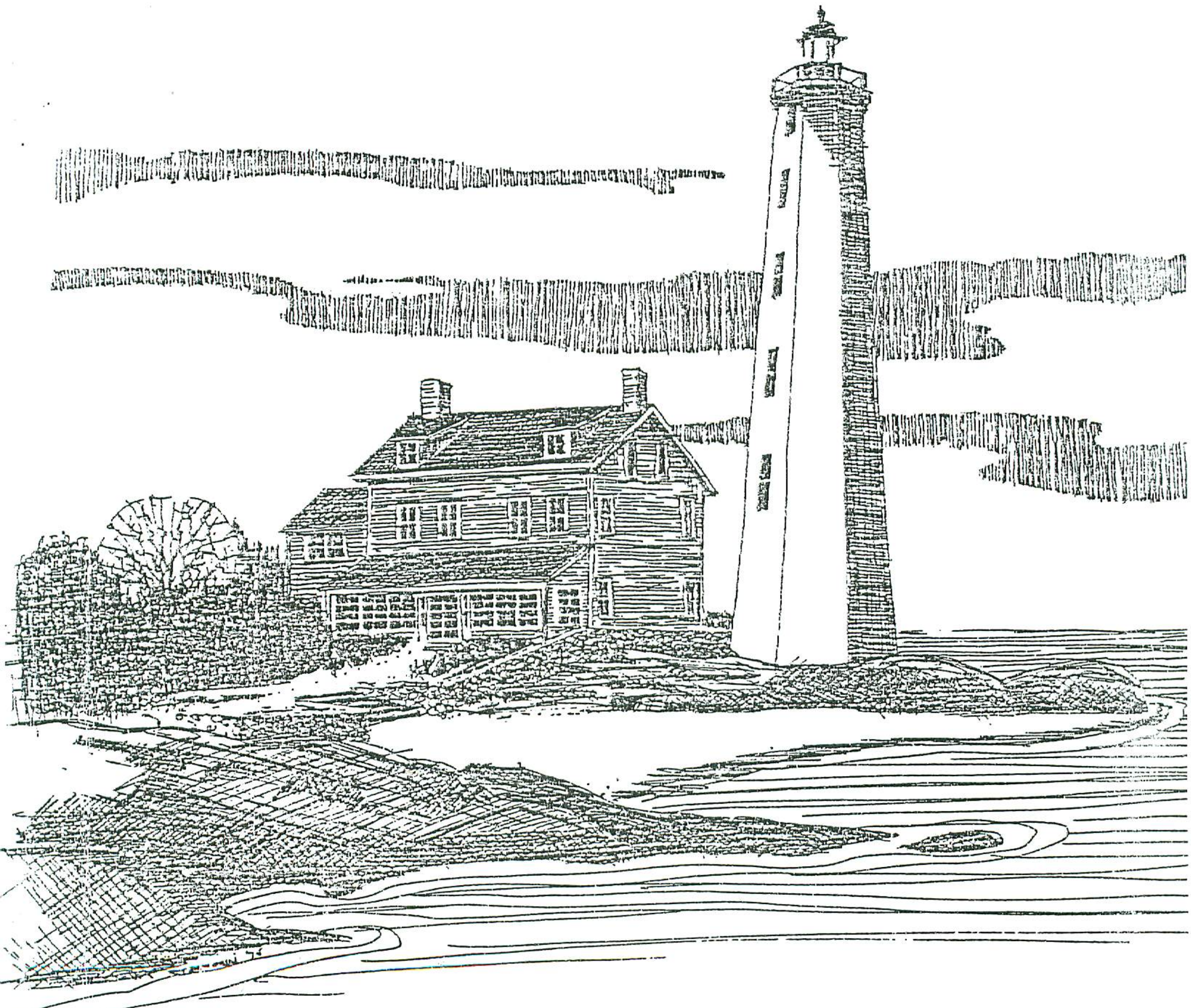
# WHITE ISLAND POND



## WATER QUALITY STUDY 1976 - 1978

massachusetts department of environmental quality engineering

DIVISION OF WATER POLLUTION CONTROL

thomas c. mcmahon, director

# WHITE ISLAND POND

# WATER QUALITY STUDY

AUGUST 1976 - MAY 1978

GAYLE E. WHITTAKER
ASSISTANT SANITARY ENGINEER

WATER QUALITY AND RESEARCH SECTION

MASSACHUSETTS DIVISION OF WATER POLLUTION CONTROL

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

## INTRODUCTION

White Island Pond is located in a region of southeastern Massachusetts known as the "Gateway to Cape Cod." Tourism comprises the major portion of the area's economy. Lakes such as White Island Pond offer great recreational opportunities not only for local residents but for the many visitors who vacation in this region. The beautiful lakes of southeastern Massachusetts, especially those located on Cape Cod, are valuable resources and therefore, merit further study and preservation.

The following report documents the intensive water quality study of White Island Pond conducted by the Division of Water Pollution Control from August 1976 to May 1978. The objectives of this intensive survey were as follows:

1. To estimate and to characterize the lake's trophic level and limnology;

2. To collect data for the state's lake classification and restoration/preservation program in fulfilling the requirements of Section 314, PL92-500, of the Federal Water Pollution Control Act, and amended under PL95-217;

3. To meet the public demand for attention to lake problems; and

4. To provide diagnostic data as a preliminary requirement for lake restoration/preservation.

# GENERAL INFORMATION

## Lake Description

White Island Pond, located in Plymouth County, has its approximate center at latitude 41° 48' 0" and longitude 70° 37' 30". The majority of the lake and its watershed lie in the Town of Plymouth with the remainder lying in the Town of Wareham. The lake, an enlarged Great Pond of 284 acres (115 ha), is part of the Buzzards Bay drainage system (see Appendix A).

The morphometry of White Island Pond divides the lake into two basins (see Figure 1). These basins are designated in this report as the eastern and western basins, respectively. The inlets and outlet are all located around the eastern basin. There are two major inlets with at least two other irrigation ditches which flow through cranberry bogs before entering the lake. The outlet leaves the lake from the southern end of the eastern basin, flows through a cranberry bog and becomes Red Brook which drains into Buttermilk Bay, a part of Buzzards Bay. Both the inlets and outlet are regulated by control structures owned by A.D. Makepeace Company.

According to the Massachusetts Water Quality Standards[1], White Island Pond is classified as a Class B water. This designation signifies that the lake can be utilized for both primary and secondary contact recreation. Specifically, primary contact refers to recreational activities such as swimming and water skiing. Examples of secondary contact are fishing and boating.

## Lake Uses

Since the early 1900's, White Island Pond has been utilized as a water supply for flooding and irrigating the surrounding cranberry bogs. The shoreline in the early 1900's was sparsely settled, but by the 1930's, however, there were many cottages lining the shore of the western basin. In the 1950's, the western basin was described by the Massachusetts Division of Fisheries and Game (MDFG) as densely settled. The local residents have always utilized the lake for fishing, boating, and swimming.

White Island Pond was stocked by the Massachusetts Division of Fisheries and Game from 1939 to 1953 with smallmouth black bass, bluegills, bullheads, white perch, yellow perch, and crappies. Other fish species found in the lake include golden shiners, bridled shiners, pumpkinseeds and banded killifish. Management has specifically dealt with the smallmouth black bass, white perch and herring populations. The herring are

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[1] Massachusetts Division of Water Pollution Control. 1978. Massachusetts Water Quality Standards. Boston, Massachusetts.

# WHITE ISLAND POND
## GENERAL WATERSHED (1.9 SQ. MI.)

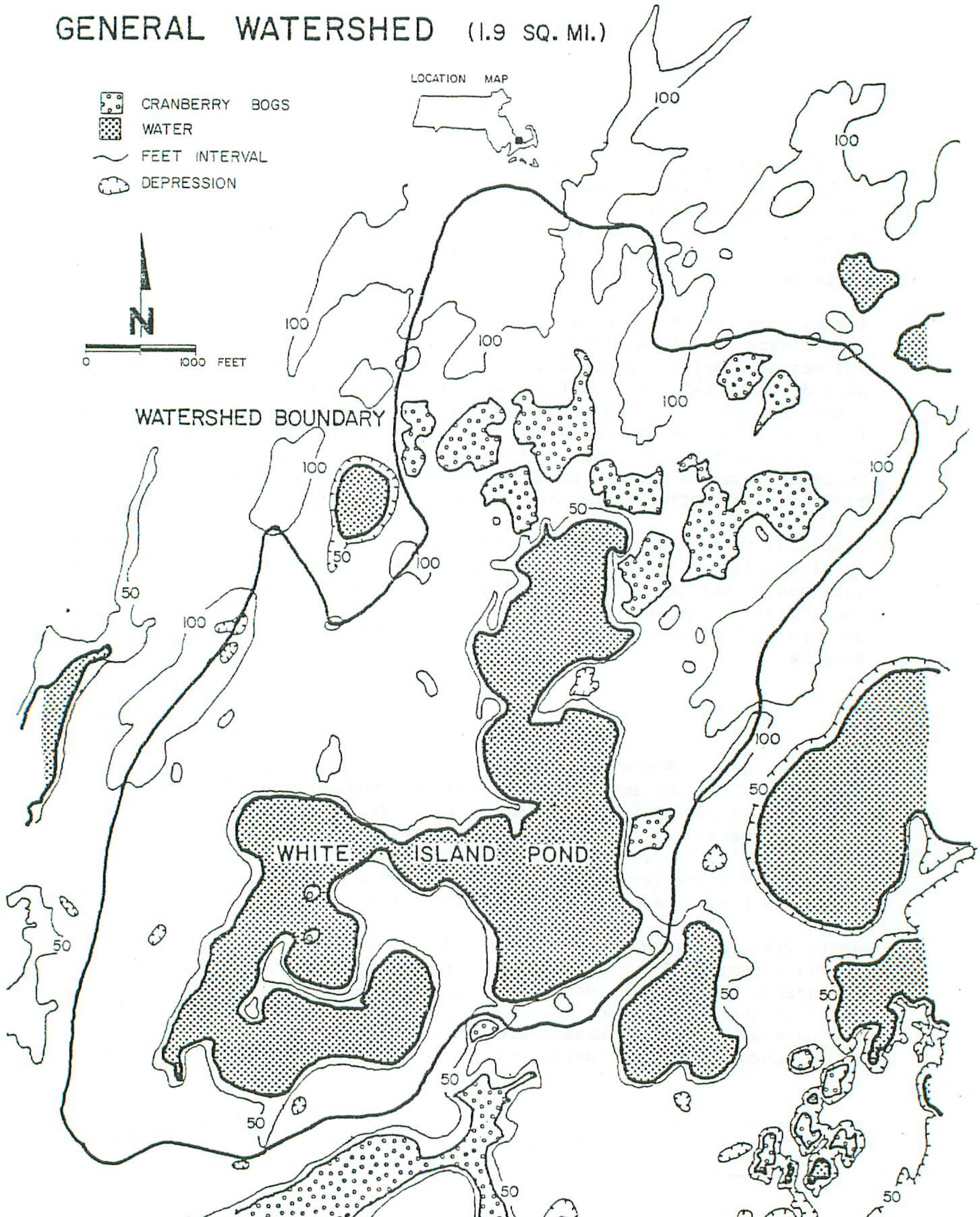


FIGURE I

a special case because they are an anadromous species. That is, a species of fish which spends the majority of its life history at sea but returns to freshwater to spawn. Those in control of the outlet, therefore, must regulate the flow so as to allow the herring to enter and exit from the lake.

Present day uses of White Island Pond include fishing, boating, and swimming. There are several private beaches along the shoreline, particularly in the western basin. Besides the above usages, the lake remains a water source for flooding and irrigating the cranberry bogs.

White Island Pond is utilized to the same extent as other lakes and ponds within a 50-mile radius. This includes not only recreational activities, but the provision of a water supply for adjacent cranberry production. Although White Island Pond has uses similar to other lakes in the surrounding area, its extensive surface area makes it more attractive to the public.

## Lake Degradation

Degradation of the lake water quality has manifested itself mainly in the form of algal blooms. These blooms have affected the water color turning it green in coloration. Other observed effects include unpleasant odors and occasional fish kills. Another problem present in White Island is dense growths of aquatic macrophytes in the northern bay of the eastern basin.

Other complaints from the lake residents are low water levels and possible insecticide, herbicide and/or fertilizer contamination from the cranberry bogs. The suspicions of these types of contamination have not been substantiated in most cases. However, in the early 1950's, there were known problems with the use of rotenone as an insecticide on the bogs. Its application by plane allowed some to drift into the lake which resulted in localized fish kills. Usage of this particular insecticide has been discontinued by the cranberry industry since the mid to late 1950's.

The impact of the lake degradation on the local residents is twofold. The algal blooms result in limited recreational usage because of the offensive nature of the water during a bloom. Additionally, the dense growth of aquatic macrophytes in the northern bay of the eastern basin limits boating. However, the population utilizing this area is comparatively small in relation to the rest of the pond. Also, the majority of the pond has limited macrophytes and is available for boating.

## Lake Management

No organized efforts have been made to treat the lake for either the nuisance algal blooms or the aquatic macrophyte problem. However, the White Island Pond Association[1] believes that in recent years some residents of the lake

[1] An organization of concerned White Island Pond residents. There are two other associations also involved with White Island Pond.

have privately applied copper sulfate to control the algal blooms (Fisher, 1979).

Section 208 of the Federal Water Pollution Control Act of 1972 is an area-wide study of water quality problems, specifically, dealing with non-point source problems, point source problems, land use, urban runoff, and industrial problems. The 208 program developed by the Southeastern Regional Planning and Economic Development District (SRPEDD) suggested several general watershed management practices which could improve the water quality of White Island Pond (SRPEDD, 1978). Although point sources of pollution are lacking within the watershed, two potential non-point sources exist. These non-point sources are related to cranberry-growing and subsurface sewage disposal. The main recommendations concerning cranberry-growing were as follows:

1. Slow release of flood water to prevent erosion and sedimentation and the excess scouring of ditches and canals;

2. Design of sprinkler systems to include semi-circle heads to avoid sprinkling in non-bog areas;

3. Aerial spraying of pesticides only when application by irrigation is not possible, and when the wind speed is less than 7 mph, preferably at dusk;

4. Reliance on sanding and flooding to control pests whenever possible; and

5. Use of biodegradable pesticides rather than persistent ones.

6. Application of pesticides only after the infestation level is serious to warrant treatment.

The major recommendation concerning subsurface sewage disposal called for a maintenance program which entails the inspection and pumping of all septic systems every three years. SRPEDD believes that in septic pollution the septic system design is a minor problem whereas poor septic system maintenance is the major problem.

## WATERSHED

### Morphometry

White Island Pond has a surface area of 284 acres (115 ha) and a total volume of 1,600 acre feet ($2.0 \times 10^6$ $m^3$). The lake has a drainage area of 1,216 acres or 1.9 square miles (492 ha). The length of the shoreline measures 33,000 feet (10,065 m) and the development of the shoreline is 2.6, which means its shape is highly irregular.

The eastern basin is larger (159 acres, 64 ha), than the western basin (125 acres, 51 ha). The surface area of the eastern basin is only 25% larger than the surface area of the western basin, however, the volume of the eastern basin is twice the volume of the western basin. The eastern basin has a maximum depth of 15 feet (4.6 m), a mean depth of 6.7 feet (2.0 m) and a volume of 1,067 acre feet ($1.3 \times 10^6$ $m^3$). The western basin has a maximum depth of 14 feet (4.3 m), a mean depth of 4.2 feet (1.3 m) and a volume of 533 acre feet ($6.5 \times 10^5$ $m^3$). It should be kept in mind that the water level is controlled by flow structures at both the inlets and outlet. A complete listing of morphometric data for White Island Pond can be found in Table 1.

### Sampling Station

A bathymetric map of White Island Pond is presented in Figure 2. The location of the sampling stations for this study are marked on the bathymetric map. Stations 1, 2, and 3 were the deep water stations with Stations 1 and 2 located in the eastern basin and Station 3 located in the western basin. "White Island Bogs" inlet was designated as Station 4 and "Ware Bogs" inlet was labelled as Station 5. The outlet was denoted as Station 6.

### Public Access and Transportation

According to the Massachusetts Division of Fisheries and Wildlife there was once a boat livery in the western basin which was accessible to the public. Evidence of its existence today could not be found; in fact there appears to be no formal public access to White Island Pond. The main transportation to the lake is via automobile. The lake's close proximity to several major routes makes it readily available to a large number of people. Two of these routes are U.S. Route 6 and State Route 25. White Island Pond itself is serviced by both paved and dirt roads.

TABLE 1

WHITE ISLAND POND STUDY

MORPHOMETRIC DATA[1]

| | EAST BASIN | WEST BASIN | TOTAL |
|---|---|---|---|
| Maximum Length | 4,182 feet (1,275 m) | 3,636 feet (1,109 M) | --- |
| Maximum Effective Length | 4,182 feet (1,275 m) | 3,636 feet (1,109 m) | --- |
| Maximum Width | 2,500 feet (762 m) | 1,773 feet (541 m) | --- |
| Maximum Effective Width | 2,500 feet (762 m) | 1,773 feet (541 m) | --- |
| Maximum Depth | 15 feet (4.6 m) | 14 feet (4.3 m) | 15 feet (4.6 m) |
| Mean Depth | 6.7 feet (2.0 m) | 4.2 feet (1.3 m) | 5.6 feet (1.7 m) |
| Mean Width | 1,652 feet (504 m) | 150 feet (46 m) | --- |
| Area | 159 acres (64 ha) | 125 acres (51 ha) | 284 acres (115 ha) |
| Volume | 1,067 acre feet ($1.3 \times 10^6$ $m^3$) | 533 acre feet ($6.5 \times 10^5$ $m^3$) | 1,600 acre feet ($2.0 \times 10^6$ $m^3$) |
| Shoreline | 17,000 feet (5,185 m) | 16,000 feet (4,880 m) | 33,000 feet (10,065 m) |
| Development of Shoreline | 1.8 | 1.9 | 2.6 |
| Mean to Maximum Depth Ratio | 0.4 | 0.3 | --- |
| Drainage Area | -- | -- | 1.9 sq. mi (492 ha) |

[1]Morphometric data calculated from Sagamore, Massachusetts quadrangle (1967) and Wareham, Massachusetts quadrangle (1957) USGS topographic maps (7.5 minute series).

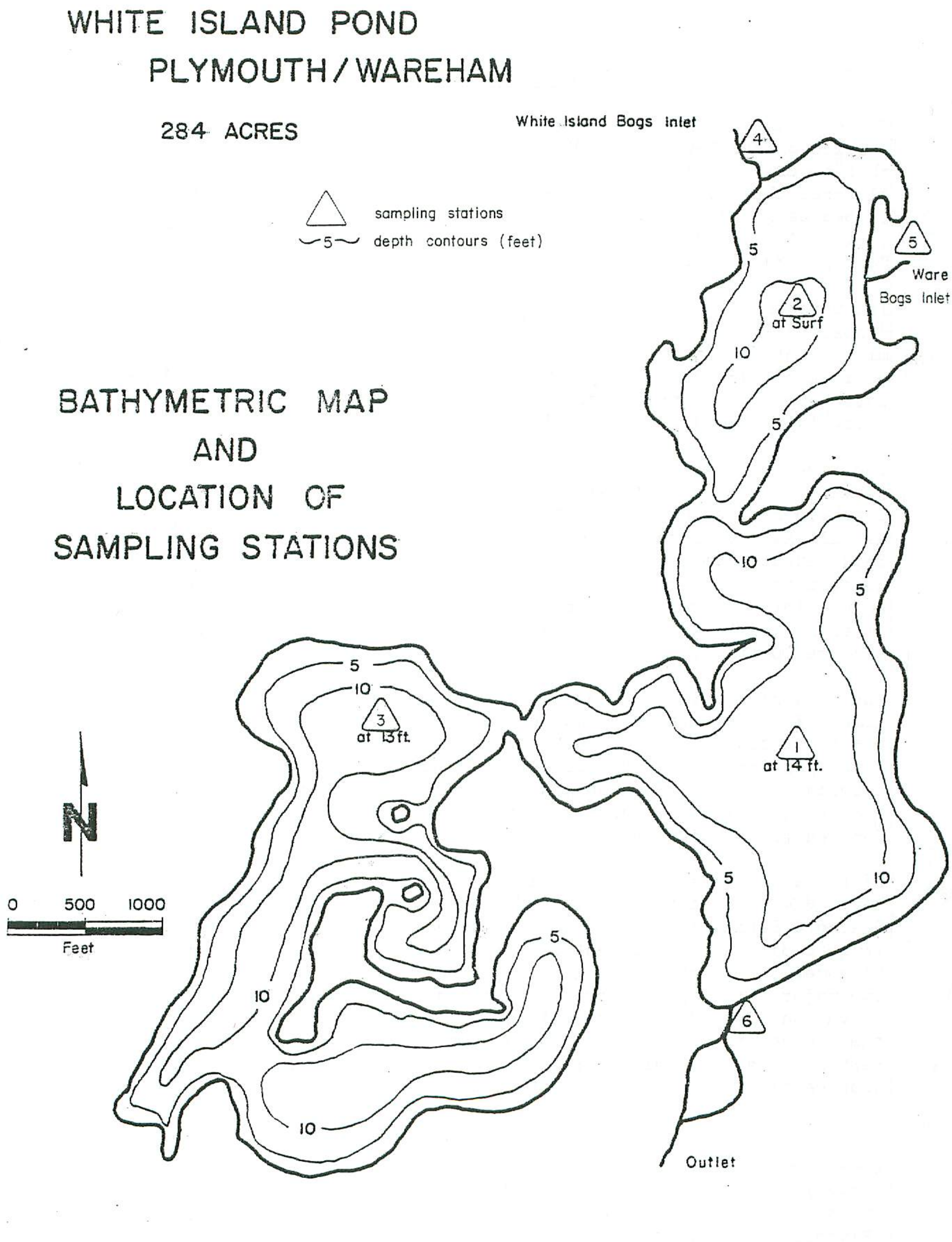
WHITE ISLAND POND
PLYMOUTH / WAREHAM
284 ACRES
BATHYMETRIC MAP
AND
LOCATION OF
SAMPLING STATIONS
sampling stations
5 depth contours (feet)
White Island Bogs Inlet
Ware Bogs Inlet
at Surf
at 13ft.
at 14 ft.
Outlet
N
0 500 1000
Feet

FIGURE 2

## Geology and Soil Types[1]

White Island Pond and its watershed lie within the Coastal Lowland section of the New England Physiographic Province. Glacial movements that occurred during the Late Wisconsin Stage of glaciation have influenced the topography of the region. The topography can best be described as gently rolling. The elevations in the watershed are predominantly less than 100 feet (30 m). The elevation of White Island Pond is 48 feet (14.6 m).

