Rice County

WATER QUALITY EVALUATION

1972 to 1984/85

— APRIL 1986 —

By

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CONTENTS

PREFACE

The Rice County Board commissioned this study in 1984 to expand our knowledge of surface water resources. The Commissioners and Citizen Lake Associations sponsored an evaluation of water quality in Rice County in 1972. This commitment to water management has continued in Soil Conservation Service, Planning and Zoning and Environmental Health programs. The new study has attempted to ascertain how well our waters have fared since 1972 and if these environmental programs have been productive. It has also sharpened insight into our impact on surface waters and given us clues to better stewardship of our environment.

Many people contributed to gathering the information contained herein. The foresightedness of the Commissioners and the Community Health Advisory Committee created the funding and inspiration for this project. The Rice County Sheriff's Department donated equipment used during sampling periods. Perspiration, ninety percent of any endeavor, was provided by Merton Hoover, Cliff Linse, Dennis McCusker, Bruce Peterson and Robin Wille. Reference information was generously shared by the Department of Natural Resources and Minnesota Pollution Control Agency.

Any attempt to protect our environment from pollution hinges upon knowledge, understanding and personal responsibility. Each one of us has a stake in water management because we all need water to survive. The choices we make today affect environmental quality tomorrow. Wise choices will enable us to continue using lakes, rivers and streams for our basic needs. This wisdom is an essential endowment to future generations.

Sigurd Scheurle
Rice County Environmental Health
Specialist

INTRODUCTION

The purpose of this study is to evaluate changes in surface water quality in Rice County. Fortunately there exists an extensive data base describing the quality of Rice County lakes and streams. During 1972, a substantial comprehensive evaluation of water quality was conducted. National Biocentric measured the chemical and physical properties of nine lakes and both the Cannon and Straight Rivers. This work serves as a picture of water quality as it was in 1972. This study attempts to duplicate the previous one in order to create a new picture, one worthy of comparison. To expand our understanding and create a more accurate data base, this study includes more frequent sampling and expanded analysis. By comparing the picture of water quality developed between 1984 and 1985 to past information, we can determine what has changed in our waters.

Water quality data must be viewed in conjunction with a complex changing background. It is beyond the scope of this report to adequately evaluate all these variables. Yet, a brief look at the context and general properties of Rice County's waters will be helpful. General information about each lake appears on the first page of each section.

Each Rice County lake is unique, but all reflect the topography, soils, and climate they share. Most are shallow depression basins with high alkalinities. This is due to the fertile soils left behind by the last Wisconsin ice sheet. All our lakes are much more productive than those found in northern Minnesota. This is due to our soils which have sustained forest, grasslands, and now tremendous agriculture production. Shallow lakes and those with large, heavily tilled watersheds are the most productive and heavily enriched with nutrients. These lakes frequently look like pea soup during the summer. They are at times, unfit for game fish and recreation. This condition (eutrophiciation) is not due to fertile soils or long summer days. It is caused by the activities of man and pollution!

To detect the impact man is having on our waters, water was sampled at key locations. Water samples were gathered from three discrete points on twelve lakes and from seventeen discrete points on rivers and streams. Each sampling point was visited six times. The sampling was repeated about every other month between May of 1984 and June of 1985. Lake samples were drawn with a P.V.C. tube (150 cm x 5 cm) yielding a column of epilimnetic water with a volume of just over two liters. Running waters were sampled by the grab method from the surface at midchannel.

Laboratory and field analysis methods were employed to yield the most accurate data. Below is a general discussion of the parameters evaluated, their significance and their relationship to other parameters.

Secchi Disc - Transparency - (ft.)

The visual transparency of water is measured by lowering a white disc into the water. These readings are quite variable depending upon the season, time of day and the observer. There is a relationship between these measures, phosphorus concentration and algae population. The M.P.C.A. has been collecting readings from citizen observers for many years. The average summer transparencies are expressed in Transparency vs. Time tables for each lake.

Temperature - (C) and Dissolved Oxygen (mg/l)

Because both are sensitive and transient they required field measurement with a Y.S.I. portable meter. Aquatic organisms have temperature and dissolved oxygen tolerances. Fluxuations up or down naturally favor or select one species over another.

Game fish, for example, require abundant oxygen and stable temperatures to thrive. Furthermore, nutrient fluxuations are affected by the disbribution of oxygen and thermal gradients.

Phosphorus - (mg/l)

Primary productive potential is largely dependent upon the presence and availability of phosphorus. Phosphorus is essential for plant growth and is cycled through the food chain. It is usually in short supply in aquatic systems because it is not readily soluble in water. Once introduced into a lake or stream it is often used by plants and animals many times before becoming bound to sediments. The bottom sediments (benthos) are a store house of phosphorus. Large rooted plants, turbulence and seasonal turnover replenish the phosphorus consumed by algea near the surface. Oxygen depletion in the benthos increases the amount of phosphorus available for cycling. Both total phosphorus and ortho-phosphorus were measured in the laboratory.

Ammonia - Nitrogen - (mg/l)

Nitrogen is another essential nutrient. It was measured in many forms, but ammonia is an especially important one. It is produced when dead plants and animals decompose. Ammonia is toxic to fish. All nitrogen measurements were made in the laboratory.

Biochemical Oxygen Demand 5 - (mg/l)

B.O.D. is an estimate of the amount of organic matter available for microbial decomposition and oxidation in water. Water choked with algea or polluted by sewage has a large demand for oxygen. Without abundant oxygen production such waters will become ammonia rich and oxygen poor. B.O.D. was measured in the laboratory using a five day method.

pH

Acidity and Alkalinity are functions of hydrogen ion activity. High pH values may be attributed to alkaline soils and heightened photosynthetic activity. Field measurement showed our waters to be quite alkaline and therefore very capable of buffering acidic precipitation.

Conductivity - (muhos/cm2)

Conductivity was directly measured in the field. It is an estimate of dissolved solids in water. It is usually quite constant within lakes. High, isolated values may indicate pollutant discharges close by.

Bacteria - (Conlonies/L)

This is one of the most specific pollution indicators. Coliform bacteria is a family of organisms found in the intestines of warm blooded animals. Fecal coliform is a more specific member within this family. These organisms may cause disease in humans. Septic systems, feedlots and agricultural runoff may be sources of this dangerous pollutant.

Bacterial measurements are expressed in terms of their presence or absence. For example "A+, C+" would indicate the presence of bacteria at monitoring point A and C. National Biocentric measured total coliform. The Rice County W.Q.E. measured fecal coliform bacteria.

All laboratory analysis was performed at Minnesota Valley Testing Laboratories. John Gray and Jeff Henderson of M.V.T.L. provided services and aid beyond the scope of their contract. The staff of M.V.T.L. deserves special thanks for their efforts.

RECOMMENDATIONS

1. As a community and as individuals we must recognize and admit that our culture has damaged the quality of our waters. We must look at our soil and water resources as an economic base that cannot be exploited carelessly. Government edict will never replace informed self interest as a motivational force for positive change and environmental protection.

2. As individuals and community leaders we must decide if the pollution problems, soil loss, and health risks are important enough to warrant the commitment of resources. Solving these problems will require commitment of time and money by local government and grass roots support by farmers and lakeshore dwellers.

3. A watershed improvement program integrating County staff and S.C.S. should be organized, initially at a low cost. In this way resources could be channeled into a program with limited, well defined, and measurable objectives. Only by prioritizing problems and focusing effort can we lick pollution without going broke.

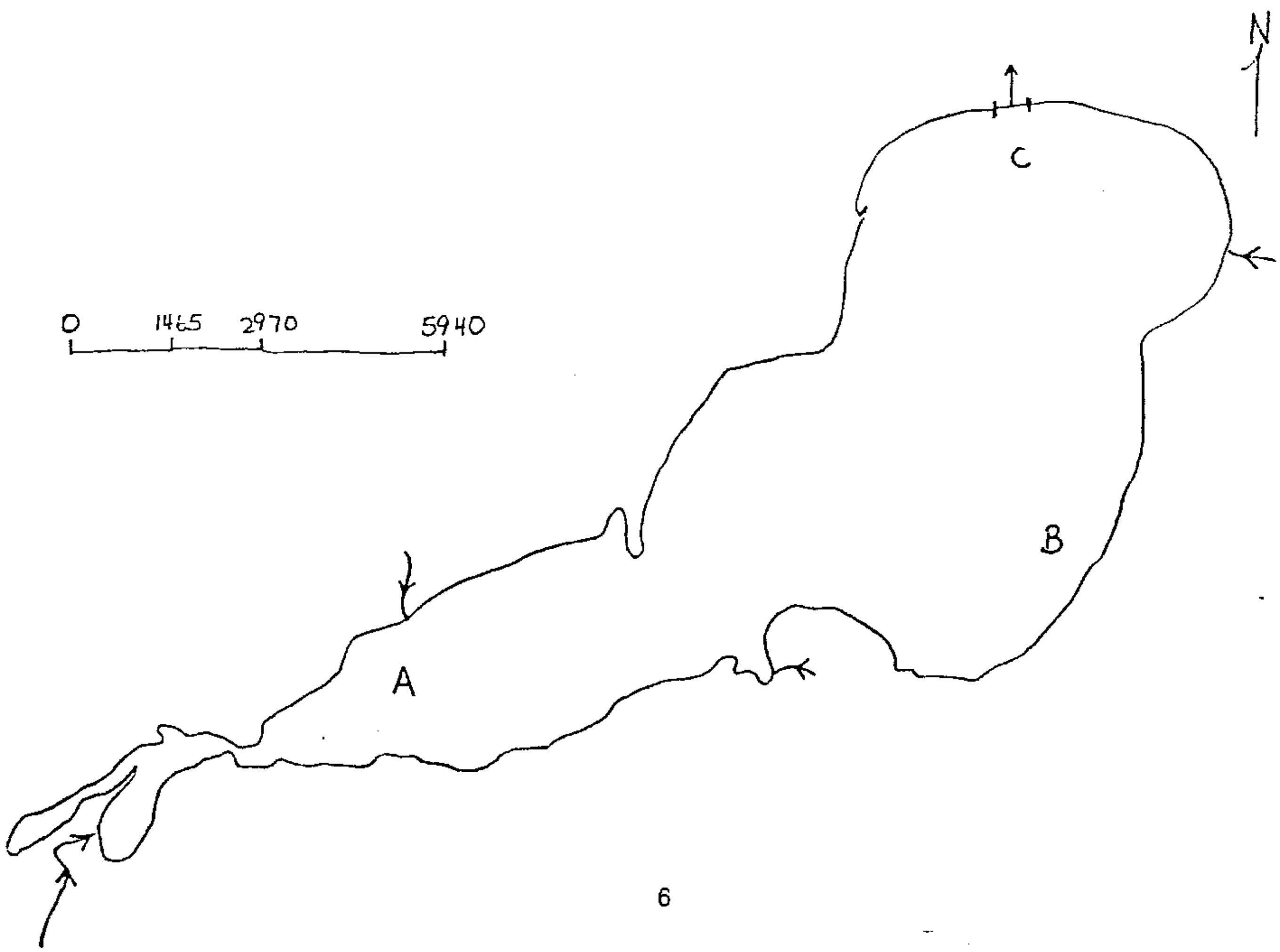
4. Existing efforts must be maintained. Lakeshore development codes, on-site sewage regulations, and S.C.S. programs have prevented many acute pollution events. State regulation has limited allowable or permitted discharges of waste waters. Yet, chronic eutrophication continues to occur. State and local governments must strictly uphold the regulations already in place in order to slow this deterioration in water quality.

CANNON LAKE

D.N.R. LAKE NUMBER 66-008

General Information

SIZE OF LAKE	=	1476	Acres
SHORELENGTH	=	11.5	Miles
MAXIMUM DEPTH	=	15.2	Feet
MEDIAN DEPTH	=	10.0	Feet
% LITORAL	=	100%	
TOTAL HOMES (1967)	=	67	Homes
TOTAL HOMES (1982)	=	143	Homes



CANNON LAKE

Summary/Conclusions

Cannon Lake has not changed significantly since 1972. Except for an especially high secchi measure in 1978 (7.0'), Cannon has experienced frequent algae blooms during the summer months which keeps the transparency low. Frequently nuisance forms of blue-green algae dominate along shoreland areas making beaches unfit for recreation. Yet Cannon is one of the most popular fishing lakes, especially during the winter when panfish are abundantly harvested.

Cannon is unique among Rice County Lakes because it is actually part of the Cannon River channel. As such, it's watershed is tremendously large, including the cities of Waterville, Morristown, and Warsaw. The Cannon River carries pollutants like sediment, nutrients and bacteria downstream to Cannon Lake. The lake is entirely available for plant growth because of its shallow depth. Large quantities of sediment and nutrients are deposited and lush green growth occurs. While the River input at Warsaw is a pollution source with respect to suspended solids, bacteria and nutrients, it is also a source of life giving oxygen. This constant input of oxygen prevents it's complete depletion and prevents winter kills. Only at Point A where the B.O.D. was the greatest did a serious oxygen deficiency appear.

Considering Cannon Lake's dense development and the consistent detection of bacterial contamination, a close look at on-site sewage systems would be appropriate. There are also tributaries on the north and south side feeding Cannon Lake which could be contributing animal waste to the water. One stream flows directly through a cattle feedlot and undoubtedly carries pollutants during melt periods and rainfall events. Although inventoring the entire watershed for such pollution problems would be impossible, special attention to the immediate tributary waters might reduce obvious erosion and runoff problems.

CANNON LAKE

Average Data from points A, B, and C

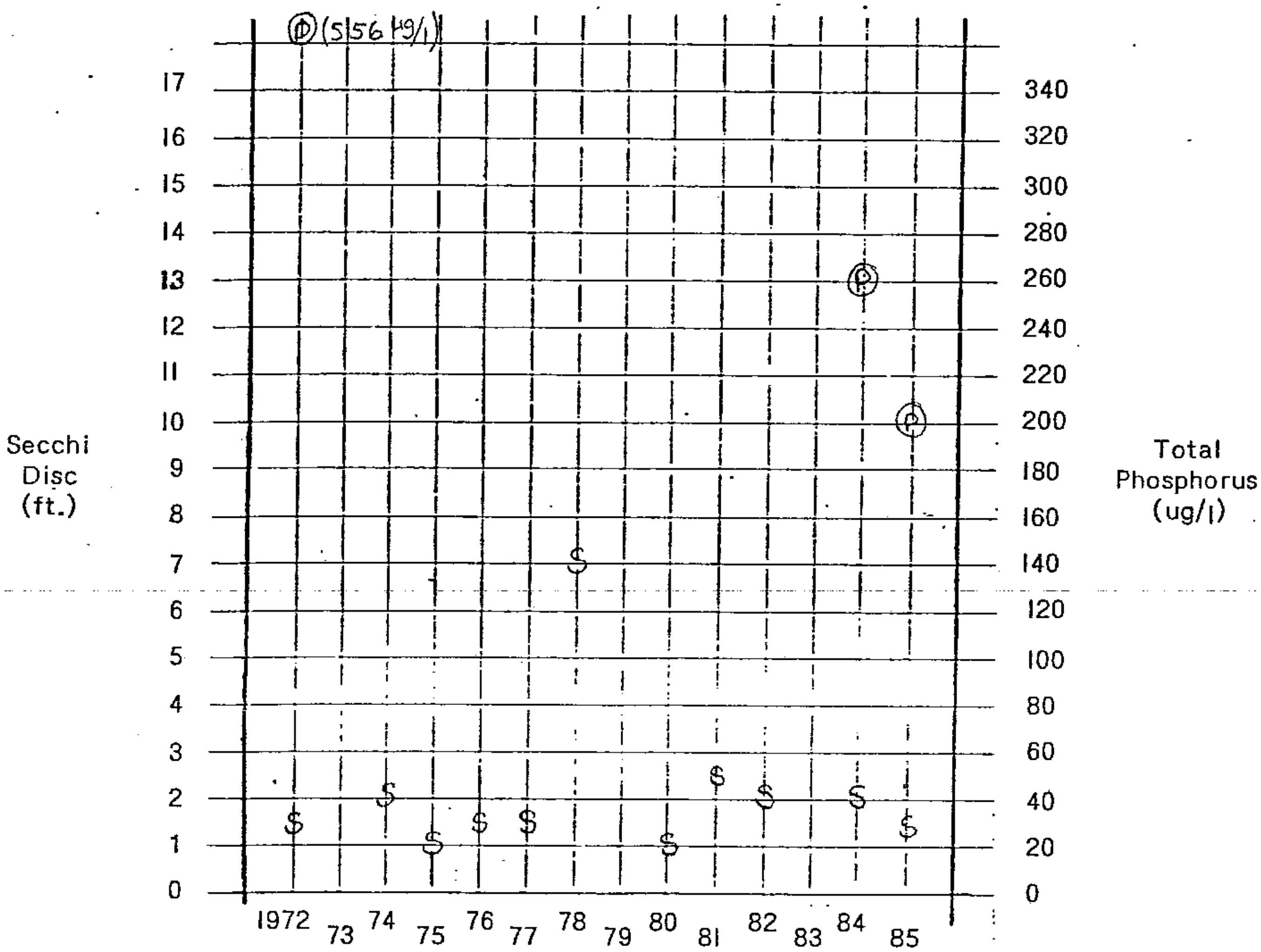
	National Biocentric	Rice County W.Q.E.	
Date	6-7-72	6-19-84	6-25-85
Depth (ft. in.)	6' 2"	7'	7' 4"
Secchi (ft.)	1'	2'	1' 4"
Temp. (C)	24	22	22
D.O. (mg/l)	10.5	9.5	10.7
B.O.D. (mg/l)	9.42	4	17.3
Total P (mg/l)	583	160	200
Ammonia (mg/l)	.918	1.06	.55
pH	7.5	8.2	9.2
Conduct. (muhos/cm2)	395	410	333
bacteria	A+	A+, C+	A+, C+

Date	8-14-72	8-8-84
Depth (ft. in.)	3'	6' 10"
Secchi (ft.)	1' 5"	2'
Temp (C)	26	25
D.O. (mg/l)	10.48	6.8
B.O.D. (mg/l)	4.81	3.66
Total P (mg/l)	529	320
Ammonia (mg/l)	.286	1.21
pH	8.2	8.5
conduct. (muhos/cm2)	457	401
bacteria	A+, B+, C+	A+, B+, C+

Date	2-25-72	1-7-85
Depth (ft. in.)	7' 1"	7' 2"
Secchi (ft.)	NA	NA
Temp. (C)	1	2
D.O. (mg/l)	6.27	11.9
B.O.D. (mg/l)	1.68	3
Total P (mg/l)	683	140
Ammonia (mg/l)	1.330	1.09
pH	7.3	7.9
conduct. (muhos/cm2)	NA	303
bacteria	A+, B+, C+	A+

CANNON LAKE

TRANSPARENCY AND TOTAL PHOSPHORUS
VS.
TIME



S = Transparency Average (June - September) Secchi Disc Reading in feet.

Ⓟ = Phosphorus Concentration Average (June - September) Total Phosphorus expressed in ug/l.

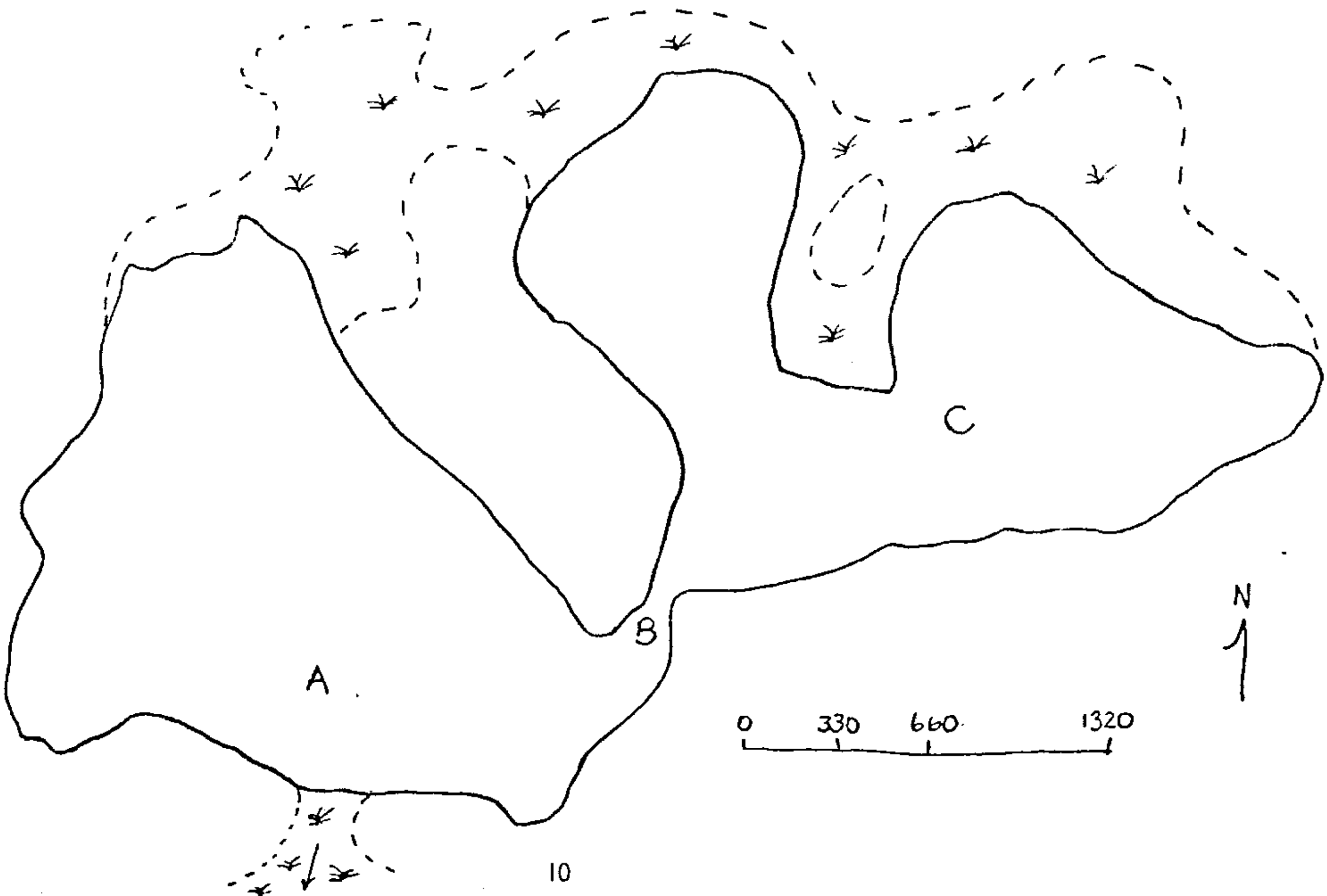
* National Biocentric reported Average Transparency between 1947 and 1953 to be 2' 5" feet.

KELLY - DUDLEY LAKES

D.N.R. LAKE NUMBERS (66-014) - (66-015)

General Information

SIZE OF LAKE	=	145 Acres
SHORELENGTH	=	2.3 Miles
MAXIMUM DEPTH	=	60.0 Feet
MEDIAN DEPTH	=	28.5 Feet
% LITORAL	=	42%
TOTAL HOMES (1967)	=	14 Homes
TOTAL HOMES (1982)	=	29 Homes



KELLY - DUDLEY LAKES

Summary/Conclusions

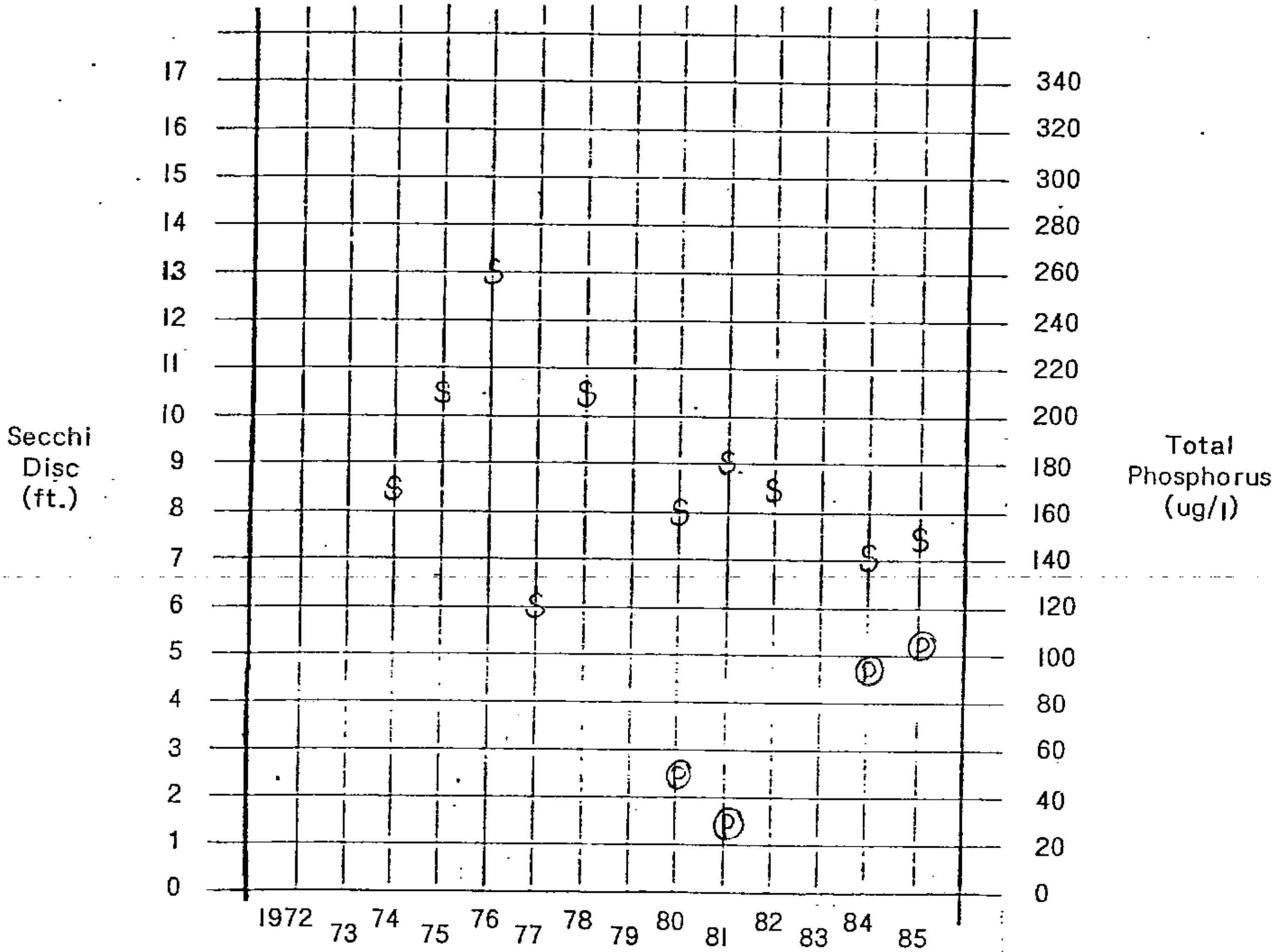
These two lakes have been added to the group studied during the 1984-85 Water Quality Evaluation. They are unlike other lakes in Rice County in many ways. They are small, very deep, and relatively infertile. It is likely that groundwater seepage into their basins significantly dilutes and cools their waters. Wide marshlands line the border of both lakes reducing nutrient invasion from their small watersheds.

Both Kelly and Dudley have highly transparent, algae free water as a result of these unique characteristics. Lillypads, rooted plants, and emerging vegetation all vie for nutrients, leaving little for unicellular plants (algae). This is a fine environment for gamefish, yet unlike neighboring lakes, Kelly and Dudley do not have large foodbanks. Low fish populations reflect this side of the nutrient equasion.

Development around these pristine lakes has increased in recent years and it appears that phosphorus concentrations have jumped as well. Great care must be taken to avoid disturbing their balance. Proper sewage treatment and careful selection and maintenance of building sites will keep nutrients, sediment and fecal bacteria out of these lakes. The wetlands that catch the runoff from fields around Kelly and Dudley are also essential parts of these lakes. Destroying or draining these areas would allow the basins to fill with sediment and cloud the clear water.

KELLY - DUDLEY LAKES

TRANSPARENCY AND TOTAL PHOSPHORUS
VS.
TIME



S = Transparency Average (June - September)
Secchi Disc Reading in feet.

Ⓟ = Phosphorus Concentration Average (June - September)
Total Phosphorus expressed in ug/l.

* National Biocentric reported Average Transparency between 1947 and 1953 to be unknown feet.

KELLY - DUDLEY LAKES

Average Data from points A, B, and C

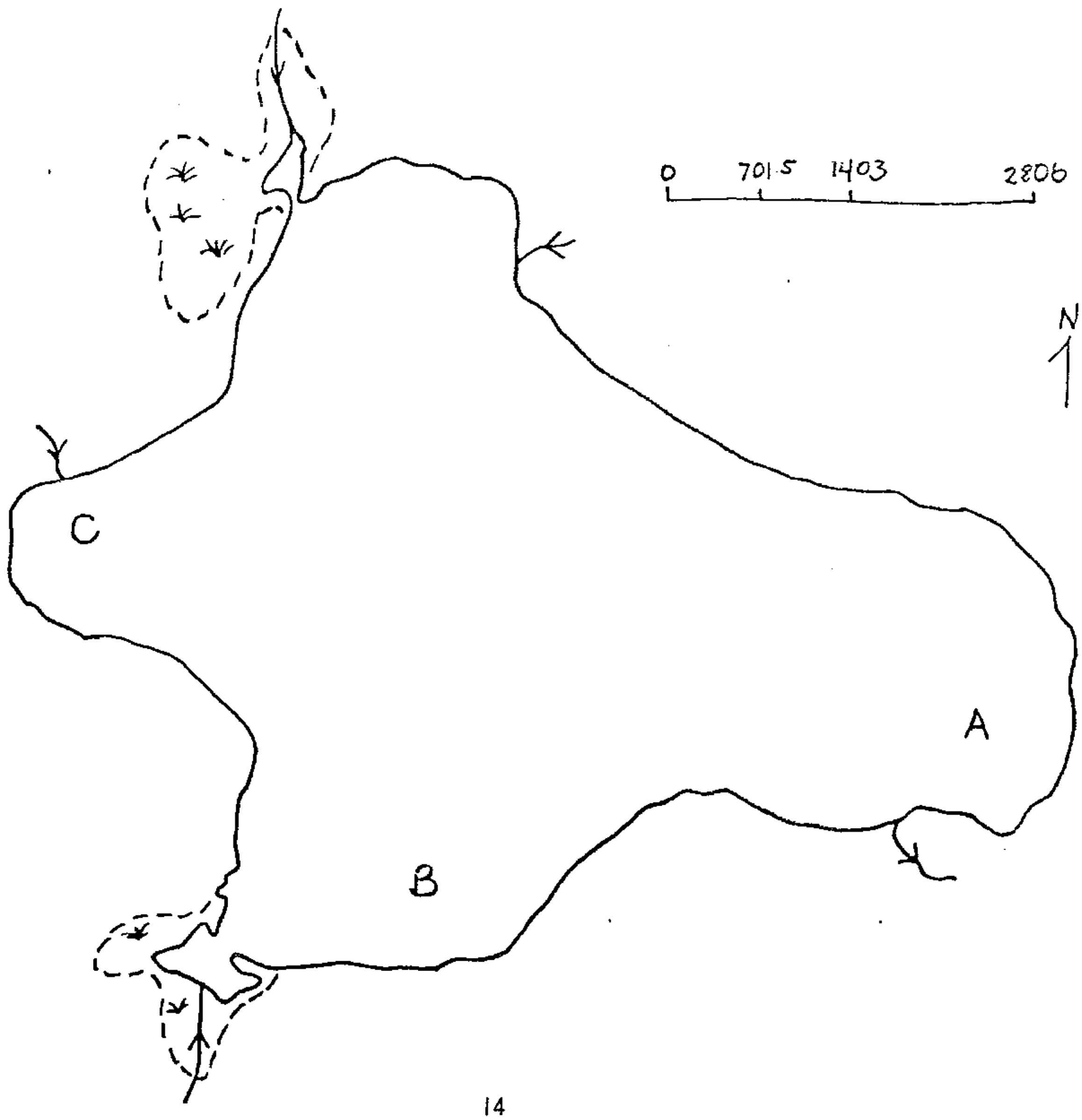
	National Biocentric	Rice County W.Q.E.	
Date		6-18-84	8-9-84
Depth (ft. in.)		11' 2"	12' 10"
Secchi (ft.)		7'	7'
Temp. (C)		22	25
D.O. (mg/l)		9.3	7.7
B.O.D. (mg/l)		2.3	2.3
Total P (mg/l)		100	93
Ammonia (mg/l)		.92	.73
pH		8.4	7.5
Conduct. (muhos/cm^2)		200	305
bacteria		neg	A+, B+, C+
Date		10-23-84	1-8-85
Depth (ft. in.)		18'	18'-4"
Secchi (ft.)		8'	NA
Temp (C)		8	2.0
D.O. (mg/l)		9.2	10.3
B.O.D. (mg/l)		1.6	3
Total P (mg/l)		47	17
Ammonia (mg/l)		.86	.57
pH		7.5	7.5
conduct. (muhos/cm^2)		147	137
bacteria		B+	neg
Date		4-18-85	6-26-85
Depth (ft. in.)		18' 8"	17' 6"
Secchi (ft.)		7'	7.5'
Temp. (C)		12	23
D.O. (mg/l)		12.4	9.6
B.O.D. (mg/l)		3	3
Total P (mg/l)		53	113
Ammonia (mg/l)		.24	.57
pH		8.5	8.5
conduct. (muhos/cm^2)		168	202
bacteria		neg	A+, B+

ROBERDS LAKE

D.N.R. LAKE NUMBER 66-018

General Information

SIZE OF LAKE	=	654	Acres
SHORELENGTH	=	5.0	Miles
MAXIMUM DEPTH	=	43	Feet
MEDIAN DEPTH	=	13	Feet
% LITORAL	=	62%	
TOTAL HOMES (1967)	=	124	Homes
TOTAL HOMES (1982)	=	160	Homes



ROBERDS LAKE

Summary/Conclusions

Roberds has been one of the most heavily used and thoroughly studied lakes in Rice County. The data from both the 1972 and 1984-85 evaluations indicate that Roberds Lake is highly fertile, prone to algae blooms, and moderately polluted with fecal bacteria. Comparison of new data with information from 1972 and 1956 (D.N.R. Lake Survey, Jerome H. Kuehn) indicated that Roberds has had these problems for many years. One alarming piece of information came from Kuehn's report. He noted a maximum depth of forty-four feet in 1956. In 1969 a similar D.N.R. study noted thirty-eight feet as maximum depth. This may indicate eutrophication is quickly reducing the depth of Roberds Lake.

