LAKE WATER QUALITY ASSESSMENT REPORT

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

DIVISION OF WATER RESOURCES

SHEPHERDS LAKE

RINGWOOD TOWNSHIP, PASSAIC COUNTY

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PREFACE

The 1986 revisions to the Clean Water Act requires states to provide the United States Environmental Protection Agency (USEPA) with water quality information on public lakes. This information is a prerequisite for eligibility in the USEPA Clean Lakes Program.

The New Jersey Department of Environmental Protection obtained a grant to assess the water quality of the State's lakes during 1989. The objectives of the FY 89 Project were to acquire limited limnological data for 21 lakes. The data was analyzed to determine the trophic status for each lake.

Lakes were selected based on several criteria which included; the amount of public access the lake provided, it's recreational usage (e.g. swimming, fishing, ...) and it's value as a local resource. The following lakes were surveyed during 1989:

COUNTY	LAKE
Burlington	Lake Absegami
	Crystal Lake
	Evans Pond
	Indian Mills Lake
	Jefferson Lake
	Smithville Lake
Camden	Cooper River Lake
Cape May	East Creek Pond
	Lake Nummy
Gloucester	Greenwich Lake
	Iona Lake
	Narriticon Lake
Mercer	Mercer County Park Lake
	Rosedale Lake
Middlesex	Brainerd Lake
	Farrington Lake
Monmouth	Mac's Pond
Morris	Lake Ames
	Mount Hope Pond
Ocean	Lake Carasaljo
Passaic	Shepherds Lake

CONTENTS

SCOPE OF SURVEY

The quality of a lake's water is determined by many factors. These factors may be found within the lake itself or they may come from the watershed surrounding it. The collection of data through sampling and measurements can help to determine what may be influencing the lake's water quality. Although the scope covered by this report is somewhat limited, the following data may be found:

1. Limited Historical Data
2. Geology
3. Morphology and Hydrology
4. Physical & Chemical Data Results
5. Biological Data

All lakes in the program were monitored three times during the year; once each during the spring, summer and fall. Samples were taken at the major inlets and at sites deemed representative of the entire lake. Samples were taken above the outlet when a boat was unavailable. The samples were analyzed for the following parameters:

In-situ analysis:

1. Temperature
2. Dissolved Oxygen
3. pH
4. Depth and Secchi readings
5. Visual check of Macrophytes

Laboratory Analysis (NJ Department of Health):

1. Bacterial Analysis
2. Alkalinity
3. Nutrients

Biological Analysis (Bio-Monitoring Unit of the NJDEP):

1. Chlorophyll a
2. Algal Scan (Microscopic)
3. Macrophyte Survey

EXPLANATION OF PARAMETERS SAMPLED

PHYSICAL AND CHEMICAL PARAMETERS

1. TEMPERATURE AND DISSOLVED OXYGEN (D.O.):
The temperature of a shallow lake generally follows climatic changes. As the temperature of the water increases the dissolved oxygen level of the water decreases. A deeper lake will usually stratify thermally, during the summer. A warmer, less dense layer of water (epilimnion) will float on a cooler, denser layer of water (hypolimnion). These two layers are separated by a zone of rapidly changing temperature and density called the metalimnion. The metalimnion, can form a barrier, which can keep the hypolimnion from being reoxygenated from the atmosphere. In a productive (eutrophic) lake this can cause anoxic conditions in the hypolimnion as oxygen is used up by animals and decomposers (bacteria).

2. ALKALINITY AND pH:
Alkalinity is a measurement that indicates the degree to which an aquatic system can buffer pH changes that can occur during photosynthesis and/or by the introduction of pollutants. The toxicity of certain pollutants can be reduced by this buffering action. A minimum of 20 mg/L $CaCO_3$ has been recommended, except where natural conditions are lower (Quality Critera for Water, 1986, EPA 440/5-86-001). The Pine Barrens are an example of an area where natural conditions favor low alkalinity.
PH is a measurement of hydrogen ion activity or the acid-base equilibruim in natural waters. The pH can be raised by the photosynthetic processes of algae and/or macrophytes.

