EAST AND WEST MONPONSETT PONDS
DIAGNOSTIC/FEASIBILITY STUDY
HALIFAX AND HANSON, MASSACHUSETTS
FINAL REPORT

Project Director: Lee Lyman
Project Manager: Dr. Alexander P. Duran

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THE MASSACHUSETTS DIVISION OF WATER POLLUTION CONTROL

By: LYCOTT ENVIRONMENTAL RESEARCH, INC.
600 CHARLTON STREET
SOUTHBRIDGE, MASSACHUSETTS 01550

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TABLE OF CONTENTS

LYCOTT

LYCOTT

LIST OF FIGURES

LYCOTT

LIST OF TABLES

LYCOTT

LYCOTT

1.0 SUMMARY

1.1 Study Background

The Monponsett Ponds are an important aesthetic and recreational resource for the Town of Halifax and the surrounding communities in Massachusetts. A Town operated beach plus a state maintained boat launching ramp provide varied and heavily utilized accesses to this resource. In addition, many lake-side residents use the pond extensively for swimming, boating and fishing.

This study has been undertaken in response to an increasingly rapid degradation of the previously high quality of the Monponsett Ponds. The study, completed by LYCOTT ENVIRONMENTAL RESEARCH, INC. and their sub-contractor, GREENMAN, PETERSON, INCORPORATED (GPI) under contract to the Town of Halifax provides a comprehensive Diagnostic and Feasibility Study for the restoration and management of Monponsett Ponds. This study provides a specific and complete program for management of the problems identified in the diagnostic portion of the study. These recommendations are provided as a specific program which includes all information required for application to funding agencies for implementation of the recommendations. Cost information in 1986 dollars is provided with a milestone schedule for completion of the recommendations.

Funding for this project was provided at 70 percent by the 628 Clean Lakes Program (CLP) as administered by the Division of Water Pollution Control and 30 percent by the Town of Halifax. The recommendations for pond restoration, summarized below, are also potentially eligible for funding under the CLP, Phase II grants, which provide for 75% state funding. The recommended sewage treatment plant and sewer system is also eligible for state funding by the Construction Grants Program at the Massachusetts Division of Water Pollution Control.

1.2 Summary of Problems and Findings

During the period of study four major problems were identified in Monponsett Pond. These problems are:

- increasing aquatic weed growth
- nutrient pollution from septic system leachate
- siltation from solids carried in by the storm drains
- fecal contamination from storm drains which empty into the Monponsett Ponds

Dense stands of aquatic weeds have been mapped along the shoreline and in the cove areas of the pond. These weeds are substantially reducing the recreational potential of the pond and are aesthetically offensive.

As a result of the investigations of this study, the impact of the septic systems which surround the pond has been quantified. Using a modeling procedure, the loading of the limiting nutrient phosphorus has been calculated. This process provides a quantification of the overall loading of this nutrient and a breakdown of the input by specific sources. The septic systems have been shown to contribute over sixty percent of the total load of phosphorus entering the lake. Several neighborhoods were identified as major nutrient sources due to soils unsuitability for septic systems. The increases in aquatic weed growth are a result of this phosphorus loading.

In response to these specific problems, several specific solutions are proposed for mitigation. Through a detailed analysis of the alternatives the following are recommended for the management and restoration of the Monponsett Ponds:

- Shoreline aquatic weed raking
- Engineering and installation of a sewage treatment plant to serve neighborhoods at the north ends of East and West Monponsett Ponds and the southern end of the Town of Hanson
- Installation of sand filter beds at four locations

A shoreline of 13,800 linear feet is recommended to be aquatic weed raked at a cost of roughly $41,000.

Construction of a regional sewer system and sewage treatment plant which will remove a significant portion of the phosphorus loading which the ponds receive is recommended. The sewage treatment plant will consist of biological oxidation, sand filtration, carbon filtration, and chlorination. The treatment plant will have a subsurface effluent disposal at a site north of West Monponsett Pond in the Town of Hanson (See Appendix H for a site location map). Once the key areas are served by sanitary sewers, the problem of fecal contamination of the storm drains will be lessened. This is because much of the present fecal contamination of the storm drains is probably due to illegal connections to storm sewers and infiltration of septic leachate through cracks in the storm sewers. In conjunction with the sewering of the northern end of the ponds it is recommended that the Towns of Halifax and Hanson perform a study to identify improperly operating septic systems. The total cost of this study is estimated to be $30,000.

It is also recommended that the Town of Halifax perform a study to size and design open sand filters to remove suspended solids from four storm drains at locations specified in this report. Estimated costs of the sand filter is $10.00 per square foot of filter area. The size of each filter will be determined by the quantity of flowage from each drainage system. The estimated cost to have this study performed is $25,000.

These alternatives, when implemented, will provide a comprehensive overall management plan for the Monponsett Ponds and the surrounding watershed area. The weed control will provide a short term, ongoing management plan for restoring the recreational potential to areas of the pond which are currently becoming inaccessible. The sewer system and sand filters basins will provide long term benefits to the overall pond system. This program is intended to maintain the pond for generations to come.

SECTION 2 DIAGNOSTIC STUDY LITERATURE REVIEW

2.1 GEOGRAPHY AND MORPHOMETRY

2.1.1 Watershed Geography

The Monponsett Ponds are an important and highly utilized recreational resource for the Town of Halifax, Hanson, and the surrounding communities. East and West Monponsett Ponds are divided by State Route 58 and interconnected by a small culvert at the southern end of the lakes (See Figure 4-1). The eastern basin is 246 acres in extent and the western basin is 282 acres. Both lakes are relatively shallow, having mean and maximum depths of 7.0 feet and 13.0 feet, respectively. The ponds have several small tributaries which, under normal rainfall conditions flow into the pond: a small unnamed tributary flows into the southeastern shore of East Monponsett Pond from the Peterson Swamp. A larger tributary, Stetson Brook, flows into the northern end of East Monponsett Pond. This brook originates in Stetson Pond which lies to the northeast of East Monponsett Pond. Three small tributaries enter at the northern end of West Monponsett Pond. Of the three, only White Oak Brook is named. At the northwest corner of West Monponsett Pond, an outlet stream, Stump Brook, flows in a southwesterly direction. The ponds are located at approximately 70 degrees, 50 minutes and 30 seconds east longitude and 42 degrees, zero minutes and 30 seconds north latitude. The watershed which drains to the Monponsett Ponds has an area of nearly four thousand acres, which is 7.5 times the area of the lakes themselves. This is a fairly low ratio of watershed area to pond surface area.

The Monponsett Ponds are classified as a Class B water (DEQE, Summary of Water Quality, 1985). The designated uses of Class B waters include "the protection and propagation of fish, other aquatic life and for primary and secondary contact recreation".

2.1.2 Morphometry of the Monponsett Ponds

Figure 2-1 shows the bathymetric contours for East and West Monponsett Ponds. This map is derived from field measurement with a continuous reading sonar device. The mean and maximum depths of both ponds are 2.1 meters and 4.0 meters. Morphometric data are presented in Table 2-1. These data were generated from the 1978 revised Hanover and Plympton U.S.G.S. Topographic Quadrangles and therefore may be considered approximate values.

Monponsett Ponds
Diagnostic/Feasibility Study

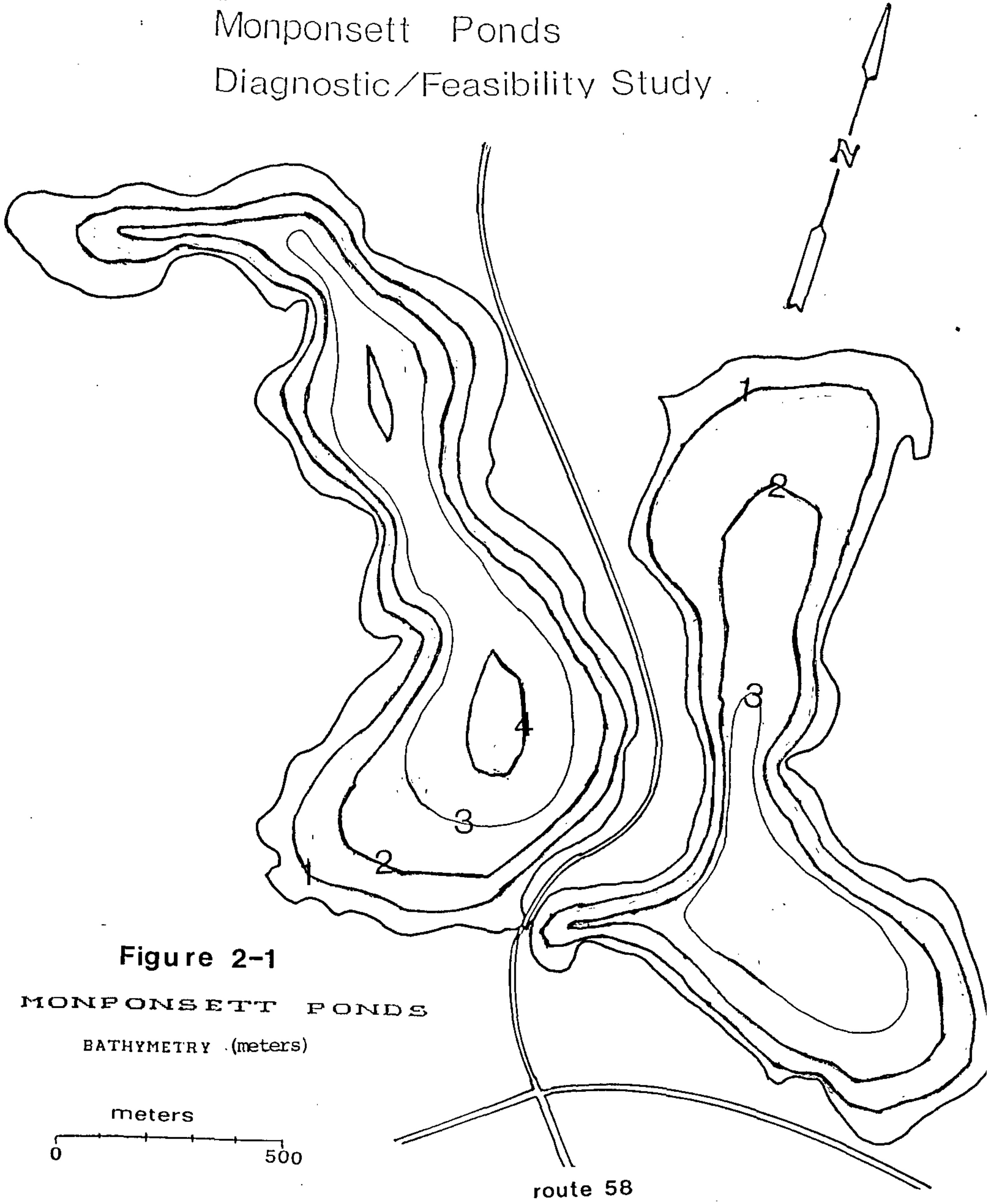

Figure 2-1

MONPONSETT PONDS

BATHYMETRY (meters)

TABLE 2-1

MONPONSETT PONDS

MORPHOMETRIC DATA

Parameter	West Monponsett	East Monponsett
Maximum length	1950 m (6398 feet)	1750 m (5742 feet)
Maximum width	900 m (2953 feet)	1075 m (3526 feet)
Maximum depth	4.0 m (13.0 feet)	4.0 m (13.0 feet)
Mean depth	2.1 m (7.0 feet)	2.1 m (7.0 feet)
Lake surface area	112 ha (276 acres)	99.6 ha (246 acres)
Volume	2,383,000 m^3 (1932 acre-feet)	2,124,000 m^3 (1722 acre-feet)
Shoreline length	6759 m (22,176 feet)	5,632 m (18,480 feet)
Development of shoreline	1.8	1.6
Watershed area	772 ha (1907 acres)	834 ha (2060 acres)

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2.2 Public Access and Historic Uses

2.2.1 Public Access

The Monponsett Ponds have three major areas of public access for swimming and boating. The major access point for swimming is at the Halifax Beach, at the southern end of West Monponsett. Access is through a town owned right of way off of Lingan Street. This beach is restricted to residents of Halifax. There is parking for 15-20 cars at this beach. A second, smaller beach is located in the north end of East Monponsett. Parking is available at a dirt lot across the street with space for about 20 cars. This beach is not restricted to town residents, it is open to the public. Access to the Monponsett Ponds is available at two ramps, one each on East Monponsett and West Monponsett. Since the culvert between the Ponds is not navigable, boat ramps on each pond are necessary for complete boating access to the ponds. One of the boat ramps, unpaved, is at the southeastern shore of East Monponsett, off of Holmes Street. There is a dirt parking lot across the street with parking for 10-15 cars and trailers. There is also a state maintained, paved, boat ramp off of Monponsett Street. This ramp gives access to West Monponsett. There is no fee for the use of the ramp, and there is parking space, unpaved for roughly 10 cars and trailers.

2.2.2 Historic Uses

The shores of the Monponsett Ponds were first inhabited by American Indian tribes, particularly the Robins of East Bridgewater and the Hobanock of Pembroke (Thompson, 1928). Several presently unexcavated and poorly documented sites dot the shoreline. There may also be archaeological sites to the northwest, in Cedar Swamp and on the tributary streams to the ponds (Valerie A. Talmage, personal communication).

During this century several lives have been lost in the lakes by drowning. The growing awareness of the possibility of accidents has brought the use of lifeguards to the town beach during the bathing season. Water sports, including boating, fishing and water skiing are quite popular in Halifax as is ice fishing during the winter.

Cottages on the shores of the Monponsett Ponds have served during the early and mid nineteen hundreds as meeting sites for a number of community organizations such as the American Legion, the Kiwanis and the Jaycees. Also during the early and mid nineteen hundreds there were numerous hunting lodges and gunning stands constructed on the shores of the ponds.

Summer resort cottages were built on the shores of the Monponsett Ponds starting in the late 1800's. Bostonians came to pass the summer in Halifax because of its scenery and cordial atmosphere. From the 1920's to the 1950's, the Boston Young Men's Christian Association maintained Camp Ousamequin on a seven hundred acre tract of the western shore of West Monponsett Pond (Margaret McGrath, personal communication). This camp is now used as a juvenile justice center by the Massachusetts Department of Youth Services. Since the 1960's most of the summer cottages have been converted for permanent residence. At present only about 25% of the houses on the shoreline are seasonal. This represents a significant shift in the intensity of cultural, land use impact on the Monponsett Pond ecosystem.

2.3 Land Use and Watershed

For the watershed as a whole, the overall percentages of land use are dominated by forest, followed by open water, residential, and agricultural (Table 2-2, Figure 2-2). Very small percentages of the watershed land area are occupied by wetland or urban areas. Land uses were determined from the MacConnell Land Cover Maps (MacConnell, 1971 a, b) for the Hanover and Plympton U.S.G.S. Quadrangles. The measurement of areas was done using a Keuffel & Esser Model 62 planimeter.

The shoreline of East Monponsett Pond is developed in those areas where construction of houses is possible, with several areas of the shoreline heavily developed; residential development is continuing in the northeast quadrant of East Monponsett Pond.

Low sand and gravel hills to an elevation of 80 feet above mean sea level easterly of East Monponsett Pond have been completely developed.

Major roadways through the area are East-West Route 106, North-South Route 58, and North-South Route 36.

The intersection of Routes 58 and 106 south of East Monponsett Pond is developed into a commercial center, with some drainage to the pond. This commercial development does not appear to be a source of concern at this time. An undeveloped industrially zoned area lies west of Route 36 in the northeastern quadrant of the Pond.

Route 58, bisecting East and West Monponsett Ponds has recently been reconstructed with all new storm drains. Development along Route 58 appears essentially complete.

The shoreline of West Monponsett Pond is mostly developed with single family homes in Halifax and Hanson except in unbuildable areas, near cranberry bogs and the former Camp Ousamequin, last used by the Division of Youth Services, and now closed. The former camp presents the last large tract of land for building on West Monponsett Pond.

Maximum housing development occurred in areas most easily built upon, and nearest, to the lake because of desirability. There has been residential construction in coarse sand and gravel adjacent to the shoreline of the ponds. In many cases, foundations and septic systems are immediately above the ground water table, even during summertime, and in the saturated zone over much of the year.

Coarse sand and gravel, low in clay content, humus or

TABLE 2-2

MONPONSETT PONDS WATERSHED AREAS FOR LAND USE[1]

Land Cover Type	West Monponsett Drainage Area[2]	East Monponsett Drainage Area[3]	Total Watershed
Forest	61.8	55.2	59.0
Agricultural	9.0	7.0	7.9
Residential	12.7	18.7	15.8
Wetland	1.2	0.7	0.9
Open areas	0.0	0.0	0.0
Open water	15.1	17.9	16.5
Urban	0.3	0.5	0.4

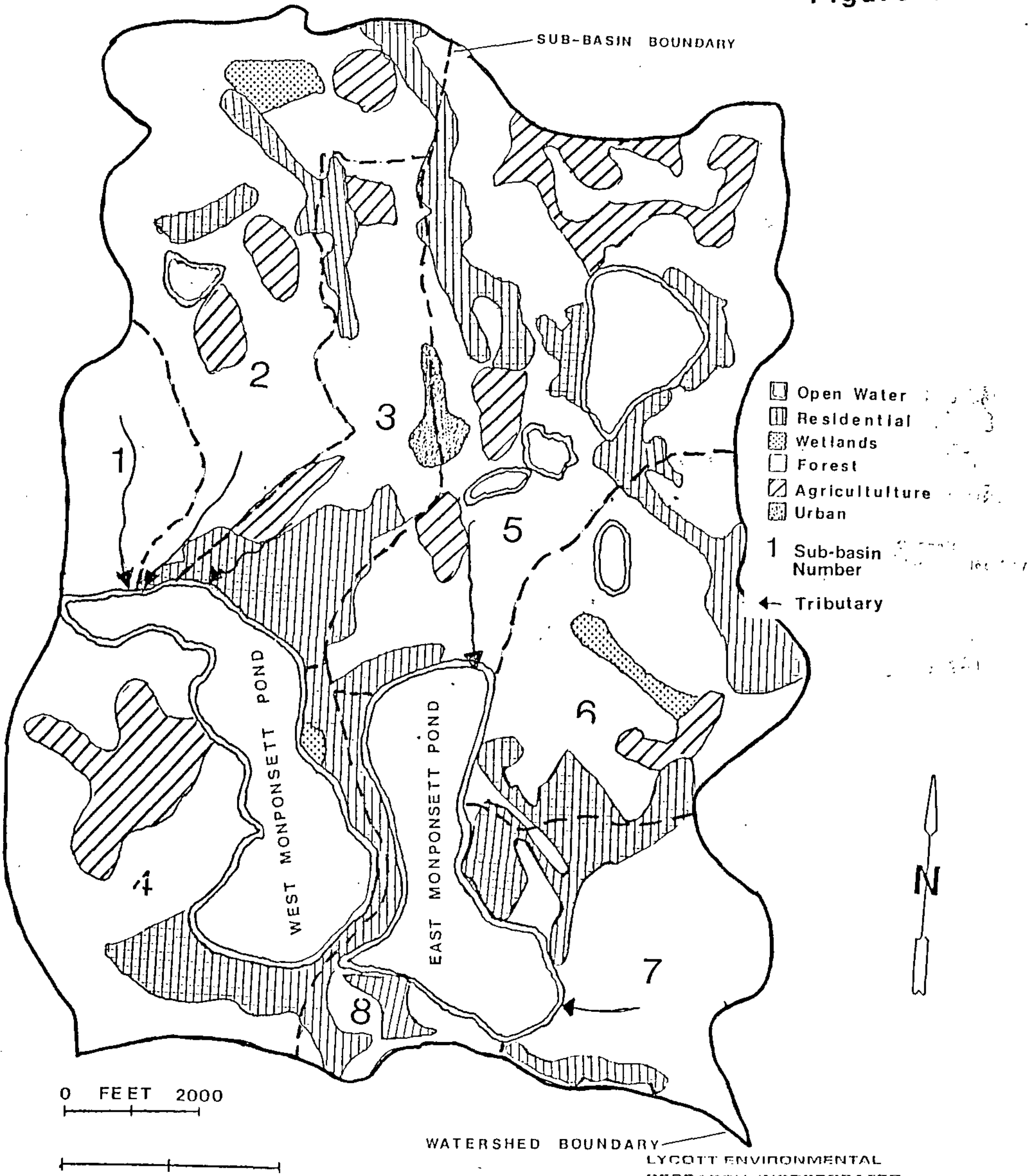
[1] Listed values are percentages of the drainage basin occupied by the given land use category.