Roberds is heavily enriched by agricultural runoff, lakeshore development, and it's own nutrient-rich sediment. Each year the huge algae crop dies and falls to the bottom. This builds a thick decomposing muck that consumes oxygen. Unfortunately these conditions can lead to oxygen depletion and winter kills. One benefit of this huge annual crop of algae and plants is the food it provides for fish. The transparency-phosphorus graph shows the wide variation of environmental conditions in Roberds. This type of fluxuation will favor hardier, rough species of fish.

Removing the threat posed by fecal contamination of Roberds Lake must be the priority for the future. Because much of the development was completed prior to tight regulation of on-site sewage systems and the Shoreland Management Act, many old nonconforming systems probably still pollute Roberds. Otter Tail County has used a systematic, lake by lake survey to require upgrading of old malfunctioning sewers. This program has been very successful in cleaning up lakes in that area and could be used here in Rice County.

ROBERDS LAKE

Average Data from points A, B, and C

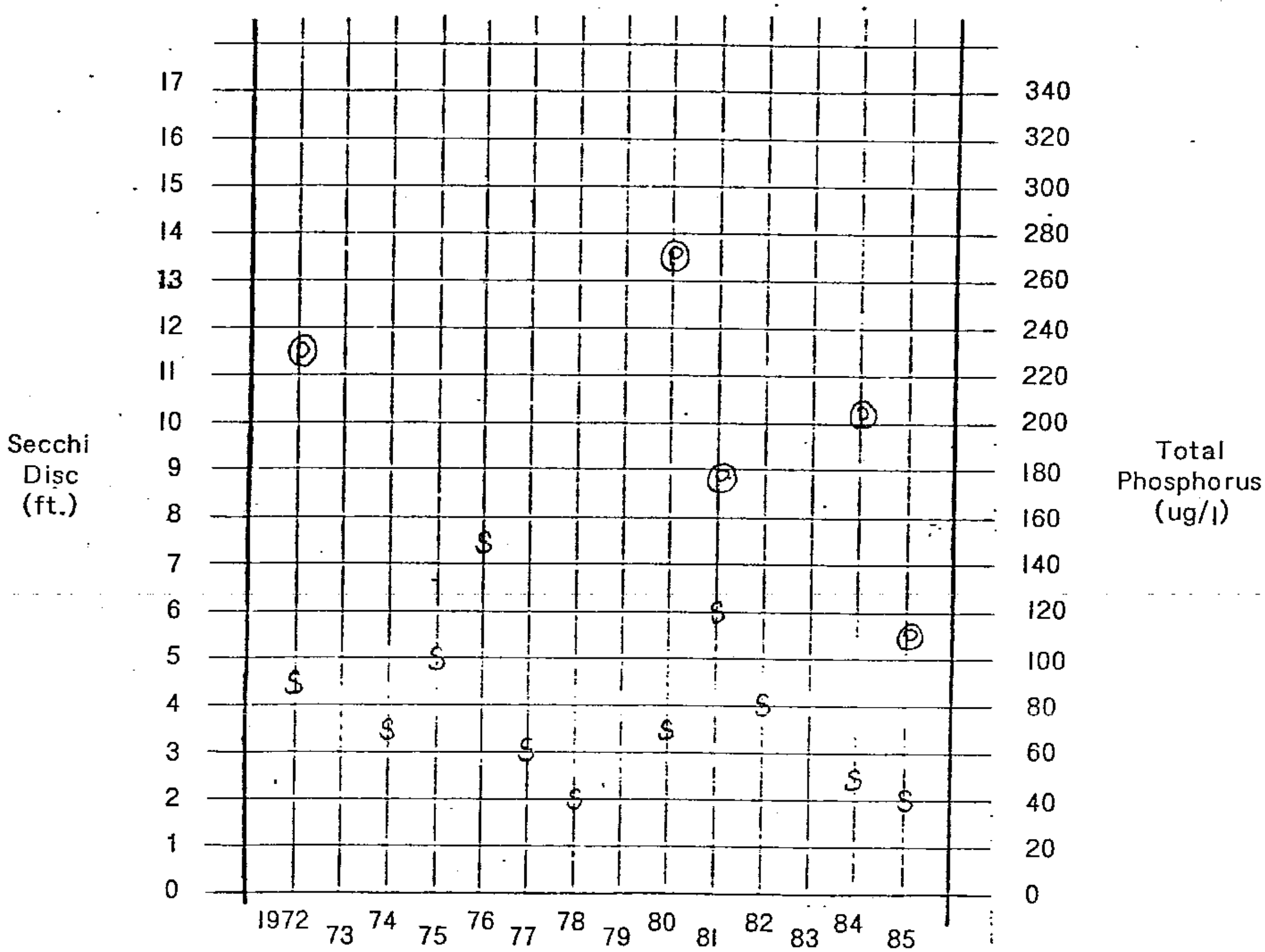
	National Biocentric	Rice County W.Q.E.	
Date	6-7-72	6-19-84	6-25-85
Depth (ft. in.)	8' 9"	6' 10"	9' 6"
Secchi (ft.)	6	4	4.5
Temp. (C)	23	24	23
D.O. (mg/l)	10.1	8.9	11
B.O.D. (mg/l)	1.5	3	7.6
Total P (mg/l)	222	110	110
Ammonia (mg/l)	.752	.85	.50
pH	8.4	8.6	9.0
Conduct. (muhos/cm^2)	263	310	285
bacteria	neg	B+	neg

Date	8-22-72	8-8-84
Depth (ft. in.)	7'	6'8"
Secchi (ft.)	3	1
Temp (C)	26	27
D.O. (mg/l)	6.0	12.6
B.O.D. (mg/l)	9.5	8.6
Total P (mg/l)	448	300
Ammonia (mg/l)	.341	.34
pH	NA	9.3
conduct. (muhos/cm^2)	263	250
bacteria	C+	C+

Date	2-25-72	1-7-85
Depth (ft. in.)	7' 1"	8' 10"
Secchi (ft.)	NA	NA
Temp. (C)	1.5	3
D.O. (mg/l)	7.8	17.6
B.O.D. (mg/l)	1.2	4.6
Total P (mg/l)	439	50
Ammonia (mg/l)	1.595	.36
pH	7.5	9.3
conduct. (muhos/cm^2)	NA	175
bacteria	neg	neg

ROBERDS LAKE

TRANSPARENCY AND TOTAL PHOSPHORUS
VS.
TIME



S = Transparency Average (June - September)
Secchi Disc Reading in feet.

(P) = Phosphorus Concentration Average (June - September)
Total Phosphorus expressed in ug/l.

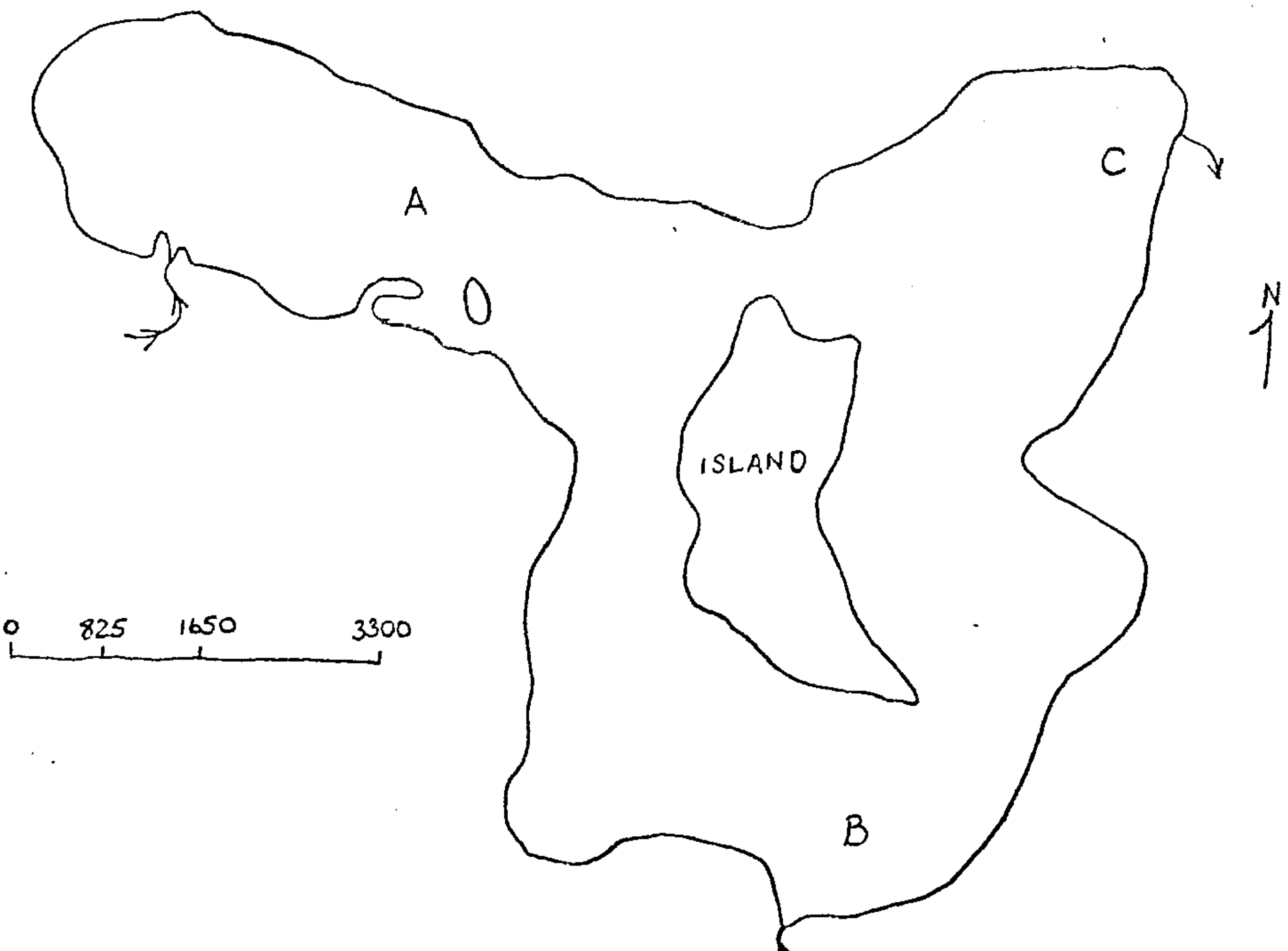
* National Biocentric reported Average Transparency between 1947 and 1953 to be 8' 6" feet.

CIRCLE LAKE

D.N.R. LAKE NUMBER 66-027

General Information

SIZE OF LAKE	=	976	Acres
SHORELENGTH	=	5.8	Miles
MAXIMUM DEPTH	=	14.0	Feet
MEDIAN DEPTH	=	6.0	Feet
% LITORAL	=	100%	
TOTAL HOMES (1967)	=	25	Homes
TOTAL HOMES (1982)	=	29	Homes



CIRCLE LAKE

Summary/Conclusions

In Circle Lake very little has changed with regard to water quality since 1972. The data collected does indicate that little or no pollution of the lake is occuring from conventional sources. Fecal coliform bacteria, a disease causing organism from human and animal waste, was found in only four of eighteen samples, recurring only at point B. Site A, on the other hand reflected the impacts cropland runoff water is having on the lake. At this point a thick soft mud covers the bottom, and emergent vegetation is pushing into the open water. Higher phosphorus concentrations were also found here in the northwest bay.

The combination of fertile runoff and a shallow basin add up to "hypereutrophication". "Hyper" means extremely and "eutrophication" means well-nourished. Extremely well nourished lakes can appear like pea soup during the summer. Fortunately during the winter of 1984-85, a snow free ice sheet allowed Circle's algea to continue to use sunlight to produce oxygen through photosynthesis. In March, oxygen depletion was apparent, extending from the bottom to within three feet of the ice sheet. This low oxygen concentration threatened fish populations.

Circle Lake is seriously threatened by two important problems. The first is advancing shorelines which are already choking one bay. Sedimentation has contributed to this problem and to the threat of annual winter kills due to oxygen depletion. This second problem is unavoidable without artificial aeration.

CIRCLE LAKE

Average Data from points A, B, and C

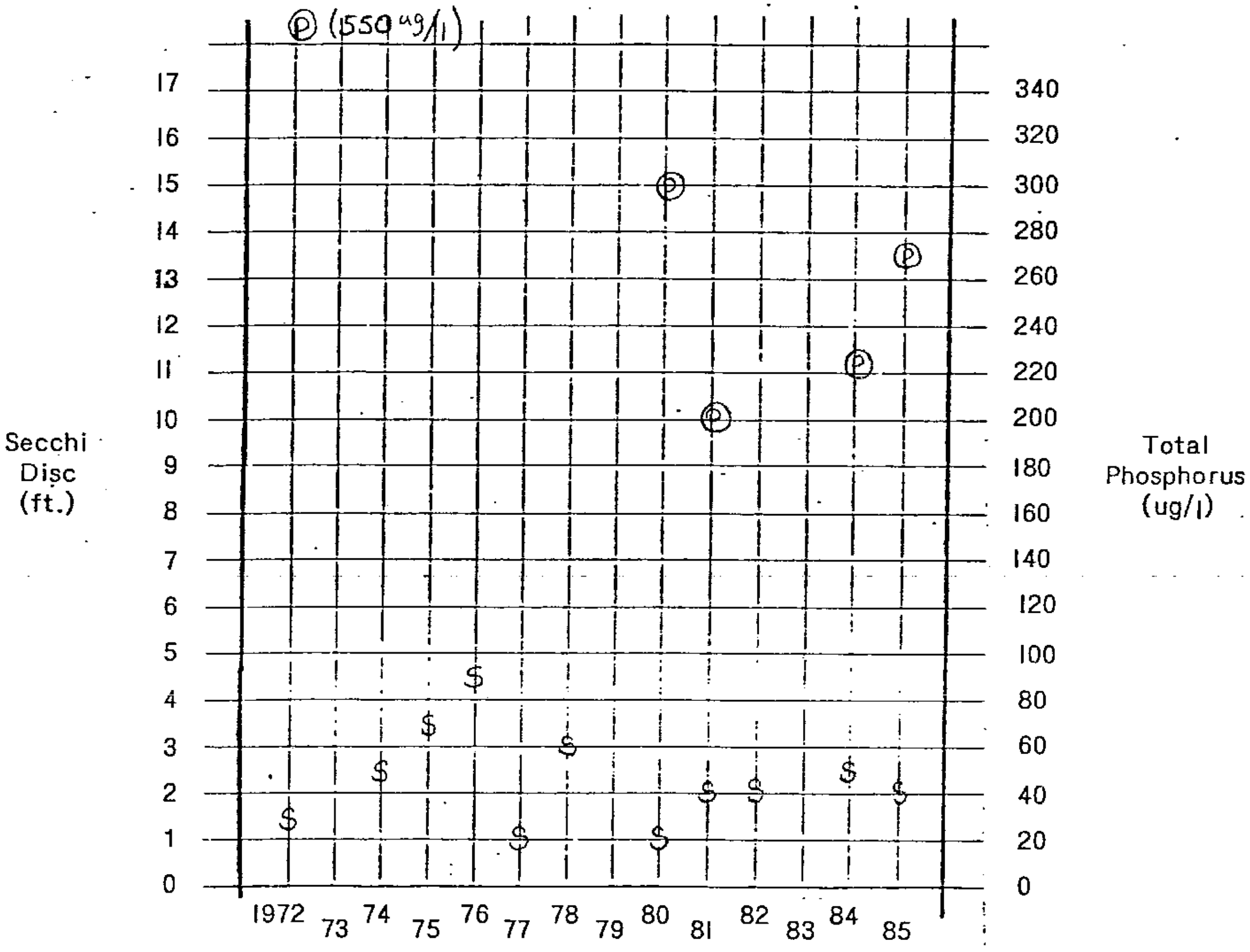
	National Biocentric	Rice County W.Q.E.	
Date	6-7-72	6-20-84	6-27-85
Depth (ft. in.)	6' 9"	5'	7' 3"
Secchi (ft.)	2.0	2.5	2.5
Temp. (C)	24	23	22
D.O. (mg/l)	10.1	8.5	6.7
B.O.D. (mg/l)	3.1	3	6
Total P (mg/l)	392	130	270
Ammonia (mg/l)	.859	1.31	.91
pH	8.5	8.1	9.0
Conduct. (muhos/cm^2)	292	347	293
bacteria	B+	B+	neg

Date	8-22-72	8-10-84
Depth (ft. in.)	8'	3' 8"
Secchi (ft.)	1'	1.5
Temp (C)	25	26
D.O. (mg/l)	5.2	10.2
B.O.D. (mg/l)	5.6	7
Total P (mg/l)	708	420
Ammonia (mg/l)	1.324	1.18
pH	NA	9.2
conduct. (muhos/cm^2)	292	307
bacteria	A+, B+, C+	A+, B+, C+

Date	2-25-72	1-9-85
Depth (ft. in.)	7' 3"	6' 2"
Secchi (ft.)	NA	NA
Temp. (C)	1.5	2
D.O. (mg/l)	3.3	8.6
B.O.D. (mg/l)	1.2	1.3
Total P (mg/l)	569	470
Ammonia (mg/l)	1.548	1.64
pH	7.5	7.5
conduct. (muhos/cm^2)	NA	213
bacteria	neg	neg

CIRCLE LAKE

TRANSPARENCY AND TOTAL PHOSPHORUS
VS.
TIME



S = Transparency Average (June - September)
Secchi Disc Reading in feet.

Ⓟ = Phosphorus Concentration Average (June - September)
Total Phosphorus expressed in ug/l.

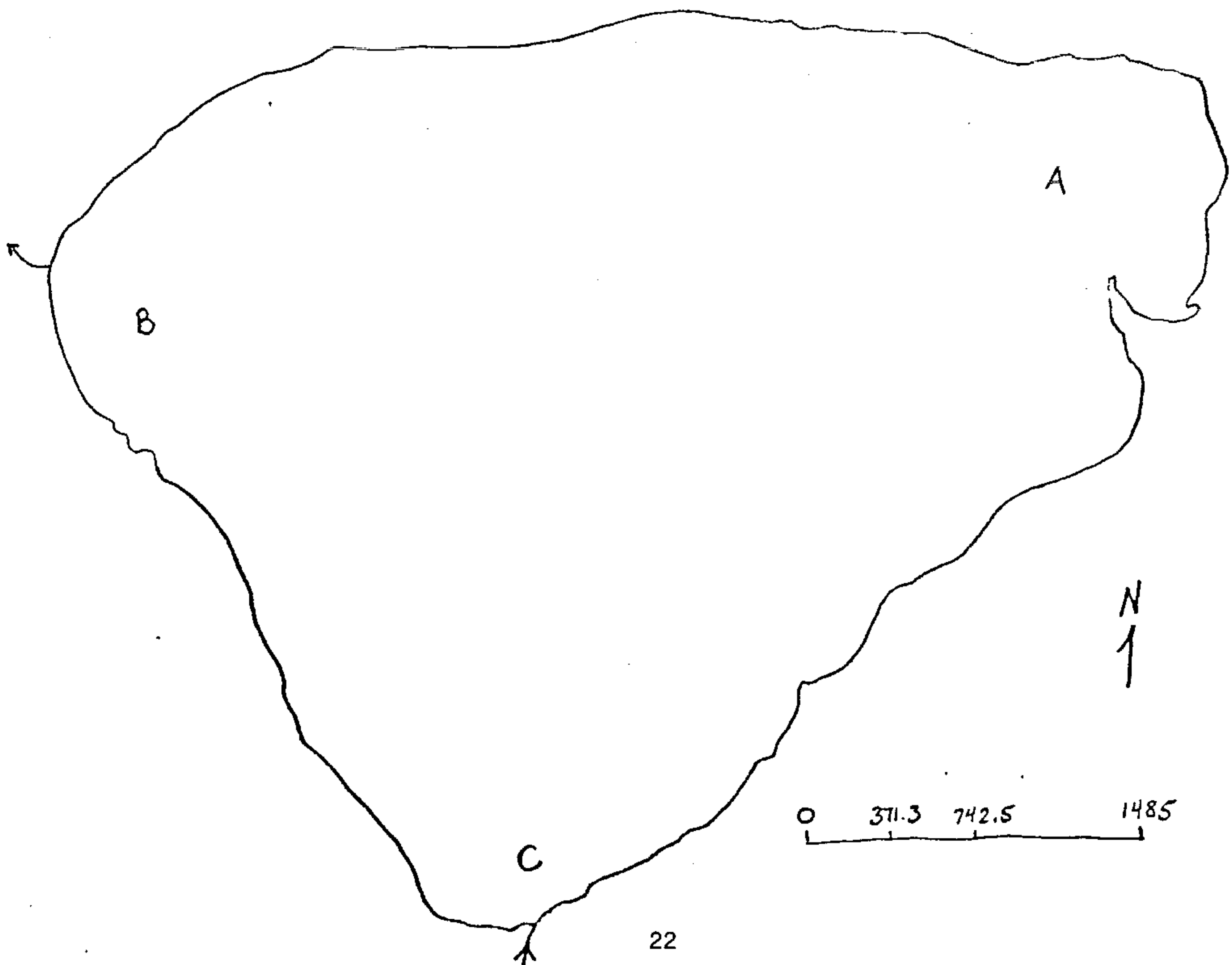
* National Biocentric reported Average Transparency between 1947 and 1953 to be .5 feet.

<u>FOX LAKE</u>

D.N.R. LAKE NUMBER 66-029

General Information

SIZE OF LAKE	=	330	Acres
SHORELENGTH	=	2.7	Miles
MAXIMUM DEPTH	=	47.0	Feet
MEDIAN DEPTH	=	21.0	Feet
% LITORAL	=	45%	
TOTAL HOMES (1967)	=	26	Homes
TOTAL HOMES (1982)	=	20	Homes



FOX LAKE

Summary/Conclusions

In comparison to data from previous years the water quality of Fox Lake has deteriorated noticeably. During the 1984-85 period the lowest average secchi disc transparencies were recorded. The graph plotting phosphorus concentration and transparency vs. time illustrates that recently higher concentrations of phosphorus have sustained lush algae blooms. Although this over abundance of algae has been a nuisance during the summer, Fox Lake has not suffered the winter depletion of oxygen often associated with eutrophic lakes. One reason for this may be that Fox Lake is a deep kettle lake with large oxygen reserves sandwiched between oxygen rich water near the surface and oxygen poor water along the bottom.

Fox Lake showed signs of human or animal waste pollution. Points A and C consistently showed some fecal coliform contamination. Both animal waste runoff and malfunctioning on-site sewage systems could be responsible. Residential development has not significantly increased since 1972. Pasture and cropland south and east of the lake are more likely sources of this bacterial pollution. This area is characteristic of the heavily tilled Fox Lake watershed.

Fox Lake is beginning to show signs of sedimentation and phosphorus overloading from cropland runoff. If improvements to the watershed are not made, these problems will build on one another. Nutrient pollution will lead to algae blooms which will lead to the decomposition of huge crops of expired algae. This decomposition on the lake bottom, will deplete oxygen and unlock nutrients to be recycled in an already overloaded system.

FOX LAKE

Average Data from points A, B, and C

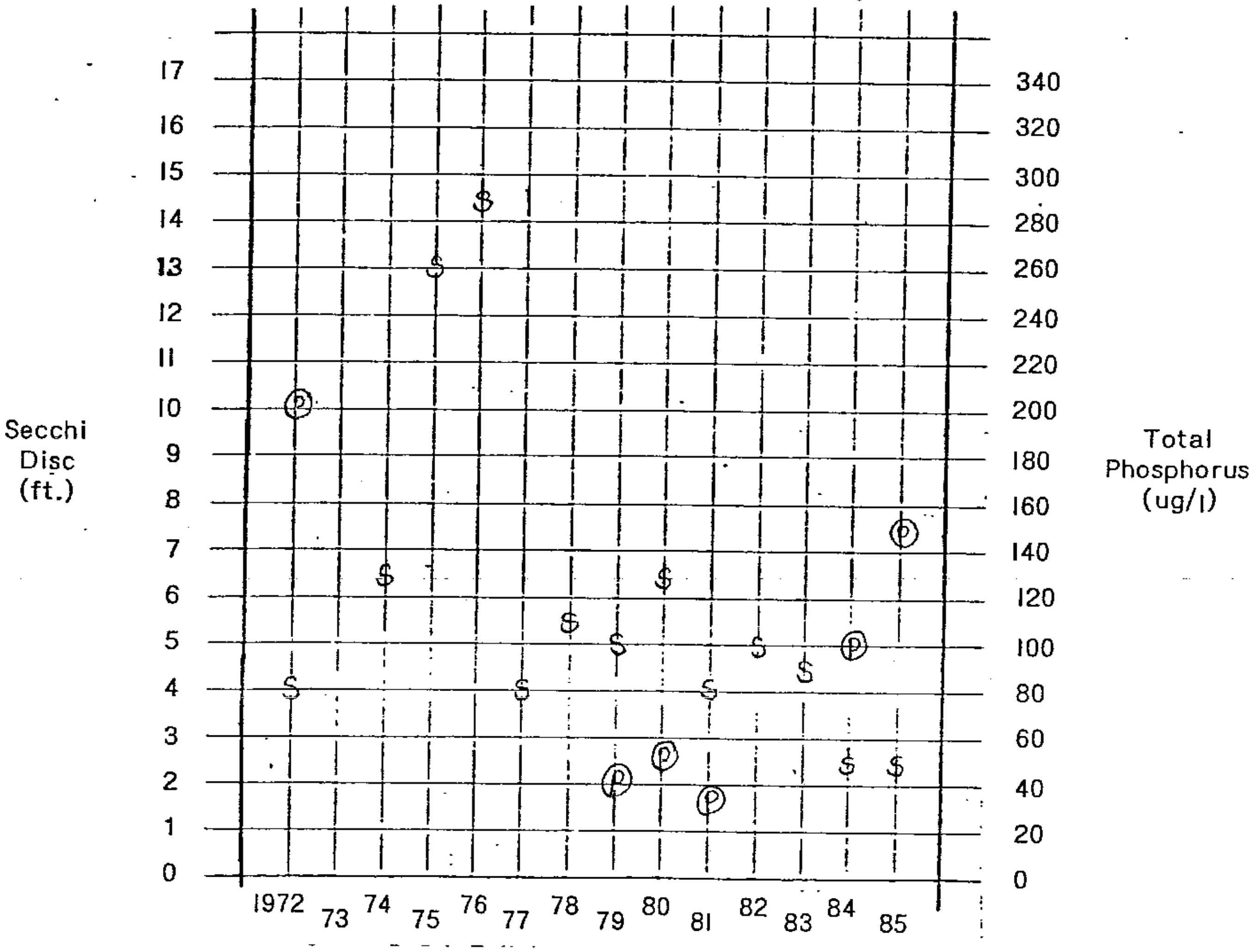
	National Biocentric	Rice County W.Q.E.	
Date	6-7-72	6-20-84	6-27-84
Depth (ft. in.)	19' 9"	9'	8' 4"
Secchi (ft.)	5	2.5	2.5
Temp. (C)	22	23	21
D.O. (mg/l)	11.4	11.4	10.5
B.O.D. (mg/l)	2.5	2.7	5.3
Total P (mg/l)	231	60	170
Ammonia (mg/l)	.682	.84	.57
pH	8.1	8.8	8.8
Conduct. (muhos/cm^2)	280	340	320
bacteria	neg	A+, C+	B+, C+

	National Biocentric	Rice County W.Q.E.
Date	8-22-72	8-10-84
Depth (ft. in.)	7'	8' 7"
Secchi (ft.)	3.5	2.5
Temp (C)	25	25
D.O. (mg/l)	7.7	9.8
B.O.D. (mg/l)	2.9	3
Total P (mg/l)	179	130
Ammonia (mg/l)	.145	.70
pH	NA	8.9
conduct. (muhos/cm^2)	388	317
bacteria	B+, C+	A+, B+, C+

	National Biocentric	Rice County W.Q.E.
Date	2-25-72	1-9-84
Depth (ft. in.)	14' 8"	13'
Secchi (ft.)	NA	NA
Temp. (C)	1.5	1.0
D.O. (mg/l)	8.9	12.2
B.O.D. (mg/l)	1.3	2.3
Total P (mg/l)	325	140
Ammonia (mg/l)	.551	.80
pH	7.3	8.1
conduct. (muhos/cm^2)	NA	218
bacteria	neg	neg

FOX LAKE

TRANSPARENCY AND TOTAL PHOSPHORUS
VS.
TIME



S = Transparency Average (June - September) Secchi Disc Reading in feet.

(P) = Phosphorus Concentration Average (June - September) Total Phosphorus expressed in ug/l.