The movement of the glacier eroded large quantities of rock and redeposited it in the form of glacial till. Glacial till consists of a mixture of silt, sand, gravel, cobbles and boulders. The till overlays bedrock of igneous and metamorphic rock. As the glacier melted streams were formed which transported and deposited sediment in glacial outwash. White Island Pond is a glacial outwash lake.

The five soil types in the White Island Pond watershed, in order of prominence are Carver and Gloucester soils, Carver Series, Sanded Muck, Scarboro Series and Peat (Figure 3). The Carver and Gloucester soils, as well as the Carver Series, consist mainly of a coarse, sandy texture. This texture comes about because the soils were formed in material derived from rock rich in coarse crystalline feldspar, quartz and a few dark-colored or readily weatherable minerals. Some other characteristics of these soils are that they do not retain moisture, are extremely acid, and are low in nutrients.

The remaining soil types are very poorly drained and thus wet most of the time. Peat is a soil formed from an accumulation of partly decomposed plant materials. Sanded Muck consists of Muck and Peat which has been developed for cranberry production by sanding over the layer of organic material. The Scarboro Series is formed in thick deposits of sand or sand and gravel. The moisture content of the Scarboro Series is generally derived from a high water table.

Of the soil types in the watershed,Peat, Sanded Muck and Scarboro Series have severe limitations for use as homesites or septic tank fields. The Scarboro Series is located in the southeastern portion of the watershed (Figure 3). At the present time five homes are built on this soil type. No homes are constructed on Peat or Sanded Muck. The suitability of the two major soil types--Carver Series and Carver and Gloucester--for the above uses depends on their slope. Severe limitations are the case if the slopes are greater than 15 percent. Only a small area of the Carver Series soils has a slope greater than 15 percent. This area is in the southeastern portion of the watershed adjacent to the Scarboro Series

[1]Geological data and soil type information was furnished by U.S. Department of Agriculture, Soil Conservation Service, (1969) Soil Survey, Plymouth County, Massachusetts and (1978) Water and Related Land Resources of the Coastal Region, Massachusetts. Washington, D.C.

# WHITE ISLAND POND
# GENERAL SOILS MAP

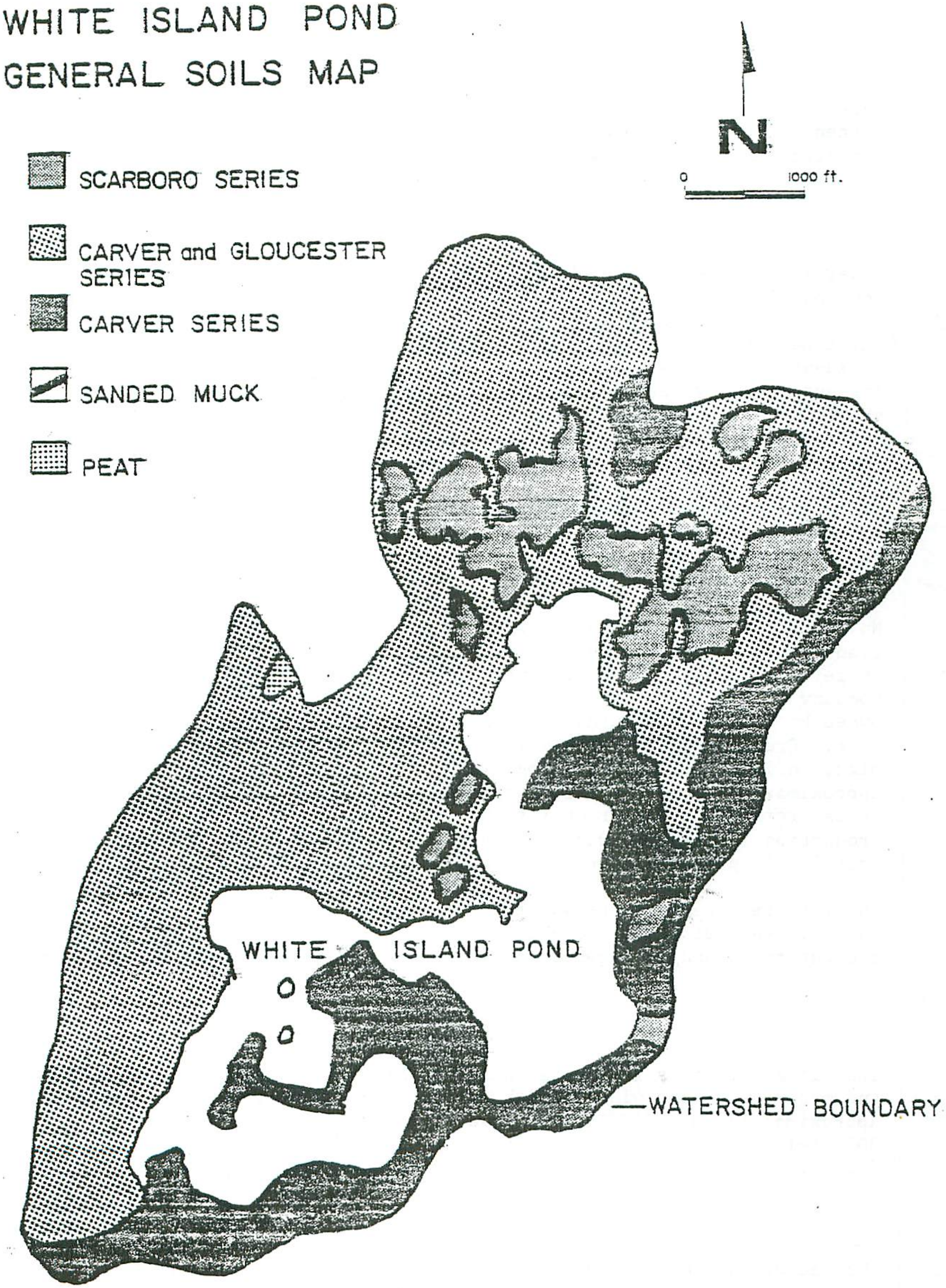


FIGURE 3

soils (Figure 3). Approximately nine homes are located on this soil type. The slopes of the Carver and Gloucester soils range from 8 to 35 percent. Erosion problems are not common in the watershed except from construction sites of new homes.

## Land Uses

General land uses of the White Island Pond watershed are residential housing (16%) comprised of both seasonal and year-round homes, agricultural in the form of cranberry-growing (27%), and forestland (57%). The watershed of White Island Pond is not densely populated. Most of the residences are of a seasonal nature with only a few year-round homes present in the watershed. The population is concentrated along the shoreline of the western basin, especially the southwestern portion. In contrast, the shoreline of the eastern basin is comparatively sparsely settled. The potential for growth in the eastern basin is somewhat limited by a high water table and bog areas. Zoning laws in Wareham dictate that residences and septic systems be set back 100 feet (30 m) from the water.[1] In Plymouth the zoning laws require septic systems to be set back 75-100 feet (23-30 m) and homes to be set back at least 10 feet (3 m) from the water.[2]

No industry exists within the watershed, but agriculture in the form of cranberry-growing is present. Two cranberry bogs border the northern shore of the eastern basin. One cranberry bog is owned by A.D. Makepeace Company and is 43.6 acres (17.6 ha) in size. The other cranberry bog is owned by the Federal Furnace Cranberry Company and is 55 acres (22 ha) in size. Cranberry production varies from year to year. Keeping this in mind, in 1978 the cranberry bog owned by A.D. Makepeace Company produced approximately 7,400 barrels of cranberries which amounts to $148,000 in gross profit at the current rate of $20/barrel (Severance, 1979). No production information was available for the other cranberry bog, but it most likely produced an equivalent amount of cranberries.

The forested areas of the watershed are a mix of pitch pine and scrub oak. These trees have the ability to grow in the coarse, sandy soils of the watershed and to regenerate after fire damage, which is commonplace.

## Climatology[3]

The climate in this region is characterized by moderately warm summers and moderately cold winters with the average annual temperature being approximately 50°F (10°C). The average temperature in January is about 30°F (-1°C) and the average temperature in July is approximately 71°F (22°C). The temperatures of the watershed are influenced by southerly

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[1] Source of information was town clerk of Wareham, Massachusetts

[2] Source of information was town clerk of Plymouth, Massachusetts

[3] Climatology information furnished by the U.S. Department of Agriculture, Soil Conservation Service. 1969. Soil Survey, Plymouth County, Massachusetts. Washington, D.C.

sea breezes from Buttermilk Bay and possibly easterly sea breezes from Cape Cod Bay. Also, on clear nights radiational cooling effectively lowers the temperature, especially in the bogs. Furthermore, bog soils, because of their high moisture content, have a low heat conductivity resulting in their surfaces being colder at night than the surrounding mineral soils. These factors contribute to an increased frost threat to cranberry crops, even during the summer. The average growing season for the area is approximately 174 days long.

The annual precipitation in this region ranges from 41 (104 cm) to 47 inches (119 cm). The precipitation is evenly distributed throughout the seasons. Generally speaking, annual snowfall amounts range from 27 (68 cm) to 38 inches (96 cm). A prolonged snow cover is not common in this area.

## Watershed Practices

The major watershed practice involves the irrigation and flooding of the cranberry bogs surrounding the eastern basin of White Island Pond. All the inlets and outlet have control structures which regulate their flow. These control structures consist of cement spillways with removable flashboards. The flow is manipulated during the late fall to flood the bogs and during the spring to drain the bogs. These actions directly affect the lake's water level. In addition to the above general scheme, certain circumstances dictate further regulation of the flow. One instance is a dry summer resulting in drought conditions necessitating irrigation. Another circumstance is that if during the winter the ice becomes snow-covered, the bogs must be drained and re-flooded. The reason being the snow blocks the sun from the cranberry vines therefore inhibiting photosynthesis. Without photosynthesis, dissolved oxygen is depleted from the flood waters, resulting in oxygen-deficiency injury to the cranberry vines (Peterson et al, 1968).

# LIMNOLOGICAL DATA

## Methods

### Field Sampling

Temperature profiles were made "in situ" with a Tele-Thermometer (Yellow Springs Instrument, Model 42 SC). Transparency measurements were made with a standard 20 cm. Secchi disc. Field pH tests were taken with a Hack Model 17N wide range pH test kit. In addition wind direction and velocity, weather and air temperatures were recorded on each survey (See Appendix B).

### Chemical Analyses

Chemical analyses were performed on water samples from the three deep stations, the inlets and the outlet, as well as on groundwater well samples. Open water samples from the deep stations were collected with a standard-type brass Kemmerer water sampler. The inlet and outlet samples were collected below the surface by hand after thoroughly rinsing the sample bottle. Bacteriological samples were collected below the surface by hand in sterilized, screw-capped glass bottles. The groundwater samples were obtained by taking water directly from the taps of nineteen homes in the watershed. All samples for chemical analyses were packed in ice and transported as soon as possible to the Lawrence Experiment Station of the Department of Environmental Quality Engineering, Division of Laboratories, and analyzed according to Standard Methods for the Examination of Water and Wastewater (APHA, 1976).

The following analyses were conducted on each sample: pH, total alkalinity, suspended solids, total solids, hardness, silica, color, total Kjeldahl-nitrogen, ammonia-nitrogen, nitrate-nitrogen, total phosphorus, specific conductance, iron, sulfate and manganese. Bacterial analyses were for total and fecal coliforms.

Dissolved oxygen samples were collected in the manner prescribed by Welch (1948). Dissolved oxygen concentrations were measured by the azide modification of the Winkler technique (Standard Methods, APHA 1976). Titrations were made within several hours after being fixed in the field with manganese sulfate and alkali-azide-iodide reagents. The sulfuric acid was added just prior to the titrations in the laboratory.

### Phytoplankton and Chlorophyll a

Phytoplankton samples were obtained by a standard procedure described by the Maine Department of Environmental Protection, Division of Lakes and Biological Studies. Each sample consisted of a composite core taken with a one-quarter inch I.D. plastic tube with a weight attached to one end. The tube was lowered at each of the deep stations close to the bottom, pinched below the meniscus, and raised into the boat. The sample was allowed to drain into a clean and rinsed collection bottle. The procedure was repeated until a volume of 500 ml was collected. The samples were normally analyzed for phytoplankton on the day of collection using a Whipple micrometer and Sedgewick-Rafter cell. Algal counts were reported as cells per milliliter.

Chlorophyll a analysis (Appendix 2) was based on methodology from a modified EPA fluorometric procedure developed by the Division of Water Pollution Control at Westborough (Kimball, 1979). Filtered samples were refrigerated for 24 hours after being ground and extracted in 90% acetone. Fluorometer readings were taken at 750 and 630 nannometers before and after treatment with 1N Hydrochloric acid (HCl) to correct for pheophytin interference.

## Aquatic Macrophytes

The aquatic macrophyton community in White Island Pond was located and mapped by slowly examining the entire littoral zone by boat. Where the bottom was not visible, it was dragged for aquatic vegetation using a weighted grappling hook. Identification for the most part was made "in situ", except for a few samples which were taken back to the laboratory and identified according to Fassett (1957), Weldon et al (1973), or Hotchkiss (1972). Some plants could not be keyed to species because the plants were not in flower or fruit.

## Bathymetric Map

A bathymetric map of White Island Pond was prepared from an original map provided by the Massachusetts Division of Fisheries and Wildlife as confirmed in the field with a fathometer (Raytheon Model DE728A).

## Bottom Sediment Analyses

On March 14, 1978 representative samples of surface sediments from all three deep stations were collected through the ice using a standard 6" X 6" Eckman dredge. The sediment samples were each placed in separate one-quart containers, packed in ice and transported to the Lawrence Experiment Station for analysis. Using Standard Methods (APHA, 1976), the following analyses were performed on each sample: total Kjeldahl-nitrogen, total phosphorus, arsenic, cadmium, chromium, copper, iron, lead, manganese and zinc.

## Data

### Physical Data

#### Temperature-Stratification

The temperature profile for White Island Pond was of an unstratified nature except for the March 1978 survey. During this survey there was an ice cover of 15 inches resulting in inverse stratification. This is a normal phenomenon of colder water in the epilimnion and warmer water in the hypolimnion. In all other cases, the lake was well-mixed and the temperature was relatively uniform throughout the water column. During the spring the water temperature was 11-13$^{\circ}$C. In early summer the water temperature ranged from 16-20$^{\circ}$C but as the summer progressed the water warmed to a high of approximately 24$^{\circ}$C. The temperature data is presented in Tables 3, 4, and 5 and Figures 5, 6, and 7.

#### Secchi Disc Transparency

The secchi disc data is presented in Table 2 and Figure 4. Transparency at all three stations was high over most of the sampling period. According to the Department of Public Health (1969) the transparency at a public beach should be four feet (1.2 m) or more if the lake is to be utilized for swimming. All readings were over four feet except for the August 1977 survey at Station 2 which was 3.5 feet (1.1 m). The transparency on this date was affected by a blue-green algal bloom.

Another factor contributing to the transparency of the lake is the water color which was reported as clear on all occasions except for the August 1976 survey. During the August 1976 survey the water at all three stations was green in color and turbid. These conditions were caused by the mixing action of a hurricane which had skirted the area the day before sampling.

### Chemical Data

#### Dissolved Oxygen

The dissolved oxygen profiles are presented in conjunction with the temperature data in Tables 3, 4, and 5 and Figures 5, 6, and 7. For each of the three deep stations the oxygen concentration remained relatively constant throughout the water column, as did the temperature readings. With the exception of the March 1978 survey when Station 2 under ice conditions had an oxygen profile typically found in dimictic lakes with ice coverage. This profile is characterized by a reduction in oxygen concentration with depth indicating a high sediment oxygen demand. The percent saturation at the ten feet interval was 68%. This level is the lowest percent saturation of dissolved oxygen reached at any time during the sampling period. Although all three deep stations were under ice, only Station 2 exhibited this phenomenon because it was shallower and had more organically rich sediments than the other stations.

TABLE 2

WHITE ISLAND POND STUDY

SECCHI DISC READINGS[1]

READINGS FEET (Meters)

| Date | Station 1 | Station 2 | Station 3 | Weather and General Water Condition |
|---|---|---|---|---|
| 8/11/76 | 7.5 (2.3) | 6.0 (1.8) | 11.5 (3.5) | Sunny, calm |
| 4/27/77 | 15.0 (4.6) | 10.0 (3.0) | 13.5 (4.1) | 95% cloudy, slight wind |
| 6/14/77 | 14.0 (4.3) | 7.5 (2.3) | 14.0 (4.3) | Hazy sun, calm |
| 7/28/77 | 11.5 (3.5) | 5.0 (1.5) | 7.5 (2.3) | 20% cloudy, calm |
| 8/22/77 | 8.0 (2.4) | 3.5 (1.1) | 9.0 (2.7) | 100% cloudy, calm |
| 11/15/77 | 14.5 (4.4) | 10.0 (3.0) | 12.0 (3.6) | 30% cloudy, slight wind |
| 3/14/78 | 13.0 (4.0) | - - | 10.0 (3.0) | 100% cloudy, ice cover |
| 5/4/78 | 15.0 (4.6) | 10.0 (3.0) | 14.0 (4.3) | Sunny, calm |

[1]All readings were generally taken between the hours of 1000 and 1300.