[2] Total area equals 7.72 km^2.

[3] Total area equals 8.34 km^2.

MONPONSETT PONDS GENERAL LAND USE

Figure 2-2



LYCOTT ENVIRONMENTAL RESEARCH, INCORPORATED organic material does not retain soluble materials such as phosphates, nitrates and chlorides and allows rapid draining of the soil. Areas of excessively drained soils are found in the northern end of West Monponsett Pond in Hanson and Halifax north of Ocean Avenue and in the southern end of the pond at Halifax Beach. The same conditions can be found in the eastern portion of East Monponsett Pond in an area known as Annawan Avenue and a smaller area at East Lake Street at the northern end of the Pond.

In summary, the land use which impacts the Monponsett Ponds most severely is residential development. This use is most concentrated immediately around the pond.

2.4 Geology and Soils

2.4.1 Geology

The bedrock geology in the area of East and West Monponsett Ponds consists mainly of sedimentary rocks from the Pennsylvanian Age. There are no bedrock outcrops in the watershed area; a thick sequence or surficial deposits composed of sands and gravel overlie the bedrock. To the north of the study area, Pennsylvanian sediments unconformably overlie a pre-Pennsylvanian grantic gneiss. A large outcrop of the granite gneiss is found in East Pembroke along Taylor Street. The nearest outcrop of bedrock, non-marine sedimentary rocks of the Rhode Island formation, are found one mile west of Island Grove Pond in Abington, MA to the north west of the Monponsett Ponds.

The surficial geology in the watershed area consists of stratified sand and gravel deposits, glacial till and recent swamp deposits. The stratified sand and gravel deposits were laid down by glacial melt waters as the ice retreated to the northwest. During the ice retreat, stagnant ice blocks remained, affecting the deposition of the stratified sands and gravel by causing meltwater streams carrying this material to flow around the blocks. After the ice melted, depressions were left in the sand and gravel deposits. Water exists today in these depressions because the water level in the surrounding sands and gravels is higher than the floor of the depression (the depressions intersect the surrounding water table). Many present-day lakes and ponds in the area, including East and West Monponsett Ponds, were formed in this way (Thompson, 1928).

Glacial till, which exists as only a small percentage of the surficial deposits in the Monponsett Ponds watershed, consists of unsorted, unstratified sediment from clay to boulder size. This material is deposited by the glacial ice itself, rather than by meltwater streams (Williams and Willey, 1973).

Swamp deposits have been designated in areas where peat and organic matter are known to extend to a depth of three feet. The swamp deposits may be underlain by more permeable glacial formations. Groundwater held in the swamp deposits may at times act to recharge the underlying glacial formations; however, vertical movement in swamp deposits is low.

2.4.2 Soils

The Monponsett Pond watershed is part of a larger area of soil in Central Plymouth County categorized as The Hinkley-Merrimac-Muck Association (USDA, 1969). The soils in the association have their origins from glacial stream deposits of sand and gravel. Knowledge of the soil association is useful for gaining a general idea of the proportional pattern of soils within a region. A more detailed assessment of the soil types formed in this watershed is provided in Figure 2-3 and Table 2-3. Descriptions of the hydrologic soil groups are given in Table 2-4. The topography of the area accounts for much of the differences in soil type with ridges, terraces, and plains intermingled with poorly drained, flat low-lying areas.

In the northern watershed areas, the Merrimac series comprises a majority of the landscape (Figure 2-3). This soil occurs primarily on higher plains and terraces in the watershed. These soils are typically sandy loams that are underlain by sand and gravel at a depth of about 2 - 2 1/2 feet (USDA, 1969). Due to the rapid permeability of water through these soils, they are limited for septic systems. The restrictions are imposed because water may move through too quickly to allow for adequate renovation and purification to occur. The limitations range from slight in level areas to severe as the slope becomes increasingly steep (Veneman, 1982).

Other soils frequently found in the northern watershed include peat and muck-type soils (Figure 2-3). Unlike Merrimac soils, these tend to be found in very poorly drained, low-lying areas. The sanded muck soils have been developed for cranberry production by spreading coarse sand over the peat and muck soils already present (USDA, 1969). All of these soils are saturated much of the year and as a result have severe limitations for septic systems.

The remainder of the soils in this part of the watershed are Hinkley, Windsor, and smaller parcels from the Scituate, Augres/Wareham, and Deerfield series. Hinkley and Windsor types are found in the northwest corner of the watershed and occur mainly on terraces and plains (USDA, 1969). These soils generally have moderate limitations for septic systems except where the slope is steep, thus making its limitations severe. The other three soils, Scituate, Augres/Wareham and Deerfield, occur in small, isolated locations and all have aspects which severely limit their effectiveness for septic system installation (Veneman, 1982).

As in the northern sector Merrimac soils dominate the

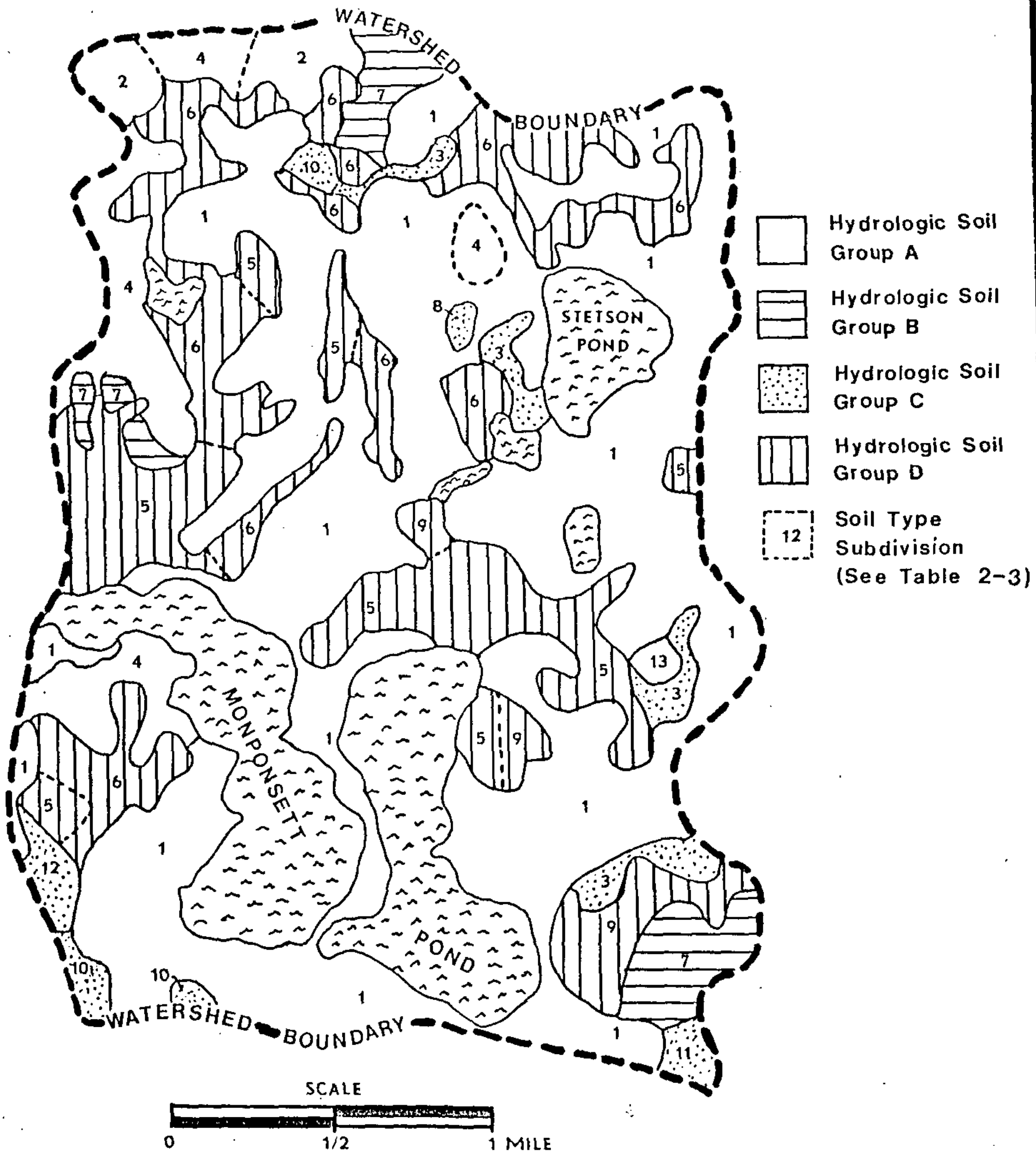


Figure 2-3

MONPONSETT PONDS WATERSHED

SOIL TYPES and HYDROLOGIC GROUPS

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TABLE 2-3
MONPONSETT PONDS
SOIL DESCRIPTIONS

MAPPING UNIT	SOIL NAME	SOIL DESCRIPTION
1	Merrimac	Somewhat excessively drained soils formed in sandy and gravelly material underlain by sands and gravel at 1 1/2 to 2 1/2 feet. Fine sandy loam or sandy loam surface soil and sandy loam subsoil. Surface soil and subsoil moderately rapid or rapid permeability. May have a stony surface. Occur on level to steep slopes. Hydrologic Group A.
2	Windsor	Excessively drained soils on glacial outwash plains and terraces formed in medium and fine sand. Loamy sand surface soil and sandy subsoil. Permeability is rapid to very rapid. Occur on level to steep slopes. Hydrologic group A.
3	Augres/ Wareham	Poorly drained soils formed in thick deposits of sand on the low-lying portions of outwash plains. Loamy sand surface soil and sandy subsoil. Water table at or near surface much of the year. Hydrologic group C.
4	Hinckley	Droughty soils formed in water sorted sand and gravel consisting mainly of gravel with gravelly loamy sand below. Rapid permeability throughout. Gravel and cobblestones on and near the surface occur on level to steep slopes. Hydrologic group A.
5	Peat	Poorly drained bog soils formed in organic deposits underlain by mineral soil materials. Dark reddish soils with unidentifiable plant materials. Water table at or near the surface most of the year. Hydrologic group D.

TABLE 2-3 (Continued)

MAPPING UNIT	SOIL NAME	SOIL DESCRIPTION
6	Muck	Poorly drained soils formed on an accumulation of organic material underlain by mineral soils. Dark reddish-brown to black decayed organic material of unidentifiable plant materials. Water table at or near the surface throughout much of the year. Sanded muck has a layer of coarse sand spread over the surface for cranberry production. Hydrologic group D.
7	Deerfield	Moderately well drained soils on glacial outwash plains formed in thick deposits of sand. Loamy sand surface soil and loamy sand or sandy subsoil. Surface and subsoil moderately rapid to rapid permeability. Surface and subsoil moderately rapid to rapid permeability. Surface may contain a few pebbles. Level to gently sloping. Hydrologic group B.
8	Gloucester	Somewhat excessively drained and well-drained soils that formed in glacial till derived chiefly from granite. Sandy loam or loamy sand in the surface soil and gravelly loamy sand in the subsoil. Rapid permeability throughout. Surface very stony or extremely stony. Level to steep slope. Hydrologic group A.
9	Scarboro	Very poorly drained sandy loams formed in thick deposits of sand or sand and gravel. Sandy loam surface soil and loamy sand subsoil. Wet much of the year due to high water table but when drained they are rapidly permeable. Surface tends to have a layer of muck 4-12 inches thick with few stones. Level of nearly level slopes. Hydrologic group D.

TABLE 2-3 (Continued)

MAPPING UNIT	SOIL NAME	SOIL DESCRIPTION
10	Scituate	Moderately well drained soils that formed in compact glacial till. Sandy loam surface and sub-subsoil with a hardpan layer at 1 1/2 to 2 1/2 feet. Permeability is rapid to slow in the hardpan. Very stony or extremely stony surface. Level to gently sloping. Hydrologic group C.
11	Essex	Well drained soils formed in firm glacial till. Occur chiefly on glacial deposits known as drumlins. Coarse sandy loam surface and subsoil with a hardpan layer at 2 to 2 1/2 feet. Rapid permeability to slow through the hardpan. Very stony to extremely stony surface. Occur on level to steep slopes. Hydrologic group C.
12	Raynham	Poorly drained silt loams formed on glacial lake sediments. Silt loam surface soil and silt loam or very fine sandy subsoil. Permeability is moderately slow or slow in both the subsoil and substratum. Saturated 7 to 9 months per year. Occur on level slopes. Hydrologic group C.
13	Made Land	Artificial fill with no discernable soil characteristics. Hydrologic group unknown.

TABLE 2-4

DESCRIPTIONS OF HYDROLOGIC SOIL GROUPS

Hydrologic Group	Description
A	Soils with high infiltration rates even when thoroughly wetted consists mainly of deep and excessively drained sands and/or gravel. They have a moderate rate of water transmission (0.30 in/hr) and low runoff potential. (Examples: Hinkley, Merrimac and Windsor).
B	Soils with moderate infiltration even when thoroughly wetted consists mainly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. They have a moderate rate of water transmission (0.05-0.15 in/hr). (Example: Deerfield).
C	Soils have low infiltration rates when thoroughly wetted. Consists mainly of moderately fine to fine textured soils with a layer that impedes downward movement of water. They have a low rate of water transmission. (0.05-0.15 in/hr) Example: Augres/Wareham, Raynham and Scituate).
D	Soils have a high runoff potential. Have a very low infiltration rate when thoroughly wetted. Consist mainly of (1) clay soils with a high swelling potential (2) soils with a permanently high water table (3), soils with a clay pan on or near the surface (4) and soils resting on impervious material. They have a very low rate water transmission (0.-0.05 in/hr) (Example: Peat, Muck, Sanded Muck and Scarboro).

Source: U.S.D.A. (1986)

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landscape in the southern watershed. These soils have only slight limitations in most of the southern region except in some portions adjacent to the pond itself where the slope increases. In such steep areas the septic system limitations become more severe. Poorly drained peat and muck soils are present in abundance. However, the sanded-muck areas are less extensive than in the northern watershed and, in addition, Scarboro soils are present. These soils occur in low areas and depressions on outwash plains in the area (USDA, 1969). All have severe septic system limitations.

Bordering much of the peat/muck type soils in this area are smaller parcels of Hinkley, Windsor, Deerfield, Essex, Raynham and Augres soils. As stated previously, the Hinkley and Windsor soils have moderate limitations on septic systems when the slope is moderate, as is the case here. The Deerfield series occurs in the southeastern corner of the watershed. This soil, which occurs in a glacial outwash plain area, has moderate limitations for septic systems. The remaining three soils, Essex, Raynham and Augres, all have limitations which are severe (Veneman, 1982). There is also a small portion of man-made land which is a "non-soil" area and is thus not classified for septic system considerations.

The differences in the above mentioned soils are greatly influenced by the variables of land surface shape, slope and position of the water table. All of these factors contribute to the establishment of a wide variety of soil types within the watershed. This requires that on-site investigation of an individual area be done so that a more exact assessment may be implemented when necessary.

2.5 Point Source and Non-Point Source Pollution

2.5.1 Erosion

A review of the projects now underway on the watershed of East and West Monponsett Pond, discussion with the Water Department and Highway Department and the results of meetings with the Board of Health and the Board of Selectmen and examination of the Ponds shows that the contribution of silt to the pond from on-going construction is now minimal.

Twin Lake, a large condominiums construction project is nearing the end of construction with one phase to be completed. However, this last phase is proximate to East Monponsett Pond and will need to be closely monitored to ensure that proper precautions are taken during and immediately after construction to prevent siltation of a nearby shallow pond area. This construction is under the jurisdiction of the Halifax Conservation Commission and the Halifax Board of Health because of the requirements of Chapter 131 Section 40 Wetlands Act and Title V of the State Environmental Code, Minimum Requirements for the Subsurface Disposal of Sanitary Sewage. No large development projects other than Twin Lake are currently under construction.

Several meetings and discussions with the Board of Health of Halifax showed that the Board is unaware of any sizeable projects presently planned that may add to the existing siltation. Single family house construction upon the watershed will require mitigation through Orders of Conditions issued by the Halifax Conservation Commission.

quarter of the homes around the ponds have disposal systems which are less than ten vertical feet above the lake level. Thus a number of systems may be very near to the water table or even below it during wet periods of the year. The average distance between septic systems and the lake shore for the surveyed homes is 130 feet. Since soils are largely sand and gravel with low capacity to retain phosphorus and nitrogen, septic leachate plumes are probably entering the ponds.

The perception of problems with septic systems and with the lake quality is widespread. Twenty percent of the responds were aware of sewage disposal problems in the neighborhood. Two thirds of the respondents indicated a need for conventional sewer service. However, less than one third supported any town sponsored septic system maintenance program.

