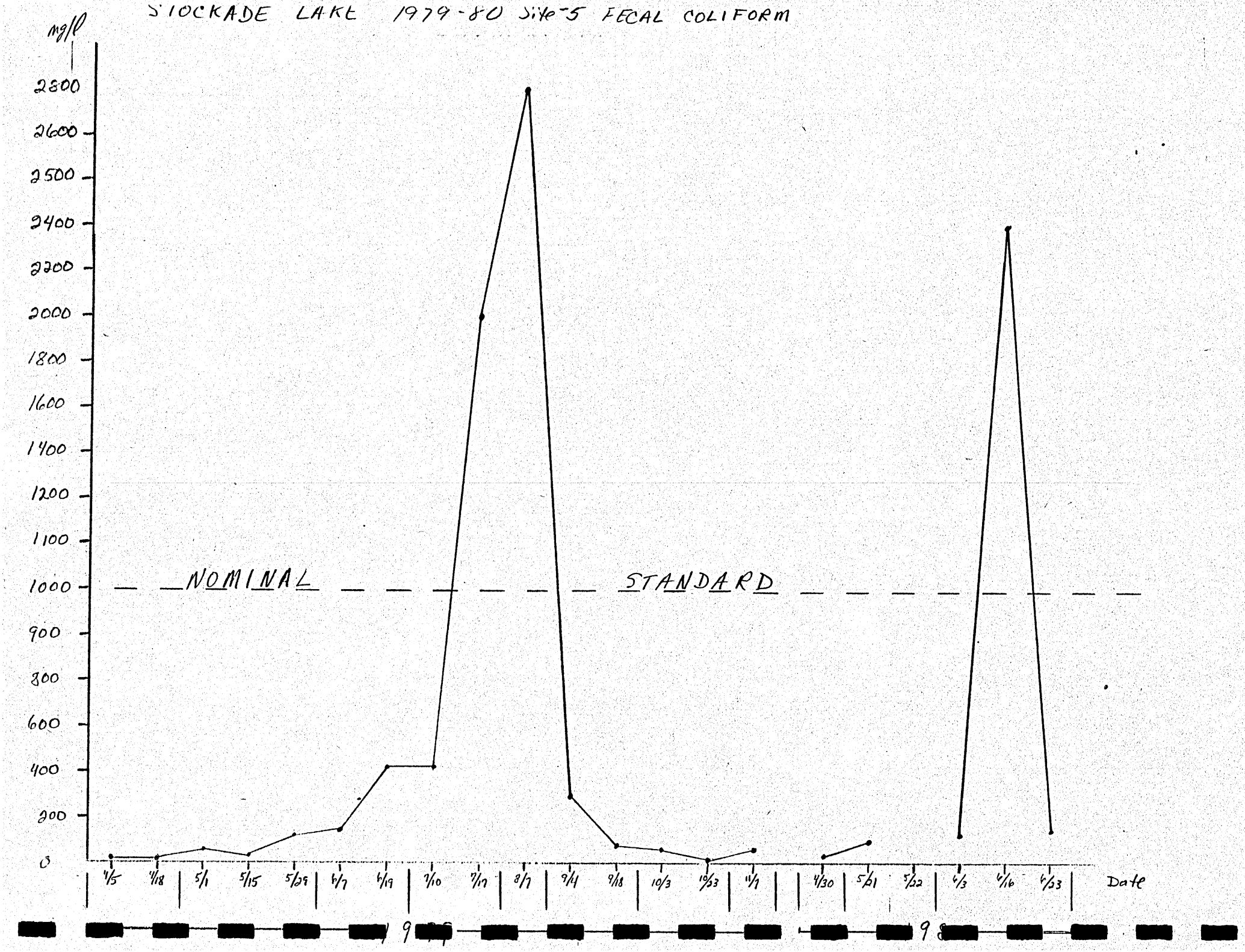

mg/l
(1.94)
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.70
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Hyper-eutrophic
Eutrophic
Meso-eutrophic
Oligo-Mesotrophic
Ultra-Oligotrophic
11/5
11/18
5/1
5/15
5/29
6/9
6/16
6/19
7/10
7/17
8/1
9/4
9/18
10/3
10/23
11/7
11/28
4/30
5/21
5/22
6/3
6/22
Date
Ap.
May
Je.
Jly.
Aug.
Sept.
Oct.
Nov.
Ap.
May
Je
1979
1980

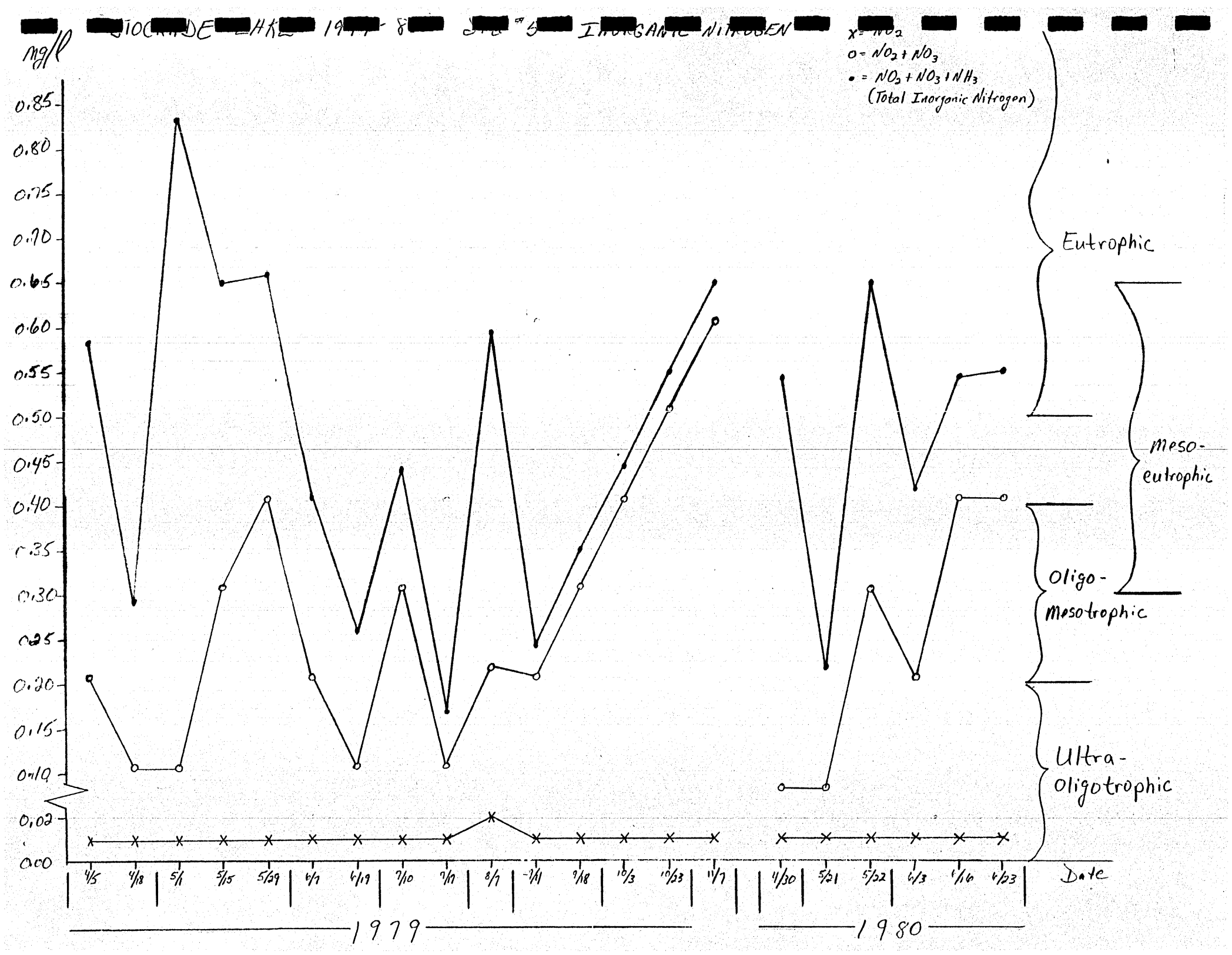

STOCKADE LAKE 1979-80 Site #4 INORGANIC NITROGEN
mg/l
X = NO2
o = NO2 + NO3
• = NO2 + NO3 + NH3
(Total Inorganic Nitrogen)
(2.11)
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.02
0.01
0.00
Eutrophic
meso-eutrophic
oligo-mesotrophic
ultra-oligotrophic
11/5 4/18 5/1 5/15 5/29 6/7 6/16 6/19 7/10 11/17 8/7 9/4 9/18 10/3 10/23 11/7 11/28 4/30 5/21 5/22 6/3 6/22
Date
Ap. May Je. Jly Aug. Sept. Oct. Nov. Ap. May Je.
1979 1980

[redacted] [redacted] [redacted] [

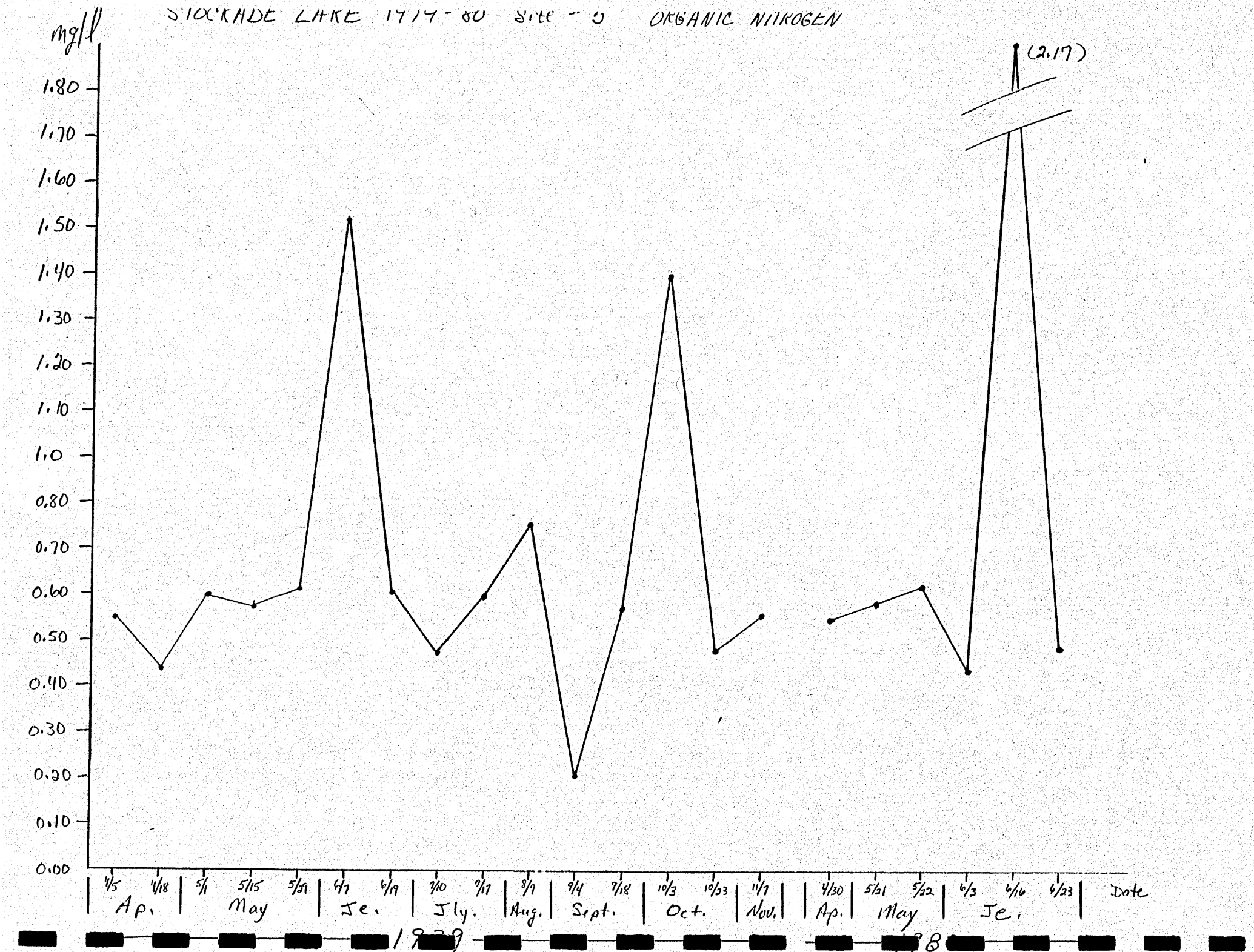

mg/l
STOCKADE LAKE 1979-80 Site #4 TOTAL PO4 as P
(2.920)
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Hyper eutrophic
11/5
11/18
5/1
5/15
5/29
6/7
6/16
6/19
7/10
7/17
8/7
9/4
9/18
10/3
10/23
11/7
11/28
4/30
5/21
7/22
6/3
6/22
Date


mg/l
(2.310)
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Hyper
Eutrophic
Eutrophic
4/5
4/18
5/1
5/15
5/29
6/11
6/19
7/10
7/17
8/7
9/4
9/18
10/3
10/23
11/7
4/30
5/21
5/22
6/3
6/16
6/23
Dave
Ap.
May
Je.
Jly.
Aug.
Sept.
Oct.
Nov.
Ap.
May
Je.
1979
1980

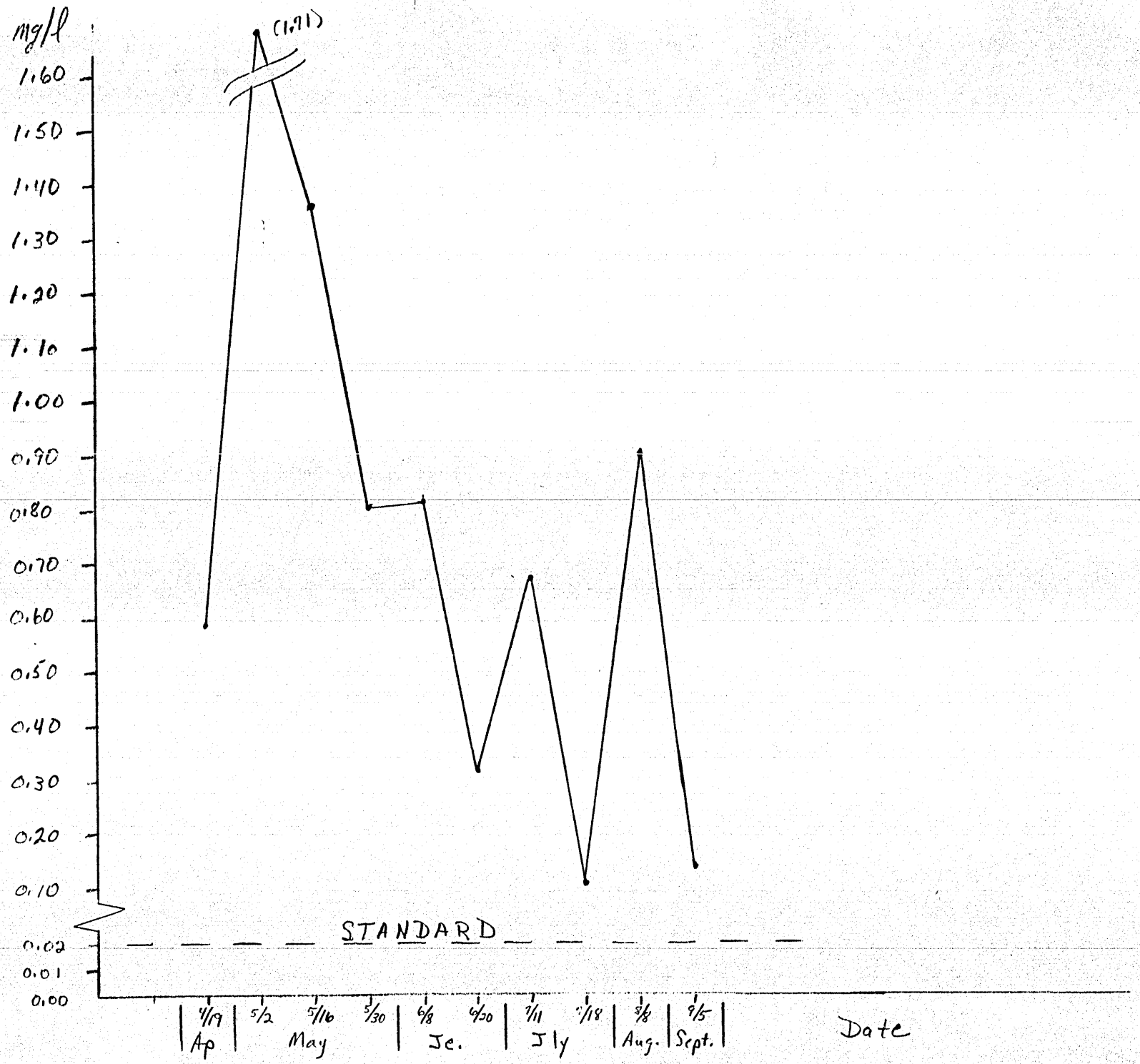

SIOCKADE LAKE 1979-80 Site-5 FECAL COLIFORM
mg/l
2800
2600
2500
2400
2200
2000
1800
1600
1400
1200
1100
1000
900
800
600
400
200
0
NOMINAL
STANDARD
11/5
11/18
5/1
5/15
5/29
6/7
6/19
7/10
7/17
8/7
9/4
9/18
10/3
10/23
11/1
4/30
5/21
5/22
6/3
6/16
6/23
Date

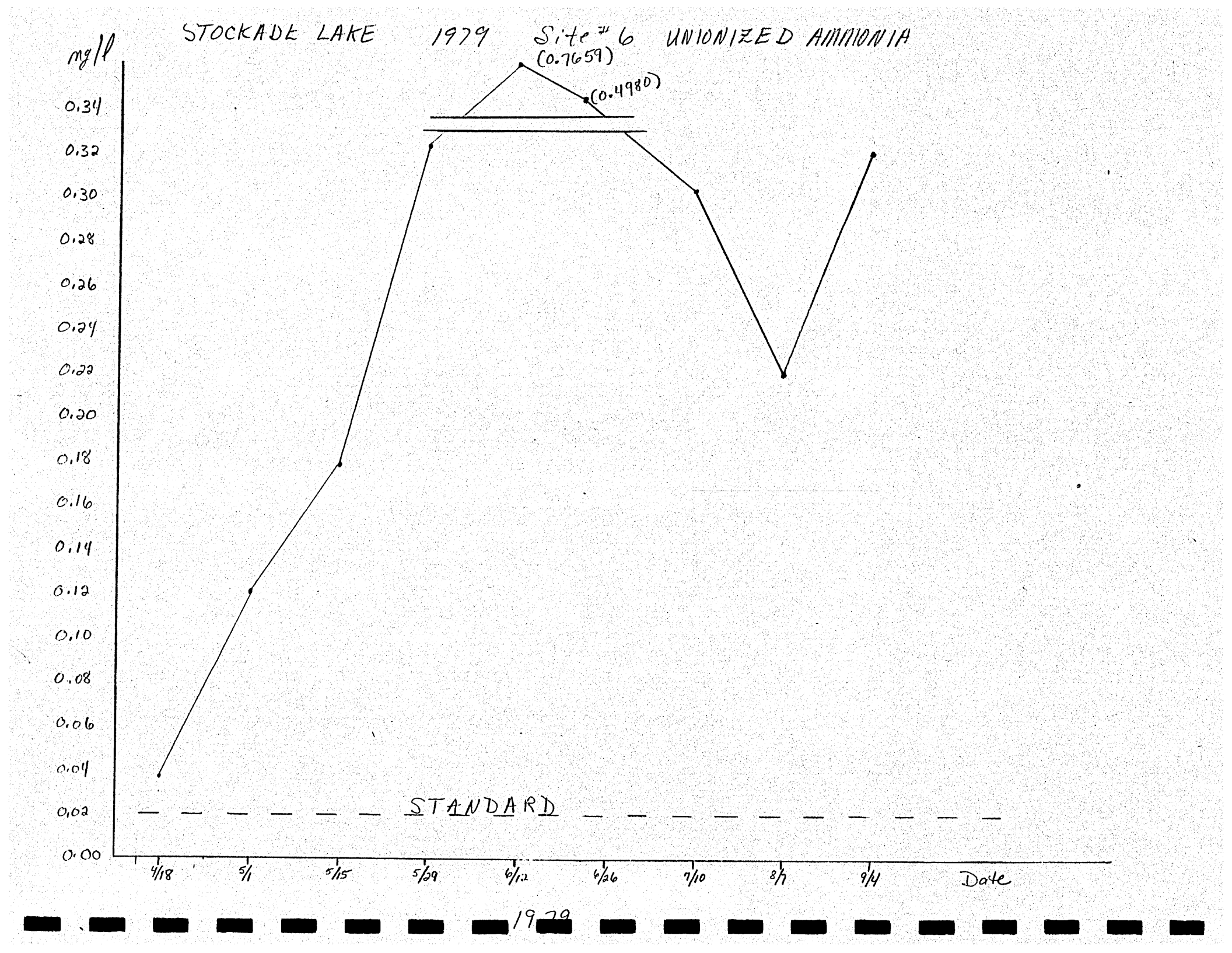


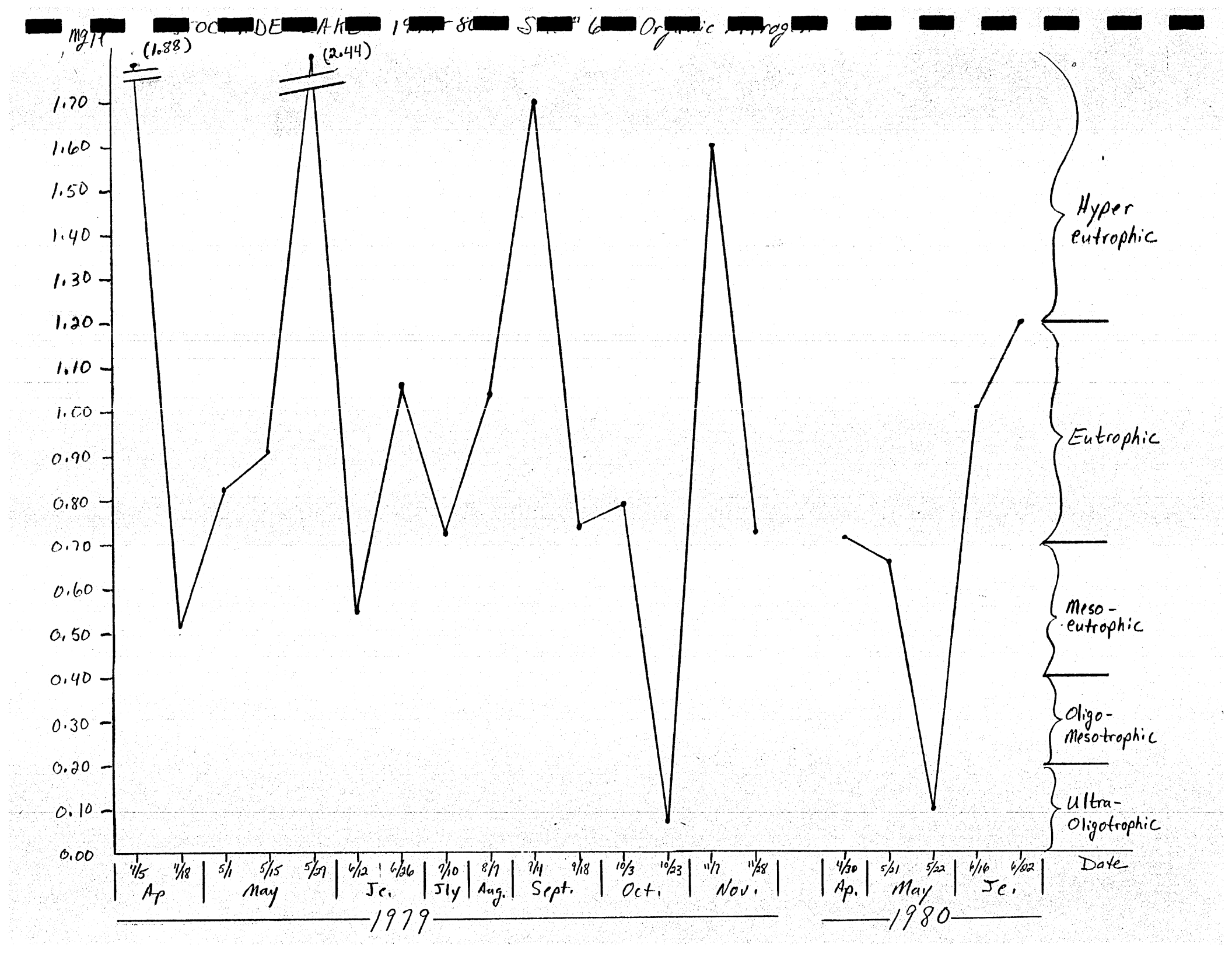
[redacted]TOC[redacted]DE [redacted]LAKE [redacted] 19[redacted] - 8[redacted] [redacted] #5 [redacted] INORGANIC NITROGEN
x = NO2
o = NO2 + NO3
• = NO2 + NO3 + NH3
(Total Inorganic Nitrogen)
mg/l
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.02
0.00
4/5
4/18
5/1
5/15
5/29
6/7
6/19
7/10
7/17
8/7
9/11
9/18
10/3
10/23
11/7
4/30
5/21
5/22
6/3
6/16
6/23
Date
1979
1980
Eutrophic
Meso-eutrophic
Oligo-Mesotrophic
Ultra-Oligotrophic


STOCKADE LAKE 1979-80 Site - 5 ORGANIC NITROGEN
mg/l
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.0
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
(2.17)
4/5
4/18
5/1
5/15
5/29
6/7
6/19
7/10
7/17
8/7
9/4
9/18
10/3
10/23
11/7
4/30
5/21
5/22
6/3
6/16
6/23
Date
Ap.
May
Je.
Jly.
Aug.
Sept.
Oct.
Nov.
Ap.
May
Je.
1979
1980

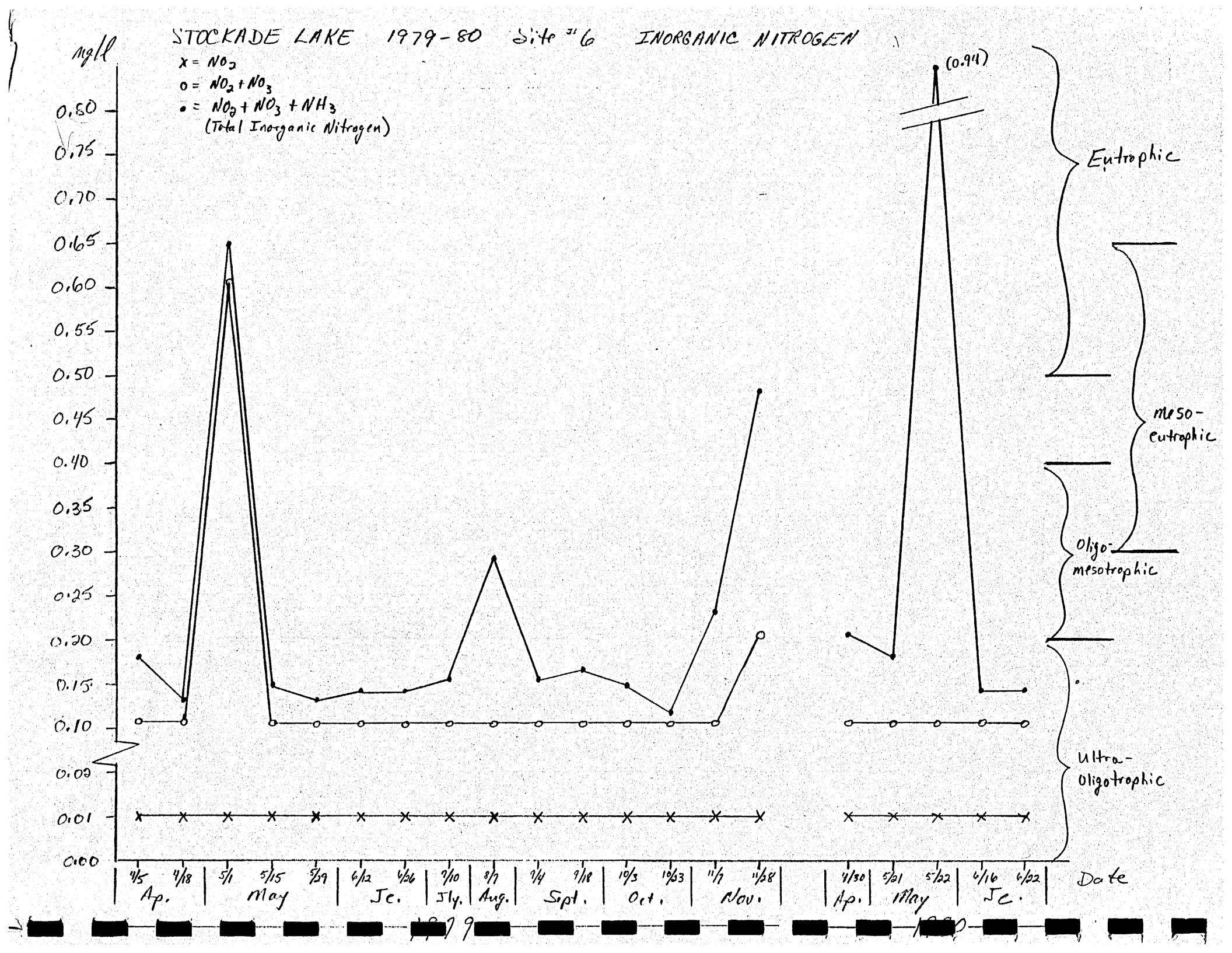
[redacted]