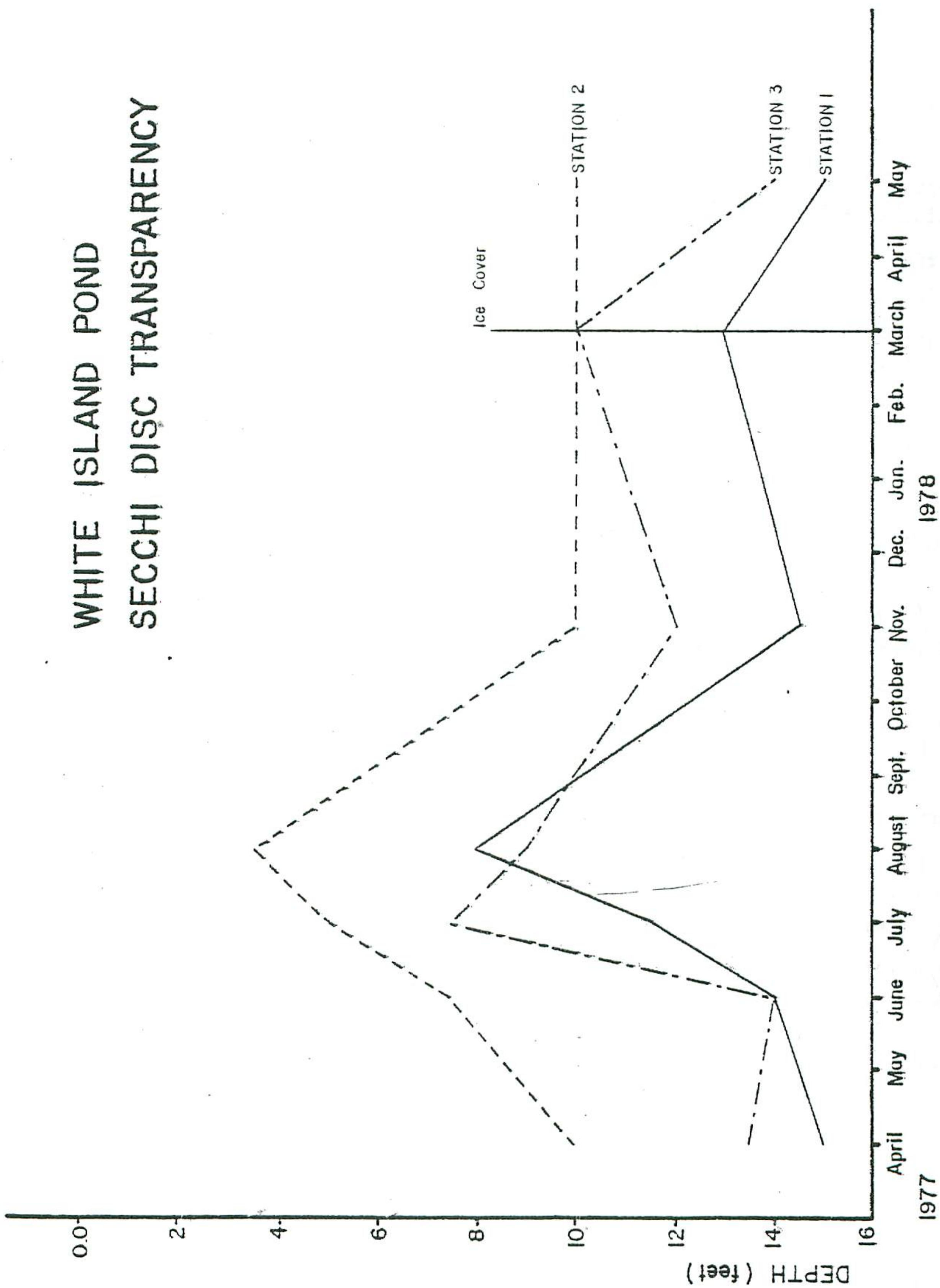

WHITE ISLAND POND
SECCHI DISC TRANSPARENCY
DEPTH (feet)
0.0
2
4
6
8
10
12
14
16
April
May
June
July
August
Sept.
October
Nov.
Dec.
Jan.
Feb.
March
April
May
1977
1978
Ice Cover
STATION 2
STATION 3
STATION I

FIGURE 4

TABLE 3

WHITE ISLAND POND STUDY

TEMPERATURE ($^{o}$C) & DISSOLVED OXYGEN DATA (mg/l)

STATION 1

| Depth Feet (Meters) | 8/11/76 | | 4/27/77 | | 6/14/77 | |
|---|---|---|---|---|---|---|
| | Temp. | D.O. | Temp. | D.O. | Temp. | D.O. |
| Surface | 23.9 | 8.3 | 13.1 | 9.5 | 20.0 | 9.7 |
| 5 (1.5) | 23.7 | 8.3 | 12.8 | 9.5 | 18.3 | 9.7 |
| 10 (3.0) | 22.8 | 8.1 | 12.5 | 9.5 | 16.7 | 9.7 |
| 12 (3.6) | -- | -- | -- | -- | -- | -- |
| 14 (4.3) | 22.5 | 8.2 | -- | -- | 16.1 | 9.7 |
| 15 (4.6) | -- | -- | 12.5 | 9.5 | -- | -- |

| | 7/28/77 | | 8/22/77 | | 11/15/77 | |
|---|---|---|---|---|---|---|
| Surface | 23.9 | 7.8 | 22.2 | 8.0 | 9.7 | 10.6 |
| 5 (1.5) | 23.9 | 8.2 | 22.2 | 8.2 | 9.7 | 11.0 |
| 10 (3.0) | 23.4 | 7.7 | 22.2 | 8.0 | 9.7 | 10.9 |
| 12 (3.6) | -- | -- | 22.2 | -- | -- | -- |
| 14 (4.3) | 23.4 | 8.0 | -- | -- | 9.7 | 11.0 |
| 15 (4.6) | -- | -- | -- | -- | -- | -- |

| | 3/14/78 | | 5/4/78 | |
|---|---|---|---|---|
| Surface | 1.0 | 13.0 | 12.5 | 10.8 |
| 5 (1.5) | 4.5 | 13.5 | 12.2 | 10.1 |
| 10 (3.0) | 5.0 | 12.5 | 11.7 | 10.2 |
| 12 (3.6) | -- | -- | -- | -- |
| 14 (4.3) | -- | -- | -- | -- |
| 15 (4.6) | 5.0 | 13.0 | 11.7 | 10.2 |

TABLE 4

WHITE ISLAND POND STUDY

TEMPERATURE ($^{o}C$) & DISSOLVED OXYGEN DATA (mg/l)

STATION 2

| Depth Feet (Meters) | 8/11/76 Temp. | 8/11/76 D.O. | 4/27/77 Temp. | 4/27/77 D.O. | 6/14/77 Temp. | 6/14/77 D.O. |
|---|---|---|---|---|---|---|
| Surface | 25.0 | -- | 12.8 | 9.5 | 20.0 | 10.2 |
| 5 (1.5) | -- | -- | 12.5 | 9.5 | 18.3 | 10.5 |
| 10 (3.0) | -- | -- | 12.2 | 9.6 | 16.7 | 10.5 |
| | 7/28/77 | | 8/22/77 | | 11/15/77 | |
| Surface | 23.4 | 9.0 | 22.2 | 8.0 | 8.6 | 11.0 |
| 5 (1.5) | 23.4 | 9.3 | 22.2 | 8.2 | 8.6 | 11.0 |
| 10 (3.0) | 23.4 | 9.7 | 22.2 | 8.0 | 8.9 | 11.0 |
| | 3/14/78 | | 5/4/78 | | | |
| Surface | 1.1 | 13.9 | 12.8 | 9.9 | | |
| 2 (0.6) | 4.4 | 11.1 | -- | -- | | |
| 4 (1.2) | 4.4 | 11.7 | -- | -- | | |
| 5 (1.5) | -- | -- | 12.5 | 10.2 | | |
| 6 (1.8) | 4.4 | 10.8 | -- | -- | | |
| 8 (2.4) | 4.4 | 10.5 | -- | -- | | |
| 10 (3.0) | 4.4 | 8.7 | 12.2 | 10.4 | | |

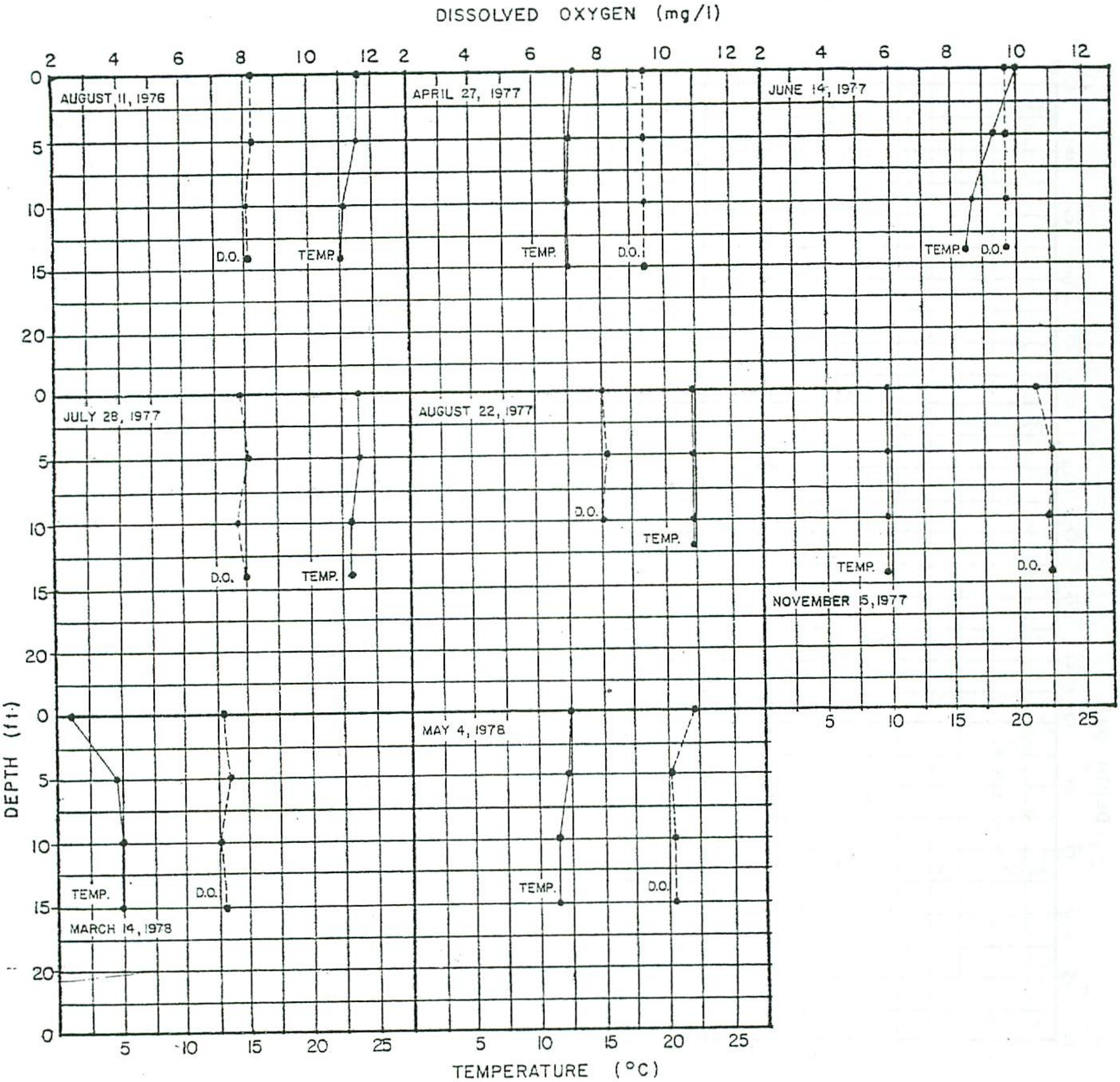
TABLE 5

WHITE ISLAND POND STUDY

TEMPERATURE ($^{o}$C) & DISSOLVED OXYGEN DATA (mg/1)

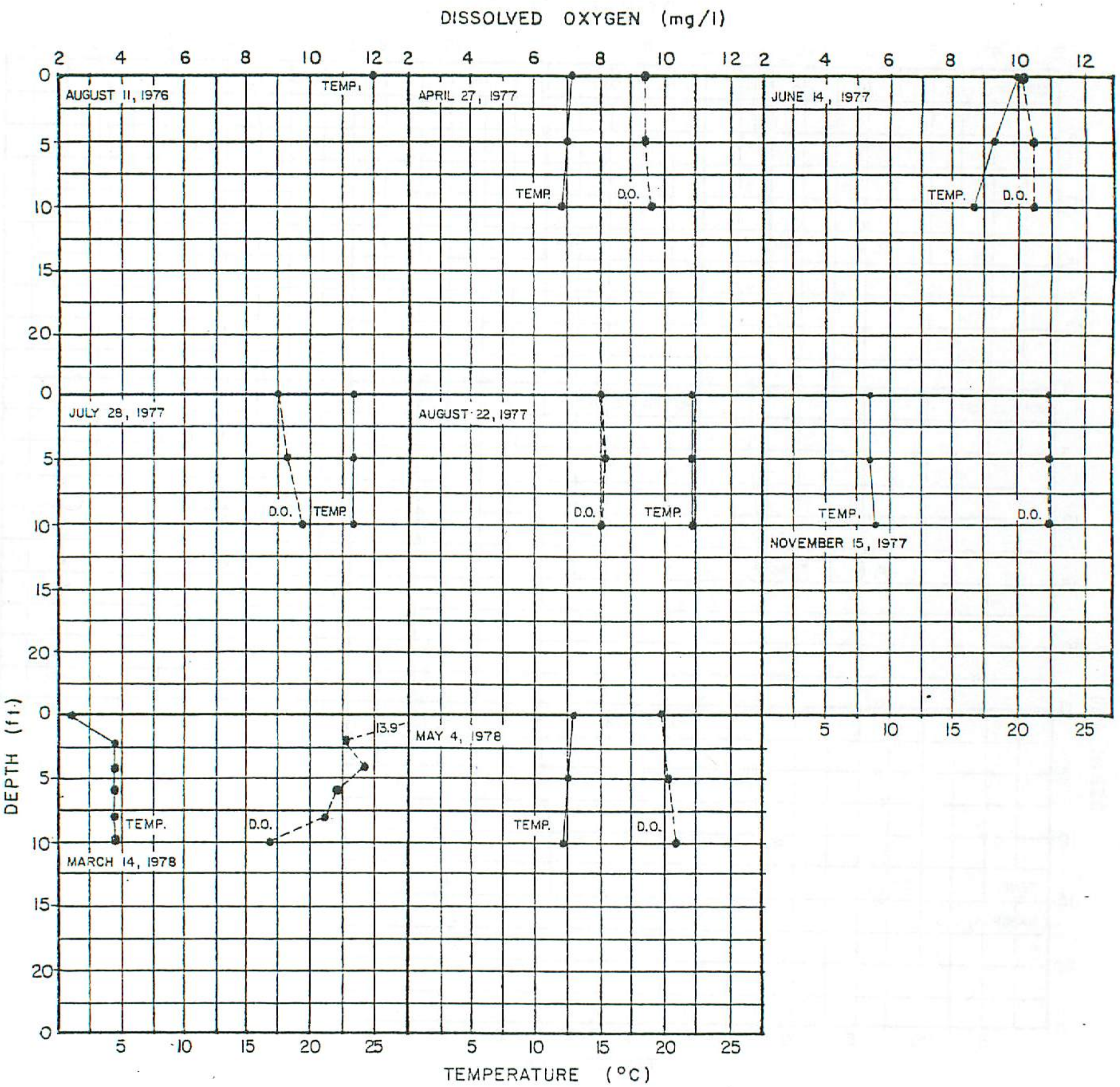
STATION 3

| Depth Feet (Meters) | 8/11/76 Temp. | 8/11/76 D.O. | 4/27/77 Temp. | 4/27/77 D.O. | 6/14/77 Temp. | 6/14/77 D.O. |
|---|---|---|---|---|---|---|
| Surface | 24.5 | 8.2 | 13.9 | 9.7 | 20.3 | 9.2 |
| 5 (1.5) | 23.9 | 8.2 | 13.3 | 9.6 | 18.9 | 9.2 |
| 10 (3.0) | 23.4 | 8.4 | 13.1 | 9.6 | 17.5 | 9.3 |
| 12 (3.6) | -- | -- | -- | -- | -- | -- |
| 13 (3.9) | 23.1 | 8.4 | 12.8 | 9.6 | -- | -- |
| 14 (4.3) | -- | -- | -- | -- | 17.2 | 9.3 |
| | **7/28/77** | | **8/22/77** | | **11/15/77** | |
| Surface | 23.9 | 8.3 | 22.8 | 8.4 | 9.7 | 10.8 |
| 5 (1.5) | 23.9 | 8.1 | 22.8 | 8.1 | 9.7 | 10.8 |
| 10 (3.0) | 23.9 | 8.0 | 22.8 | 8.0 | 9.7 | 10.9 |
| 12 (3.6) | -- | -- | 22.8 | -- | -- | -- |
| 13 (3.9) | 23.4 | 8.0 | -- | -- | 9.7 | -- |
| 14 (4.3) | -- | -- | -- | -- | -- | -- |
| | **3/14/78** | | **5/4/78** | | | |
| Surface | 1.0 | 13.8 | 13.3 | 10.0 | | |
| 5 (1.5) | 4.5 | 13.0 | 12.8 | 10.0 | | |
| 10 (3.0) | 4.5 | 12.5 | 12.8 | 10.1 | | |
| 12 (3.6) | -- | -- | -- | -- | | |
| 13 (3.9) | -- | -- | -- | -- | | |
| 14 (4.3) | 4.5 | 12.0 | 12.8 | 10.1 | | |



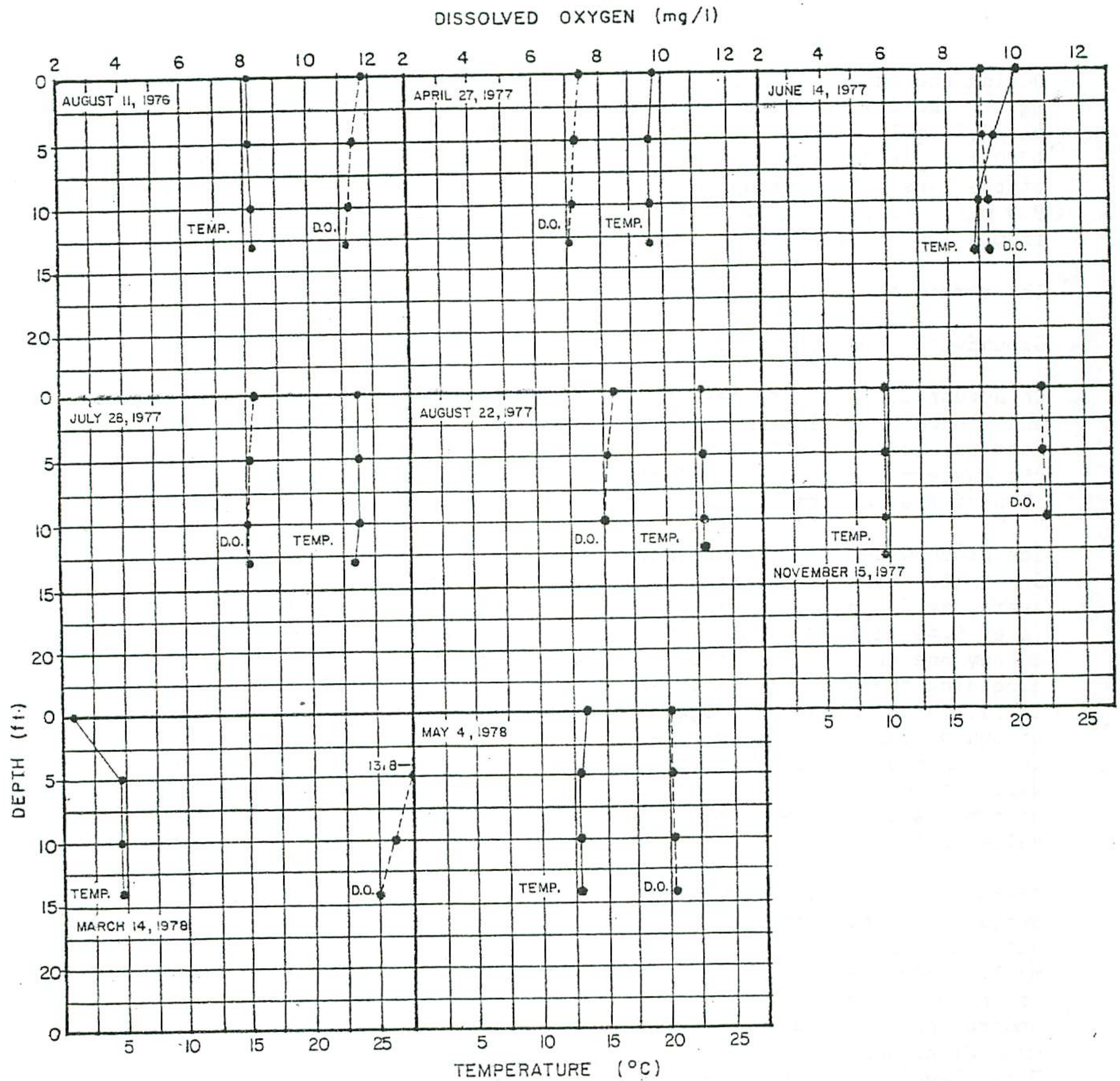

WHITE ISLAND POND
TEMPERATURE (°C) and
DISSOLVED OXYGEN DATA
STATION I

FIGURE 5




WHITE ISLAND POND
TEMPERATURE (°C) and
DISSOLVED OXYGEN DATA
STATION 2

FIGURE 6




# WHITE ISLAND POND TEMPERATURE (°C) and DISSOLVED OXYGEN DATA STATION 3

FIGURE 7

During the summer dissolved oxygen values ranged from 7.7 mg/l to 10.5 mg/l. The lowest value of dissolved oxygen for any station at any time was 7.7 mg/l recorded at Station 1 in July 1977 at the depth of 10 feet (3.0 m). At no time was an anoxic condition reached in the hypolimnion of the lake. The spring and fall dissolved oxygen levels ranged between 9.5 mg/l and 11.0 mg/l. Dissolved oxygen values in the winter ranged from a low of 8.7 mg/l to a high of 13.9 mg/l.

The remaining chemical parameters will be discussed by station.

Groundwater Well Stations

On August 1, 1977 a representative of the Southeastern Regional Planning and Economic Development District sampled 19 wells in the White Island Pond watershed. Well sites 1-10 were located on the western shoreline of the eastern basin while well sites 11-19 were located on the western portion of the western basin. For the exact well site locations see Figure 8.

The groundwater had the characteristic low pH of the region ranging from 5.3 to 6.4 with the average being 5.8. The total alkalinity was also low, averaging 5.7 mg/l. Seven of the wells had high ammonia-nitrogen readings (i.e. 0.45 mg/l, 0.24 mg/l, 0.32 mg/l). These wells were not clustered in any one area. Also, two wells had nitrate-nitrogen concentrations exceeding the 0.5 mg/l limit set for drinking water (U.S. EPA, 1975 and 1977). High ammonia-nitrogen and nitrate-nitrogen levels can be an indication of subsurface septic leaching. However, in White Island Pond there is no increased macrophyte growth in the lake adjacent to the problem wells to substantiate subsurface septic leaching. Only one well located on the western shore of the western basin, had a high total phosphorus value (0.12 mg/l).

There were eight cases of high iron values. Three of these wells had excessive concentrations (2.0-5.0 mg/l). The other wells were not as high, but still exceeded the U.S. EPA limits for drinking water which is 0.3 mg/l. Only one well showed a high concentration of manganese. According to the U.S. Geological Survey (1979) the elevated iron and manganese concentrations in groundwater of this region originate naturally from the unoxidized sand of the area. Also iron can originate from the water pipes. These levels are not a health risk, but may affect the taste of the water and may cause fixture and laundry staining.

The complete results of the groundwater chemical analyses are presented in Table 6.