EXPLANATION OF PARAMETERS SAMPLED

3. NUTRIENT ANALYSIS:
Phosphorus and nitrogen are the major nutrients required by algae for growth. In New Jersey's lakes, phosphorus is the nutrient most often responsible for limiting algal growth. Dissolved orthophosphorus is believed to approximate the solid reactive phosphorus used by all photosynthetic organisms (aquatic plants/ algae). However, all forms of total phosphorus can become reactive through biological decomposition and can be used as nutrients to enhance weed growth and/or algae blooms.

Nutrients can enter a lake or it's watershed via point (i.e. sewerage treatment plant) or nonpoint sources (i.e. fertilizer runoff from lawns). Nutrients may also be recycled from the sediments in the lake.

4. SECCHI DISC TRANSPARENCY:
A greater depth of light transmission generally indicates good water quality (low algal growth). However, heavy macrophyte growth can also keep the water clear. The macrophytes may outcompete the algae for nutrients and therefore, restrict most algal growth. Erosion from the watershed or upwelling of the lake's sediments, from adverse weather conditions, could also decrease the water's transparency. To determine the transparency of a lake's water a secchi disk is used. The secchi disk is an 8 inch black and white disk. Measurements are taken by lowering the disk until it is no longer visible.

EXPLANATION OF PARAMETERS SAMPLED

BIOLOGICAL DATA

1. BACTERIAL ANALYSIS:

Bacterial samples for Total coliform, Fecal coliform (FC) and Fecal streptococcus (FS) were taken at the inlets and in-lake. While sources are difficult to determine with 3 sampling runs, the ratio of FC/FS can imply whether the source is from human or animal waste.

FC/FS	Possible Bacterial source (Millipore Corp. 1972)
>4	-Human wastes
2-4	-Mainly human wastes and other sources
1-2	-Inconclusive
0.7-1	-Mainly animal wastes and other sources
<.7	-Animal wastes

A lake's water is considered unsafe for swimming when Fecal coliform levels exceed 200 mpn/100ml.

2. CHLOROPHYLL a/ALGAE

Chlorophyll a is a pigment that is present in all types of algae. The chlorophyll a content of the water can indicate the amount of planktonic algae present in the lake. Algae are an important part of a lake ecosystem because they are a vital part of the food chain. However, an excessive amount of algae can negatively impact a lake. Excessive algae growth can inhibit the growth of other plants, cause aesthetic problems and curtail recreational uses. Through the processes of photosynthesis, increased algal growth can raise the dissolved oxygen level in a lake during the daytime (sunlight) and decrease the dissolved oxygen level during the night (dark). Depressed dissolved oxygen levels, if extreme, could cause fishkills.

EXPLANATION OF PARAMETERS SAMPLED

3.ALGAL SURVEY:
As the growing season proceeds, a succession of algal communities typically occurs in a lake. During the spring and fall, diatoms are usually dominant. In the early summer, chlorophytes (green algae) become dominant. As available nutrients change during the summer, filamentous green or blue-green algae may become dominant. These may float to the surface forming mats that can cause aesthetic and recreational problems.

High chlorophyll a levels with little algal species diversity are indicative of nutrient rich water.

4.MACROPHYTE SURVEY:
Macrophytes are also a vital part of a lake. They provide cover for fish and food for wildlife. However, excessive macrophyte growth can limit the recreational uses of a lake including swimming, fishing and boating. A visual survey was done to identify and determine areal coverage of macrophytes.

LAKE TROPHIC STATES

Lake eutrophication (aging) is a natural process resulting from the gradual accumulation of nutrients, increased productivity, and filling in from sediments, silt and organic matter.