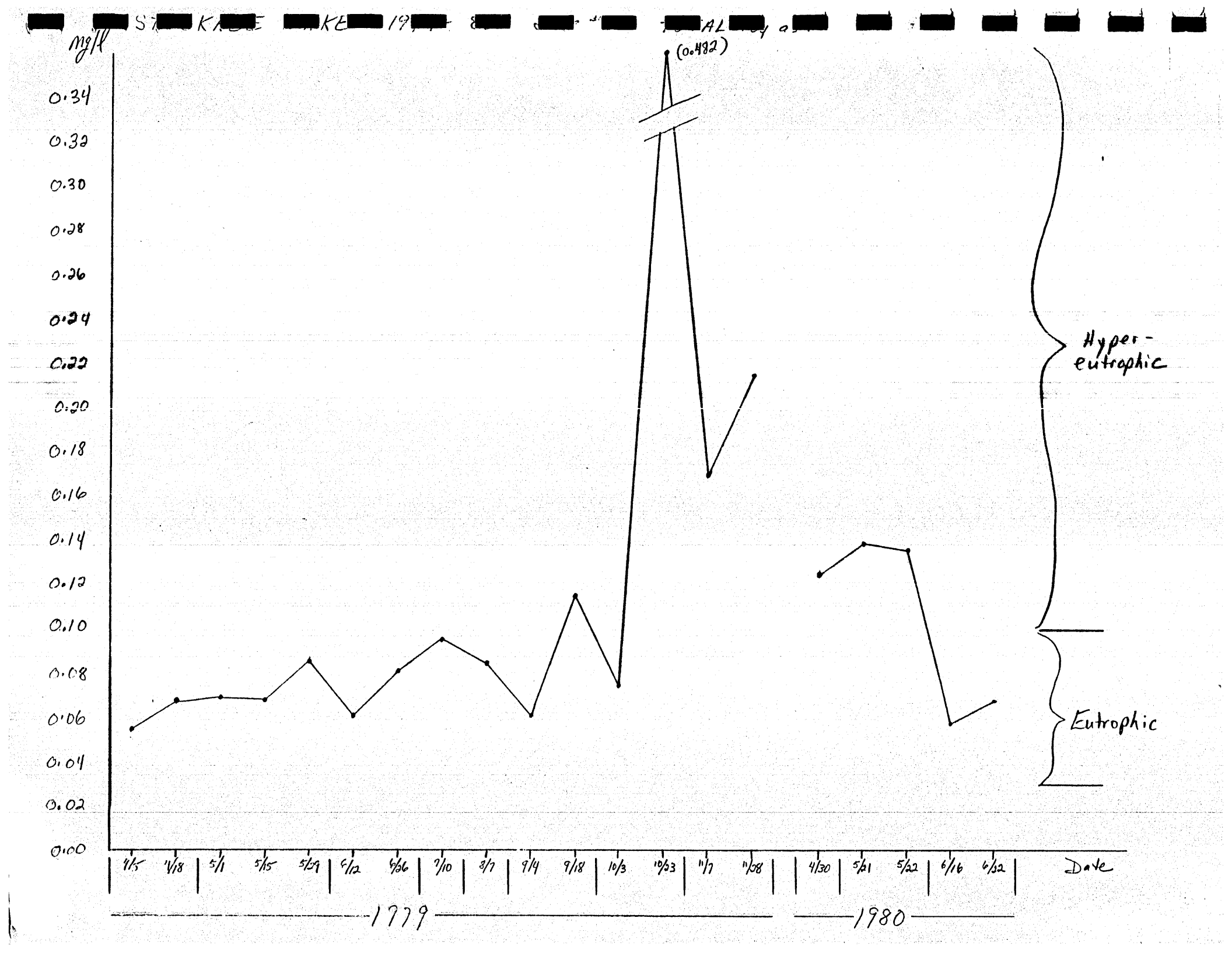

mg/l
(1.91)
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
STANDARD
0.02
0.01
0.00
4/19
5/2
5/16
5/30
6/8
6/20
7/11
7/18
8/8
9/15
Ap
May
Je.
Jly
Aug.
Sept.
Date


STOCKADE LAKE 1979 Site #6 UNIONIZED AMMONIA
mg/l
(0.7659)
(0.4980)
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
STANDARD
4/18
5/1
5/15
5/29
6/12
6/26
7/10
8/7
9/4
Date
1979

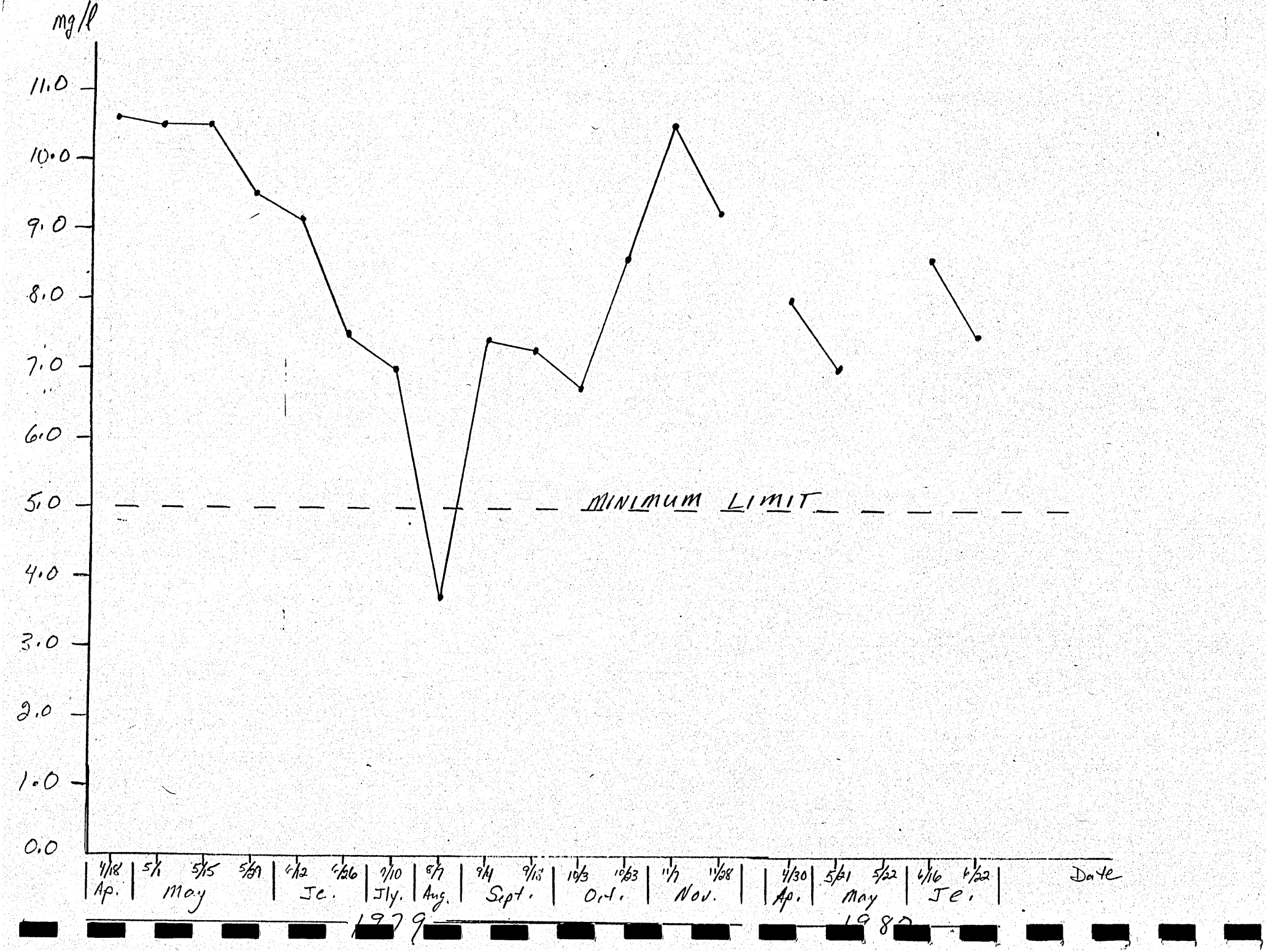


mg/l
(1.88)
(2.44)
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Hyper eutrophic
Eutrophic
Meso-eutrophic
Oligo-Mesotrophic
Ultra-Oligotrophic
4/5
4/18
5/1
5/15
5/29
6/12
6/26
7/10
8/7
9/4
9/18
10/3
10/23
11/7
11/28
4/30
5/21
5/22
6/16
6/22
Date
Ap
May
Je.
Jly
Aug.
Sept.
Oct.
Nov.
Ap.
May
Je.
1979
1980

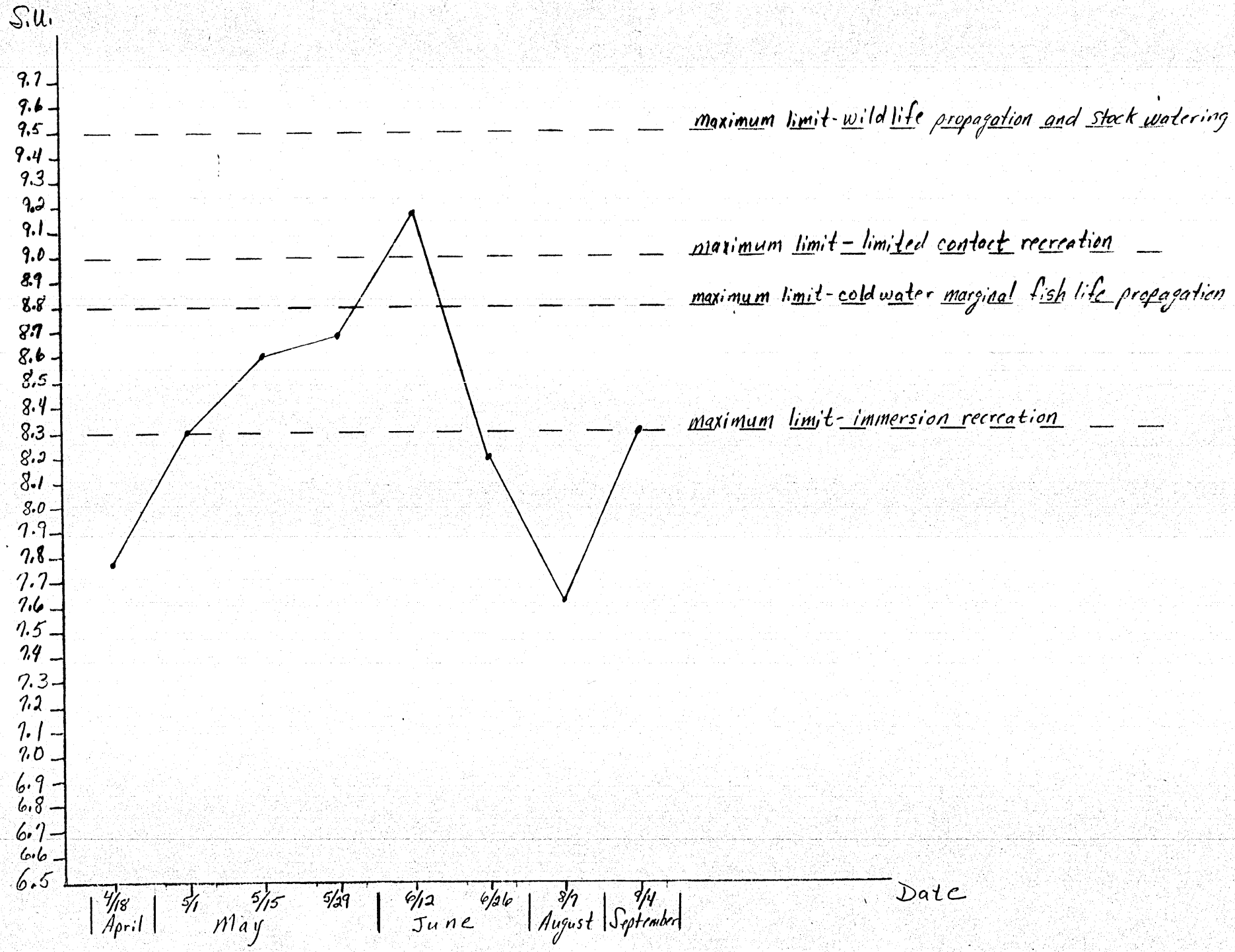

STOCKADE LAKE 1979-80 Site #6 INORGANIC NITROGEN
mg/l
x = NO2
o = NO2 + NO3
• = NO2 + NO3 + NH3
(Total Inorganic Nitrogen)
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.09
0.01
0.00
(0.94)
Eutrophic
meso-
eutrophic
Oligo-
mesotrophic
Ultra-
Oligotrophic
4/5 4/18 5/1 5/15 5/29 6/12 6/26 7/10 8/7 9/4 9/18 10/3 10/23 11/7 11/28 4/30 5/21 5/22 6/16 6/22
Date
Ap. May Jc. Jly. Aug. Sept. Oct. Nov. Ap. May Jc.
1979 1980

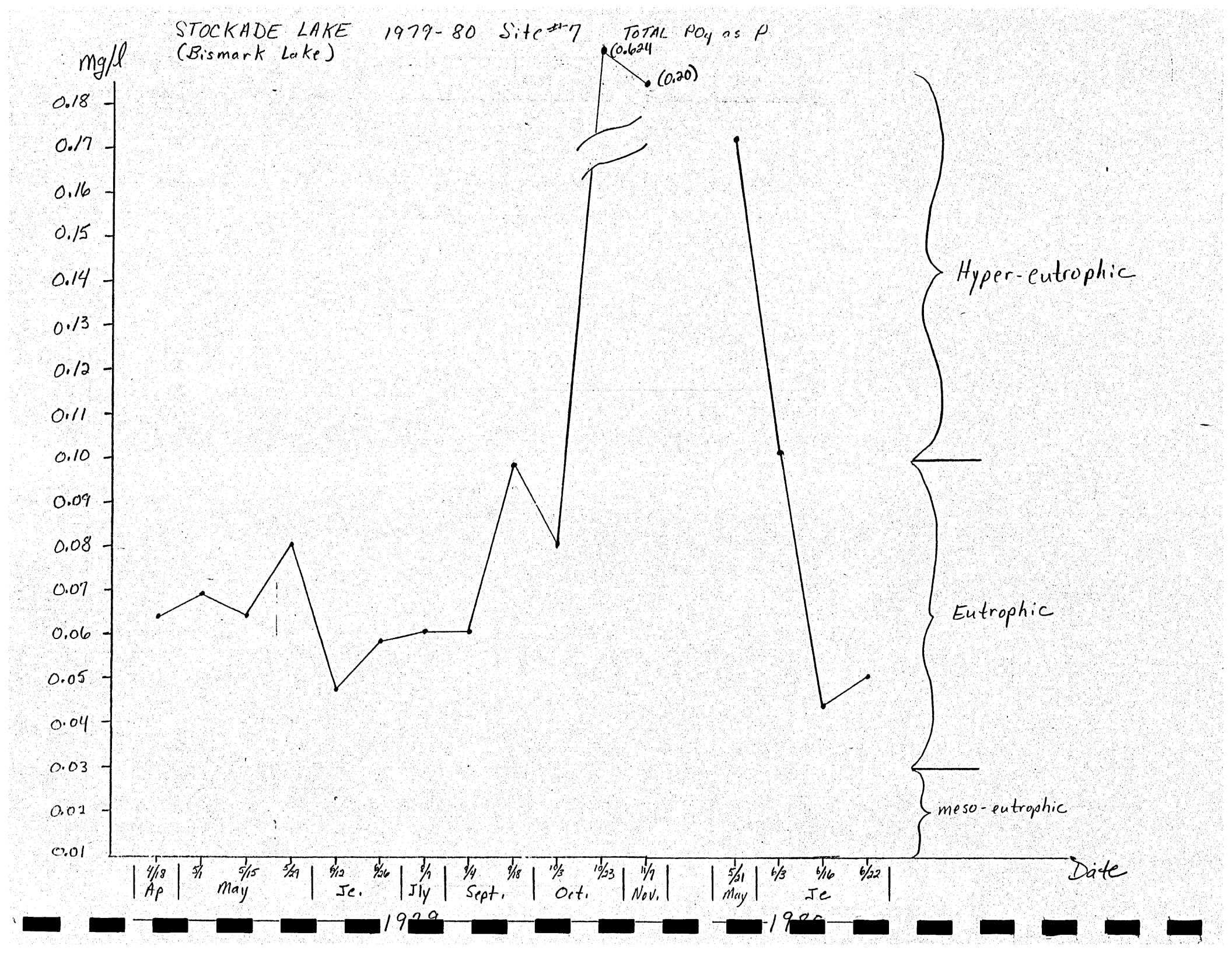

mg/l
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
(0.482)
Hyper-
eutrophic
Eutrophic
4/5
4/18
5/1
5/15
5/29
6/12
6/26
7/10
8/7
9/4
9/18
10/3
10/23
11/7
11/28
4/30
5/21
5/22
6/16
6/32
Date
1979
1980

STOCKADE LAKE 1979-80 Site # 6 DISSOLVED OXYGEN



[redacted] K[redacted] [redacted] 19[redacted] [redacted] [redacted]
(Bismark Lake)




STOCKADE LAKE 1979-80 Site #7 TOTAL PO4 as P
(Bismark Lake)
mg/l
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
(0.624)
(0.20)
Hyper-eutrophic
Eutrophic
meso-eutrophic
4/8
5/1
5/15
5/29
6/12
6/26
8/1
8/14
9/18
10/3
10/23
11/9
5/21
6/3
6/16
6/22
Ap
May
Je.
Jly
Sept.
Oct.
Nov.
May
Je
1979
1980
Date

[redacted] STOCKADE LAKE [redacted] 1979-80 SITE 1 [redacted] INORGANIC NITROGEN [redacted]

(Bismark Lake)

mg/l

• = NO_2

o = $NO_2 + NO_3$

x = $NO_2 + NO_3 + NH_3$
(Total Inorganic Nitrogen)

0.65

0.4

Meso-
eutrophic

Oligo-
mesotrophic

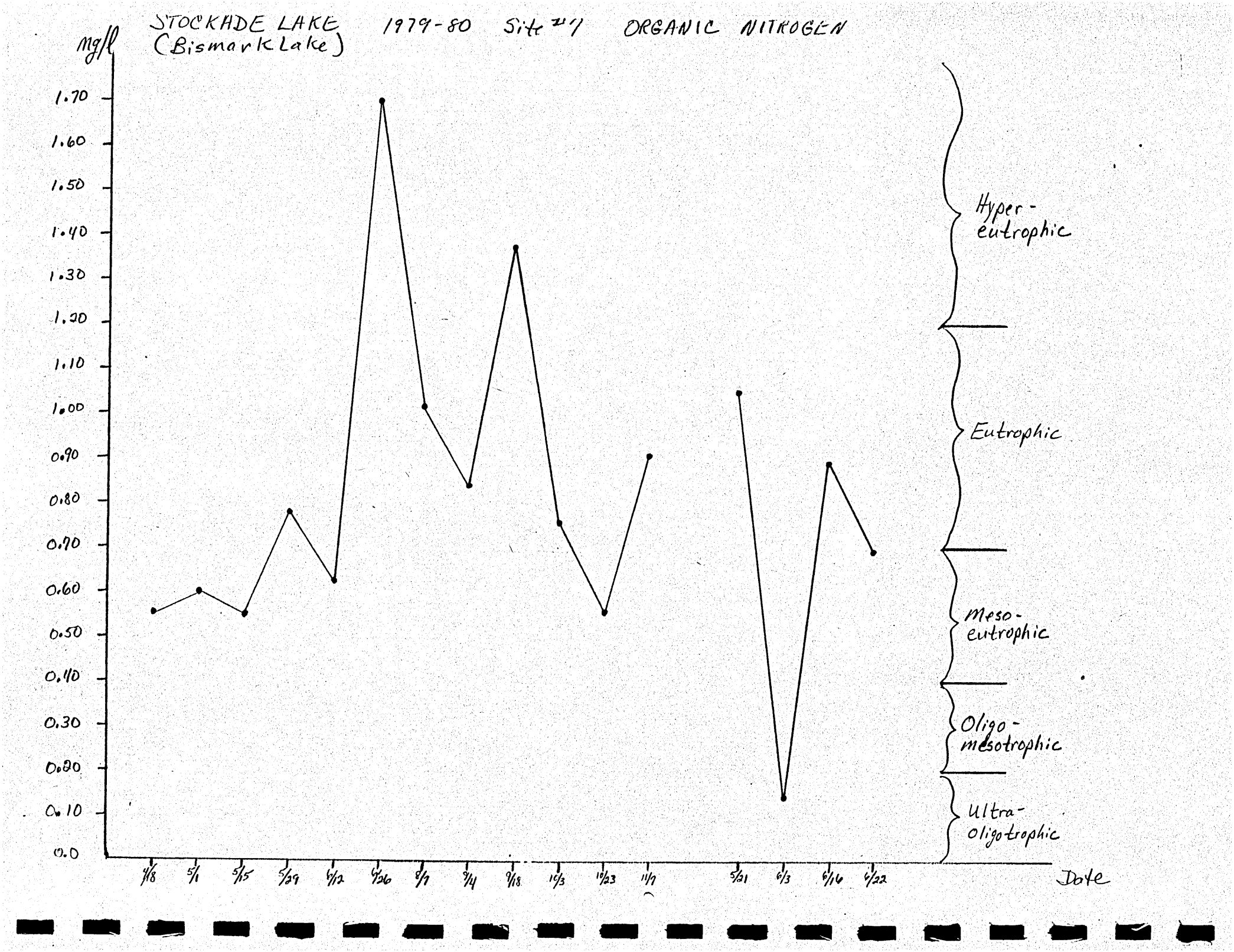
Ultra-
oligotrophic

0.36
0.35
0.34
0.33
0.32
0.31
0.30
0.29
0.28
0.27
0.26
0.25
0.24
0.23
0.22
0.21
0.20
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.02
0.01
0.00

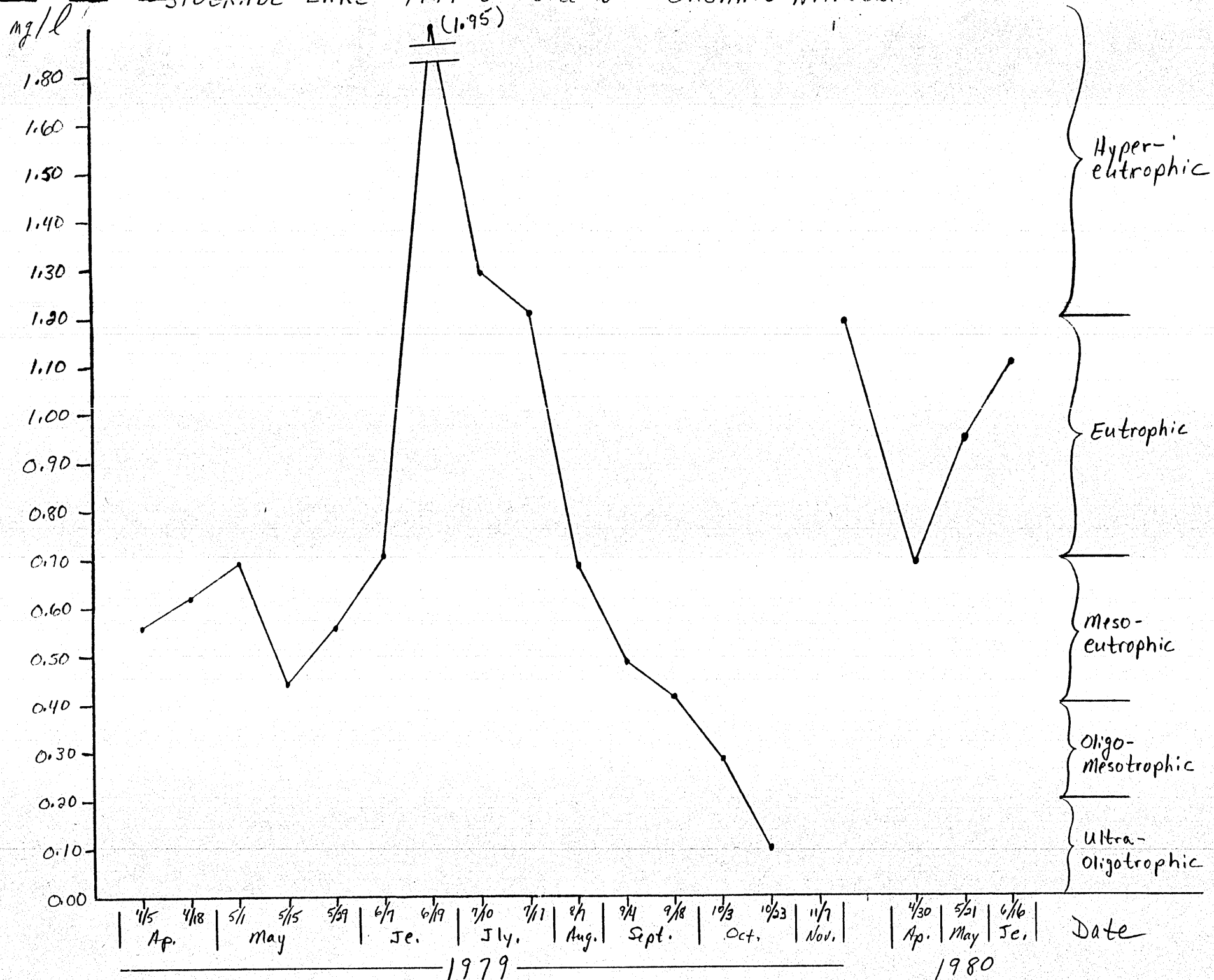
4/18 Ap. | 5/1 | 5/15 | 5/29 May | 6/12 | 6/26 Je. | 8/7 Aug. | 9/4 | 9/18 Sept. | 10/5 | 10/23 Oct. | 11/7 Nov. | 1979

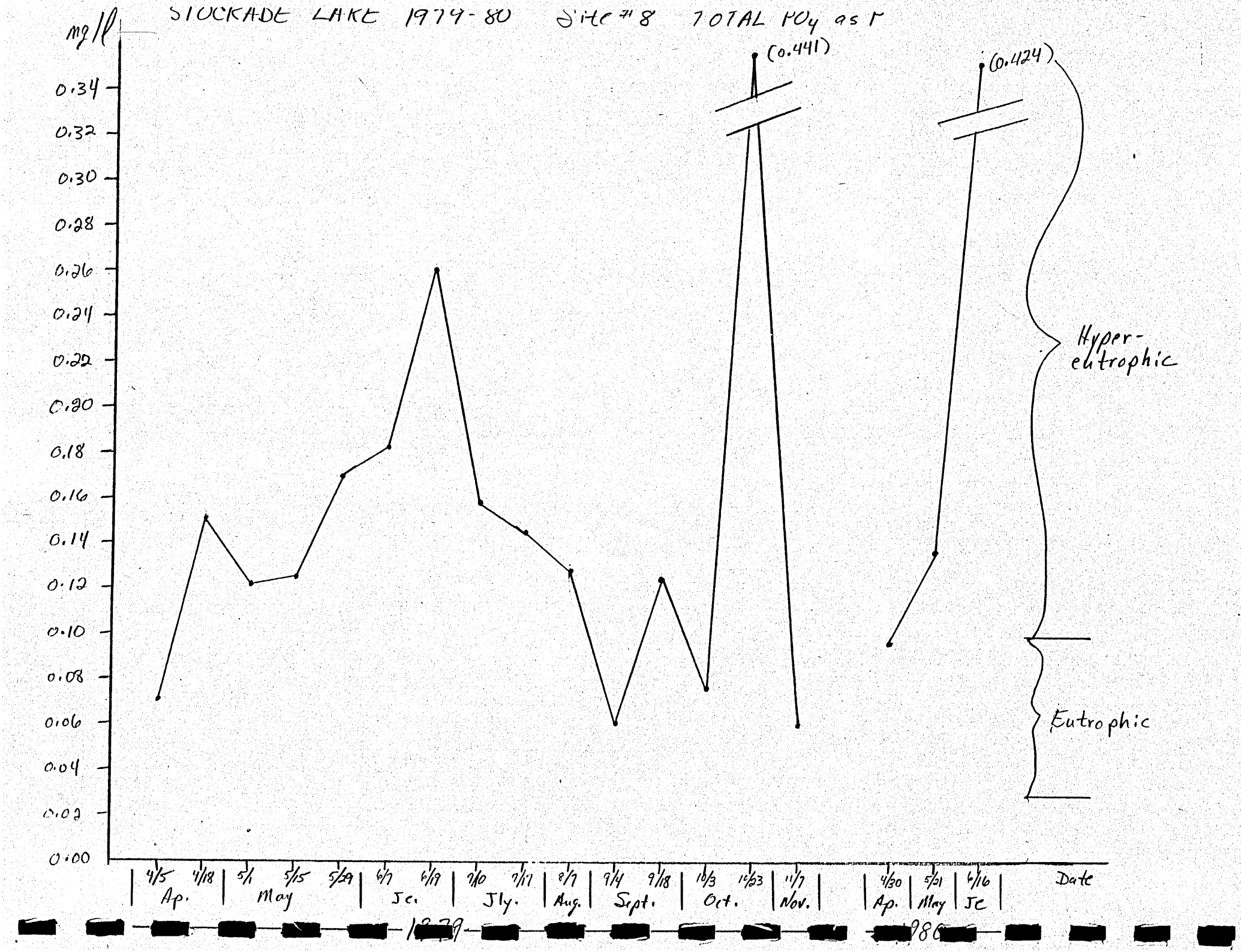
5/21 May | 6/3 | 6/16 | 6/22 Je. | 1980

Date

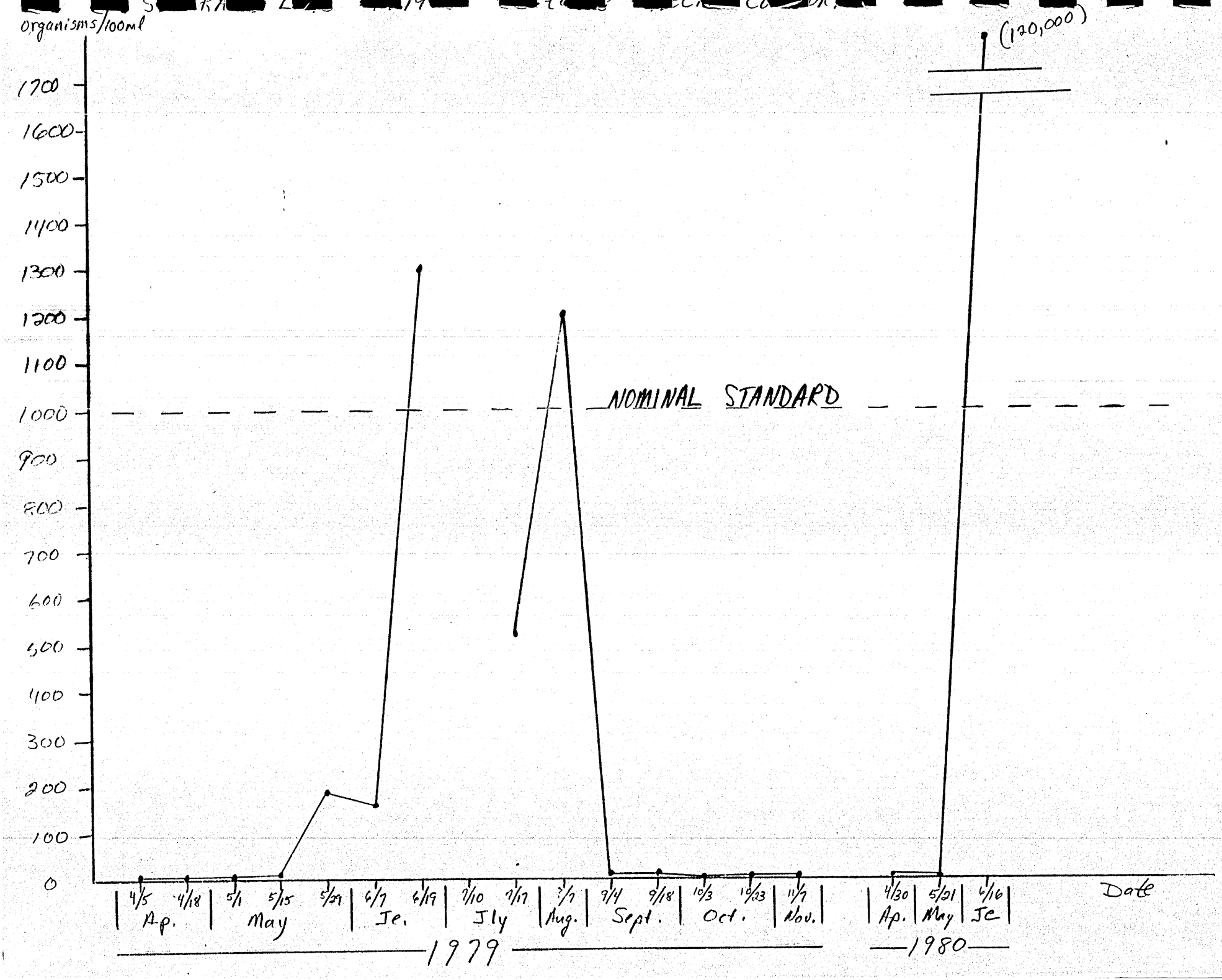

STOCKADE LAKE (Bismark Lake) 1979-80 Site #1 ORGANIC NITROGEN
mg/l
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.0
4/8
5/1
5/15
5/29
6/12
6/26
8/7
9/4
9/18
10/3
10/23
11/7
5/21
6/3
6/16
6/22
Date
Hyper-eutrophic
Eutrophic
Meso-eutrophic
Oligo-mesotrophic
Ultra-oligotrophic