Station 1 - Deep Station

Complete tabulation of the water quality data of Station 1 can be found in Table 7. Station 1 is located in the southern portion of the eastern basin. The maximum depth at this station is 15 feet (4.6 m). The shoreline of this section of the lake is settled by both seasonal and permanent homes, but not as heavily as the western basin shoreline. The average total alkalinity is 3.4 mg/l for the sampling period.

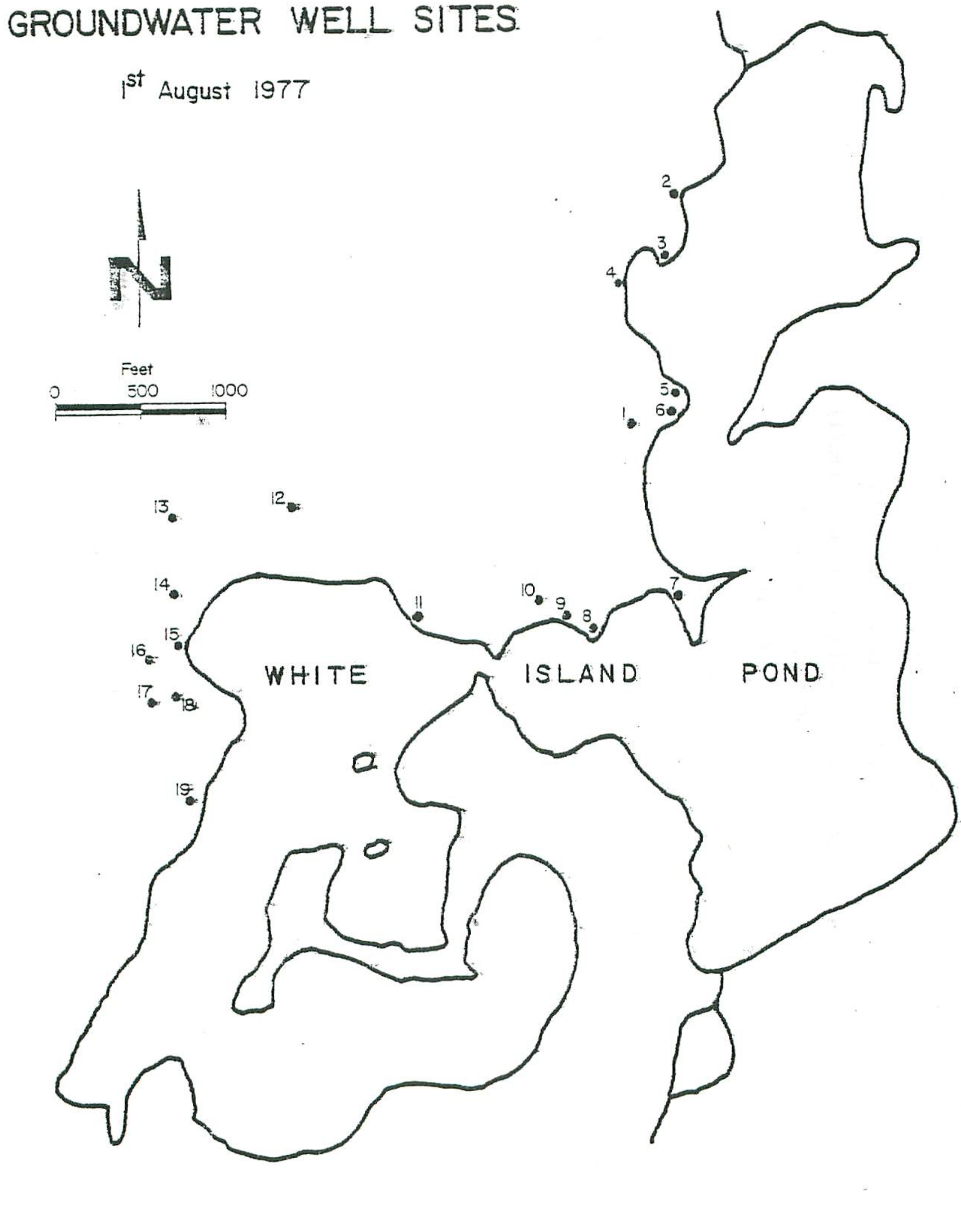

GROUNDWATER WELL SITES
1st August 1977
N
Feet
0
500
1000
WHITE
ISLAND
POND
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19

FIGURE 8

TABLE 6

WHITE ISLAND POND STUDY

RESULTS OF CHEMICAL ANALYSES (mg/l)

GROUNDWATER SAMPLES

AUGUST 1,1977

| | Well Number | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Parameter | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| pH (Standard Units) | 5.6 | 5.6 | 5.5 | 5.7 | 5.2 | 5.4 | 5.3 | 5.8 | 5.4 |
| Total Alkalinity | 6.0 | 4.0 | 4.0 | 3.0 | 5.0 | 9.0 | 3.0 | 5.0 | 3.0 |
| Suspended Solids | 0.5 | 1.5 | 0.5 | 0.5 | 3.5 | 0.5 | 3.5 | 1.0 | 2.0 |
| Total Solids | 36 | 40 | 16 | 14 | 22 | 44 | 58 | 34 | 60 |
| MBAS[1] | 0.0 | 0.1 | 0.0 | 0.0 | 0.01 | 0.01 | 0.01 | 0.01 | 0.0 |
| Chlorides | 9 | 6 | 7 | 7 | 6 | 6 | 15 | 7 | 7 |
| Ammonia-N | 0.45 | 0.06 | 0.00 | 0.01 | 0.24 | 0.13 | 0.01 | 0.01 | 0.03 |
| Nitrate-N | 0.5 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.5 |
| Total Phosphorus | 0.02 | 0.01 | 0.01 | 0.02 | 0.04 | 0.02 | 0.02 | 0.01 | 0.01 |
| Total Coliform/100 ml | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| Fecal Coliform/100 ml | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| Sodium | -- | -- | -- | -- | -- | -- | 9.0 | 6.5 | 10 |
| Iron | 0.35 | 0.16 | 0.04 | 0.0 | 5.0 | 1.0 | 0.52 | 0.30 | 0.18 |
| Manganese | 0.05 | 0.04 | 0.08 | 0.03 | 0.05 | 0.03 | 0.05 | 0.0 | 0.02 |

TABLE 6 (Continued)

| Parameter | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|
| pH (Standard Units) | 6.0 | 6.3 | 6.4 | 6.2 | 5.6 | 6.0 | 6.2 | 6.2 | 6.2 | 6.0 |
| Total Alkalinity | 4.0 | 14 | 10 | 7.0 | 3.0 | 4.0 | 10 | 4.0 | 6.0 | 5.0 |
| Suspended Solids | 2.0 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 1.5 | 1.0 |
| Total Solids | 64 | 54 | 40 | 32 | 44 | 28 | 74 | 22 | 14 | 10 |
| MBAS[1] | 0.0 | 0.01 | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.01 | 0.0 |
| Chlorides | 7 | 13 | 7 | 7 | 13 | 7 | 18 | 8 | 7 | 7 |
| Ammonia-N | 0.02 | 0.03 | 0.01 | 0.01 | 0.04 | 0.04 | 0.32 | 0.09 | 0.15 | 0.20 |
| Nitrate-N | 0.5 | 0.7 | 0.0 | 0.4 | 0.1 | 0.0 | 1.0 | 0.4 | 0.0 | 0.5 |
| Total Phosphorus | 0.02 | 0.01 | 0.02 | 0.03 | 0.02 | 0.12 | 0.02 | 0.02 | 0.01 | 0.01 |
| Total Coliform/100 ml | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| Fecal Coliform/100 ml | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| Sodium | 5.0 | 5.6 | 5.0 | 6.0 | 6.5 | 5.5 | 7.5 | 6.5 | 5.0 | 5.5 |
| Iron | 0.08 | 0.03 | 0.16 | 0.0 | 0.18 | 0.34 | 0.24 | 0.34 | 2.0 | 0.2 |
| Manganese | 0.03 | 0.03 | 0.02 | 0.05 | 0.05 | 0.05 | 0.21 | 0.04 | 0.07 | 0.06 |

[1] MBAS (Methylene Blue Active Substance) is a measure of detergents.

TABLE 7

WHITE ISLAND POND STUDY

RESULTS OF CHEMICAL ANALYSES (mg/1)

STATION 1

| | 8/11/76 | 4/27/77 | 6/14/77 | 7/28/77 | | 8/22/77 | | 11/15/77 | 3/14/78 | | 5/4/78 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Parameter | 7 ft. | 10 ft. | 5 ft. | Surface | 14 ft. | 1 ft. | 12 ft. | 5 ft. | 5 ft. | 15 ft. | 5 ft. |
| pH (Standard Units) | 6.7 | 6.2 | 7.1 | 6.1 | 6.1 | 6.5 | 6.6 | 6.4 | 5.7 | 5.8 | 6.3 |
| Total Alkalinity | 3.0 | 4.0 | 4.0 | 2.0 | 2.0 | 4.0 | 4.0 | 4.0 | 3.0 | 4.0 | 4.0 |
| Suspended Solids | 0.5 | 0.0 | 1.0 | 4.5 | 4.5 | 2.5 | 4.5 | 1.5 | 1.0 | 1.0 | 2.5 |
| Total Solids | 8.0 | 6.0 | 10 | 20 | 16 | 28 | 26 | 28 | 20 | 24 | 70 |
| Total Hardness | 6.0 | 6.0 | 6.0 | 7.0 | 6.0 | 6.0 | 5.0 | 4.5 | 6.0 | 5.0 | 10 |
| Silica | 2.7 | 0.1 | 0.3 | 0.2 | 0.2 | 0.8 | 0.7 | 0.5 | 0.8 | 0.8 | 0.2 |
| Color (std. units) | 10 | 5 | 10 | 20 | 20 | 15 | 10 | 5 | 10 | 10 | 5 |
| Chlorides | 7.0 | 7.0 | 6.0 | 8.0 | 7.0 | 7.0 | 7.0 | 13 | 12 | 11 | 7.0 |
| Total Kjeldahl-N | 0.35 | 0.70 | 0.38 | 0.56 | 1.1 | 1.0 | 0.82 | 0.73 | 0.33 | 0.30 | 0.63 |
| Ammonia-N | 0.06 | 0.10 | 0.19 | 0.01 | 0.0 | 0.04 | 0.01 | 0.01 | 0.0 | 0.0 | 0.03 |
| Nitrate-N | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Total Phosphorus | 0.03 | 0.05 | 0.03 | 0.03 | 0.03 | 0.05 | 0.04 | 0.03 | 0.01 | 0.02 | 0.03 |
| Total Coliform/100 ml | 440 | 20 | 200 | 5 | -- | 200 | -- | 20 | 20 | -- | <10 |
| Fecal Coliform/100 ml | -- | <5 | <5 | <5 | -- | <10 | -- | <10 | <5 | -- | <5 |
| Conductivity (μmhos/cm) | 54 | 38 | 43 | 52 | 48 | 41 | 41 | 42 | 40 | 40 | 80 |
| Iron | 0.15 | 0.02 | 0.05 | 0.1 | 0.1 | 0.09 | 0.1 | 0.06 | 0.04 | 0.07 | 0.01 |
| Sulfate | 12 | 4.0 | 5.0 | 3.0 | 3.0 | 3.0 | 3.0 | 4.0 | 5.0 | 2.0 | 5.0 |
| Manganese | 0.01 | 0.0 | 0.0 | 0.01 | 0.01 | 0.0 | 0.0 | 0.01 | 0.03 | 0.02 | 0.05 |

Total nitrogen values ranged from a low of 0.3 mg/l to a high of 1.1 mg/l. The nitrogen concentrations were high in April 1977, May 1978, July 1977, August 1977 and November 1977, with the greatest levels occurring in July and August of 1977.

Total phosphorus levels ranged from 0.01 mg/l to 0.05 mg/l. The phosphorus concentrations were high in April 1977 and August 1977.

Iron content was high in August 1976 as well as in July and August of 1977. Manganese levels were high during the May 1978 survey. The manganese value on this date was 0.05 mg/l. It should be kept in mind that the soil in this area is high in both iron and manganese content.

Station 2 - Deep Station

The location of Station 2 is in the northern bay of the eastern basin. The maximum depth of Station 2 is 10 feet (3.0 m). The water quality in this portion of the lake is influenced by the cranberry bogs which surround it. The two main inlets plus several irrigation ditches enter the lake near Station 2 after flowing through the bogs. All water quality data pertaining to Station 2 is presented in Table 8.

The pH was low, an average of 6.2 which is typical of this lake. During the study the total alkalinity was also low averaging 4.0 mg/l.

Levels of total nitrogen were high during the 1977 surveys of June, July and August. The August value of 1.0 mg/l was the highest. Total phosphorus concentrations ranged from 0.02 to 0.04 mg/l.

Iron content at this station was high with the exception of the June 1977 sampling. The elevated iron concentrations can again be attributed to the basic soil types of the region.

Station 3 - Deep Station

Station 3 is located in the western basin and has a maximum depth of 13 feet (3.9 m). This portion of the pond is surrounded by many residences, both seasonal and year-round. The water quality data for this station is presented in Table 9.

The average pH during the sampling period was 5.8. The pH was determined, in the laboratory, to be extremely low on two occasions. The June 1977 sample had a pH of 7.7 using the Hack pH kit in the field; the laboratory, however, reported a pH of 2.9. With such a large discrepancy the possibility of acid contamination in the laboratory becomes a real factor and the field pH should be considered the truer value. The second low pH was recorded in July 1977 at the depth of 13 feet (3.9 m). There is no field pH data to substantiate or contradict this value.

TABLE 8

WHITE ISLAND POND STUDY

RESULTS OF CHEMICAL ANALYSES (mg/l)

STATION 2

| Parameter | 8/11/76 Surface | 4/27/77 5 ft. | 6/14/77 5 ft. | 7/28/77 5 ft. | 8/22/77 5 ft. | 11/15/77 5 ft. | 3/14/78 4 ft. |
|---|---|---|---|---|---|---|---|
| pH (Standard Units) | 6.7 | 6.1 | 6.7 | 6.2 | 6.5 | 6.0 | 5.8 |
| Total Alkalinity | 6.0 | 3.0 | 4.0 | 2.0 | 5.0 | 4.0 | 4.0 |
| Suspended Solids | 3.0 | 0.0 | 0.0 | 4.5 | 8.0 | 0.5 | 1.0 |
| Total Solids | 12 | 4.0 | 8.0 | 38 | 32 | 30 | 32 |
| Total Hardness | 6.0 | 6.0 | 6.0 | 5.0 | 6.0 | 5.1 | 6.0 |
| Silica | 2.7 | 0.2 | 0.6 | 2.5 | 0.7 | 0.6 | 2.6 |
| Color (std. units) | 15 | 15 | 10 | 20 | 15 | 20 | 25 |
| Chlorides | 7.0 | 7.0 | 6.0 | 8.0 | 7.0 | 7.0 | 12 |
| Total Kjeldahl-N | 0.42 | 0.50 | 0.52 | 0.63 | 1.0 | 0.57 | 0.28 |
| Ammonia-N | 0.13 | 0.05 | 0.02 | 0.0 | 0.02 | 0.01 | 0.0 |
| Nitrate-N | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Phosphorus | 0.03 | 0.04 | 0.04 | 0.03 | 0.04 | 0.03 | 0.02 |
| *Total Coliform/100 ml | 440 | 20 | 130 | 10 | <10 | 400 | <10 |
| *Fecal Coliform/100 ml | -- | <5 | <5 | <5 | <10 | <10 | <5 |
| Conductivity (μmhos/cm) | 54 | 40 | 42 | 48 | 43 | 42 | 44 |
| Iron | 0.15 | 0.11 | 0.02 | 0.14 | 0.13 | 0.09 | 0.12 |
| Sulfate | 12.0 | 3.0 | 5.0 | 3.0 | 3.0 | 4.0 | 2.0 |
| Manganese | 0.01 | 0.01 | 0.0 | 0.01 | 0.0 | 0.01 | 0.02 |

*These parameters were also tested on 5/4/78 and were as follows:
Total Coliform/100 ml 20
Fecal Coliform/100 ml <5

TABLE 9

WHITE ISLAND POND STUDY

RESULTS OF CHEMICAL ANALYSIS (mg/l)

STATION 3

| | 8/11/76 | 4/27/77 | 6/14/77 | 7/28/77 | | 8/22/77 | | 11/15/77 | 3/14/78 | 5/4/78 |
|---|---|---|---|---|---|---|---|---|---|---|
| Parameter | 3 ft. | 10 ft. | 5 ft. | 5 ft. | 13 ft. | 1 ft. | 12 ft. | 5 ft. | 5 ft. | 5 ft. |
| pH (Standard Units) | 6.5 | 6.0 | 2.9 | 6.1 | 3.2 | 6.5 | 6.3 | 5.8 | 5.9 | 6.0 |
| Total Alkalinity | 3.0 | 2.0 | -- | 2.0 | -- | 4.0 | 4.0 | 3.0 | 3.0 | 3.0 |
| Suspended Solids | 0.5 | 0.0 | 0.5 | 7.0 | 8.0 | 2.5 | 5.5 | 0.5 | 1.0 | 3.5 |
| Total Solids | 4.0 | 16 | 132 | 38 | 74 | 40 | 36 | 26 | 30 | 80 |
| Total Hardness | 5.0 | 6.0 | 6.0 | 7.0 | 5.0 | 6.0 | 6.0 | 4.6 | 6.0 | 5.0 |
| Silica | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 1.5 | 0.3 | 0.3 | 0.4 | 0.1 |
| Color (std. units) | 5 | 15 | 10 | 15 | 20 | 5 | 10 | 5 | 10 | 5 |
| Chlorides | 7.0 | 7.0 | 6.0 | 8.0 | 8.0 | 7.0 | 9.0 | 6.0 | 11.0 | 7.0 |
| Total Kjeldahl-N | 0.35 | 0.58 | 0.45 | 0.60 | 1.5 | 0.75 | 0.60 | 0.52 | 0.28 | 0.50 |
| Ammonia-N | 0.0 | 0.02 | 0.0 | 0.0 | 0.01 | 0.01 | 0.0 | 0.0 | 0.0 | 0.04 |
| Nitrate-N | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Phosphorus | 0.02 | 0.04 | 0.03 | 0.02 | 0.05 | 0.04 | 0.03 | 0.02 | 0.01 | 0.03 |
| Total Coliform/100 ml | 490 | 50 | 90 | 5 | -- | 60 | -- | 40 | 30 | 40 |
| Fecal Coliform/100 ml | -- | <5 | <5 | <5 | -- | <10 | -- | <10 | <5 | <5 |
| Conductivity (μmhos/cm) | 41 | 38 | 620 | 48 | 56 | 41 | 45 | 41 | 44 | 39 |
| Iron | 0.05 | 0.03 | 0.20 | 0.04 | 0.05 | 0.04 | 0.06 | 0.0 | 0.03 | 0.02 |
| Sulfate | 4.0 | 3.0 | 90 | 3.0 | 7.0 | 3.0 | 3.0 | 4.0 | 7.0 | 2.0 |
| Manganese | 0.0 | 0.0 | 0.05 | 0.01 | 0.03 | 0.0 | 0.0 | 0.01 | 0.01 | 0.02 |
| Acidity | -- | -- | 92 | -- | 31 | -- | -- | -- | -- | -- |

Average total alkalinity was 3.5 mg/1 which is very low and indicates a poorly buffered system. The total hardness which is influenced by the local geology is also low.

Total nitrogen concentrations ranged from 0.28 to 1.5 mg/1 over the sampling period. High values were evident in April, July, and August of 1977. Total phosphorus levels ranged from 0.01 to 0.05 mg/1. The highest value was recorded in July 1977 at a depth of 13 feet (3.9 m).

Station 4 - White Island Bogs Inlet

This inlet flows through cranberry bogs before entering the lake from the northwestern portion of the eastern basin. This inlet was flowing on all the sampling dates except for the April 1977 and November 1977 surveys. The water quality data for the inlet is presented in Table 10.

The average pH for the inlet was 5.6 and the average total alkalinity was 3.8 mg/1. The alkalinity value is low, but it is not uncommon for this particular region.

During the July 1977 and August 1977 surveys, the water in this inlet was high in iron content (0.8 and 0.6 mg/1, respectively). In conjunction with the high iron content, the water was also highly colored. The total Kjeldahl nitrogen values were high on two occasions, August 1977 (1.0 mg/1) and May 1978 (0.74 mg/1). The total phosphorus concentrations ranged from a low of 0.02 mg/1 to a high of 0.14 mg/1. The July and August 1977 surveys each had high total phosphorus levels (0.14 and 0.12 mg/1, respectively).

Station 5 - Ware Bogs Inlet

This inlet flows through cranberry bogs before entering the lake from the northeastern section of the eastern basin. Of the eight sampling dates the inlet was flowing only twice. The two dates of flow were August 1976 and March 1978. Water quality data from Ware Bogs inlet is presented in Table 11.

The average pH for the inlet was 5.8 and the average total alkalinity was 4.0 mg/1. This alkalinity value is low; however, it is not atypical for this particular region and very similar to White Island Bog Inlet.