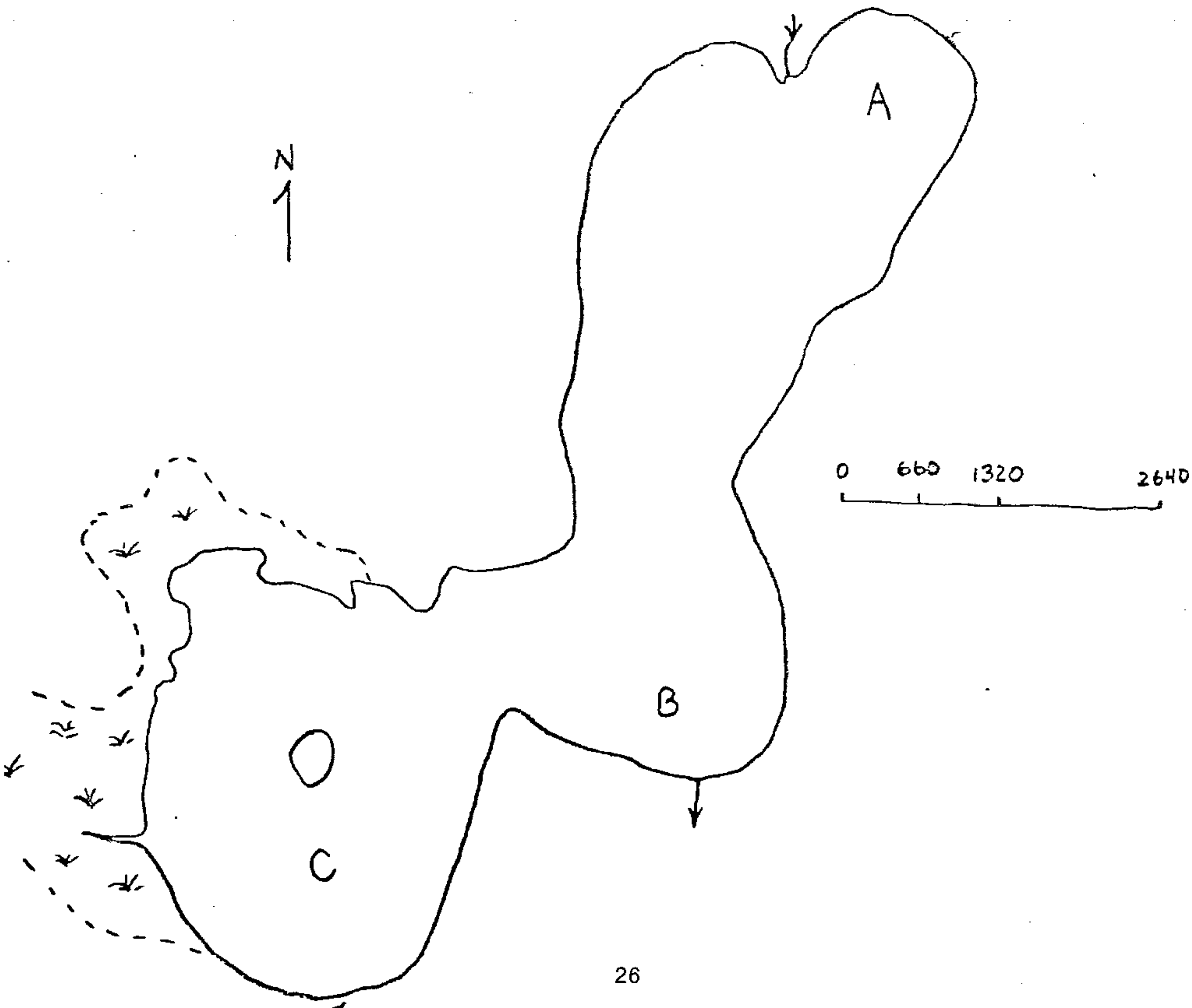
* National Biocentric reported Average Transparency between 1947 and 1953 to be 3' feet.

UNION LAKE

D.N.R. LAKE NUMBER 66-032

General Information

SIZE OF LAKE	=	498	Acres
SHORELENGTH	=	5.0	Miles
MAXIMUM DEPTH	=	9.0	Feet
MEDIAN DEPTH	=	4.0	Feet
% LITORAL	=	100%	
TOTAL HOMES (1967)	=	8	Homes
TOTAL HOMES (1982)	=	48	Homes



UNION LAKE

Summary/Conclusions

Just as the Cannon River heavily influences Cannon Lake, Heath Creek is a great influence on Union Lake. The water quality of Union Lake has remained poor. Fecal contamination has increased slightly and phosphorus concentration remains high. One indicator of the heavy pollution of Union Lake is the high conductivity readings. Union's large watershed includes Lonsdale's sewage treatment plant, Knowles and Heath Creeks. These are all sources of suspended solids, nutrients, and organic matter.

Algae blooms and suspended material keep the transparency in Union Lake very low. The oxygen content of Union Lake's water remained high during the 1984-85 study period. This was due to clear snow free ice throughout the winter of 1984-85. Heavy snow in 1985-86 cut off the light required for oxygen production and the resulting oxygen depletion led to opening Union Lake for promiscuous fishing. Winter kills will continue to plague Union Lake without artifical aeration.

Considering the size of Union Lake's watershed, the depth of the lake, and the extent of eutrophication, little can be done to improve its water quality. Recreational uses, sailing and waterfowl hunting will not be impaired so long as fecal contamination is kept under control.

UNION LAKE

Average Data from points A, B, and C

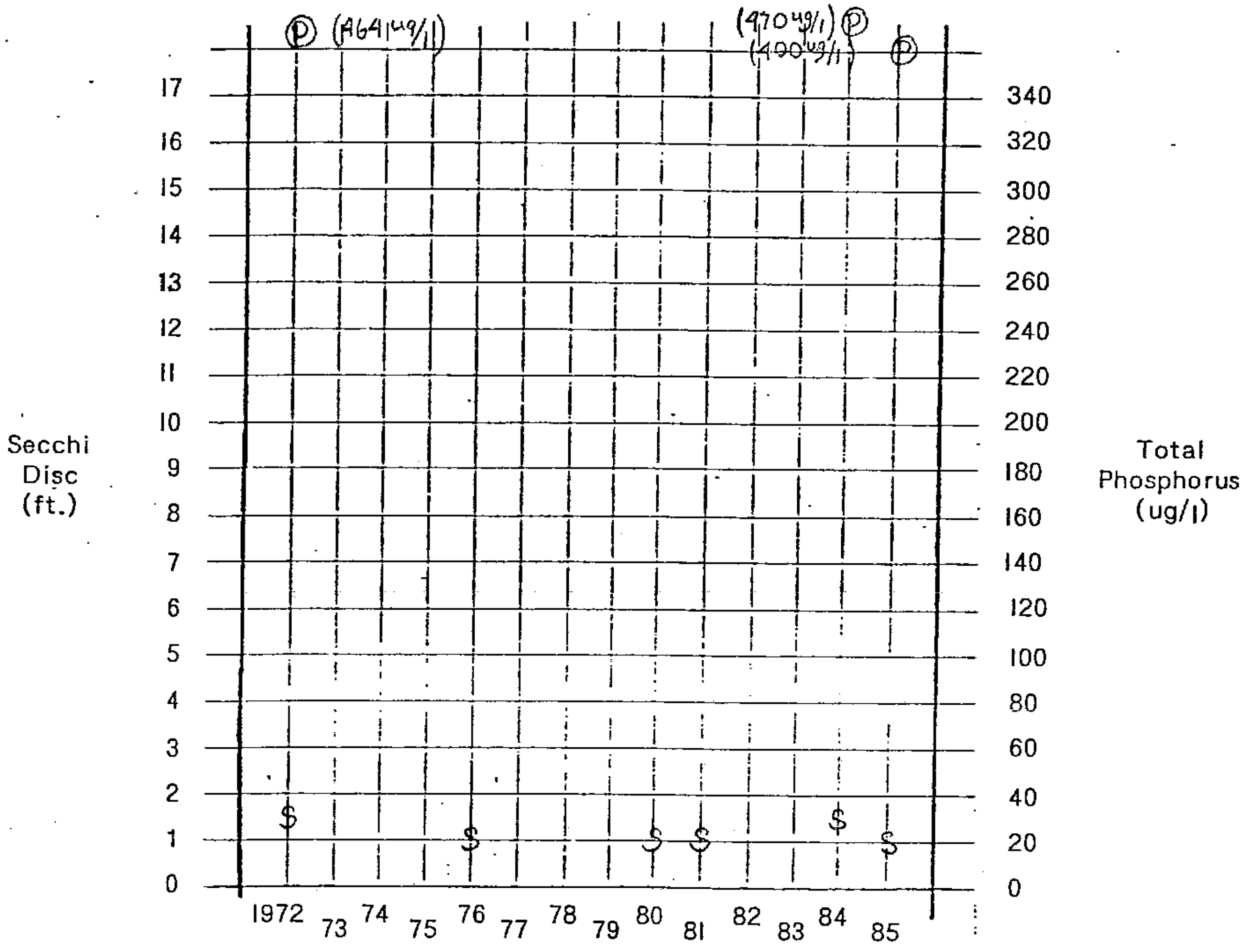
	National Biocentric	Rice County W.Q.E.	
Date	6-7-72	6-20-84	6-27-85
Depth (ft. in.)	5' 6"	6' 4"	6'
Secchi (ft.)	1.5'	2'	1'
Temp. (C)	24	23	23
D.O. (mg/l)	13.5	8.0	8.3
B.O.D. (mg/l)	5.3	2.6	6.6
Total P (mg/l)	570	340	400
Ammonia (mg/l)	.941	1.01	.88
pH	8.6	7.9	8.8
Conduct. (muhos/cm^2)	317	403	403
bacteria	neg	A+	A+, C+

	National Biocentric	Rice County W.Q.E.
Date	8-14-72	8-10-84
Depth (ft. in.)	5' 9"	5' 2"
Secchi (ft.)	1.5'	1'
Temp (C)	25	25.5
D.O. (mg/l)	16.3	10.8
B.O.D. (mg/l)	4.2	7.6
Total P (mg/l)	358	600
Ammonia (mg/l)	.691	.94
pH	9.9	9.1
conduct. (muhos/cm^2)	316	398
bacteria	neg	A+, B+, C+

	National Biocentric	Rice County W.Q.E.
Date	2-25-72	1-9-85
Depth (ft. in.)	4'	6' 2"
Secchi (ft.)	NA	NA
Temp. (C)	2	1.5
D.O. (mg/l)	2.0	10.1
B.O.D. (mg/l)	1.2	2.6
Total P (mg/l)	797	170
Ammonia (mg/l)	1.137	1.31
pH	7.5	7.5
conduct. (muhos/cm^2)	NA	336
bacteria	neg	B+

UNION LAKE

TRANSPARENCY AND TOTAL PHOSPHORUS VS. TIME



S = Transparency Average (June - September) Secchi Disc Reading in feet.

Ⓟ = Phosphorus Concentration Average (June - September) Total Phosphorus expressed in ug/l.

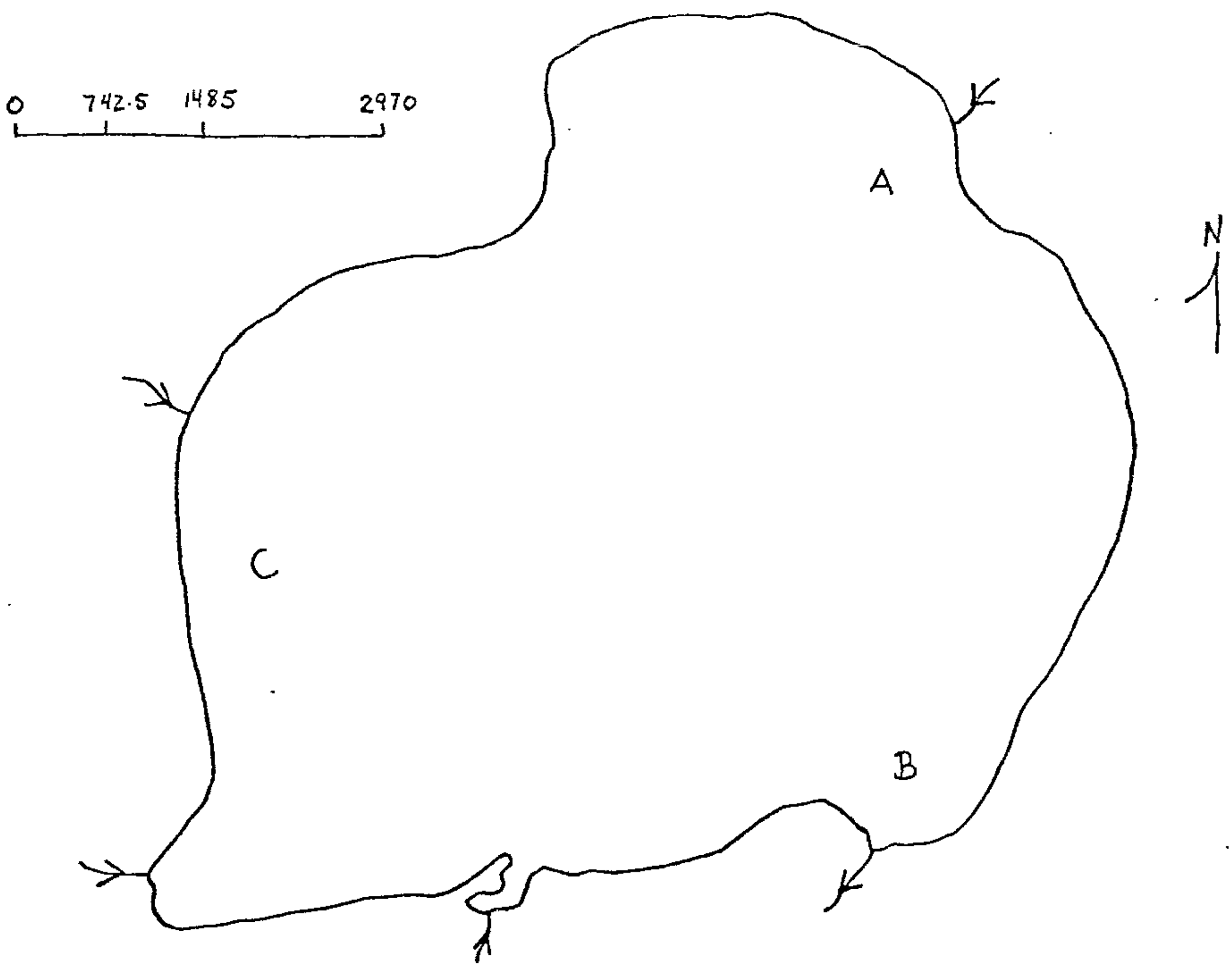
* National Biocentric reported Average Transparency between 1947 and 1953 to be 1' feet.

FRENCH LAKE

D.N.R. LAKE NUMBER 66-038

General Information

SIZE OF LAKE	=	842	Acres
SHORELENGTH	=	5.1	Miles
MAXIMUM DEPTH	=	56	Feet
MEDIAN DEPTH	=	16	Feet
% LITORAL	=	48%	
TOTAL HOMES (1967)	=	132	Homes
TOTAL HOMES (1982)	=	191	Homes



FRENCH LAKE

Summary/Conclusions

Water quality data from French Lake gathered in 1972 and 1984-85 is almost identical. No significant change is apparent in comparison of old and new data. French Lake appears to be resistant to the pollution experienced by other area lakes. It is a stable home for French's new Muskie population. One cloud on the horizon may be the phosphorus concentrations. This growth-limiting nutrient is up in recent years. Keeping nutrients, particularly phosphorus, out of French Lake is essential to retaining good water quality.

French is blessed with a small but highly developed watershed. Shoreland developments exists on all sides without any apparent sewage contamination. The lake receives relatively clean water from Kelly and Dudley Lakes and undoubtedly some groundwater discharge. On the other hand, creeks feeding French from the northwest are polluted with soils and nutrients. This sedimentation fills the basin directly and indirectly by increasing the fertility of the water. Keeping French Lake's nutrient budget in balance will require abating this soil loss problem.

One key factor in French Lake water quality maintenance is the "French Lakers". These residents have paid for good water quality in many ways. Proper construction and maintenance of on-site sewage systems is not cheap. This commitment to water quality was reflected by an aquatic weed harvesting program conducted by the "French Lakers" during 1985. Motivated lake associations are perhaps the most effective tool in protecting waters.

FRENCH LAKE

Average Data from points A, B, and C

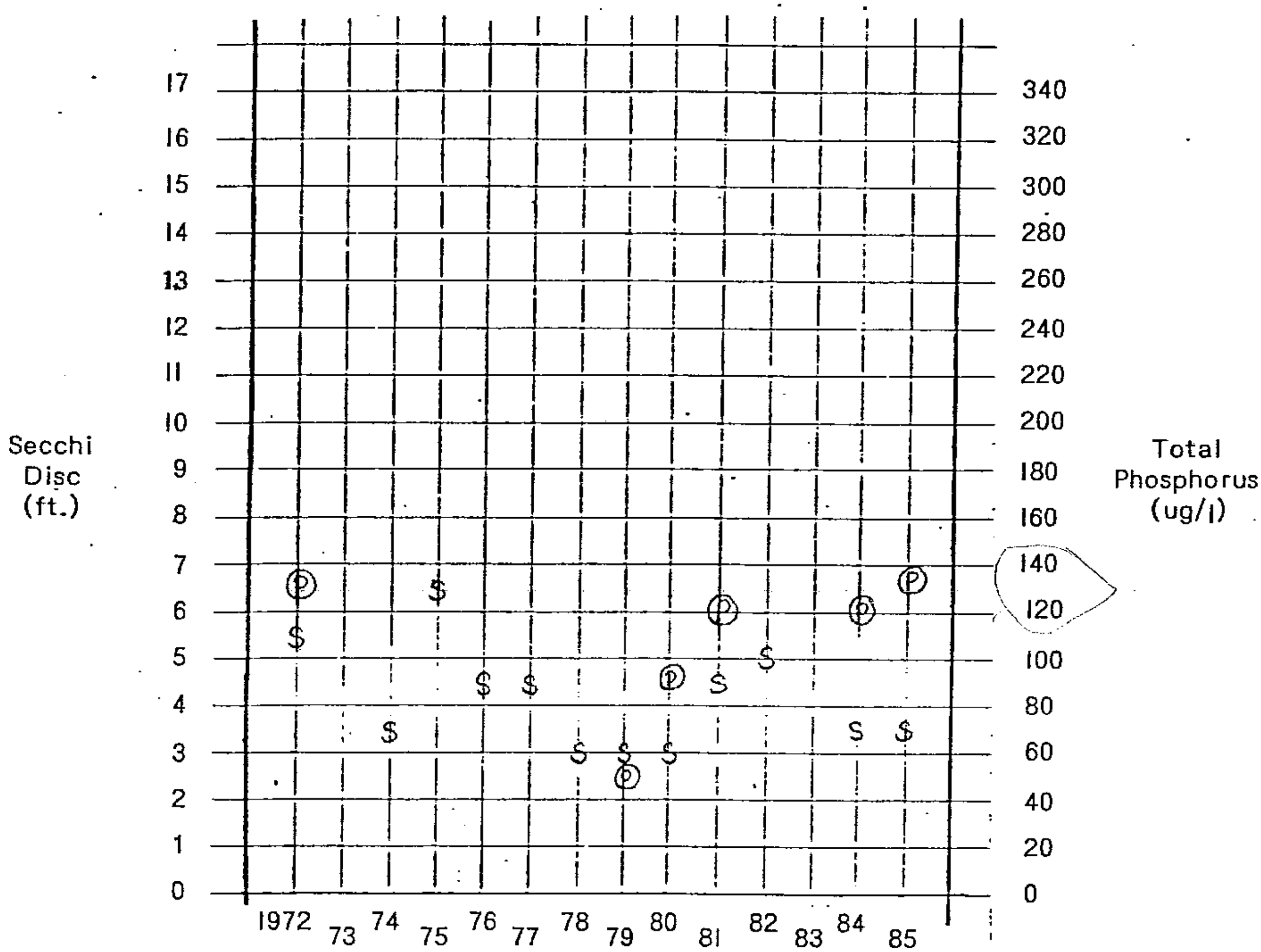
	National Biocentric	Rice County W.Q.E.	
Date	6-7-72	6-18-84	6-26-85
Depth (ft. in.)	10' 6"	8'	9' 6"
Secchi (ft.)	9	5	6.5
Temp. (C)	23	21	22
D.O. (mg/l)	9.9	9.8	9.2
B.O.D. (mg/l)	1.2	2.3	2.3
Total P (mg/l)	133	70	133
Ammonia (mg/l)	.570	.69	.39
pH	8.0	8.7	8.5
Conduct. (muhos/cm^2)	283	250	262
bacteria	neg	neg	neg

	National Biocentric	Rice County W.Q.E.
Date	8-22-72	8-9-84
Depth (ft. in.)	5'	6' 3"
Secchi (ft.)	2.0	2.5
Temp (C)	25	25
D.O. (mg/l)	7.6	9.9
B.O.D. (mg/l)	5.75	7
Total P (mg/l)	142	160
Ammonia (mg/l)	.139	.70
pH	NA	8.9
conduct. (muhos/cm^2)	251	244
bacteria	A+, C+	A+, B+, C+

	National Biocentric	Rice County W.Q.E.
Date	2-25-72	1-8-85
Depth (ft. in.)	4' 5"	8'
Secchi (ft.)	NA	NA
Temp. (C)	1	1
D.O. (mg/l)	7.18	14.3
B.O.D. (mg/l)	1.24	4
Total P (mg/l)	211	50
Ammonia (mg/l)	.728	.56
pH	7.4	8.1
conduct. (muhos/cm^2)	NA	148
bacteria	neg	neg

FRENCH LAKE

TRANSPARENCY AND TOTAL PHOSPHORUS
VS.
TIME



S = Transparency Average (June - September)
Secchi Disc Reading in feet.

Ⓟ = Phosphorus Concentration Average (June - September)
Total Phosphorus expressed in ug/l.

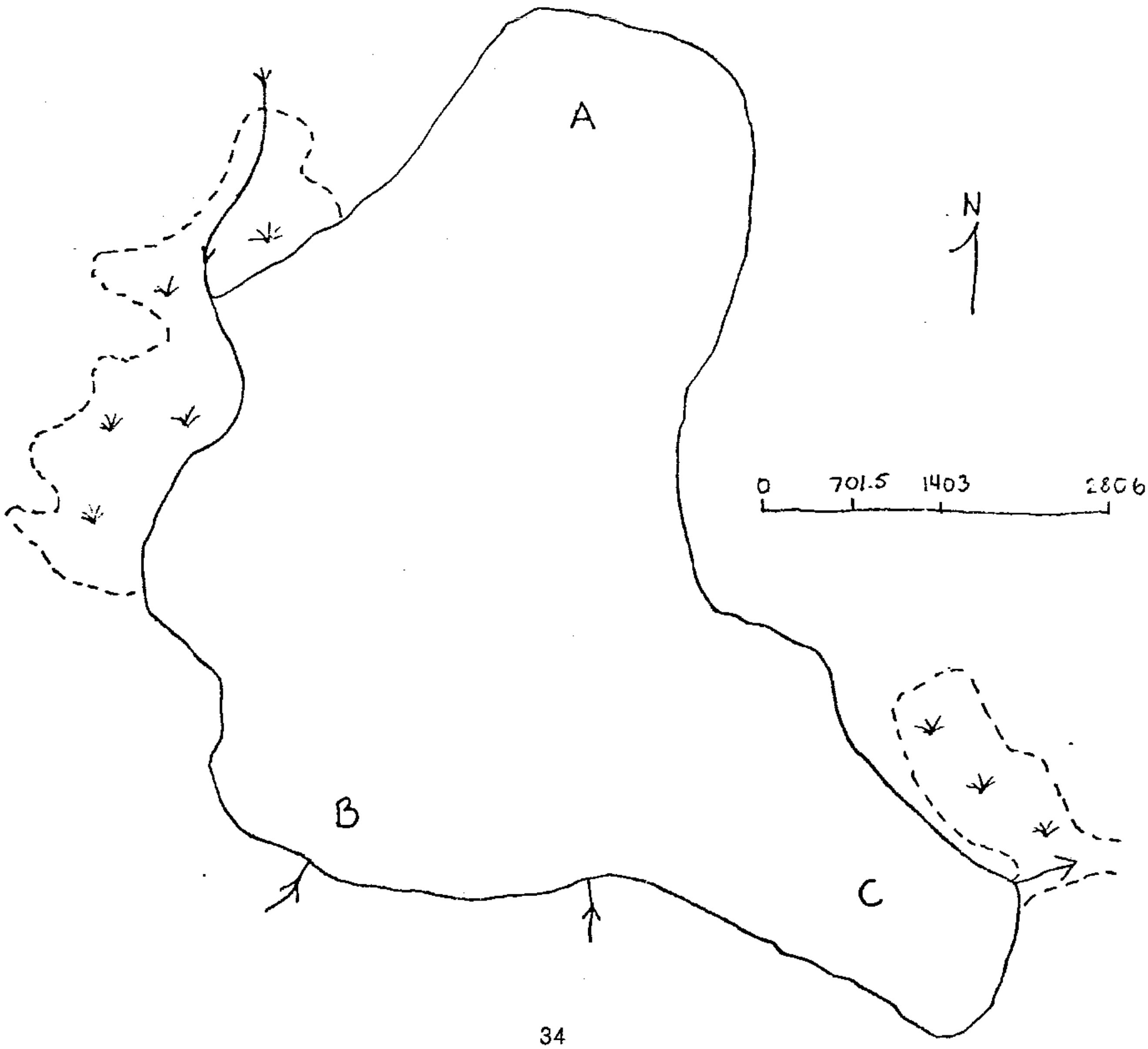
* National Biocentric reported Average Transparency between 1947 and 1953 to be 11' 3" feet.

MAZASKA LAKE

D.N.R. LAKE NUMBER 66-039

General Information

SIZE OF LAKE	=	687	Acres
SHORELENGTH	=	4.8	Miles
MAXIMUM DEPTH	=	46.0	Feet
MEDIAN DEPTH	=	15.0	Feet
% LITORAL	=	49%	
TOTAL HOMES (1967)	=	45	Homes
TOTAL HOMES (1982)	=	175	Homes



MAZASKA LAKE

Summary/Conclusions

Mazaska rates as a lake with good water quality through the study period 1972 to 1985. Recent data (1984-1985) indicates that the phosphorus concentration is within the expected range for Mazaska although it is up from both 1980 and 1981. One problem is the presence of fecal coliform bacterial contamination. This study showed Point B on Mazaska's south shore, highly and consistently polluted with human or animal waste. The source is probably malfunctioning sewage systems in the village of Shieldsville, and failing sewage systems along Highway #21 also. With the exception of this man-made problem, Mazaska has retained good water quality.

Mazaska's location at the head of the Wolf Creek watershed isolates it from the serious nonpoint pollution (runoff) experienced by lakes downstream. Most inflowing waters are buffered by large wetlands along the north lobe of Mazaska. One stream entering the south side between Points B and C carries sediment and nutrients during runoff periods. This fast-flowing creek falls sharply before entering Mazaska. Eroded soil is slowly building a delta out into Mazaska below this small creek. Stablizing this stream bank and controlling erosion in this area might nip this problem in the bud.

Mazaska is reportedly the home of a prehistoric monster. It's deep basin has provided a refuge for the unusual garfish and assured an adequate oxygen supply throughout the winter periods. Man's activities have degraded Mazaska's water quality but fortunately it has strong natural defenses against this pollution. We must be careful to allow it's ancient wetlands to buffer pollutants and it's steep banks to isloate it from runoff.

MAZASKA LAKE

Average Data from points A, B, and C

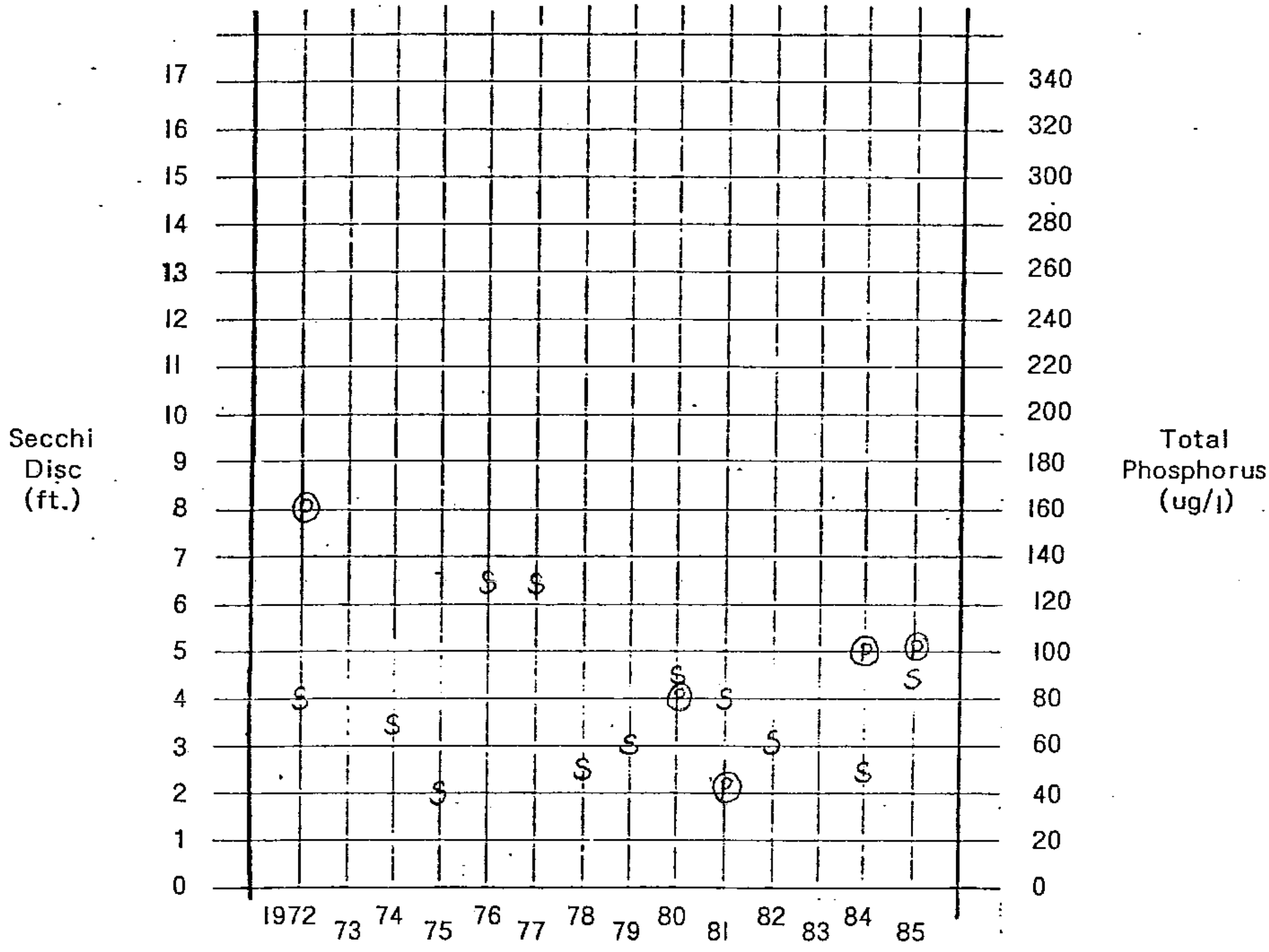
	National Biocentric	Rice County W.Q.E.	
Date	6-7-72	6-18-84	6-26-85
Depth (ft. in.)	7' 9"	5' 7"	8' 4"
Secchi (ft.)	5	3	4.5
Temp. (C)	22	23	22
D.O. (mg/l)	11.3	10.2	11.5
B.O.D. (mg/l)	1.47	3.3	5.3
Total P (mg/l)	163	147	106
Ammonia (mg/l)	.534	.72	.45
pH	8.6	8.8	9.1
Conduct. (muhos/cm^2)	269	300	245
bacteria	neg	neg	A+

Date	8-22-72	8-9-84
Depth (ft. in.)	7'	6'
Secchi (ft.)	3	2.5
Temp (C)	25	26
D.O. (mg/l)	6.8	9.5
B.O.D. (mg/l)	4.42	6.6
Total P (mg/l)	161	60
Ammonia (mg/l)	.161	.67
pH	NA	8.7
conduct. (muhos/cm^2)	274	280
bacteria	neg	A+, B+, C+

Date	2-25-72	1-8-85
Depth (ft. in.)	8'	7' 4"
Secchi (ft.)	NA	NA
Temp. (C)	2	1.5
D.O. (mg/l)	4.63	15.8
B.O.D. (mg/l)	1.24	5
Total P (mg/l)	244	70
Ammonia (mg/l)	.259	1.02
pH	7.6	8.8
conduct. (muhos/cm^2)	NA	188
bacteria	neg	neg

MAZASKA LAKE

TRANSPARENCY AND TOTAL PHOSPHORUS
VS.
TIME



S = Transparency Average (June - September)
Secchi Disc Reading in feet.