The respondents to the survey are aware of lake problems and are active in combatting weeds on their own lake frontage. The respondents enjoy a number of water based activities: swimming, fishing and boating and to a lesser extent, water skiing. The most common problems which have interfered with lake use are, in order of most major to less important weed growth, algae, color, lake level, purity, transparency and odor. Respondents reported that they employed a number of methods to control weed growth. The most common activity is weed raking, 85% of the respondents reported raking out weeds from their lake frontage. Based on the amounts the respondents said they would be willing to pay for lake improvement, a total of $3500 could be raised. This was calculated based on the range of 35% to 52% of respondents who were willing to pay a fee for lake improvement and a range of $69 to $88. per year that respondents were willing to pay. Clearly a voluntary fee paid by lakeshore residents would not raise a sufficient amount to effectively restore lake quality.

TABLE 2-5
MONPONSETT PONDS DIAGNOSTIC/FEASIBILITY STUDY
SURVEY RESULTS

	East Monponsett	West Monponsett	Between Lakes
1. Total No. Interviewed	57	13	15
2. Avg. years living near lake	20	15	19
3. Ages of homes (yrs.)	64	55	39
4. Residences reported to be built for seasonal use (%)	63%	46%	33%
5. Seasonal residences now occupied year round (%)	61%	83%	100%
6. No. residences occupied year round	49	12	15
7. Avg. annual residency (months/yr)	10.4	12.0	12.0
8. Avg. no. bedrooms per dwelling	3.0	2.5	2.5
9. Avg. no. bathrooms per dwelling	1.3	1.3	1.2
10. Use commercial fertilizer %	34%	25%	25%
11. Type of sewage system:			
cesspool	27	7	8
septic system	33	7	9
holding tank	6	2	2
do not know	2	-	-
12. Age of sewage system (yrs)			
0-5	2	3	2
5-10	6	1	4
10-20	26	6	9
over 20	28	3	3
13. Residents reporting major sewage system replacement or expansion within last 20 years (%)	25%	42%	47%
14. Sewage systems with less than 10 ft. vertical height			

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TABLE 2-5 (Continued)

		East Monponsett	West Monponsett	Between Lakes
	above lake level (%)	28%	38%	7%
15.	Avg. septic tank pumping frequency (times per 5 yrs.)	3	3	3
16.	Avg. reported distance (ft.) from sewage system to lake shore (ft.)	132	125	146
17.	Reporting recurrent sewage system problems: (%)			
	Repeated pump-outs	3.5%	-	-
	System backs up or drains slowly	2%	7%	-
	Sewage flows on ground	-	-	-
	System undersized	3.5%	-	-
	Odors	7%	-	-
18.	Appliances connected to system: (%)			
	Dishwasher	32%	38%	40%
	Washing machine	56%	62%	80%
	Garbage disposal	9%	8%	7%
19.	Keeps grease out of drains (%)	94%	100%	94%
20.	Use yeast or chemical additives for sewage system (%)	19%	42%	32%
21.	Aware of sewage disposal problems in the neighborhood (%)	15%	15%	43%
22.	Respondents indicating need for conventional sewer service (%)	70%	83%	33%
23.	Respondents supporting a town-sponsored septic system maintenance program %	33%	23%	29%
24.	Respondents opposed to a town-sponsored septic system maintenance program	46%	38%	57%

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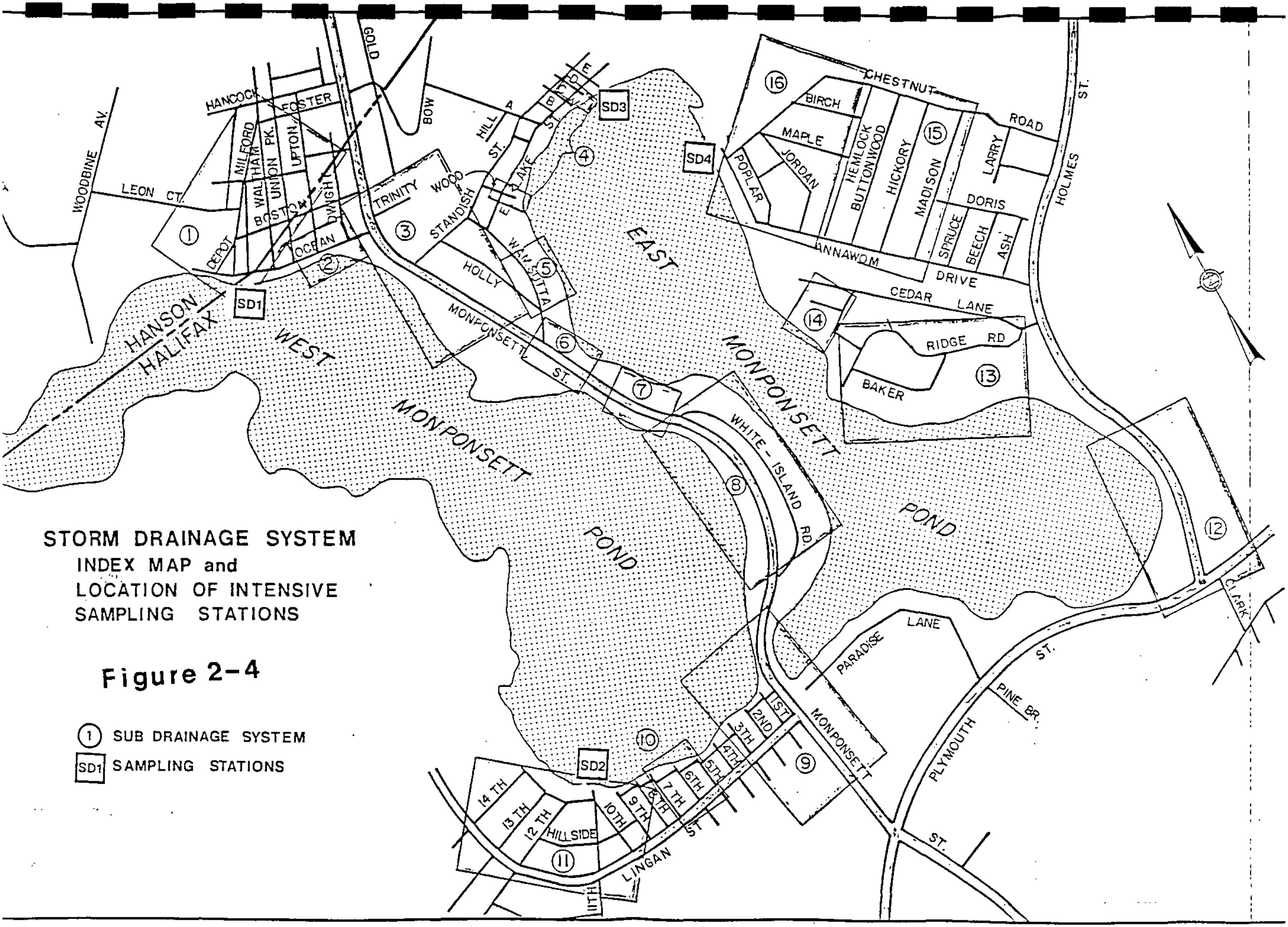
TABLE 2-5 (Continued)

		East Monponsett	West Monponsett	Between Lakes
25.	Respondents willing to voluntarily eliminate use of phosphate detergents to protect lake quality (%)	89%	83%	80%
26.	Local involvement: (%)			
	Rake out weeds	86%	77%	43%
	Dig out muck	37%	54%	38%
	Apply weed killers	2%	-	-
	Deposit sand/gravel	21%	46%	25%
27.	Respondents willing to pay an annual fee for improvement of lake quality (%)	52%	35%	50%
28.	If yes, how much per year ($)	88	81	69
29.	Water based activities (%)			
	Swimming	83%	62%	60%
	Fishing	69%	62%	47%
	Boating	88%	85%	73%
	Water skiing	39%	15%	20%
30.	Problems which have interfered with lake use (%):			
	Weed growth	81%	62%	63%
	Algae	54%	31%	63%
	Odor	20%	8%	25%
	Color	36%	38%	50%
	Transparency	31%	23%	31%
	Purity	27%	38%	38%
	Lake level	42%	31%	31%

2.5.3 Stormwater Drainage Systems

Drainage systems in the Town of Halifax in the Monponsett Ponds area are shown in the Figure 2-4 and Appendix E of this report. Over thirty separate storm drain discharges have been identified entering East and West Monponsett Ponds. Most are simple and consist of one or two catch basins, a few feet of pipe and a discharge point with or without an outlet headwall. Several small storm drainage systems are in the Halifax Beach area: sub-drainage systems 9, 10 and 11. There are also a number of small systems in the East Lake Street and Ocean Avenue areas: sub-drainage systems 1, 2, 3, 4 and 5. The largest drainage systems are in the Annawan Drive section: sub-drainage systems 13, 15 and 16.

Each of these drains were examined and evaluated, and two drains from each lake singled out for intensive sampling. The drains designated as sampling stations SD1 through SD4 were chosen because of size of area contributing to the drains, density of housing in the tributary area, and previous assessment of screening samples collected and analyzed.



STORM DRAINAGE SYSTEM
INDEX MAP and
LOCATION OF INTENSIVE
SAMPLING STATIONS

Figure 2-4

(1) SUB DRAINAGE SYSTEM
SD1 SAMPLING STATIONS

3.0 HYDROLOGIC BUDGET

Hydrology of the Monponsett Pond watershed was assessed to allow the nutrient budget to be calculated. The hydrology of the ponds includes the determination of all water inputs and outputs from the ponds. Since these water fluxes transport nutrients and other contaminants such as suspended solids, a knowledge of the magnitudes of the water fluxes is essential to assess the amounts of nutrients entering and leaving the lake ecosystem. The components of the hydrology which we assessed include runoff from the lake watershed, precipitation and evaporation from the lake surface and pumping of water to Silver Lake by the City of Brockton. The magnitude of water loss from the Monponsett Ponds to Stump Brook, the outlet, was assessed using the following equation:

$$R + (P - E) - D = Ex \qquad (3.1)$$

Where R = Watershed runoff including surface and subserface flow to the ponds

(P - E) = Precipitation minus evaporation on the lake surface

D = Diversion to Silver Lake

Ex = Water Exported to Stump Brook

The watershed runoff was assessed using data from a nearby watershed for the study period (May 1985 to April 1986). Lack of streamflow measurements of the Monponsett tributaries made this necessary. Streamflow records from the Wading River at Norton, Massachusetts (James Linney, U.S.G.S., personal communication) were used to estimate streamflows from the Monponsett watershed. The total watershed of the Monponsett Ponds was first divided into eight subwatersheds on the basis of the elevation contours indicated on the U.S.G.S. 7.5 minute topographic maps of the Hanover, Massachusetts (1978) and the Plympton, Massachusetts (1977) quadrangles (Figure 3-1). The areas of the subwatersheds were determined by planimeter and are listed in Table 3-1. Four of the subwatersheds (#1,3,5,7) drain directly to the ponds through surface streams; the remaining subwatersheds (#2,4,6,8) drain to the ponds through subsurface flow. Although subwatershed #2 would appear to be

Tributary Sampling Stations and Sub-Basins

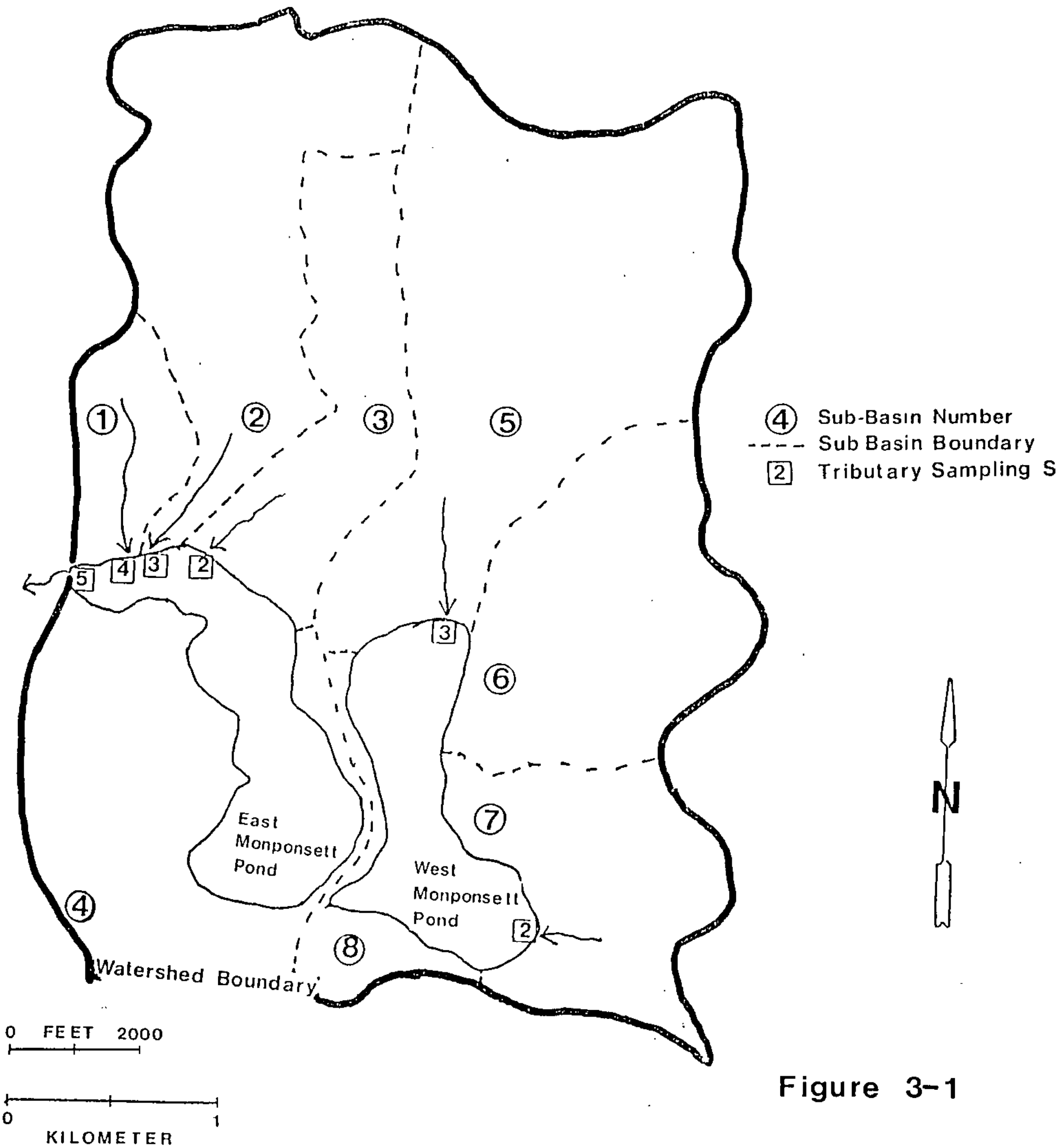


Figure 3-1

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drained by White Oak Brook, during the study period, this stream was never observed to be flowing. The flows for the Monponsett Pond subwatersheds were calculated by multiplying the Wading River flows by the ratios of the Monponsett subwatershed areas to the Wading River watershed area. Calculated runoff valves for each subwatershed and for the entire Monponsett Pond watershed are given in Table 3-1, both on a monthly basis and also the totals for the twelve month study period. The three months during which most runoff occurred were February and March, 1986, followed by November, 1985. The total annual runoff from stream-drained subwatersheds was 107,000,000 ft^3 (3,030,000 m^3), which was 36% of the total water input to the lakes. Annual runoff from the remaining subwatersheds amounted to 108,000,000 $ft.^3$ (3,060,000 m^3), which was also 36% of the total hydraulic input.

National Weather Service records (NOAA, 1985-1986) for two nearby stations were used to estimate precipitation and evaporation from the lake surface. Monthly precipitation records were obtained for the Brockton weather station, 10 miles to the northwest, and pan evaporation records from the Rochester, Massachusetts station, 15 miles to the south. These data were combined to calculate the excess input of precipitation over evaporation inputs to the Monponsett Ponds on a monthly basis throughout the study period (Table 3-1). The pan evaporation records were multiplied by a factor of 0.7 to estimate the lake surface evaporation rates. This procedure is technically correct only for annual average pan evaporation values (Winter, 1981), but given the lack of any directly measured pan coefficients, the value of 0.7 was used. Annual totals of precipitation and evaporation are given in Table 3-2. Water supplied to the lakes due to precipitation over the study period was 2,374,000 m^3/yr, which was 28% of the total water input to the ponds.

The City of Brockton diverts water from East Monponsett Pond to Silver Lake on the Halifax/Pembroke line for municipal water supply. This diversion was authorized under chapter 371 of the acts of 1964. There is a diversion station located on the shore of East Monponsett at Route 36 consisting of a weir set at 52.00 feet above mean sea level and gate-controlled 48 inch aqueduct leading to Silver Lake. Water flows to Silver Lake under gravity, there is no pumping capability. Monthly diversion records given in Table 3-1 were obtained from K.T. Nawrocki, Supervisor of the Brockton Water Treatment Plant. Water was diverted to Silver Lake during all months of the study period except June, July and August, 1985. The amount of water diverted during the 12 month study period was slightly more than one half of the total watershed runoff to the ponds during that period.

Water loss from the Monponsett Pond watershed to the outlet of West Monponsett, Stump Brook, was calculated as the difference of measured or estimated inflows and outflows, using equation 3-1. Stump Brook estimated flows are given, on a monthly basis, in Table 3-1. It is recognized that changes in lake storage, which were not measured, would tend to reduce the magnitude of inflow/outflow at Stump Brook. According to our calculations, Stump Brook actually functioned as an inlet to West Monponsett Pond during the months of July, August and September 1985. The magnitude of the Stump Brook export from the ponds for the twelve month study period amounted to slightly more than one half of the total watershed runoff to the ponds (Table 3-1).

The lake retention time for the study period was 0.65 years. In order to estimate how quickly the ponds will respond to changes in nutrient loading, it is useful to calculate the "response time", a term described by Dillon and Rigler (1975). It is calculated using the equation:

$$t_{1/2} = \frac{0.693}{(T^{-1} + 10/Z)}$$

where $t_{1/2}$ is the half life of the change in concentration of a given constituent, T is the retention time in years and Z is the mean depth in meters. Three to five times the half life is considered a good indicator of the response time in a lake.

For the Monponsett Ponds, the half life is 0.11 years and the corresponding response time is 0.32 to 0.55 years. Thus the ponds will reflect changes in nutrient loading rather quickly, resulting in improved or degraded water quality depending on whether the change is a decease or an increase in loading.