On both sampling dates the water was quite colored and iron values were high (0.7 mg/1 and 0.25 mg/1). Total phosphorus was 0.17 mg/1 in the August 1976 survey. On August 11, 1976 this inlet was sampled specifically for the pesticide Dieldrin. Dieldrin is the only organochlorine compound still used in cranberry production (Deubert, 1974). Application of pesticides on the White Island Pond cranberry bogs is done only when infestation levels of pests are reached (Severance, 1979). No Dieldrin was detected in the August 1976 sample.

TABLE 10

WHITE ISLAND POND STUDY

RESULTS OF CHEMICAL ANALYSES (mg/l)

STATION 4 INLET

| Parameter | 8/11/76 | 4/27/77 | 6/14/77 | 7/28/77 | 8/22/77 | 11/15/77 | 3/14/78 | 5/4/78 |
|---|---|---|---|---|---|---|---|---|
| pH (Standard Units) | 6.4 | NO FLOW | 4.5 | 5.2 | 6.5 | NO FLOW | 5.1 | 5.9 |
| Total Alkalinity | 4.0 | | -- | 4.0 | 4.0 | | 3.0 | 4.0 |
| Suspended Solids | 1.0 | | 0.0 | 4.0 | 5.0 | | 2.0 | 1.5 |
| Total Solids | 4.0 | | 16 | 32 | 28 | | 34 | 78 |
| Total Hardness | 6.0 | | 7.0 | 9.0 | 6.0 | | 7.0 | 6.0 |
| Silica | 2.8 | | 1.1 | 1.0 | 0.1 | | 5.4 | 5.3 |
| Color (std. units) | 30 | | 25 | 150 | 60 | | 25 | 15 |
| Chlorides | 7.0 | | 6.0 | 7.0 | 7.0 | | 11.0 | 7.0 |
| Total Kjeldahl-N | 0.42 | | 0.38 | 0.26 | 1.0 | | 0.30 | 0.74 |
| Ammonia-N | 0.07 | | 0.0 | 0.0 | 0.02 | | 0.0 | 0.02 |
| Nitrate-N | 0.0 | | 0.0 | 0.0 | 0.0 | | 0.2 | 0.0 |
| Total Phosphorus | 0.06 | | 0.04 | 0.14 | 0.12 | | 0.02 | 0.04 |
| Total Coliform/100 ml | -- | | 60 | 60 | 200 | | 400 | 170 |
| Fecal Coliform/100 ml | -- | | <5 | <5 | <10 | | <5 | <5 |
| Conductivity (μmhos/cm) | 43 | | 53 | 58 | 41 | | 47 | 40 |
| Iron | 0.25 | | 0.08 | 0.80 | 0.60 | | 0.17 | 0.15 |
| Sulfate | 4.0 | | 10.0 | 4.0 | 3.0 | | 6.0 | 2.0 |
| Manganese | 0.0 | | 0.04 | 0.03 | 0.0 | | 0.02 | 0.0 |

TABLE 11

WHITE ISLAND POND STUDY

RESULTS OF CHEMICAL ANALYSES (mg/l)

STATION 5 INLET

| Parameter | 8/11/76 | 4/27/77 | 6/14/77 | 7/28/77 | 8/22/77 | 11/15/77 | 3/14/78 | 5/4/78 |
|---|---|---|---|---|---|---|---|---|
| pH (Standard Units) | 6.5 | NO FLOW | NO FLOW | NO FLOW | NO FLOW | NO FLOW | 5.2 | NO FLOW |
| Total Alkalinity | 5.0 | | | | | | 3.0 | |
| Suspended Solids | 1.5 | | | | | | 1.5 | |
| Total Solids | 8.0 | | | | | | 44 | |
| Total Hardness | 6.0 | | | | | | 8.0 | |
| Silica | 1.4 | | | | | | 3.0 | |
| Color (std. units) | 50 | | | | | | 30 | |
| Chlorides | 7.0 | | | | | | 17 | |
| Total Kjeldahl-N | 0.56 | | | | | | 0.35 | |
| Ammonia-N | 0.10 | | | | | | 0.0 | |
| Nitrate-N | 0.0 | | | | | | 0.20 | |
| Total Phosphorus | 0.17 | | | | | | 0.05 | |
| Total Coliform/100 ml | 50 | | | | | | 110 | |
| Fecal Coliform/100 ml | -- | | | | | | <5 | |
| Conductivity (µmhos/cm) | 43 | | | | | | 60 | |
| Iron | 0.70 | | | | | | 0.25 | |
| Sulfate | 3.0 | | | | | | 10 | |
| Manganese | 0.02 | | | | | | 0.06 | |

## Station 6 - Outlet

The outlet is located at the southern end of the eastern basin. The outlet flow is controlled by the owners of Century Bogs into which it flows. The only survey date when the outlet did not flow was November 1977.

The water quality of the outlet was relatively consistent with high total Kjeldahl-nitrogen values recorded for all sampling dates except March 1978. The average total phosphorus for this outlet was 0.04 mg/l. The iron content was slightly elevated on the following survey dates: August 1976, June 1977, and August 1977. The remaining water quality data for the outlet is presented in Table 12.

# Biological Data

## Bacteriological Analysis

The bacteriological analyses entailed testing for fecal and total coliform bacteria. During the sampling period, the fecal coliform counts never exceeded the Class B waters criteria of a log mean for a set of samples of 200 per 100 ml (MDWPC, 1978). The total coliform counts were elevated on August 11, 1976 at Stations 1, 2, 3, and 6. On two other occasions the total coliform levels were high. These occurred at Station 4 on March 14, 1978 and at Station 2 on November 15, 1977. These levels were high but not serious enough to present a health hazard which would limit fishing or swimming in the lake.

The results of the bacteriological analyses are presented in Tables 7, 8, 9, 10, 11, and 12.

## Phytoplankton and Chlorophyll a

White Island Pond phytoplankton and chlorophyll a data are presented in Tables 13, 14, and 15 and Figures 9, 10, and 11. During the study no algal bloom conditions (15,000 cells/ml, Weber, 1974) were reached at White Island Pond. The algal populations in White Island Pond were lower at Stations 1 and 3 than at Station 2. Station 3 had the smallest algal populations of all three stations. The largest numbers at Station 3 occurred in August 1976 (630 cells/ml) and August 1977 (686 cells/ml). The algal populations at Station 1 were highest in August 1976 (1,859 cells/ml) and July 1977 (1,158 cells/ml). The dominant algae during the August 1976 survey was blue-green algae while green algae dominated during the July 1977 survey.

Station 2 showed the highest populations of all types of algae. The algal populations during the August 1976 sampling was 2,460 cells/ml and during the July 1977 sampling 3,529 cells/ml. The dominant types of algae on these two sampling dates were blue-green and green algae. During the August 1977 survey the algal population was 2,717 cells/ml but dominance had shifted completely to the blue-green algae.

TABLE 12

WHITE ISLAND POND STUDY

RESULTS OF CHEMICAL ANALYSES (mg/l)

STATION 6 OUTLET

| Parameter | 8/11/76 | 4/17/77 | 6/14/77 | 7/28/77 | 8/22/77 | 11/15/77 | 3/14/78 | 5/4/78 |
|---|---|---|---|---|---|---|---|---|
| pH (Standard Units) | 6.7 | 6.1 | 4.1 | 6.9 | 6.3 | | 5.8 | 5.9 |
| Total Alkalinity | 6.0 | 3.0 | -- | 2.0 | 7.0 | | 5.0 | 3.0 |
| Suspended Solids | 0.5 | 0.0 | 2.0 | 4.5 | 3.0 | | 1.5 | 7.0 |
| Total Solids | 12 | 8.0 | 26 | 34 | 38 | | 20 | 76 |
| Total Hardness | 6.0 | 13.0 | 7.0 | 5.0 | 8.0 | NO FLOW | 6.0 | 31 |
| Silica | 1.4 | 0.6 | 0.3 | 0.0 | 0.3 | | 0.4 | 0.1 |
| Color (std. units) | 10 | 10 | 30 | 15 | 20 | | 10 | 5 |
| Chlorides | 7.0 | 7.0 | 8.0 | 8.0 | 8.0 | | 13.0 | 7.0 |
| Total Kjeldahl-N | 0.42 | 0.62 | 0.75 | 0.99 | 0.85 | | 0.28 | 0.81 |
| Ammonia-N | 0.05 | 0.02 | 0.07 | 0.0 | 0.01 | | 0.0 | 0.08 |
| Nitrate-N | 0.1 | 0.1 | 0.4 | 0.0 | 0.0 | | 0.0 | 0.0 |
| Total Phosphorus | 0.04 | 0.04 | 0.04 | 0.03 | 0.05 | | 0.01 | 0.04 |
| Total Coliform/100 ml | 350 | 10 | 120 | 10 | 40 | | 10 | 10 |
| Fecal Coliform/100 ml | -- | <5 | <5 | <5 | <10 | | <5 | <5 |
| Conductivity (μmhos/cm) | 45 | 38 | 51 | 48 | 50 | | 40 | 41 |
| Iron | 0.15 | 0.03 | 0.12 | 0.08 | 0.30 | | 0.04 | 0.07 |
| Sulfate | 3.0 | 3.0 | 4.0 | 3.0 | 2.0 | | 7.0 | 3.0 |
| Manganese | 0.0 | 0.02 | 0.04 | 0.0 | 0.1 | | 0.02 | 0.02 |

TABLE 13

WHITE ISLAND POND STUDY

MICROSCOPIC EXAMINATION[1]

STATION 1

| Organisms | 8/11/76 | 4/27/77 | 6/14/77 | 7/28/77 | 8/22/77 | 11/15/77 | 3/14/78 |
|---|---|---|---|---|---|---|---|
| Diatoms | | | | | | | |
| Centric | -- | -- | -- | -- | 28.6 | -- | -- |
| Pennate | 29 | -- | 9.6 | 271.7 | -- | -- | -- |
| Blue-Greens | | | | | | | |
| Coccoid | 686 | -- | 9.6 | 171.6 | 57.2 | -- | -- |
| Filamentous | 429 | -- | -- | 28.6 | -- | -- | -- |
| Greens | | | | | | | |
| Coccoid | 629 | -- | 96 | 629.2 | 200.2 | -- | -- |
| Desmids | -- | -- | -- | 14.3 | -- | -- | -- |
| Filamentous | -- | -- | -- | -- | -- | -- | -- |
| Flagellates | | | | | | | |
| Green | 86 | 71.5 | 86.4 | 42.9 | 429 | -- | 260 |
| Other | -- | -- | -- | -- | 143 | -- | 40 |
| TOTAL | 1,859 | 71.5 | 201.6 | 1,158.3 | 858 | 0 | 300 |
| Chlorophyll a ($mg/m^3$) | 6.1 | -- | -- | 4.3 | 16.1 | -- | -- |

[1]Cells/ml

TABLE 14

WHITE ISLAND POND STUDY

MICROSCOPIC EXAMINATION[1]

STATION 2

| Organisms | 8/11/76 | 4/27/77 | 6/14/77 | 7/28/77 | 8/22/77 | 11/15/77 | 3/14/78 |
|---|---|---|---|---|---|---|---|
| Diatoms | | | | | | | |
| Centric | -- | -- | -- | 57.6 | -- | -- | -- |
| Pennate | -- | 14.3 | 105.6 | 902.4 | -- | -- | -- |
| Blue-Greens | | | | | | | |
| Coccoid | 1,001 | -- | 403.2 | 19.2 | 286 | | |
| Filamentous | 29 | -- | 9.6 | 1,228.8 | 1,973.4 | -- | -- |
| Greens | | | | | | | |
| Coccoid | 1,001 | 42.9 | 96 | 1,286.4 | 143 | -- | 20 |
| Desmids | -- | -- | -- | -- | -- | -- | -- |
| Filamentous | -- | -- | -- | -- | -- | -- | -- |
| Flagellates | | | | | | | |
| Green | 429 | 14.3 | 9.6 | 57.6 | 314.6 | -- | 140 |
| Other | -- | -- | -- | 76.8 | -- | 285 | 680 |
| TOTAL | 2,460 | 71.5 | 624 | 3,528.8 | 2,717 | 285 | 840 |
| Chlorophyll a ($mg/m^3$) | 12.0 | -- | -- | 16.2 | 21.7 | -- | -- |

[1] cells/ml

TABLE 15

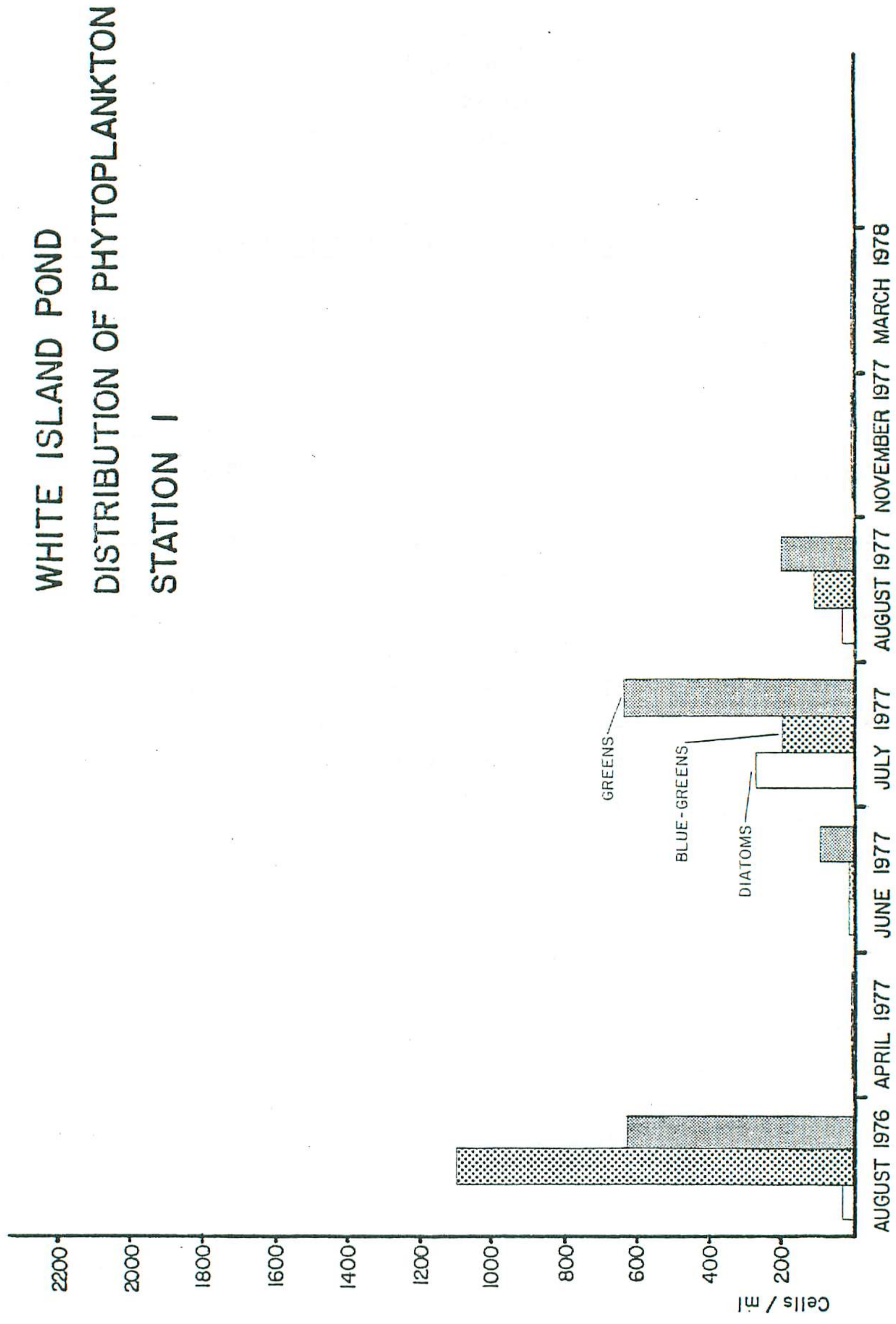
WHITE ISLAND POND STUDY

MICROSCOPIC EXAMINATION[1]

STATION 3

| Organisms | 8/11/76 | 4/27/77 | 6/14/77 | 7/28/77 | 8/22/77 | 11/15/77 | 3/14/78 |
|---|---|---|---|---|---|---|---|
| Diatoms | | | | | | | |
| Centric | 172 | -- | -- | -- | -- | -- | -- |
| Pennate | -- | -- | -- | 19.2 | -- | -- | 10 |
| Blue-Greens | | | | | | | |
| Coccoid | 29 | -- | -- | -- | -- | -- | -- |
| Filamentous | -- | -- | -- | 19.2 | 28.6 | -- | -- |
| Greens | | | | | | | |
| Coccoid | 315 | -- | 38.4 | 76.8 | 28.6 | -- | -- |
| Desmids | -- | -- | -- | -- | -- | -- | -- |
| Filamentous | -- | -- | -- | -- | -- | -- | -- |
| Flagellates | | | | | | | |
| Green | 114 | 42.9 | 57.6 | 249.6 | 257.4 | -- | 210 |
| Other | -- | -- | 9.6 | 230.4 | 371.8 | 225 | 110 |
| TOTAL | 630 | 42.9 | 105.6 | 595.2 | 686.4 | 225 | 330 |
| Chlorophyll *a* ($mg/m^3$) | 3.6 | -- | -- | 8.1 | 9.6 | -- | -- |

[1] cells/ml



WHITE ISLAND POND
DISTRIBUTION OF PHYTOPLANKTON
STATION I
Cells / ml
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
AUGUST 1976
APRIL 1977
JUNE 1977
JULY 1977
AUGUST 1977
NOVEMBER 1977
MARCH 1978
GREENS
BLUE-GREENS
DIATOMS


FIGURE 9

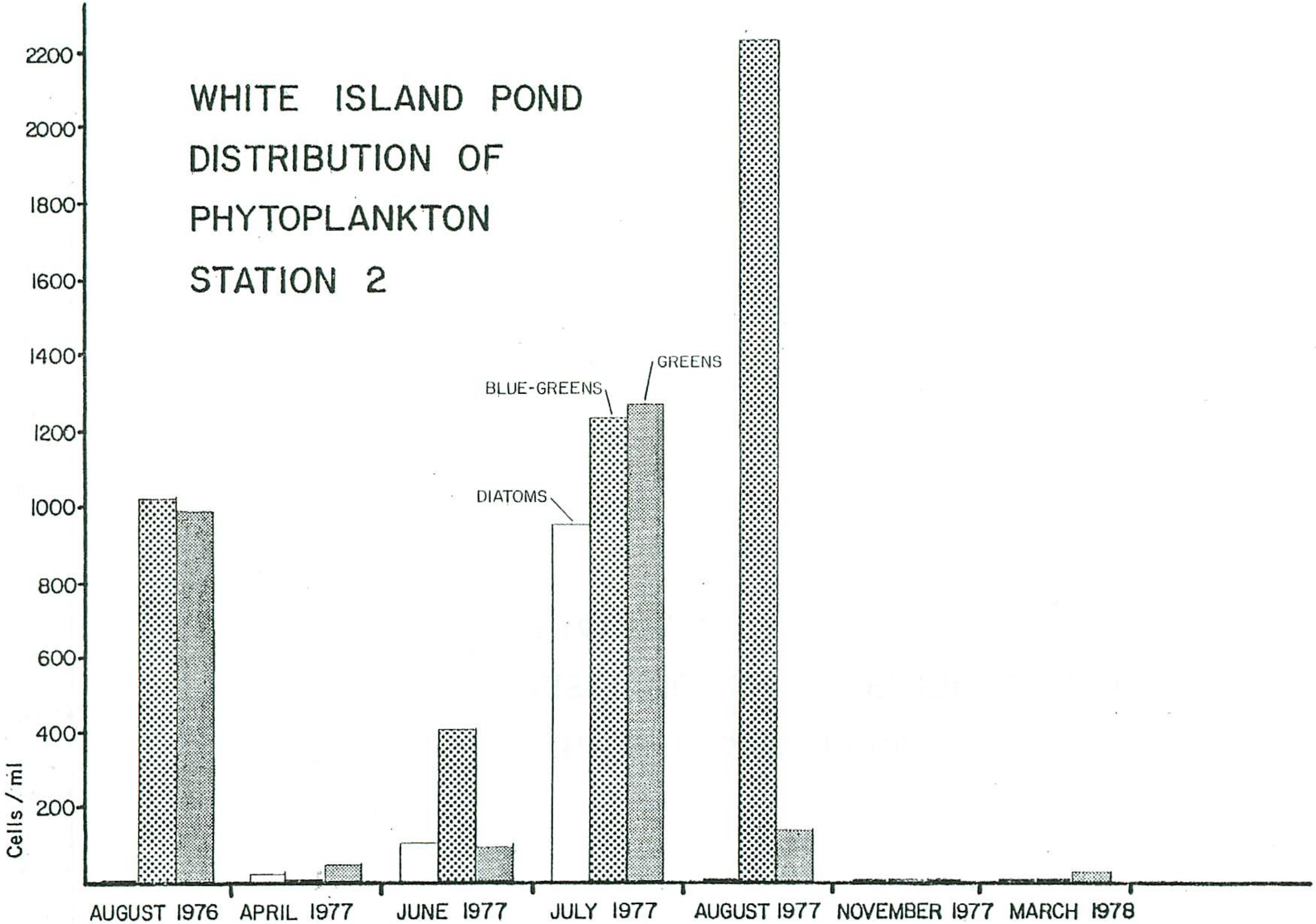

WHITE ISLAND POND
DISTRIBUTION OF
PHYTOPLANKTON
STATION 2
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
Cells / ml
GREENS
BLUE-GREENS
DIATOMS
AUGUST 1976
APRIL 1977
JUNE 1977
JULY 1977
AUGUST 1977
NOVEMBER 1977
MARCH 1978