Lakes usually follow a progression through a series of trophic states, which are the following:

1. Oligotrophic
   - -nutrient poor and low biological productivity.

2. Mesotrophic
   - -intermediate levels of nutrients and biological productivity.

3. Eutrophic
   - -nutrient rich and highly productive.

Accelerated or cultural eutrophication occurs to a lake when nutrients, silt and organic matter inputs are increased by activity in the watershed. Several examples of increased inputs include; a sewage treatment plant discharging into a lake, runoff of fertilizers from farms or lawns, and erosion from new construction sites. Because of New Jersey's large population, all lakes in the State are considered to be threatened by accelerated eutrophication.

INTRODUCTION

Shepherds Lake is a 74 acre body of water that is part of the Ringwood State Park located in Passaic County. The lake is fed by underground springs and has a maximum depth of about thirty feet. Recreational uses of the lake include swimming, fishing and boating. There is a large beach with guarded swimming area and picnic area, a boat launch and a small marina with boats for rent.

LAKE NUM.AND NAME: #7072 SHEPHERDS LAKE

STUDY PERIOD: SPRING, SUMMER, FALL 1989

LOCATION: RINGWOOD TWP., PASSAIC CO.

U.S.G.S. QUAD: #3 SLOATSBURG

LAKE AREA: 74 ACRES

LAKE MAXIMUM DEPTH: 30 ft.

GEOLOGIC DESIGNATION: IGW LOOSE GNEISS

TRIBUTARIES: NONE

LAKE USE AND HISTORICAL NOTES: SWIMMING, FISHING, BOATING.
SAMPLED 1975, 1976 AND 1977.

COMMENTS: EDGES AND COVES HAVE HEAVY GROWTH OF PONDWEED AND COONTAIL. POTENTIAL RUNOFF FROM SURROUNDING WOODLANDS AND PARK.

RESULTS

PHYSICAL/CHEMICAL PARAMETERS

Temperature and Dissolved Oxygen

Because of it's depth, Shepherds Lake was thermally stratified during each sampling run. Anoxic conditions were present in the lake's hypolimnion during both the summer and fall.

Secchi Disk

The transparency of the water was relatively good ranging from about 8 feet during the spring to about 15 feet during the fall.

Alkalinity and pH

The alkalinity of the water ranged from 15 mg/l to 19 mg/l and therefore, offered little buffering capacity. The pH fluctuated from a high of 7.75 during elevated algae growth in the spring to 6.87 during the fall.

Nutrients

Total phosphorus levels in the water column were 0.03 mg/l for each sampling run.

RESULTS

BIOLOGICAL DATA

Chlorophyll a/Algae

Chlorophyll a levels were 12.46 mg/m^3 during the spring and 6.46 mg/m^3 and 3.89 mg/m^3 for the summer and fall respectively. There was little species diversity, with the diatom tabellaria dominant during the summer only.

Macrophytes

Two types of macrophytes were predominant in Shepherd Lake, pondweed (Potamogeton spp.) and water milfoil (Myriophyllum spp.). Their growth was confined to the shallower sides and upper portion of the lake and their areal coverage was equal to about 30% of the lake.

Bacteria

Fecal coliform levels were less than 20 mpn/100ml for each sampling run and therefore, the lake was considered safe for swimming on these days.

CONCLUSION

Shepherds Lake is an excellent recreational resource that is utilized for swimming, boating and fishing. Although it's water quality appears to be good, with relatively low nutrient levels and fair to good transparency, the lake was experiencing some problems that help categorize it as eutrophic. Those problems included aquatic macrophytes that were growing wherever the depths of the lake were shallow enough for light penetration (up to about 10 feet) and anoxic conditions in the hypolimnion of the lake.