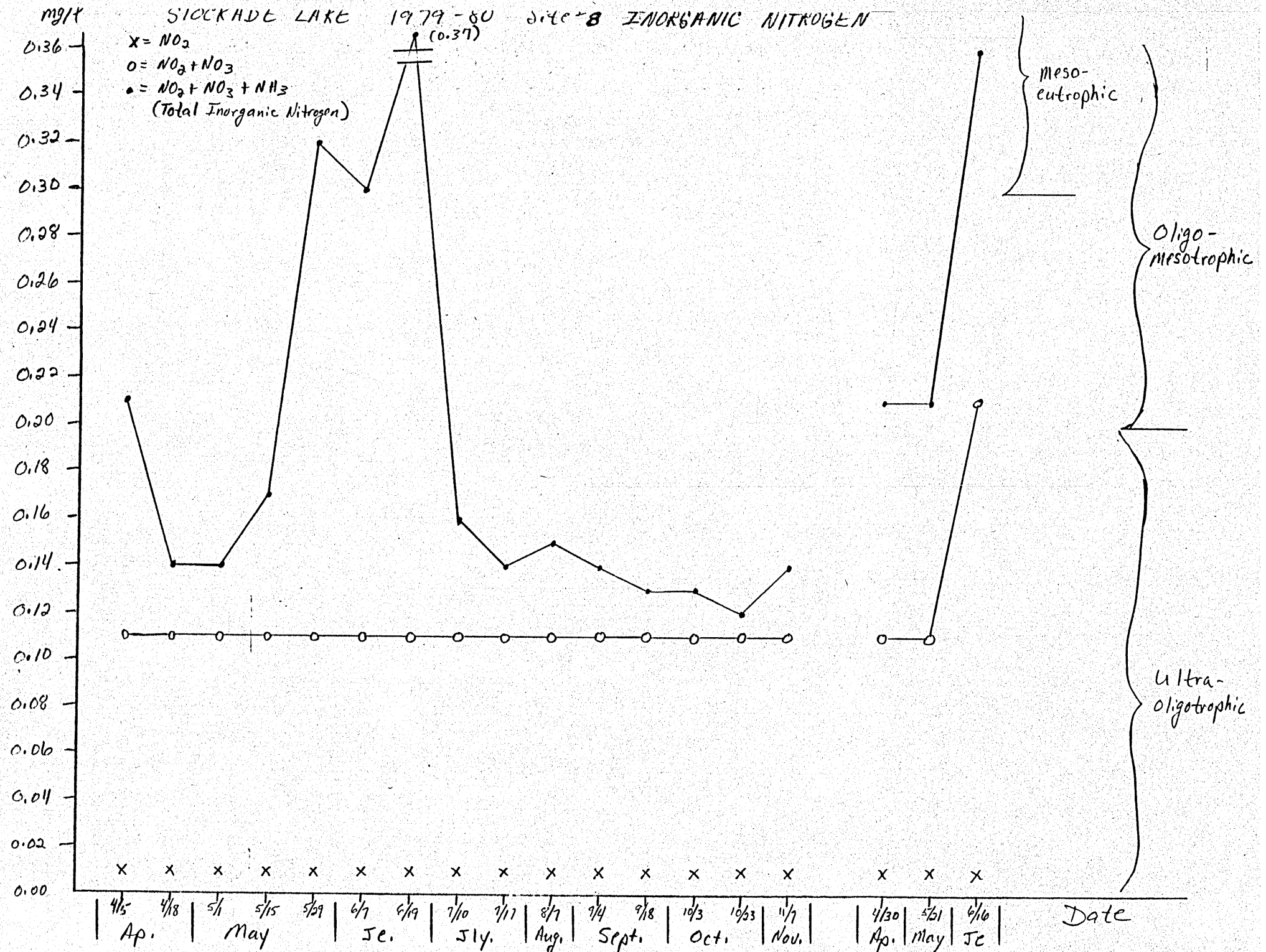
[redacted] STOCKADE LAKE 1979-80 SURFACE ORGANIC NITROGEN



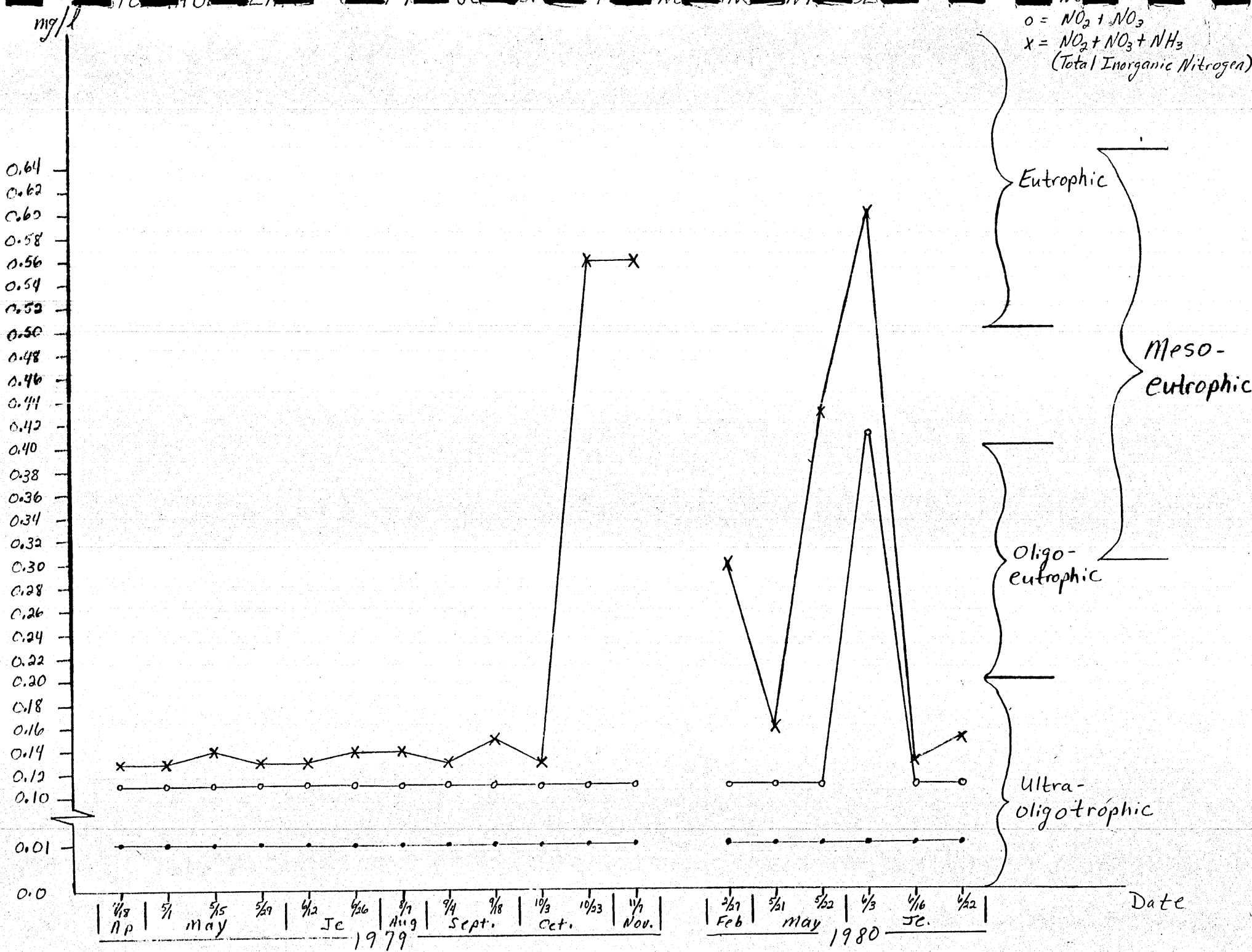

STOCKADE LAKE 1979-80 Site #8 TOTAL PO4 as P
mg/l
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
(0.441)
(0.424)
Hyper-eutrophic
Eutrophic
4/5 4/18 5/1 5/15 5/29 6/7 6/19 7/10 7/11 8/7 9/4 9/18 10/3 10/23 11/7 4/30 5/21 6/16
Ap. May Jc. Jly. Aug. Sept. Oct. Nov. Ap. May Jc
Date
1979
1980

[redacted] SITKA [redacted] 1979 [redacted] TOTAL COLIFORM [redacted]

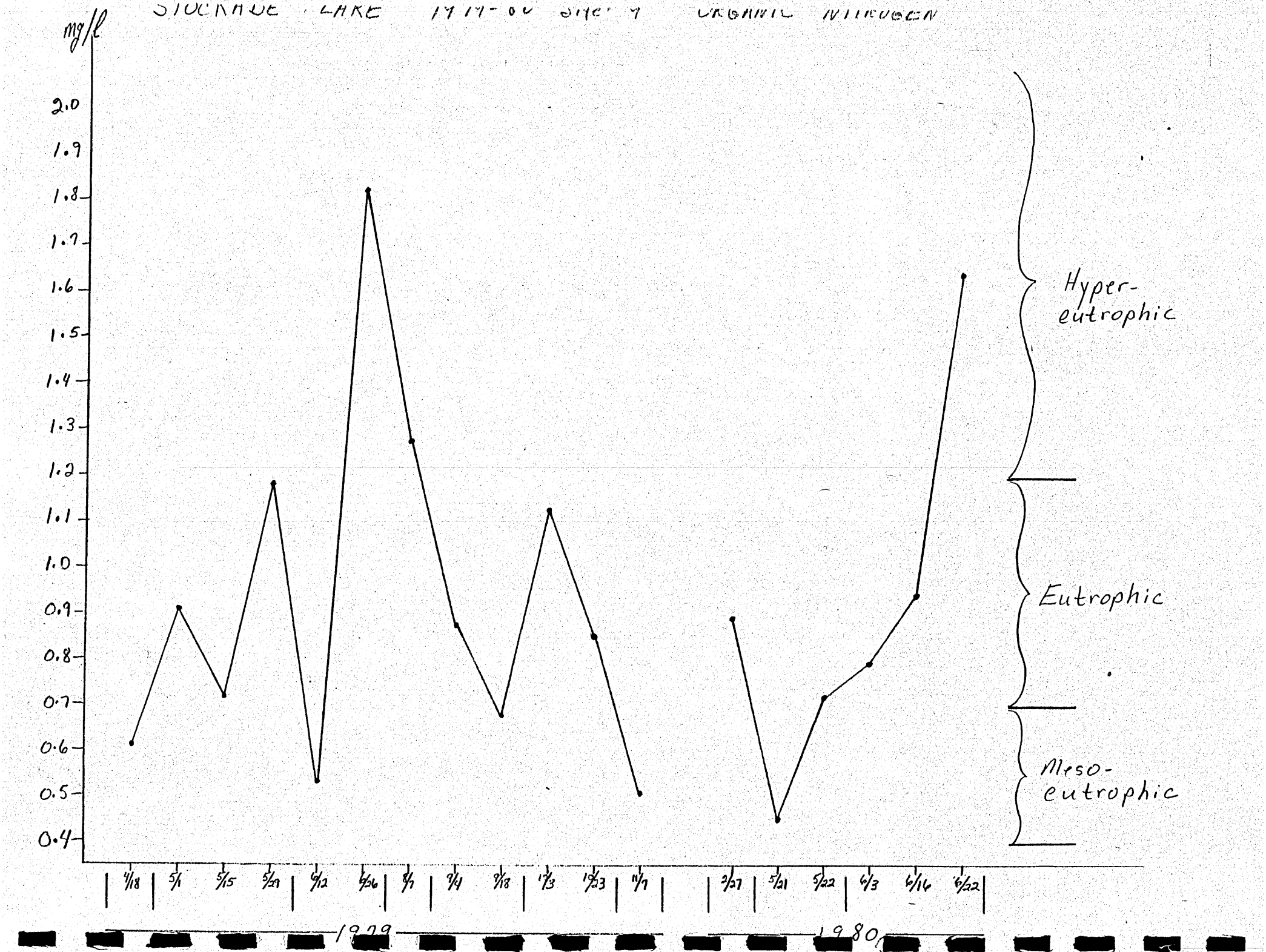




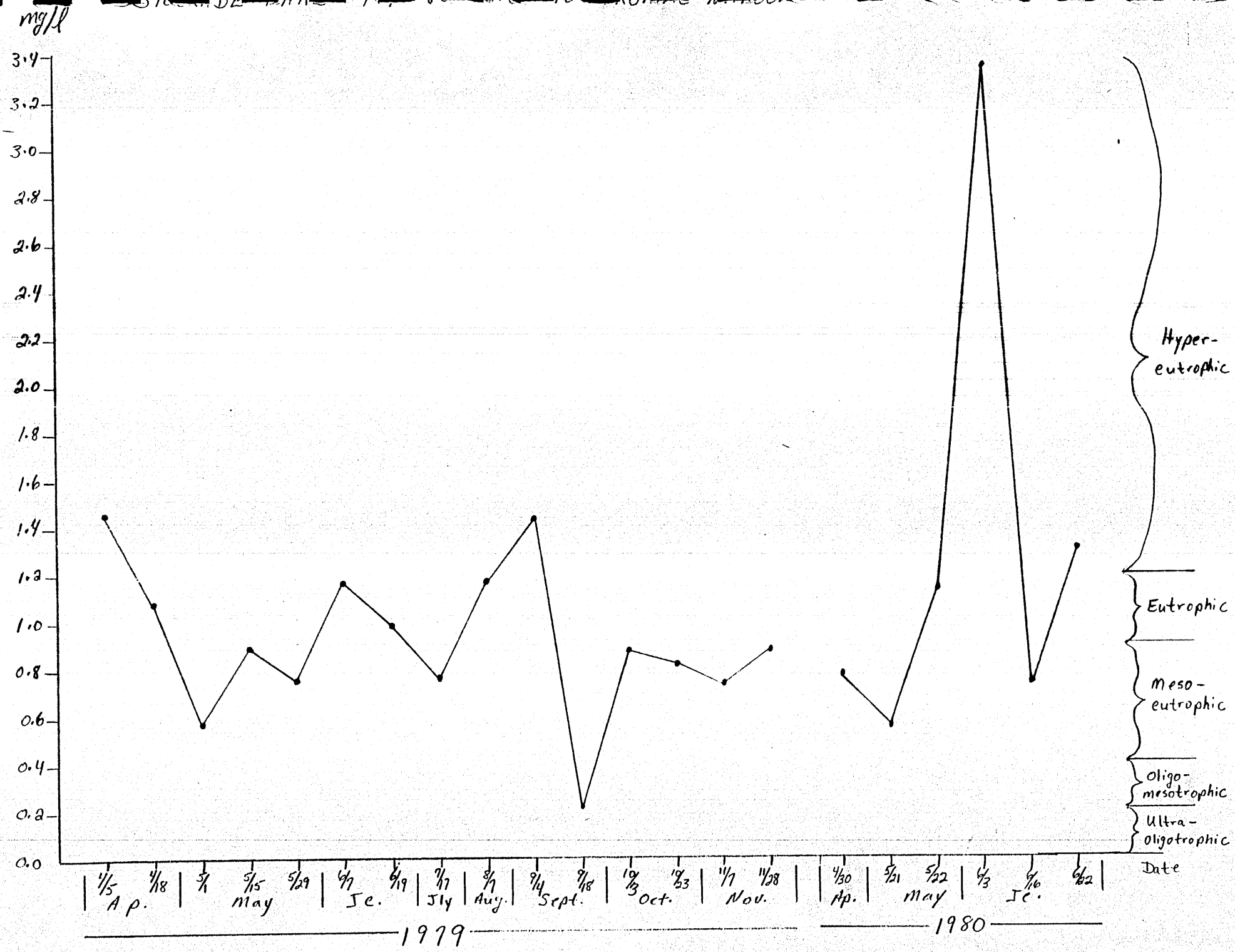
STOCKADE LAKE 1979-80 Site #8 INORGANIC NITROGEN
mg/l
x = NO2
o = NO2 + NO3
• = NO2 + NO3 + NH3
(Total Inorganic Nitrogen)
(0.37)
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Meso-eutrophic
Oligo-mesotrophic
Ultra-oligotrophic
4/5 4/18 5/1 5/15 5/29 6/7 6/19 7/10 7/17 8/7 9/4 9/18 10/3 10/23 11/7 4/30 5/21 6/16
Ap. May Je. Jly. Aug. Sept. Oct. Nov. Ap. May Je
Date

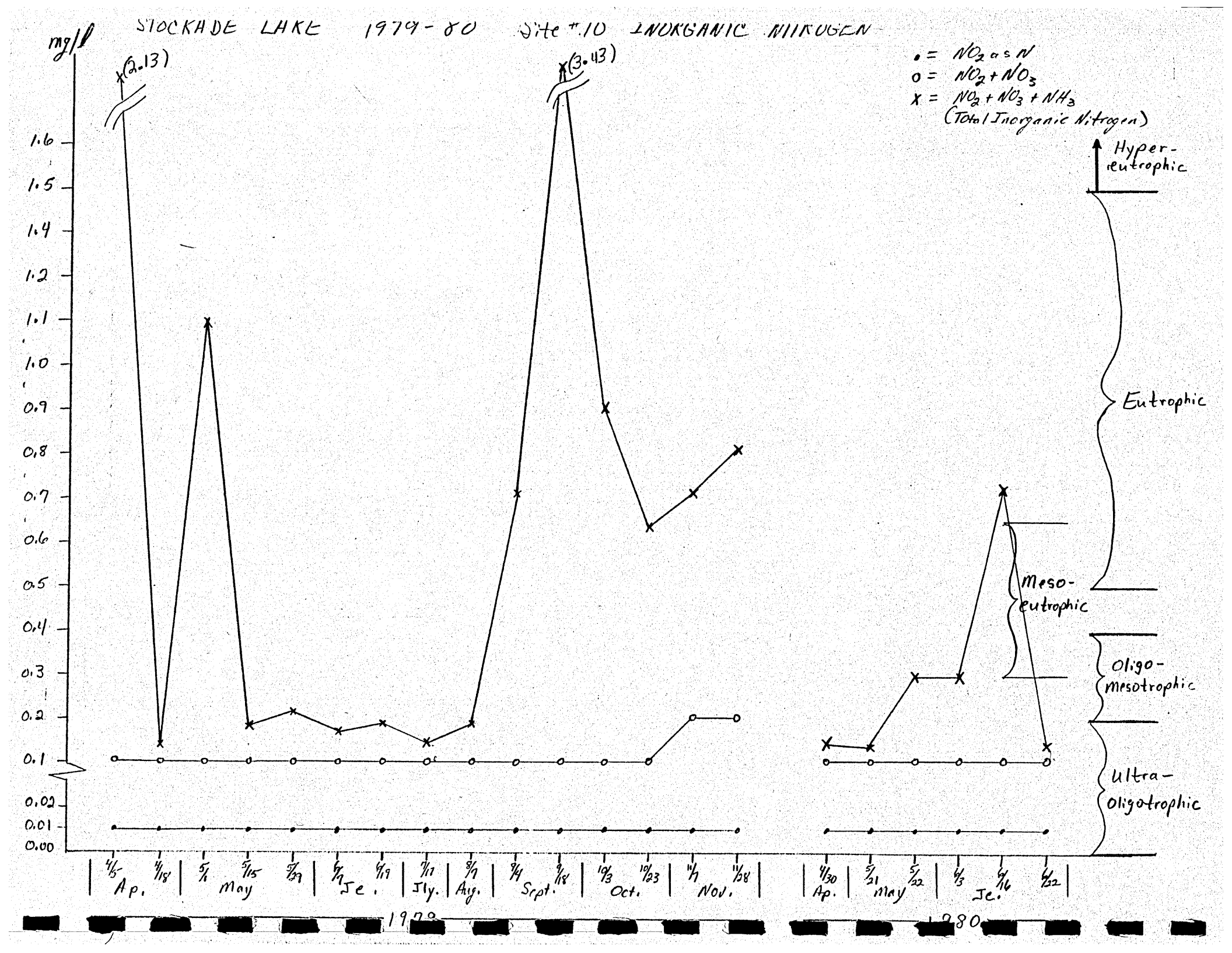

mg/l
o = $NO_2 + NO_3$
x = $NO_2 + NO_3 + NH_3$
(Total Inorganic Nitrogen)
0.64
0.62
0.60
0.58
0.56
0.54
0.52
0.50
0.48
0.46
0.44
0.42
0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.01
0.0
Eutrophic
Meso-
eutrophic
Oligo-
eutrophic
Ultra-
oligotrophic
11/8
Ap
5/1
May
5/15
5/29
6/12
Je
6/26
8/7
Aug
9/4
9/18
Sept.
10/3
10/23
Oct.
11/7
Nov.
1979
2/27
Feb
5/21
May
5/22
6/3
6/16
Jc.
6/22
1980
Date

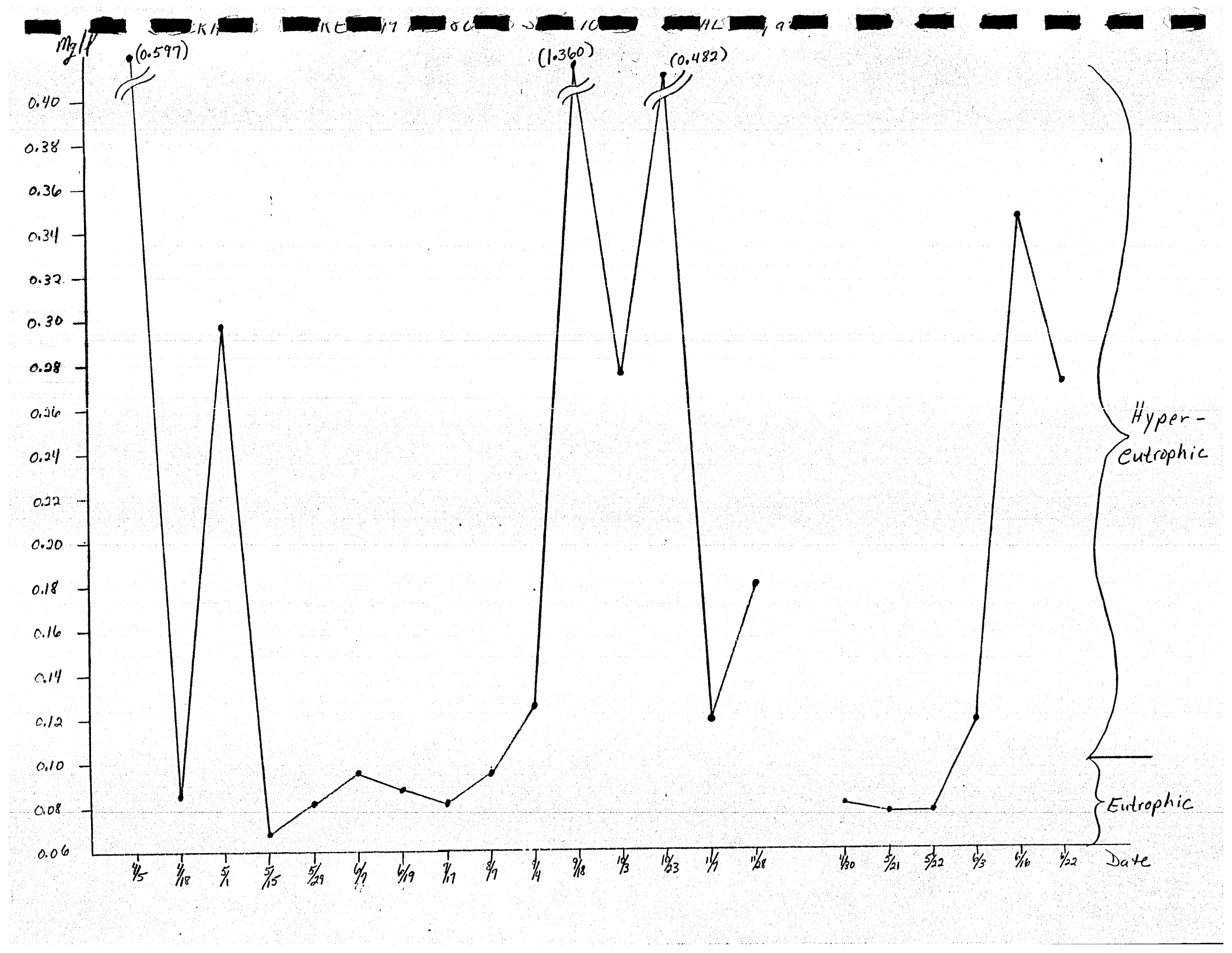
SUCKAUE LAKE 1979-80 SITE 4 ORGANIC NITROGEN

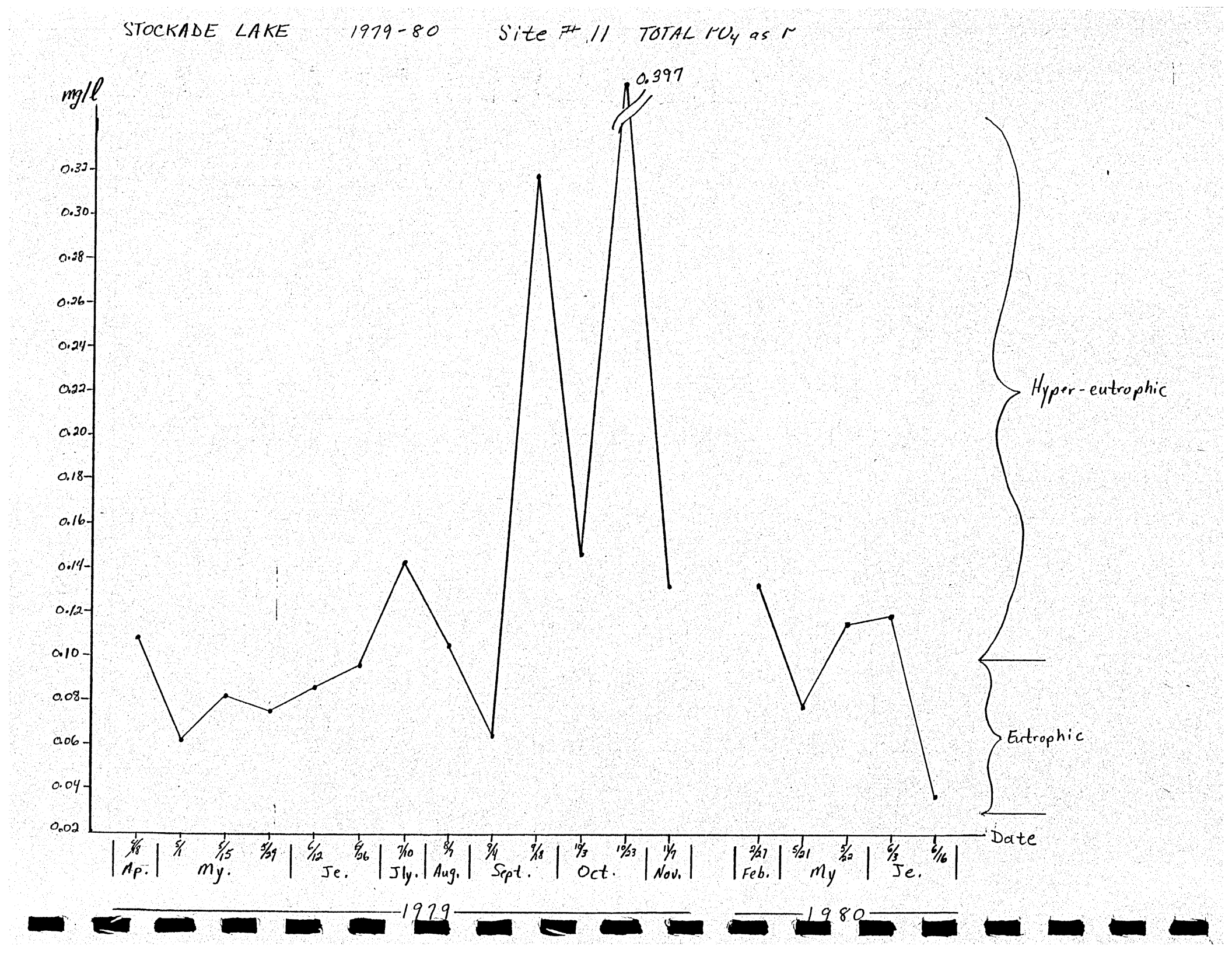


[redacted]