FIGURE 10

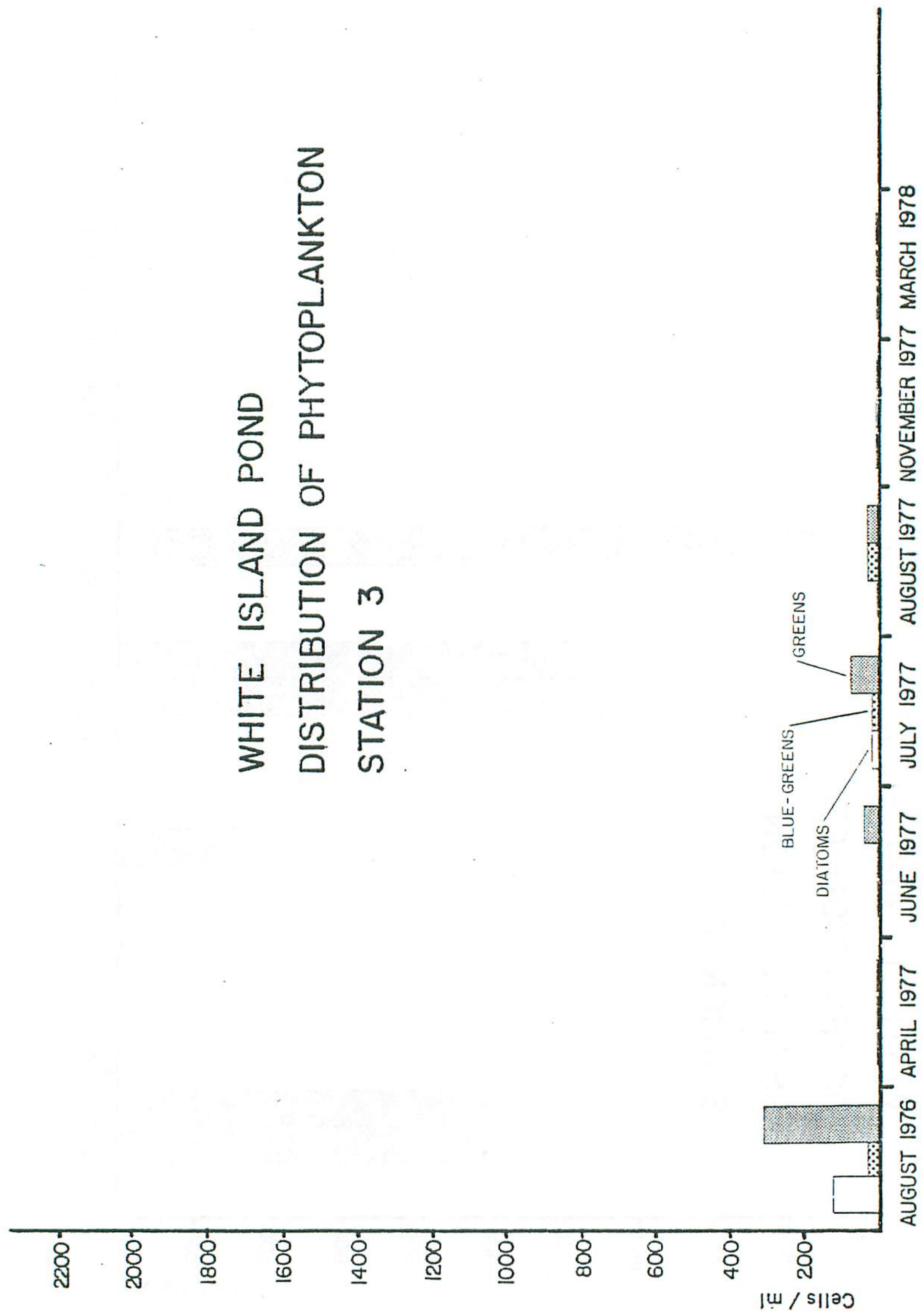

WHITE ISLAND POND
DISTRIBUTION OF PHYTOPLANKTON
STATION 3
GREENS
BLUE-GREENS
DIATOMS
AUGUST 1976
APRIL 1977
JUNE 1977
JULY 1977
AUGUST 1977
NOVEMBER 1977
MARCH 1978
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
Cells / ml

FIGURE 11

Chlorophyll a was analyzed for only three sampling dates (August 1976, July 1977 and August 1977). The values for chlorophyll a ranged from 3.6 to 21.7 $mg/m^3$.

According to Weber (1974) phytoplankton and chlorophyll a data can be utilized as indicators of lake trophic status. Chlorophyll a values ranging from 3-20 $mg/m^3$ indicates an eutrophic state. Phytoplankton numbers ranging from 2,000 to 15,000 algae/ml represents a mesotrophic condition whereas any number greater than 15,000 algae/ml is indicative of an eutrophic condition. Using Weber's system, White Island Pond would be classified as a mesotrophic lake.

Aquatic Macrophytes

The aquatic macrophyton community of White Island Pond was mapped during the July 1977 survey. The survey was accomplished by visual observation and grab sampling where visibility was limited.

The distribution of the aquatic macrophytes in the lake is illustrated in Figure 12. Dense growth of aquatic macrophyton was present in the northern bay of the eastern basin particularly where the inlets enter the lake. Algae covered the bottom of this section during the mapping. There were sixteen different macrophyte genera located in this section of the basin. The dominant aquatic plant was Elodea (water weed).

There was only sparse growths of aquatic macrophyton in the remainder of the eastern basin and all of the western basin. The predominant plant species in these sections of the lake was Eleocharis acicularis needlerush.

## Sediment Analyses

During the March 1978 survey, when the lake was ice-covered, a bottom sediment grab was collected at all three deep stations. The results of the chemical analyses from these sediments are presented in Table 16.

The mean total Kjeldahl-nitrogen concentration in the sediment of White Island Pond was 4,200 mg/kg which was below the state-wide mean (9,500 mg/kg) for other lakes and ponds of the Commonwealth.[1] The total phosphorus content of the sediments was also lower than the mean of seven previously studied Massachusetts lakes (1,325 mg/kg).

All metals were within the range of other lakes except the chromium level at Station 3, the arsenic concentrations at all three stations and the lead concentrations at Stations 2 and 3. Arsenic, chromium and lead can all occur naturally in the environment.

[1] Winter sediment values were averaged for the following seven Massachusetts lakes: Lake Attitash, Indian Lake, Lake Mattawa, Pontoosuc Lake, Red Bridge Impoundment, Waushakum Pond, and Lake Winthrop.

# WHITE ISLAND POND PLYMOUTH / WAREHAM
# DISTRIBUTION OF AQUATIC MACROPHYTON

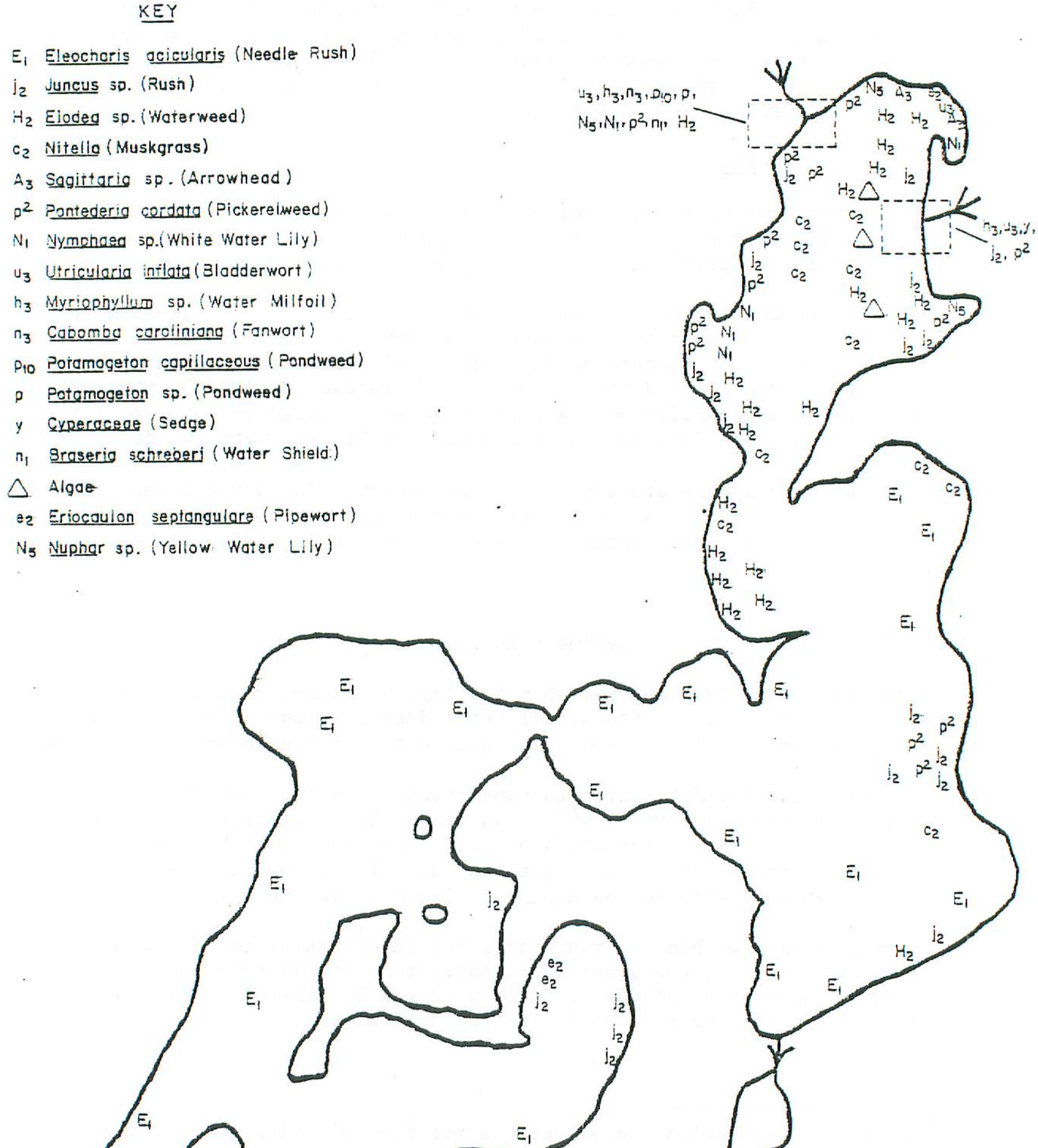



FIGURE 12

TABLE 16

WHITE ISLAND POND STUDY

RESULTS OF CHEMICAL ANALYSES (mg/kg)

LAKE SEDIMENTS

March 14, 1978

| Parameter | Station 1 | Station 2 | Station 3 |
|---|---|---|---|
| Total Kjeldahl-N | 3,100 | 4,000 | 5,500 |
| Total Phosphorus | 690 | 860 | 710 |
| Arsenic | 16 | 20 | 43 |
| Cadmium | 0.0 | 0.0 | 0.0 |
| Chromium | 36 | 40 | 150 |
| Copper | 20 | 49 | 39 |
| Iron | 6,200 | 9,000 | 9,700 |
| Lead | 59 | 150 | 140 |
| Manganese | 105 | 150 | 100 |
| Zinc | 80 | 200 | 150 |

The chromium concentration (Table 16) at Station 3 was higher than the levels at the other stations in White Island Pond. Also this concentration was higher than expected with comparison to data available from other lakes of the Commonwealth (47 mg/kg).[1] In its present state chromium is bonded in the sediments and will not contribute anything to the water column. If anaerobic conditions occur in the hypolimnion, then chromium could be transferred into the water column. Presently in White Island Pond, the hypolimnion does not become anaerobic and thus, chromium transfer is not a problem.

The arsenic concentrations (Table 16) in the sediments of White Island Pond were higher than the natural levels (1.1 to 9.4 mg/kg) found in the sediments of lakes in western Massachusetts (Kuzminski and Stine, 1973). A possible source for the elevated arsenic levels is past application of arsenic based pesticides and herbicides to the lake itself or to the surrounding cranberry bogs. As with chromium, arsenic is bonded to the sediments and not contributing to the water column.

The lead levels at Station 2 (150 mg/kg) and Station 3 (140 mg/kg) were higher than those reported for Western Massachusetts' lakes (30 to 80 mg/kg) by Kuzminski and Hogan (1974). These authors state that the major source of lead in lakes is outboard motor exhaust. Lead is also bonded in the sediments.

## Biological Resources

As discussed earlier in the Lake Uses section, the fish community of White Island Pond includes smallmouth black bass, crappies, bluegills, pumpkinseeds, white perch, yellow perch and bullheads. These fish have been stocked in the lake by the Massachusetts Division of Fisheries and Game from 1939 to 1953. Also present are golden shiners, bridled shiners and banded killifish. Herring utilize the lake as a spawning ground only, spending the remainder of their life cycle at sea.

The flagellates found in White Island Pond were generally represented by two genera, Peridinium and Dinobryon. These organisms are characterized by flagella which are whip-like structures that propel the organisms along.

The phytoplankton community of White Island Pond consisted of diatoms, green algae and blue-green algae. Diatoms generally reached their greatest numbers in the spring and the late fall when the water temperature and light intensities were low. As the water warmed and the light intensities increased during early summer, diatom dominance was replaced by increased numbers of green algae. The green algae dominated until mid- to late-summer when the conditions were advantageous for the

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[1] The mean includes the previous mentioned lakes plus Lake Quinsigamond.

increase and dominance of the blue-green algae. The preceding scheme was not a steadfast sequence of events, but rather a generalized version of the phytoplankton succession.

The representative diatom genera present in White Island Pond were Tabellaria and Asterionella. The genera of green algae were characterized by Micractinium, Golenkina, Acanthosphaeris, and Dictyosphaeria. The blue-green algae found in the lake were mainly of the genus Anabaena with some Anacystis present.

The biological resources presented above represent only the data available and not all the resources that may exist in White Island Pond.

# CONCLUSIONS AND RECOMMENDATIONS

## Conclusions

1. White Island Pond is a thermally unstratified lake with excellent transparency and generally acceptable water quality. The lake has been classified as mesotrophic in the Massachusetts Lake Classification Program (1978). This trophic state indicates the presence of nutrient enrichment of the lake.

2. The major problems encountered in White Island Pond are nuisance algal blooms and dense aquatic macrophyte growth in the northern bay of the eastern basin. To decrease the algal blooms and stabilize the aquatic macrophyte growth, the nutrient input into the lake has to be reduced.

3. According to Deubert (1974) the water quality of cranberry bog drainage is comparable to the water quality of natural bogs. That is, the drainage leaving a bog may have a greater phosphate concentration and a lower pH than the lake it flows into even if the bog is not being cultivated. In the case of White Island Pond the two main inlets flow through cranberry bogs before entering the lake. Therefore, the water quality of these inlets is influenced by the bogs. The pH of the inlets was not appreciably different from the lake. However, there were higher concentrations of total phosphorus in the inlets compared to the concentrations found in the lake.

4. White Island Pond plays an integral part in the production of cranberries. Cranberries are an important cash crop and the cranberry industry as a whole is an important part of the local economy.

The cranberry bog owners recognize and try to work with other lake interests to maximize the multiple uses of White Island Pond. An illustration of this is the A.D. Makepeace Company manipulating the outlet of White Island Pond so as to allow the passage of the herring into the lake at spawning time.

## Recommendations

White Island Pond functions as a recreational area for local residents and as a water source for the cranberry growers. The conflict between these two users is recognized and hopefully a harmonious co-existence on the lake can be achieved. The first priority of these groups should be to maintain and/or improve the water quality of White Island Pond. To this end, several recommendations can be made:

1. Limit all development within the White Island Pond watershed to reduce siltation.

2. All associations concerned with White Island Pond should initiate education programs for their members and other lake residents on watershed pollution abatement practices. Some of these practices include eliminating the use of phosphate detergents, limiting the use of lawn fertilizers, and maintaining home septic systems. The septic system maintenance program recommended in the region's 208 report (SPREDD, 1978) would cost an estimated $20 per household per year. This program entails inspecting and pumping all septic systems every three years.

3. Limit the size of boat motors and/or convert to electric motors from gasoline motors. This will decrease noise, reduce shoreline erosion and limit the spread of aquatic weeds.

4. The cranberry bog owners should review their current farming techniques to determine if any changes can be implemented to safeguard against adversely affecting the water quality of the surrounding groundwater and lake. Two practices which should be re-evaluated are application of fertilizers and irrigation. Any costs incurred in implementing better management techniques may be covered under a federal cost-sharing program for farmers (SPREDD, 1978).

5. Further study on White Island Pond is warranted if specific sources of nutrient inputs are to be identified. Additional sampling should be done in the lake as well as in the watershed. Specifically, further groundwater analyses should be conducted especially on the eastern shore since the groundwater analyses reported were from western shore wells. Several homes and septic systems on the eastern shore are built in areas of questionable soils. If these septic systems fail, leaching may occur into Ezekiel Pond rather than White Island Pond because of the high water table between these ponds. Furthermore, the groundwater data presented in this report indicates some water quality problems. However, at this time it cannot be determined whether the groundwater is influencing the water quality of the lake, or whether the cranberry bogs and other factors are influencing the water quality of the groundwater and the lake.

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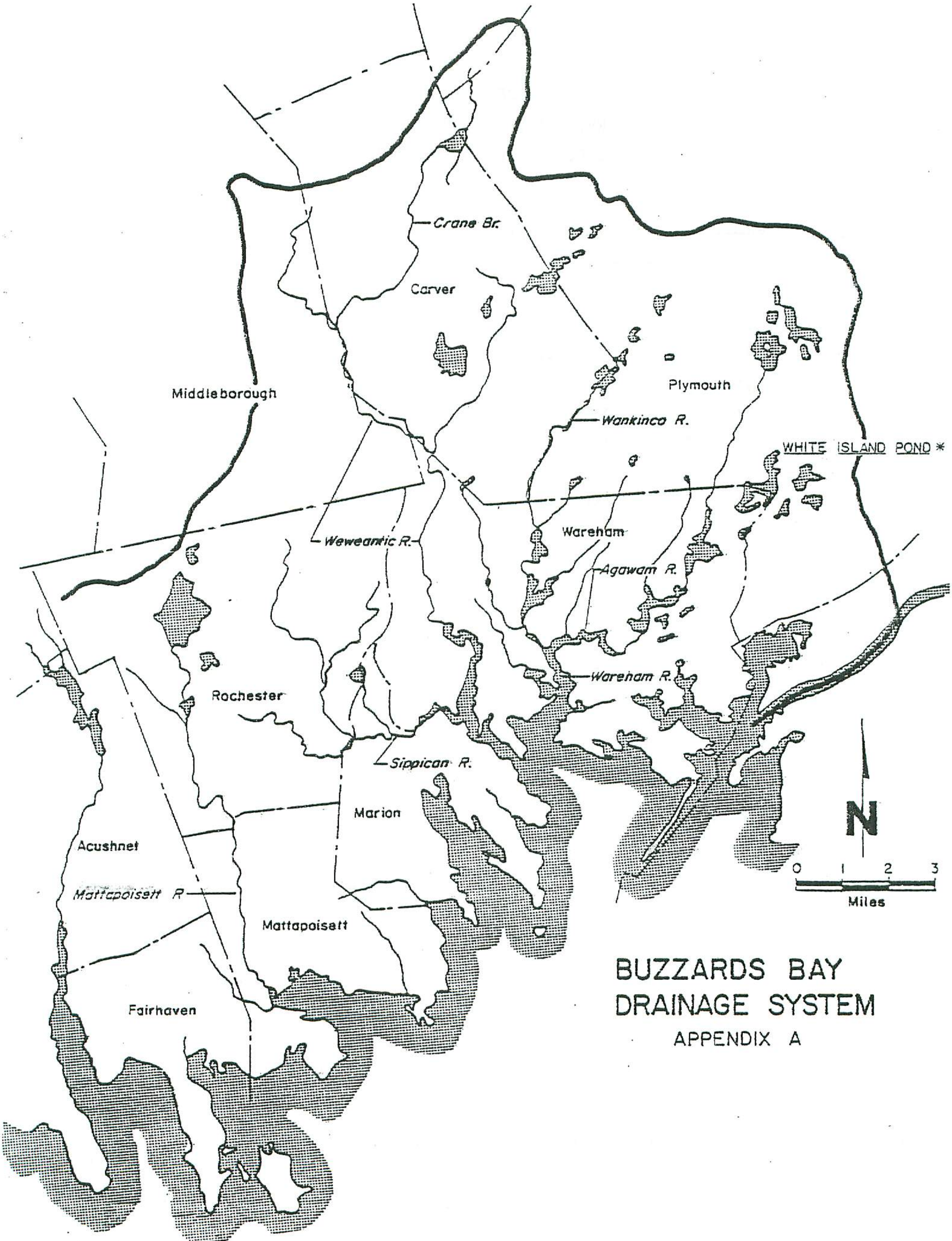
Weber, C.I. 1974. Biological Indicators of the Trophic Status of Lakes. From a symposium on Biological Indicators for Assessing Water Pollution. Newton, Massachusetts.