TABLE 3-2
MONPONSETT PONDS STUDY
HYDROLOGIC SUMMARY
May 1985 - April 1986

Total Lake Area	211.6 ha (522 acres)
Volume	4,505,000 m^3 (3653 acre-ft)
Drainage Area	1606 ha (2741 acres)
Precipitation	112.06 cm (44.12 inches)
Water Supplied to Lakes from Precipitation	2,374,000 m^3
Water Input to Lake from Watershed:	
East Monponsett	3,200,000 m^3 (113,000,000 ft^3)
West Monponsett	2,870,000 m^3 (101,300,000 ft^3)
Total Water Input to Lakes Including Precipitation	8,444,000 m^3
Evaporation from Lakes	65.3 cm (25.7 inches)
Diversion from East Monponsett to Silver Lake	3,403,000 m^3 (120,200,000 ft^3)
Flushing Rate	1.53/yr
Retention Time (Lake Volume/Outlet Discharges)*	0.65 yr
Water Export from the Monponsett Ponds to Stump Brook	3,491,000 m^3 (123,300,000 ft^3)

*Outlet discharges = discharge from Stump Brook plus diversion to Silver Lake.

4.0 LIMNOLOGICAL AND WATER QUALITY DATA FOR TRIBUTARIES AND OUTLETS

4.1 Historic Data Evaluation

Prior to this study, the only information available on water quality of the Monponsett Ponds was the unpublished data from a survey performed on August 3, 1982 by personnel of the Division of Water Pollution Control, Technical Services Branch. At that time, the most significant water quality problems in East Monponsett Pond were low visibility and high counts of blue-green algae. To a lesser degree, dissolved oxygen depletion in the hypolimnion, elevated levels of total phosphorus and moderate amounts of aquatic vegetation were observed. The total phosphorus level in Stetson Brook was 0.10 mg/liter and the coliform counts were 40/100 fecal and 600/100 total. Although these coliform counts do not violate Class B standards, they are definitely elevated over background levels. The lake was assigned a total of seven severity points on the basis of the values for visibility, algae counts, hypolimnetic dissolved oxygen, epilimnetic ammonia plus nitrate, epilimnetic total phosphorus and aquatic vegetation. The seven severity points it received placed the lake in the mesotrophic category. This category is less nutrient rich (less culturally degraded) than the eutrophic category but more nutrient rich than an oligotrophic lake. West Monponsett Pond was assigned a total of thirteen severity points, primarily on the basis of low transparency, high phytoplankton counts and dense aquatic vegetation.

4.2 Sampling Stations and Methods

Chemical, physical, and biological data were collected during a year-long diagnostic study commencing on 4/18/85 and ending on 5/14/86.

A total of 18 dates were sampled during this period. Two in-lake stations, five tributary stations, the outlet, eight shallow test well/seepage sampler sites, and four intensive storm sample locations. The inlake and tributary/outlet stations are shown in Figure 4-1. The test well/seepage samplers sites are shown in Figure 4-7. The storm sample sites are shown in Figures 4-8 and 4-9.

Water samples were collected at each station in bottles prepared in LYCOTT's State Approved Laboratory. Deep water samples were collected using a standard Van Dorn remote water sampler. Surface samples were collected by hand. Samples were stored on ice and transported to LYCOTT's laboratory for analyses. All analyses were made according to Standard Methods for Examination of Water and Wastewater (APHA, 1985) and EPA Methods for Chemical Analysis of Water and Wastes (1983). Sample preservation methods, bottle types and

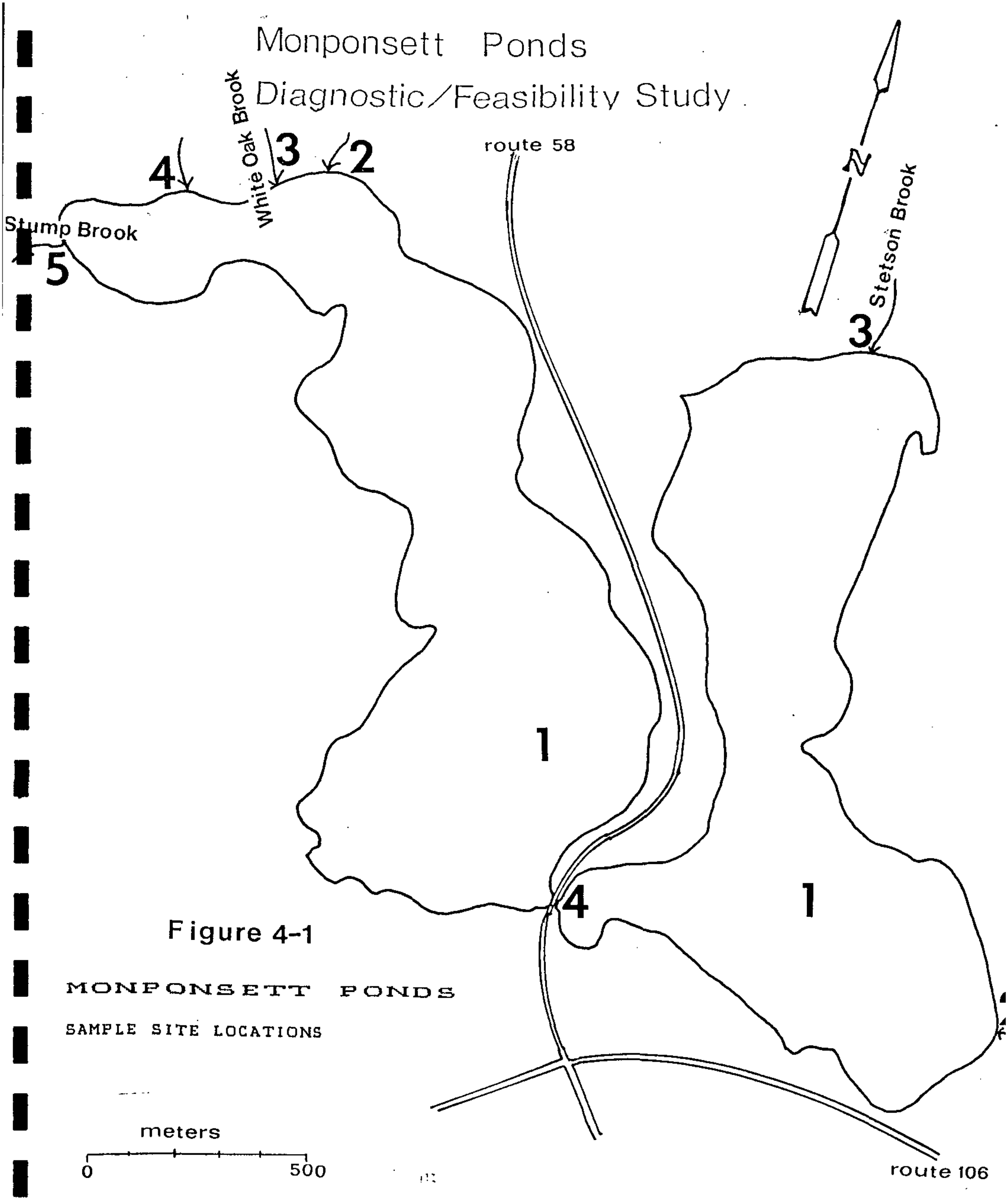


Figure 4-1

MONPONSETT PONDS

SAMPLE SITE LOCATIONS

holding times were also taken from the latter reference.

Several parameters were measured in the field at all stations. These included measurement of dissolved oxygen and temperature using a Yellow Springs Instrument Co. (YSI) Model 57 remote probe. Conductivity was measured with a YSI Model 33 conductivity meter and pH using a VWR Model 47 mini pH meter. Measurements of dissolved oxygen and temperature, were recorded at 1 meter intervals to the bottom of the pond.

Phytoplankton samples were stained with Lugal's solution and concentrated on 45 micron millipore filters. The filters were made transparent with immersion oil and counted on Swift Instruments phase contrast microscope at a magnification factor of 100X.

Aquatic macrophytes were sampled using a weighted grappling hook and mapped visually. Plants were identified using Fassett (1957).

Temperature, Secchi disk transparency and weather conditions were measured in the field during the period of study from April 1985 to May 1986 (see Field Results, Appendix A), these data were gathered at the deep basin stations for East and West Monponsett Ponds.

4.3 Water Quality Sampling Results

4.3.1 Physical Parameters

Temperature

Due to the shallow nature of these pond basins neither pond developed a hypolimnion during the period of study. The two pond basins are remarkably similar in shape and depth and as a result the temperature profiles are similar throughout the year. Figure 4-2 to 4-5 show selected temperature profiles during the period of study. The 11/25/85 and 3/19/86 data represent periods of vertical homogeneity of temperature which is consistent with periods of intense mixing.

Secchi Disc Transparency

Secchi disc is a method of measuring the transparency of the water column. This simple measurement is dependent on a host of factors including: dissolved and suspended solids, phytoplankton populations, and weather conditions. Secchi disc readings ranged from 1.1 to 2.7 meters in both ponds (see Field Data, Appendix A). The minimum visibility standard for bathing beach in Massachusetts, as set by article VII of the State Sanitary Code (310 CMR 17.00) is four feet or 1.2 meters. This is primarily due to an assumed

TABLE 3-1

MONPONSETT PONDS HYDROLOGIC BUDGET
MAY 1985 TO APRIL 1986 (10^7 ft.^{3})

Sub Watershed	#	Area (sq.mi)	1985 MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	1986 JAN	FEB	MAR	APR	Total 12 month Discharge
Sub-Watershed Runoff*	1	0.26	0.07	0.04	0.02	0.02	0.03	0.02	0.14	0.10	0.13	0.17	0.17	0.08	0.99
	2	0.98	0.27	0.16	0.06	0.08	0.11	0.09	0.54	0.37	0.48	0.66	0.65	0.30	3.76
	3	0.54	0.15	0.09	0.03	0.04	0.06	0.05	0.30	0.20	0.27	0.36	0.36	0.16	2.07
	4	0.86	0.24	0.14	0.05	0.07	0.10	0.08	0.48	0.32	0.42	0.58	0.58	0.26	3.31
	5	1.40	0.39	0.17	0.08	0.11	0.16	0.13	0.78	0.53	0.69	0.94	0.94	0.43	5.38
	6	0.79	0.22	0.13	0.05	0.06	0.09	0.07	0.44	0.30	0.39	0.53	0.53	0.24	3.04
	7	0.60	0.17	0.10	0.04	0.05	0.07	0.05	0.33	0.23	0.29	0.40	0.40	0.18	2.30
	8	0.15	0.04	0.02	0.01	0.01	0.02	0.01	0.08	0.06	0.07	0.10	0.10	0.05	0.58
Total Runoff to lake			1.55	0.85	0.34	0.44	0.64	0.50	3.09	2.11	2.74	3.74	3.73	1.70	21.43
Pumped to Silver Lake			1.17	0.00	0.00	1.03	1.25	0.00	1.87	0.37	1.72	2.20	1.71	0.70	12.02
Precipitation minus Evaporation from lake			0.00	0.01	-0.63	-0.42	0.00	0.07	1.20	0.20	0.96	0.71	0.66	0.16	2.92
Watershed Export at Stump Brook			0.38	0.86	0.29	-1.01	-0.61	0.57	2.42	1.94	1.98	2.25	2.68	1.16	12.33