P = Phosphorus Concentration Average (June - September)
Total Phosphorus expressed in ug/l.

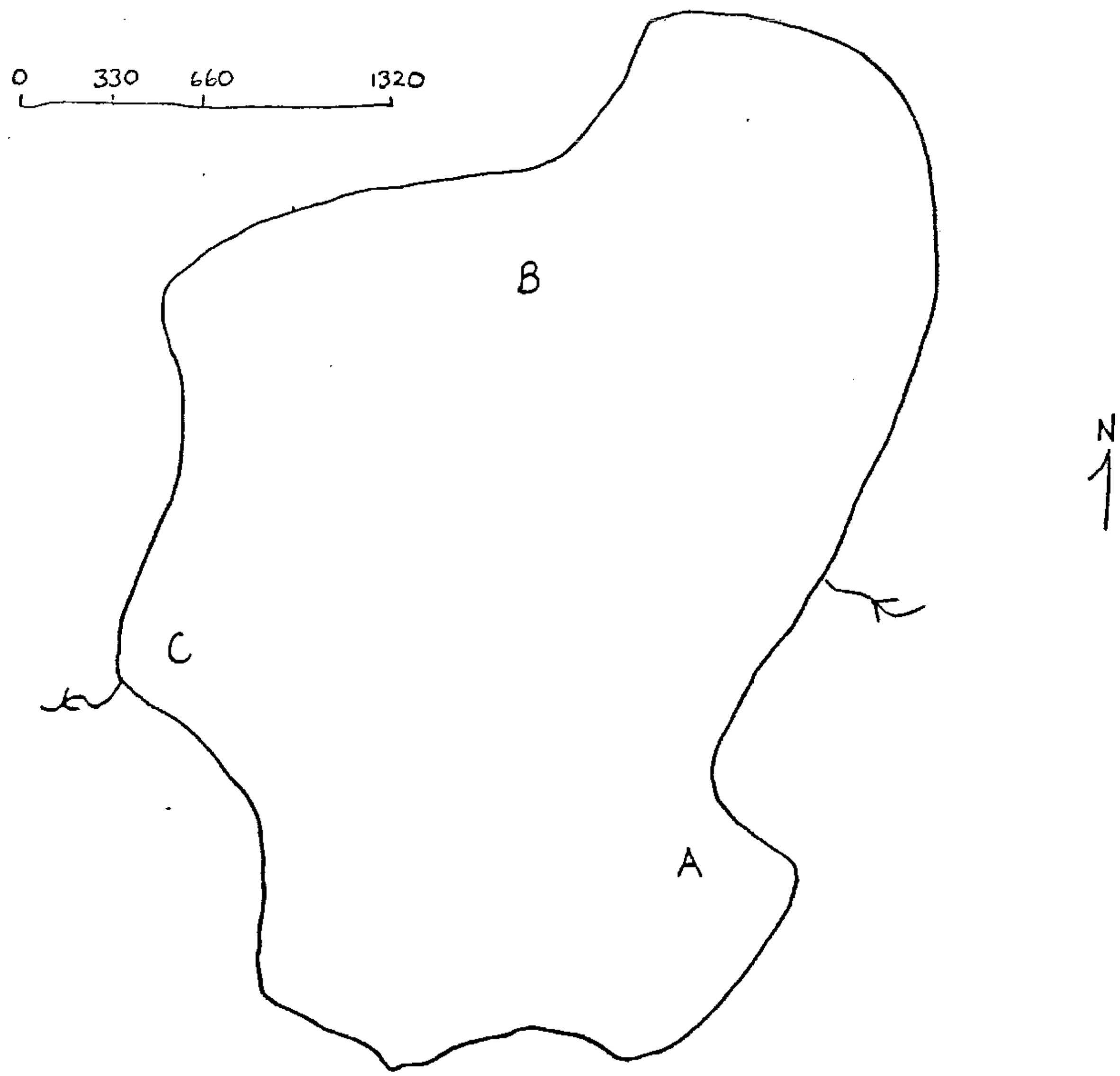
* National Biocentric reported Average Transparency between 1947 and 1953 to be 7' 2" feet.

HUNT LAKE

D.N.R. LAKE NUMBER 66-047

General Information

SIZE OF LAKE	=	190	Acres
SHORELENGTH	=	2.1	Miles
MAXIMUM DEPTH	=	27.0	Feet
MEDIAN DEPTH	=	10.0	Feet
% LITORAL	=	84%	
TOTAL HOMES (1967)	=	4	Homes
TOTAL HOMES (1982)	=	24	Homes



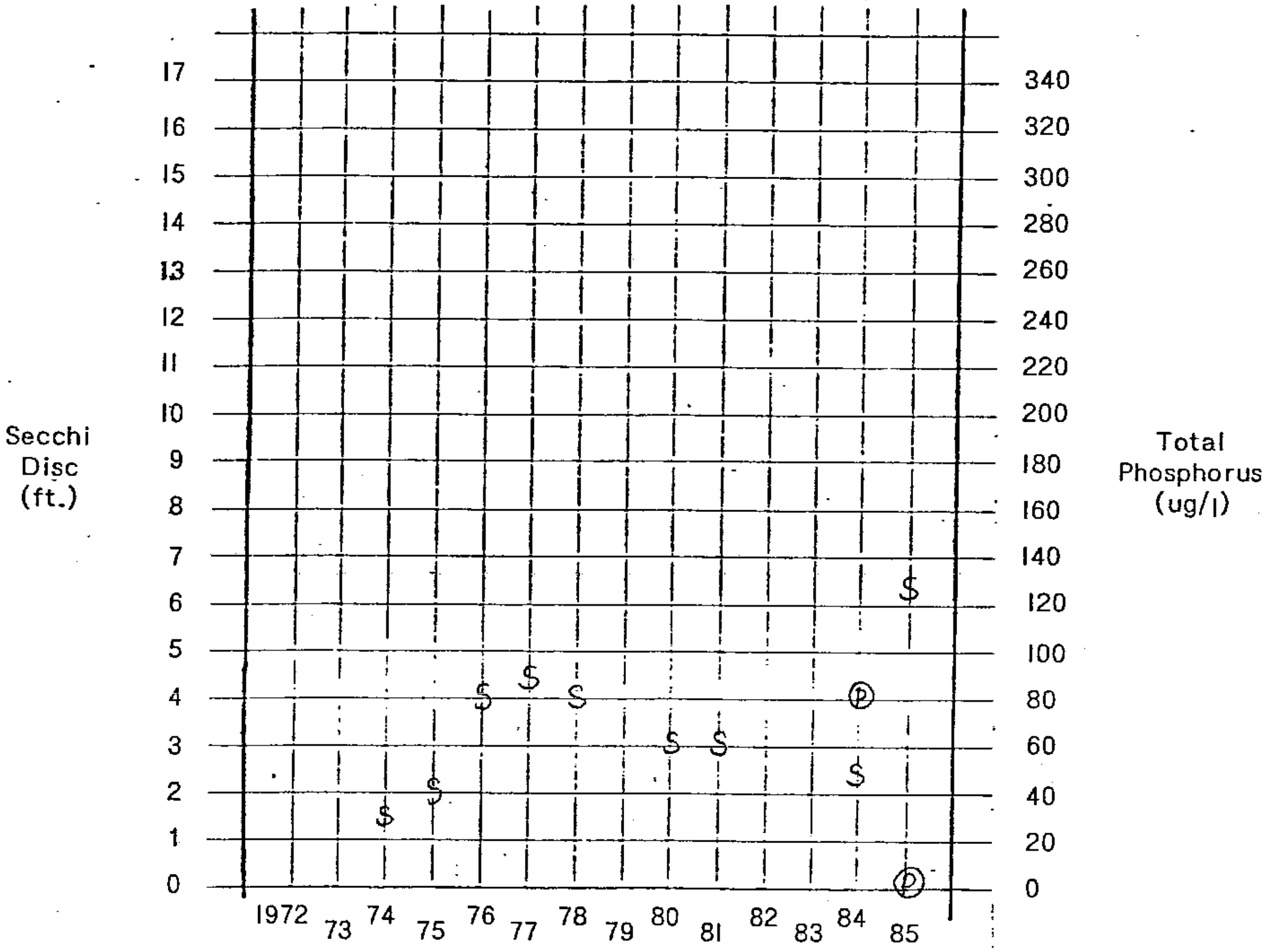
HUNT LAKE

Average Data from points A, B, and C

	National Biocentric	Rice County W.Q.E.	
Date		6-19-84	8-8-84
Depth (ft. in.)		7' 10"	6' 2"
Secchi (ft.)		3'	2'
Temp. (C)		24	26
D.O. (mg/l)		11.8	11.1
B.O.D. (mg/l)		4.3	6
Total P (mg/l)		73	93
Ammonia (mg/l)		.75	.48
pH		9.0	8.9
Conduct. (muhos/cm^2)		303	305
bacteria		neg	A+,B+, C+
Date		10-22-84	1-7-85
Depth (ft. in.)		8' 7"	7' 7"
Secchi (ft.)		8'	NA
Temp (C)		8	4
D.O. (mg/l)		9.6	15
B.O.D. (mg/l)		1.3	3.3
Total P (mg/l)		160	<10
Ammonia (mg/l)		1.58	.45
pH		7.8	8.6
conduct. (muhos/cm^2)		220	252
bacteria		neg	neg
Date		4-17-85	6-25-86
Depth (ft. in.)		7' 4"	7' 7"
Secchi (ft.)		3'	6.5'
Temp. (C)		11	23
D.O. (mg/l)		14	9.4
B.O.D. (mg/l)		5.6	6
Total P (mg/l)		100	<10
Ammonia (mg/l)		.25	.40
pH		9.0	8.9
conduct. (muhos/cm^2)		252	317
bacteria		C+	neg

HUNT LAKE

TRANSPARENCY AND TOTAL PHOSPHORUS
VS.
TIME



S = Transparency Average (June - September)
Secchi Disc Reading in feet.

(P) = Phosphorus Concentration Average (June - September)
Total Phosphorus expressed in ug/l.

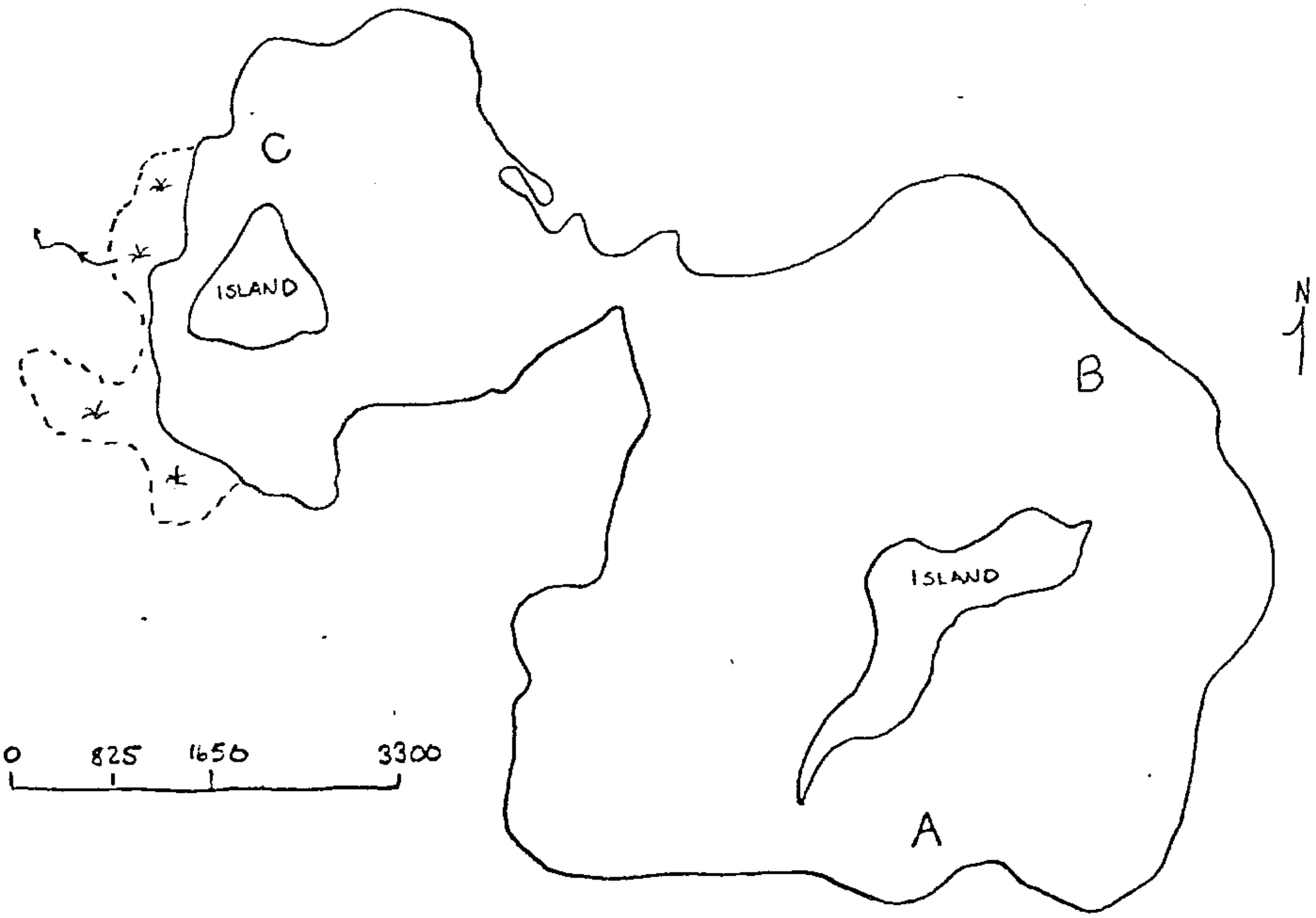
* National Biocentric reported Average Transparency between 1947 and 1953 to be unknown feet.

CEDAR LAKE

D.N.R. LAKE NUMBER 66-052

General Information

SIZE OF LAKE	=	927	Acres
SHORELENGTH	=	9.6	Miles
MAXIMUM DEPTH	=	40.0	Feet
MEDIAN DEPTH	=	12.0	Feet
% LITORAL	=	73%	
TOTAL HOMES (1967)	=	40	Homes
TOTAL HOMES (1982)	=	118	Homes



CEDAR LAKE

Summary/Conclusions

Cedar Lake showed improvement in many respects between 1972 and 1985. Total phosphorus concentration declined and transparency increased since 1972. The potential for further improvement is obvious from transparency data from 1975 and 1976 when secchi disc readings averaged six feet. One notable exception to this positive trend was the detection of fecal coliform bacteria at Point A on four occasions. Discharging sewage is the probable source of this disease-causing pollutant.

Cedar Lake's good water quality is a product of a small watershed. It is insulated from nutrient and soil laden runoff by marshland and slews. Another important quality is Cedar Lake's deep basin. This deep water provides a reservoir of oxygen during winter.

This excellent water quality has attracted many people to Cedar Lake. Significant new development has occured since 1972. Seventy-eight new homes were built between 1967 and 1982. This increase in year-around housing seems to have negatively affected water quality. Fortunately this problem can probably be solved by the repair or replacement of malfunctioning shoreland sewer systems. Although sewage is a serious pollutant, it is one that is easily focused on and abated using the County On-Site Sewage Ordinance.

CEDAR LAKE

Average Data from points A, B, and C

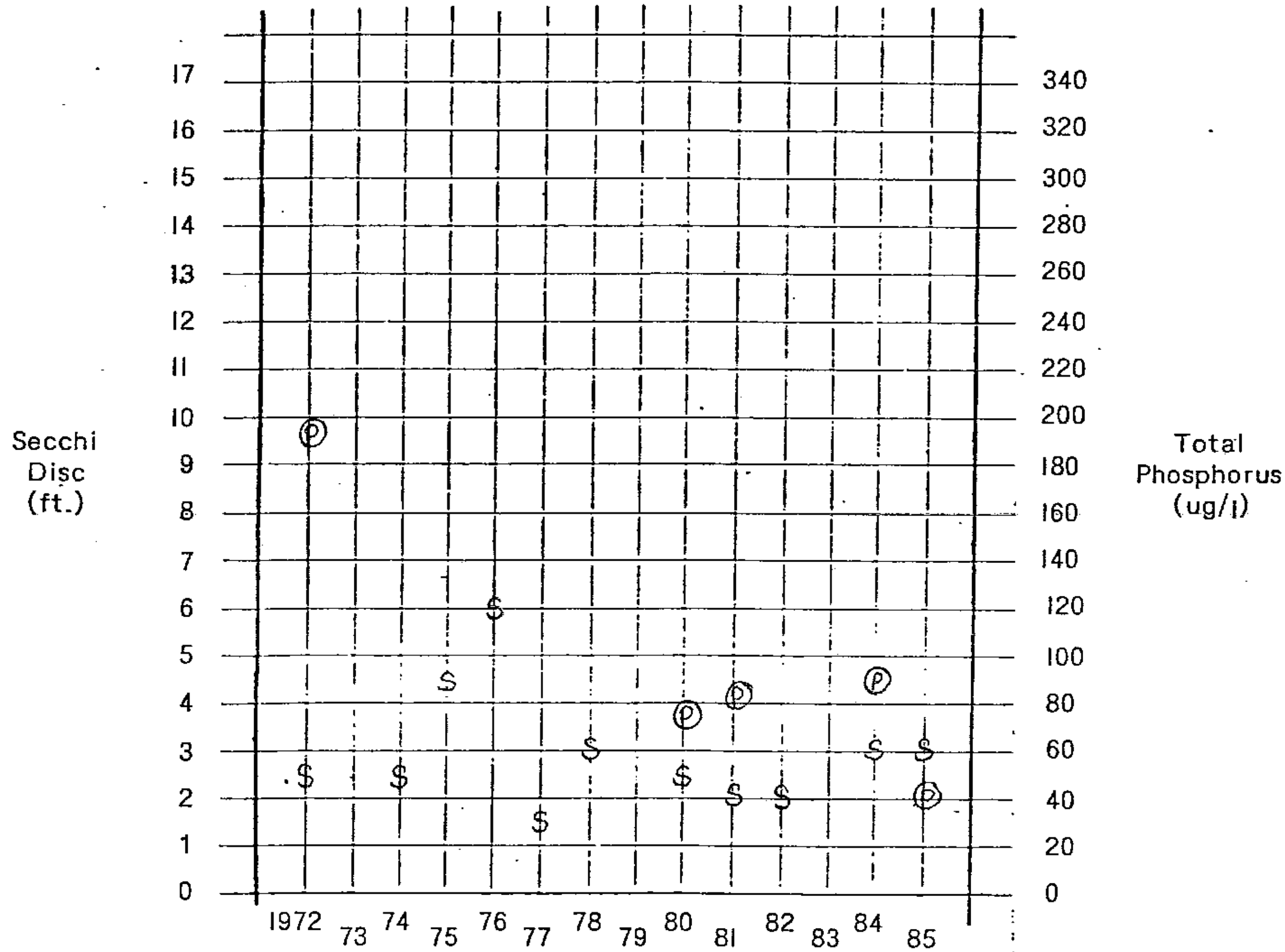
	National Biocentric	Rice County W.O.E.	
Date	6-7-72	6-19-84	6-25-85
Depth (ft. in.)	5' 6"	7' 6"	7' 6"
Secchi (ft.)	3'	4.5	2
Temp. (C)	24	23	22
D.O. (mg/l)	13	10.6	10.3
B.O.D. (mg/l)	5.28	2	9
Total P (mg/l)	242	90	40
Ammonia (mg/l)	.481	.99	.49
pH	8.5	8.8	9.2
Conduct. (muhos/cm^2)	235	250	215
bacteria	neg	A+, C+	neg

Date	8-22-72	8-8-84
Depth (ft. in.)	8'	9' 6"
Secchi (ft.)	2.5	2.0
Temp (C)	27	26
D.O. (mg/l)	5.98	9.6
B.O.D. (mg/l)	3.98	5.6
Total P (mg/l)	143	86
Ammonia (mg/l)	.176	.34
pH	NA	8.9
conduct. (muhos/cm^2)	230	223
bacteria	A+, B+	A+, C+

Date	2-25-72	1-7-85
Depth (ft. in.)	5' 6"	10'
Secchi (ft.)	NA	NA
Temp. (C)	1.5	2
D.O. (mg/l)	7.4	14.5
B.O.D. (mg/l)	2.78	4.6
Total P (mg/l)	374	73
Ammonia (mg/l)	1.041	.72
pH	7.5	8.2
conduct. (muhos/cm^2)	NA	153
bacteria	A+, B+, C+	neg

CEDAR LAKE

TRANSPARENCY AND TOTAL PHOSPHORUS
VS.
TIME



S = Transparency Average (June - September)
Secchi Disc Reading in feet.

(P) = Phosphorus Concentration Average (June - September)
Total Phosphorus expressed in ug/l.

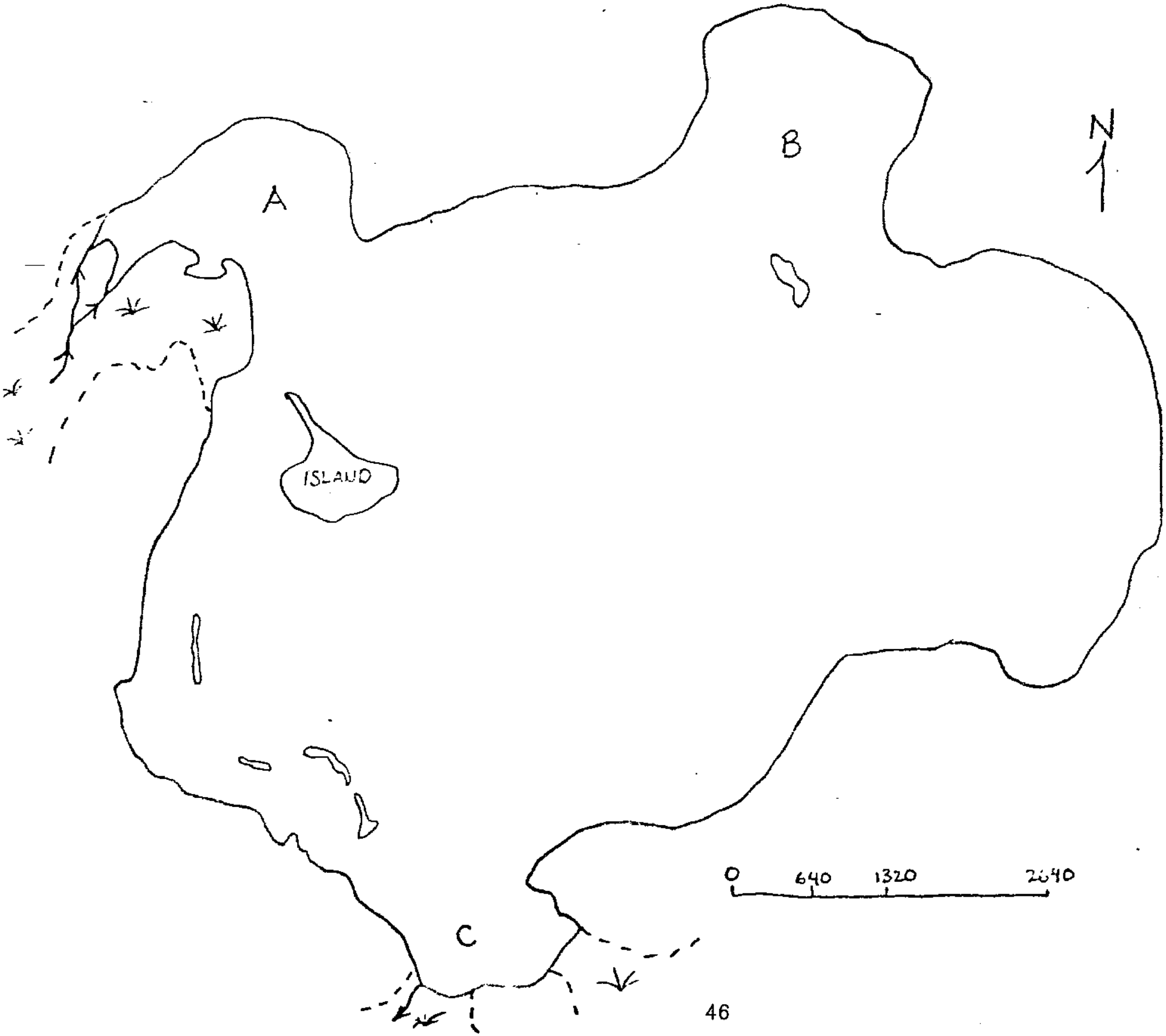
* National Biocentric reported Average Transparency between 1947 and 1953 to be 2' 9" feet.

SHIELDS LAKE

D.N.R. LAKE NUMBER 66-055

General Information

SIZE OF LAKE	=	877	Acres
SHORELENGTH	=	6.5	Miles
MAXIMUM DEPTH	=	42.0	Feet
MEDIAN DEPTH	=	9.0	Feet
% LITORAL	=	59%	
TOTAL HOMES (1967)	=	28	Homes
TOTAL HOMES (1982)	=	31	Homes



SHIELDS LAKE

Summary/Conclusions

Shields Lake has experienced a slow, steady decline in transparency and wide fluxuations in nutrient concentrations since 1972. It receives water from a large basin in western Rice County. No consistent fecal contamination was noticed over the study period. After a brief stay in Shields Lake, water discharges at the southern tip to become the Cannon River.

The highly enriched waters of Shields Lake are produced by runoff from a large watershed. Like other eutrophic lakes, Shields becomes oxygen-poor during winter periods. Large summer crops of algae and vegetation provide an excellent environment for panfish. Yet this over-productivity threaten to choke the water in years to come. If the watershed continues to yield more and more nutrients and sediment this lake environment will change.

Intercepting major tributaries with marsh impoundments or diversions would help remove the non-point pollutants they carry. This method utilizes a natural process to buffer water before it reaches the lake basin. Undoubtedly, much of the Shields Lake watershed was wetland before being drained and put into production. Returning some of this area to it's original state would prolong the life of the lake and improve wildlife habitat.

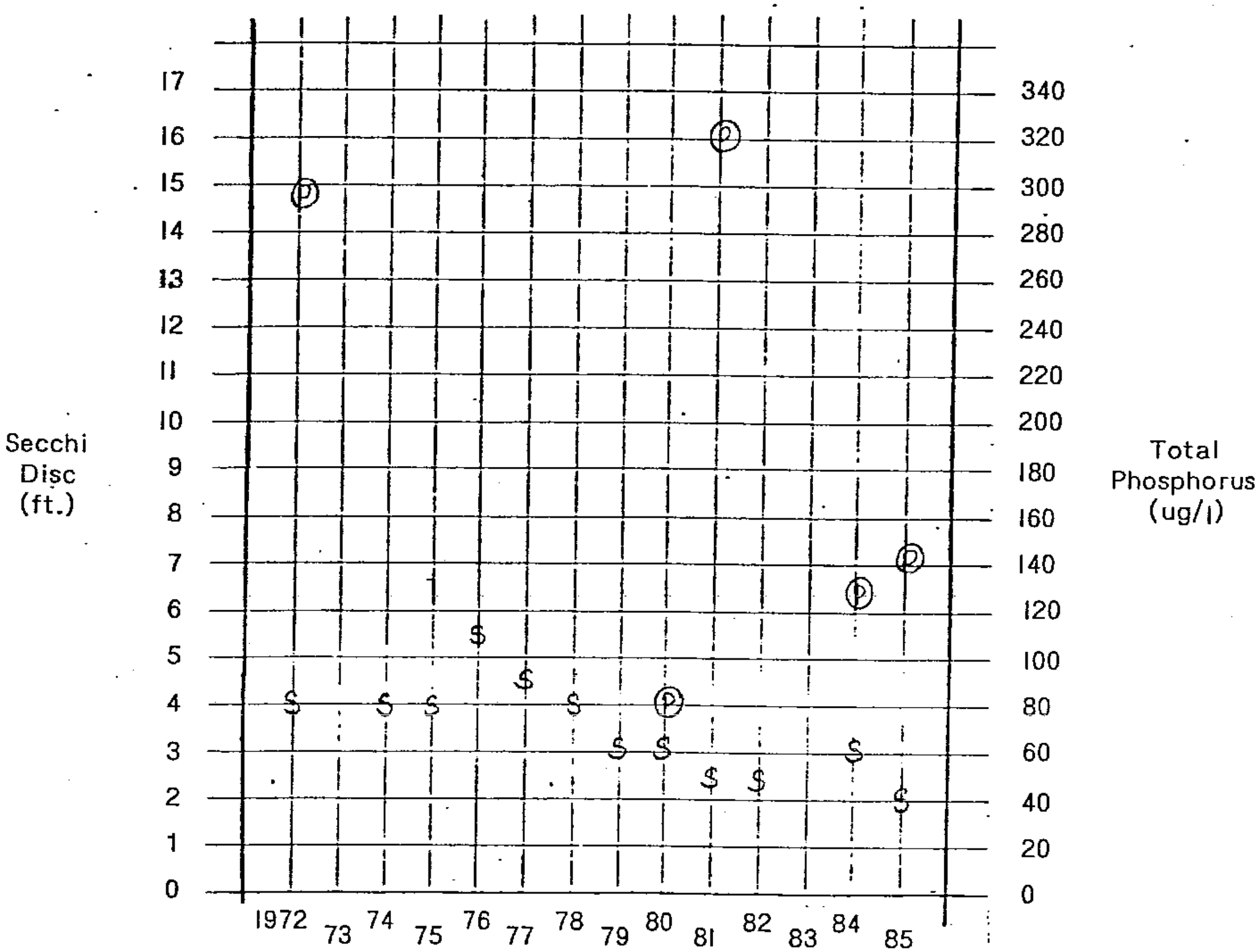
SHIELDS LAKE

Average Data from points A, B, and C

	National Biocentric	Rice County W.Q.E.	
Date	6-7-72	6-18-84	6-27-85
Depth (ft. in.)	11' 2"	6' 5"	7' 7"
Secchi (ft.)	5.5'	4'	2'
Temp. (C)	23	22	22
D.O. (mg/l)	9.6	8.0	9.9
B.O.D. (mg/l)	.45	2.3	11.6
Total P (mg/l)	311	190	150
Ammonia (mg/l)	.692	1.06	.66
pH	8.4	8.1	8.8
Conduct. (muhos/cm2)	350	315	297
bacteria	neg	neg	A+, B+
Date	8-22-72	8-9-84	
Depth (ft. in.)	4'	5' 6"	
Secchi (ft.)	2.5	2	
Temp (C)	24	25	
D.O. (mg/l)	6.4	9.5	
B.O.D. (mg/l)	6.5	6	
Total P (mg/l)	278	73	
Ammonia (mg/l)	.418	.85	
pH	NA	8.8	
conduct. (muhos/cm2)	318	290	
bacteria	A+, B+	A+, B+, C+	
Date	2-25-72	1-8-84	
Depth (ft. in.)	10'	7' 2"	
Secchi (ft.)	NA	NA	
Temp. (C)	1	2	
D.O. (mg/l)	6.15	11.5	
B.O.D. (mg/l)	1.26	4.3	
Total P (mg/l)	309	90	
Ammonia (mg/l)	1.330	.70	
pH	7.3	8.1	
conduct. (muhos/cm2)	NA	185	
bacteria	neg	neg	

SHIELDS LAKE

TRANSPARENCY AND TOTAL PHOSPHORUS
VS.
TIME



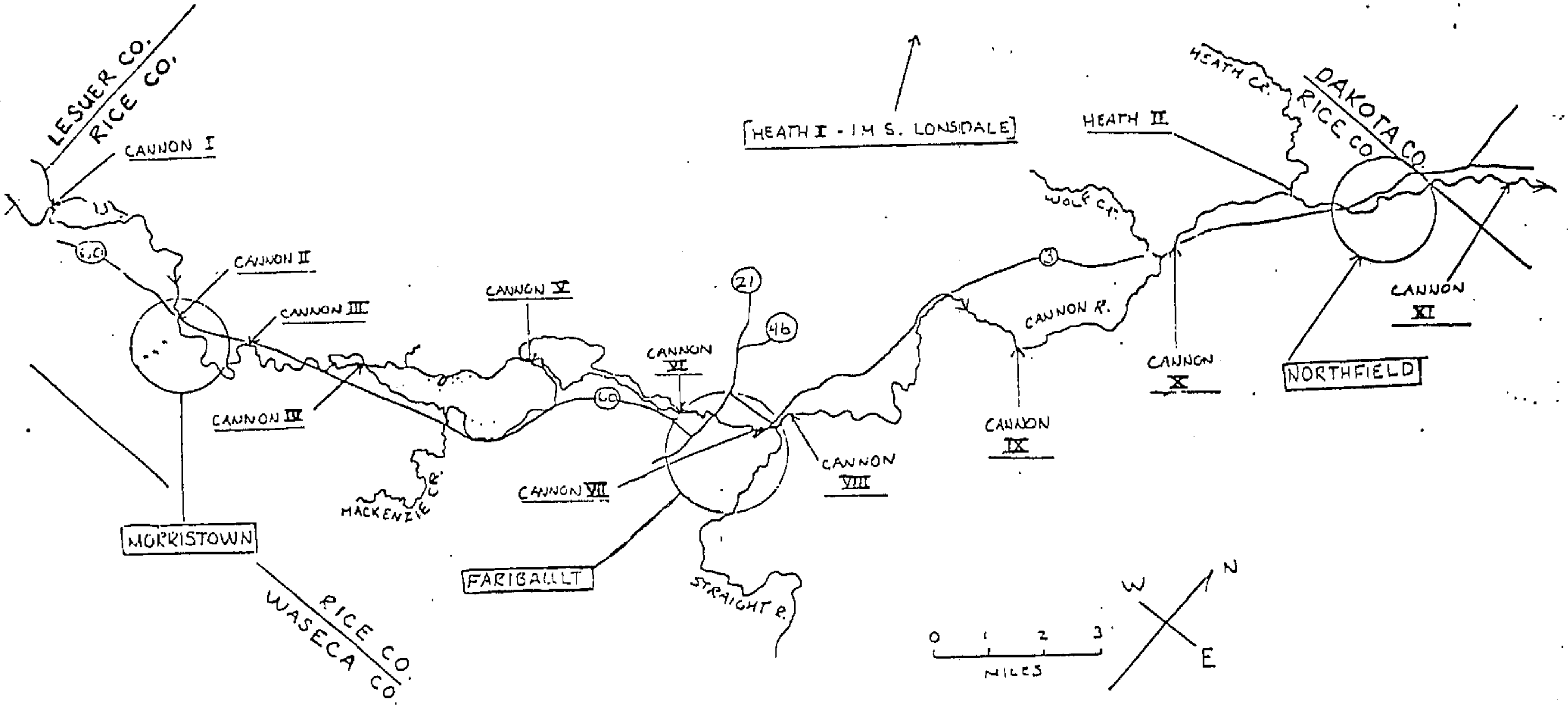
S = Transparency Average (June - September) Secchi Disc Reading in feet.