BUZZARDS BAY
DRAINAGE SYSTEM
APPENDIX A

APPENDIX B

WHITE ISLAND POND STUDY

METEOROLOGICAL CONDITIONS[1]

| Date of Survey | Cloud Cover | Precipitation | Air Temp. °C(°F) |
|---|---|---|---|
| 11 August 1976[2] | 0% | None | 25.6 (78) |
| 27 April 1977 | 95% | None | 15.0 (59) |
| 14 June 1977 | 0% (Hazy) | None | 20.0 (68) |
| 28 July 1977 | 20% | None | 21.7 (71) |
| 22 August 1977 | 100% | Rain | 16.7 (62) |
| 15 November 1977 | 30% | None | 8.9 (48) |
| 14 March 1978 | 100% | None | 3.3 (38) |
| 4 May 1978 | <5% | None | 12.8 (55) |

[1] Actual Recorded Field Conditions

[2] Hurricane conditions occurred the day before this sampling date.

APPENDIX C

## A NOTE ON LIMNOLOGY AND LAKE RESTORATION PROJECTS

Limnology is the study of inland fresh waters, especially lakes and ponds (lentic water vs. lotic water for streams and rivers). The science encompasses the geological, physical, chemical, and biological events that operate together in a lake basin and are dependent on each other (Hutchinson, 1957). It is the study of both biotic and abiotic features that make up a lake's ecosystem. As pointed out by Dillon (1974) and others before him, in order to understand lake conditions, one must realize that the entire watershed and not just the lake, or the lake and its shoreline, is the basic ecosystem. A very important factor, and one on which the life depends, is the gravitational movement of minerals from the watershed to the lake. Admittedly, the report contained herein concentrates mainly on the lake itself. Yet the foremost problem affecting the lakes and ponds today is accelerated cultural eutrophication, which originates in the watershed and is translated into various non-point sources of pollution. A great deal of lake restoration projects will have to focus on shoreland and lake watershed management.

Hynes (1974) sums up the science well in stating:

> ...The conclusions... are therefore that any interference with the normal condition of a lake or a stream is almost certain to have some adverse biological effect, even if, from an engineering point of view, the interference results in considerable improvement. At present, it would seem that this is little realized and that often much unnecessary damage is done to river and lake communities simply because of ignorance. It is of course manifest that sometimes engineering or water-supply projects have over-riding importance and even if they have not, the question of balancing one interest against the other must often arise. But, regrettably, even the possibility of biological consequences is often ignored. It cannot be emphasized too strongly that when it is proposed to alter an aquatic environment the project should be considered from the biological as well as the engineering viewpoint. Only then can the full implications of the proposed alteration be assessed properly, and a reasonable decision be taken. Obviously this will vary with the circumstances and the relative importance of the various consequences involved, but, at present, unnecessary and sometimes costly mistakes are often made because the importance of biological study is unknown to many administrators. Often, as for instance in drainage operations, it would be possible to work out compromises which would satisfy both engineering and biological interests.[1]

[1] Hynes, H.B.N., 1974. The Biology of Polluted Waters. University of Toronto Press, Toronto, Ontario, Canada.

## EUTROPHICATION

The term "eutrophic" means well-nourished; thus, "eutrophication" refers to natural or artificial addition of nutrients to bodies of water and to the effects of added nutrients (Eutrophication: Causes, Consequences And Correctives, 1969). The process of eutrophication is nothing new or invented by man. It is the process whereby a lake ages and eventually disappears. An undistributed lake will slowly undergo a natural succession of stages, the end product usually being a bog and, finally, dry land (see Figure A). These stages can be identified by measuring various physical, chemical, and biological aspects of the lake's ecosystem. Man can and often does affect the rate of eutrophication. From a pollutional point of view, these effects are caused by increased population, industrial growth, agricultural practices, watershed development, recreational use of land and waters, and other forms of watershed exploitation.

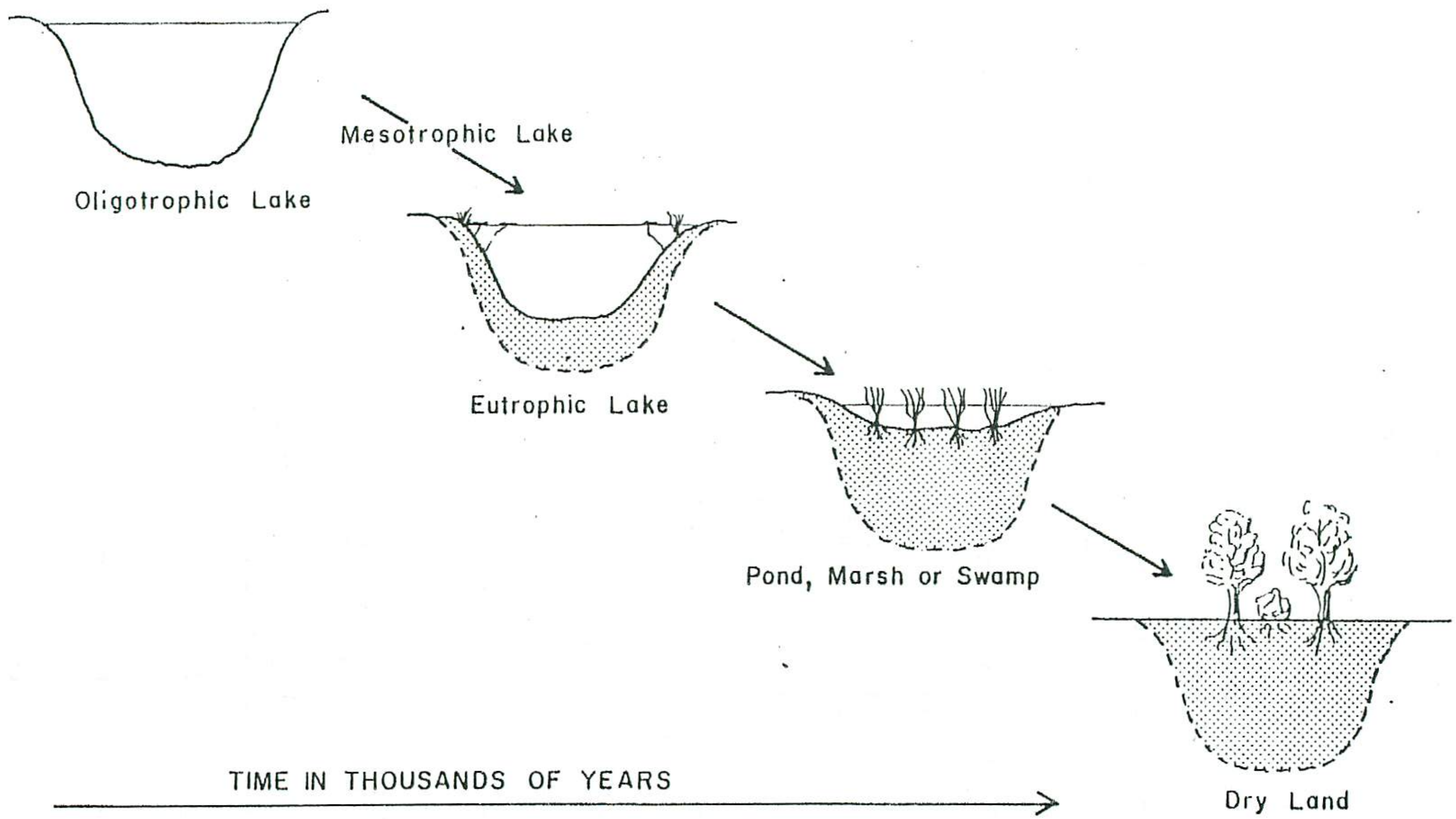
It might also be mentioned that some forms of water pollution are natural. Streams and ponds located in densely wooded regions may experience such heavy leaf fall as to cause asphyxiation of some organisms. Discoloration of many waters in Massachusetts is caused by purely natural processes. As pointed out by Hynes (1974), it is extremely difficult to define just what is meant by "natural waters, " which is not necessarily synonomous with "clean waters."

For restorative or preservative purposes of a lake and its watershed, it is important to identify both a lake's problem and the cause of the problem. Problems associated with eutrophication include nuisance algal blooms (especially blue-green algae), excessive aquatic plant growth, low dissolved oxygen content, degradation of sport fisheries, low transparency, mucky bottoms, changes in species type and diversity, and others. The pollutional cause is identified as either point or non-point in origin. A point source of pollution may be an inlet to the lake carrying some waste discharge from upstream. Or it may be an industrial, agricultural, or domestic (e.g., washing machine pipe) waste discharge which can be easily identified, quantified, and evaluated.

Non-point sources of pollution, which are the more common type affecting a lake, are more difficult to identify. They include agricultural runoff, urban runoff, fertilizers, septic or cesspool leakage, land clearing, and many more. They are often difficult to quantify, and thus evaluate.

An objective of a lake survey is to measure a lake's trophic state; that is, to describe the point at which the lake is in the aging process. The measure most widely used is a lake's productivity. Technically, this involves finding out the amount of carbon fixed per meter per day by the primary producers. Since it is a rather involved procedure to determine the energy flow through a lake system, the lake survey attempts to indirectly describe the lake's trophic state or level of biological productivity.

During the process of eutrophication, a lake passes through three major broad stages of succession: oligotrophy, mesotrophy, and eutrophy. Each stage has its characteristics (Table A). Data from a lake survey can be analyzed for assessment of the lake's trophic state. Although the level of productivity is




EUTROPHICATION – the process of aging by ecological succession.

Source: Measures for the Restoration and Enhancement of Quality of Freshwater Lakes. Washington, D.C.: United States Environmental Protection Agency, 1973.

FIGURE A

TABLE A

LAKE TROPHIC CHARACTERISTICS

1. Oligotrophic Lakes

   a. Very deep, thermocline high; volume of hypolimnion large; water of hypolimnion cold.

   b. Organic materials on bottom and in suspension very low.

   c. Electrolytes low or variable; calcium, phosphorus, and nitrogen relatively poor; humic materials very low or absent.

   d. Dissolved oxygen content high at all depths and throughout year.

   e. Larger aquatic plants scarce.

   f. Plankton quantitatively restricted; species many; algal blooms rare; Chlorophyceae dominant.

   g. Profundal fauna relatively rich in species and quantity; Tanytarsus type; Corethra usually absent.

   h. Deep-dwelling, cold-water fishes (salmon, cisco, trout) common to abundant

   i. Succession into eutrophic type.

2. Eutrophic Lakes

   a. Relatively shallow; deep, cold water minimal or absent.

   b. Organic materials on bottom and in suspension abundant.

   c. Electrolytes variable, often high; calcium, phosphorus, and nitrogen abundant; humic materials slight.

   d. Dissolved oxygen in deep stratified lakes of this type minimal or absent in hypolimnion.

   e. Larger aquatic plants abundant.

   f. Plankton quantitatively abundant; quality variable; water blooms common, Myxophyceae and diatoms predominant.

   g. Profundal fauna, in deeper stratified lakes of this type; poor in species and quantity in hypolimnion; Chironomus type; Corethra present.

TABLE A (CONTINUED)

h. Deep-dwelling, cold water-fishes usualy absent; suitable for perch, pike, bass, and other warm-water fishes.

i. Succession into pond, swamp, or marsh.

3. Dystrophic Lakes

a. Usually shallow; temperature variable; in bog surroundings or in old mountains.

b. Organic materials in bottom and in suspension abundant.

c. Electrolytes low; calcium, phosphorus, and nitrogen very scanty; humic materials abundant.

d. Dissolved oxygen almost or entirely absent in deeper water.

e. Larger aquatic plants scanty.

f. Plankton variable; commonly low in species and quantity; Myxophyceae may be very rich quantitively.

g. Profundal macrofauna poor to absent; all bottom deposits with very scant fauna; Chironomus sometimes present; Corethra present.

h. Deep-dwelling, cold-water fishes always absent in advanced dystrophic lakes; sometimes devoid of fish fauna; when present, fish production usually poor.

i. Succession into peat bog.

---

Source: Welch, P.S., Limnology, McGraw Hill Book Co., New York, 1952. (Reprinted with permission of the publisher.)

not quantified, the physical, chemical, and biological parameters measured go a long way in positioning the lake as to its trophic status. The perimeter survey helps locate and identify sources of pollution. It should be noted, however, that at the present time, there is no single determination that is a universal measure of eutrophication.

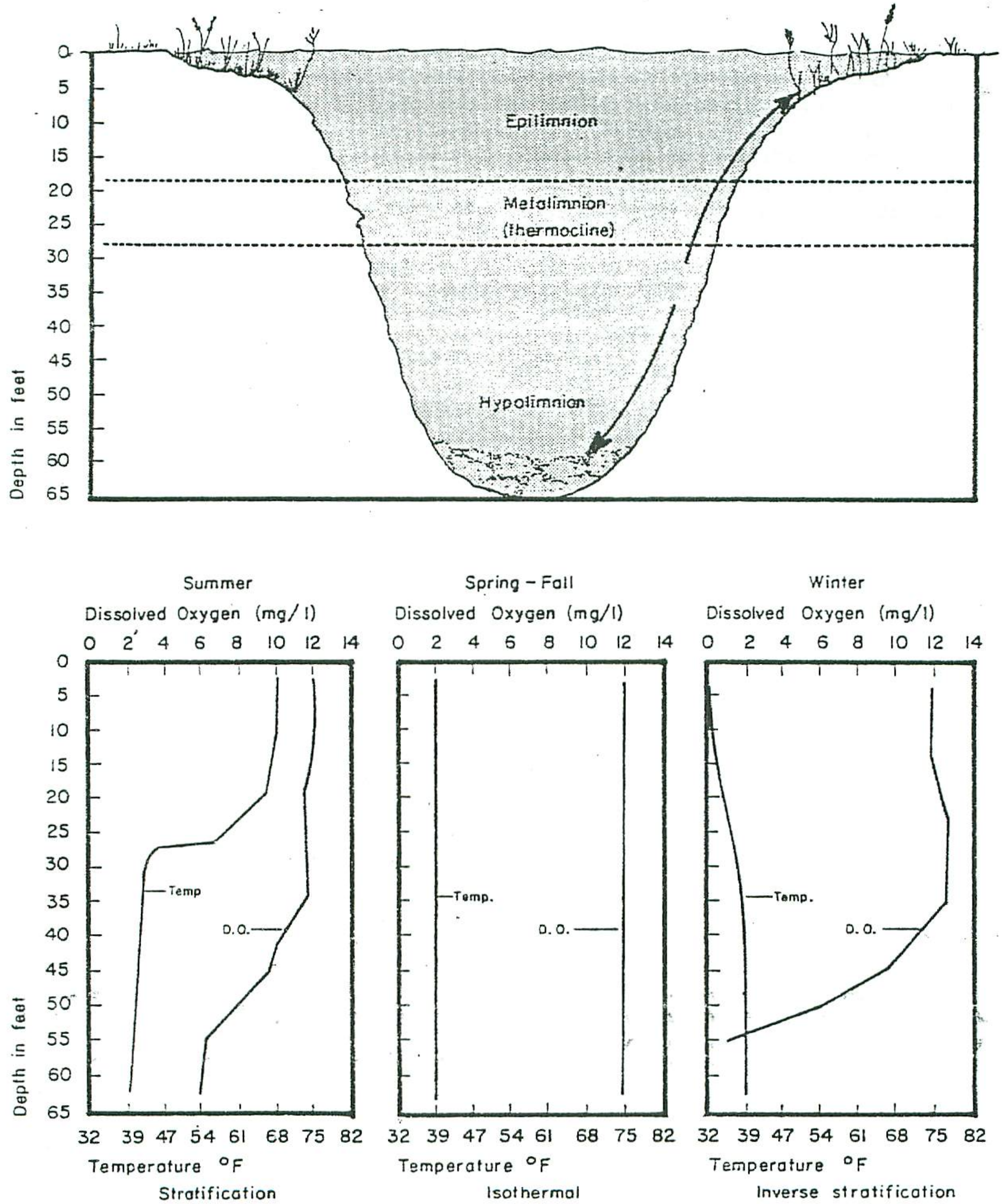
Figure B shows the various zones of a typical stratified lake. In addition to the lake's life history mentioned above, a lake also has characteristic annual cycles. Depending on the season, a lake has a particular temperature and dissolved oxygen profile (Figure B). During the summer season, the epilimnion, or warm surface water, occupies the top zone. Below this is the metalimnion, which is characterized by a thermocline. In a stratified lake, this is the zone of rapid temperature change with depth. The bottom waters, or hypolimnion, contain colder water. The epilimnion is well mixed by wind action, whereas the hypolimmion does not normally circulate. During the spring and fall seasons, these regions break down due to temperature change and the whole lake circulates as one body. In shallow lakes (i.e., 10 to 15 feet maximum depth) affected by wind action, these zones do not exist except for short periods during calm weather.

The summer season (July and August) is the best time to survey a lake in order to measure its trophic status. This is the time when productivity and biomass are at their highest and when their direct or indirect effects can best be measured and observed. The oxygen concentration in the hypolimnion is an important characteristic for a lake. A high level of productivity in the surface waters usually results in low oxygen concentrations in the lake's bottom. Low oxygen in the hypolimnion can adversely affect the life in the lake, especially the cold-water fish which require a certain oxygen concentration. Organic material brought in via an inlet can also cause an oxygen deficit in the hypolimnion. Hutchinson (1957) has amply stressed the importance of dissolved oxygen in a lake.

> A skilled limnologist can probably learn more about the nature of a lake from a series of oxygen determinations than from any other kind of chemical data. If the oxygen determinations are accompanied by observations on secchi disc transparency, lake color, and some morphometric data, a very great deal is known about the lake.

Nitrogen and phosphorus have assumed prominance in nearly every lake investigation in relating nutrients to productivity (eutrophication). Some investigators (Odum, 1959) use the maximum nitrogen and phosphorus concentrations found during the winter as the basis of nutrient productivity correlation due to the biological minimum caused by environmental conditions. Others use data following the spring overturn as a more reliable basis for nutrient productivity correlation. In any event, considerable caution must be used in transporting nutrient concentration limits found in other lakes to the present situation.

## Diagrammatic sketch showing thermal characteristics of temperate lakes




Source: Measures for the Restoration and Enhancement of Quality of Freshwater Lakes. Washington, D.C.: United States Environmental Protection Agency, 1973.

FIGURE B

Table B depicts concentrations of various substances and other data for two hypothetical lakes, one eutrophic, the other oligotrophic. It is intended as a guide for comparison to the data presented in this report. Each lake, of course, is different from all others. There is no hard and fast rule as to the critical concentrations for each lake. The morphology of a lake (e.g., mean depth) plays an important part in its general well-being. A small, deep lake will react differently to nutrient loading than a large, shallow lake. In the final analysis, each lake is found unique and must be evaluated on an individual basis.

TABLE B

SELECTED DATA FOR TWO HYPOTHETICAL LAKES[1]

CONCENTRATIONS IN mg/l

| TROPHIC STATUS[2] | DISSOLVED OXYGEN AT BOTTOM | TRANSPARENCY (SECCHI LEVEL) | $NH_3$-N | $NO_3$-N | TOTAL P | PHYTOPLANKTON ASSEMBLAGES | AQUATIC VEGETATION | CHARACTERISTIC FISHERIES |
|---|---|---|---|---|---|---|---|---|
| Lake A (Oligotrophic) | High >5.0 | High | Low <.03 | Low <0.3 | Low <0.01 | High diversity, low numbers, nearly complete absence of blue-greens. | Sparse | Cold water types |
| Lake B (Eutrophic) | Low <5.0 | Low | High >0.3 | High >0.3 | High >0.01 | Low diversity, high numbers, abundance of blue-greens. | Abundant | Warm-water types |

[1]Not established as State standards.

[2]Oligotrophic - nutrient - poor
Eutrophic - high concentrations of nutrients

## DESCRIPTION OF TERMS

The terms related to limnology and other limnological entities, as used in this report, are defined below to assist the reader in interpreting some of the data presented:

AREA of a lake refers to the size of the surface, exclusive of islands, measured in square units by planimetry.

AQUATIC PLANTS or aquatic macrophyton can be defined as those vascular plants which germinate and grow with at least their base in the water and are large enough to be seen with the naked eye. The following three broad categories are recognized:

1. Emergent types are those plants rooted at the bottom and projecting out of the water for part of their length. Examples: arrowhead (*Sagittaria* spp.), pickerelweed (*Pontederia* spp.)

2. Floating types are those which wholly or in part float on the surface of the water and usually do not project above it. Examples: water shield (*Brasenia* spp.), yellow water lily (*Nuphar* spp.)

3. Submerged types are those which are continuously submerged (except for possible floating or emergent inflorescences). Examples: bladderwort (*Utricularia* spp.), pondweed (*Potamogeton* spp.)

CLINOGRADE is a stratification curve of temperature or of a chemical substance in a lake that exhibits a uniform slope from the surface into deep water.

CULTURAL EUTROPHICATION refers to the enrichment or rapid increase in productivity of a body of water caused by man. It is an accelerated process as opposed to natural, slow aging of a body of water. Visual effects include nuisance algal blooms, low transparency, extensive aquatic plant growth, and loss of cold-water fisheries due to oxygen depletion. It is caused by the rapid increase in nutrient additions to a lake.

DEVELOPMENT OF SHORELINE is the degree of regularity or irregularity of a shoreline expressed as an index figure. It is the ratio of the length of the shoreline to the length of the circumference of a circle of an area equal to that of the lake. It cannot be less than unity. The quantity can be regarded as a measure of the potential effect of littoral processes on the lake.