The aquatic macrophyte growth in Shepherds Lake had some impact on recreational use as well as the ecology of the lake. Several areas of the lake (upper-most end, parts of the shoreline and coves) were restricted to fishing and boating because of heavy macrophyte growth. The macrophytes were also partially responsible for the low dissolved oxygen levels in the hypolimnion. When macrophytes die, they sink and settle on the lake bottom becoming a part of the lake's sediments. The decomposition of these plants by bacteria increases the oxygen consumption in the hypolimnion. The combination of respiration from bacteria and the other organisms inhabiting the hypolimnion could deplete the dissolved oxygen, especially in a deep stratified lake such as Shepherds. Stratification restricts oxygen from the surface mixing with the hypolimnion and depth precludes any light from penetrating to the lower depths to allow for oxygen producing photosynthesis by plants. These anoxic conditions are lethal to many organisms including favorable fish species and may preclude some cold water species such as trout from surviving in the lake. Anoxic conditions in the hypolimnion also favors the release of nutrients from the sediments which could lead to increased algal production.

REFERENCES

Aquatic Vegetation of New Jersey. 1965. Rutgers Extension Service Bulletin # 382.

Lake and Reservoir Restoration Guidance Manual. 1988. North American Lake Management Society. First Edition.

NJDEP. 1987. Water Resources Field Procedures Manual.

Trudeau, Philip N. 1982. Nuisance Aquatic Plants and Aquatic Plant Management Programs in The United States.

USEPA 1980. Clean Lakes Program Guidance Manual. EPA 440/5-81-003.

Wetzel, Robert G. 1983. Limnology. Saunders College Publishing, New York.

APPENDIX

STATION	DATE	TEMP	D O	pH	ALK	TOT P	ORTHO P	F COLI	F STREP	TOT COLI	FC/FS	SECCHI (feet)
LOWER LAKE	06/07/89	22.0	7.9	7.69	15	.02	<.01	20	22	20	NA	8.0
	07/19/89	25.4	9.2	6.94	28	.03	<.01	<20	2	<20	NA	10.5
	09/11/89	25.5	8.9	6.93	18	.03	.04	<20	2	60	NA	15.0
UPPER LAKE	06/07/89	22.0	7.9	7.75	15	.03	<.01					
	07/19/89	25.0	9.3	7.39	19	.03	<.01					
	09/11/89	25.6	8.9	6.87	19	.03	.03					

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
GEOLOGICAL SURVEY
LABORATORY OPERATIONS SECTION

89/06/07
Sample No. 61480
Lakes Management
Shepherd Lake, NJ

Plankton Identification

CHLOROPHYCEAE (green)
Chlamydomonas sp.
Palmella mucosa

EUGLENOPHYCEAE (motile green)
Lepocinclis texta

BACILLARIOPHYCEAE (diatom)
Synedra sp.

MYXOPHYCEAE (blue-green or other color)
Anabaena circinalis

Chlorophyll Analysis

Chlorophyll "a" (mg/m^3) = 12.46

Analyst(s)/Unit _____

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
GEOLOGICAL SURVEY
LABORATORY OPERATIONS SECTION

89/07/19
Sample No. 76839
Lakes Management
Shepherd Lake (lower lake), NJ

Plankton Identification

CHLOROPHYCEAE (green)
Chlamydomonas sp.
Chlorella vulgaris

CHRYSOPHYCEAE (golden or brown)
Mallomonas acaroides

BACILLARIOPHYCEAE (diatom)
Tabellaria fenestrata **DOMINANT**

DINOPHYCEAE (dinoflagellate)
Ceratium hirundinella
Gymnodinium sp.
Peridinium aciculiferum

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Macrophyte Identification

Ceratophyllum demersum
Tilleae aquatica

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Chlorophyll Analysis

Chlorophyll "a" (mg/m^3) = 6.46

Analyst(s)/Unit _____

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
GEOLOGICAL SURVEY
LABORATORY OPERATIONS SECTION

89/09/11
Sample No. 76019
Lakes Management
Shepherd Lake (lower lake), NJ

Plankton Identification

CHLOROPHYCEAE (green)
Chlorella vulgaris
Scenedesmus sp.

EUGLENOPHYCEAE (motile green)
Trachelomonas hispida
T. volvocina

CHRYSOPHYCEAE (golden or brown)
Mallomonas caudata

DINOPHYCEAE (dinoflagellate)
Peridinium sp.