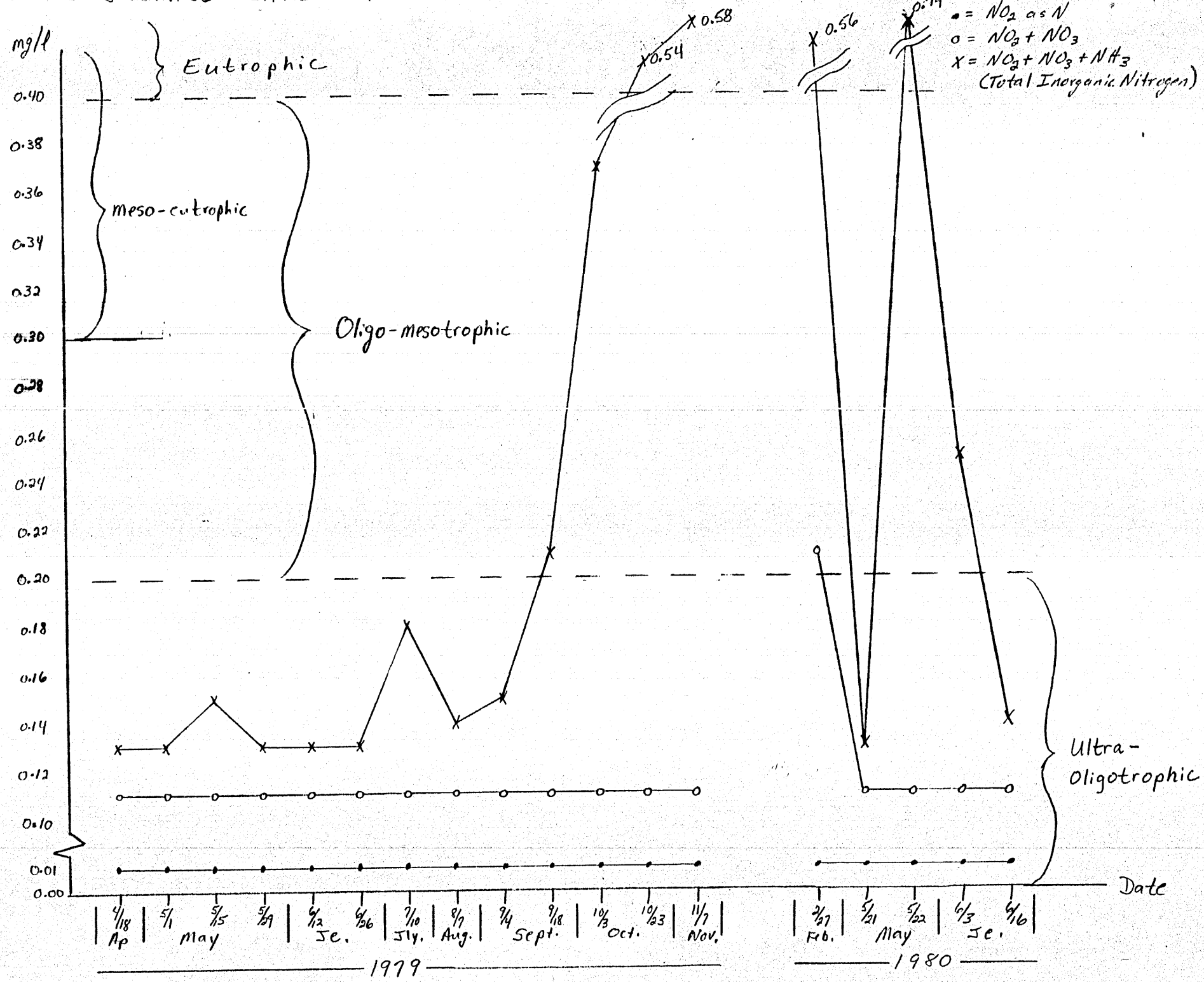

mg/l
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Hyper-eutrophic
Eutrophic
Meso-eutrophic
Oligo-mesotrophic
Ultra-oligotrophic
1/5
4/18
5/1
5/15
5/29
6/7
6/19
7/17
8/7
9/4
9/18
10/3
10/23
11/7
11/28
4/30
5/21
5/22
6/3
6/16
6/22
Ap.
May
Je.
July
Aug.
Sept.
Oct.
Nov.
Ap.
May
Je.
Date
1979
1980


STOCKADE LAKE 1979-80 Site #10 INORGANIC NITROGEN
mg/l
(2.13)
(3.43)
• = NO2 as N
o = NO2 + NO3
x = NO2 + NO3 + NH3
(Total Inorganic Nitrogen)
1.6
1.5
1.4
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.02
0.01
0.00
Hyper-eutrophic
Eutrophic
Meso-eutrophic
Oligo-mesotrophic
Ultra-Oligotrophic
4/15 4/18 5/1 5/15 5/29 6/9 6/19 7/11 8/1 8/14 9/2 9/18 10/3 10/23 11/7 11/28
Ap. May Je. Jly. Aug. Sept. Oct. Nov.
1979
4/30 5/21 5/22 6/3 6/16 6/22
Ap. May Je.
1980

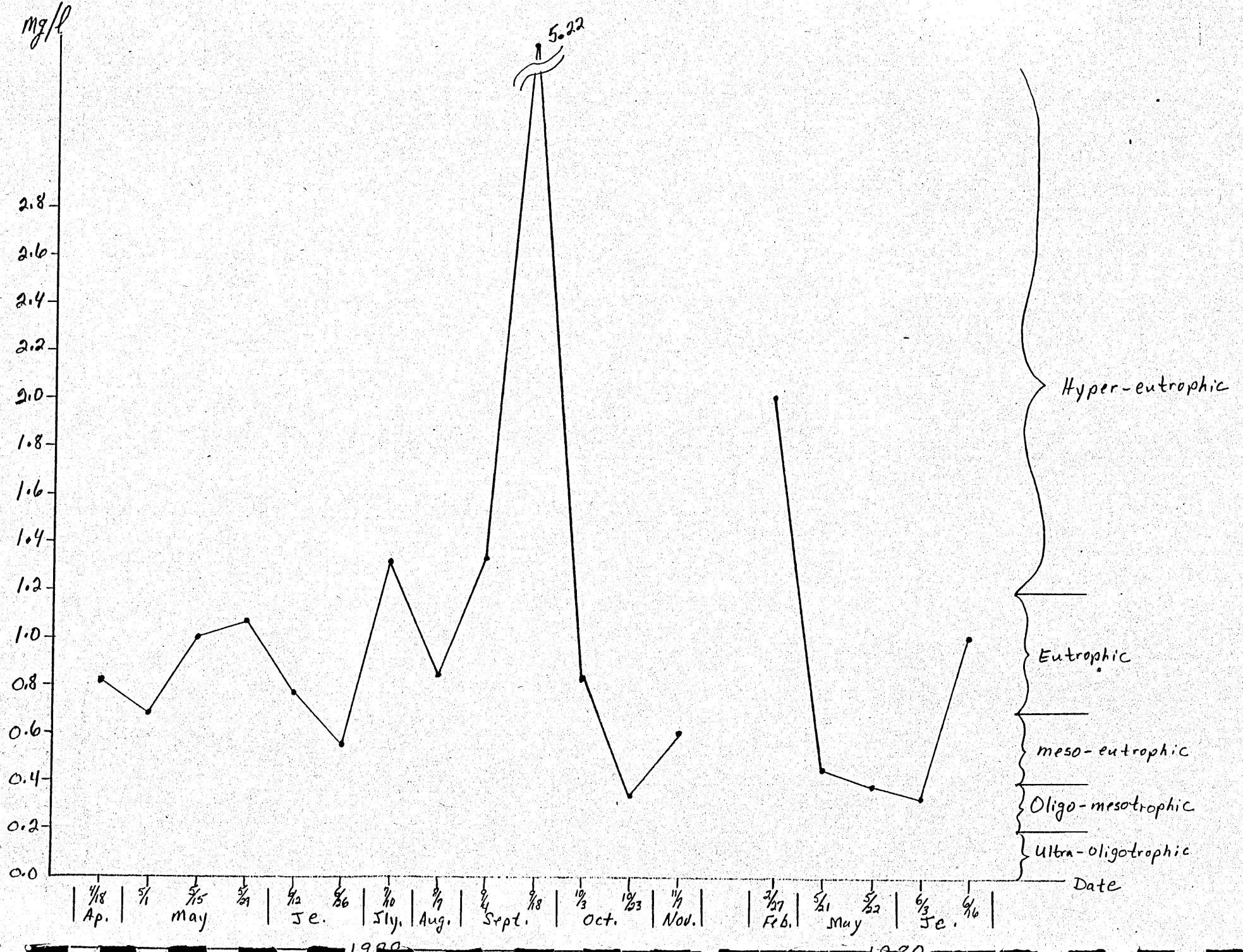

mg/l
(0.597)
(1.360)
(0.482)
0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
4/5
4/18
5/1
5/15
5/29
6/7
6/19
7/7
8/9
9/4
9/18
10/3
10/23
11/7
11/28
1/30
5/21
5/22
6/3
6/16
6/22
Date
Hyper-
eutrophic
Eutrophic

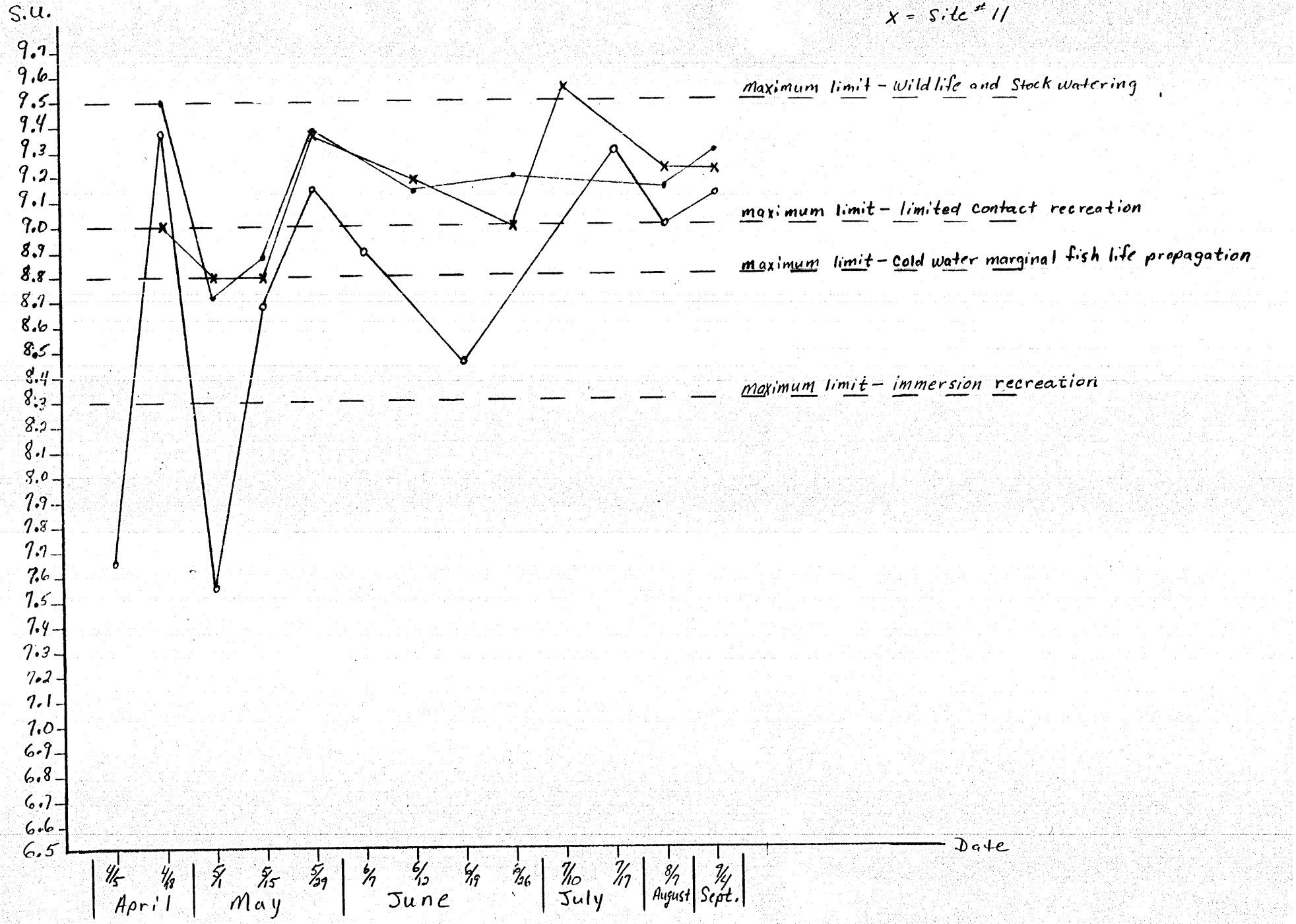

STOCKADE LAKE 1979-80 Site # 11 TOTAL PO4 as P
mg/l
0.397
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
Hyper-eutrophic
Eutrophic
Date
4/8 Ap.
5/1
5/15
5/29 My.
6/12
6/26 Je.
7/10 Jly.
8/7 Aug.
9/4
9/18 Sept.
10/3
10/23 Oct.
11/7 Nov.
2/27 Feb.
5/21
5/20 My
6/3
6/16 Je.
1979
1980

[redacted] KA[redacted] LAKE [redacted] 19[redacted] 8[redacted] S[redacted] IN[redacted] AR[redacted] NI[redacted] GE [redacted]



SICKADE LAKE 1977-80 Site #11. ORGANIC NITROGEN





• = Site #9
o = Site #10
x = Site #11
S.U.
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6.6
6.5
maximum limit - Wildlife and Stock watering
maximum limit - limited contact recreation
maximum limit - Cold water marginal fish life propagation
maximum limit - immersion recreation
Date
4/5
4/18
5/1
5/15
5/29
6/7
6/12
6/19
6/26
7/10
7/17
8/7
9/4
April
May
June
July
August
Sept.

Appendix E1.

Calculations of Nutrient Loads to Stockade Lake

For Custer WWTP - February 21, 1980

Above treatment Plant - (#1 in field notes)

Flow = 4.17 cfs = 118.09 l/s.

Assume constant flow for 6 month period - 1.857×10^9 l/yr

for 12 months - 3.714×10^9 l/yr.

Total PO_4 .25 mg/l - 4.6425×10^5 g/yr - .8824 g/m^2/yr - 6 mo.

- 9.285×10^5 - 1.765 g/m^2/yr - 12 mo

Ammonia .10 mg/l - 1.857×10^5 g/yr - .3530 g/m^2/yr - 6 mo.

.7059 g/m^2/yr - 12 mo.

TKN .17mg/l - 3.1569×10^5 g/y - .600 g/m^2/yr - 6 mo.

1.200 g/m^2/yr- 12 mo.

NO_3 .32 mg/l - 5.9424×10^5 g/yr - 1.1295 g/m^2/y 6 mo.

2.2590 g/m^2/y 12 mo.

Eff. Pipe - (2) flow = .26 cfs = 7.3632 l/sec. (168×10^3 gal/day)

Assume constant flow for 6 months - 1.1578×10^8 l/yr.

Total PO_4 4.50 mg/l - 5.2101×10^5 g/yr - .9903 g/m^2/yr.

Ammonia 4.10 mg/l - 4.74698×10^5 g/yr - .9022 g/m^2/yr

TKN 4.5 mg/l - 5.210×10^5 g/yr - .9903 g/m^2/yr

NO_3 1.29 mg/l - 1.493562×10^5 g/yr - .2839 g/m^2/yr.

At Station 5 - Assume all 6.7 cfs flow through site 5-

$$6.7 \text{ cfs} = 2.1144 \times 10^8 \text{ ft}^3\text{/yr.}$$

- Mean Total PO_4 concentration of .552 mg/l.
- Mean Total Org. N concentration of .703 mg/l.
- Mean Total Inorg. N concentration of .475 mg/l.

$2.1144 \times 10^8 \times 7.481 = 1.5818 \times 10^9$ gal/yr.

$1.5818 \times 10^9 \times 3.785 = 5.9871 \times 10^9$ liters/yr.

$5.9871 \times 10^9 \times .475 = 2.8439 \times 10^9$ mg/yr Inorg N.

$5.9871 \times 10_9 \times .703 = 4.2089 \times 10^9$ Org N.

$\times .522 = 3.1253 \times 10^9$ mg/yr PO_4 =

The nutrient loading under these assumptions is then:

Inorg N	2.8439×10^9 g/yr.
org N	4.2089×10^6 g/yr.
PO_4	3.1253×10^6 g/yr.

Surface area of Stockade Lake = 130 acres =

$130 \times 4047 = 526110$ m^2

Total PO_4 $\quad \dfrac{3.1253 \times 10^6}{5.2611 \times 10^5} = 5.94 \text{ g yr}^{-1}(\text{m}^2)^{-1}$

Org N $\quad \dfrac{4.2089 \times 10^6}{5.2611 \times 10^5} = 8.00 \text{ g yr}^{-1}(\text{m}^2)^{-1}$

Inorg N $\quad \frac{2.8439 \times 10^6}{5.2611 \times 10^5} = 5.4055 \text{g yr}^{-1}(\text{m}^2)^{-1}$

Assume only 4 cfs gives through site 5 (mean value).
4.0 cfs = 1.2623×10^8 ft^3/yr.
$\times 28.32 = 3.5749 \times 10^9$ l/yr.
at [PO_4] = .522, [Org.N] = .703, [Inorg.N] = .475,
PO_4 - 1.8661×10^6 g/yr.
Org. N - 2.5132×10^6 g/yr.
Inorg. N - 1.6981×10^6 g/yr
surface acre of lake = 130 acres = 5.2611×10^5 m^2

LOADINGS:
PO_4 - $3.5470 \text{ g yr}^{-1}(\text{m}^2)^{-1}$
Org. N - $4.7769 \text{ g yr}^{-1}(\text{m}^2)^{-1}$
Inorg N - $3.227 \text{ g yr}^{-1}(\text{m}^2)^{-1}$

Using 3.1 cfs and nutrient concentrations from site 1 (6th District data)
PO_4 = .085 mg/l, org N = .709 mg/l, Inorg N = .17 mg/l.
3.1 cfs = 87.92 l/s.

$$88 \frac{\text{l}}{\text{sec}} \times \frac{3600 \text{ sec}}{\text{hour}} \times \frac{24 \text{ hr}}{\text{day}} \times \frac{365.25 \text{ day}}{\text{yr}} = 2.7705 \times 10^9 \frac{\text{l}}{\text{yr.}}$$

Nutrirent Inputs:
PO_4 - 2.354×10^5 g/yr.
Org N. - 1.9643×10^6 g/yr.
Inorg N - 4.7099×10^5 g/yr.

With lake surface of 130 acres or 5.26110 m^2

PO_4 loading - .4467 g yr^{-1}(m^2)$^{-1}$
Org N loading - 3.734 g yr^{-1}(m^2)$^{-1}$
Inorg N loading - .8952 g yr^{-1}(m^2)$^{-1}$

Mean Flow = 3.1 cfs, for drainage area of 31 mi^2
at 2 mi W of Custer (46% of total basin drainage area).
watershed area = 49,915 acres =
49,915 x 1.562 x 10^{-3} = 77.967 mi^2
drainage above lake 66.8 mi^2
surface area 130 acres
storage area = 2,470 ac. ft.

Bismark Lake 318 ac. ft.
25.3 acres - surface area
3.2 mi^2 drainage area.

3.1 cfs = .46 total cfs
total cfs = .675
total loading into lake, ft^3/yr.

$$6.7 \text{ cfs} = \frac{60 \text{ sec}}{\text{min}} \times \frac{60 \text{ min}}{\text{hour}} \times \frac{24 \text{ hr}}{\text{day}} \times \frac{365.25 \text{ day}}{\text{yr}} = 2.1144 \times 10^8 \text{ ft.}^3/\text{yr}$$

with storage of 2,470 acre-feet
$\times$ 43,560 = 1.0759×10^8 ft^3

$$\frac{1.0759 \times 10^8 \text{ ft}^3}{2.1144 \times 10^8 \text{ ft}^3/\text{yr}} = .508 \text{ yr}$$

= 6 mo. hydraulic retention time
(8-24-79 data)

Custer Wastewater Treatment Plant flow = 0.40 cfs, = 11.33 l/sec.
= 3.5748×10^8 l/yr.

Total PO_4 concentration = 2.44 mg/l - 8.7225×10^5 g/yr
= 1.658 g/m^2/yr PO_4 loading to lake

Ortho P 2.30 mg/l - 8.222×10^5 g/yr
- 1.5628 g/m^2/yr

Ammonia N - 2.05 mg/l - 7.3283×10^5 g/yr.
- 1.3929 g/m^2/yr.

TKN - 2.32 mg/l - 8.2935×10^5 g/yr
- 1.5764 g/m^2/yr.

These values assume uniform loadings throughout the year.

Past records (to 1978) indicate discharging for at least 6 months per year, at a flow rate greater than .25 MGD. Using these 2 limits, nutrient loading is as follows.

.25 MGD = 2.5×10^5 gal/day = 9.4625×10^5 l/day.
x 182 days (6 months) = 1.7222×10^8 l/yr.
Total PO_4 2.44 mg/l - 4.2021×10^5 g/yr loading.

- .7987 g/m^2/yr

Ammonia N - 2.05 mg/l - 3.53051×10^5 g/yr
- .67106 g/m^2/yr

TKN 2.32 mg/l - 3.9955×10^5 g/yr
- .75944 g/m^2/yr

Effluent Pipe - (C2) flow = .26 cfs = 7.3632 l/sec.
EPO_4 = 4.50 mg/l = 33.1344 lng/sec
= 2.8628×10^3 g/day

Assuming a mean depth z of 5m, dangerous P loading is 0.13 $g/m^2/yr$ (Vollenweider, 1968, in Wetzel, 1975, p. 245) With Stockade Lake surface area of 5.261×10^5 m^2, "dangerous" loadings would occur if total P loading exceeded 6.8394×10^4 g. With a loading of 2.86×10^3 g/day, this level will be reached in

$$\frac{6.8394 \times 10^4 \text{ g}}{2.86 \times 10^3 \text{ g/day}} = 23.89 \text{ days} = 24 \text{ days}$$

WQSL

Appendix E2.

Custer Wastewater Treatment Plant Effluent Data

MUNICIPALITY: CUSTER

TE	BOD IN	BOD EFF	BOD % RE	TSS IN	TSS EFF	TSS %RE	PH min	PH max	NH_3-N ave	NH_3-N max	F. Col.	Cl_2 ave	Cl_2 max	FLOW mgd*	OTHER
6/76		7			13		2.5	7.6	0	.1	23		0		
9/76									.1	.1					
12/76	No Discharge														
4/77		17.5			16			8.3	<2		33				
6/77		14.5	95		14	91			<2	2.5	17				
8/77		7			3		7.8		.37		23				
9/77		8			8		2.4		.5		"				
9/77		11.8			7		"	8	.32		17				
3/78		9			11		2.2		3.23		135				
5/2/78		"			13		*		3.32		140				
5/15/78		14			12		2.2		3.37		130,000				
5/22/78					14		8.2		3.32		90				
5/30/78		"			"		2.8		4.93		7				
5/31/78		9			7		8.2		4.32		47				
6/13/78		10			14		8.5		4		3				
6/20/78		9			4		8.6		4.05		23				
6/27/78		8			6		"		2.65		"				
6/78	131	13	90		11		2.2	8.6	4.21	6.01	100				
7/78		15			10			8.2	3.58		23				
7/78		9			12		2.3		<2		"				
7/6/78		15			14		2.7				"				
7/20/78		7			5		2.6		1		"				
7/27/78		12			6		2.2		1.84		"				
8/3/78		6			4		2.3		2.27		"				
8/10/78		11			8		2.4		1.24		"				
8/16/78		5			3		2.2		1.2		40				
8/24/78		7			5		"		1.1		60				
9/1/78		4			"		"		1.8		160				
9/7/78		5			3		"		2.6		3				
9/13/78		2			5		7		2.1		23				
9/20/78		5			12		"		5.1		3				
9/28/78		6			7		2.1		4.1		23				
(7-10)78	229	8	97	27	9	96	6.9	8.2	5.6	4.9	"				
10/4/78		6			8		"		2.7		10				
10/12/78		14			15		2.1		2.5		17				
10/20/78		10			14		2.2		3		30				

MUNICIPALITY: CUSTER continued PAGE:

PE	BOD IN	BOD EFF	BOD % RE	TSS IN	TSS EFF	TSS % RE	PH min	PH max	NH_3-N ave	NH_3-N max	F. Col.	Cl_2 ave	Cl_2 max	FLOW mgd*	OTHER:
(10-12) 78		3			2			7			23				
(10-12) 78		14			14		7.6	8.5		9D	196				
V25/79		5			20		7.8		5.9		11,000				
5/24/79		20			<1		"			7.8	440				
6/21/79		12			5		7.6		.3		3				
6/28/79		3			"		7.1		2.74		23				
(4-6) 79	210	9		289	8		7.2	7.8	3.2	7.2	18				
7/5/79		11			11		6.7				23				
7/12/79		5			5		6.6		3.16		"				
7/19/79		10			2		6.5		3.45		330				
7/26/79		6			4		6.4		3.54		210				
8/3/79		9			12		6.6		3.83		13				
8/10/79		"			3		"		3.52		"				
8/16/79		8			5		"		1.69		1300			180 GPM	
8/23/79		"			3			6.6	2.98		230			"	
8/29/79		6			4			"	2.5		3				3.02 T-PO4
9/6/79		10			9			"	2.12		23			"	
9/11/79		6			10			"	2.32		"			"	
9/21/79		5			5			6.7	"		Lab acid			"	
9/27/79		12			12			7	2.3		130			"	3.8 T-PO4
(7-9) 79	200	8		224	7		6.4	"	2.9		50				2.95 PO4-T
10/4/79		"			2			6.9	2.2		23			"	
10/11/79		9			4		6.5				7				
10/18/79		5			2		6.9		2.98		20				
10/26/79		8			9		6.8		3.25		20				
11/2/79		10			"		6.7		3.3		17				
11/8/79		12			8		6.9				53				4.21 T Ph
11/14/79		9			11		6.8		2.35		77				
11/19/79		"			10		"		2.05						
11/30/79		10			11		6.6				230			"	
(10-12) 79		8			1.4		6.4				23				Phos - .C
(10-12) 79	248	9		246	7		6.5	6.9	2.52	3.3	25			25	Phos. 4.1
(1-3) 80	187	"		122	8.6		6.3	6.8	3.07	6	150		NA	.25	Phos. 3.
(4-6) 80	310	12		250	11		6.7	7.3	4.19	7.3	10		"	"	
(7-9) 80	564	13		237	6.8		"	7	5.09	20.0D	2.5			.17	Phos. 4.
(10-12) 80	513	10		256	9		6.6	6.9	4.83	20.0D	12			.14	5.6

Appendix F.

Nutrient Pollution Sources - WQSA Coordinator Map and Narrative

NUTRIENT POLLUTION

Description of Potential Sources of Significant Nutrient Pollution

1. Waste Water Treatment Plant Effluent

The results of water sampling and testing of French Creek during 1979 and 1980 indicate that the discharge from the Custer City sanitary sewer system has contributed significant nutrients into French Creek and Stockade Lake. The basic problem appears to be overloading of the treatment plant primarily during the summer months which apparently is largely due to infiltration of ground water into the collector and outfall lines and to the increase in volume of domestic wastes caused by the influx of tourists during the summer season. The volume of liquids is also increased by the discharge from some roof drains which are connected to the sanitary sewer system rather than to a storm sewer.

During late summer when surface runoff is minimal the discharge from the Waste Water Treatment Plant represents a significant portion of the total inflow into Stockade Lake during this dry season.

A Phase I diagnostic-feasibility study is presently being conducted by the City of Custer to analyze and evaluate this problem.

2. Septic Tank Systems *

Analysis of infrared aerial photography obtained in May, 1980, by the Environmental Protection Agency indicated that there are 62 septic tank systems within the Stockade Lake watershed which were discernible on the photography and were reported as "probable surface failing systems". The report however does caution that "using color infrared photography does not always mean that a particular system is malfunctioning to the extent that it may cause a public nuisance". Visual examination of the systems located outside of the city limits of Custer indicates that some of the identified septic systems are not causing discernible problems, however, this should be verified by a detailed ground survey using appropriate scientific procedures.

Visual observation on the ground also indicated the possibility that some failing septic systems exist within the watershed which were not discernible on the IR photography. These systems also need further ground survey verification.

* on next page

/* The criteria used for the preliminary mapped of potential pollution from septic tanks are:

(a) Systems indentified by Infrared photography which visual observation did not rule out possible pollution

(b) Systems located within 100' of tributary streams

(c) Multiple (or cluster) systems located within 100' of each other.

3. Agricultural Wastes

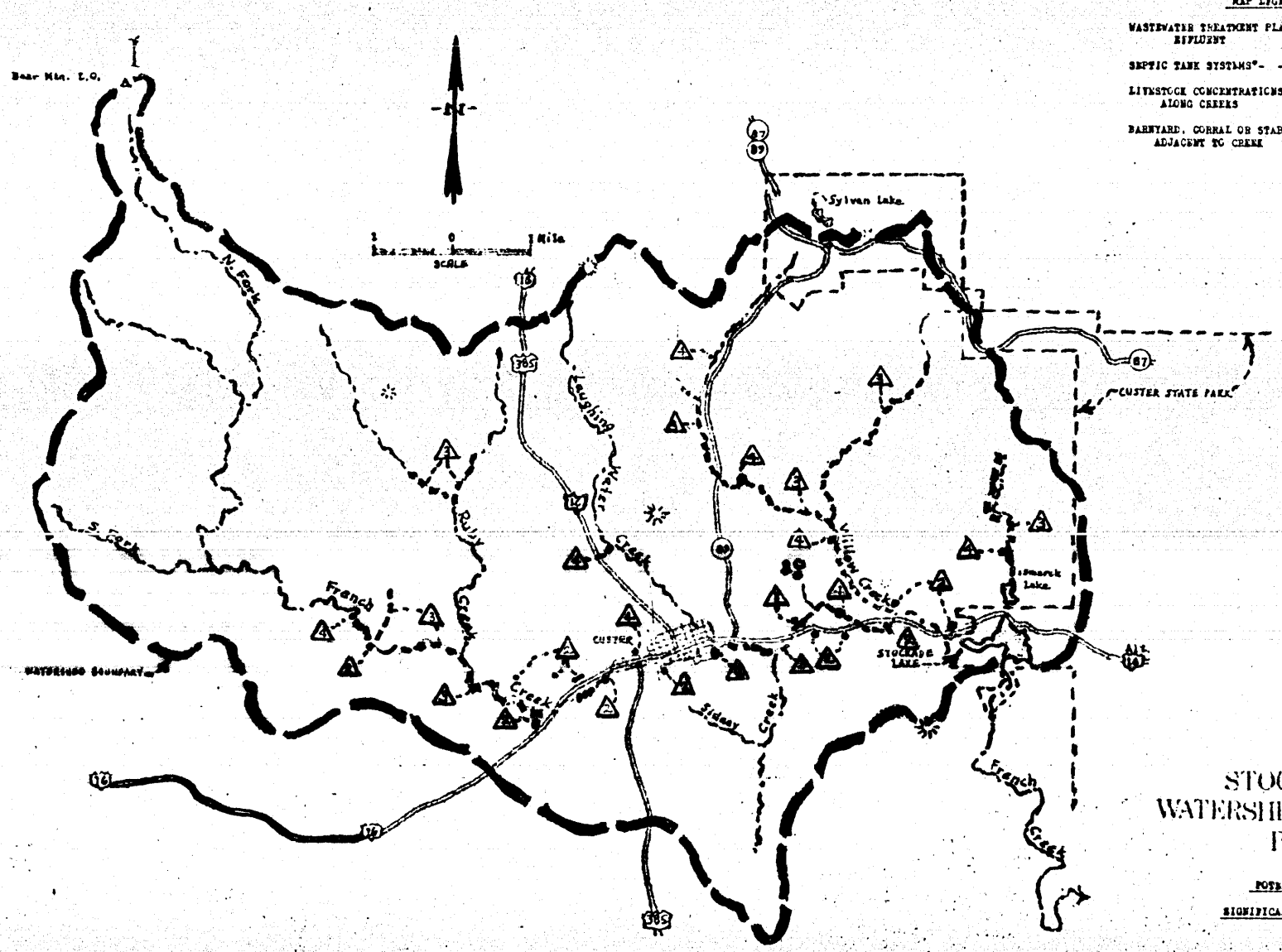
Animal wastes which contribute nutrients to the tributaries of Stockade Lake are derived primarily from horses and cattle grazing in the meadows adjacent to the streams and from livestock holding facilities such as barnyards, corrals or stables located along the creek banks.