DEVELOPMENT OF VOLUME is defined as the ratio of the volume of the lake to that of a cone of basal area equal to the lake's area and height equal to the maximum depth.

DIMICTIC LAKE is one with spring and fall turnovers (temperate lakes).

DISSOLVED OXYGEN (D.O.) refers to the uncombined oxygen in water which is available to aquatic life; D.O. is therefore the critical parameter for fish propagation. Numerous factors influence D.O., including organic wastes, bottom deposits, hydrologic characteristics, nutrients, and aquatic organisms. Saturation D.O., or the theoretical maximum value, is primarily a function of temperature. D.O. values in excess of saturation are usually the result of algal blooms and therefore indicate an upset in the ecological balance. Optimum D.O. values range from 6.0 mg/l (minimum allowable for cold water fisheries) to saturation values. The latter range from 14.6 mg/l at $0^{\circ}C$ ($32^{\circ}F$) to 6.6 mg/l at $40^{\circ}C$ ($104^{\circ}F$).

EPILIMNION refers to the circulating, superficial layer of a lake or pond lying above the metalimnion which does not usually exhibit thermal stratification.

HETEROGRADE is a stratification curve for temperature or a chemical substrate in a lake which exhibits a non-uniform slope from top to bottom. It can be positive (metalimnetic maximum) or negative (metalimnetic minimun).

HYPOLIMNION refers to the deep layer of a lake lying below the metalimnion and removed from surface influences (i.e., not circulating).

LENTIC refers to still or calm water, such as lakes or ponds.

LOTIC refers to moving water, such as rivers or streams.

MAXIMUM DEPTH is the maximum depth known for a lake.

MAXIMUM EFFECTIVE LENGTH is the length of a straight line connecting the most remote extremities of a lake along which wing and wave action occur without any kind of land interruption. It is often identical with maximum length.

MAXIMUM EFFECTIVE WIDTH is similar to maximum effective length but at right angles to it.

MAXIMUM LENGTH is the length of a line connecting the two most remote extremities of a lake. It represents the true open-water length and does not cross any land other than islands.

MAXIMUM WIDTH is the length of a straight line connecting the most remote transverse extremities over the water at right angles to the maximum length axis.

MEAN DEPTH is the volume of a lake divided by its surface area.

MEAN DEPTH-MAXIMUM DEPTH RATIO is the mean depth divided by the maximum depth. It serves an an index figure which indicates in general the character of the approach of basin shape to conical form.

MEAN WIDTH is the area of a lake divided by its maximum length.

METALIMNION is the layer of water in a lake between the epilimnion and the hypolimnion in which the temperature exhibits the greatest difference in a vertical direction.

MILLIGRAMS PER LITER (mg/l) is used to express concentrations in water chemistry because it allows simpler calculations than the English System. The basis of the metric system is the unit weight and volume of water at standard conditions ($20^{\circ}C$). At these conditions, one milliliter of water equals one cubic centimeter and weighs one gram. One milligram per liter is therefore essentially equal to one part per million by weight or volume.

NON-POINT SOURCE POLLUTION can be defined as any pollutant which reaches a water body by means other than through a pipe. Examples of non-point sources include leachate from dumps and agricultural runoff from dairy farms.

NUTRIENTS are basically organic compounds made up of carbon, hydrogen, oxygen, nitrogen, phosphorus, and sulfur. Small amounts are vital to the ecological balance of a water body. Larger amounts can lead to an upset of the balance by allowing one type of organism, such as algae, to proliferate. The most significant nutrients in water bodies are those of carbon, nitrogen, and phosphorus. Nutrients of carbon are measured indirectly in the BOD test; separate tests are run to measure nutrients of nitrogen and phosphorus.

ORTHOGRADE is a stratification curve for temperature or a chemical substance in a lake which has a straight, uniform course.

pH is the measure of the hydrogen ion concentration of a solution on an inverse logarithmic scale ranging from 0 to 14. Values from 0 to 6.9 indicate acidic solutions, while values from 7.1 to 14 indicate alkaline solutions. A pH of 7.0 indicates a neutral solution. Natural streams usually show pH values between 6.5 and 7.5, although higher and lower values may be caused by natural conditions. Low pH values may result from the presence of heavy metals from acid mine drainage or metal-finishing waste. High pH values may result from detergents or photosynthetic activities of phytoplankton.

POINT SOURCE OF POLLUTION refers to continuous discharge of pollutants through a pipe or similar conduit. Primarily included are sewage and industrial waste, whether treated or untreated.

SESTON refers to all the particulate matter suspended in the water.

SHORELINE is the length of a lake's perimeter, measured from a map with a rotometer(map measurer).

SILICA ($SiSO_2$) is necessary for diatom growth. The concentration of silica is often closely linked with the diatom population's growth. The limiting concentration is usually considered to be 0.5 mg/l.

THERMOCLINE is coincident with the metalimnion and relates to the lakes zone with the greatest temperature change in a vertical direction.

VOLUME is determined by computing the volume of each horizontal stratum as limited by the several submerged contours on the bathymetric (hydrographic) map and taking the sum of the volumes of all such strata.

# APPENDIX D

## CHLOROPHYLL a

## PROCEDURES

I. Reagents and apparatus

A. Flourometer

1. "Blue lamp" Turner No. 110-853
2. Excitation Filter: Corning CS-5-60, #5543, 2 $in^2$, 4.9 mm polished
3. Emission Filter: Corning CS-2-64, #2408 2 $in^2$, 3.0 mm polished
4. R-136 photo multiplier tube

B. Tissue grinder and tube

C. Vacuum flask and pump

D. Millipore filter holder

E. Glass fiber filters: Reeve Angel, grade 934AH, 2.1 cm.

F. Centrifuge (Fisher Scientific Safety Centrifuge)

G. 15 ml graduated conical end centrifuge tubes with rubber stoppers

H. 90% acetone

I. 1 N HCl (11.1 dilution of distilled water to conc. HCl)

J. Saturated Magnesium Carbonate solution in distilled $H_2O$

II. Procedure

A. Filter 50 ml (or less if necessary) of sample through glass fiber filter under vacuum

B. Push the filter to the bottom of tissue grinding tube

C. Add about 3 ml of 90% acetone and 0.2 ml of the $MgCO_3$ solution

D. Grind contents for 3 minutes

E. The contents of the grinding tube are carefully washed into a 15 ml graduated centrifuge tube

F. Q.S. to 10 ml with 90% acetone

G. Tubes are then centrifuged for 20 minutes and the supernatent decanted immediately into stoppered test tubes.

H. Test tubes are wrapped with aluminum foil and stored in the refrigerator for 24 hours.

I. The tubes are allowed to come to room temperature, the temperature recorded, the samples poured into cuvettes, and then the samples are read on the fluorometer. (The fluorometer must be warmed up for at least ½ hr. before taking a reading.)

J. 0.2 ml of the 1 N HCl solution is added to the sample in the cuvette, the cuvette stoppered and inverted and righted 4 times to mix thoroughly, and the sample is read again

K. Both values are recorded, along with the window orifice size and whether the high-sensitivity or the regular door was used

# APPENDIX E

## REVIEW COMMUNICATIONS

Preliminary copies of the White Island Pond Water Quality Study were sent to federal, state, and local organizations for review. The letters to each organization, the letters containing review comments, and the responses to the comments are enclosed on the following pages:[1]

[1] Letters to each organization are included even if no review comments were received.

OFFICE OF THE DIRECTOR

# The Commonwealth of Massachusetts

## Water Resources Commission

Division of Water Pollution Control

110 Tremont Street, Boston 02108

February 29, 1980

Gayle E. Whittaker
Assistant Sanitary Engineer
Division of Water Pollution Control
P.O. Box 545
Westborough, Massachusetts 01581

Dear Ms. Whittaker:

I have reviewed the draft report relative to White Island Pond and find it to be consistent with the goals and objectives for lake water quality as defined by the Division of Water Pollution Control. This report presents a comprehensive view of lake and watershed conditions and will prove to be a useful tool for the restoration and preservation of White Island Pond.

Sincerely,

Thomas C. McMahon
Director

TCM/lg

THOMAS C. McMAHON
DIRECTOR

*The Commonwealth of Massachusetts*

*Water Resources Commission*

*Division of Water Pollution Control*

*Water Quality and Research Section*

*P.O. Box 545- Westborough, Mass. 01581*

January 24, 1980

Mr. Richard Post, Chairman
Board of Selectmen
Town Hall
54 Marion Road
Wareham, MA 02571

Dear Mr. Post:

The Division of Water Pollution Control has completed a water quality study of White Island Pond in Plymouth/Wareham, Massachusetts in partial fulfillment of requirements for the Clean Lakes Program (section 314 of the 1977 Amendments to the Federal Water Pollution Control Act, PL 95-217). A preliminary copy of the final report on this study is enclosed.

I would appreciate it if you would review the report and forward your written comments to me by February 29, 1980. Also, at that time, please indicate if you wish to receive a copy of the final report. All letters of correspondence will be included in the final report.

Thank you for your assistance and interest in the Clean Lakes Program.

Sincerely yours,

Gayle E. Whittaker
Gayle E. Whittaker
Assistant Sanitary Engineer

GEW/vn

Enclosure

TOWN OF WAREHAM

# Board of Selectmen

RICHARD W. POST, JR.
Chairman
JANE BEATON
Clerk
CLAIRE J. MC WILLIAMS
JOHN A. KELENOSY
CARLETON D. HAMMOND, JR.

Richard J. Bowen
Town Administrator

Wareham, Mass. 02571
TELEPHONE 295-0800 EXT. 10 & 11

March 7, 1980

Gayle E. Whittaker, Assistant Sanitary Engineer
The Commonwealth of Massachusetts
Water Resources Commission
Division of Water Pollution Control
Water Quality and Research Section
P. O. Box 545
Westborough, Ma. 01581

Dear Ms. Whittaker:

The Board of Selectmen at their meeting on March 4, 1980 voted unanimously to approve the Division of Water Pollution Control's preliminary report of a water quality study of White Island Pond in Plymouth/Wareham, Ma. This decision was reached after factual evaluation data was presented to the Selectmen by several of Wareham's Town Departments after their review and study.

The Selectmen's decision was based on the conclusions listed in the preliminary report Numbers 1 through 4.

Thank you for your patience in this matter.

Very truly yours,

Richard J. Bowen
Town Administrator

RJB:shr

*The Commonwealth of Massachusetts*
*Water Resources Commission*
*Division of Water Pollution Control*
*Water Quality and Research Section*
*P.O. Box 545- Westborough. Mass. 01581*

THOMAS C. McMAHON
DIRECTOR

January 24, 1980

A. D. Makepeace Company
P.O. Box 151
Wareham, Ma 02571

Attn: Mr. Marshall Severance

Dear Mr. Severance:

The Division of Water Pollution Control has completed a water quality study of White Island Pond in Plymouth/Wareham, Massachusetts in partial fulfillment of requirements for the Clean Lakes Program (section 314 of the 1977 Amendments to the Federal Water Pollution Control Act, PL 95-217). A preliminary copy of the final report on this study is enclosed.

I would appreciate it if you would review the report and forward your written comments to me by February 29, 1980. Also, at that time, please indicate if you wish to receive a copy of the final report. All letters of correspondence will be included in the final report.

Thank you for your assistance and interest in the Clean Lakes Program.

Sincerely yours,

Gayle E. Whittaker

Gayle E. Whittaker
Assistant Sanitary Engineer

GEW/vn

Enclosure

# A. D. MAKEPEACE COMPANY

266 MAIN STREET · WAREHAM, MASS. 02571

TELEPHONE: 617-295-1000


March 13, 1980

Gayle E. Whittaker
Division of Water Pollution Control
P. O. Box 545
Westborough, MA 01581

Dear Ms. Whittaker:

We have read your water quality study of White Island Pond with great interest. It is informative and quite detailed.

We shall continue to use our usual caution in the application of fertilizer and in irrigation methods.

We are happy to have been able to help you. If you need any more information please feel free to call upon us.

Yours very truly,

Marshall C. Severance

Marshall C. Severance

MCS/bmp

THOMAS C. McMAHON
DIRECTOR

*The Commonwealth of Massachusetts*
*Water Resourses Commission*
*Division of Water Pollution Control*
*Water Quality and Research Section*
*P.O. Box 545. Westborough, Mass. 01581*

January 24, 1980

Mr. Jeff Gould, Regional Engineer
Division of Water Pollution Control
Southeast Regional Office
P.O. Box 537
North Pembroke, MA 02350

Dear Mr. Gould:

The Division of Water Pollution Control has completed a water quality study of White Island Pond in Plymouth/Wareham, Massachusetts in partial fulfillment of requirements for the Clean Lakes Program (section 314 of the 1977 Amendments to the Federal Water Pollution Control Act, PL 95-217). A preliminary copy of the final report on this study is enclosed.

I would appreciate it if you would review the report and forward your written comments to me by February 29, 1980. Also, at that time, please indicate if you wish to receive a copy of the final report. All letters of correspondence will be included in the final report.

Thank you for your assistance and interest in the Clean Lakes Program.

Sincerely yours,

Gayle E. Whittaker

Gayle E. Whittaker
Assistant Sanitary Engineer

GEW/vn

Enclosure

*The Commonwealth of Massachusetts*
*Water Resources Commission*
*Division of Water Pollution Control*
*55 Congress Street*
*North Pembroke 02358*

SOUTHEAST REGIONAL OFFICE
P. O. BOX 537
N. PEMBROKE 02358

February 6, 1980

Ms. Gayle E. Whittaker
Assistant Sanitary Engineer
Water Quality Section,
Division of Water Pollution Control
P. O. Box 545
Westborough, Mass. 01581

Re: Plymouth (SCW)
White Island Pond
Water Quality Study
1976 - 1978

Dear Ms. Whittaker,

This office has reviewed the preliminary draft of the above referenced report and found the content of your section's study to be consistant with records and past examinations of this office.

It would be greatly appreciated if the Southeast Regional Office could be forwarded ten (10) copies of the final report.

Very truly yours,

Jeffrey E. Gould
Acting Southeast Regional Engineer

JEG/pd

*The Commonwealth of Massachusetts*

*Water Resources Commission*

*Division of Water Pollution Control*

*Water Quality and Research Section*

*P.O. Box 545- Westborough, Mass. 01581*

THOMAS C. McMAHON
DIRECTOR


January 24, 1980

Mr. Paul Anderson, District Engineer
Department of Environmental Quality Engineering
Southeastern Mass. Air Pollution Control District
Lakeville State Hospital
Main Street
Lakeville, Ma 02346

Dear Mr. Anderson:

The Division of Water Pollution Control has completed a water quality study of White Island Pond in Plymouth/Wareham, Massachusetts in partial fulfillment of requirements for the Clean Lakes Program (section 314 of the 1977 Amendments to the Federal Water Pollution Control Act, PL 95-217). A preliminary copy of the final report on this study is enclosed.

I would appreciate it if you would review the report and forward your written comments to me by February 29, 1980. Also, at that time, please indicate if you wish to receive a copy of the final report. All letters of correspondence will be included in the final report.

Thank you for your assistance and interest in the Clean Lakes Program.

Sincerely yours,

Gayle E. Whittaker
Assistant Sanitary Engineer

GEW/vn

Enclosure

THOMAS C. McMAHON
DIRECTOR

The Commonwealth of Massachusetts
Water Resources Commission
Division of Water Pollution Control
Water Quality and Research Section
P.O. Box 545- Westborough, Mass. 01581

January 24, 1980

Southeastern Regional Planning &
Economic Development District
Corner of Spring & Main Street
Marion, MA 02738

Attn: Alex Zaleski

Dear Mr. Zaleski:

The Division of Water Pollution Control has completed a water quality study of White Island Pond in Plymouth/Wareham, Massachusetts in partial fulfillment of requirements for the Clean Lakes Program (section 314 of the 1977 Amendments to the Federal Water Pollution Control Act, PL 95-217). A preliminary copy of the final report on this study is enclosed.

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Water Quality and Research Section
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THOMAS C. McMAHON
DIRECTOR

January 24, 1980

Mr. Wayne A. Fisher, Chairman
White Island Pond Association
150 Sandy Beach Road
Plymouth, Ma. 02360

Dear Mr. Fisher:

The Division of Water Pollution Control has completed a water quality study of White Island Pond in Plymouth/Wareham, Massachusetts in partial fulfillment of requirements for the Clean Lakes Program (section 314 of the 1977 Amendments to the Federal Water Pollution Control Act, PL 95-217). A preliminary copy of the final report on this study is enclosed.

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THOMAS C. McMAHON
DIRECTOR

The Commonwealth of Massachusetts
Water Resourses Commission
Division of Water Pollution Control
Water Quality and Research Section
P.O. Box 545- Westborough, Mass. 01581

January 24, 1980

Mr. David Tarantino, Chairman
Board of Selectmen
Town Hall
11 Lincoln Street
Plymouth, Ma 02360

Dear Mr. Tarantino:

The Division of Water Pollution Control has completed a water quality study of White Island Pond in Plymouth/Wareham, Massachusetts in partial fulfillment of requirements for the Clean Lakes Program (section 314 of the 1977 Amendments to the Federal Water Pollution Control Act, PL 95-217). A preliminary copy of the final report on this study is enclosed.

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DIRECTOR

*The Commonwealth of Massachusetts*
*Water Resourses Commission*
*Division of Water Pollution Control*
*Water Quality and Research Section*
*P.O. Box 545- Westborough, Mass. 01581*

January 24, 1980

Mr. Malcolm MacGregor, Chairman
Conservation Commission
Town Hall
11 Lincoln Street
Plymouth, MA 02360

Dear Mr. MacGregor:

The Division of Water Pollution Control has completed a water quality study of White Island Pond in Plymouth/Wareham, Massachusetts in partial fulfillment of requirements for the Clean Lakes Program (section 314 of the 1977 Amendments to the Federal Water Pollution Control Act, PL 95-217). A preliminary copy of the final report on this study has been sent to the Board of Selectmen for review.

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Gayle E. Whittaker
Assistant Sanitary Engineer

GEW/vn

THOMAS C. McMAHON
DIRECTOR

*The Commonwealth of Massachusetts*

*Water Resourses Commission*

*Division of Water Pollution Control*

*Water Quality and Research Section*

*P.O. Box 545- Westborough, Mass. 01581*

January 24, 1980

Mr. David Carreau, Chairman
Board of Public Health
Town Hall
11 Lincoln Street
Plymouth, MA 02360

Dear Mr. Carreau:

The Division of Water Pollution Control has completed a water quality study of White Island Pond in Plymouth/Wareham, Massachusetts in partial fulfillment of requirements for the Clean Lakes Program (section 314 of the 1977 Amendments to the Federal Water Pollution Control Act, PL 95-217). A preliminary copy of the final report on this study has been sent to the Board of Selectmen for review.

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THOMAS C. McMAHON
DIRECTOR

*The Commonwealth of Massachusetts*
*Water Resourses Commission*
*Division of Water Pollution Control*
*Water Quality and Research Section*
*P.O. Box 545. Westborough, Mass. 01581*

January 24, 1980

Mr. Louis Cotti, Chairman
Planning Board
Town Hall
11 Lincoln Street
Plymouth, Ma 02360

Dear Mr. Cotti:

The Division of Water Pollution Control has completed a water quality study of White Island Pond in Plymouth/Wareham, Massachusetts in partial fulfillment of requirements for the Clean Lakes Program (section 314 of the 1977 Amendments to the Federal Water Pollution Control Act, PL 95-217). A preliminary copy of the final report on this study has been sent to the Board of Selectmen for review.

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THOMAS C. McMAHON
DIRECTOR

The Commonwealth of Massachusetts
Water Resourses Commission
Division of Water Pollution Control
Water Quality and Research Section
P.O. Box 545- Westborough, Mass. 01581

January 24, 1980

Mr. David Warr, Chairman
Wareham Conservation Commission
184 High Street
Wareham, MA 02571

Dear Mr. Warr:

The Division of Water Pollution Control has completed a water quality study of White Island Pond in Plymouth/Wareham, Massachusetts in partial fulfillment of requirements for the Clean Lakes Program (section 314 of the 1977 Amendments to the Federal Water Pollution Control Act, PL 95-217). A preliminary copy of the final report on this study has been sent to the Board of Selectmen for review.

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Gayle E. Whittaker
Assistant Sanitary Engineer

GEW/vn

The Commonwealth of Massachusetts
Water Resourses Commission
Division of Water Pollution Control
Water Quality and Research Section
P.O. Box 545- Westborough, Mass. 01581

THOMAS C. McMAHON
DIRECTOR

January 24, 1980

Board of Public Health
Town Hall
54 Marion Road
Wareham, Ma. 02571

Dear Gentlemen:

The Division of Water Pollution Control has completed a water quality study of White Island Pond in Plymouth/Wareham, Massachusetts in partial fulfillment of requirements for the Clean Lakes Program (section 314 of the 1977 Amendments to the Federal Water Pollution Control Act, PL 95-217). A preliminary copy of the final report on this study has been sent to the Board of Selectmen for review.

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THOMAS C. McMAHON
DIRECTOR

*The Commonwealth of Massachusetts*

*Water Resourses Commission*

*Division of Water Pollution Control*

*Water Quality and Research Section*

*P.O. Box 545- Westborough, Mass. 01581*

January 24, 1980

Planning Board
Town Hall
54 Marion Road
Wareham, Ma. 02571

Gentlemen:

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