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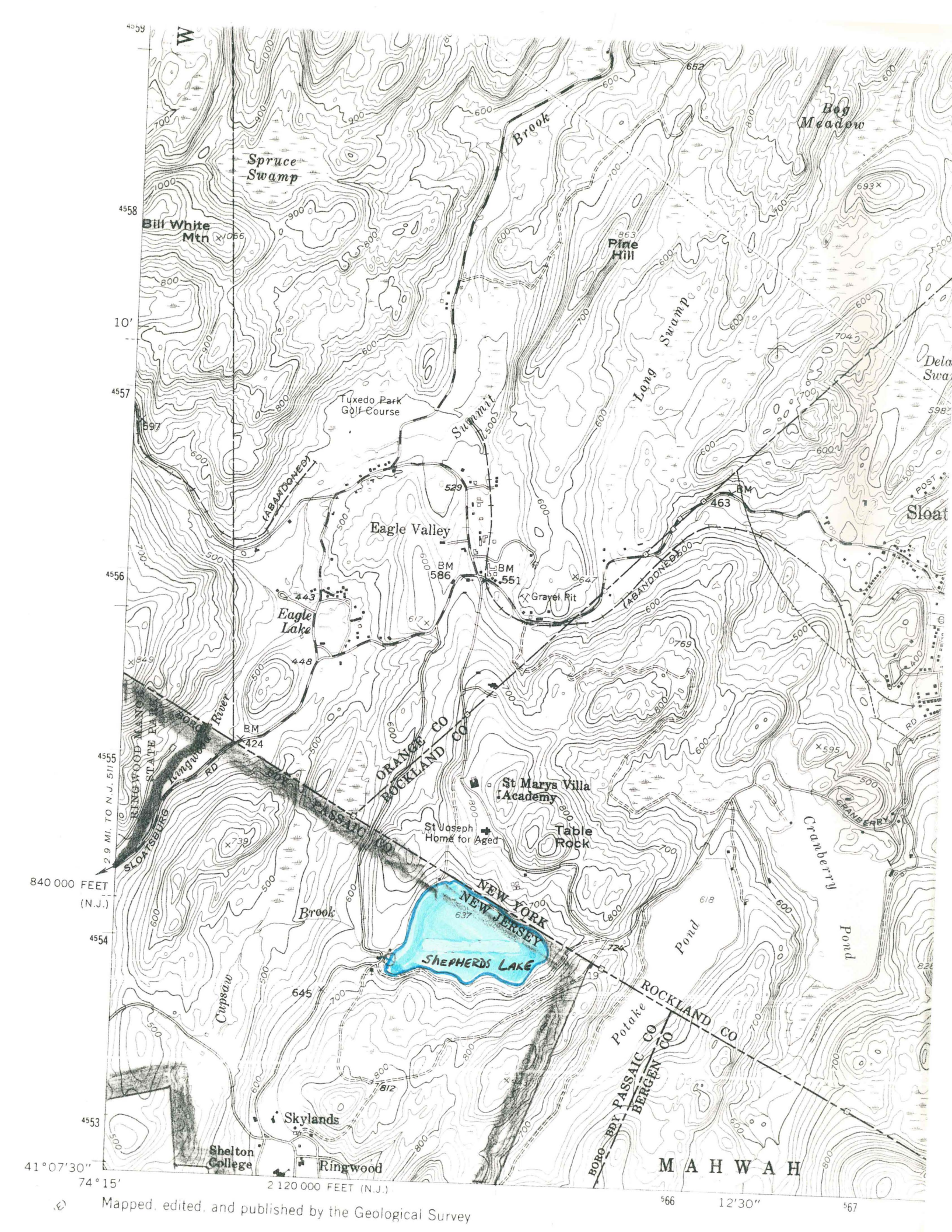