This problem appears to be more serious during the winter and spring when the livestock is concentrated near the streams for extended periods of time. Spring runoff will then wash some of the wastes into the streams and lakes. The problem is less severe during the summer months when a large portion of the livestock is located on forested lands at greater distances from the major tributaries.

4. Secondary Sources of Nutrient Pollution

Secondary sources of nutrient pollution which are contributing lesser, or minor, quantities of nutrients include fertilization, solid wastes, hazardous materials, sawmill wastes*, herbicides and insecticides. These sources are considered not to be serious contributors to the pollution problem since very little cultivated land exists within the watershed and existing regulations provide for the proper use and disposal of wastes and hazardous materials. However, it is none-the-less important that all agencies having responsibility for control or administration of the use of these materials monitor such activities so as to reduce pollution from these sources to a minimum.

* A few landowners believe this is a significant source of pollution. However, the amount of wood wastes or soot reaching the creeks & lakes is undetermined at this time.



MAP LEGEND

WASTEWATER TREATMENT PLANT EFFLUENT - 1

SEPTIC TANK SYSTEMS* - - - - 2

LIVESTOCK CONCENTRATIONS ALONG CREEKS - - 3

BARNYARD, CORRAL OR STABLE ADJACENT TO CREEK - 4

STOCKADE LAKE WATERSHED IMPROVEMENT PROJECT

POTENTIAL SOURCES OF SIGNIFICANT NUTRIENT POLLUTION

Apr. 1981

* See Appendix for criteria used

Appendix G.

Conceptual Plan for the Proposed Stockade Lake Watershed Improvement Project

TABLE OF CONTENTS

		PAGE
I.	INTRODUCTION	
	A. Contract Authorization	1
	B. Purpose of Report	1
	C. Planning Area Description	1-2
	D. Planning Participation and Cooperation	2
II.	WATER QUALITY AND WATER QUALITY OBJECTIVES	4
III.	SUMMARY OF POLLUTION SOURCES	
	A. Primary Sources	5
	B. Secondary Sources	5
IV.	ALTERNATIVES CONSIDERED	
	A. Development of Alternatives	6
	B. Description of Alternatives Considered	6
V.	EVALUATION OF ALTERNATIVES AND ENVIRONMENTAL ASSESSMENT	
	A. Views of Public and Concerned Interest	8
	B. Alternative Evaluation Method	8
	C. Evaluation of Alternatives	8
VI.	SELECTION OF PREFERRED ALTERNATIVE	9-10-11-12
VII.	FLOOD PROTECTION CONSIDERATIONS	13
VIII.	COORDINATION WITH UTILITIES, PUBLIC AGENCIES & OTHER ENTITIES	13
IX.	PROJECT PHASING & SCHEDULE	14
X.	ESTIMATED PROJECT COSTS	15
XI.	APPENDIX	17

SECTION I INTRODUCTION

A. Contract Authorization

In early 1979 the Sixth District Council of Local Governments nominated Stockade Lake Watershed as an area to be studied for methods to improve the water quality of the lake. As a result of this nomination and concurrance by the South Dakota Department of Water and Natural Resources (DWNR) the U.S. Environmental Protection Agency provided a grant to the DWNR in July, 1979, under Section 208 of the Federal Water Pollution Control Act (PL92-500).

On July 30, 1980 the Custer County Conservation District acting as local sponsors of the project, executed a contract with the DWNR to analyze methods and to develop a conceptual plan for the improvement of water quality in Stockade Lake and the tributary watershed. This contract provides for completion of the plan within one year.

B. Purpose of Report

1. Indentify and analize existing non-point and point source pollution within the Stockade Lake watershed.

2. Define and evaluate the areas within the watershed requiring corrective treatments.

3. Evaluate alternative methods of treatment and develop a conceptual plan for implementation of corrective measures or construction of required facilities on a cost effective basis.

4. Analize and evaluate the effects of alternate treatment methods on the physical and biological environment.

C. Planning Area Description

Stockade Lake is located in Custer County, South Dakota, four miles east of Custer, SD. The lake and its watershed comprise 49,915 acres (20,200 hectares or 78.0 square miles and is situated in the south-central portion of the Black Hills. The lake has a surface area of 131 acres (53 hectares), an average depth of 19 feet (5.8 meters), a maximum depth of 42 feet (12.8 meters), a volume 2492 acre feet (3,074,000 cubic meters) and a mean hydraulic retention time of 274 days. (The above data was obtained from EPA working paper no. 175).

Approximately 60 percent of the watershed above Stockade Lake is public timberland administered by the U.S. Forest Service. The remaining land is privately owned and is used for livestock grazing, hay crops or residential and commercial developments. Geology of the area consists primarily of Precambrian metamorphic formations. Some precamburain granite is also present in the watershed. Hill slopes are moderately steep. The watershed receives an average of about 18 inches or precipitation per year. The lake is located within the Custer Park boundaries.

The principal uses of Stockade Lake are fishing, swimming, and boating as well as picnicking and camping adjacent to the lake.

The City of Custer (population 1708) is located along French Creek about four miles upstream of Stockade Lake. Many permanent and summer homes are located within the watershed. Populations are considerably swelled during the summer by the influx of tourists into the area. The drainage area above Stockade Lake is one of the most extensively developed areas in the Black Hills.

Sediment surveys (in 1972 and 1981 and water quality sampling 1972, 1974, 1979, 1980) indicate that activities within the watershed are contributing sediment and plant nutrients (nitrogen and phosphorous) to Stockade Lake at excessively high rates. Stockade Lake presently is in a eutropic to hypereutrophic condition. The 1972 sediment survey was undertaken by the Black Hills Conservancy Sub-District by contract to Utility Engineering Co., Rapid City, SD. The 1981 sediment survey and the water quality sampling were conducted by the SD Dept. of Water and Natural Resources in cooperation with the Dept. of Game, Fish & Parks (Custer State Park).

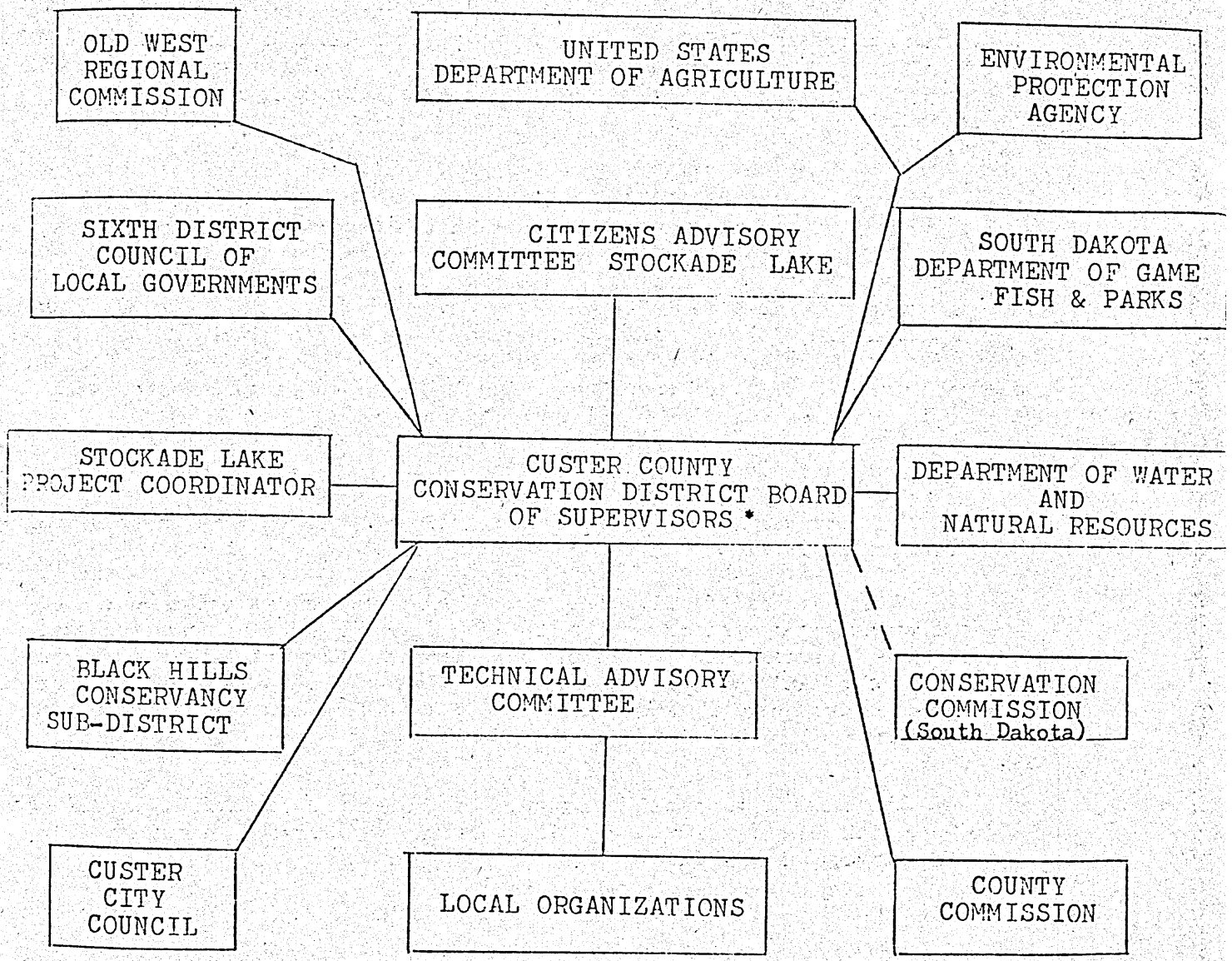
D. Planning Participation and Cooperation

The boundary of the watershed and the relationship to governmental boundaries is shown on Figure A. (Appendix A)

A number of federal, state and local agencies, as shown on the following organizational chart, are involved in the planning processes for the implementation of corrective practices and facilities. Elimination of pollution of lakes and streams has been a common goal of these agencies for several years and cooperative effort has been very much in evidence.

The contributions of the various agencies are summarized in the work plan which is on file at DWNR, Joe Foss Bldg, Pierre, SD - and at the SCS office, Custer, SD.

STOCKADE LAKE WATERSHED IMPROVEMENT PROGRAM
ORGANIZATIONAL STRUCTURE



* The County Conservation District is the local sponsor of the project under contract with the Dept. of Water and Natural Resources.

SECTION II

II WATER QUALITY AND WATER QUALITY OBJECTIVES

A. Water Quality

Stockade Lake is classified according to use for: a cold-water marginal fishery, limited contact recreation, wildlife propagation and stock watering. The most significant problems in Stockade Lake are high nutrient levels and consequent frequent heavy algae blooms which are evidence of the lakes highly eutrophic and over-productive state.

For details of analysis and interpretation of the water quality data refer to: STOCKADE LAKE "208" REPORT by South Dakota Dept. of Water and Natural Resources, 1981. Copies are on file at: DWNR, Joe Foss Bldg., Pierre, S.D. 57501 or Soil Conservation Service, Box 31, Custer, SD 57730.

B. Water Quality Objectives

The water quality objectives are dictated by the necessity to protect the natural water courses and lakes from further pollution and contamination by human activities. The primary goal of the South Dakota Statewide "208" Water Quality Management Plan is to improve and maintain water quality for the maximum beneficial uses by present and future generations of South Dakotans. The objectives to achieve this goal are as follows:

1. To eliminate or reduce underground seepage from septic tank systems into the lakes and watersources within the watershed.

2. To prevent contamination of underground water supplies by infiltration of wastewater effluents.

3. To eliminate or reduce above ground accumulations of unabsorbed effluents, plant nutrients or other pollutants which ultimately are washed into the streams and lakes.

4. To eliminate or reduce erosion caused by human activities which are contributing sediments to the streams and lakes.

5. To restore and improve the water quality of Stockade Lake by the elimination or reduction of pollutants presently in the lake.

SECTION III

III. SUMMARY OF SOURCES OF POLLUTION *

A. Primary Sources

(1) Nutrient Pollution

Municipal Waste Water Effluent

Individual Septic Tank Systems

Agricultural Wastes (Stables, Barnyards, Grazing)

(2) Sediment Pollution

Urban Runoff
Mining - Milling (Roads, Placer Operations, Quarrying)
Land Developments
Livestock concentrations adjacent to creeks
Stream channel changes
High-use areas (Picnic grounds, etc.)

B. Secondary Sources

(1) Nutrient Pollution & Toxic Materials

Lawn & Agricultural Fertilization
Solid Waste Disposal (including litter)
Hazardous Material Disposal & Spills
Sawmill Wastes
Insect & Weed Control (Insecticides, Herbicides)

(2) Sediment Pollution

Landfill encroachments
Logging roads and skidding

*See Appendix B for description of pollution sources Pages B-1 to B-4 and Appendix G for map locations, Pages G-1 and G-2.

IV. ALTERNATIVES CONSIDERED

A. Development of Alternatives

The list of alternatives to be considered was developed through input and suggestions from the Technical Advisory Committee, the Citizens Advisory Committee and the public. All suggested alternatives were included for consideration without regard to the apparent merits of the alternative.

B. Description of Alternatives Considered

a. Nutrient Sources

(1) For municipal waste water effluent:
- Rapid infiltration systems
- Overland irrigation or sprinkler irrigation
- "Wetlands" systems
- Reduce use of cleaning agents containing phosphates & nitrates
- Bypass effluent around lake
- Prevent groundwater & storm water from entering system

(2) Individual Septic Tank problems:
- Repair or replace
- Use different system (Egs: tie to municipal system, No Dak system, holding tank)
- Proper operation and maintenance
- Adherence to established regulations

(3) Recycling of nutrients within Lake:
- Sediment Removal - total or partial removal of sediments and associated nutrients
- Aeration - to increase amount and distribution of dissolved oxygen in the lake to reduce or retard eutrophication
- Chemical Treatment - to control growth of algae and other aquatic plants
- Lake-bottom Treatment - to seal off the sediments to inhibit growth of aquatic vegetation and recycling of plant nutrients
- Circulation - utilizing wind-driven circulators to reduce thermal stratification and to increase dissolved oxygen levels
- Lake Drainage - (for a period of two to five years) to allow sediments to consolidate. (with or without planting and harvest to reduce nutrients)
- Fish Management - to maintain minimal populations of fish species which feed on zooplankton
- Increase water yield -(through intensive forest management)

(4) Agricultural Wastes
- Relocate to different site
- Provide buffer zone along stream
- Dike barriers or terraces

Section IV (Continued)

b. Sediments

(1) Urban Runoff:
Sedimentation basins or traps
Erosion protection (Egs.: Paving, Curb & Gutter, Storm Sewers)
Alternate snow disposal sites
Dike barriers or terraces

(2) Land Developments and High-use Areas:
Construct sediment basins or traps
Dikes, terraces or buffer zones
Slope protection and revegetation
Relocation of facilities or replacement with erosion-proof facilities

(3) Mining/Milling - Stream channel changes:
Slope protection and Revegetation
Streambed protection (Structures, gradient reduction, etc.)
Buffer zones or dikes at mine spoil disposal areas

(4) Livestock concentrations adjacent to streams:
Reduced use (Greater distribution by alternate salting areas and watering facilities)
Streambank protection
Stream-side fencing with water gaps

V. EVALUATION OF ALTERNATIVES & ENVIRONMENTAL ASSESSMENT

A. Views of Public and Concerned Interests

Appendix F contains a summary of public hearings, letters and documents resulting from public hearings and reviews.

Evaluation of public input and comments received indicate that there is general support for implementation of a program to reduce pollution within Stockade Lake and it's tributary watershed. No opposition to the project was expressed at public meetings held on July 24, 1979, June 3 1980, and May 11, 1981.

B. Alternative Evaluation Method

Alternatives have been considered in the evaluation based on the evaluation criteria listed below:

1. Environmentally Acceptable
2. Abatement of Pollution
3. Technically Practical
4. Economically Feasible
5. Public Acceptance
6. Reliability
7. Felxibility
8. Energy Requirements
9. Land Availability

A numerical value was assigned, indicating the degree to which each alternative satisfies the particular criteria as follow:

Fully meets the criteria	3
Partially meets the criteria	2
Probably does not meet the criteria	1
Does not meet the criteria	0

The numerical sum of the assigned values for each alternative indicates the relative acceptability of each alternative with the highest number indicating the greatest acceptability.

C. Evaluation of Alternatives

The evaluation utilizing the above-listed criteria and the assessment of environmental impacts are tabulated in Appendix C.

VI. SELECTION OF PREFERRED ALTERNATIVE

Following are the recommended actions or corrective measures listed in tentative order of priority for the various sources of pollution: 1/

A. Nutrient Sources of Pollution

(1) Municipal WWTP Effluent

Recommended course of action: Recommend to the City of Custer that City analize and evaluate the following alternatives with the top priority given to alternatives having "no discharge" into the tributary streams to Stockade Lake:

(a) Prevent groudwater and storm water from entering the sewer collection and outfall system

(b) Use effluent from WWTP for irrigation of hayland, timber land and/or a "wetlands" system.

(c) Provide advanced treatment of effluent using a rapid infiltration system.

(d) Renovate or upgrade WWTP.

(2) Individual Septic Tank or Sewage Lagoon Systems

Recommended course of action:

(a) Promote homeowner education in proper inspection, operation and maintenance procedures.

(b) Promote voluntary compliance in renovation of malfunctioning systems.

(c) Enforcement of current regulations for the installation of new systems coupled with determination of the most suitable on-site disposal system for each particular site. (Examples include Evapotranspóration systems, Evapotranspiration-Absorption Systems, separation of "grey water" from the the sewage wastes, connection to municipal sewer system, etc.)

(d) Expansion of Step I planning area (Custer WWTP facility plan) to include areas outside of the city limits where septic tank problems exist

(e) Continue sampling and testing of outflow discharge from the stabilization pond which serves the facilities at Sylvan Lake to assure that the discharge meets acceptable standards. If not, corrective measures should be taken.

(3) Recycling of Nutrients within Lake

Recommended action:

(a) Continue search and evaluation of available research concerning biomanipulation techniques to improve water quality. Studies conducted by Dr. Lois Haertel, Asso. Prof., SDSU, Brookings, SD and research by Joseph Shapiro, Limnological Research Center, University of Minnesota, indicate that improvements in water quality in eutrophic lakes is possible by maintaining minimal populations of forage fish.

1/ Priorities are subject to change pending completion of detailed surveys, designs and cost estimates, concurrence of the affected landowners and on the availability of funding.

Currently there is strong support locally for the introduction of the cool/warm-water fish to Stockade Lake.

Fisheries Biologists Robert Hanten and Dick Ford, SD GF&P Dept. state that similar results can be obtained by controlling trout populations at optimum levels and recommend that the lake be retained as a trout fishery.

(b) Drain Stockade Lake, allow sediments to consolidate, then remove as much of the sediments as is economically feasible [1] utilizing land-based equipment. Removal of the sediments during early or mid-winter when the sediments are partly frozen has been accomplished successfully on other lakes in the Black Hills by the Forest Service and may be a viable technique on Stockade Lake.

(c) Continue search for markets for use of the sediment as fertilizer to offset or reduce the cost of removal.

(d) Refill lake and stock with optimum populations of fish species as determined from research evaluations discussed in item (a) and consistent with the needs and desires of the local citizenry.

(e) Monitor water quality and animal and plant life populations to maintain proper balance.

(f) Recommend to the Forest Service that Bismarck Lake be drained and sediments be removed. Recommend to GF&P that fish populations be maintained at optimum levels so that the outflow from the lake will not lower the water quality in Stockade Lake.

(4) Agricultural Wastes (from barnyards or corrals)

Recommended action: With landowner concurrence and cooperation.

(a) Construct dikes, barriers or terraces

(b) Provide buffer zone along creek

(c) Relocate facilities away from creeks

(d) Continue water quality monitoring and investigation to provide quantitative evaluation of the impact of livestock operation

(e) Promote proper grazing management on both public and private lands

[1] Lab tests indicate that the sediments contain sufficient plant nutrients to make this material useful as a fertilizer and soil conditioner. See Appendix D for results of the lab tests.

(5) Toxic Materials

Recommended Action:

(a) Proper disposal of soild wastes

(b) Conservative and proper use of fertilizers

(c) Proper use of insecticides and herbicides

B. Sediment Sources of Pollution

(1) Urban Runoff

Recommended Action:

(a) Select snow-disposal sites more remote from live streams.

(b) Construct dikes, barriers or terraces

(c) Construct sedimentation basins or traps.

(d) Erosion protection (Paving, curb & gutter or storm sewers)

(2) Land Development and High-use Areas

Recommended Action:

(a) "Hard-surfacing of roads, trails and parking areas

(b) Construction of stairs and walkways

(c) Construction of sedimentation basins or traps

(d) Slope protection and revegetation

(e) Construct dikes, terraces or buffer zones

(f) Relocate facilities.

(3) Mining/Milling - Stream Channel Changes

Recommended Action:

(a) Slope protection and revegetation

(b) Dikes or buffer zones at mine spoil disposal areas.

(c) Streambed protection (gradient reduction structures, etc.)

(4) Livestock Concentrations Adjacent to Streams

Recommended Action:

(a) Reduce use (Greater distribution by alternate salting areas and watering facilities and/or rotation grazing)

Section VI (continued)

(b) Streambank protection

(c) Streamside fencing (with water gaps)

(5) Miscellaneous

(a) Proper location, construction, maintenance and management of roads

(b) Slope protection and revegetation of landfills adjacent to creeks

(c) Encourage intensive management of Forest Service system lands to increase total water yields

(d) Promote the investigation and evaluation of the feasibility of construction of small retention dams in the headwaters for the purpose of leveling off peak flood flows and the potential for providing secondary benefits of recharging groundwater supplies, water sources for wildlife and livestock, and entrapment of sediments.

(e) Review existing county zoning ordinances and regulations for the use of land to determine their adequacy for pollution prevention.

C. General

Following implementation of corrective measures or treatments monitor water quality and evaluate effectiveness of the treatments.

SECTION VII

VII. FLOOD PROTECTION CONSIDERATIONS

Construction of facilities within the 100-year storm flood plain will need to be designed to meet the requirements of existing laws and regulations. Therefore, preference should be given to those design alternatives which are least susceptible to flood damage. (An example would be "dugout" type sediment basins in lieu of built-up dam types.)

Stream improvements where earthwork quantities or stream flows exceed the minimum established levels will require "dredge and fill" permits administered by the Corps of Engineers.

SECTION VIII

VIII. COORDINATION WITH UTILITIES, PUBLIC AGENCIES AND OTHER ENTITIES

Lands within the watershed include ownership by the U.S. Forest Service, State of South Dakota (Custer State Park), Custer County, and the City of Custer as well as lands in private ownership. Coordination and/or agreements, permits or contracts will be necessary with the respective agency for treatments or facilities affecting their lands. Also, easements for facilities crossing private lands or agreements concerning cost-share treatments on private lands will be required.

Improvements requiring electrical service will require coordination or agreement with the Black Hills Power and Light Company, or the Black Hills Electric Cooperative in their respective areas of jurisdiction.

IX. PROJECT PHASING AND SCHEDULE

Since the proposed improvement of the Custer Wastewater Treatment and Collection System is an integral part of the total watershed improvement program, the timing of the City project will influence timing of certain portions of the Stockade Lake Watershed Improvement Project. With this relationship in mind, the following phasing or sequence of sub-projects is recommended to proceed with survey, design, implementation and monitoring of the following projects as soon as funding is available for any given project:

A. Projects Not Significantly Affected by the Custer Facility Plan

(1) Septic tank survey followed by correction of malfunctioning systems.

(2) "Erosion proofing" of existing roads and high-use recreation areas adjacent to Stockade Lake and the major tributaries.

(3) Monitor outflow from Sylvan Lake stabilization pond and implement further corrective measures if needed.

(4) Utilize alternate snow disposal sites at locations away from live streams.

(5) Construction of sediment basins in French Creek and other major tributaries.

(6) Streambank protection.

(7) Buffer zones, dikes, terraces and/or revegetation at mine dumps, landfills, mill sites, land developments, barnyards and corrals.

(8) Construction of water stations for dispersal of livestock away from creeks. (Consider streamside fencing with water gaps as an alternate where feasible.)

(9) Drainage and restoration of Bismarck Lake.

(10) Increase water yield through intensive forest management together with investigation of potential to utilize small retention dams.

(11) Continue evaluation of research concerning biomanipulation techniques for eutrophic lakes.

(12) Continue search for markets for sediments for use as fertilizer.

B. Projects Related to or Affected by Custer Facility Plan

(1) Construction of "wetlands" system and/or irrigation systems utilizing effluent from the Custer Waste Water Treatment Plant.

(2) Drainage and implementation of in-lake treatments of Stockade Lake.

X. ESTIMATED PROJECT COSTS

Following is a summary of preliminary estimated project costs. It must be kept in mind that these are "preliminary estimates" only, and that more firm estimates cannot be made until specific treatments and quantities are determined through the planning process with the landowners of each tract of land or with the particular agency or entity affected.

ITEM	PRELIMINARY ESTIMATE
1-Best Management Practices for sediment control	$780,000 1/
2-Mine site restoration	$50,000 to $100,000
3-Lake drainage & sediment removal	$700,000 to $900,000 2/
4-Effluent from Custer WWTP	3/
5-Malfunctioning Septic Tanks	4/

1/ See breakdown on following page (taken from Feb. 1981 "Soil Erosion and Sediment Yield Study" by SCS)

2/ If markets for utilization of sediments as fertilizer can be found, this cost could be reduced significantly

3/ Estimate for this item will be included in the Facility Plan for the Custer WWTP, scheduled for completion by 10/1/81

4/ Estimate to follow completion of septic tank survey which is pending approval and funding assistance from EPA

TABLE 3 BEST MANAGEMENT PRACTICES (Conservation Practices and Measures) 1/ 2/ 3/
STOCKADE LAKE WATERSHED AREA

Conservation Practices	Unit	Unit Cost 4/	Non-Sediment Contributing Area		Sediment Contributing Area		Total Watershed	
			Amount Needed	Cost	Amount Needed	Cost	Amount Needed	Cost
		(Dollars)		(Dollars)		(Dollars)		(Dollars)
GRASSLAND - 11,000 ACRES								
Proper Grazing Use	acres	-	8,275	-	2,725	-	11,000	-
Pasture & Hayland Planting	acres	20	140	2,800	60	1,200	200	4,000
Deferred Hayland Planting	acres	-	1,160	-	540	-	1,700	-
Planned Grazing Systems	acres	-	1,440	-	760	-	2,200	-
Livestock Water Stations	No.	1,000	3	3,000	2	2,000	5	5,000
Pasture & Hayland Management	acres	-	400	-	200	-	600	-
Waste Management Systems	No.	1,000	1	1,000	1	1,000	2	2,000
WOODLAND - 26,085 ACRES								
Livestock Exclusion (Fencing)	rods	5	2,000	10,000	1,200	6,000	3,200	16,000
Proper Grazing Use	acres	-	3,400	-	1,800	-	5,200	-
Access Roads	feet	7	10,560	73,920	5,280	36,960	15,840	110,880
Heavy Use Area Protection	acres	200	500	100,000	500	100,000	1,000	200,000
Grade Stabilization Structures	No.	1,000	4	4,000	6	6,000	10	10,000
Diversions	No.	1,000	-	-	2	2,000	2	2,000
Critical Area Planting	acres	200	2	400	3	600	5	1,000
Grass Filter Strip	acres	200	3	600	2	400	5	1,000
Woodland Improvement	acres	66	3,900	257,400	2,100	138,600	6,000	396,000
Tree Planting	acres	350	4	1,400	6	2,100	10	3,500
FARMSTEADS, URBAN & OTHER - 800 Acres								
Sediment Control Measures 5/	acres	2,000	3	6,000	12	24,000	15	30,000
TOTALS - Total Acres - 47,930 6/				460,520		320,860		781,380
								$16.30 per acre

1/ Needed to get "Land Adequately Treated."
2/ Refer to Soil Conservation Service Technical Guide for South Dakota 1981.
3/ On site investigation and planning are necessary to determine kinds, locations, sizes, extent & costs of practices (BMP's).
4/ Refer to Soil Conservation Service Cost-Return Handbook for South Dakota 1981.
5/ Examples of measures are: cover and green manure crop, filter strips, lined and grassed waterways, diversions, mulching, sediment basins, streambank protection, and critical area planting.
6/ Includes 10,045 acres of non-sediment producing land.