Ⓟ = Phosphorus Concentration Average (June - September) Total Phosphorus expressed in ug/l.

* National Biocentric reported Average Transparency between 1947 and 1953 to be 8' 10" feet.

CANNON RIVER / HEATH CREEK

MONITORING POINTS - CI - C XI, HII, HII



CANNON RIVER

Summary/Conclusions

The Cannon River has improved in many respects since 1972. For many years municipal waste water disposal took a heavy toll on the river. The past years have seen Morristown, Faribault, and Northfield improve their sewage treatment facilities. These improvements are reflected in the Bacteria data. The disinfection of waste-water has made the river a healthier place to be. The conductivity and total phosphorus concentration of the river increases as it flows through Rice County. The magnitude of the increase has been reduced substantially between 1972 and the present. The greatest improvement seems to be in the Northfield area.

State regulation of waste water discharges has also checked serious pollution sources. These regulations take into account the great assimilative capacity of lentic systems (rivers, streams). By limiting the strength and character of permitted discharges, we have given the rivers' natural purification system an opportunity to work. In overloaded receiving streams, oxygen is often depleted below major discharge points. This depletion of oxygen is due to organic decomposition which consumes oxygen necessary for normal aquatic life. B.O.D. is a measure of this depletion potential and fortunately the Cannon River suffers little oxygen depletion.

Like other surface waters in Rice County the Cannon River is suffering from non-point pollution. High concentrations of suspended solids and nitrogen compounds were found at many locations throughout the year. Some of these corresponded to municipal impacts and others did not. Large and small tributaries like the Straight River and Mackenzie Creek have a significant negative impact. Total Suspended Solids rise dramatically as the Cannon courses through our area being fed by creeks, ditches, and tile lines. Its mucky condition makes the river an inhospitable home to normal flora and fauna, promotes sedimentation, and risks flooding. High concentrations of nitrogen are also symptomatic of agricultural runoff. Comparison of new data to other data from 1972 ("Comprehensive Survey of the Cannon River" by Joel Schilling 1972) shows that nitrogen concentrations have risen substantially while phosphorus loading has diminished.

Maintaining and improving the water quality of the Cannon River will be a difficult and costly endeavor. First, to maintain health and safety, sewage treatment plants must be operated in compliance with State regulations. Second, non point pollution must be attacked in the watershed. Erosion control measures will reduce the waters' murky appearance. Careful agriculture fertilization will keep nutrients in the soil and out of the water. Finally protection and restoration of slough and marsh lands will provide purifying areas for runoff water before pollutants get a one way ticket to the Gulf of Mexico.

HEATH CREEK

Summary/Conclusions

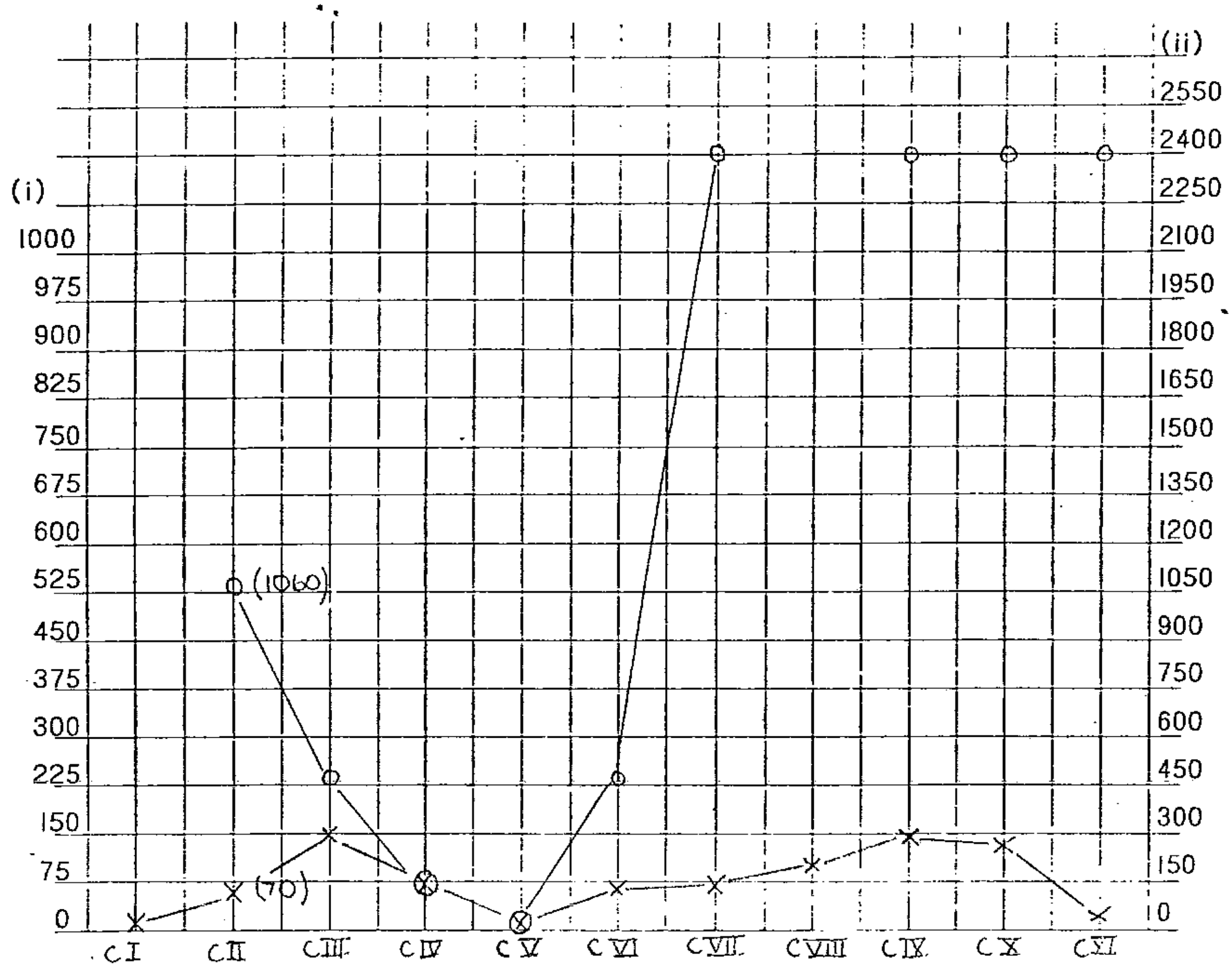
Heath Creek is a small stream meandering through the fields and wetlands of northern Rice County. It's upper reaches near Lonsdale flow intermittently, often confined in artificial channels. It receives discharges from the Lonsdale Sewage Treatment Facility and from a labyrinth of agricultural tiles draining the areas tight, wet soils. It is similar to Wolf Creek to it's south and Knowles Creek to the north. Data from Heath Creek is presented along side Straight River data to save space.

This creek carries point and non-point pollution depositing some in Union Lake and eventually discharging the balance into the Cannon River. Few specific conclusions can be drawn from comparing data from 1972 to data collected in the course of this study. Lonsdale's influence on the (HI) upper reaches is obvious. High fecal, nutrient and suspended solid measurements are due to the limited dilution offered by the stream. Further downstream (HII), these pollutants continue to appear. The pollution detected here is probably unrelated to the impacts detected upstream because of the great separation of the two points. Close examination reveals that the total suspended solids dissolved in water at point HII is consistently higher than HI. This "muddying of the waters" is perhaps the most widespread pollution problem we face. Erosion of streambanks, exposed agricultural lands, and drainageways is robbing the land of nutrients and filling in waterways.

Solutions to this runoff problem begin in the watershed where soil management practices are properly used or ignored. Once this soil is lost from fields only dredging will recover it.

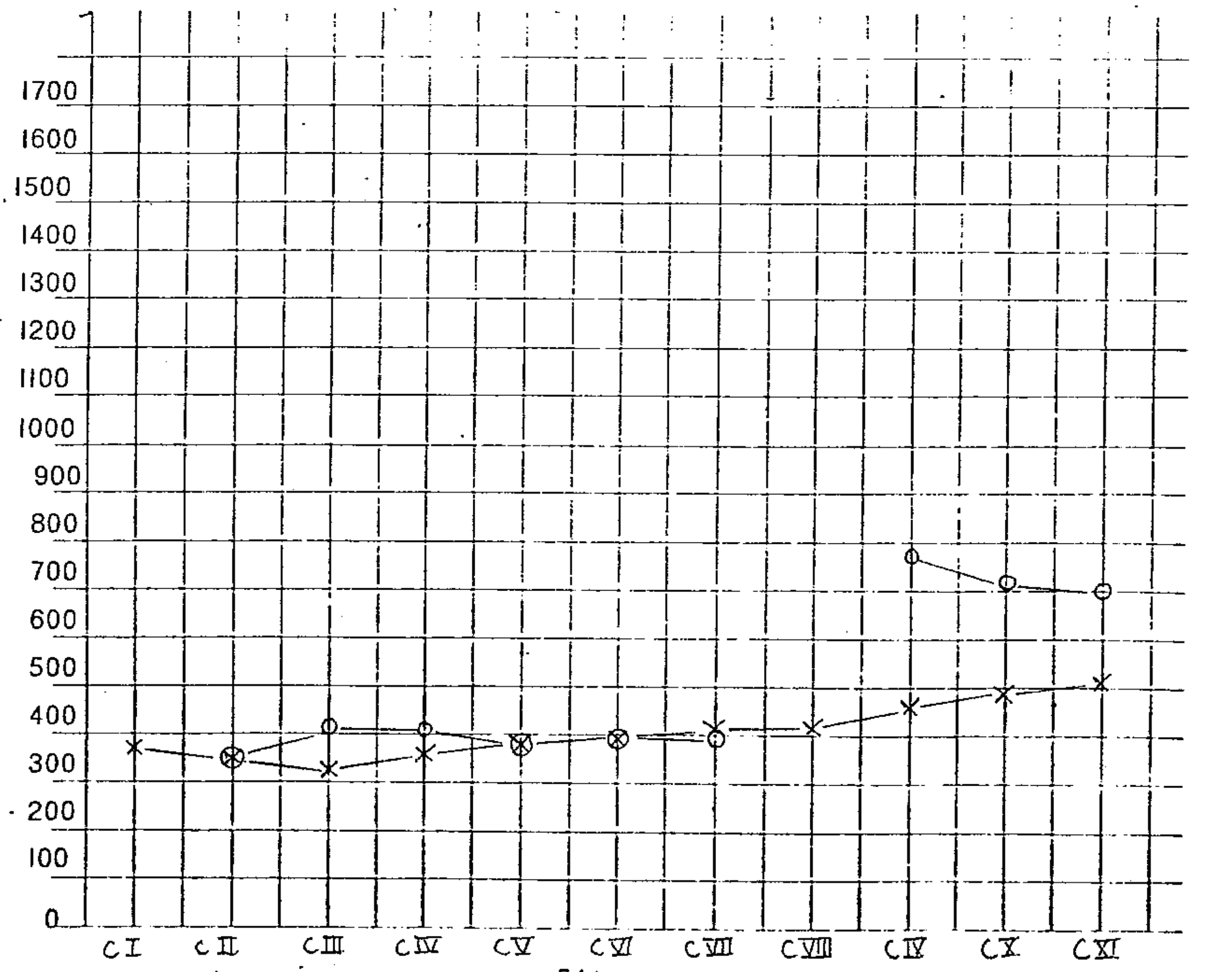
CANNON RIVER

Bacteria
i = MF/100 ml
ii = MPN/100 ml

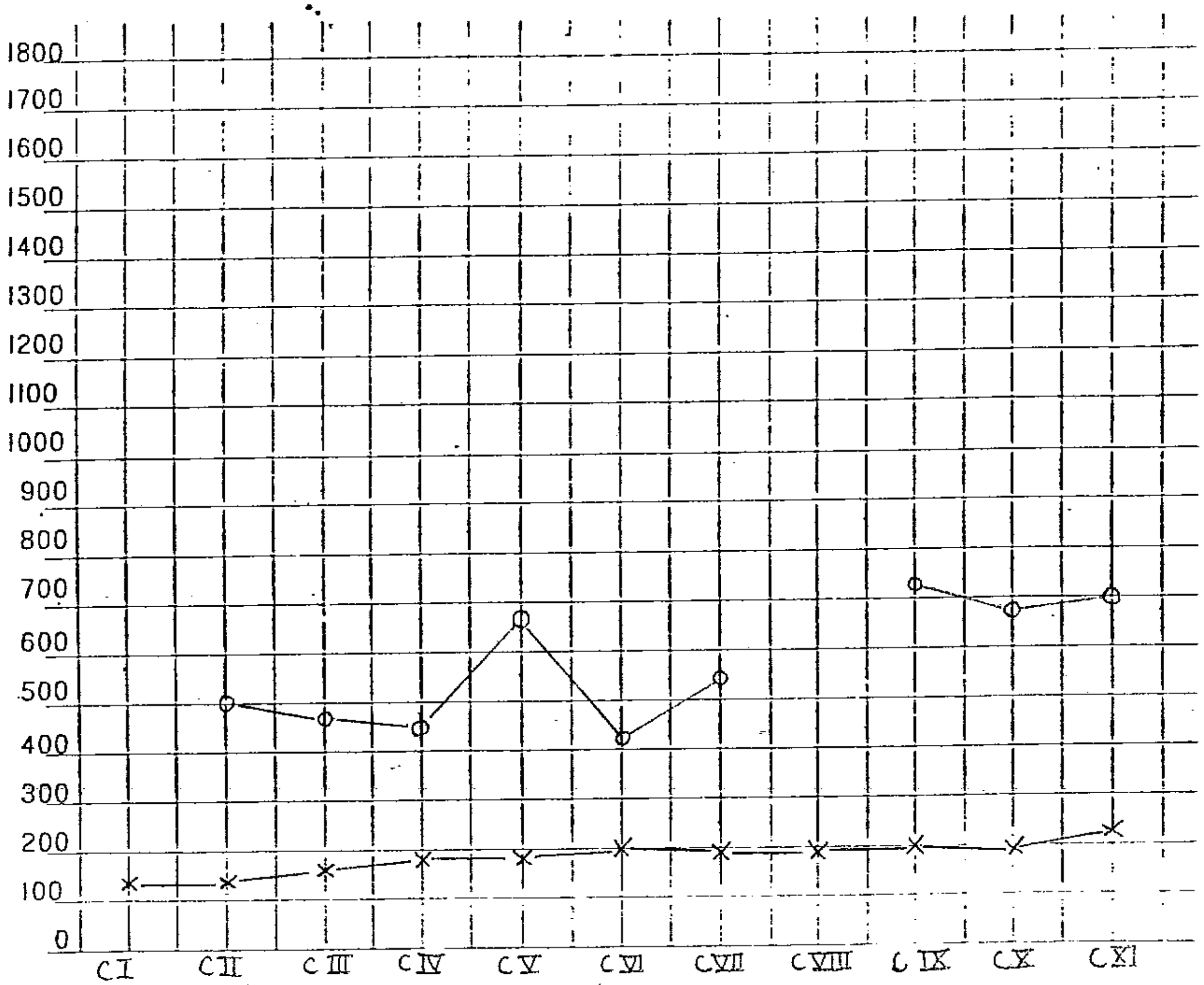


Key
X= 6-12-84
O= 6-7-72

Conductivity
muhos/cm2



CANNON RIVER



Key

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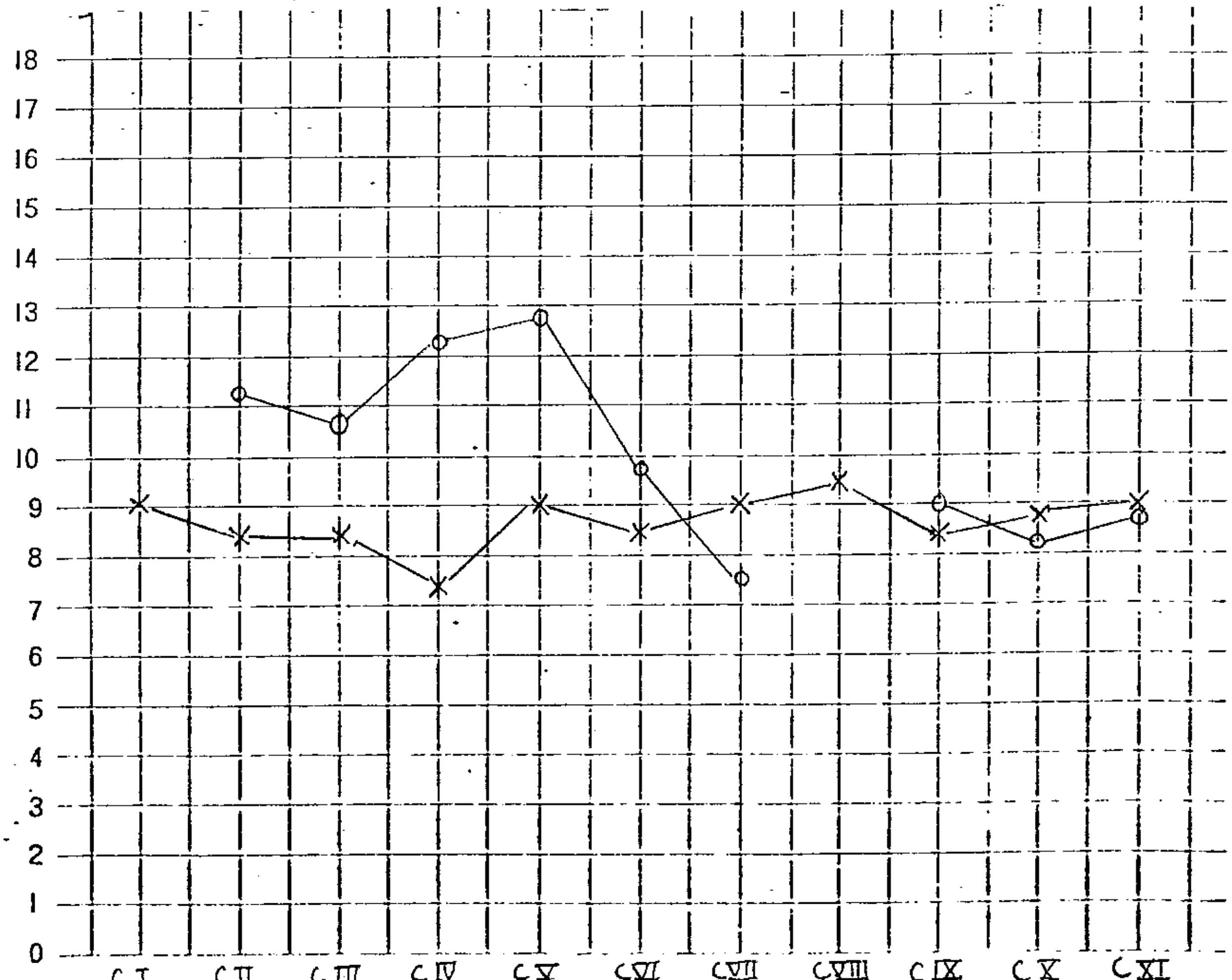
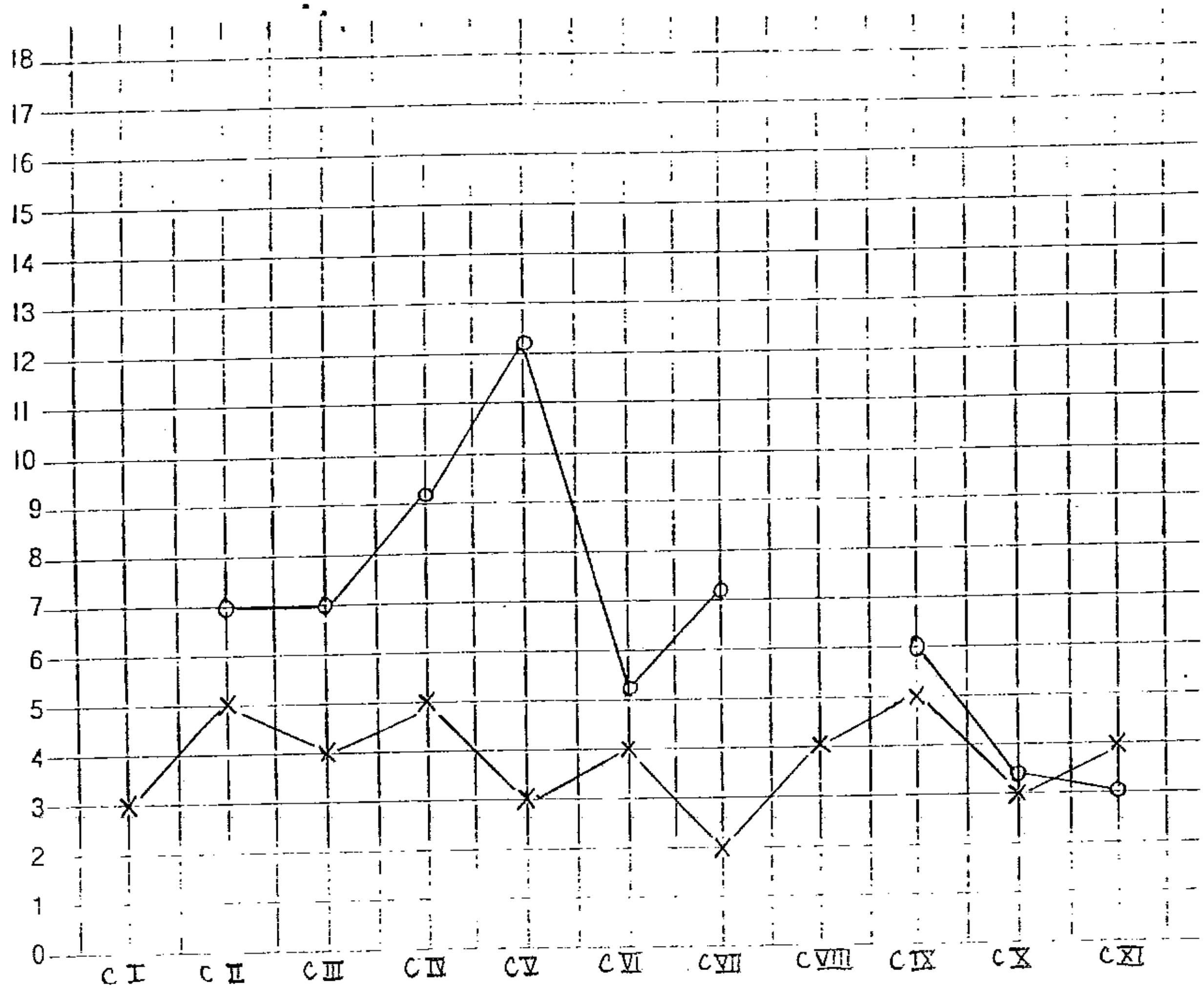
0 = 6-7-72



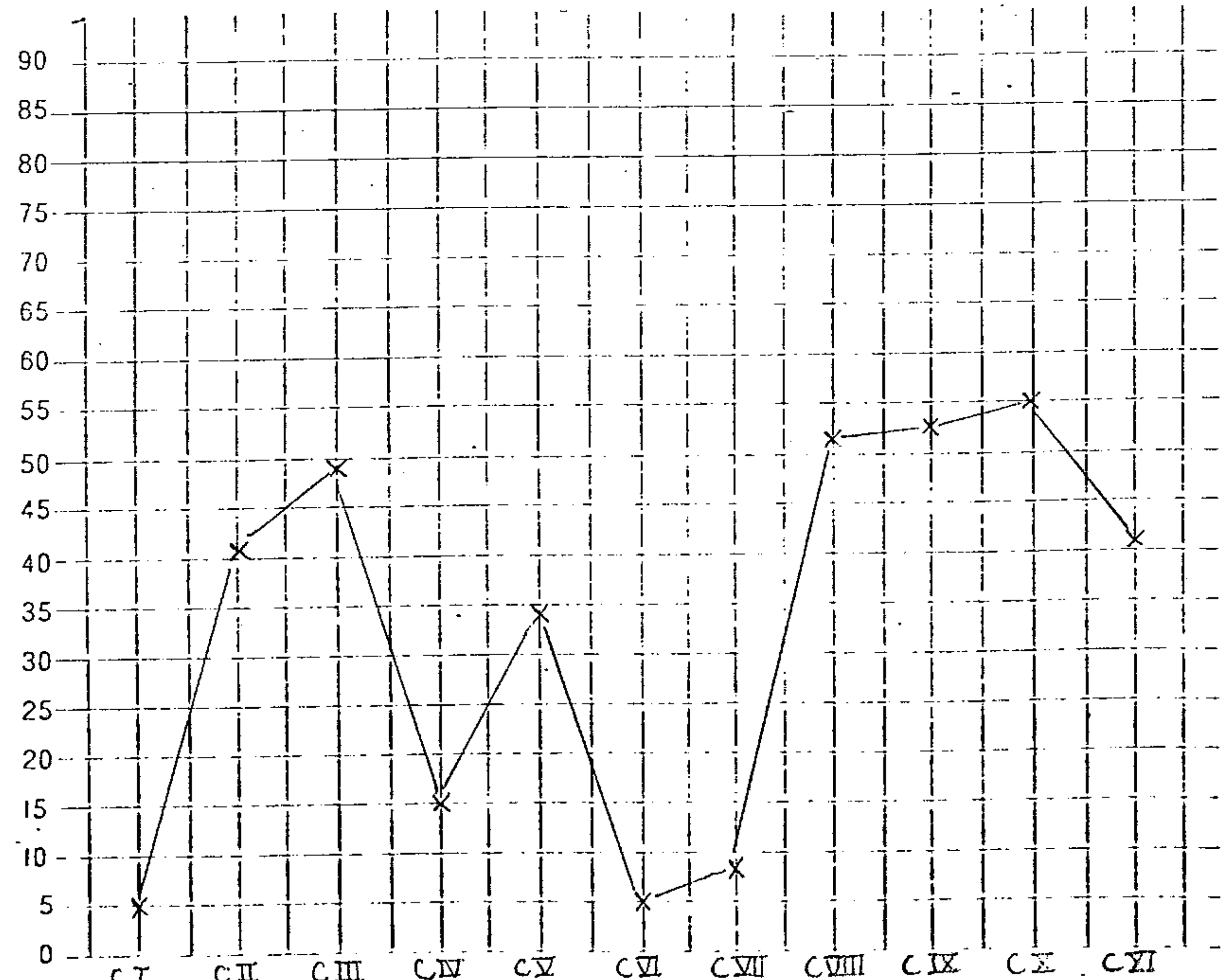
CANNON RIVER

Biochemical
Oxygen
emands 5
(mg/l)