*Sub Watershed numbers refer to Figure 3-1

Figure 4-2

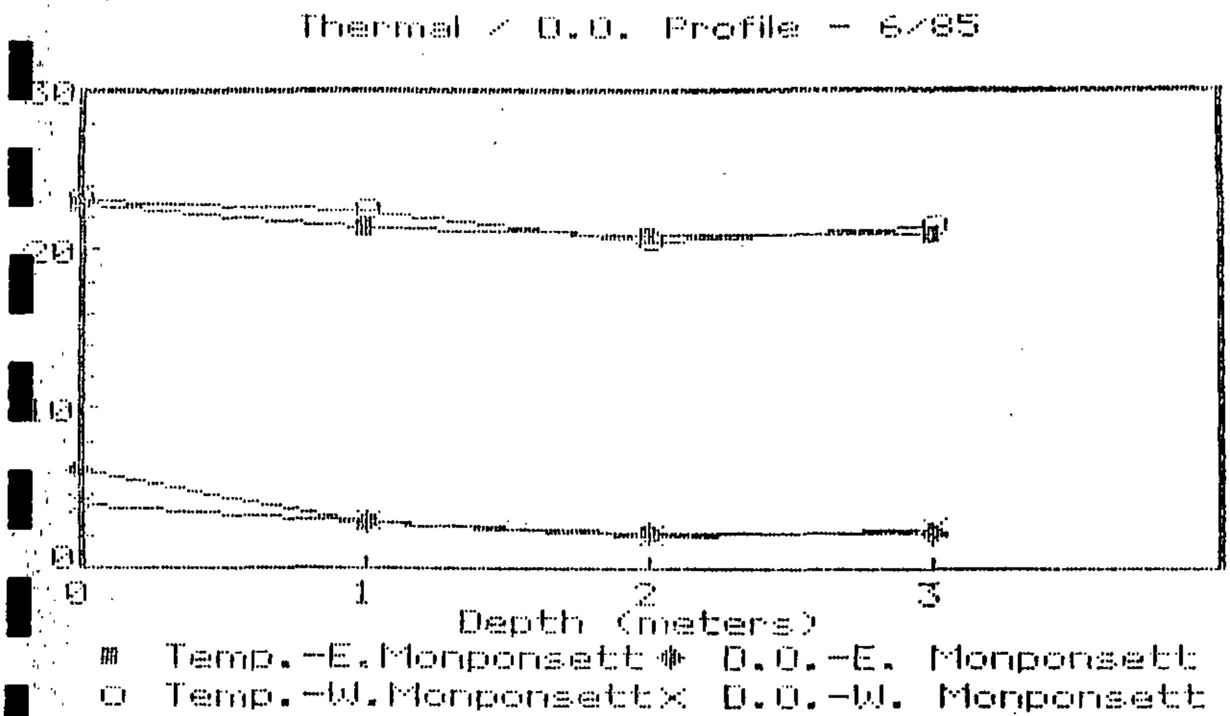


Figure 4-3

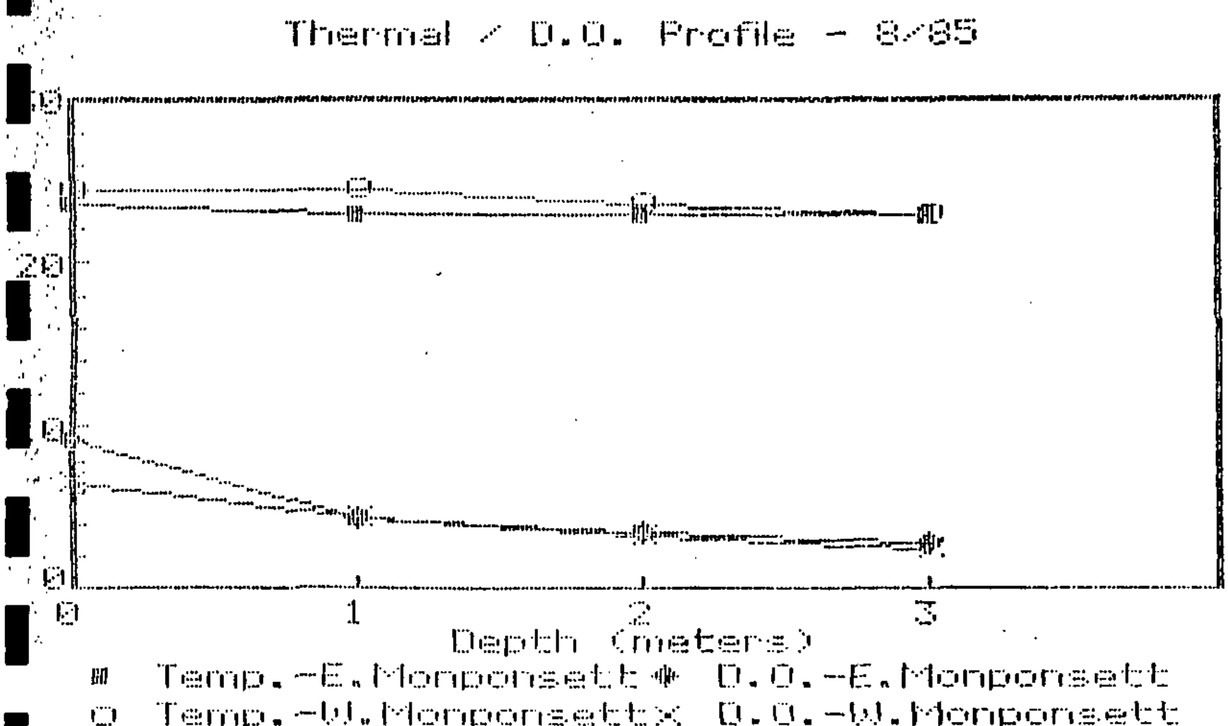


Figure 4-4

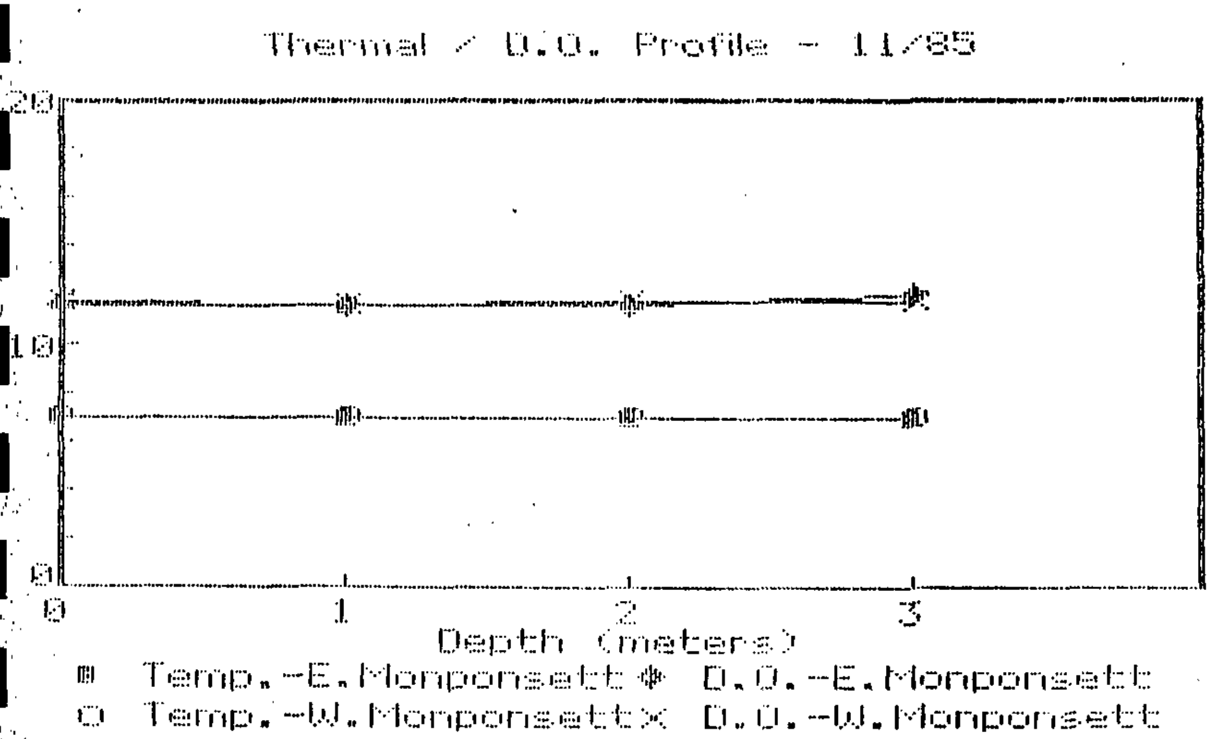
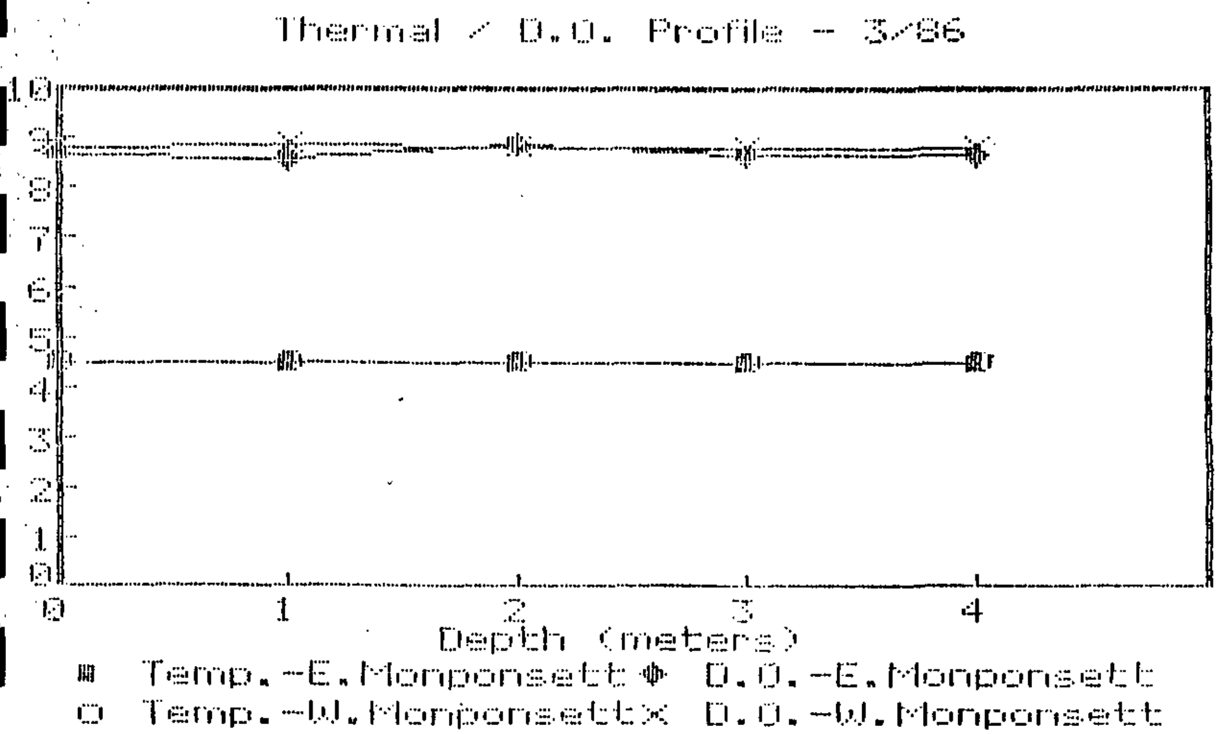


Figure 4-5



relationship between water clarity and water safety (Noss and Hatfield, 1983). On several occasions, the Monponsett Ponds did not meet the minimum visibility criteria for bathing beaches.

4.3.2 Chemical Parameters

Dissolved Oxygen

Dissolved oxygen is probably the most critical lake chemistry parameter because of importance to the metabolic needs of lake fauna, including fish. During prolonged periods of low oxygen concentrations (less than about five milligrams per liter) fish kills may occur.

Oxygen concentrations are affected both by the physical processes of dissolution from the atmosphere and by the biochemical processes of photosynthesis and respiration. During daylight hours in the summer oxygen concentrations can be depleted by the metabolism of aquatic organisms in cold bottom waters; oxygen concentrations can also be increased by photosynthetic activity of algae in warmer surface waters. The vertical concentration profiles of dissolved oxygen often vary dramatically with the seasons. Surface water (epilimnion) concentrations tend to reflect a condition of oxygen saturation due to gas exchange with the atmosphere. Bottom conditions may show depletion due to uptake by respiring macro fauna and bacterial decomposition of organic matter.

During the period of study, surface concentrations of oxygen remained near total saturation in both pond basins (see field results, Appendix A). During the summer months the Monponsett Ponds retain some oxygen in the bottom waters of the water column. Lowest values of dissolved oxygen were recorded on May 29, 1985 when the measured concentration was 1.9 milligrams per liter at a three meter depth in both east and west basins. Wind driven mixing of the water column prevented the complete development of a hypolinnion layer at any time during the summer. The graph of temperature and oxygen profiles for August 28 in Figure 4-3 show vertically homogeneous temperatures with oxygen saturation declining to 35 percent at the bottom in the east basin and 29% of saturation in the west basin.
The oxygen depletion is probably due to respiring micro-organisms such as heterotrophic bacteria.

pH and Alkalinity

The pH of a lake is a measure of the acidity of the water. A pH of 7.0 is neutral. Massachusetts water quality standards for class B waters, which are applicable to the Monponsett Ponds, specify that the pH should be in the range

6.5 to 8.0 pH units (Commonwealth of Massachusetts, 1984).

The pH and alkalinity of an aquatic system are closely related. The alkalinity measured in a pond represents the water body's buffering capacity. This capacity or acid neutralization capacity (ANC) is measured in mg/L of $CaCO_3$. The loss of this buffering capacity is indicative of water body acidification. If a ponds alkalinity is less than 20 mg/L $CaCO_3$, it can be considered "sensitive" to acidic precipitation (Godfrey et al., 1985).

The in-lake measured mean surface values for pH in East and West Monponsett Ponds respectively are 5.7 and 5.9 pH units (Tables 4-1, 4-2). These values are lower than the class B standard for pH. There is a general trend of higher levels in West Monponsett. The mean pH for the tributaries to East Monponsett is 4.5 and for the tributaries to West Monponsett, it is 5.5.

The means for all measured in-lake alkalinity values in East and West Monponsett Ponds respectively are 7.78 and 11.5 mg/L CaCO3 (Tables 4-3, 4-4). According to the alkalinity criteria given in Godfrey et al.(1985), East Monponsett is "highly sensitive" and West Monponsett is "sensitive" to acidic precipitation. The lower alkalinity in East Monponsett may be due to the extremely low alkalinity water entering from a wetland-draining stream at station #2 (Table 4-3).

Chloride and Conductivity

Most natural sources of chloride are from oceanic origin. However, due to the use of chlorides as deicing agents, man introduces this ion into the aquatic environment in increased quantities. The mean value for chloride in East and West Monponsett Ponds were calculated as 26.3 and 31.4 mg/L, respectively (Tables 4-5 and 4-6). The in-lake and tributary data did not rise over the winter months during the period of study. This indicates no measured impact of the deicing programs utilized on surrounding roadways.

Conductivity is a measure of the presence of ions in solution in the water column. The mean conductivity in East and West Monponsett Ponds were 119 and 143 micromhos, respectively (Tables 4-7 and 4-8). This parameter followed the pattern exhibited by the chloride ion.

Total Phosphorus

Phosphorus is one of the most important elements for biological metabolism. Its presence in high concentrations can be responsible for excessive weed and algae growth in lakes. Reckhow et al. (1980) listed criteria values for phosphorus concentration, in relation to the commonly used

TABLE 4-1

EAST MONPONSETT POND
pH (std. units)

DATE	STATION 1 Surface Deep	STATION 2	STATION 3	STATION 4 Drainage Connection
4/18/85	7.0 7.0	5.0	4.0	7.0
5/29/85	4.9 4.7	3.0	5.1	5.0
6/11/85	5.8 5.8	3.2	5.5	5.8
7/8/85	5.6 5.3	3.5	5.4	5.8
8/13/85	5.7 5.6	3.7	5.6	8.1
8/28/85	6.5 6.5	3.6	6.2	6.2
9/11/85	6.0 6.2	3.8	5.0	6.2
9/26/85	6.2 **	3.2	5.4	6.5
10/10/85	6.5 6.8	3.7	5.2	6.4
10/23/85	6.0 6.2	3.4	5.3	6.0
11/13/85	6.0 6.0	3.5	6.7	6.0
11/25/85	5.8 5.5	3.8	4.4	5.7

**Van Dorn bottle broke

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TABLE 4-1 (Continued)

EAST MONPONSETT POND
pH (std. units)

DATE	STATION 1 Surface Deep	STATION 2	STATION 3	STATION 4 Drainage Connection
12/20/85	4.0 *	+	5.8	6.7
1/22/86	3.7 *	3.3	5.7	5.7
2/13/86	5.8 6.0	4.2	3.8	5.8
3/19/86	5.2 5.2	2.8	4.7	5.3
4/17/86	5.5 5.5	3.2	5.5	5.3
5/14/86	5.4 5.6	3.4	6.3	5.5

*Station 1 not sampled due to thin ice; in lake station taken from shore nearest deep hole, through the ice.

+ contamination suspected

TABLE 4-2

WEST MONPONSETT POND
pH (std. units)

DATE	STATION 1 Surface Deep	STATION 2	STATION 4	STATION 5 Tributary #5
5/29/85	5.1 5.0	5.4	4.9	5.2
6/11/85	6.3 6.4	dry	dry	6.7
7/8/85	+ 5.2	5.9	5.2	dry
8/13/85	5.8 5.8	dry	dry	7.5
8/28/85	6.5 6.5	dry	dry	6.4
9/11/85	6.2 6.1	5.2	5.2	5.7
9/26/85	6.2 6.2	dry	6.7	6.2
10/10/85	6.9 7.0	dry	6.7	7.2
10/25/85	5.6 +	4.3	dry	5.0
11/13/85	6.2 6.8	5.2	5.3	5.8
11/25/85	6.2 6.2	6.8	4.7	6.2

+ contamination suspected

TABLE 4-2 (Continued)

WEST MONPONSETT POND
pH (std. units)

DATE	STATION 1 Surface Deep	STATION 2	STATION 4	STATION 5 Tributary #5
12/20/85	5.8 *	5.7	3.1	4.2
1/22/86	5.5 *	6.0	4.2	*
2/13/86	6.5 6.6	6.2	6.3	7.1
3/31/86	5.2 5.2	7.2	6.3	6.5
4/17/86	5.1 5.1	5.2	5.5	5.6
5/14/86	5.6 5.6	5.5	dry	5.2

*Station 1 not sampled due to thin ice; in lake station taken from shore nearest deep hole, through the ice.

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TABLE 4-3

EAST MONPONSETT POND
TOTAL ALKALINITY (mg/liter as $CaCO_3$)

DATE	STATION 1 Surface Deep	STATION 2	STATION 3	STATION 4 Drainage Connection
4/18/85	6.0 8.0	10.0	t	14.0
5/29/85	6.0 6.0	t	11.0	6.0
6/11/85	7.5 5.4	t	7.5	8.6
7/8/85	8.6 6.5	t	10.8	12.9
8/13/85	2.2 12.9	t	16.1	11.8
8/28/85	7.5 10.8	t	8.6	12.9
9/11/85	8.7 6.5	t	4.4	8.7
9/26/85	8.7 **	t	19.6	6.5
10/10/85	7.6 7.6	t	10.9	8.6
10/23/85	6.5 8.7	t	9.8	10.9
11/13/85	7.8 6.7	t	4.5	11.2
11/25/85	6.7 6.7	t	t	9.0
12/20/85	t	t	10.9	9.8
1/22/86	t	t	8.7	10.0

t ph is less than 4.5 so the alkalinity is undefined.
**Van Dorn sampler broke.

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TABLE 4-3 (Continued)

EAST MONPONSETT POND
TOTAL ALKALINITY (mg/liter as $CaCO_3$)

DATE	STATION 1 Surface Deep	STATION 2	STATION 3	STATION 4 Drainage Connection
2/13/86	9.8 6.5	t	10.9	8.7
3/19/86	7.6 5.7	t	5.7	7.6
4/17/86	8.8 8.8	t	13.2	8.8
5/14/86	12.1 12.1	t	9.9	9.9

tph is less than 4.5 so the alkalinity is undefined.

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TABLE 4-4

WEST MONPONSETT POND
TOTAL ALKALINITY (mg/liter as $CaCO_3$)

DATE	STATION 1 Surface Deep	STATION 2	STATION 4	STATION 5
5/19/85	11.0 12.0	9.0	18.0	9.0
6/11/85	12.9 11.8	dry	dry	10.8
7/8/85	10.8 17.2	10.8	6.5	dry
8/13/85	15.1 17.2	dry	dry	4.3
8/28/85	14.0 12.9	dry	dry	5.4
9/11/85	10.9 15.3	6.5	10.9	8.2
9/26/85	12.0	dry	4.4	7.6
10/10/85	12.0 13.1	dry	8.6	18.5
10/25/85	10.9 12.0	dry	dry	12.0
11/13/85	10.1 12.3	10.1	6.7	3.4
11/25/85	7.8 6.7	7.8	6.7	1.1
12/20/85	t	21.7	7.6	3.3
1/22/86	9.8 *	7.6	t	*

t pH $<$ 4.5, therefore unable to perform alkalinity test.

* Station 1 not sampled due to thin ice; in-lake sample taken from shore nearest deep hole, through the ice. Station 5 inaccessible due to thin ice.

TABLE 4-4 (Continued)

WEST MONPONSETT POND
TOTAL ALKALINITY (mg/liter as $CaCO_3$)

DATE	STATION 1 Surface / Deep	STATION 2	STATION 4	STATION 5
2/13/86	8.7 7.6	11.9	8.7	4.3
3/31/86	11.4 8.6	11.4	8.6	5.7
4/17/86	8.8 11.0	11.0	15.4	11.0
5/14/86	8.8 12.1	14.3	dry	11.0

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TABLE 4-5

EAST MONPONSETT POND
CHLORIDE (mg/liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 3	STATION 4 Drainage Connection
4/18/85	25.0 23.8	30.0	13.8	21.3
5/29/85	25.0 27.5	15.0	23.8	26.3
6/11/85	26.3 26.3	15.0	22.5	27.5
7/8/85	25.0 25.0	8.8	21.3	32.5
8/13/85	25.0 25.0	16.3	26.3	27.5
8/28/85	25.0 23.8	15.0	21.3	30.0
9/11/85	26.3 23.8	13.8	16.3	31.3
9/26/85	26.3 **	13.8	27.5	26.3
10/10/85	25.0 27.5	16.3	25.0	28.8
10/23/85	26.3 26.3	13.8	22.5	30.0
11/13/85	26.3 26.3	17.5	16.3	30.0
11/25/85	27.5 25.0	12.5	17.5	30.0
12/20/85	20.0*	15.0	15.0	31.3
1/22/86	16.3*	16.3	21.3	31.3

*Station 1 inaccessible due to thin ice; in-lake sample obtained from shore nearest deep hole, through the ice.
**Van Dorn sampler broke.

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TABLE 4-5 (Continued)

EAST MONPONSETT POND
CHLORIDE (mg/liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 3	STATION 4 Drainage Connection
2/13/86	32.5 27.5	20.0	22.5	28.8
3/19/86	22.5 25.0	12.5	21.3	27.5
4/17/86	32.5 25.0	25	27.5	30
5/14/86	40 45	25	35.	40

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TABLE 4-6

WEST MONPONSETT POND
CHLORIDE (mg/liter)

DATE	STATION 1 Surface	STATION 1 Deep	STATION 2	STATION 4	STATION 5
5/29/85	30.0	30.0	75.0	45.0	30.0
6/11/85	28.8	30.0	dry	dry	31.3
7/8/85	28.8	30.0	47.5	22.5	dry
8/13/85	31.3	30.0	dry	dry	82.5
8/28/85	30.0	30.0	dry	dry	17.5
9/11/85	28.8	28.8	33.8	36.3	18.8
9/26/85	32.5	**	dry	51.3	26.3
10/10/85	30.0	33.8	dry	25.0	30.0
10/25/85	32.5	30.0	55.0	dry	30.0
11/13/85	31.3	32.5	50.0	31.3	22.5
11/25/85	27.5	32.5	58.8	41.3	21.3
12/20/85	31.3*		104	50.0	32.5
1/22/86	30.0*		35.0	28.0	*

*Staion 1 not sampled due to thin ice; in-lake sample taken from shore nearest deep hole; through the ice. Station 5 inaccessible due to thin ice.
**Van Dorn sampler broke.

TABLE 4-6 (Continued)

WEST MONPONSETT POND
CHLORIDE (mg/liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 4	STATION 5
2/13/86	27.5 27.5	46.3	40.0	20.0
3/31/86	32.5 27.5	52.5	43.8	26.3
4/17/86	35.0 32.5	72.5	50.0	37.5
5/14/86	47.5 42.5	77.5	dry	35.0

TABLE 4-7

EAST MONPONSETT POND
CONDUCTIVITY (micromhos per cm.)

DATE	STATION 1 Surface	STATION 1 Deep	STATION 2	STATION 3	STATION 4 Drainage Connection
4/18/85	112	118	89	82	126
5/29/85	119	130	18	119	118
6/11/85	132	134	89	130	139
7/8/85	123	133	91	118	161
8/13/85	184	130	100	144	140
8/28/85	131	127	132	120	163
9/11/85	104	109	71	93	123
9/26/85	124	**	76	126	127
10/10/85	93	93	67	92	94
10/23/85	127	123	88	114	151
11/13/85	115	111	95	79	133
11/25/85	117	119	86	88	148
12/20/85	113*		75	73	120
1/22/86	79*		76	88	144

*Station 1 not sampled due to thin ice; in-lake sample taken from shore nearest deep hole, through the ice.
**Van Dorn sampler broke.

