

LAKE WATER QUALITY ASSESSMENT REPORT
NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

GREENWICH LAKE
GREENWICH TOWNSHIP, GLOUCESTER 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 Cape May	Cooper River Lake 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 Passaic	Lake Carasaljo Shepherds Lake

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Appendix includes	
-Data	
-Algae identification	
-Map of lake and watershed	
-Map with sampling stations	

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 CaCO₃ has been recommended, except where natural conditions are lower (Quality Criteria 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 equilibrium 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 its 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

Greenwich Lake is a 35 acre body of water that is part of a county park located in Greenwich, Gloucester County. The lake is surrounded by several small ponds none of which comes in direct contact with the lake. The lake has no major inlets and has a maximum depth of about twenty feet. The lake has a guarded swimming area, a boat launch and much of the lake is accessible to fishing from the shoreline. The lake is stocked with trout by the State of New Jersey.

LAKE NUM. AND NAME: #3192 GREENWICH LAKE

STUDY PERIOD: SPRING, SUMMER, FALL 1989

LOCATION: GREENWICH TWP., GLOUCESTER CO.

U.S.G.S. QUAD: #30 BRIDGEPORT

LAKE AREA: 35 ACRES

LAKE MAXIMUM DEPTH: 20 ft.

GEOLOGIC DESIGNATION: QCM SURFACE ON KMR MAGOTHY & RARITAN

TRIBUTARIES: NONE

LAKE USE AND HISTORICAL NOTES: SWIMMING, BOATING, FISHING.
SAMPLED BY NJDEP IN 1975, 1976
AND 1981.

RESULTS

PHYSICAL/CHEMICAL PARAMETERS

Temperature and Dissolved Oxygen

Greenwich Lake was stratified during the summer and fall samplings. The dissolved oxygen levels were fairly uniform throughout the water column until the fall sampling run when dissolved oxygen levels in the hypolimnion were 0.11 mg/l.

Secchi Disk

Transparency of the lake's water ranged between 4.0 feet and 5.5 feet.

Alkalinity and pH

The alkalinity of the water ranged from 15 mg/l to 16 mg/l and therefore, offered little buffering capacity. An elevated pH of 9.32 was observed during the algae bloom in the summer. The pH was near 7.40 for the spring and fall.

Nutrients

Total phosphorus levels in the water column were high in the summer sample (0.06 mg/l). A level of 0.03 mg/l was recorded for both the spring and fall.

RESULTS

BIOLOGICAL DATA

Chlorophyll a/Algae

Chlorophyll a levels were 9.02 mg/m³ and 14.28 mg/m³ for the summer and fall respectively (analysis not performed on spring sample due to lab malfunction). Anabaena and Chlorella were co-dominant species in the summer. Both of these species are associated with nutrient-rich waters.

Macrophytes

There was little growth of aquatic macrophytes within the lake. Small patches of spatterdock (Nuphar spp.) were present along the shoreline covering about 1% of the lake. The ponds surrounding the lake had denser populations of spatterdock.

Bacteria

Fecal coliform levels were less than 20 mpn/100ml for each sampling run, indicating safe swimming conditions on these dates.

CONCLUSION

Greenwich Lake is valuable resource because of the recreational opportunities it affords. There were no heavy algal blooms or areas of heavy macrophyte growth to impact recreational use. However, because of high total phosphorus levels and slightly elevated levels of chlorophyll a during the summer, Greenwich Lake is considered to be eutrophic.

Anoxia in the hypolimnion is usually associated with eutrophic waters. The anoxic conditions in the hypolimnion of Greenwich Lake may have been caused by several factors. Because of depth and stratification, the hypolimnion was cut-off from the reoxygenating affects of the atmosphere. Secondly, the limited transparency of the water did not allow oxygen producing photosynthesis to be carried out by aquatic plants (algae) in the lower depths. And finally, respiration by bottom dwelling organisms including bacteria, may have depleted dissolved oxygen levels. The bacteria use oxygen while breaking down accumulated biomass. Dead algae that sank to the bottom of the lake may have made up a large proportion of the biomass. The anoxic conditions, in the hypolimnion, could stress certain organisms including favorable fish species. The anoxic conditions also favor the release of nutrients from the sediments, which could lead to more algal production.

REFERENCES

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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	04/04/89	10.0	11.6	7.46	16	.03	<.01	<20	<2	50	NA	
UPPER LAKE	06/21/89	27.5	9.9	9.36	16	.04	<.01					3.5
LOWER LAKE	06/21/89	27.5	9.9	9.32	15	.06	<.01	<20	<2	<20	NA	4.0
LOWER LAKE	09/28/89	20.2	7.7	7.41	15	.03	<.01	<20	<2	<20	NA	5.5

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
GEOLOGICAL SURVEY
LABORATORY OPERATIONS SECTION

89/06/21
Sample No. 61492
Lakes Management
Greenwich Lake (lower lake), NJ

Plankton Identification

CHLOROPHYCEAE (green)

Ankistrodesmus falcatus
Chlorella vulgaris CO-DOMINANT
Crucigenia tetrapedia
Staurastrum dejectum

BACILLARIOPHYCEAE (diatom)