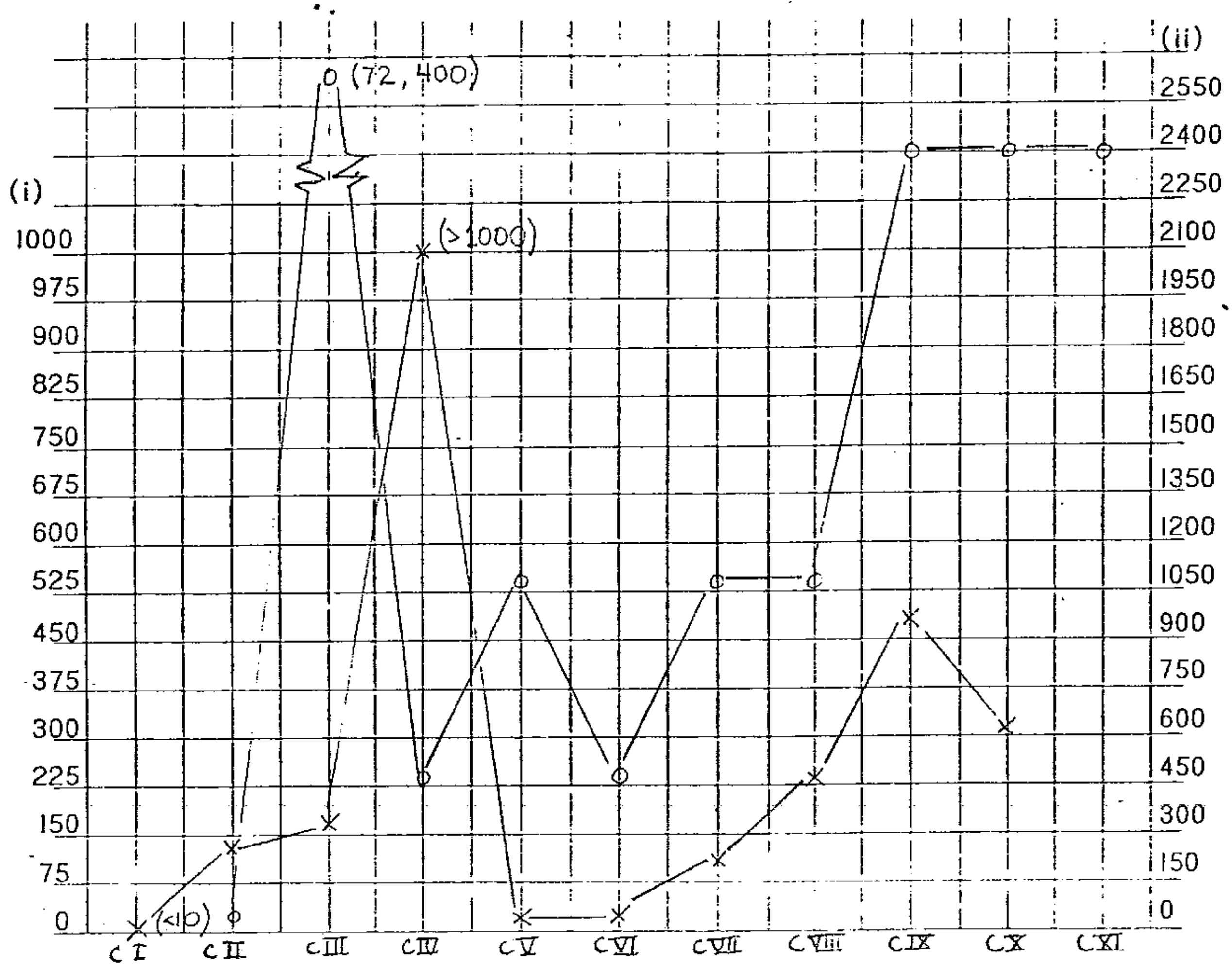
Key
X = 6-12-84
O = 6-7-72

otal Suspended
Solids
(mg/l)



CANNON RIVER

Bacteria
i = MF/100 ml
ii = MPN/100 ml



Key
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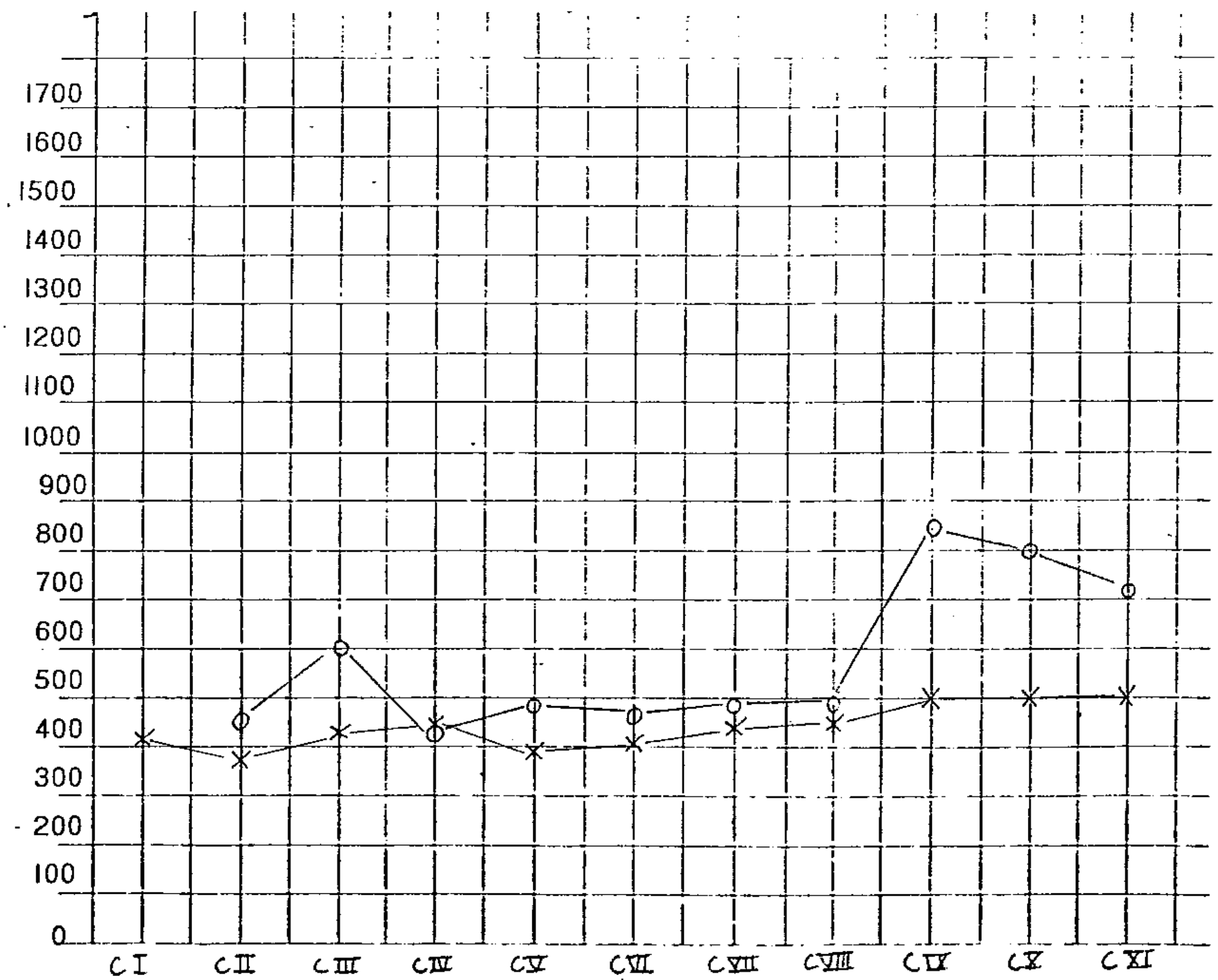
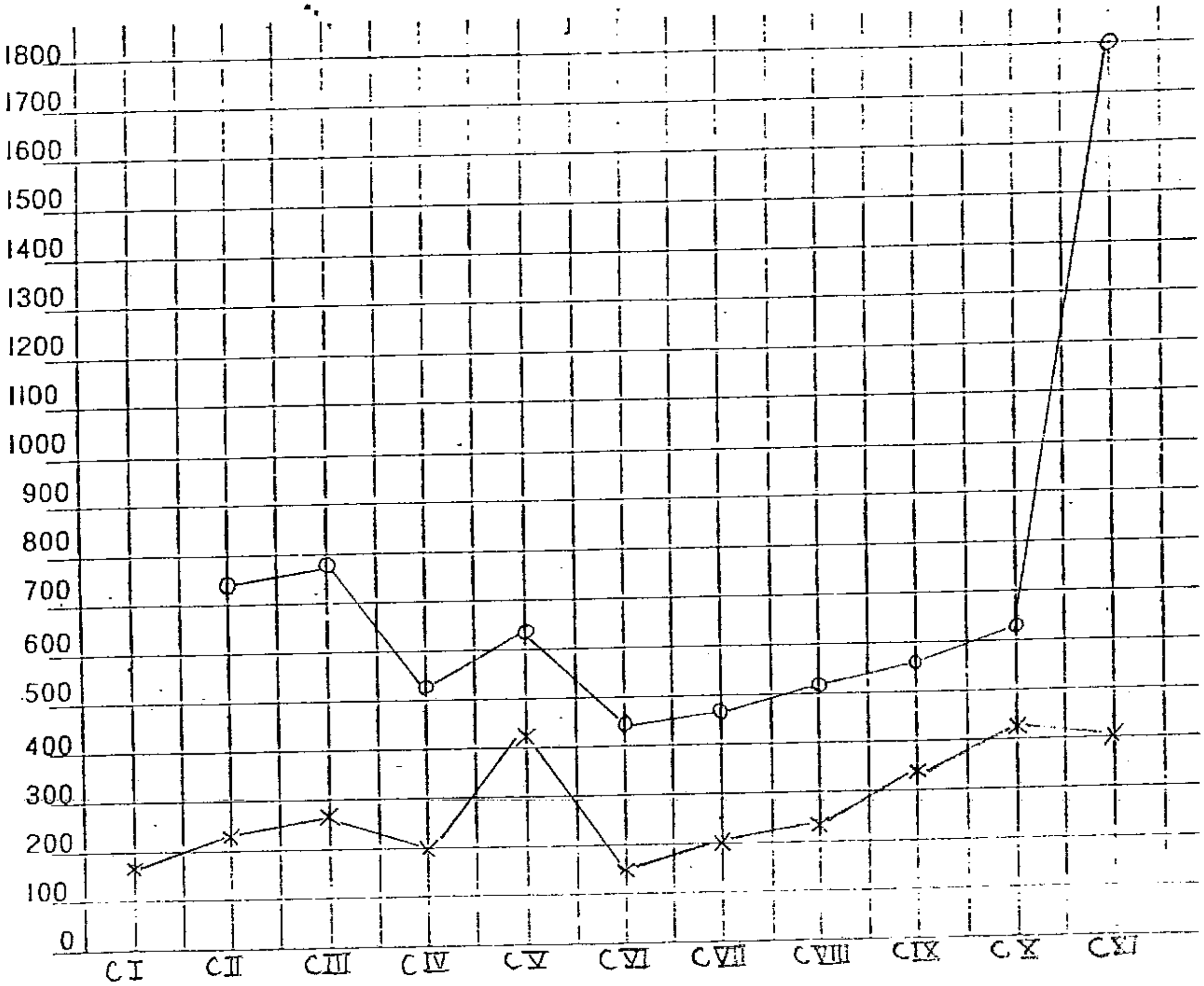
O= 8-22-72

Conductivity
muhos/cm2



CANNON RIVER

Total Phosphorus (ug/l)



Key
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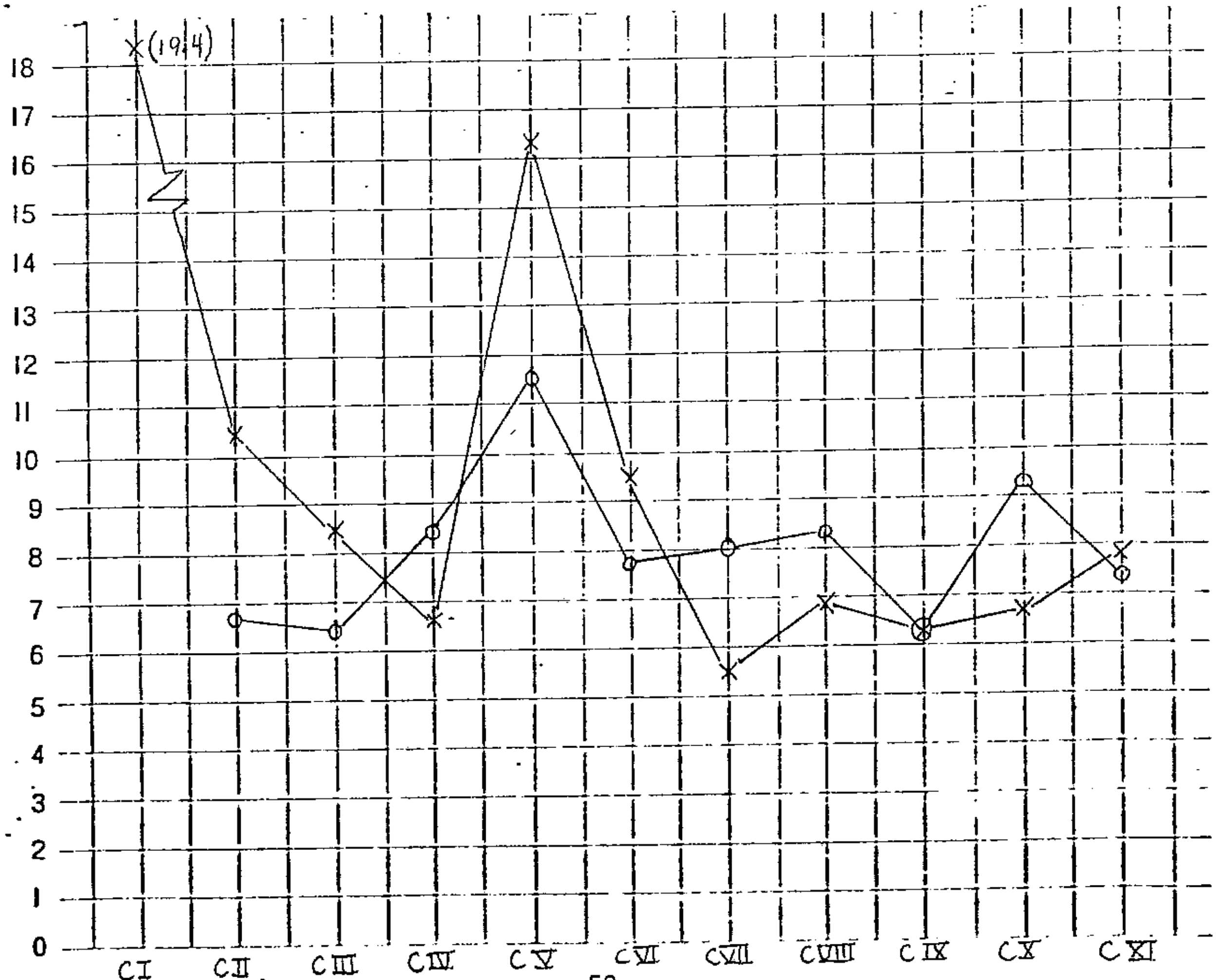
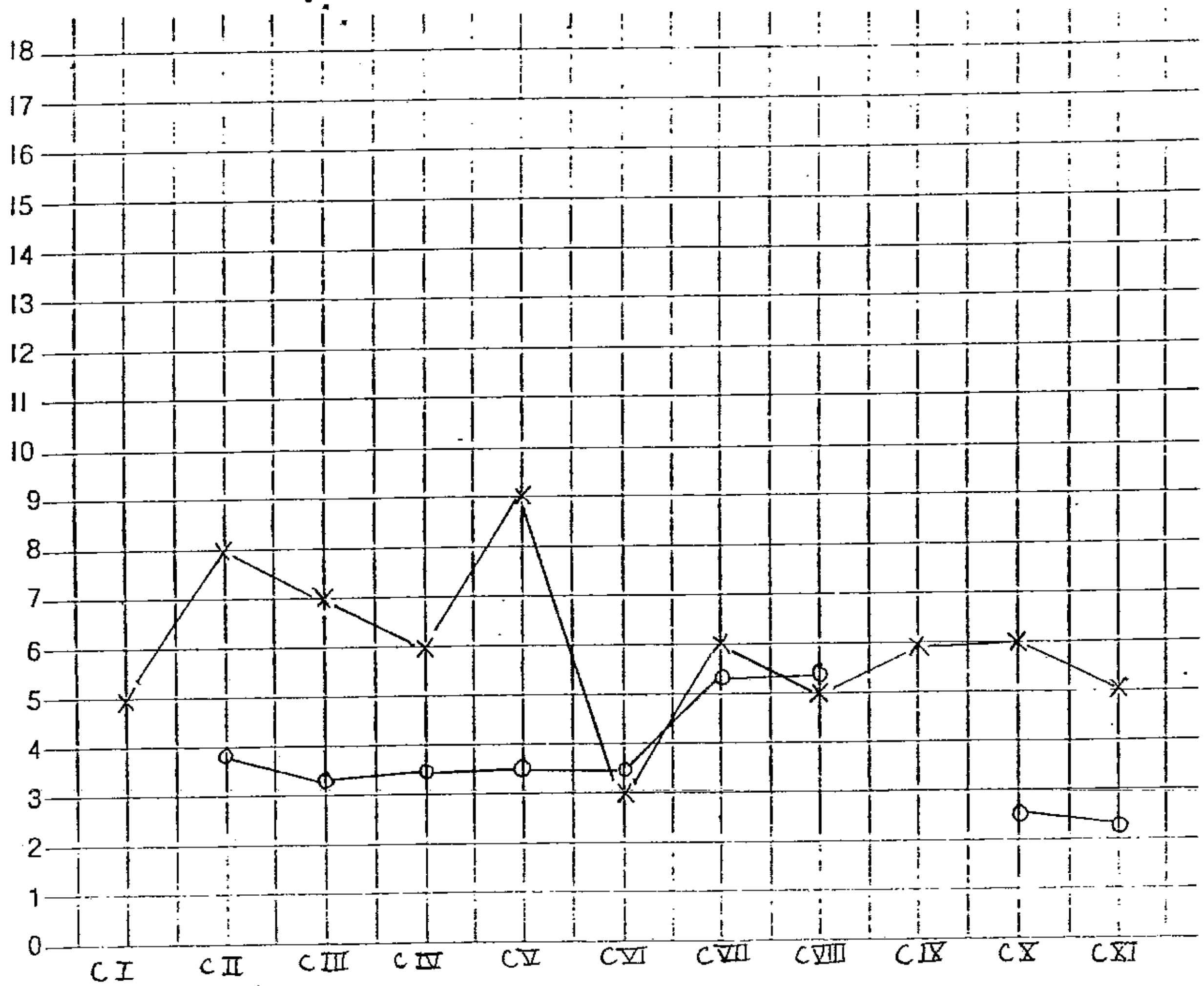
0 = 8-22-72

Dissolved Oxygen (mg/l)



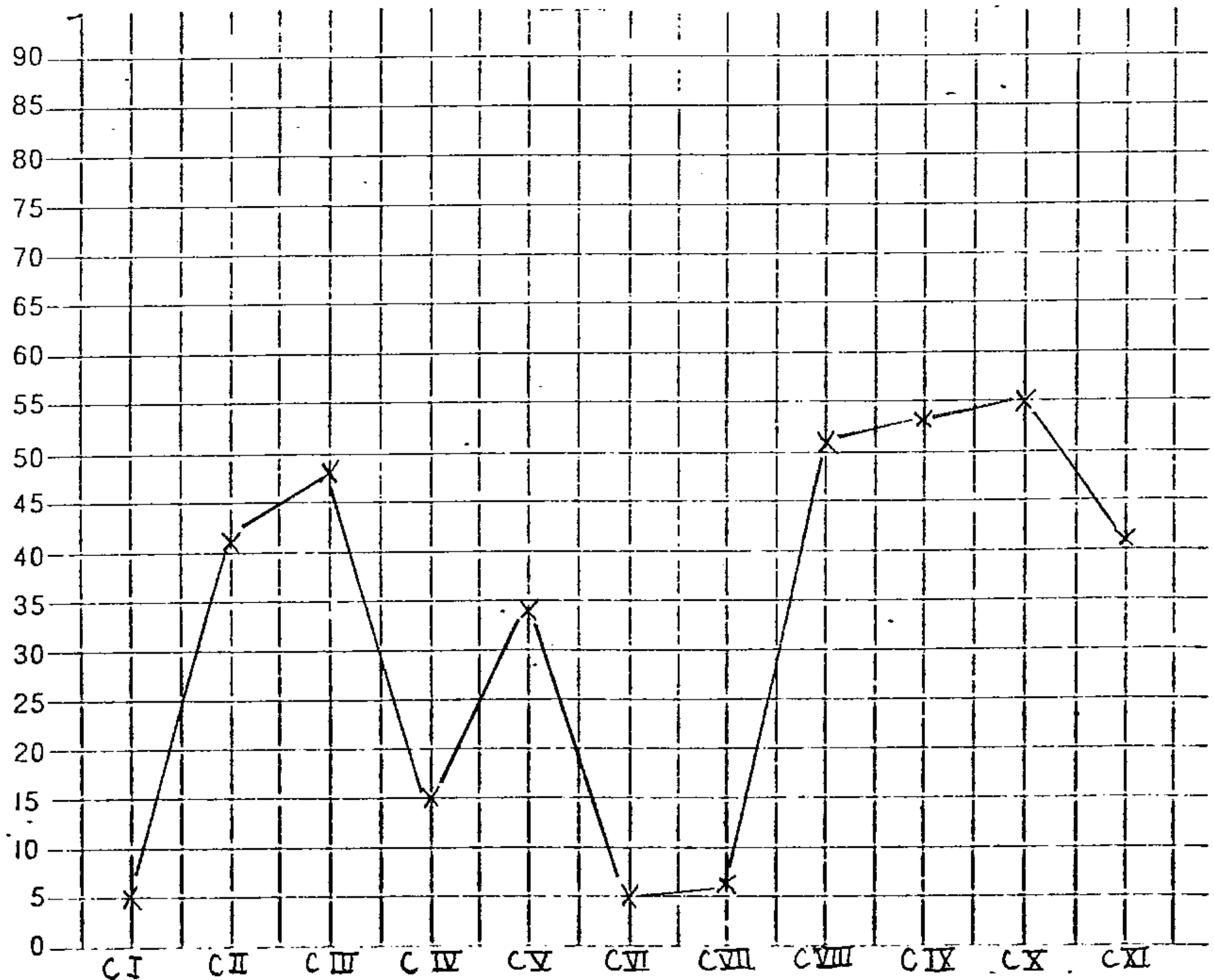
CANNON RIVER

Biochemical
Oxygen
'emands 5
(mg/l)

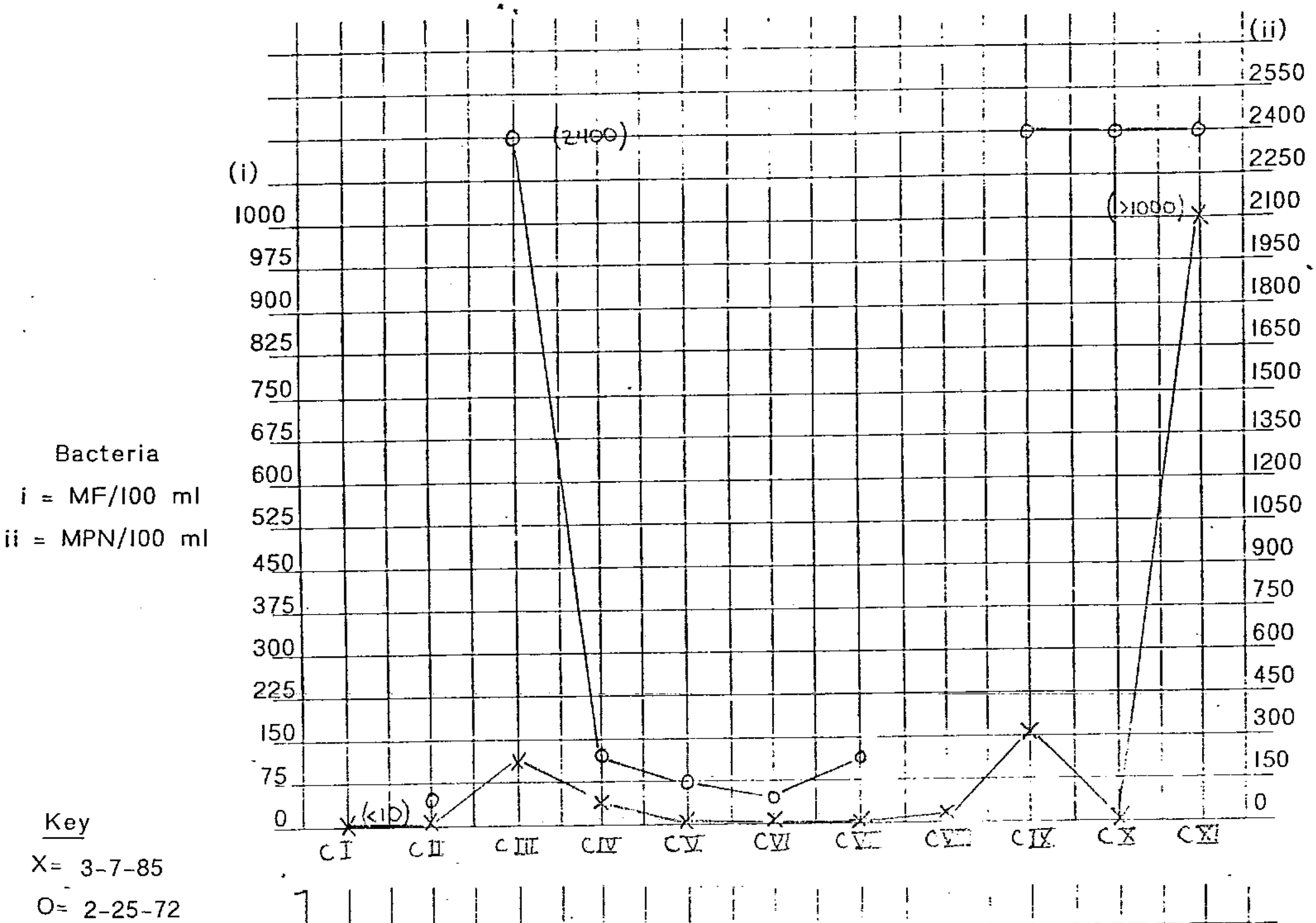


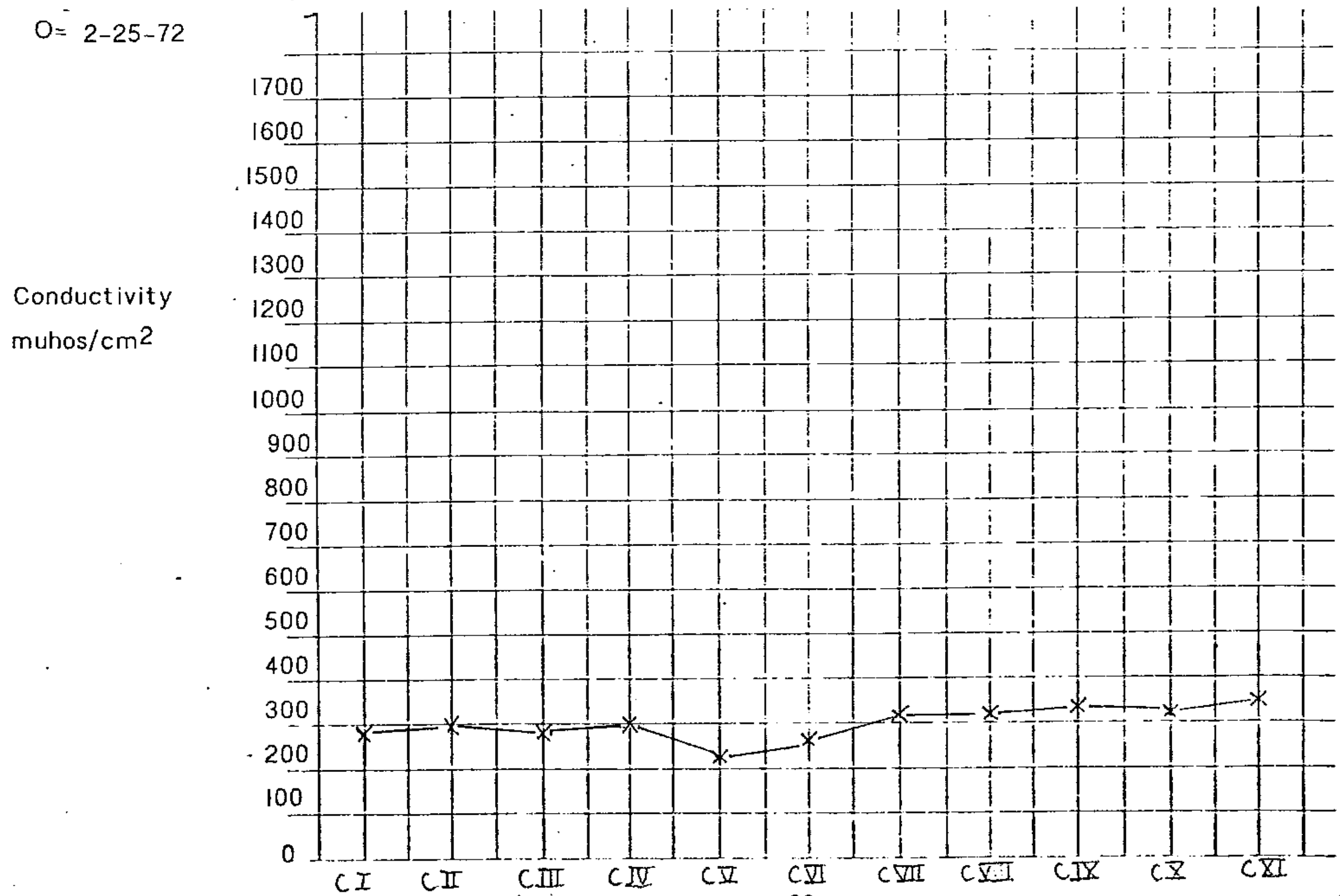
Key
X = 8-6-84
O = 8-22-72

otal Suspended
Solids
(mg/l)