TABLE 4-7 (Continued)

EAST MONPONSETT POND
CONDUCTIVITY (micromhos per cm.)

DATE	STATION 1 Surface Deep	STATION 2	STATION 3	STATION 4 Drainage Connection
2/13/86	109 94	68	86	118
3/19/86	113 119	72	102	138
4/17/86	117 115	80	117	121
5/14/86	120 121	77	117	121

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TABLE 4-8

WEST MONPONSETT POND
CONDUCTIVITY (micromhos per cm.)

DATE	STATION 1 Surface Deep	STATION 2	STATION 4	STATION 5
5/29/85	145 143	290	195	142
6/11/85	164 161	dry	dry	157
7/8/85	152 164	211	108	dry
8/13/85	163 163	dry	dry	416
8/28/85	160 162	dry	dry	106
9/11/85	117 130	133	159	126
9/26/85	156 **	dry	250	154
10/10/85	115 117	dry	183	114
10/25/85	128 117	228	dry	118
11/13/85	137 139	187	141	109
11/25/85	128 119	227	164	88
12/20/85	211*	402	176	128
1/22/86	137*	170	271	*

*Station 1 not sampled due to thin ice; in-lake sample taken from shore nearest deep hole, through the ice. Station 5 inaccessible due to thin ice.
**Van Dorn sampler broke.

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TABLE 4-8 (Continued)

WEST MONPONSETT POND
CONDUCTIVITY (micromhos per cm.)

DATE	STATION 1 Surface Deep	STATION 2	STATION 4	STATION 5
2/13/86	126 126	199	139	78
3/31/86	140 135	227	193	135
4/17/86	138 131	209	204	139
5/14/86	153 142	237	dry	137

trophic categories for lakes:

Trophic State	Total Phosphorus (mg/L)
Oligotrophic	<0.01
Mesotrophic	0.01 - 0.02
Eutrophic	>0.02

The time weighted mean surface concentration of phosphorus in East and West Monponsett Ponds are 0.022 and 0.019 mg/L respectively with a ranges of <.005 to 0.13 mg/L in East Monponsett and <.001 to 0.18 mg/L in West Monponsett (Tables 4-9, 4-10).

Levels of phosphorus are generally near the mesotrophic - eutrophic boundary. The potential damage to these systems by slight increases of the phosphorus concentration in tributary streams or subsurface inflow could be substantial.

Nitrogen

Nitrogen, along with phosphorus, is an essential element for biological metabolism. Three forms of nitrogen compounds were measured in the Monponsett Ponds: Nitrate-Nitrogen (Tables 4-11, 4-12), Ammonia-Nitrogen (Tables 4-13, 4-14), and Total Kjeldahl-Nitrogen (Tables 4-15, 4-16). Total nitrogen (Kjeldahl plus nitrate) concentrations are presented in Tables 4-17, 4-18. Nitrate-Nitrogen in-lake levels ranged from undetectable to 2.05 mg/L with a mean concentration of 0.25 mg/L in East Monponsett. In West Monponsett, Nitrate-Nitrogen ranges from undetectable to 0.8 mg/L. Ammonia-Nitrogen levels ranged in East Monponsett from <0.05 to 0.32 mg/L with a mean concentration of 0.046 mg/L and in West Monponsett ranged from <0.01 to 0.79 mg/L with a mean 0.076 mg/L.

Total Kjeldahl-Nitrogen represents a total of the organic forms of nitrogen. Concentrations of this parameter in East Monponsett Pond ranged from <0.05 to 0.6 mg/L, with a mean of 0.23 mg/L. In West Monponsett the range was from <0.1 to 1.3 mg/L with a mean of 0.36 mg/L. Total nitrogen ranged from 0.2 to 2.16 mg/L with a mean of 0.43 in East Monponsett and from <0.1 to 1.54 mg/L with a mean of 0.53 in West Monponsett.

The total nitrogen to phosphorus ratio indicates phosphorus limitation (see Section 5.1). This reduces the importance of nitrogen concentration values in the lakes. This nutrient is available in excess in these systems.

TABLE 4-9

EAST MONPONSETT POND
TOTAL PHOSPHORUS (mg/liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 3	STATION 4 Drainage Connection
4/18/85	0.02 +	0.04	0.01	0.02
5/29/85	0.01 0.02	0.02	0.08	0.02
6/11/85	0.02 0.04	0.03	0.06	0.06
7/8/85	0.02 0.02	0.02	0.05	0.002
8/13/85	0.01 0.02	0.04	0.02	0.05
8/28/85	<0.005 0.015	0.024	0.048	0.016
9/11/85	0.011 0.087	0.014	0.054	0.014
9/26/85	0.020 **	0.062	0.042	0.021
10/10/85	0.015 0.019	0.045	0.035	0.023
10/23/85	0.013 0.095	0.027	0.034	0.017
11/13/85	0.018 0.010	0.020	0.05	0.026
11/25/85	0.053 0.087	0.023	0.099	0.035

**Van Dorn bottle broke
+ Contamination suspected

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TABLE 4-9 (Continued)

EAST MONPONSETT POND
TOTAL PHOSPHORUS (mg liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 3	STATION 4 Drainage Connection
12/10/85	<0.04*	<0.04	<0.04	<0.04
1/22/86	0.015*	<0.01	0.045	<0.01
2/13/86	<0.01 0.01	<0.01	0.107	<0.01
3/19/86	0.007 <0.001	0.032	0.034	0.017
4/17/86	<0.001 0.025	<0.001	0.034	0.014
5/14/86	+ <0.001	+	0.079	0.051

*Station 1 not sampled due to thin ice; in-lake sample taken from shore nearest deep hole, through the ice.
+Contamination suspected.

TABLE 4-10

WEST MONPONSETT POND
TOTAL PHOSPHORUS (mg/liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 4	STATION 5
5/29/85	0.02 0.02	0.18	0.14	0.05
6/11/85	0.03 0.18	dry	dry	0.10
7/8/85	0.02 0.03	0.09	0.10	dry
8/13/85	0.03 0.03	dry	dry	0.25
8/28/85	0.005 0.039	dry	dry	0.043
9/11/85	0.020 0.056	0.047	0.080	0.094
9/26/85	0.052 **	dry	0.096	0.031
10/10/85	0.023 0.001	dry	0.005	0.071
10/25/85	0.017 0.024	0.191	dry	0.021
11/13/85	0.025 0.035	0.060	0.048	0.029
11/25/85	0.014 0.016	0.039	0.041	0.017
12/20/85	0.04*	0.04	0.04	0.04

*Station 1 not sampled due to thin ice; in-lake sample taken from shore nearest deep hole, through the ice.

**Van Dorn sampler broke.

TABLE 4-10 (Continued)

WEST MONPONSETT POND
TOTAL PHOSPHORUS (mg/liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 4	STATION 5
1/22/86	0.017*	0.095	0.045	*
2/13/86	0.01 0.01	0.01	0.046	0.01
3/31/86	0.002 0.015	0.049	0.030	0.028
4/17/86	0.009 0.021	0.033	0.019	0.035
5/14/86	0.001 0.001	0.082	dry	0.003

*Station 1 not sampled due to thin ice; in-lake sample taken from shore nearest deep hole, through the ice. Station 5 inaccessible due to thin ice.

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TABLE 4-11

EAST MONPONSETT POND
NITRATE NITROGEN (mg/liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 3	STATION 4 Drainage Connection
4/18/85	0.24 0.37	1.08	<0.10	0.34
5/29/85	0.17 0.18	<0.10	0.41	0.15
6/11/85	<0.10 0.60	<0.10	0.30	<0.10
7/8/85	<0.10 <0.10	0.10	0.25	3.72
8/13/85	+ 0.14	<0.10	<0.10	<0.10
8/28/85	0.36 0.42	0.37	2.15	0.55
9/11/85	<0.10 <0.10	<0.10	0.29	0.11
9/26/85	<0.10 **	<0.10	0.15	<0.10
10/10/85	<0.10 <0.10	<0.10	0.12	<0.10
10/23/85	<0.10 <0.10	0.10	0.19	0.10
11/13/85	0.20 0.10	0.30	<0.10	1.02

+contamination suspected.
**Van Dorn sampler broke.

TABLE 4-11 (Continued)

EAST MONPONSETT POND
NITRATE NITROGEN (mg/liter)

DATE	STATION 1 Surface	STATION 1 Deep	STATION 2	STATION 3	STATION 4 Drainage Connection
11/25/85	<0.10	<0.10	0.20	0.15	<0.10
12/20/85	0.10	*	<0.10	0.20	<0.10
1/22/86	<0.10	*	0.35	0.30	<0.10
2/13/86	0.70	0.70	<0.10	<0.10	<0.10
3/19/86	<0.10	<0.10	0.28	0.29	<0.10
4/17/86	0.12	2.05	0.19	0.72	0.13
5/14/86	0.38	0.10	0.25	0.88	0.32

*Station 1 not sampled due to thin ice; in-lake sample taken from shore nearest deep hole, through the ice.

TABLE 4-12

WEST MONPONSETT POND
NITRATE-NITROGEN (mg/liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 4	STATION 5
5/29/85	0.23 0.23	0.24	0.28	0.18
6/11/85	0.15 0.14	dry	dry	0.13
7/8/85	0.30 0.18	0.25	0.16	dry
8/13/85	<0.10 <0.10	dry	dry	<0.10
8/28/85	0.24 0.39	dry	dry	0.10
9/11/85	<0.10 <0.10	0.40	0.54	<0.10
9/26/85	<0.10 **	dry	0.15	<0.10
10/10/85	<0.10 <0.10	dry	0.14	<0.10
10/25/85	<0.10 <0.10	<0.10	dry	<0.10
11/13/85	0.30 <0.10	0.55	0.65	0.35
11/25/85	<0.10 0.25	0.30	0.10	0.11
12/20/85	0.20*	0.30	0.20	0.20

*Station 1 not sampled because of thin ice; in-lake sample taken from shore nearest deep hole, through the ice.
**Van Dorn sampler broke.

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TABLE 4-12 (Continued)

WEST MONPONSETT POND
NITRATE-NITROGEN (mg/liter)

DATE	STATION 1 Surface	STATION 2	STATION 4	STATION 5
1/22/86	0.10*	0.20	+	*
2/13/86	0.80 0.40	0.20	1.0	<0.1
3/31/86	<0.10 <0.10	0.52	0.43	0.26
4/17/86	0.18 0.19	0.22	0.44	0.25
5/14/86	0.30 0.15	0.32	dry	0.30

*Station 1 not sampled due to thin ice; in-lake sample taken from shore nearest deep hole, through the ice. Station 5 inaccessible due to thin ice.

+ Contamination suspected.

TABLE 4-13

EAST MONPONSETT POND
AMMONIA NITROGEN (mg/liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 3	STATION 4 Drainage Connection
4/18/85	0.06 0.05	0.05	0.06	0.07
5/29/85	0.09 0.05	0.04	0.32	0.06
6/11/85	0.03 0.02	0.02	0.09	0.03
7/8/85	0.01 0.01	0.01	0.01	0.01
8/13/85	0.08 0.10	0.06	0.10	0.31
8/28/85	0.05 0.06	0.06	0.03	0.04
9/11/85	0.11 0.05	0.13	0.05	0.06
9/26/85	0.05 **	0.04	0.01	0.06
10/10/85	0.037 0.032	<0.01	0.043	0.250
10/23/85	0.014 0.011	0.021	0.052	0.014
11/13/85	<.05 <.05	<0.05	<.05	<.05
11/25/85	0.02 0.02	0.05	0.13	0.03
12/20/85	0.01*	0.02	0.01	<0.01
1/22/86	0.32*	0.01	0.41	0.08

*Station 1 not sampled due to thin ice; in-lake sample taken from shore nearest deep hole, through the ice.
**Van Dorn sampler broke.

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TABLE 4-13 (Continued)

EAST MONPONSETT POND
AMMONIA NITROGEN (mg/liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 3	STATION 4 Drainage Connection
2/13/86	0.040 0.033	0.028	0.043	0.029
3/19/86	0.020 0.031	0.013	0.030	0.032
4/17/86	0.032 0.024	0.081	0.017	0.046
5/14/86	0.07 0.02	0.02	0.15	0.10

TABLE 4-14

WEST MONPONSETT POND
AMMONIA NITROGEN (mg/liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 4	STATION 5
5/29/85	0.06 0.05	0.32	0.49	0.05
6/11/85	0.05 0.02	dry	dry	0.07
7/8/85	0.02 0.02	0.01	0.01	dry
8/13/85	0.07 0.05	dry	dry	0.09
8/28/85	0.07 0.03	dry	dry	0.04
9/11/85	0.12 0.09	0.16	0.25	0.01
9/26/85	0.18 **	dry	0.05	0.04
10/10/85	<0.01 <0.01	dry	<0.01	0.135
10/25/85	0.013 0.025	.022	dry	0.020
11/13/85	<0.05 <0.05	<0.05	<0.05	<.05
11/25/85	0.03 0.04	0.43	0.14	0.09
12/20/85	0.01*	<0.01	<0.01	0.60
1/22/86	0.155 *	0.54	1.08	*

*Station 1 not sampled due to thin ice; in-lake sample taken from shore nearest deep hole, through the ice. Station 5 inaccessible due to thin ice.
**Van Dorn sampler broke.

TABLE 4-14 (Continued)

WEST MONPONSETT POND
AMMONIA NITROGEN (mg/liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 4	STATION 5
2/13/86	0.11 0.03	0.973	0.039	0.226
3/31/86	0.014 0.018	0.09	0.30	0.06
4/17/86	0.034 0.012	0.24	+	0.011
5/14/86	0.79 0.08	0.15	dry	0.08

+contamination suspected.

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TABLE 4-15

EAST MONPONSETT POND
KJELDAHL NITROGEN (mg/liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 3	STATION 4 Drainage Connection
4/18/85	0.35 0.30	0.28	0.37	0.32
5/29/85	0.23 0.19	0.26	0.36	0.17
6/11/85	0.19 0.21	0.34	0.14	0.20
7/8/85	0.21 0.21	0.45	0.22	0.60
8/13/85	0.19 0.60	0.88	0.18	0.47
8/28/85	<0.05 <0.05	0.40	<0.05	0.10
9/11/85	0.21 0.16	0.24	0.55	0.28
9/26/85	0.35 **	0.85	0.26	0.31
10/10/85	0.36 0.28	1.15	0.21	0.28
10/23/85	0.22 0.25	1.00	0.27	0.38
11/13/85	0.25 0.27	0.68	0.34	0.24
11/25/85	0.24 0.26	0.40	0.54	0.27
12/20/85	0.36*	0.8	0.5	1.1
1/22/86	0.1*	0.14	0.17	0.10

*Station 1 not sampled due to thin ice; in-lake sample taken from shore, near deep hole, through the ice.
**Van Dorn sampler broke.

TABLE 4-15 (Continued)

EAST MONPONSETT POND
KJELDAHL NITROGEN (mg/liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 3	STATION 4 Drainage Connection
2/13/86	<0.1 <0.1	<0.1	<0.1	<0.1
3/19/86	0.45 0.29	0.36	0.37	0.25
4/17/86	0.14 0.11	0.30	0.12	0.18
5/14/86	0.31 0.19	0.60	0.28	0.33

TABLE 4-16

WEST MONPONSETT POND
KJELDAHL NITROGEN (mg/liter)

DATE	STATION 1 Surface	STATION 1 Deep	STATION 2	STATION 4	STATION 5
5/29/85	0.45	0.50	0.66	0.60	0.37
6/11/85	0.29	0.29	dry	dry	0.31
7/8/85	0.22	0.24	0.31	0.16	dry
8/13/85	0.54	0.41	dry	dry	0.62
8/28/85	1.30	0.90	dry	dry	0.30
9/11/85	0.22	0.40	0.25	3.0	0.35
9/26/85	0.57	**	dry	0.46	0.48
10/10/85	0.45	0.27	dry	0.20	0.36
10/25/85	0.29	0.28	1.20	dry	0.32
11/13/85	0.22	0.43	0.56	0.58	0.57
11/25/85	0.1	0.1	0.37	0.33	0.22
12/20/85	0.32*		1.2	0.39	0.55
1/22/86	0.17*		0.65	0.56	*

*Station 1 not sampled due to thin ice, in-lake sample taken from shore nearest deep hole, through the ice. Station 5 inaccessible due to thin ice.
**Van Dorn sampler broke.

TABLE 4-16 (Continued)

WEST MONPONSETT POND
KJELDAHL NITROGEN (mg/liter)

DATE	STATION 1 Surface	STATION 1 Deep	STATION 2	STATION 4	STATION 5
2/13/86	< 0.1	< 0.1	0.4	<0.1	<0.1
3/31/86	0.18	< 0.1	<0.1	0.10	0.31
4/17/86	t	t	0.24	t	2.50
5/14/86	0.57	0.39	0.46	dry	0.29

t laboratory error suspected.

TABLE 4-17

EAST MONPONSETT POND
TOTAL NITROGEN (KJELDAHL & NITRATE) (mg/liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 3	STATION 4 Drainage Connection
4/18/85	0.59 0.67	1.36	0.40	0.66
5/29/85	0.40 0.37	0.30	0.77	0.32
6/11/85	0.25 0.81	0.40	0.44	0.25
7/8/85	0.25 0.25	0.55	0.47	4.3
8/13/85	+ 0.74	0.95	0.25	0.50
8/28/85	0.38 0.44	0.77	2.20	0.65
9/11/85	0.25 0.20	0.30	0.84	0.39
9/26/85	0.40 **	0.90	0.41	0.35
10/10/85	0.40 0.35	1.05	0.33	0.35
10/23/85	0.25 0.30	1.1	0.46	0.48
11/13/85	0.45 0.37	0.98	0.40	1.26
11/25/85	0.30 0.30	0.60	0.69	0.30
12/20/85	0.46 *	1.0	0.65	1.15

+laboratory error suspected.
*Station 1 not sampled due to thin ice; in-lake sample taken from shore nearest deep hole, through the ice.
**Van Dorn sampler broke.

TABLE 4-17 (Continued)

EAST MONPONSETT POND
TOTAL NITROGEN (KJELDAHL & NITRATE) (mg/liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 3	STATION 4 Drainage Connection
1/22/86	0.20 *	0.49	0.47	0.20
2/13/86	0.758 0.8	<0.10	<0.10	<0.10
3/19/86	0.50 0.35	0.64	0.66	0.30
4/17/86	0.26 2.16	0.49	0.84	0.31
5/14/86	0.69 0.29	0.85	1.16	0.65

*Station 1 not sampled due to thin ice; in-lake sample taken from shore nearest deep hole, through the ice.