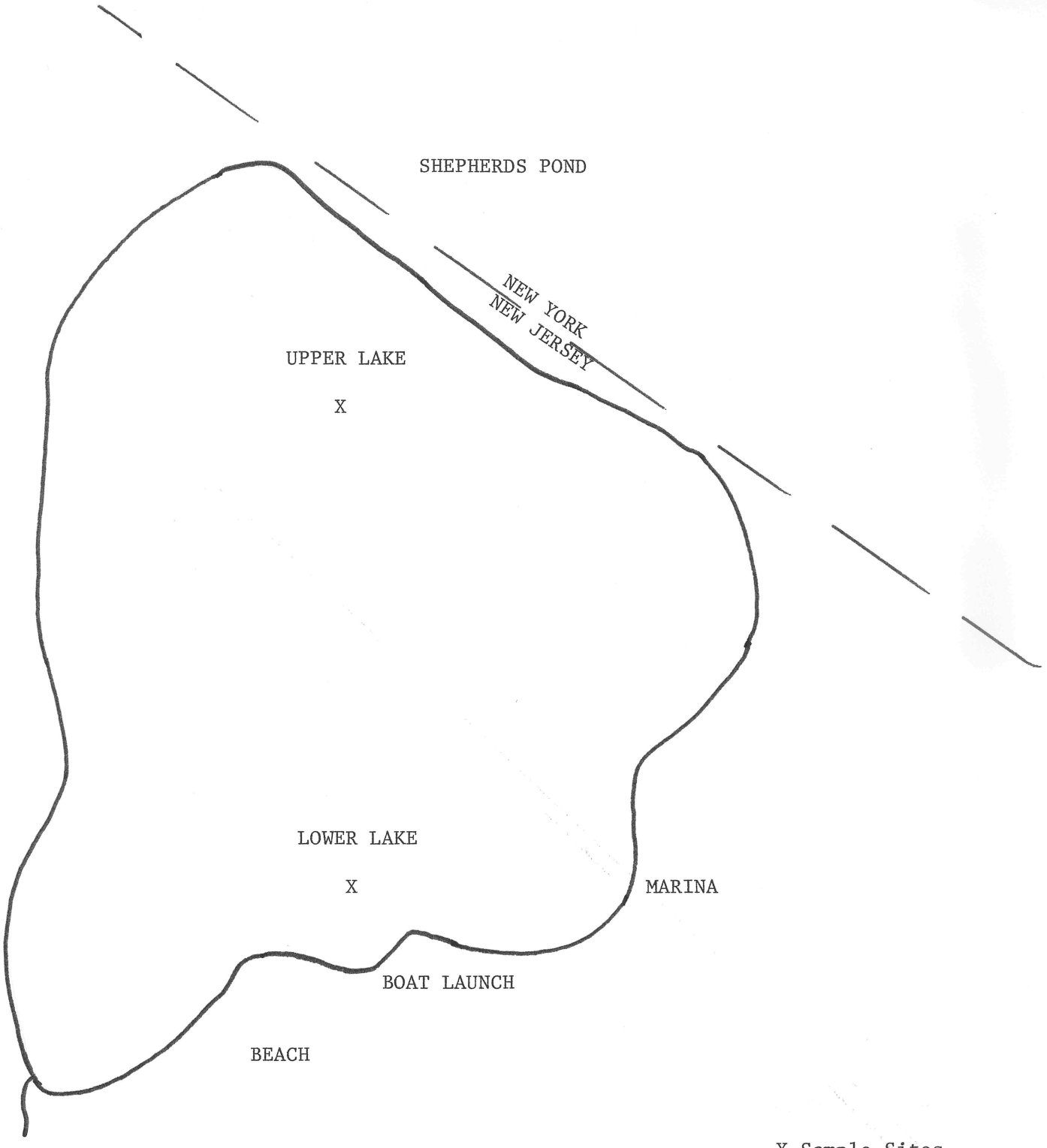
Chlorophyll Analysis

Chlorophyll "a" (mg/m^3) = 3.89

Analyst/Unit _____





X-Sample Sites