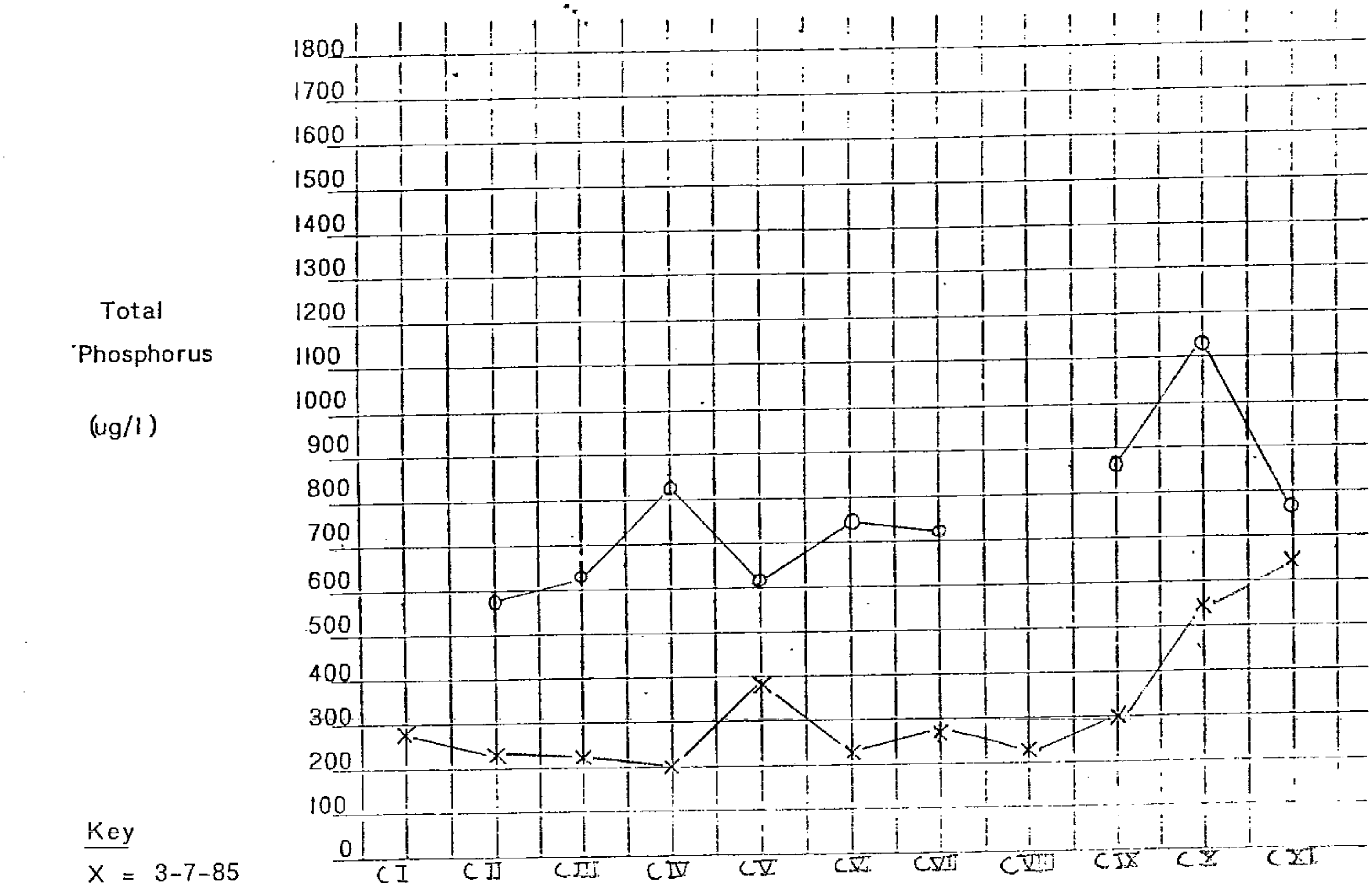


CANNON RIVER

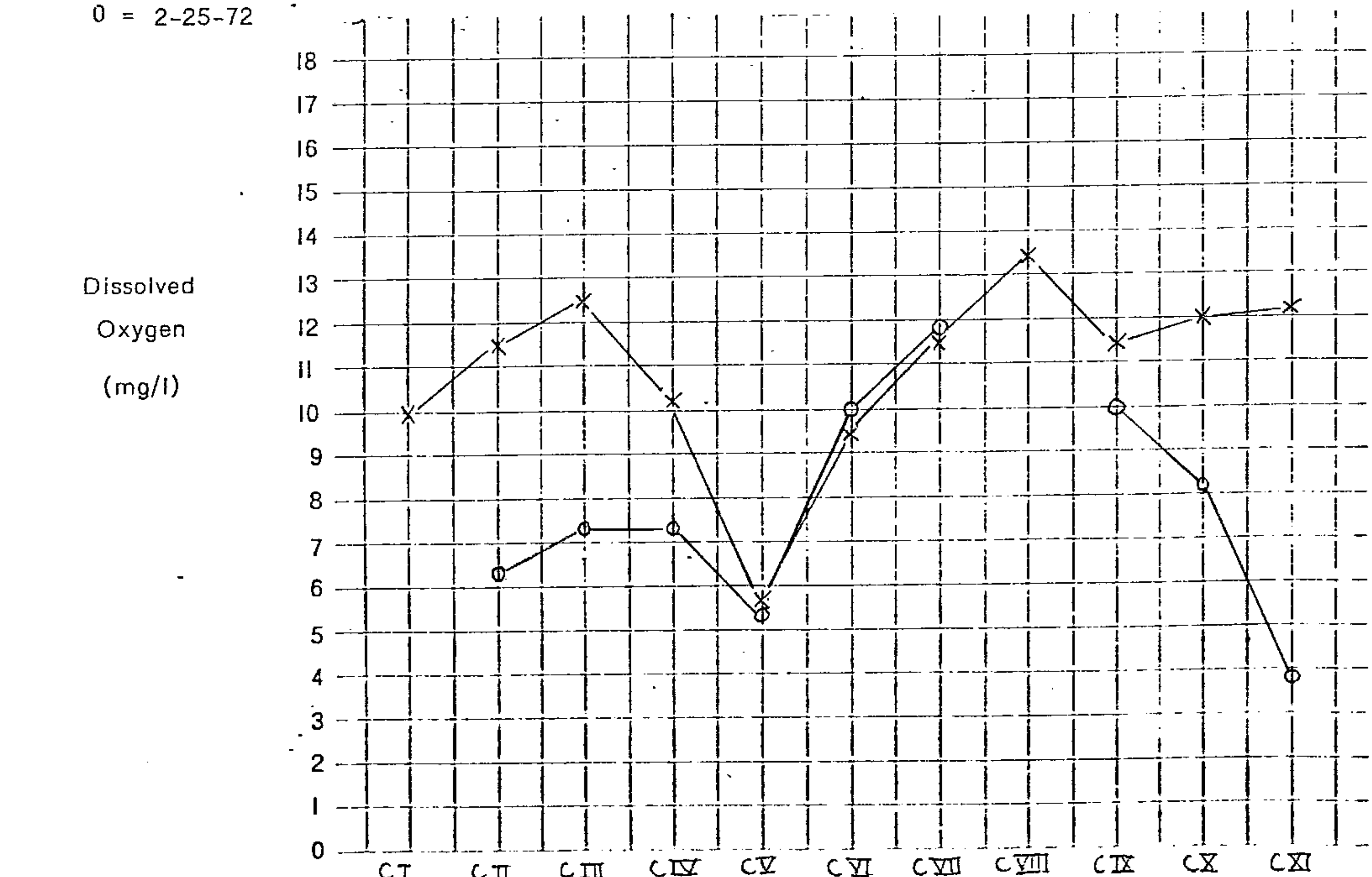




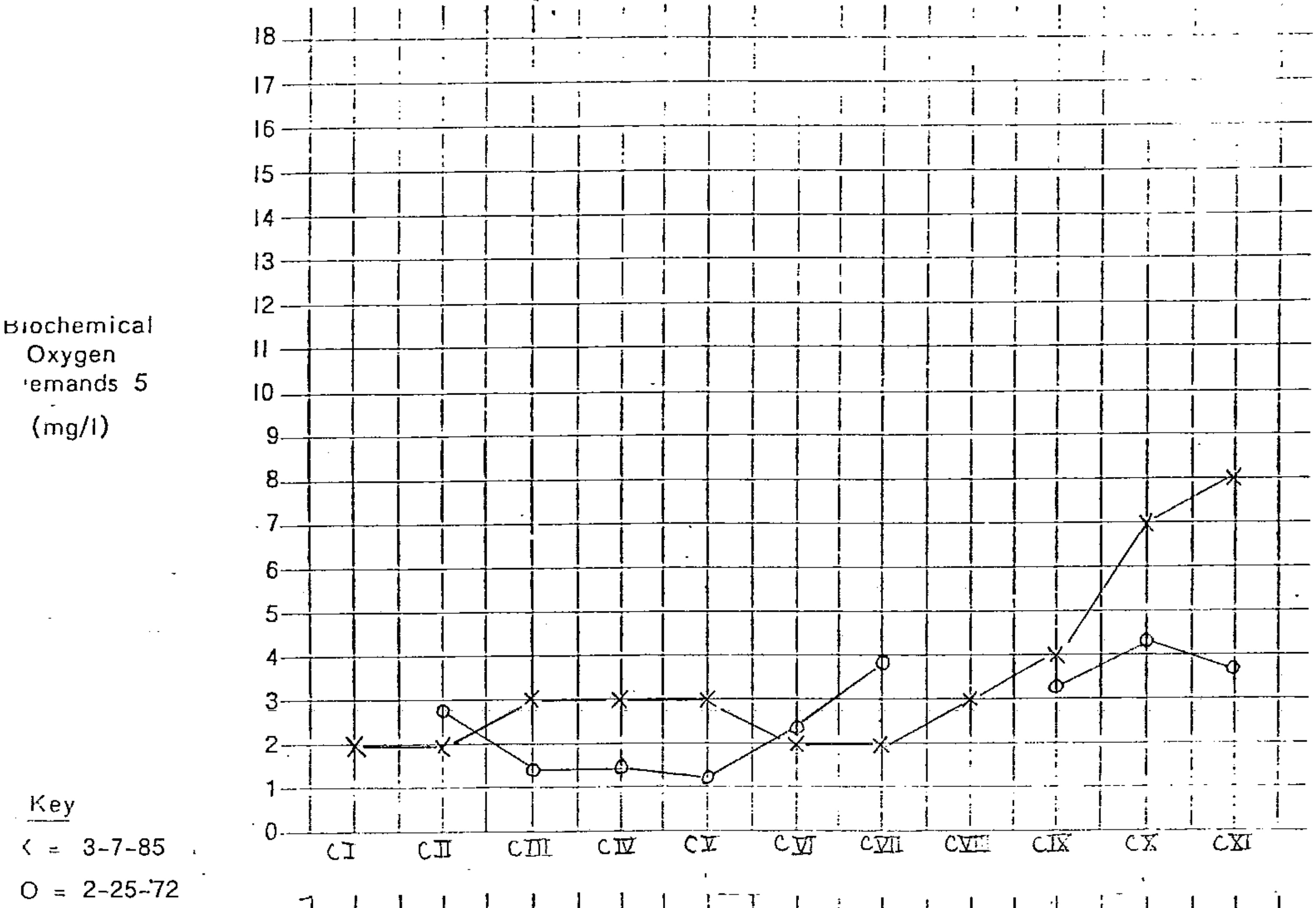
CANNON RIVER

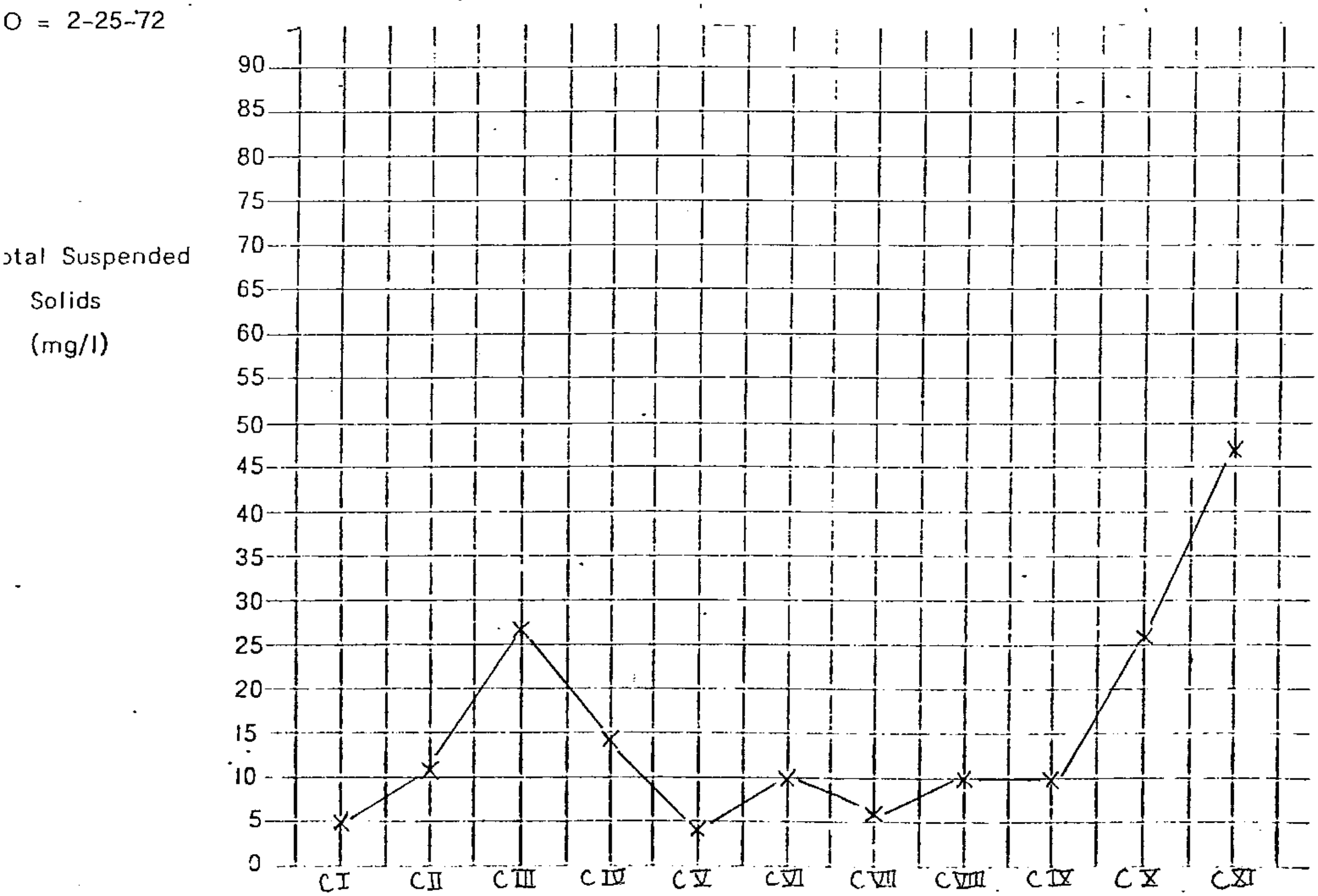


Key
X = 3-7-85
0 = 2-25-72



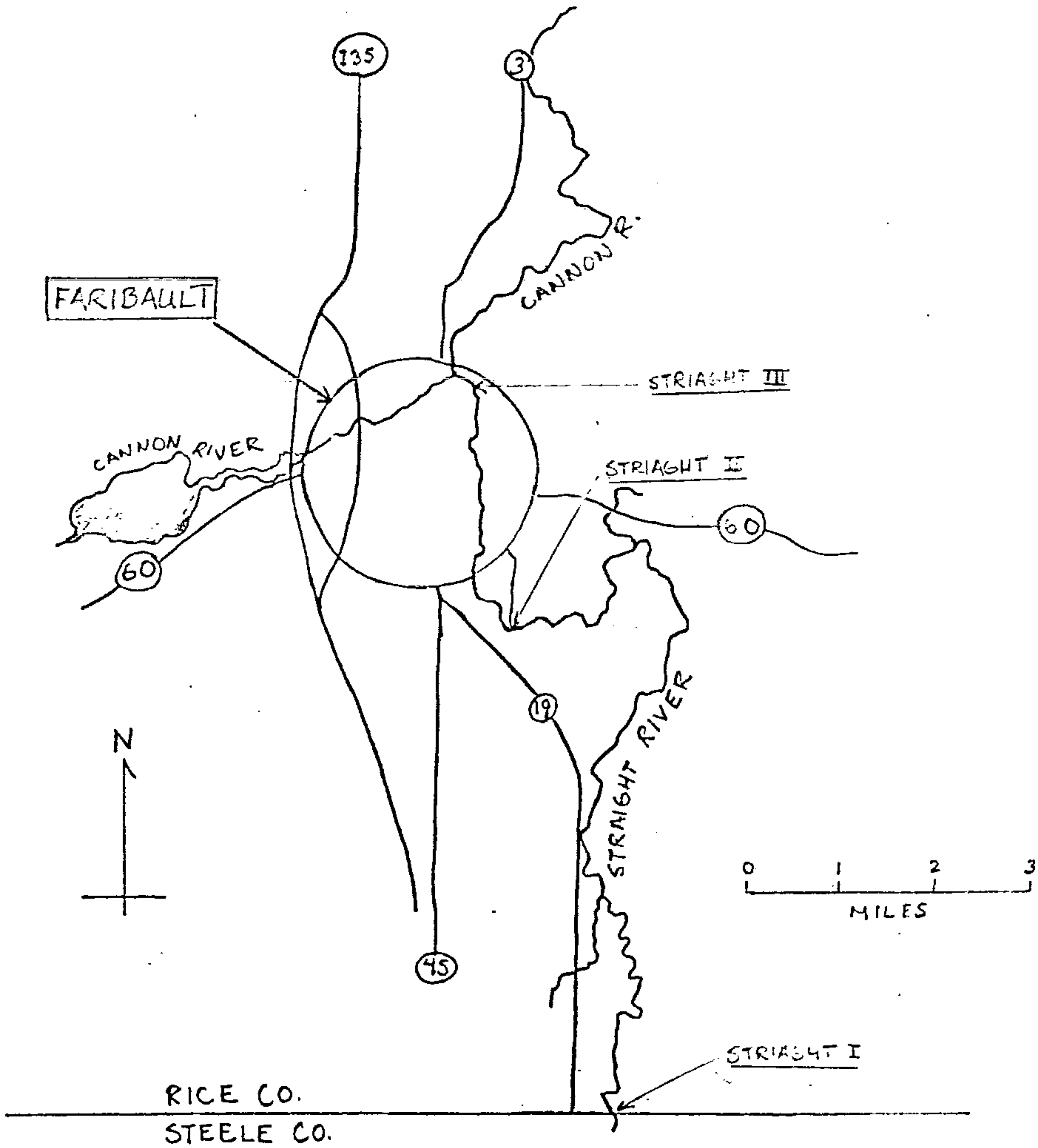
CANNON RIVER





STRAIGHT RIVER

MONITORING POINTS - SI - SIII



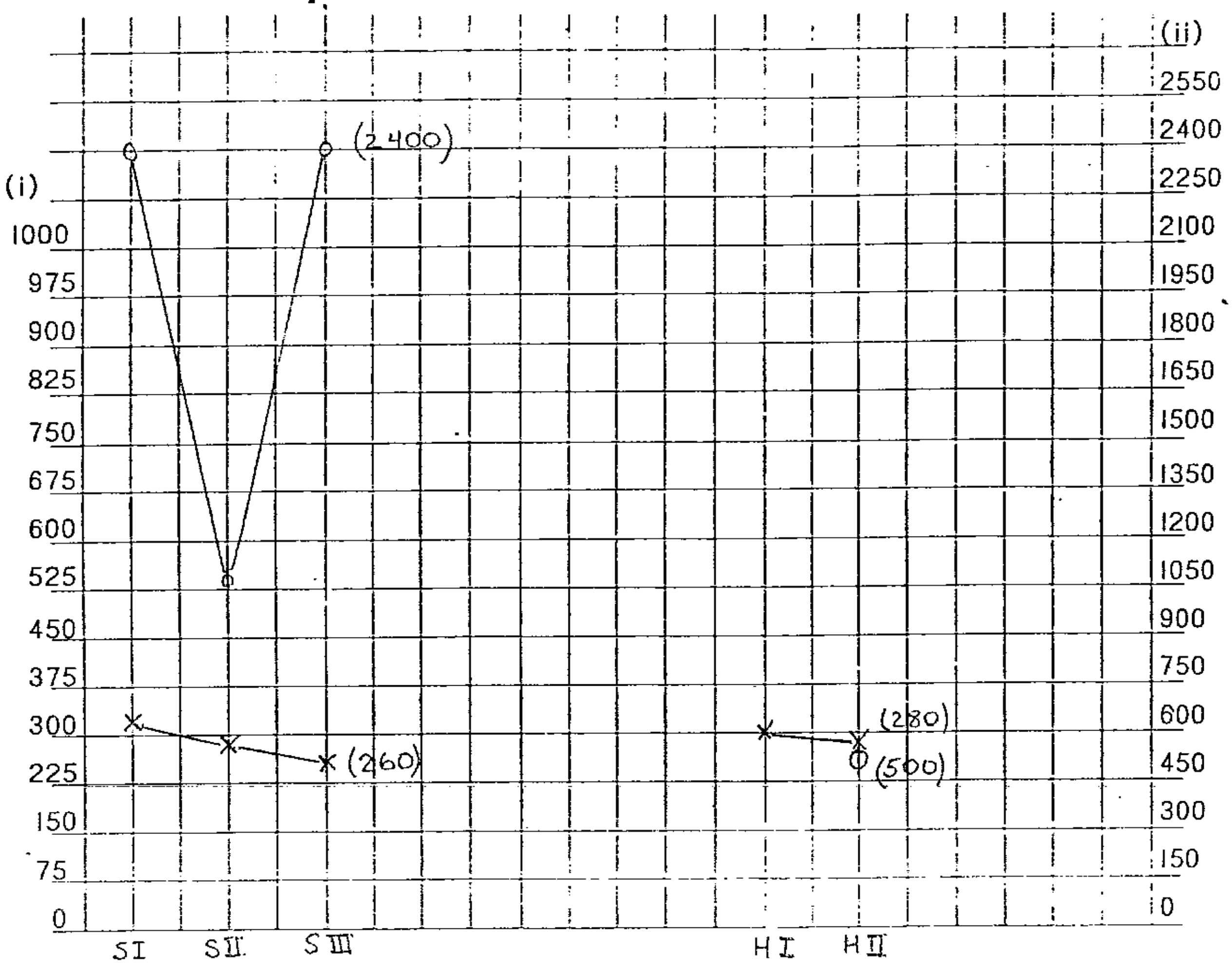
STRAIGHT RIVER

Summary/Conclusions

In it's lower reaches in Rice County, the Straight River showed little improvement in terms of water quality. One reason for this may be that the river's potential to purify itself falters under the burden of upstream pollution. Total phosphorus concentration was one parameter showing improvement in the Straight. Phosphate detergent bans may have contributed to an overall reduction in this plant nutrient and water pollutant.

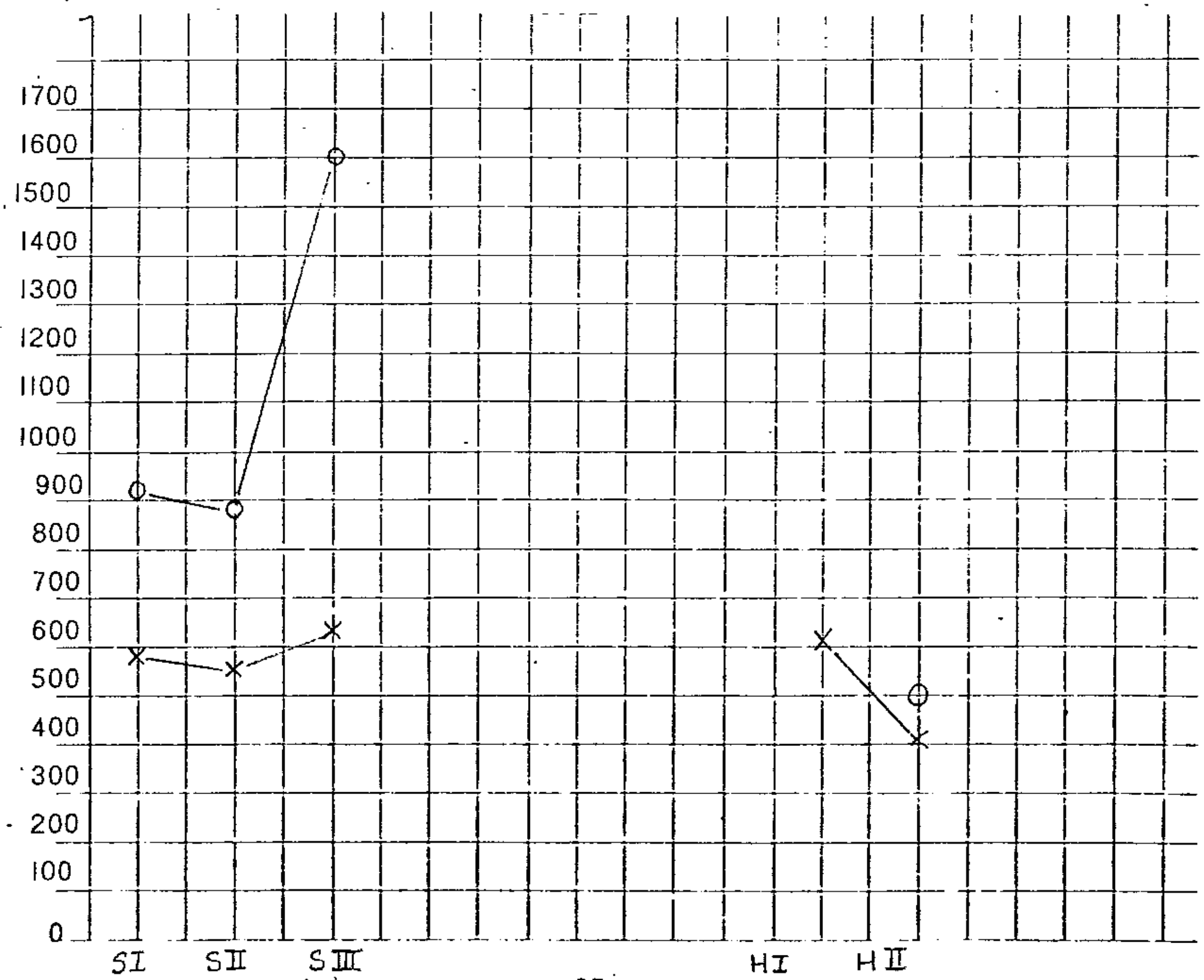
Municipal sewage treatment plants are important sources of fecal coliform bacteria which abound in the Straight. Owatonna, Medford and Faribault are possible sources. Yet, the data seems to indicate that other sources are contributing to this unhealthy condition. Septic systems and animal waste facilities are likely discharging these disease causing organism before the Straight reaches Faribault.

Improving sewage treatment in the Straight River watershed will address the river's worst problems. Fortunately Owatonna is undertaking major improvements at their municipal sewage treatment facility. For our part, identifying and removing human and animal waste discharges along the river would be advisable. Onsite sewage and feedlot programs on the County level should be helpful in reducing this risk to public health. Much of the watershed feeding the Straight is south of Rice County and as such unmanageable. Water planning, if arranged around the Straight watershed, would allow us to promote upland treatment of waters before we have the pleasure of hosting them.

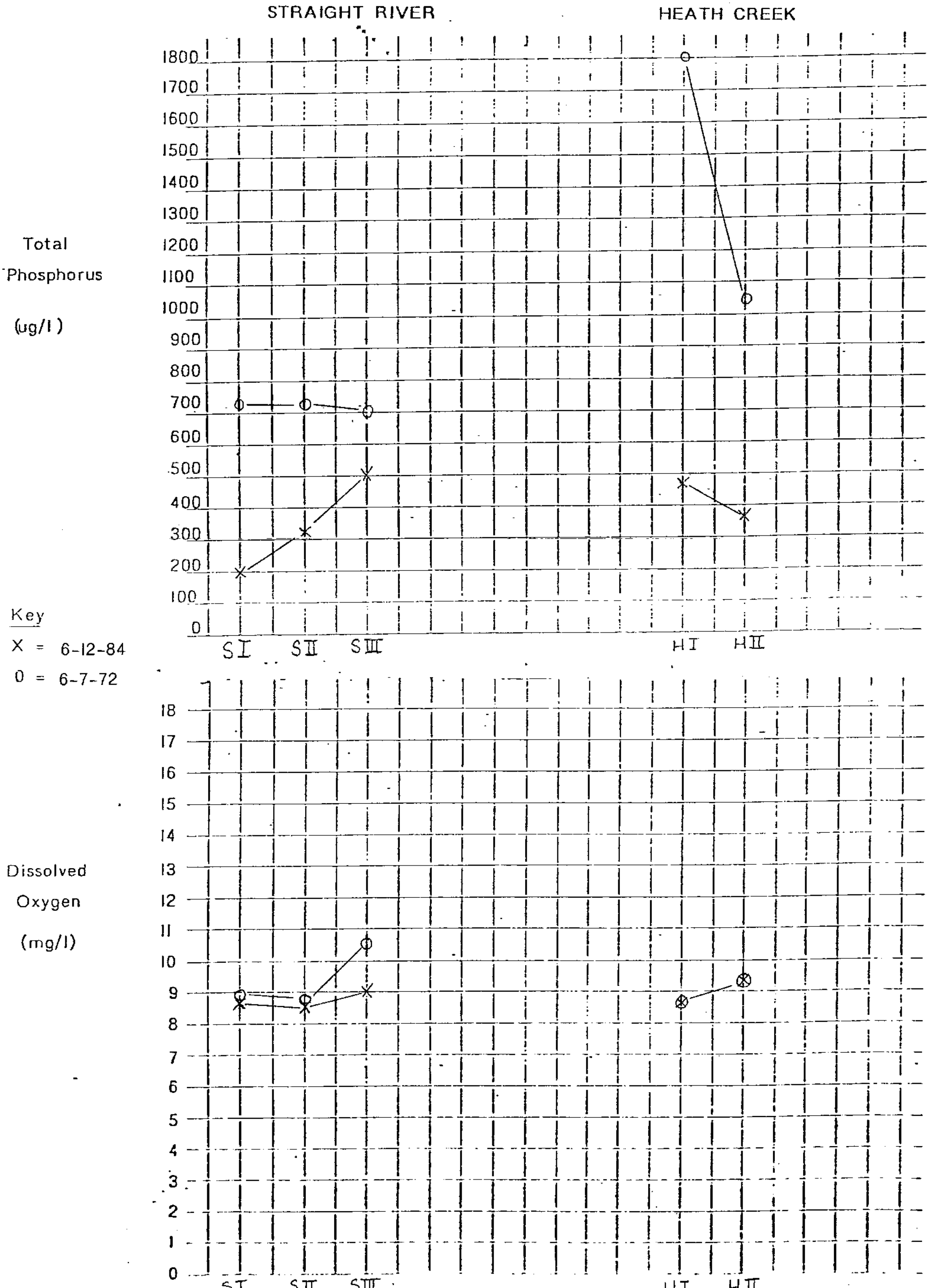


Bacteria
i = MF/100 ml
ii = MPN/100 ml

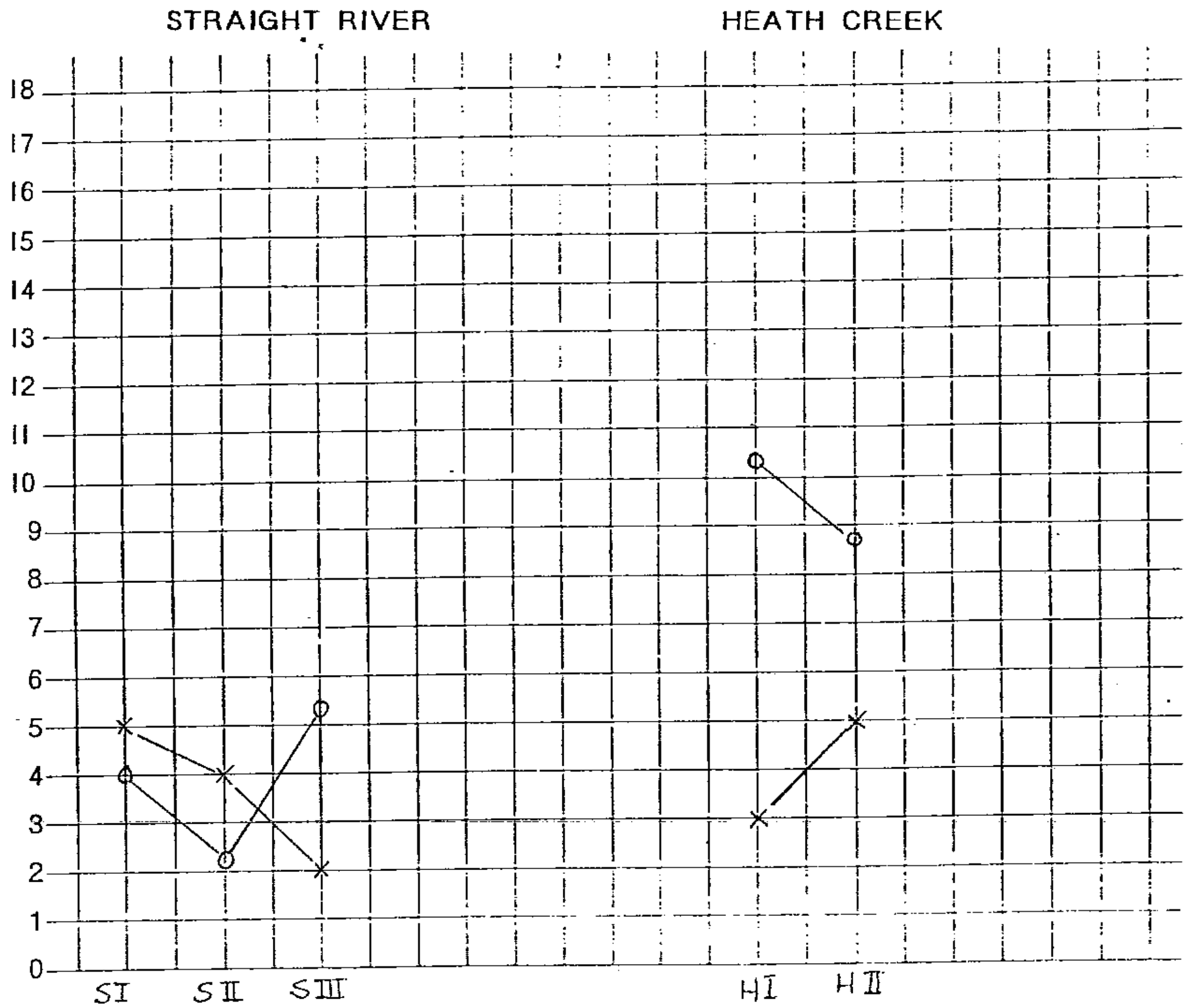
Key
X= 6-12-84
O= 6-7-72



Conductivity
muhos/cm2

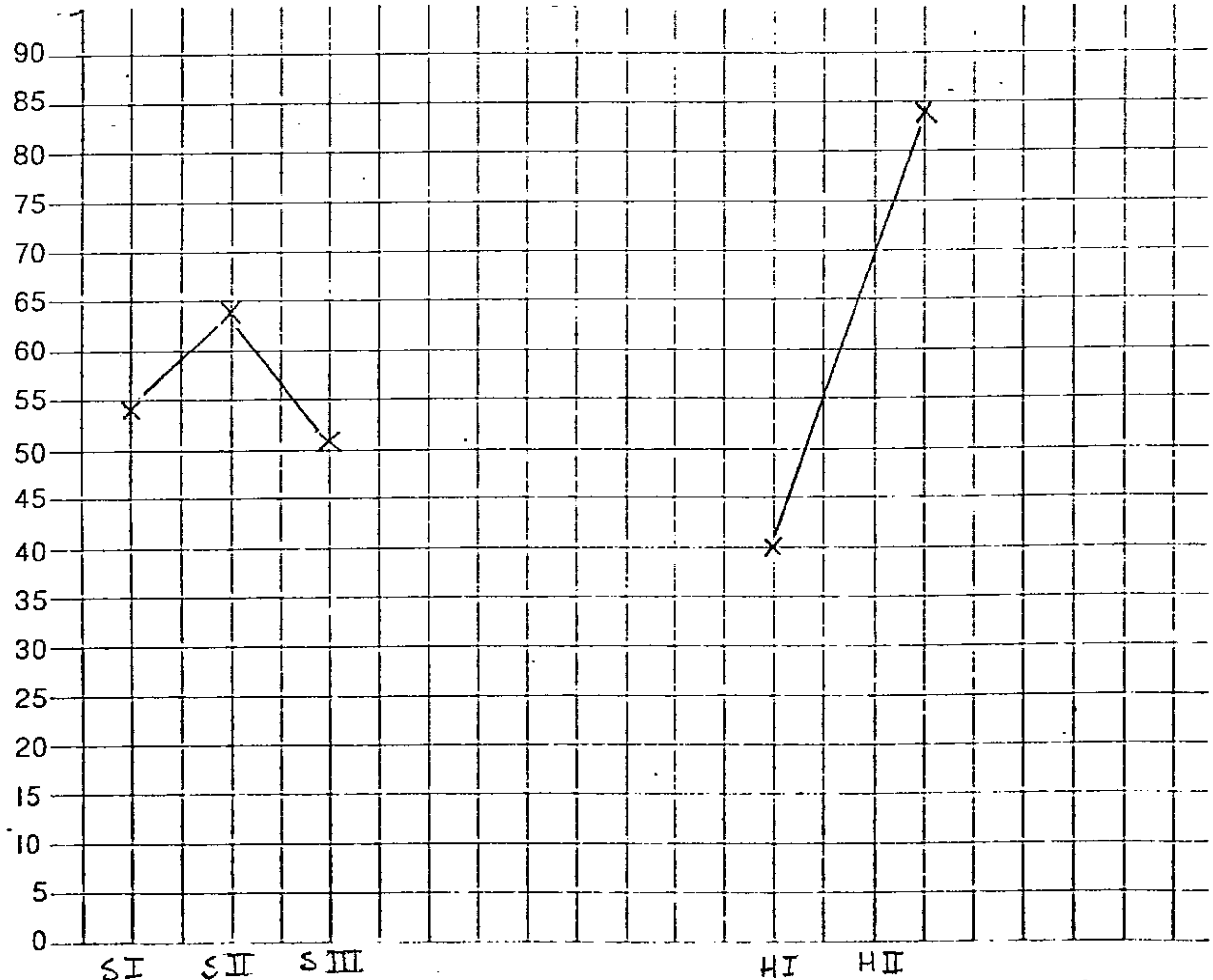

STRAIGHT RIVER
HEATH CREEK
Total Phosphorus (ug/l)
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
SI SII SIII
HI HII
Key
X = 6-12-84
0 = 6-7-72
Dissolved Oxygen (mg/l)
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
SI SII SIII
HI HII