SECTION XI. APPENDIX

A. PROJECT LOCATION MAP

B. DESCRIPTION OF SIGNIFICANT POLLUTION SOURCES

C. EVALUATION OF ALTERNATIVES AND ENVIRONMENTAL ASSESSMENT

D. SEDIMENT SURVEYS AND TESTS

E. WATER QUALITY TESTS

F. PUBLIC INPUT

G. MAP OF POLLUTION SOURCES

H. MAP OF POTENTIAL TREATMENTS

16

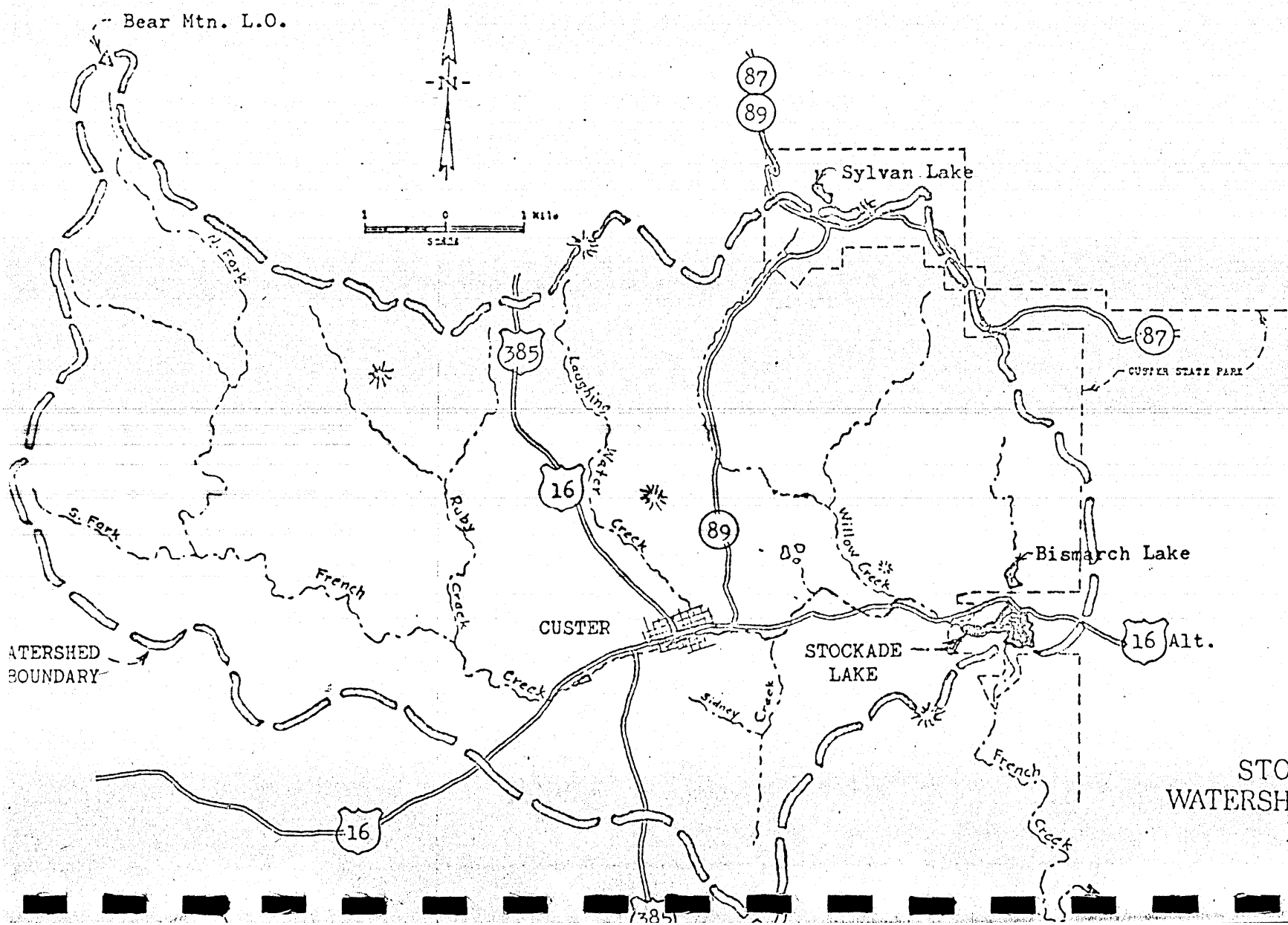
OTHER REFERENCES

STOCKADE LAKE "208" REPORT - By South Dakota Dept. of Water & Natural Resources, 1981. Copies on file at:
DWNR, Joe Foss Bldg., Pierre, SD 57501
Soil Conservation Service, Box 31, Custer, SD 57730

COLOR INFRAED AERIAL PHOTOGRAPHY REPORT (Volume II), prepared for Region VIII, EPA and South Dakota DWNR, May, 1980.
On file at:
DWNR, Joe Foss Bldg., Pierre, SD 57501

SOIL EROSION AND SEDIMENT YIELD STUDY IN STOCKADE LAKE WATERSHED, Feb. 1981 By Soil Conservation Service

On file at:
DWNR Joe Foss Bldg. Pierre, S.D. 57501
SCS Box 31 Custer, S.D. 57730



STOCKADE LAKE
WATERSHED IMPROVEMENT
PROJECT

NUTRIENT POLLUTION

Description of Potential Sources of Significant Nutrient Pollution

1. Waste Water Treatment Plant Effluent

The results of water sampling and testing of French Creek during 1979 and 1980 indicate that the discharge from the Custer City sanitary sewer system has contributed significant nutrients into French Creek and Stockade Lake. The basic problem appears to be overloading of the treatment plant primarily during the summer months which apparently is largely due to infiltration of ground water into the collector and outfall lines and to the increase in volume of domestic wastes caused by the influx of tourists during the summer season. The volume of liquids is also increased by the discharge from some roof drains which are connected to the sanitary sewer system rather than to a storm sewer.

During late summer when surface runoff is minimal the discharge from the Waste Water Treatment Plant represents a significant portion of the total inflow into Stockade Lake during this dry season.

A Phase I diagnostic-feasibility study is presently being conducted by the City of Custer to analyze and evaluate this problem.

2. Septic Tank Systems *

Analysis of infrared aerial photography obtained in May, 1980, by the Environmental Protection Agency indicated that there are 62 septic tank systems within the Stockade Lake watershed which were discernible on the photography and were reported as "probable surface failing systems". The report however does caution that "using color infrared photography does not always mean that a particular system is malfunctioning to the extent that it may cause a public nuisance". Visual examination of the systems located outside of the city limits of Custer indicates that some of the identified septic systems are not causing discernible problems, however, this should be verified by a detailed ground survey using appropriate scientific procedures.

Visual observation on the ground also indicated the possibility that some failing septic systems exist within the watershed which were not discernible on the IR photography. These systems also need further ground survey verification.

* on next page

* The criteria used for the preliminary mapping of potential pollution from septic tanks are:

(a) Systems indentified by Infrared photography which visual observat did not rule out possible pollution

(b) Systems located within 100' of tributary streams

(c) Multiple (or cluster) systems located within 100' of each other.

3. Agricultural Wastes

Animal wastes which contribute nutrients to the tributaries of Stockade Lake are derived primarily from horses and cattle grazing i the meadows adjacent to the streams and from livestock holding facil ities such as barnyards, corrals or stables located along the creek banks.

This problem appears to be more serious during the winter and spring when the livestock is concentrated near the streams for exten ed periods of time. Spring runoff will then wash some of the wastes into the streams and lakes. The problem is less severe during the summer months when a large portion of the livestock is located on forested lands at greater distances from the major tributaries.

4. Secondary Sources of Nutrient Pollution

Secondary sources of nutrient pollution which are contributing lesser, or minor, quantities of nutrients include fertilization, soli wastes, hazardous materials, sawmill wastes*, herbicides and insect- icides. These sources are considered not to be serious contributors to the pollution problem since very little cultivated land exists within the watershed and existing regulations provide for the proper use and disposal of wastes and hazardous materials. However, it is none-the-less important that all agencies having responsibility for control or administration of the use of these materials monitor such activities so as to reduce pollution from these sources to a minimum

* A few landowners believe this is a significant source of pollution However, the amount of wood wastes or soot reaching the creeks & lakes is undetermined at this time.

SEDIMENT POLLUTION

Description of Potential Sources of Significant Sediment Pollution

While all soil disturbing activities within the watershed have the potential for contributing sediment to the tributary creeks visual observations indicate that the following sources are the most significant.

1. Urban Runoff

French Creek and Laughing Water Creek run through the City of Custer for a total distance of two miles. There are approximately eight miles of paved* streets within the city and twelve miles of gravel and/or dirt streets. A very limited portion of the city is served by storm sewers.

Runoff from the gravel streets is contributing a significant quantity of sand and silt into the tributary creeks. The runoff also washes dirt and oil together with sand and salt from the paved streets which are sanded during the winter. Snow removal and disposal to sites adjacent to French Creek add further quantities of sediment to the creek and lake.

2. Disturbance of Stream Channels

Moderate to significant amounts of sediments are being derived from placer mining and soil disturbing activities such as channel changes associated with these operations.

Two placer sites were being operated adjacent to French Creek in 1980.

The extent of placer mining operations can be expected to fluctuate proportionately with changes in the price of gold.

3. Raw Stream Banks and Livestock Concentrations Adjacent to Creeks

Sediment from this source is caused by exposed bare soil on steep stream banks and by livestock located in areas as described in item 3 under nutrient pollution. Livestock trampling and grazing along stream banks and exposed soils at barnyards, corrals and stables are the primary cause of moderate sedimentation under this item.

4. Gravel or Dirt Roads or trails

Several gravel and dirt roads exist from which sediment is washed into the tributary creeks due to the proximity of the roads to the creeks

*Incl. 2.4 mi. "light surface treatments"

or to steep road grades. Also roads adjacent to the shore of Stockade Lake and foot trails within the picnic areas in Custer State Park are causing some sediments to be washed into the lake during heavy runoff periods.

5. Dirt Fill and Mine Spoil Encroachments

Approximately three locations along French Creek have been noted where site development and/or dumping of dirt to encroach into the waterway has occurred in recent years. Also one old mine spoil dump located immediately adjacent to French Creek still contributes some sediment to the creek due to the steep slopes and proximity of the spoil pile. Also some dust and sediment is derived from milling operations near the tributary creeks.

6. Barnyards, Corrals and Stables

At least six sites exist where livestock holding facilities are located within 100 feet of the tributary streams which creates the potential for sediments from the bare soils to be washed into the creeks. Since these areas are relatively small in size the amount of sediment is also estimated to be quite small.

7. Land Developments

Significant residential home development has occurred within the watershed during the past decade with most of the development occurring within a half mile of French Creek between Stockade Lake and a point about two miles west of Custer. The necessary disturbance of soil during site grading and the construction of roads, streets and utility services result in moderate amounts of erosion and sedimentation particularly during the first few years after the development work is begun. Since virtually none of these new developments have paved roads or streets sedimentation from this source is continuous and long term.

ALTERNATIVES	Evaluation Criteria											
	Environmentally Acceptable 1/	Technically Practical	Economically Feasible 1/	Public Acceptance 1/	Reliability	Flexibility	Energy Requirements	Land is Available	Abatement of Pollution 1/			Total
Nutrient Sources												
(1) For municipal waste water effluent:												
Rapid infiltration systems	3*	3	1-2	3	3	0-1	3	1	3			20-22
Irrigation (overland or sprinkler)	2-3	3	1-2	2	2	2	1-2	1-2	2			16-20
"Wetlands" systems	2-3	3	1-2	2	2	2	1-2	1	2			16-19
Reduce use of detergents high in P & N	3	3	3	2	3	3	3	3	2			25
Bypass effluent around lake	0	3	1	0-1	3	0	3	2	0-1			12-14
(2) Individual Septic Tank problems:												
Repair or replace	3	3	3	3	2	1	3	1	2-3			21-22
Use of different system	3	3	1-2	3	2	1	2-3	1-3	2-3			18-23
Proper operation and maintenance	3	3	3	3	3	3	3	3	3			27
Adherence to established regulations-												
(3) Agricultural Wastes:												
Relocate to different site	2	3	1-2	3	2	1-2	2-3	2	2			18-21
Provide buffer zone along stream	2	3	2	3	2	2-3	3	1-2	2			20-22
Dike barriers or terraces	3	3	2	3	2-3	2-3	3	2	2-3			22-25
(4) Toxic materials:												
Conservative & proper use of fertilizers	3	3	3	3	2-3	3	3	3	2-3			25-27
Proper disposal of solid wastes, etc.	3	3	2	3	2-3	3	2-3	3	2-3			23-26
Proper use of insecticides and herbicides	3	3	3	3	2-3	3	3	3	2-3			25-27

* See Page 3

1/ Alternatives rated less than 2 in these elements will not be considered further

ALTERNATIVES	Evaluation Criteria											
	Environmentally Acceptable 1/	Technically Practical	Economically Feasible 1/	Public Acceptance 1/	Reliability	Flexibility	Energy Requirements	Land is Available	Abatement of Pollution 1/			Total
Sediment Sources												
(1) Urban Runoff:												
Sedimentation basins or traps	3	3	1-2	3	2	1	3	1	3			20-21
Erosion protection (Egs.: Paving, Curb & Gutter, Storm Sewers)	2	3	1-2	2-3	2	1	3	2-3	2			18-21
Alternate snow disposal sites	3	3	2-3	2-3	2-3	3	2-3	2-3	2-3			21-27
Dike barriers or terraces	3	3	2-3	3	2-3	2	3	1	2-3			21-24
(2) Land Developments and High-use Areas:												
Proper layout & design												
Dikes, terraces or buffer zones	3	3	2-3	3	2-3	2-3	2-3	2-3	2-3			21-27
Slope protection and revegetation	3	3	3	3	2-3	3	3	3	2-3			25-27
Relocation of facilities	3	3	1-2	2-3	3	2	2	1-2	2-3			19-23
	3	3	1-2	3	2	1	3	2-3	2-3			20-23
(3) Mining/Milling -Stream channel changes:												
Slope protection and Revegetation	3	3	1-2	3	2-3	2	1-3	3	3			21-25
Streambed protection (Structures, gradient reduction, etc.)	2-3	3	1-2	2-3	2-3	1-2	2-3	3	2-3			18-25
Buffer zones or dikes at mine spoil disp. areas	2-3	3	2-3	3	2-3	2-3	2-3	1-2	2-3			19-26
(4) Livestock concentrations adjacent to streams:												
Reduces use (Greater distribution by alternate salting areas & watering facilities)	3	3	1-3	2-3	2-3	1-3	2-3	1-3	2-3			17-27
Streambank protection	3	3	2	2-3	2	2	2-3	3	2-3			21-24
Stream-side fencing with water gaps	2-3	3	1-2	2-3	2	2	3	1-2	2-3			18-23
(5) Miscellaneous:												

(E) Miscellane[redacted]
Slope protection & revegetation for landfills

ALTERNATIVES	Environmentally Acceptable	Technically Practical	Economically Feasible	Public Acceptance	Reliability	Flexibility	Energy Requirements	Land is Available	Abatement of Pollution			Total
In-lake Treatments (Total =	2-3	3	0-1	1-2	3	0-1	1	2-3	3			15-20
a. Dredging [2] total or partial (Partial =	2	3	1-2	1-2	2	1	1-2	3	2			16-19
b. Aeration	3	3	1-2	2-3	3	1	1-2	3	1-2			18-22
c. Chemical Treatment w/ Copper sulfate	1-2	3	1	1-2	2-3	2	2-3	3	0			15-19
d. Lake-bottom Treatment w/ Aluminum sulfate	2	2-3	1-2	1-2	1-2	1	2	3	1-2			14-19
e. Circulation (wind-driven circulators)	3	3	2-3	2	1-2	1	3	3	1-2			19-22
f. Lake Drainage [3] (for two to five years)	2-3	3	3	1-2	1-2	2	3	3	1-2			19-23
g. Fish Management	3	2-3	3	1-3	2	2-3	3	3	2-3			21-26
h. Increase water yield	2-3	3	2-3	2	3	1	2-3	3	2			20-23
"No Action" Alternative	1	3	3	0-1	3	2-3	3	3	0			18-20

*Rating System:

0 = Does not meet criteria
1 = Probably does not meet criteria
2 = Probably does meet criteria
3 = Meets criteria

2/ Draining lake, then load and truck haul sediments to disposal area(s).

3/ With vegetative planting of bottom sediments

ALTERNATIVES	Negative Impacts											
	Water Quality Downstream	Odor	Aesthetics	Economic Impacts	Erosion	Land Use Impact	Air Pollution	Noise Pollution				
Nutrient Sources												
(1) For municipal waste water effluent:												
Rapid infiltration systems	0*	0	0	0	0	-1	0	0				-1
Irrigation (overland or sprinklers)	0	0,-1	0	0	0,-1	0	0	0				0,-2
"Wetlands" systems	0	0,-1	0	0,-1	0	0,-1	0	0				0,-3
Reduce use of detergents high in P & N	0	0	0	0	0	0	0	0				0
Bypass effluent around lake	-2	-1	-2	-2	0	0,-1	0	0				-7,-8
(2) Individual Septic Tank problems:												
Repair or replace	0	0	0	0	0	0,-1	0	0				0,-1
Use of different system	0	0	0	0	0	**-1,-2**	0	0				**-1,-2**
Proper operation and maintenance	0	0	0	0	0	0	0	0				0
Adherence to established regulations												
(3) Agricultural Wastes:												
Relocate to different site	0	0,-1	0,-1	0	0,-1	0,-1	0	0				0,-4
Provide buffer zone along stream	0	0	0	0,-1	0	0,-1	0	0				0,-2
Dike barriers or terraces	0	0	0,-1	0	0	0,-1	0	0				0,-2
(4) Toxic materials:												
Conservative & proper use of fertilizers	0	0	0	0	0	0	0	0				0
Proper disposal of solid wastes, etc.	0	0	0	0	0	0,-1	0	0,-1				0,-2
Proper use of insecticides and herbicides	0	0	0	0	0	0	0	0				0

ALTERNATIVES	Water Quality Downstream	Odor	Aesthetics	Economic Impacts	Erosion	Land Use Impact	Air Pollution	Noise Pollution				
Sediment Sources												
(1) Urban Runoff:												
Sedimentation basins or traps	0	0	0,-1	0	0	0,-1	0	0				0,-2
Erosion protection (Egs.: Paving, Curb & Gutter, Storm Sewers)	0,-1	0	0	0	0	0	0	0				0,-1
Alternate snow disposal sites	0	0	0,-1	0	0,-1	0,-1	0	0,-1				0,-4
Dike barriers or terraces	0	0	0,-1	0	0	0,-1	0	0				0,-2
(2) Land Developments and High-use Areas:												
Proper layout & design												
Dikes, terraces or buffer zones	0	0	0,-1	0	0	0,-1	0	0				0,-2
Slope protection and revegetation	0	0	0	0	0	0,-1	0	0				0,-1
Relocation of facilities	0	0	0,-1	0,-1	0	0,-1	0	0				0,-3
(3) Mining/Milling -Stream channel changes:												
Slope protection and Revegetation	0	0	0	0	0	0,-1	0	0				0,-1
Streambed protection (Structures, gradient reduction, etc.)	0	0	0,-1	0	0	0	0	0				0,-1
Buffer zones or dikes at mine spoil disp. areas	0	0	0,-1	0	0	-1	0	0				0,-2
(4) Livestock concentrations adjacent to streams:												
Reduces use (Greater distribution by alternate salting areas & watering facilities)	0	0	0	0	0	0	0	0				0
Streambank protection	0	0	0,-1	0	0	-1	0	0				0,-2
Stream-side fencing with water gaps	0	0	0,-1	0,-1	0	-1	0	0				0,-3
(5) Miscellaneous:												
Slope protection & revegetation for landfills	0	0	0	0	0	0	0	0				0
Constr., O & M of Timber Roads and Skid Trls.	0	0	0	0	0	0	0	0				0

ALTERNATIVES	Short Term Negative Impacts: Water Quality Downstream	Odor	Aesthetics	Economic Impacts	Erosion	Land Use Impact	Air Pollution	Noise Pollution				
In-lake Treatments												
a. Dredging - total or partial — Total	-2	-1	-2	-1	-2	-2	0,-1	0,-1				-10
a. Dredging - total or partial — Partial	-2	-1	-2	-1	-2	-2	0,-1	0,-1				-10
b. Aeration	0	0,-1	0	0	0	0	0	0,-1				0,-2
c. Chemical Treatment w/ Copper sulfate	-1-2	0	0	0	0	-1	0	0				-2,-
d. Lake-bottom Treatment w/ Aluminum sulfate	0	0	0	0	0	0	0	0				(
e. Circulation (wind-driven circulators)	0,-1	0,-1	0,-1	0,-1	0	0,-1	0	0				0,-5
f. Lake Drainage (for two to five years)	-2	-1	-2	-1	-2	-2	0	0				-1
g. Fish Management	0	0	0	0	0	0	0	0				(
h. Increase water yield	0,-1	0	0,-1	0	0,-1	0	0	0				0,-3

[redacted]ncl[redacted]s_la[redacted]ise[redacted]

A. Description

A sediment survey was conducted in January, 1981, of the inlet portions of Stockade Lake by measuring the elevation of the top of the sediment deposits along the same cross-sections as established by the survey in 1972 by Utility Engineering Co., Rapid City, SD. (See attached pages D-2 and D-3.) Utility Engineering Co. advised that their survey was made prior to the major flood of June 9-10, 1972.

Survey of the main body of the lake was made in Feb., 1981, with metal probe of the depth of sediment at locations shown on the sketch map, page D-4.

B. Survey Results

(1) 1972 Survey:
Total sediment deposition within the inlet areas from the mid-1930s to early 1972 (per Utility Eng. Co. survey) was 117,000 cubic yards.

(2) 1981 Survey:
(a) Inlet areas: Sediment deposition within the inlet areas from early 1972 to Jan. 1981, is shown on cross-sections pages D-5 to D-10.
(b) Main body of lake: Sediment deposition from the mid-1930s to Feb., 1981, is shown on page D-4 with sediment depths as follows:

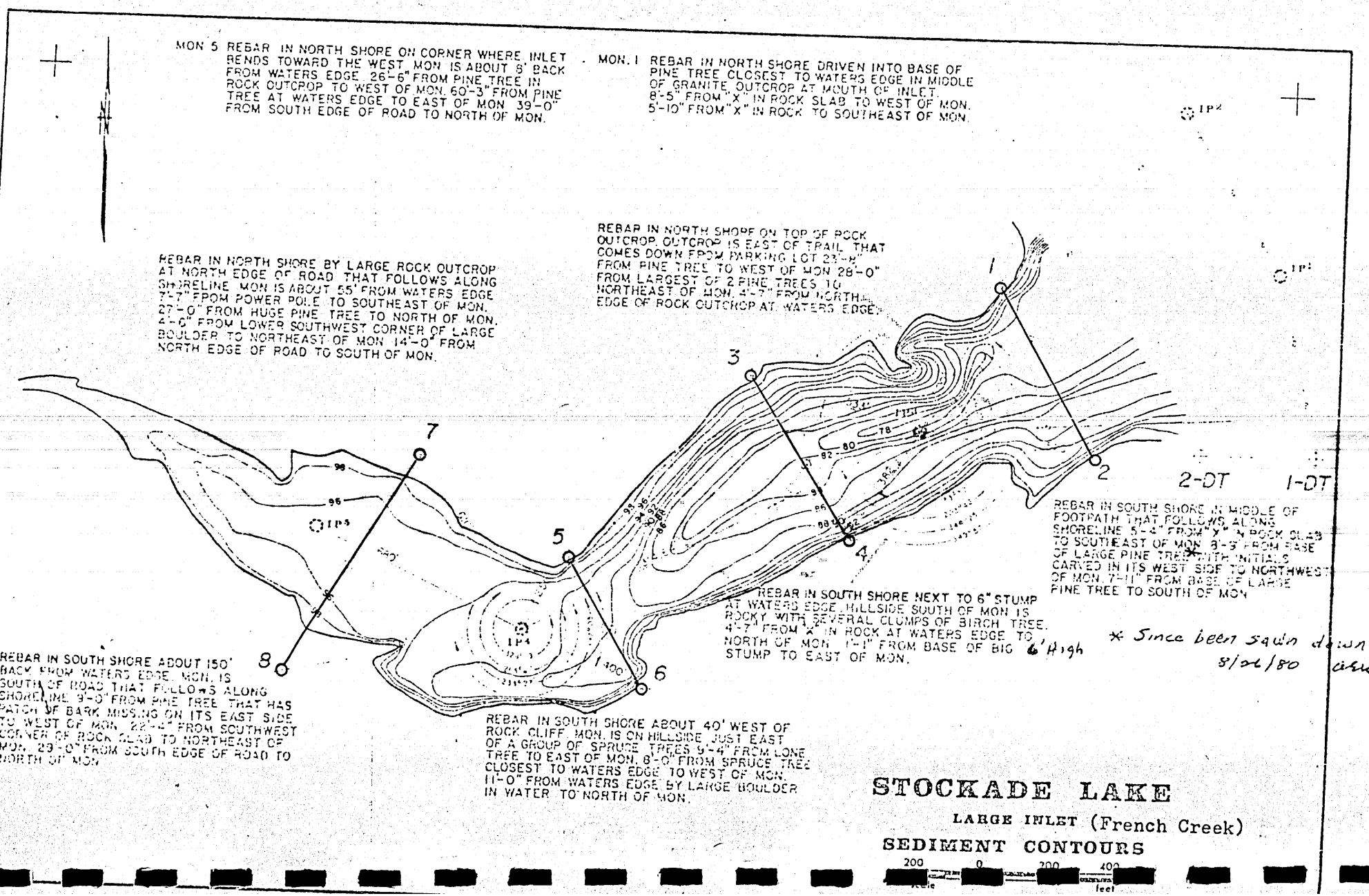
Line A-B	Line C-D	Line E-F
Pt. B = 0+00	Pt. D = 0+00	Pt. F = 0+00
3+00 = 2.3' depth	3+00 = 1.2' depth	2+00 = 1.0' depth
6+00 = 2.3' "	6+00 = 1.7' "	6+00 = 0.5' "
9+00 = 3.2' "	9+00 = 1.8' "	10+00 = 0.4' "
Pt. A = 10+27	Pt. C = 12+94	Pt. E = 12+84

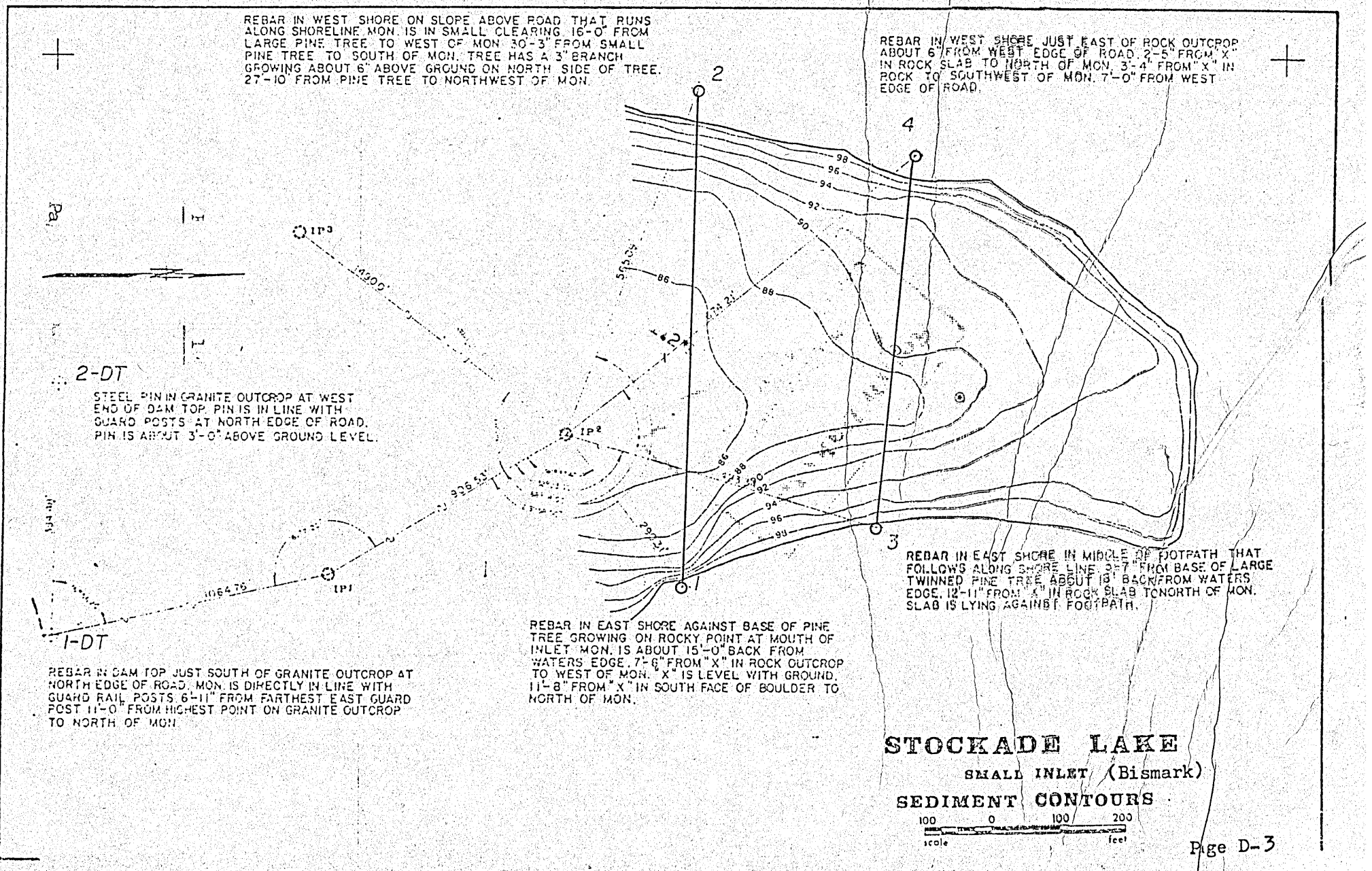
(c) Entire lake area:
Total volume of sediments deposited since the mid-1930s within the entire lake is 284,000 cubic yards or 176 acre feet.