TABLE 4-18

WEST MONPONSETT POND
TOTAL NITROGEN (KJELDAHL & NITRATE) (mg/liter)

DATE	STATION 1 Surface	STATION 1 Deep	STATION 2	STATION 4	STATION 5
12/20/85	0.52	*	1.5	0.59	0.75
1/22/86	0.27	*	0.85	+	*
2/13/86	0.85	0.45	0.60	1.05	<0.1
3/31/86	0.25	<0.1	0.55	0.53	0.57
4/17/86	+	+	0.46	+	2.75
5/14/86	0.87	0.54	0.78	dry	0.59

+ laboratory error suspected.
* Station 1 not sampled due to thin ice; in-lake sample taken from shore nearest deep hole, through the ice. Station 5 inaccessible due to thin ice.

TABLE 4-18 (Continued)

WEST MONPONSETT POND
TOTAL NITROGEN (KJELDAHL & NITRATE) (mg/liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 4	STATION 5
5/29/85	0.68 0.73	0.90	0.88	0.55
6/11/85	0.44 0.43	dry	dry	0.44
7/8/85	0.52 0.42	0.56	0.32	dry
8/13/85	0.60 0.50	dry	dry	0.65
8/28/85	1.54 1.29	dry	dry	0.40
9/11/85	0.30 0.45	0.65	3.5	0.40
9/26/85	0.60 **	dry	0.61	0.55
10/10/85	0.50 0.30	dry	0.34	0.35
10/25/85	0.35 +	1.25	dry	0.35
11/13/85	0.52 0.50	0.92	0.88	0.68
11/25/85	0.15 0.35	0.67	0.43	0.33

+ laboratory error suspected.
**Van Dorn sampler broke.

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Suspended Solids and Dissolved Solids

Suspended solids is a measure of the amount of particulate matter which is present in the water. If the water is calm suspended solid can settle out and contribute to the lake bottom sediments. Wind induced wave turbulence can resuspend unconsolidated bottom sediments.

Suspended solids values for the Monponsett Ponds are presented in Table 4-19 and 4-20. The mean concentration of suspended solids ranged from 3.9 mg/L in East Monponsett to 5.6 mg/L in West Monponsett. At these levels there may be an impact on the water clarity.

Dissolved solids comprise all soluble ionic salts, organic compounds and colloidal solids in the water. These materials do not settle out in the lake. The organic materials present as dissolved solids can contribute to a brown or orange coloration of the water.

The values of dissolved solids ranged from a low of 28 to a high of 130 mg/L in the open waters of East Monponsett Pond and from 68 to 190 mg/L in the open waters of West Monponsett Pond (Tables 4-21 and 4-22). Comparison of dissolved and suspended solids values observed at the inlets, in-lake and outlet reveal that most of the solids are in the dissolved form. This is typical of most lakes.

4.3.3 Biological Results

Bacteriological Parameters

Bacteria of the coliform group are indicators of fecal contamination. Total coliform includes soil bacteria whereas fecal coliform bacteria are restricted to bacteria which are found in the intestinal tract of animals. Massachusetts Water Quality Standards (Commonwealth of Massachusetts, 1984) set a criteria of 200 organisms per 100 milliliters (ml) fecal coliform for primary (swimming) contact waters and 1,000 per 100 ml for secondary contact (boating) waters.

The results for total coliform in East Monponsett range from 1 to 530 organisms per 100 ml with a geometric mean of 20, West Monponsett total coliform results ranged from undetectable to 1500 organisms per 100 ml, with a geometric mean of 43 per 100 ml (Tables 4-23 and 4-24). Fecal coliform results for East Monponsett ranged from undetectable to 10 organisms per 100 ml, with an arithmetic mean of 4.8 per 100 ml, (Tables 4-25 and 4-26). In West Monponsett Pond, fecal coliforms ranged from undetectable to 270 organisms per 100 ml on November 25, 1985. The geometric mean was 9.5 organisms per 100 ml. The high result on November 25 was probably due to contamination by deposits of seagull feces

TABLE 4-19

EAST MONPONSETT POND
SUSPENDED SOLIDS (mg/liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 3	STATION 4 Drainage Connection
4/18/85	1.6 1.6	3.8	24.6	2.8
5/29/85	<0.3 <0.3	10.4	0.3	1.3
6/11/85	0.3 2.6	1.3	2.1	6.7
7/8/85	7.7 5.9	7.1	12.6	10.0
8/13/85	7.0 1.0	3.2	1.4	6.9
8/28/85	2.4 3.5	<0.3	3.6	0.3
9/11/85	<0.3 33.7+	0.4	8.5	1.7
9/26/85	0.4 **	1.2	2.7	2.4
10/10/85	6.0 6.8	7.4	14.5	7.6
10/23/85	6.4 7.6	0.4	3.9	5.3
11/13/85	2.0 0.3	3.0	1.7	3.0
11/25/85	1.9 0.4	3.9	5.8	1.0
12/20/85	3.9*	<.4	0.7	<.3

*Station 1 not sampled due to thin ice; in-lake sample taken from shore nearest deep hole, through the ice.
**Van Dorn sampler broke.
+probable sediment disturbance.

TABLE 4-19 (Continued)

EAST MONPONSETT POND
SUSPENDED SOLIDS (mg/liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 3	STATION 4 Drainage Connection
1/22/86	1.1*	<.3	3.3	2.1
2/13/86	4.5 5.1	5.7	13.7	7.4
3/19/86	1.3 1.3	<.3	<.3	1.4
4/17/86	1.0 11.5	<.3	4.4	4.0
5/14/86	3.4 2.7	7.3	3.7	2.8

*Station 1 not sampled due to thin ice; in-lake sample taken from shore nearest deep hole, through the ice.

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TABLE 4-20

WEST MONPONSETT POND
SUSPENDED SOLIDS (mg/liter)

DATE	STATION 1 Surface	STATION 1 Deep	STATION 2	STATION 4	STATION 5
5/29/85	<0.3	0.4	8.9	22.2	0.3
6/11/85	0.7	41.5	dry	dry	2.0
7/8/85	13.2	11.2	21.5	14.3	dry
8/13/85	2.4	3.2	dry	dry	2.0
8/28/85	3.2	5.6	dry	dry	4.0
9/11/85	0.6	11.6	10.5	5.0	<0.5
9/26/85	3.8	**	dry	4.0	2.7
10/10/85	11.6	9.8	dry	7.2	11.0
10/25/85	< .4	2.3	11.4	dry	< .4
11/13/85	2.9	3.9	6.9	2.1	1.6
11/25/85	3.0	2.7	4.4	4.3	5.2
12/20/85	1.4*		39.3	2.7	3.9

*Station 1 not sampled due to thin ice; in-lake sample taken from shore nearest deep hole, through the ice.
**Van Dorn sampler broke.

TABLE 4-20 (Continued)

WEST MONPONSETT POND
SUSPENDED SOLIDS (mg/liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 4	STATION 5
1/22/86	< 0.3	3.8	0.7	*
2/13/86	2.3 7.7	11.3	9.4	6.3
3/31/86	<0.3 <0.3	3.9	<0.3	4.2
4/17/86	2.3 2.3	7.8	3.7	12.4
5/14/86	5.1 13.6	17.8	dry	4.1

*Station 1 not sampled due to thin ice; in-lake sample taken from shore nearest deep hole, through the ice. Station 5 inaccessible due to thin ice.

TABLE 4-21

EAST MONPONSETT POND
DISSOLVED SOLIDS (mg/liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 3	STATION 4 Drainage Connection
4/18/85	62.4 130.4	72.2	105.4	95.2
5/29/85	68.0 94.0	105.6	83.7	76.7
6/11/85	88.0 97.3	122.7	103.9	71.3
7/8/85	56.3 72.1	140.9	65.4	102.0
8/13/85	55.0 69.0	160.8	98.6	91.1
8/28/85	77.6 60.5	156.0	118.4	93.7
9/11/85	28.0 118.8	137.6	79.5	74.3
9/26/85	111.6 **	184.8	81.3	99.6
10/10/85	76.0 64.2	100.6	77.5	86.4
10/23/85	85.6 84.4	150.0	98.1	112.7
11/13/85	82.0 73.7	89.0	80.3	81.0
11/25/85	90.1 109.6	72.1	60.2	75.0
12/20/85	74.1*	70.0	65.3	96.0
1/22/86	96.9*	44.0	66.7	69.9

*Station 1 not sampled due to thin ice; in-lake sample taken from shore nearest deep hole, through the ice.
**Van Dorn sampler broke.

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TABLE 4-21 (Continued)

EAST MONPONSETT POND
DISSOLVED SOLIDS (mg/liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 3	STATION 4 Drainage Connection
2/13/86	89.5 94.9	54.3	82.3	80.6
3/19/86	60.7 54.7	60.0	72.0	88.6
4/17/86	105.0 102.5	138.0	95.6	90.0
5/14/86	120.6 101.3	108.7	146.3	143.2

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TABLE 4-22

WEST MONPONSETT POND
DISSOLVED SOLIDS (mg/liter)

DATE	STATION 1 Surface	STATION 1 Deep	STATION 2	STATION 4	STATION 5
5/29/85	88.0	83.6	195.1	155.8	78.0
6/11/85	139.3	189.5	dry	dry	158.0
7/8/85	72.8	76.8	114.5	99.7	dry
8/13/85	87.6	70.8	dry	dry	374.
8/28/85	110.8	94.4	dry	dry	84.0
9/11/85	79.4	190.4	93.5	168.	134
9/26/85	100.2	**	dry	182	115.3
10/10/85	72.4	110.2	dry	172.8	115.0
10/25/85	120.0	115.0	164.6	dry	104.0
11/13/85	93.1	106.1	135.1	131.9	88.4
11/25/85	75.0	101.3	157.6	115.7	100.8
12/20/85	128.6*		234.7	159.3	124.1
1/22/86	82.0*		136.2	151.3	*

*Station 1 not sampled due to thin ice; in-lake sample taken from shore nearest deep hole, through the ice. Station 5 inaccessible due to thin ice.
**Van Dorn sampler broke.

TABLE 4-22 (Continued)

WEST MONPONSETT POND
DISSOLVED SOLIDS (mg/liter)

DATE	STATION 1 Surface Deep	STATION 2	STATION 4	STATION 5
2/13/86	107.0 82.3	151.0	115.0	77.7
3/31/86	74.0 68.0	112.1	182.0	137.8
4/17/86	67.7 123.7	182.2	158.3	119.6
5/14/86	162.9 160.4	228.2	dry	119.9

TABLE 4-23

EAST MONPONSETT POND
TOTAL COLIFORM (organisms per 100 ml)

DATE	STATION 1 Surface	STATION 2	STATION 3	STATION 4 Drainage Connection
4/18/85	30/100	750/100	600/100	60/100
5/29/85	1/100	1010/100	310/100	300/100
6/11/85	10/100	430/100	300/100	800/100
7/8/85	10/100	230/100	150/100	170/100
8/13/85	8/100	80/100	650/100	960/100
8/28/85	27/100	180/100	500/100	370/100
9/11/85	25/100	240/100	460/100	50/100
9/26/85	3/100	80/100	150/100	80/100
10/10/85	20/100	110/100	220/100	80/100
10/23/85	16/100	10/100	900/100	200/100
11/13/85	21/100	80/100	260/100	120/100
11/25/85	19/100	10/100	500/100	120/100
12/20/85	270/100	<10/100	400/100	2900/100
1/22/86	530/100	200/100	600/100	10/100
2/13/86	130/100	30/100	2100/100	10/100
3/19/86	20/100	260/100	300/100	210/100
4/17/86	10/100	80/100	1500/100	800/100
5/14/86	10/100	700/100	100/100	60/100

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TABLE 4-24

WEST MONPONSETT POND
TOTAL COLIFORM (organisms per 100 ml)

DATE	STATION 1 Surface Deep	STATION 2	STATION 4	STATION 5 Tributary #5
5/29/85	390/100	780/100	900/100	60/100
6/11/85	15/100	dry	dry	70/100
7/8/85	18/100	160/100	< 10/100	dry
8/13/85	20/100	dry	dry	10/100
8/28/85	6/100	dry	dry	70/100
9/11/85	15/100	300/100	380/100	250/100
9/26/85	10/100	dry	480/100	30/100
10/10/85	120/100	dry	40/100	20/100
10/25/85	30/100	200/100	dry	20/100
11/13/85	990/100	600/100	330/100	600/100
11/25/85	980/100	390/100	110/100	130/100
12/20/85	1500/100	2100/100	700/100	600/100
1/22/86	30/100	450/100	550/100	
2/13/86	< 10/100	260/100	4300/100	160/100
3/31/86	150/100	520/100	330/100	250/100
4/17/86	< 10/100	1100/100	500/100	350/100
5/14/86	< 10/100	700/100	dry	300/100

TABLE 4-25

EAST MONPONSETT POND
FECAL COLIFORM (organisms per 100 ml)

DATE	STATION 1 Surface	STATION 2	STATION 3	STATION 4 Drainage Connection
4/18/85	<10/100	30/100	<10/100	20/100
5/29/85	0/100	120/100	94/100	260/100
6/11/85	0/100	40/100	170/100	50/100
7/8/85	2/100	10/100	50/100	10/100
8/13/85	6/100	60/100	320/100	240/100
8/28/85	9/100	60/100	50/100	10/100
9/11/85	6/100	70/100	45/100	8/100
9/26/86	0/100	<10/100	50/100	20/100
10/10/85	4/100	<10/100	40/100	50/100
10/23/85	5/100	10/100	30/100	40/100
11/13/85	12/100	<10/100	140/100	120/100
11/25/85	4/100	<10/100	20/100	50/100
12/20/85	1/100	<10/100	<10/100	50/100
1/22/86	<10/100	<10/100	<10/100	<10/100
2/13/86	<10/100	<10/100	<10/100	<10/100
3/19/86	10/100	<10/100	10/100	10/100
4/17/86	<10/100	<10/100	30/100	200/100
5/14/86	<10/100	<10/100	40/100	20/100

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TABLE 4-26

WEST MONPONSETT POND
FECAL COLIFORM (organisms per 100 ml)

DATE	STATION 1 Surface	STATION 2	STATION 4	STATION 5
5/29/86	14/100	550/100	330/100	32/100
6/11/85	0/100	dry	dry	1/100
7/8/85	2/100	40/100	0/100	dry
8/13/85	1/100	dry	dry	<10/100
8/28/85	2/100	dry	dry	<10/100
9/11/85	3/100	16/100	50/100	20/100
9/26/85	8/100	dry	90/100	<10/100
10/10/85	75/100	dry	20/100	10/100
10/25/85	20/100	150/100	dry	<10/100
11/13/85	250/100	60/100	30/100	24/100
11/25/85	270/100	<10/100	<10/100	<10/100
12/20/85	10/100	<10/100	<10/100	<10/100
1/22/86	<10/100	40/100	<10/100	dry
2/13/86	<10/100	<10/100	<10/100	<10/100
3/31/86	50/100	<10/100	10/100	10/100
4/17/86	<10/100	10/100	20/100	<10/100
5/14/86	<10/100	40/100	dry	10/100

when a hole was augured through the ice. The coliform bacteria results clearly indicate a low level of contamination of the ponds. The Monponsett Ponds meet the Massachusetts bacterial criteria for swimming waters. It should be noted however, that the storm drains discharges to the Monponsett Ponds show high levels of bacterial contamination (see section 4.8). After rain storms it is likely that lake waters near storm drain discharge pipes could exceed the bacterial swimming standard.

Phytoplankton and Chlorophyll-a

Phytoplankton and chlorophyll-a data are summarized in Tables 4-27, 4-28 and 4-29. Phytoplankton species counts are given in Appendix B. The dominant algae group varied from Diatoms in the spring to blue-green algae during August. The dominant diatom was Cyclotella sp. and the dominant blue-green algae was Nostoc sp. A seasonal pattern in phytoplankton abundance was noted with higher counts occurring in July, August and September.

Chlorophyll-a concentrations ranged from <0.3 to 8.0 mg/m^3 at the deep hole of East Monponsett Pond and from <0.3 to 15.14 mg/m^3 at the deep hole of West Monponsett Pond. According to Chlorophyll-a criteria values for trophic state classification (Reckhow, 1979), the values at both deep holes generally fall in the range of a mesotrophic system (7 - 12 mg/m^3).

4.4 Aquatic Vegetation

Aquatic vegetation is found in most lake ecosystems and at moderate abundance they are beneficial. They provide food and cover for birds, fish, and surface feeding invertebrates. They also produce oxygen and help stabilize bottom sediments. Unfortunately, many lakes develop overabundant aquatic vegetation, which interferes with swimming and boating, has a negative aesthetic impact, and adversely affects aquatic life.

The dense aquatic weed growth along the shoreline of the Monponsett Ponds are the most serious symptom of lake eutrophication. Figure 4-6 indicates the approximate locations of the aquatic macrophytes identified during field surveys of the Monponsett Ponds. Cabomba caroliniana, fanwort, was the dominant species present. Density, in terms of areal coverage was 50 -75% (dense) along the entire shore line of both ponds excluding the central eastern shore of West Monponsett and the central western shore of East Monponsett. Those two shoreline areas had only sparse coverage. The areas of dense aquatic weed growth are shown in Figure 7-1. Due to the steeply sloped shoreline in these areas, the littoral zone (zone capable of supporting rooted

TABLE 4-27

TOTAL PHYTOPLANKTON COUNTS
(natural units/ml)

Date	East Monponsett	West Monponsett
4/18/85	1385.5	
5/29/85	603.9	1540.6
6/11/85	858.9	1639.9
7/8/85	1033.3	1046.8
8/13/85	6492.54	7284.37
8/28/85	638.79	3585.82
9/11/85	915.24	2839.67
9/26/85	754.20	1033.34
10/10/85	826.67	225.0
10/23/85	1199.92	1876.11
11/13/85	399.9	518.0
11/25/85	185.2	378.4
1/22/86	72.4	1473.5
2/13/86	54	270
3/19/86*	600	
3/31/86*		1300
4/17/86	420	1200
5/14/86	220	290

* March 1986 sampling at East Monponsett was done on 3/19 and sampling at West Monponsett was done on 3/31.