Biochemical Oxygen Demands 5 (mg/l)



Key
X = 6-12-84
O = 6-7-72

Total Suspended Solids (mg/l)



Bacteria

i = MF/100 ml

ii = MPN/100 ml

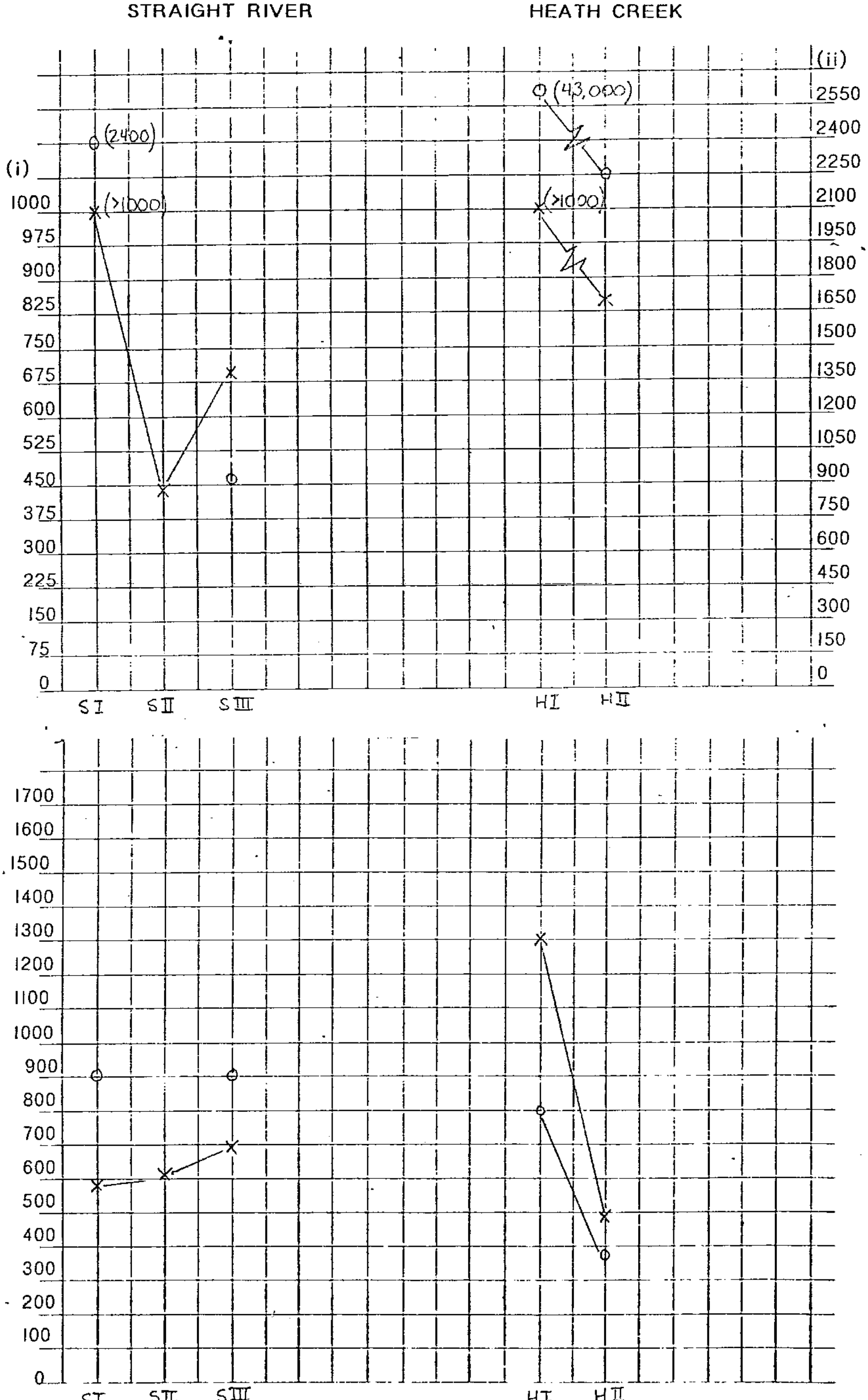
Key

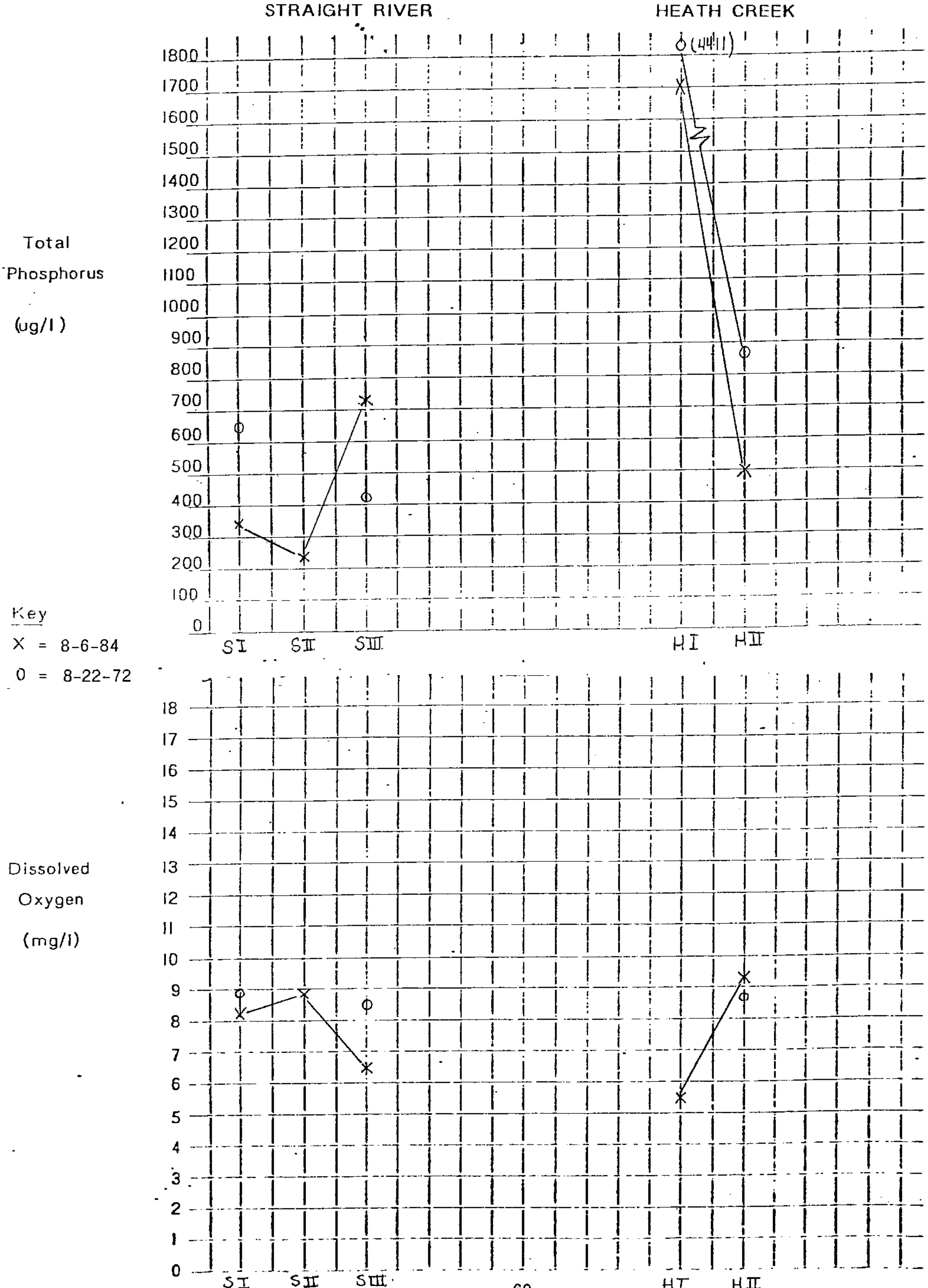
X= 8-6-84

O= 8-22-72

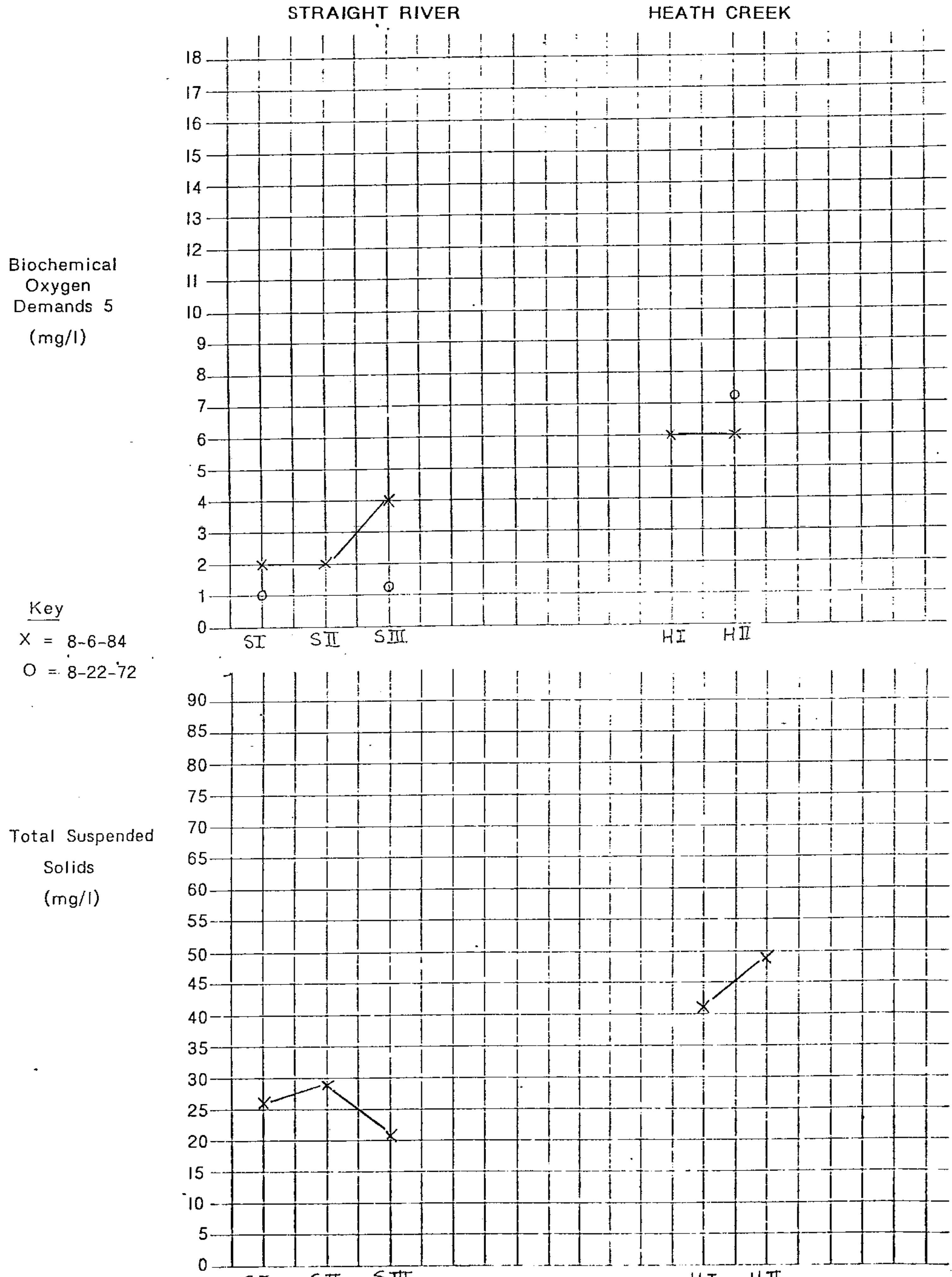
Conductivity

muhos/cm2

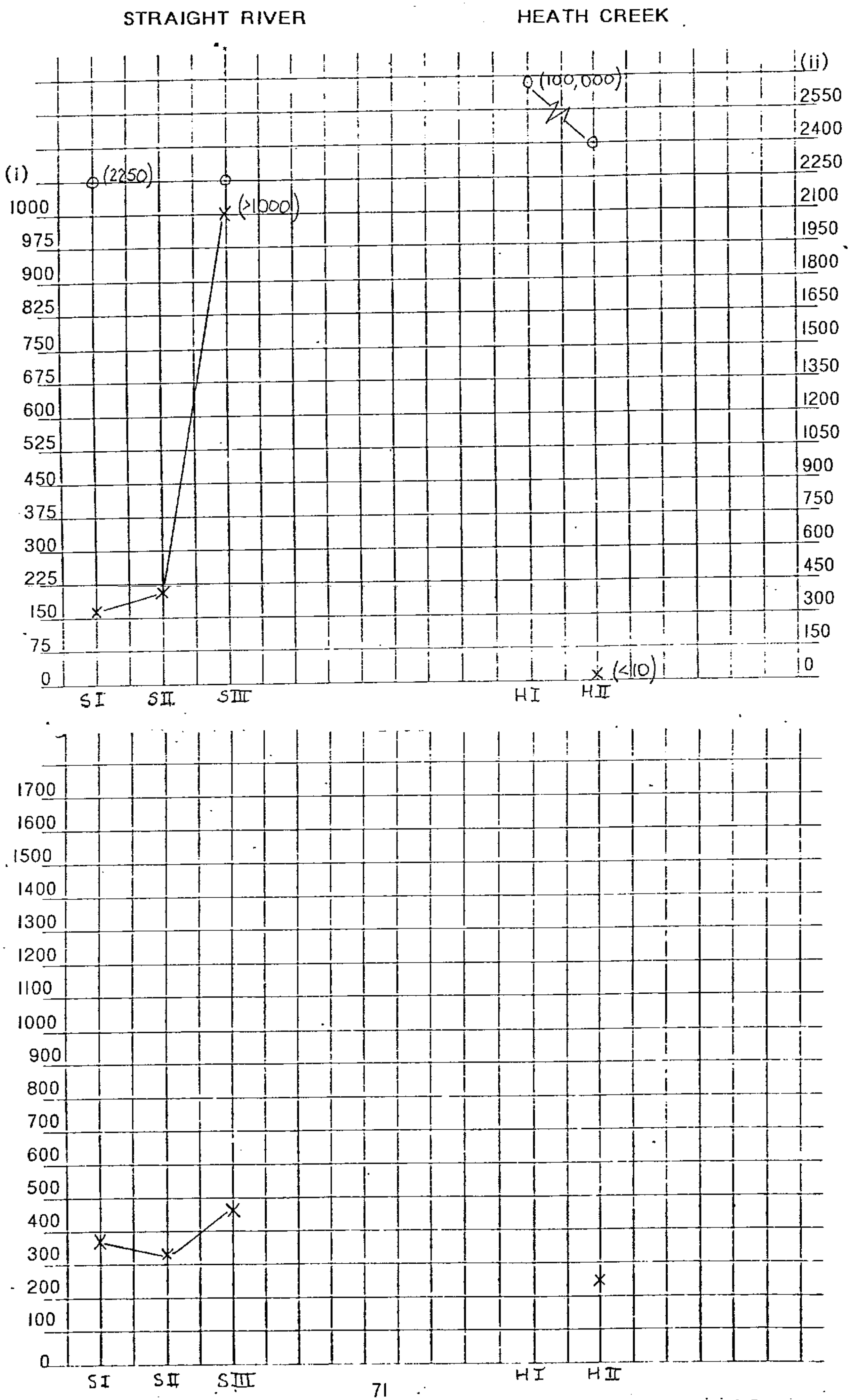




STRAIGHT RIVER
HEATH CREEK
Total Phosphorus (ug/l)
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
(4411)
SI SII SIII
HI HII
Key
X = 8-6-84
0 = 8-22-72
Dissolved Oxygen (mg/l)
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
SI SII SIII
HI HII



STRAIGHT RIVER
HEATH CREEK
Biochemical Oxygen Demands 5 (mg/l)
Key
X = 8-6-84
O = 8-22-72
Total Suspended Solids (mg/l)
SI
SII
SIII
HI
HII



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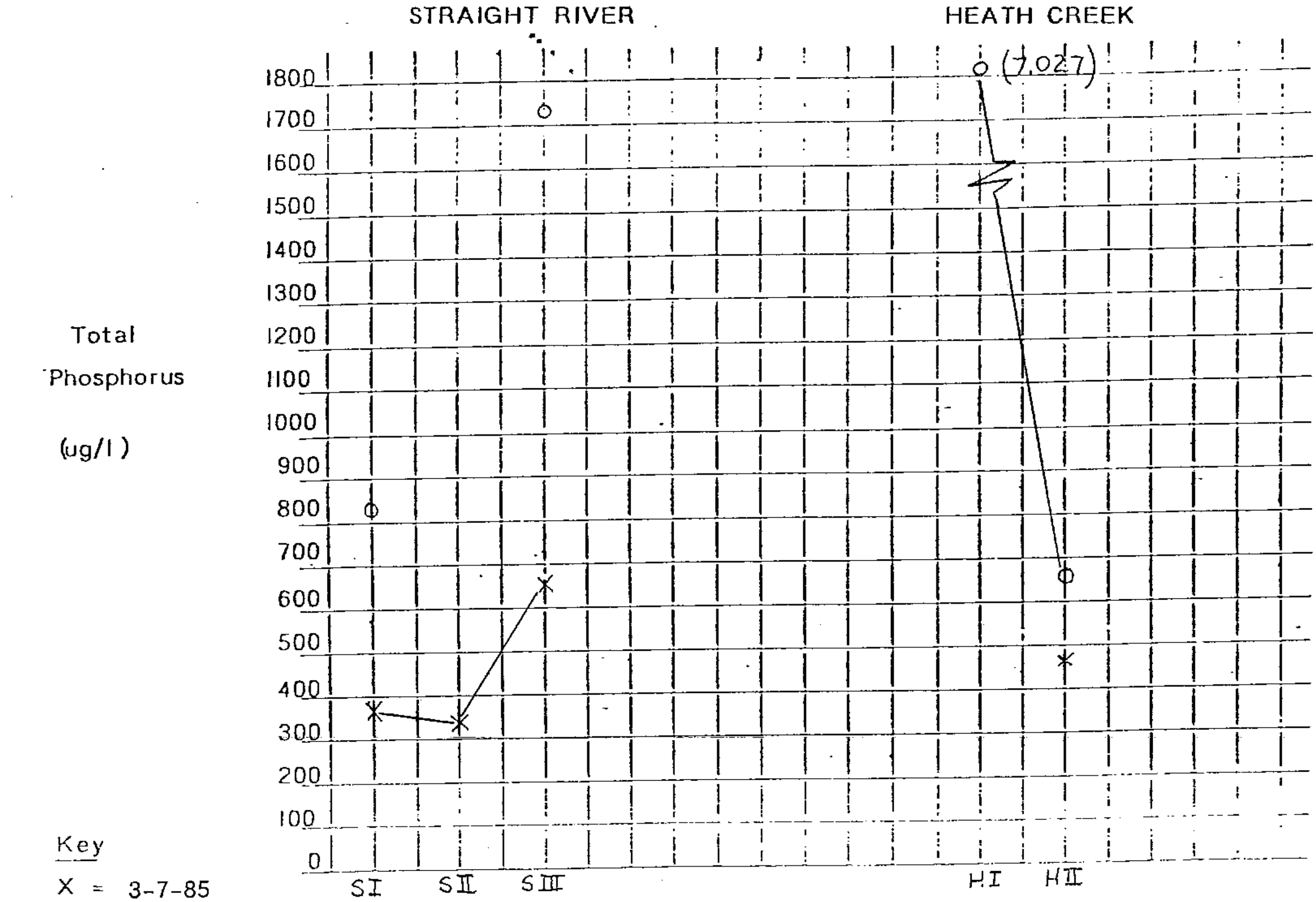

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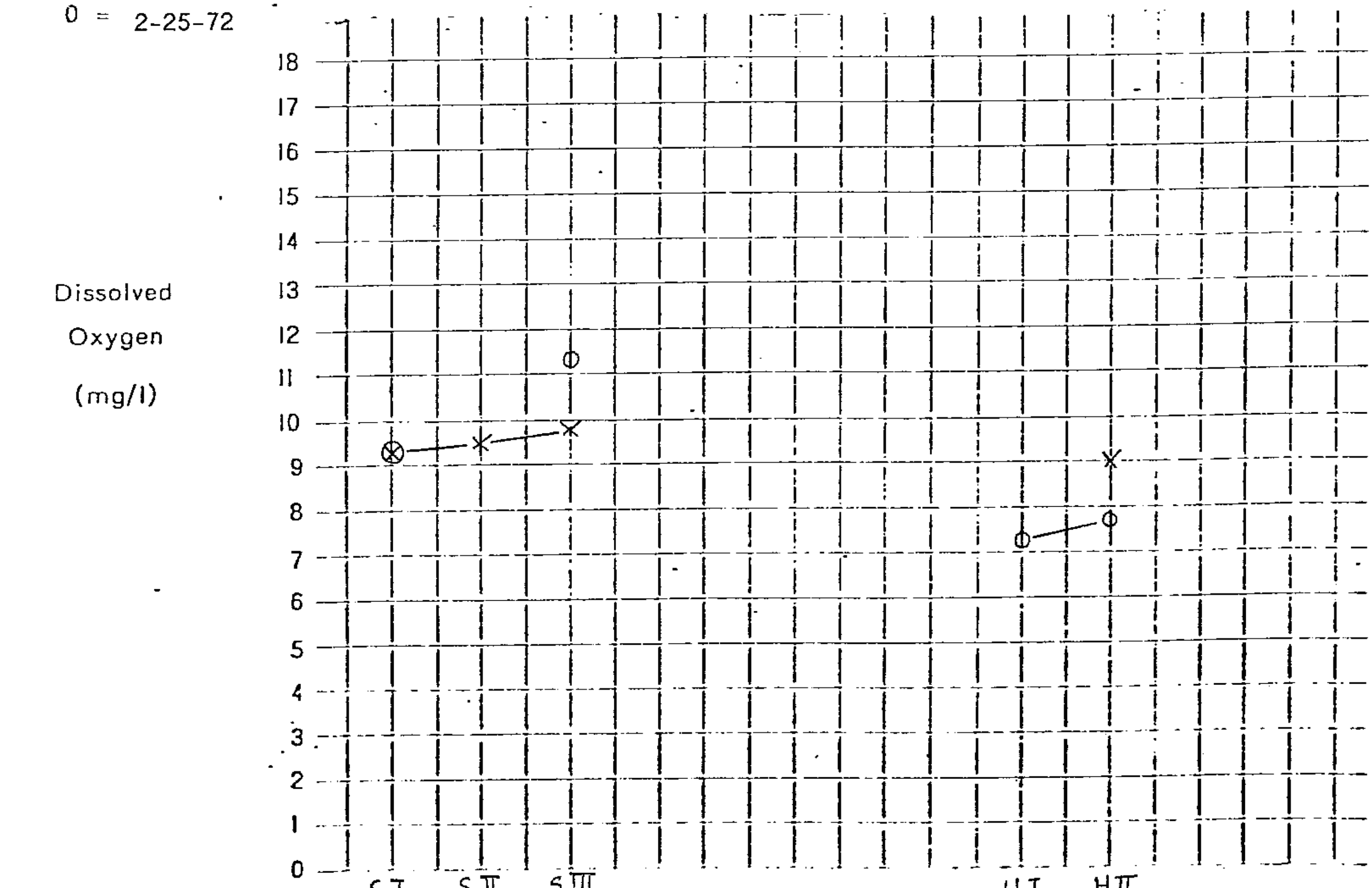
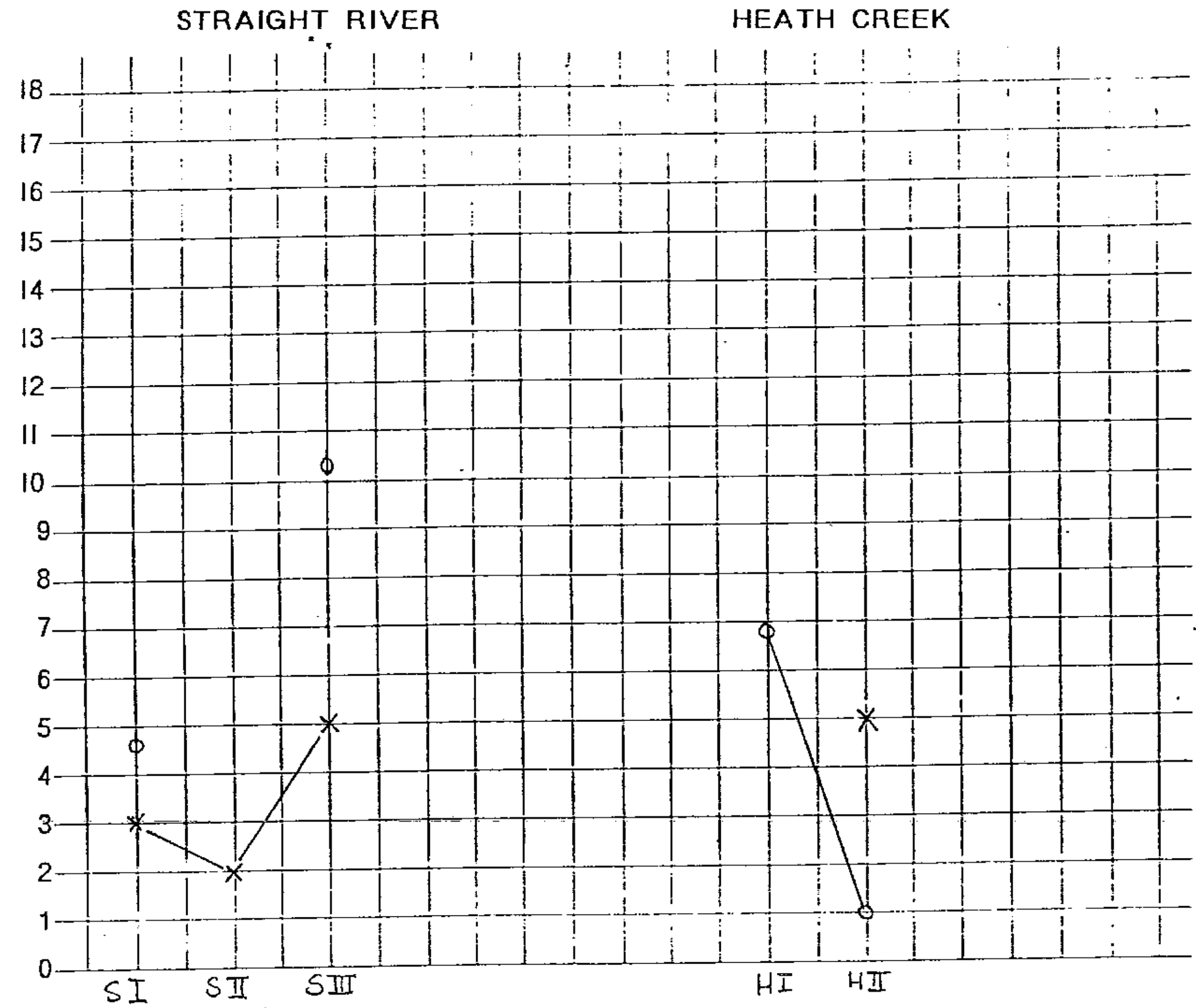


Biochemical Oxygen Demands 5 (mg/l)



Key
X = 3-7-85
O = 2-25-72

Total Suspended Solids (mg/l)