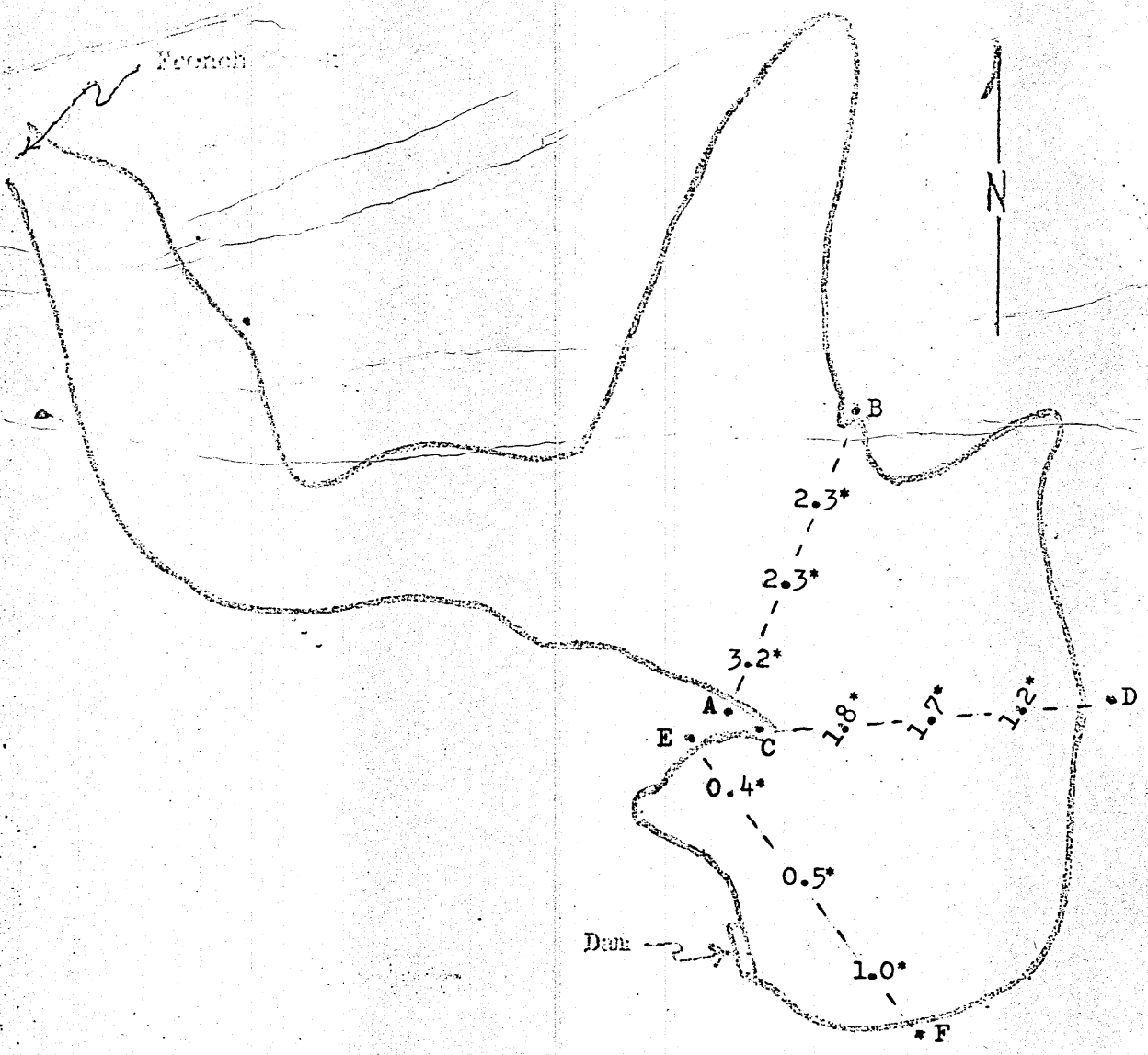
C. Sediment Sampling

Samples of the sediment were taken in Feb., 1981, (using a clam scoop sediment sampler) to test for the quantity of phosphates and nitrates. The locations where these samples were taken are shown on page D-11 and the results of the lab tests are shown on page D-12 which indicate that the nitrates (TKN as N) range from about 7% (by dry weight) in the French Creek inlet to about 28% near the dam. Phosphate content (Total PO_4 as P) ranges from about 0.3% to 2% by dry weight.

= Includes lake use


MON 5 REBAR IN NORTH SHORE ON CORNER WHERE INLET BENDS TOWARD THE WEST. MON IS ABOUT 8' BACK FROM WATERS EDGE. 26'-6" FROM PINE TREE IN ROCK OUTCROP TO WEST OF MON. 60'-3" FROM PINE TREE AT WATERS EDGE TO EAST OF MON. 39'-0" FROM SOUTH EDGE OF ROAD TO NORTH OF MON.
MON. 1 REBAR IN NORTH SHORE DRIVEN INTO BASE OF PINE TREE CLOSEST TO WATERS EDGE IN MIDDLE OF GRANITE OUTCROP AT MOUTH OF INLET. 8'-5" FROM "X" IN ROCK SLAB TO WEST OF MON. 5'-10" FROM "X" IN ROCK TO SOUTHEAST OF MON.
REBAR IN NORTH SHORE BY LARGE ROCK OUTCROP AT NORTH EDGE OF ROAD THAT FOLLOWS ALONG SHORELINE. MON IS ABOUT 55' FROM WATERS EDGE 7'-7" FROM POWER POLE TO SOUTHEAST OF MON. 27'-0" FROM HUGE PINE TREE TO NORTH OF MON. 4'-0" FROM LOWER SOUTHWEST CORNER OF LARGE BOULDER TO NORTHEAST OF MON 14'-0" FROM NORTH EDGE OF ROAD TO SOUTH OF MON.
REBAR IN NORTH SHORE ON TOP OF ROCK OUTCROP. OUTCROP IS EAST OF TRAIL THAT COMES DOWN FROM PARKING LOT 23'-8" FROM PINE TREE TO WEST OF MON 28'-0" FROM LARGEST OF 2 PINE TREES TO NORTHEAST OF MON. 4'-7" FROM NORTH EDGE OF ROCK OUTCROP AT WATERS EDGE.
IP4
IP5
1
2
3
4
5
6
7
8
2-DT
1-DT
REBAR IN SOUTH SHORE IN MIDDLE OF FOOTPATH THAT FOLLOWS ALONG SHORELINE. 5'-4" FROM "X" IN ROCK SLAB TO SOUTHEAST OF MON. 8'-5" FROM BASE OF LARGE PINE TREE WITH INITIALS CARVED IN ITS WEST SIDE TO NORTHWEST OF MON. 7'-11" FROM BASE OF LARGE PINE TREE TO SOUTH OF MON
REBAR IN SOUTH SHORE NEXT TO 6" STUMP AT WATERS EDGE. HILLSIDE SOUTH OF MON IS ROCKY WITH SEVERAL CLUMPS OF BIRCH TREE. 4'-7" FROM "X" IN ROCK AT WATERS EDGE TO NORTH OF MON. 1'-1" FROM BASE OF BIG 6' High STUMP TO EAST OF MON.
* Since been sawn down, 8/21/80
REBAR IN SOUTH SHORE ABOUT 150' BACK FROM WATERS EDGE. MON. IS SOUTH OF ROAD THAT FOLLOWS ALONG SHORELINE. 9'-0" FROM PINE TREE THAT HAS PATCH OF BARK MISSING ON ITS EAST SIDE TO WEST OF MON. 22'-4" FROM SOUTHWEST CORNER OF ROCK SLAB TO NORTHEAST OF MON. 29'-0" FROM SOUTH EDGE OF ROAD TO NORTH OF MON.
REBAR IN SOUTH SHORE ABOUT 40' WEST OF ROCK CLIFF. MON. IS ON HILLSIDE JUST EAST OF A GROUP OF SPRUCE TREES. 9'-4" FROM LONE TREE TO EAST OF MON. 8'-0" FROM SPRUCE TREE CLOSEST TO WATERS EDGE TO WEST OF MON. 11'-0" FROM WATERS EDGE BY LARGE BOULDER IN WATER TO NORTH OF MON.
STOCKADE LAKE
LARGE INLET (French Creek)
SEDIMENT CONTOURS
200 0 200 400
Scale feet

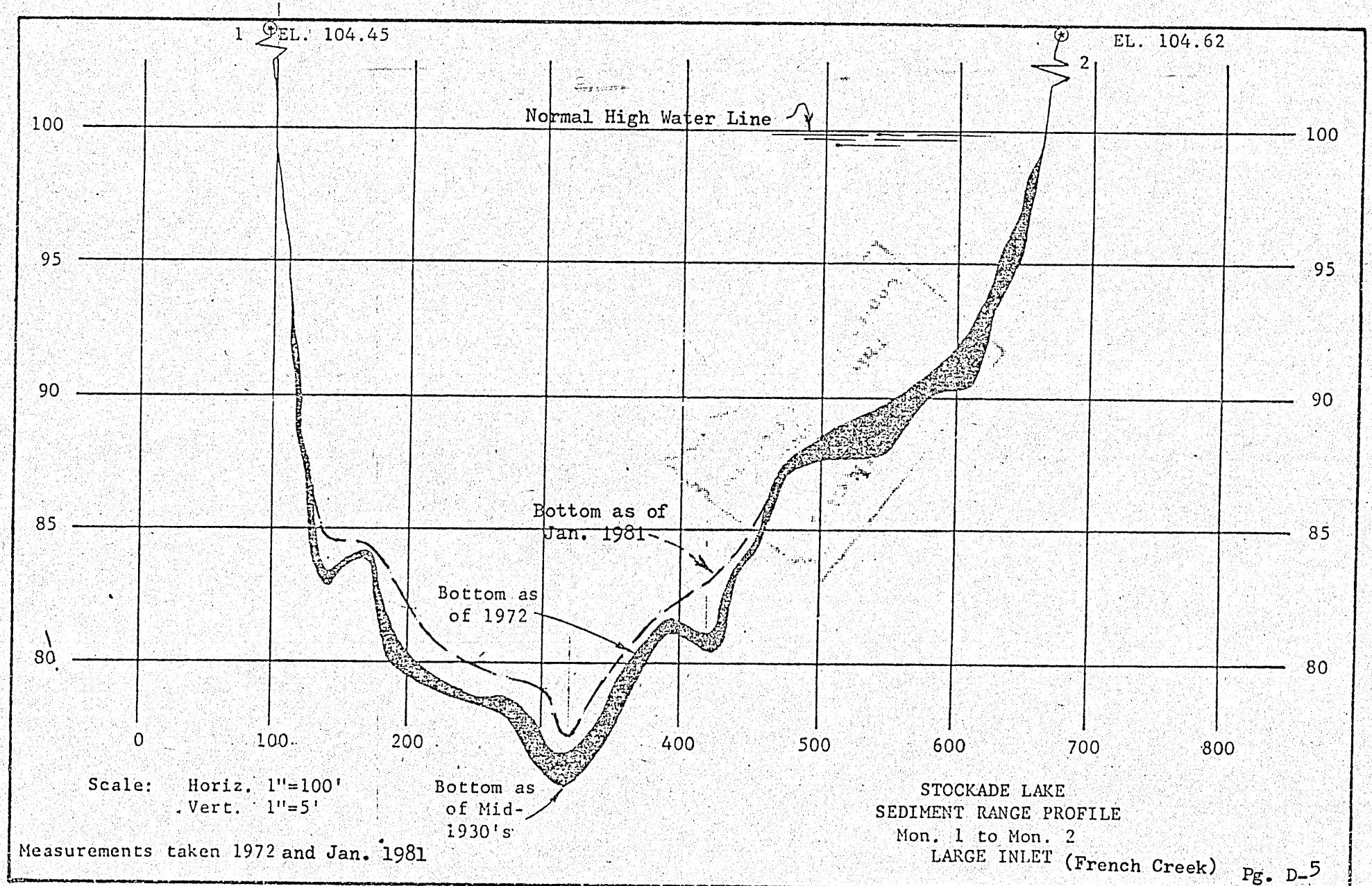

REBAR IN WEST SHORE ON SLOPE ABOVE ROAD THAT RUNS ALONG SHORELINE MON. IS IN SMALL CLEARING 16'-0" FROM LARGE PINE TREE TO WEST OF MON 30'-3" FROM SMALL PINE TREE TO SOUTH OF MON. TREE HAS A 3" BRANCH GROWING ABOUT 6" ABOVE GROUND ON NORTH SIDE OF TREE. 27'-10" FROM PINE TREE TO NORTHWEST OF MON.
REBAR IN WEST SHORE JUST EAST OF ROCK OUTCROP ABOUT 6" FROM WEST EDGE OF ROAD. 2'-5" FROM "X" IN ROCK SLAB TO NORTH OF MON. 3'-4" FROM "X" IN ROCK TO SOUTHWEST OF MON. 7'-0" FROM WEST EDGE OF ROAD.
2-DT
STEEL PIN IN GRANITE OUTCROP AT WEST END OF DAM TOP. PIN IS IN LINE WITH GUARD POSTS AT NORTH EDGE OF ROAD. PIN IS ABOUT 3'-0" ABOVE GROUND LEVEL.
1-DT
REBAR IN DAM TOP JUST SOUTH OF GRANITE OUTCROP AT NORTH EDGE OF ROAD. MON. IS DIRECTLY IN LINE WITH GUARD RAIL POSTS. 6'-11" FROM FARTHEST EAST GUARD POST 11'-0" FROM HIGHEST POINT ON GRANITE OUTCROP TO NORTH OF MON.
REBAR IN EAST SHORE AGAINST BASE OF PINE TREE GROWING ON ROCKY POINT AT MOUTH OF INLET MON. IS ABOUT 15'-0" BACK FROM WATERS EDGE. 7'-6" FROM "X" IN ROCK OUTCROP TO WEST OF MON. "X" IS LEVEL WITH GROUND. 11'-8" FROM "X" IN SOUTH FACE OF BOULDER TO NORTH OF MON.
REBAR IN EAST SHORE IN MIDDLE OF FOOTPATH THAT FOLLOWS ALONG SHORE LINE. 3'-7" FROM BASE OF LARGE TWINNED PINE TREE ABOUT 18' BACK FROM WATERS EDGE. 12'-11" FROM "X" IN ROCK SLAB TO NORTH OF MON. SLAB IS LYING AGAINST FOOTPATH.
IP3
IP2
IP1
1
2
3
4
98
96
94
92
90
88
86
STOCKADE LAKE
SMALL INLET (Bismark)
SEDIMENT CONTOURS
100 0 100 200
scale feet



Scale: 1 in.= 700 ft.

* Indicates sediment depth in feet

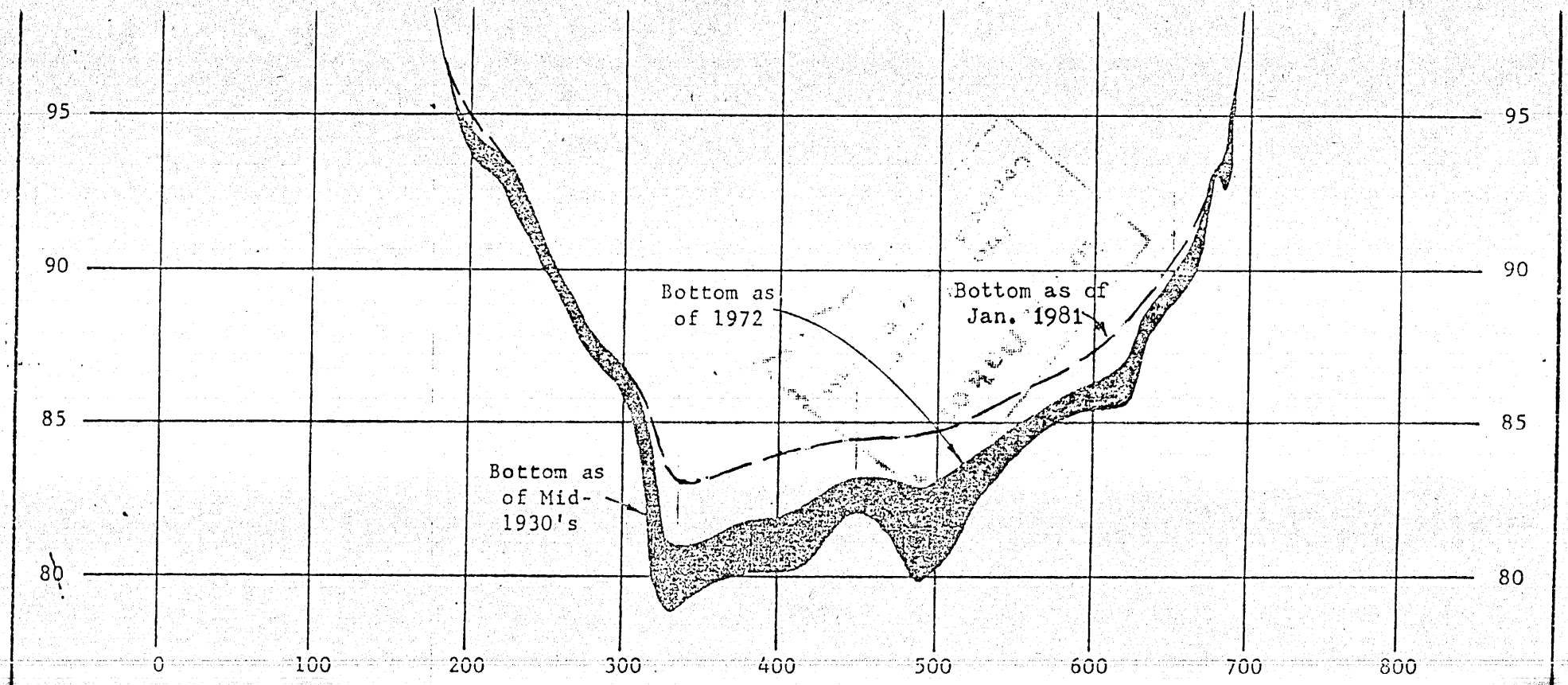
SEDIMENT SURVEY, FEB., 1981



Scale: Horiz. 1"=100'
Vert. 1"=5'

Measurements taken 1972 and Jan. 1981

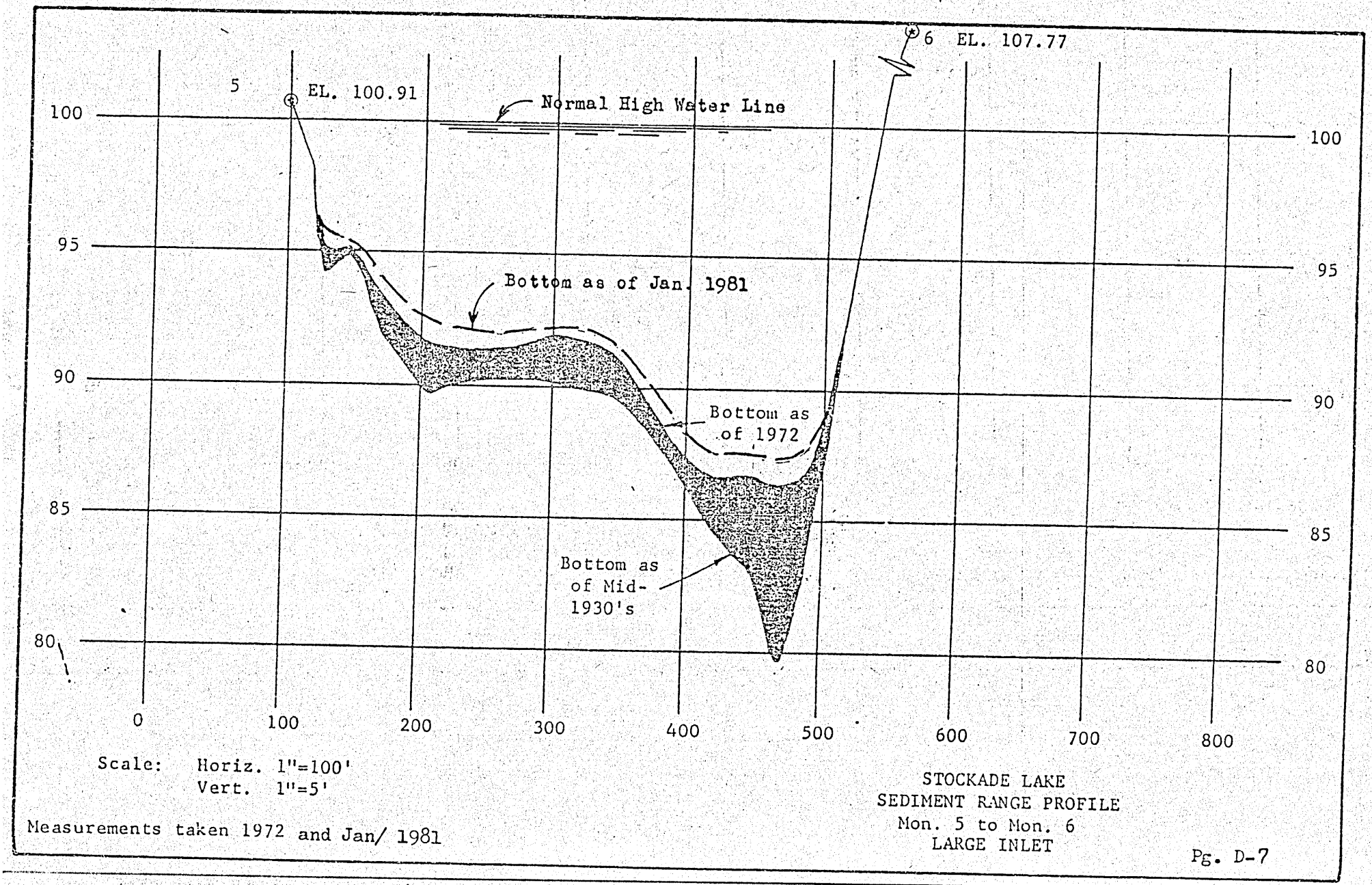
STOCKADE LAKE
SEDIMENT RANGE PROFILE
Mon. 1 to Mon. 2
LARGE INLET (French Creek)



Scale: Horiz. 1"=100'
Vert. 1"=5'

Measurements taken 1972 and Jan. 1981

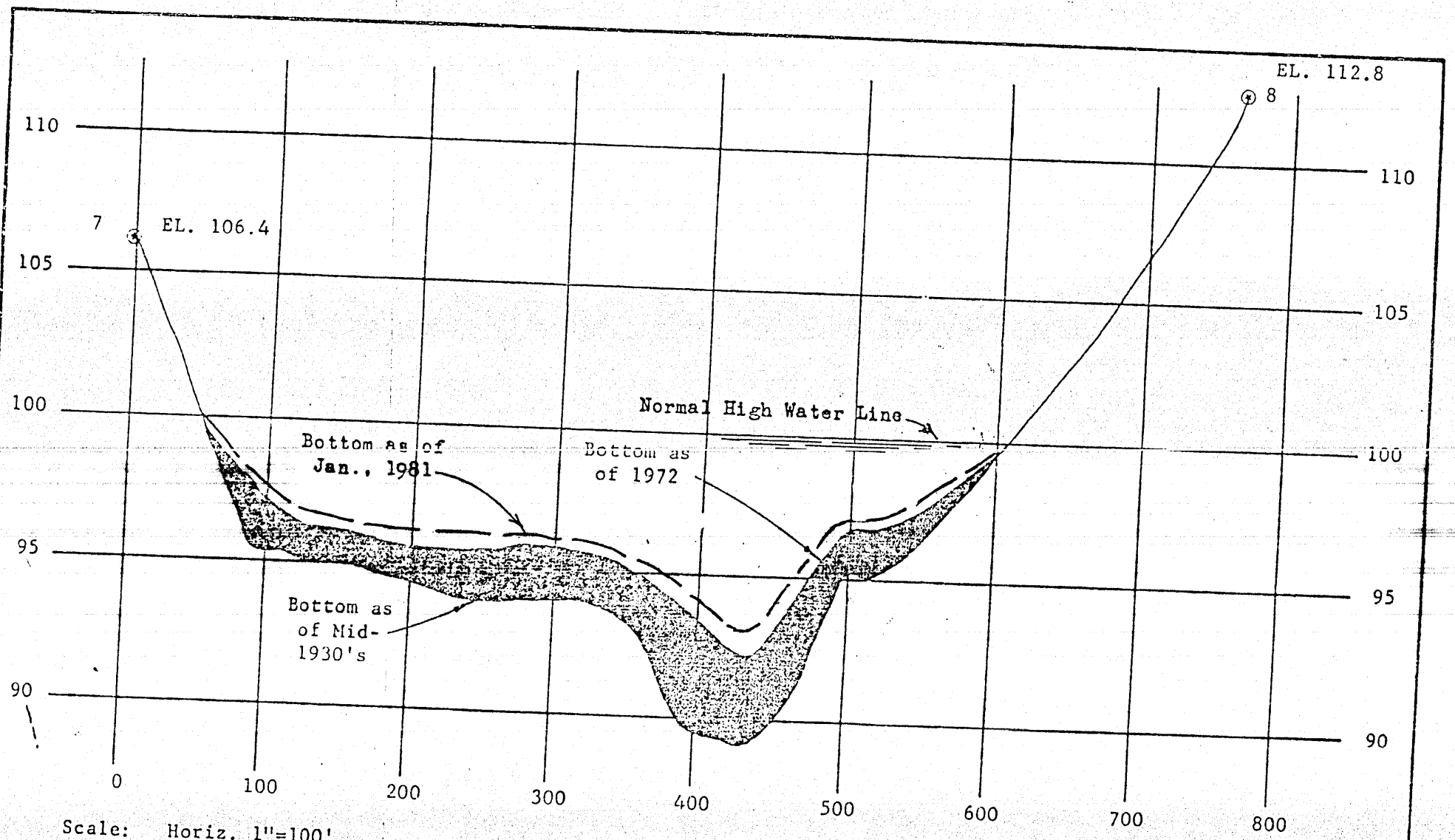
STOCKADE LAKE
SEDIMENT RANGE PROFILE
Mon. 3 to Mon. 4
LARGE INLET



Scale: Horiz. 1"=100'
Vert. 1"=5'

Measurements taken 1972 and Jan/ 1981

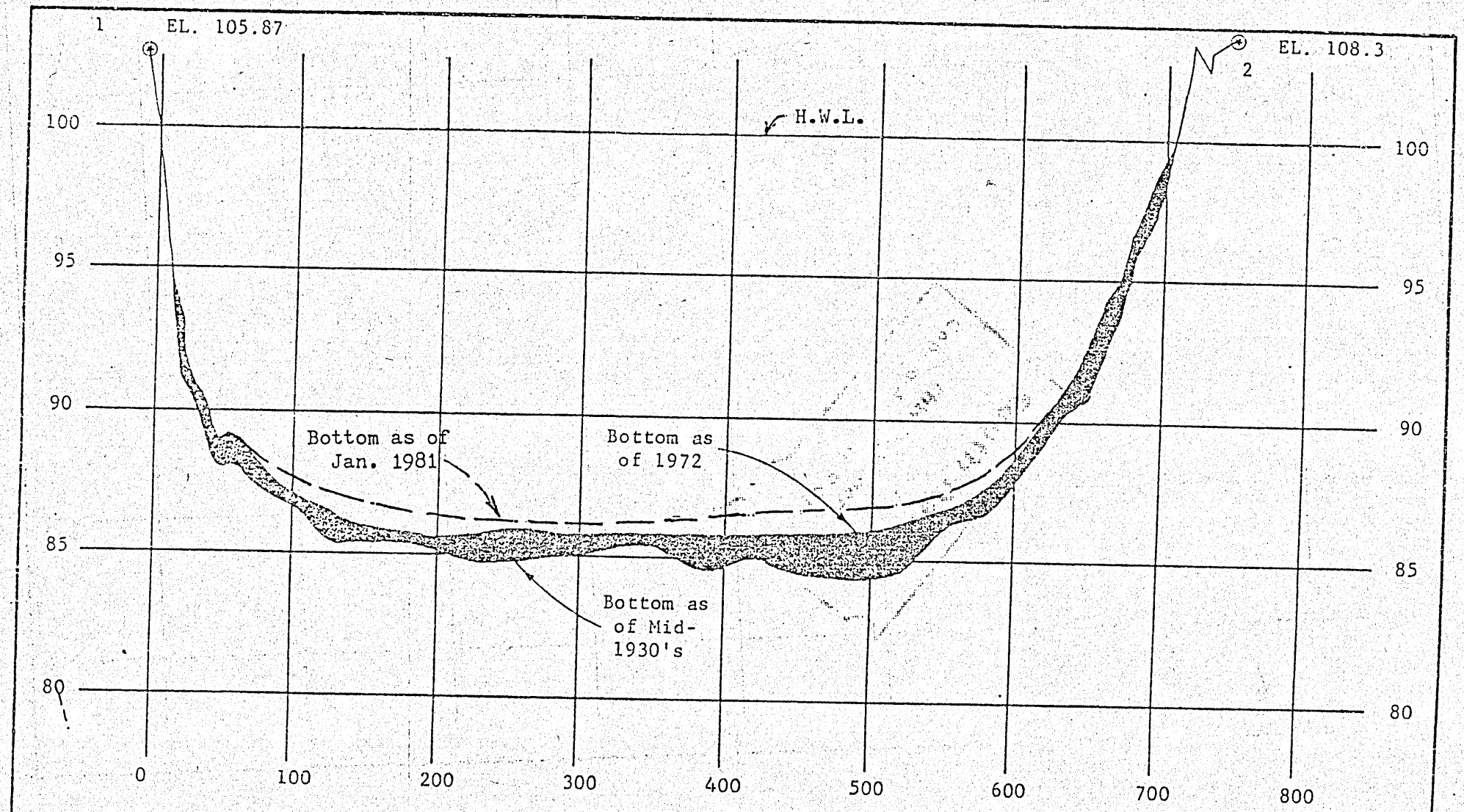
STOCKADE LAKE
SEDIMENT RANGE PROFILE
Mon. 5 to Mon. 6
LARGE INLET



Scale: Horiz. 1"=100'
Vert. 1"=5'