Fragilaria sp.
Nitzschia acicularis

MYXOPHYCEAE (blue-green or other color)

Anabaena constricta CO-DOMINANT
Chroococcus minutus

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Chlorophyll Analysis

Chlorophyll "a" (mg/m³) = 14.28

Analyst(s)/Unit _____

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
GEOLOGICAL SURVEY
LABORATORY OPERATIONS SECTION

89/09/28
Sample No. 53435
Lakes Management
Greenwich Lake, NJ

Plankton Identification

CHLOROPHYCEAE (green)

Ankistrodesmus falcatus
Kirchneriella obesa
Micractinium pusillum
Nannochloris sp.
Pediastrum biradiatum
Scenedesmus quadricauda

XANTHOPHYCEAE (yellowish green)

Centritractus belanophorus

BACILLARIOPHYCEAE (diatom)

Melosira sp.
Nitzschia sp.

DINOPHYCEAE (dinoflagellate)

Gymnodinium sp.
Peridinium sp.

MYXOPHYCEAE (blue-green or other color)

Oscillatoria minima

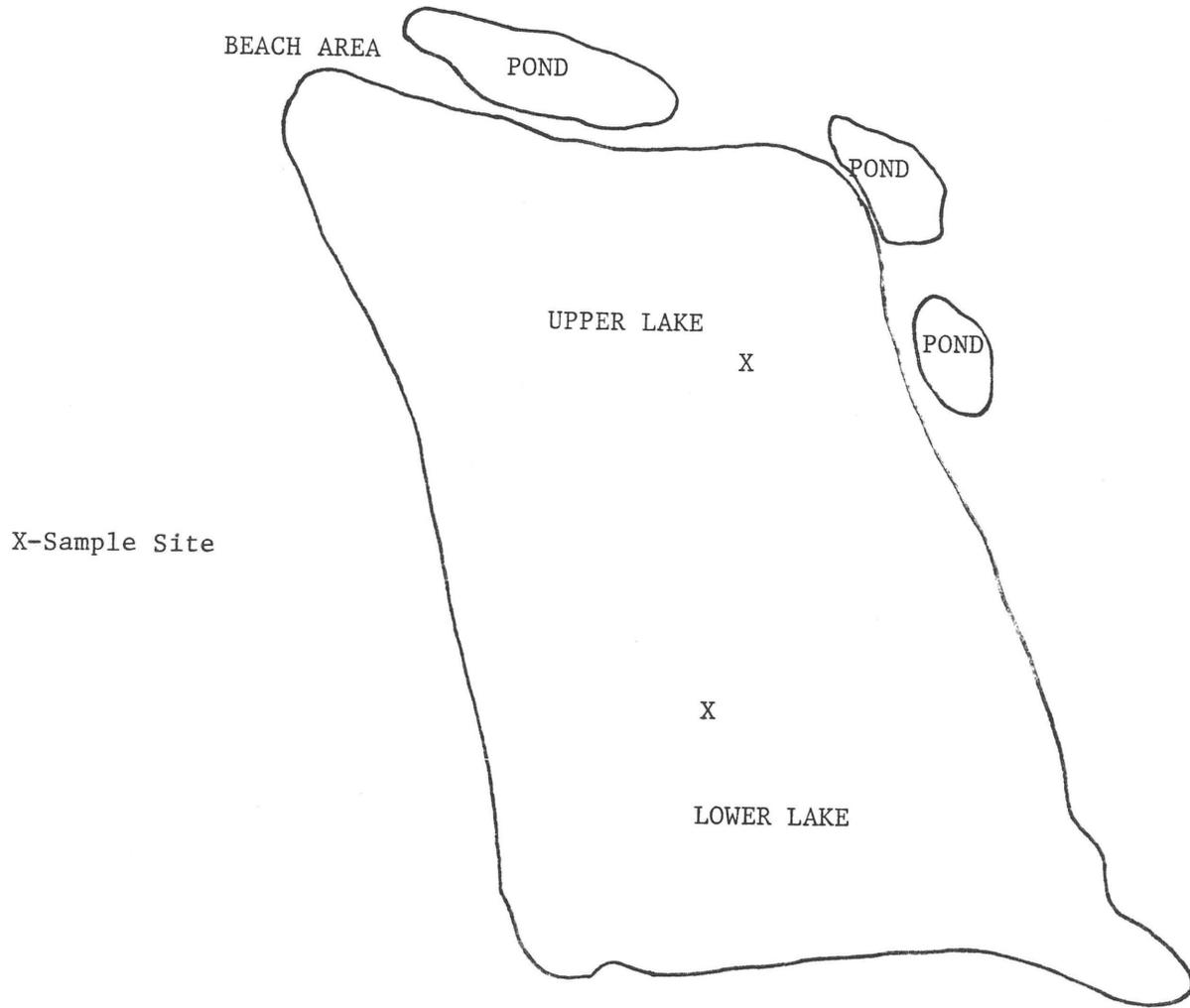
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Chlorophyll Analysis

Chlorophyll "a" (mg/m³) = 9.02

Analyst/Unit _____



GREENWICH LAKE



ROUTE 295