Measurements taken 1972 and Jan. 1981

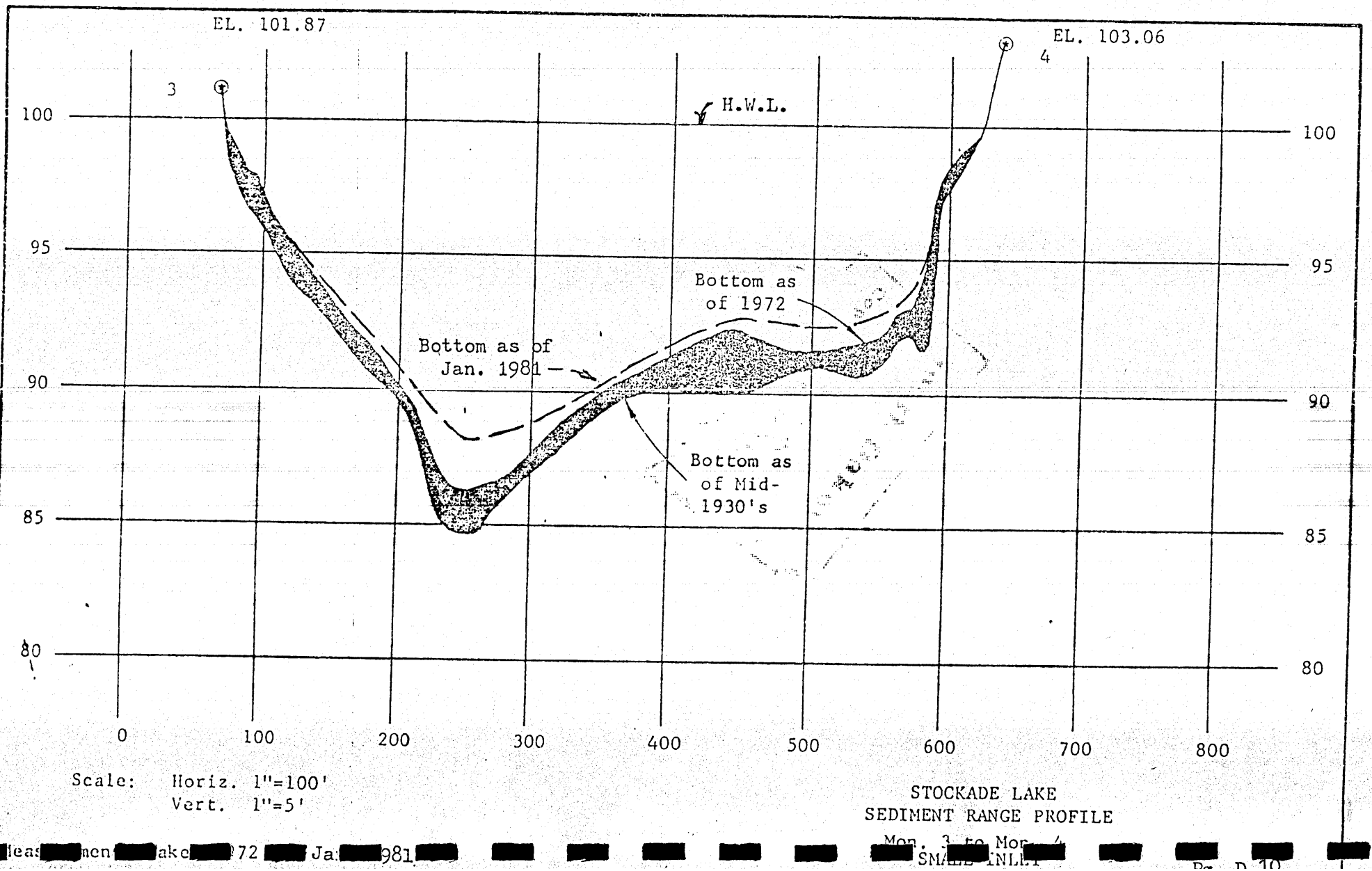
STOCKADE LAKE
SEDIMENT RANGE PROFILE
Mon. 7 to Mon. 8
LARGE INLET



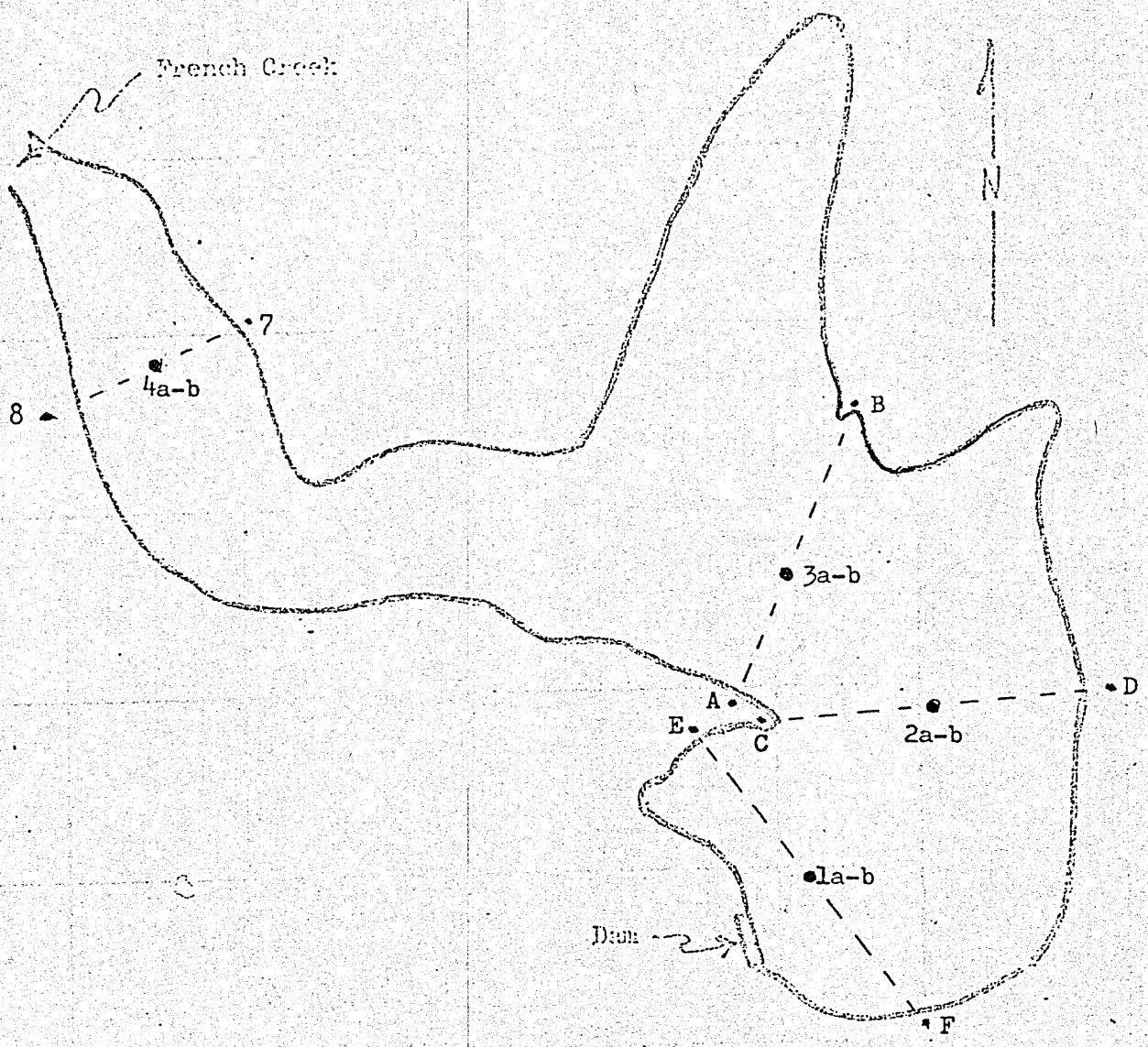
Scale: Horiz. 1"=100'
Vert. 1"=5'

Measurements taken 1972 and Jan. 1981

STOCKADE LAKE
SEDIMENT RANGE PROFILE
Mon. 1 to Mon. 2
SMALL INLET (Bismark)



[redacted]leas[redacted]men[redacted]ake[redacted]72[redacted]Ja[redacted]981[redacted]



Scale: 1 in. = 700 ft.

• Indicates location of sediment sample

LOCATIONS OF SEDIMENT SAMPLES
Feb., 1981

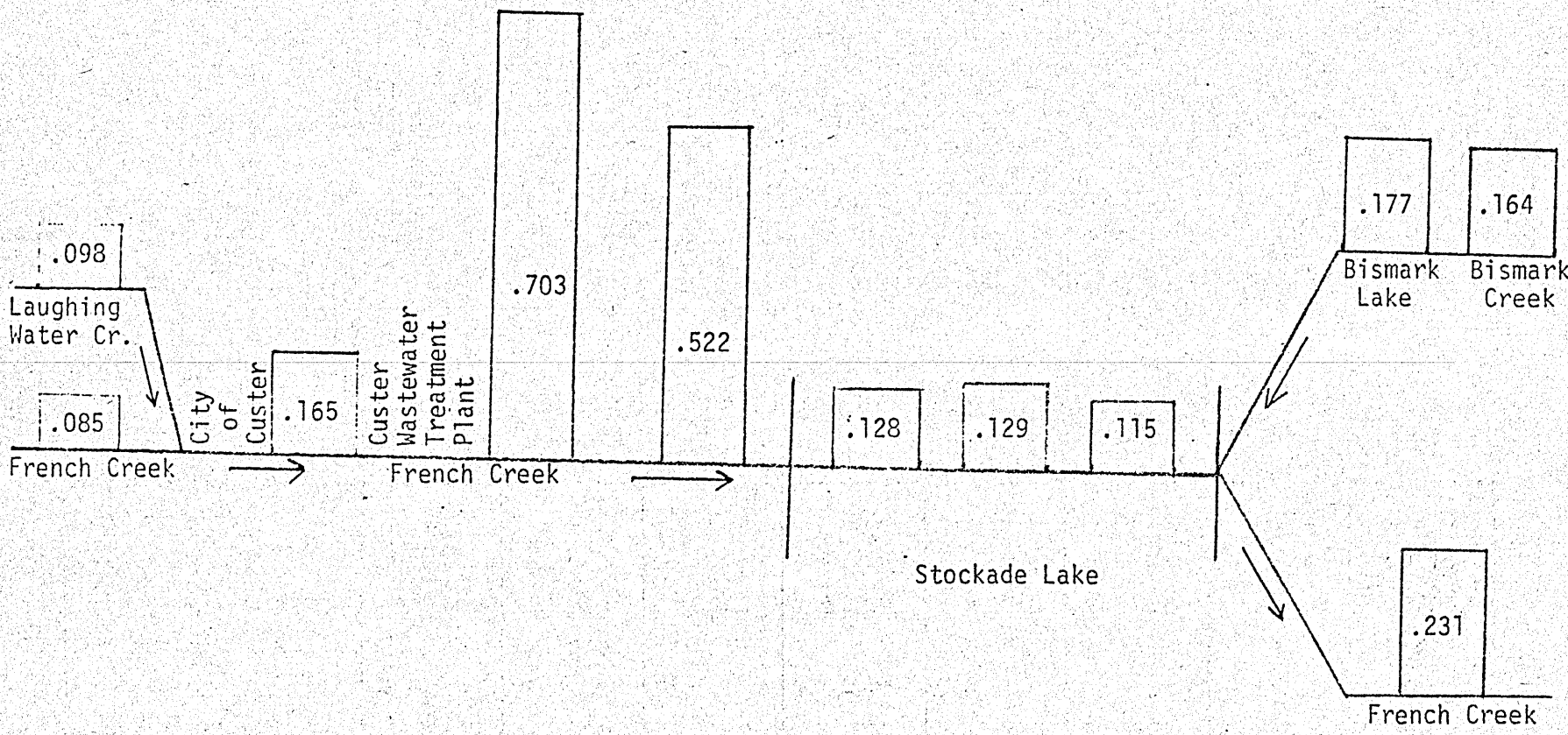
STOCKADE LAKE SEDIMENT TESTS, Feb. 25, 1981

ELEMENT	SAMPLE NO.							
	1a	1b	2a	2b	3a	3b	4a	4b
Ammonia as N	210	520	230	200	310	290	47	65
TKN as N	270,000	290,000	270,000	150,000	250,000	180,000	86,000	74,000
Ortho PO_4 as P	20	8.0	11	4.6	18	12	2.8	4.4
Total PO_4 as P	2,600	6,700	8,200	7,000	9,000	21,000	2,500	3,500
NO_3 as N	23	95	34	16	5.6	16	11	12
NO_2 as N	0.6	0.6	0.4	0.4	0.6	0.5	0.2	0.2

NOTES:

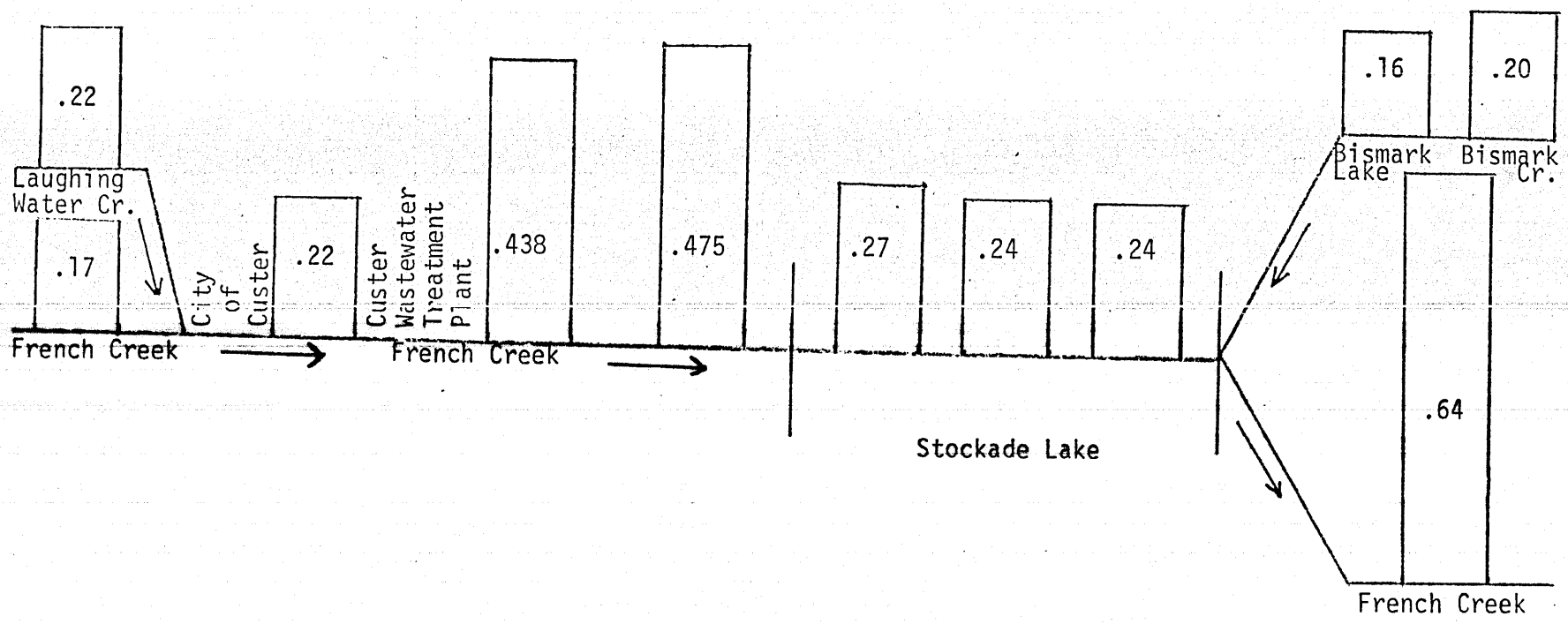
Type of sample: Dredge
Results based on dry weight and expressed in mg/Kg
See sketch map, page D-11 for sample locations

Stockade Lake Watershed, 1979-80, Mean Total PO_4 as P



NOTE: Copies of the individual lab tests are on file at DWNR, Joe Foss Bldg., Pierre, SD

Stockade Lake Watershed, 1979-80, Mean Inorganic Nitrogen



PUBLIC INPUT

Following is a brief summary of public input received on the proposed Stockade Lake improvement project:

(1) A public meeting conducted by the 6th District COLG and the State DWNR was held on July 24, 1979, in Custer, SD, to determine public interest in the proposed project. A total of 21 signed responses (on file at the Soil Conservation Service office, Custer) were received stating that a project should be undertaken to improve water quality of Stockade Lake. No negative responses were received. (See press release, pages F-2 and F-3, summarizing this meeting)

(2) A second meeting was held on June 3, 1980, to get public input prior to beginning a diagnostic-feasibility study. General support for undertaking the project was indicated by those in attendence and no opposition to the proposed project was expressed. (See agenda for this meeting, page F-4)

(3) On May 11, 1981, a public meeting was held for the purpose of reviewing the tentative recommendations proposed by the Technical Advisory Committee and the Citizens Advisory Committee. A total of 33 people were in attendence and generally agreed to the tentative recommendations. Thirteen questionaires were returned at the close of the meeting with 12 concurring to the recommended course of action. The 13th recommended exploring commercial outlets for disposal of the lake sediments for use as fertilizer. (Copies of the questionaires are on file at the Soil Conservation Service office, Custer, SD)

July 25, 1979

6th District News
For Immediate Release:

AUG 1979
RECEIVED

Proposals for rehabilitation of Stockade Lake were outlined Tuesday evening at a meeting in Custer attended by more than 20 persons. The audience included representatives of the U.S. Forest Service and the South Dakota Department of Game, Fish, and Parks, as well as local officials and private citizens.

Steve Pirner, consultant with the Sixth District Council of Local Governments, opened the meeting and outlined the background on the proposed study. Stockade Lake had been nominated by the Sixth District Council as an area to be studied for methods to improve the water quality of the lake. Pirner stressed the need for public input, and said in addition to oral comments at the meeting, written comments concerning the proposed study will be accepted until August 7. They should be mailed to Sixth District Council of Local Governments, P. O. Box 1586, Rapid City.

Dick Ford of the Department of Game, Fish, and Parks gave a history of the lake and its pollution problems. He reported on incidents of fish kills, and said a major problem has been the growth of algae, and resulting changes in the PH factor of the water. Ford said this is not desirable to maintain a healthy fish population.

Jim Seyfer of the Department of Water and Natural Resources discussed what the proposed study will include. It would be funded and conducted by his department. Seyfer said there would be a review of environmental problems of the watershed, and on-site monitoring to identify critical sources of pollution. The study would also include preparation of material which could be used in applications for funding and development of potential Best Management Practices to reduce the pollution. Seyfer said it is expected the study will be completed by the end of the year, following which there will be another

public meeting to determine support for implementation of the recommendations. If support is indicated at that time, local steering committees and a sponsor will be selected to carry out the suggestions.

Questions from persons attending the meeting were mostly concerned with funding and procedures to be used in the study. Seyfer said the amount of local funding needed could range from zero to 25% of the cost, depending on several factors. An estimate of the total cost of the program would be a part of the study. One suggestion from the audience was that the monitoring stations be placed farther back in the watershed than originally proposed. There was also a question of the legality of implementing study recommendations. It was explained that the program is designed for voluntary implementation, or through actions of local government.

At the close of the meeting it was indicated that unless a substantial number of negative comments are received, the Department of Water and Natural Resources will proceed with the study.

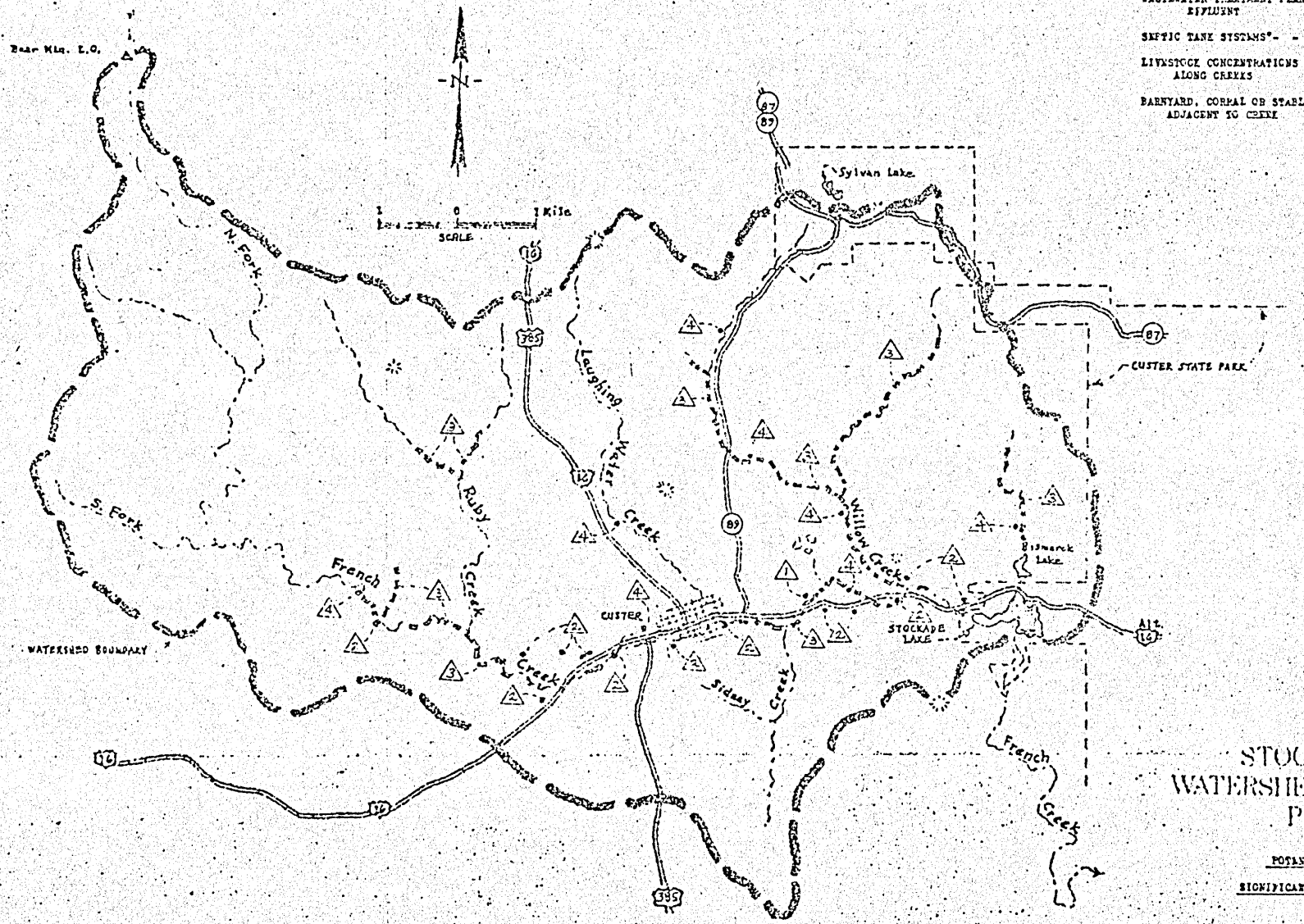
6/3/80
Custer Co.
Conservation
Stockade Lake
Meeting

AGENDA

1. Introduce yourself, Supervisor, urban representative, etc
2. Custer Conservation District agreed to sponsor the Stockade Lake restoration project after local support was shown at the first public meeting.
3. Purpose meeting-informational, the public has to be aware of and involved with the project if its to be successful.
4. Kerry Stiner, Soil Conservation Service, will show several slides showing results of pollution at Stockade Lake....
5. Mike Sturb, Environmental Engineer with Sixth District will give a background of the project and how it came about....

   Mike to introduce Jim Seyfer, or Rich Whitson
   Dept. Water and Natural Resources, Pierre, S.D.

6. Closing-(if not mentioned before) Arvo Kujala has been selected by the District as coordinator for the project-Thank everyone for coming.



MAP LEGEND

WASTEWATER TREATMENT PLANT EFFLUENT - (1)

SEPTIC TANK SYSTEMS* - - - (2)

LIVESTOCK CONCENTRATIONS ALONG CREEKS - - (3)

BARNYARD, CORRAL OR STABLE ADJACENT TO CREEK - (4)

STOCKADE LAKE WATERSHED IMPROVEMENT PROJECT

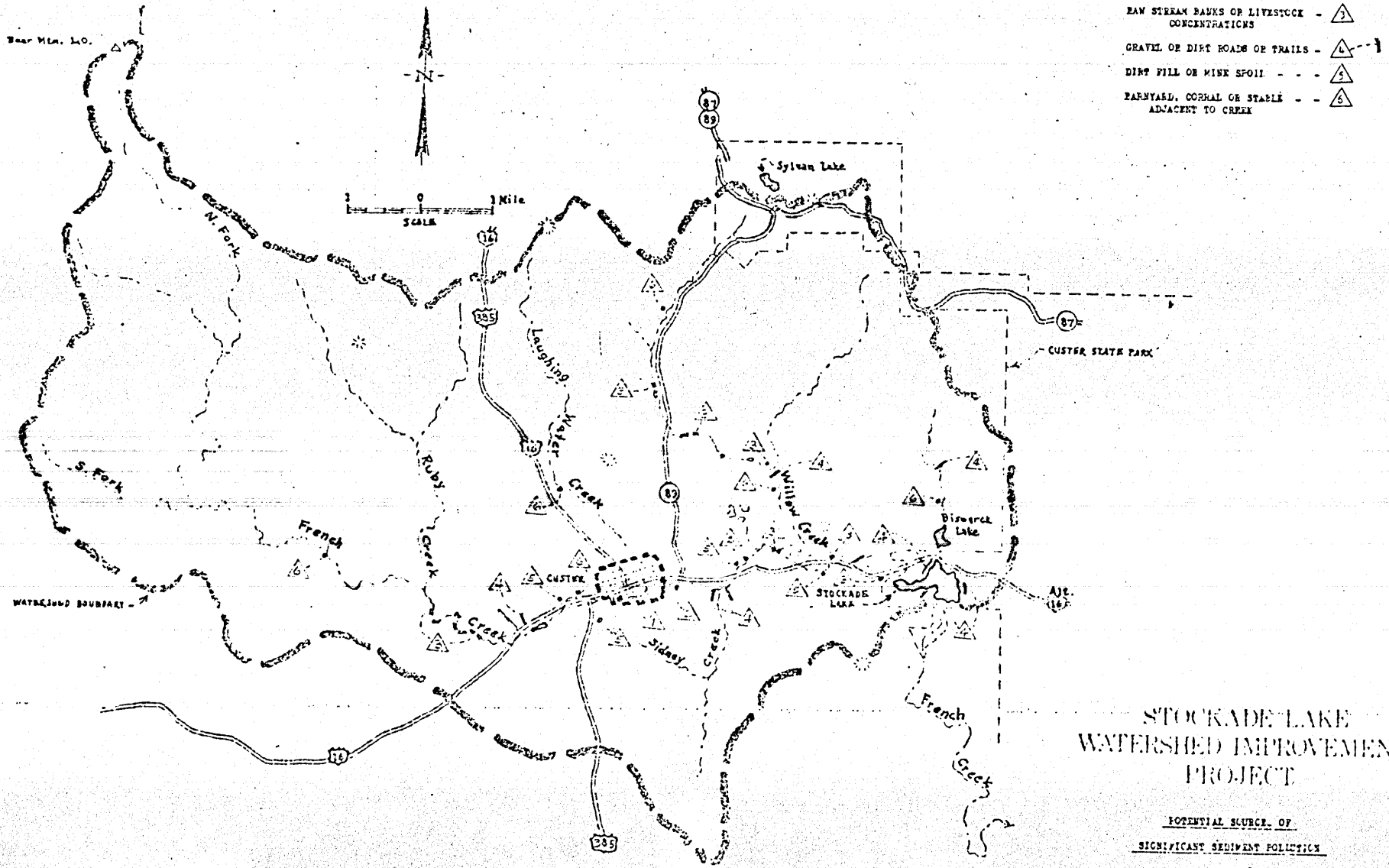
POTENTIAL SOURCES OF SIGNIFICANT NUTRIENT POLLUTION

Apr. 1981

* See Appendix for criteria used

APP. G.

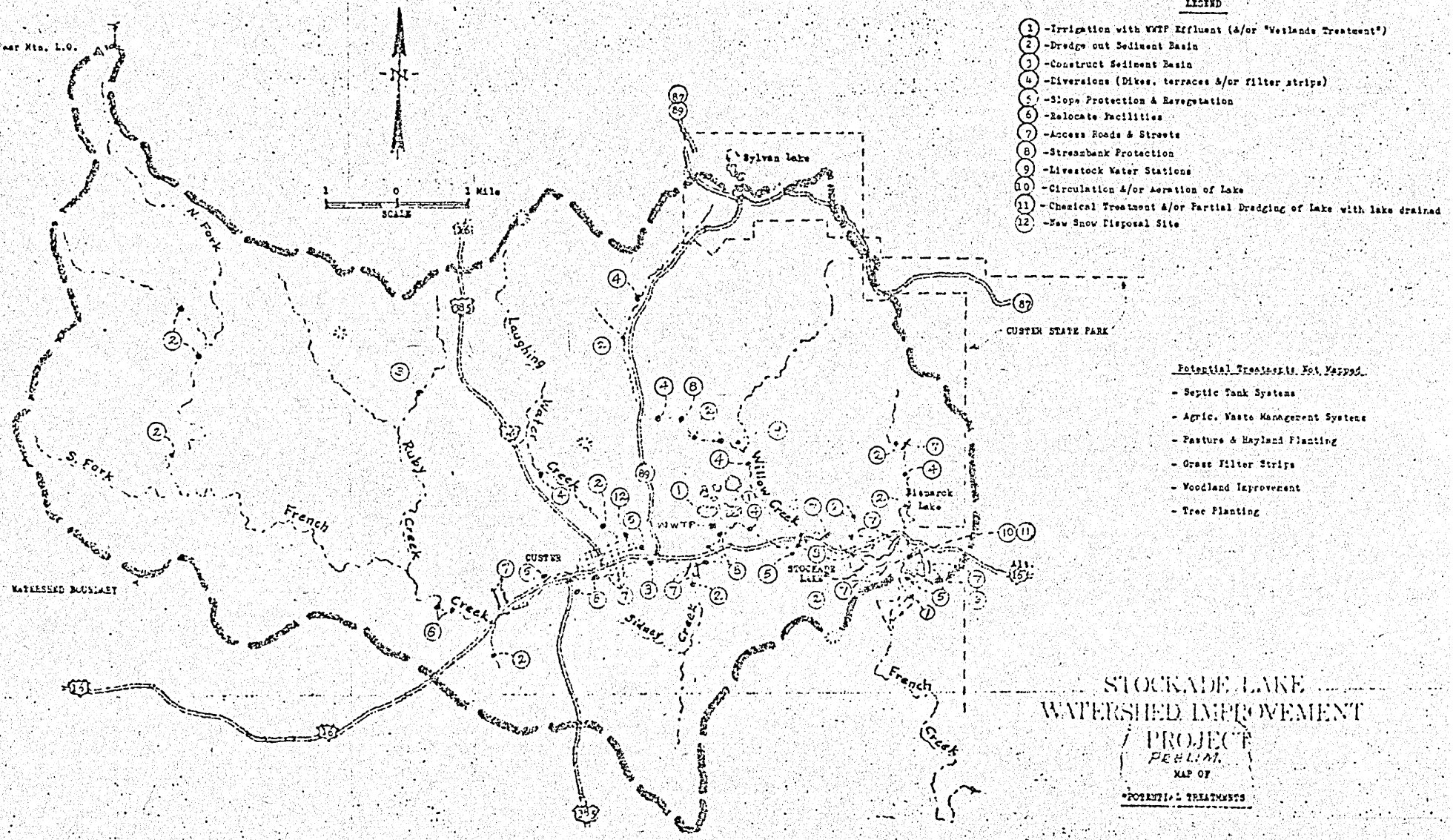
G-1



STOCKADE LAKE WATERSHED IMPROVEMENT PROJECT

POTENTIAL SOURCE OF SIGNIFICANT SEDIMENT POLLUTION

Apr. 1981



STOCKADE LAKE WATERSHED IMPROVEMENT PROJECT

PRELIM.

MAP OF

*POTENTIAL TREATMENTS

*SUBJECT TO CONCURRENCE OF LANDOWNER

APP. H. 4/81