TABLE 4-28

EAST MONPONSETT POND
CHLOROPHYLL-a (mg/cubic meter)

DATE	STATION 1 Composite
4/18/85	4.71
5/29/85	5.27
6/11/85	4.56
7/8/85	3.29
8/13/85	5.45
8/28/85	5.38
9/11/85	0.0
9/26/85	0.0
11/25/85	0.0
2/13/86	6.2
3/19/86	6.0
4/17/86	8.0
5/14/86	2.7

TABLE 4-29

WEST MONPONSETT POND
CHLOROPHYLL-A (mg per cubic meter)

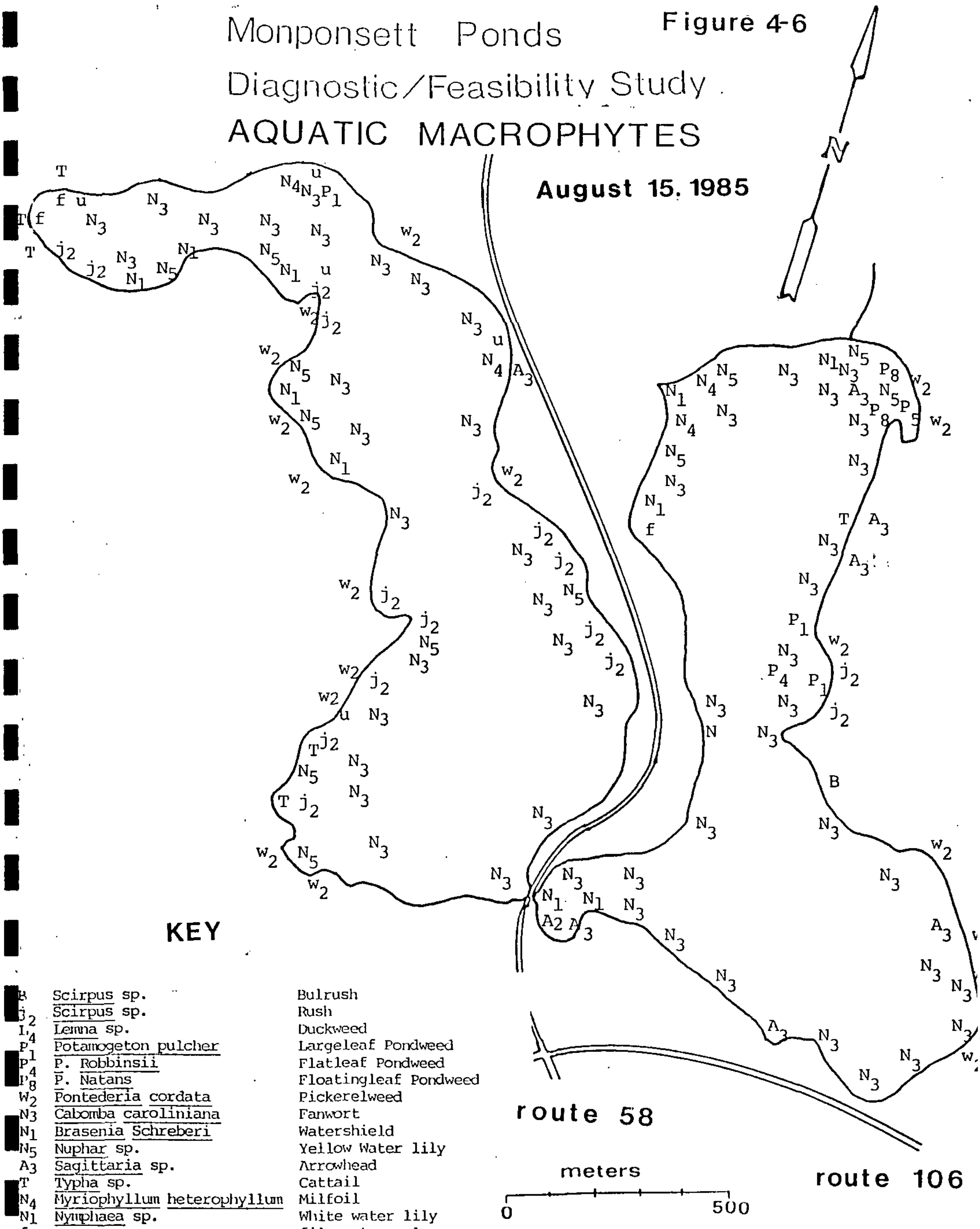
DATE	STATION 1 Composite
5/29/85	15.14
6/11/85	6.84
7/8/85	7.18
8/13/85	10.83
8/28/85	12.48
9/11/85	0.0
9/26/85	0.0
11/13/85	0.0
11/25/85	0.0
2/13/86	5.7
3/31/86	6.0
4/17/86	0.87
5/14/86	0.32

Monponsett Ponds

Figure 4-6

Diagnostic/Feasibility Study

AQUATIC MACROPHYTES



KEY

B	Scirpus sp.	Bulrush
j_2	Scirpus sp.	Rush
L_4	Lemna sp.	Duckweed
P_1	Potamogeton pulcher	Largeleaf Pondweed
P_4	P. Robbinsii	Flatleaf Pondweed
P_8	P. Natans	Floatingleaf Pondweed
W_2	Pontederia cordata	Pickerelweed
N_3	Cabomba caroliniana	Fanwort
N_1	Brasenia Schreberi	Watershield
N_5	Nuphar sp.	Yellow Water lily
A_3	Sagittaria sp.	Arrowhead
T	Typha sp.	Cattail
N_4	Myriophyllum heterophyllum	Milfoil
N_1	Nymphaea sp.	White water lily
f		filamentous algae

plants) is narrower than along the rest of the shoreline. The dense growth of aquatic macrophytes in the Monponsett Ponds is probably related to the extent of the shallow areas and to the suitability of the sediment.

4.5 Test Wells and Seepage Samplers

In consultation with GPI Engineering, LYCOTT placed five test wells around each lake in October 1985. The test wells were all located within 5 to 10 feet of the edge of the lake at sites shown on Figure 4-7. The sites were located down-gradient of known septic tank leach fields in order to intercept septic leachate plumes which flow towards the lake. In all cases, the property owner was consulted in order to determine the location of the leaching field. The test wells were constructed from two-inch I.D. PVC pipe with a series of fine saw cuts near the bottom of the pipe to serve as a particulate screen. The well points were driven to a depth of two feet below grade.

In order to determine the nutrient concentrations at the point of entry into the ponds, in-lake seepage samplers were deployed just off shore from the test wells at sites shown in Figure 4-7. The seepage samplers were constructed by cutting off the top of a plastic 55 gallon drum and drilling two holes in opposite ends of the face. The holes were sealed with rubber stoppers with plastic tubes inserted through them. The samplers were placed in water one to two feet deep, just off shore of the test well sites. The edges of the drum were pushed into the sediment so as to seal the bottom. Samples were collected by slowly pumping out a sample with a portable hand-operated peristaltic type pump. Seepage samplers were sampled after undisturbed equilibration periods of at least two weeks. Unfortunately the seepage samples were often found to have been removed either by vandals or vigorous wave action.

Samples from both shallow test wells and groundwater seepage samplers were sampled for the same parameters: total Kjeldahl nitrogen, ammonia, nitrate, total phosphorus, total and fecal coliform bacteria, sodium and conductivity. The results from the test wells and seepage samplers are given in Appendix C. The average total phosphorus concentration in the seepage samplers was 0.194 mg/liter, a factor of ten higher than the mean in-lake values, but nearly a factor of ten lower than the mean test well concentration of 1.6 mg per liter total phosphorus. Although fecal coliform levels were generally below the limit of detection in both test wells and seepage samplers, occasional violations of the 200 organisms per 100 ml was detected. Fecal coliform concentrations of 350 per 100 ml measured at seepage sampler on the east shore of East Monponsett on May 22, 1986. Fecal coliform concentrations of 520 and 300 per 100 ml were measured at

Monponsett Ponds

Diagnostic/Feasibility Study

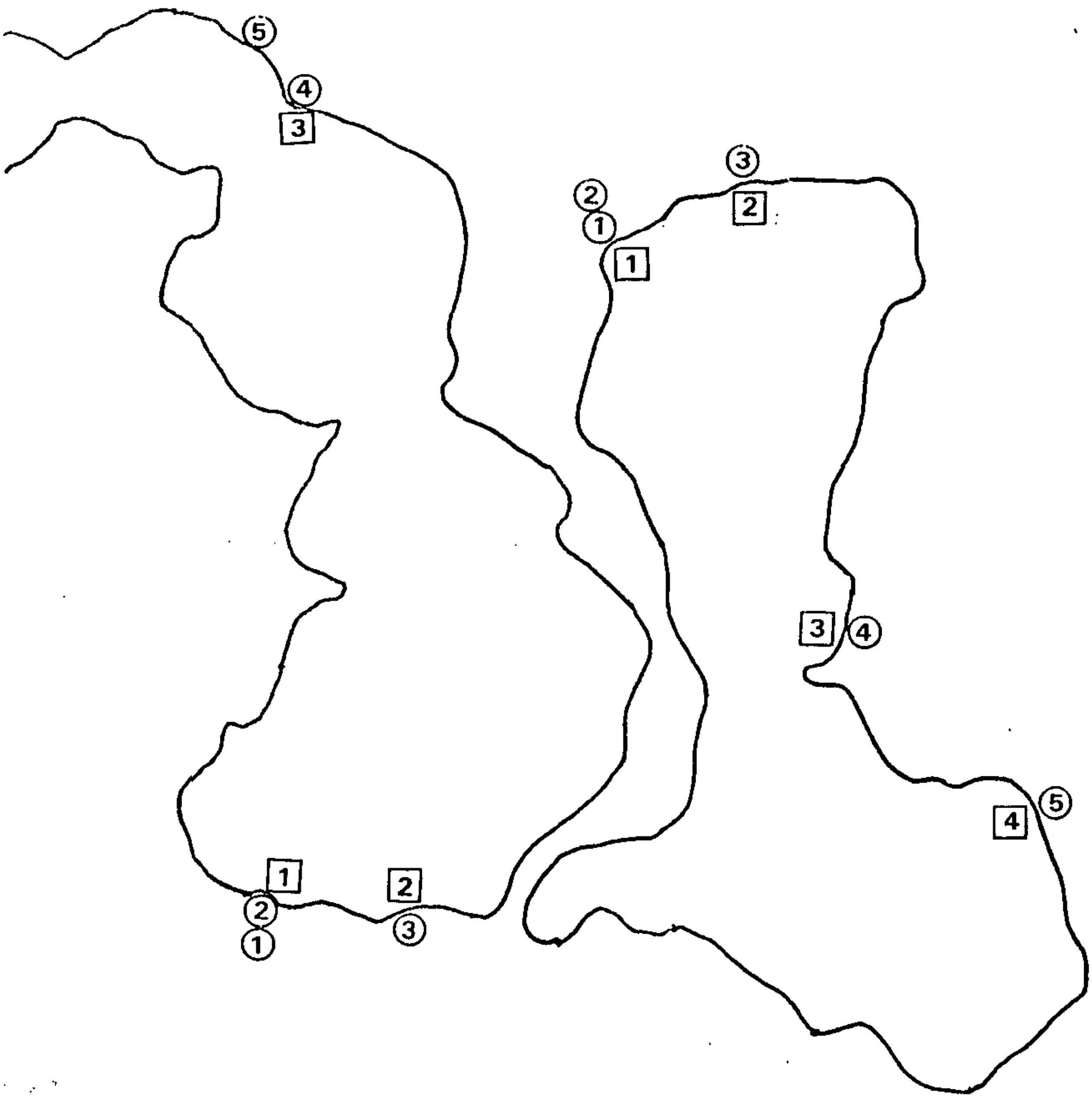


Figure 4-7

Test Well & Seepage Sampler Locations

LEGEND

1 seepage sampler

① test well

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test wells 1 and 2 respectively on the northern shore of East Monponsett Pond on May 22, 1986. Fecal coliform concentrations of 1500 and 250,000 per 100 ml were measured at test wells 1 and 3 repsectively on the southern shore of West Monponsett on November 13, 1985. The test wells showed the impact of the leachate more clearly than the seepage samplers, possibly because leachate was entering the lakes right at the shoreline, in water which was too shallow to deploy the seepage samplers.

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4.6 Sediment Analysis

Representative core samples of bottom sediments from the deep holes and near beach areas of East and West Monponsett Ponds were obtained on October 10, 1985. A core sampler consisting of a coring tube made of 50 mm inside diameter galvanized pipe in five foot sections was used to collect the samples. The sediments were tested for the following parameters:

Arsenic	Nickel	Total Phosphorus
Cadmium	Vanadium	Volatile Solids
Chromium	Zinc	% Moisture
Copper	Ammonia Nitrogen	Volatile Organic Chemicals
Iron	Nitrate Nitrogen	(E.P.A. Methods 8010 & 8020)
Lead	Nitrite Nitrogen	
Manganese	Kjeldahl Nitrogen	
Mercury	Oil & Grease	

The results for the inorganic analyses are given in Table 4-30. Compared to a average values for levels of the inorganic constituents measured in cores from 17 lakes in Massachusetts (Notini and Whitaker, 1982) the Monponsett Pond cores contained low concentrations of metals, nitrogen and phosphorus. Phosphorus can be readily released from bottom sediments if the bottom waters become completely anoxic (Lazoff, 1984). On the basis of results from the 12 month study period, East and West Monponsett Ponds do not become completely anoxic (Field Results, Appendix A); thus bottom sediments are not expected to be significant sources of phosphorus to the bottom waters of the ponds.

All four sediment samples were tested for 20 volatile organic chemicals using E.P.A. method 8010. They were also tested for an additional 10 volatile organic chemicals using E.P.A. method 8020. In all cases, no compounds were detected. The limit of detection for method 8010 is 0.25 micrograms per gram and the limit of detection for method 8020 is 0.05 micrograms per gram. The 1983 MDWPC Regulations for Water Quality Certification for Dredge Material Disposal (314 CMR 9.00) sets sediment criteria concentrations for heavy metals, and oil & grease relative to disposal methods and placement. Sediments are classified Category I, II or III according to the level of restrictions to which any dredging operations are restricted. Category I is the least restricted and Category III is the most restricted. The sediment from the deep hole of East Monponsett falls in Category II, and the sample from the beach area of East Monponsett falls in Category I. The sediment from the deep hole of West Monponsett falls in Category III because of its high levels of oil & grease. The sediment from the beach area of West Monponsett falls in Category II.

TABLE 4-30

East-West Monponsett Sediment Samples

Date of collection: 10/10/85

Sample A: East Monponsett Inlake
Sample B: East Monponsett Beach
Sample C: West Monponsett In-lake
Sample D: West Monponsett Beach

	A	B	C	D
Analysis Number	EM-60	EM-61	WM-53	WM-54
Arsenic	7.0	2.88	3.0	7.0
Cadmium	6.0	2.2	2.0	7.0
Chromium	6.0	2.2	2.0	7.0
Copper	6.0	2.2	2.0	7.0
Iron	8220.0	2955.5	3040.0	10,060.0
Lead	30.0	11.1	9.4	36.0
Manganese	480.0	177.7	257.0	459.0
Mercury	< 1.0	<.444	0.8	<1.46
Nickel	6.0	2.2	2.2	7.0
Vanadium	0.87	0.45	0.64	0.36
Zinc	100.0	208.8	13.0	44.0
Nitrogen:				
Ammonia	91.7	44.1	287.	15.8
Nitrate	3.33	3.92	3.70	0.90
Nitrite	13.8	11.3	24.4	2.97
Kjeldahl	3920	961	6480	94.6
Oil-Grease % as dry solid	0.57	0.11	4.0	0.12
Phosphorus- Total as P	196	83.3	806	63.1
Solids Volatile % of the dry solid	11.2	7.3	14.8	0.8
% Moisture	80	66	82	26

All results are expressed in mg/kg dry basis except oil & grease, volatile solids and moisture.

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4.7 Lake Biology and Fisheries

Fish Species Present:

The fish population was sampled in June 1980 by the Massachusetts Division of Fisheries and Wildlife. The nine species observed in the eastern basin, listed in order of abundance, included: white perch (*Morone americana*), yellow perch (*Perca flavescens*), pumpkinseed (*Lepomis gibbosus*), bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis nigro-maculatus*), golden shiner (*Notemigonus crysoleucas*), brown bullhead (*Ameiurus nebulosus*), and white sucker (*Catostomus commersonnii*). The western basin had a similar complex. The eastern basin is dominated by white and yellow perch; the western basin by bluegills and pumpkinseeds.

Fishing:

Sampling indicated an adequate stock density of largemouth bass in the eastern basin, but a scarcity of quality size fish (12.0 inches and greater) in the western basin. Yellow perch in both basins were generally 8 inches or less.

4.8 *Stormwater Sampling*

4.8.1 Sampling Stations and Metals Concentrations

Storm drains which empty into East and West Monponsett Ponds were sampled on three occasions: November 1985, April 1986 and May 1986. On November 11, 1985 sampling was done at nine storm drain discharges identified by G.P.I. Engineers (see Figure 4-8) as the outlets of the most comprehensive storm drain networks in the watershed (Appendix E). The storm drain system which discharges to the Monponsett Ponds was mapped for this study by G.P.I. Engineers. There were no previous maps of these drains. Rainfall on November 11 amounted to 0.5 inches; this storm was preceded by four dry days (NOAA, 1985). The sample analysis results indicated that significant concentrations of nitrogen, phosphorus and coliform bacteria could be entering the lake at the storm drains during rainstorms (Appendix D). On the basis of the November results, four storm drains (SD1 through SD4) were selected for intensive sampling (Figure 2-4). Station SD1 on Figure 2-4 corresponds to West Monponsett station 4 on Figure 4-8; SD2 was located at West Monponsett station 1; SD3 was located at East Monponsett 8; SD4 was located at East Monponsett 6. These drains were chosen because of the size of their drainage areas and because of the density of housing in the drainage area. Water entering the ponds through the four storm drains was sampled on April 14, 1986 and on May 22, 1985. In each case the first flush was sampled as well as subsequent samples at intervals of 10, 20, 30, 45, 60, 75, 90, 105 and 120 minutes after first flush. Composite samples were also obtained on each occasion for cadmium, copper, iron, lead, manganese and zinc. The results for the heavy metal analyses, given in Tables 4-31 and 4-32, indicate that of the metals tested for, only iron, manganese and zinc were present at concentrations greater than 0.01 mg/L. Iron concentrations ranged up to a maximum of 0.91 mg/L during the April storm and from six to nine ppm during the May storm. Manganese concentrations showed little variation between storm drains or between storms, ranging from 0.07 to 0.19 mg/L. Zinc concentrations showed a marked difference between storm drains but no consistent difference during the two storm events. Concentrations at Station SD3, draining the Annawam Drive area showed the highest levels of zinc, ranging from 0.35 to 0.58 mg/L. Ranked in order of decreasing zinc levels were Stations SD2, SD1 and SD4 with corresponding concentration ranges of 0.05-0.16, <0.01-0.07, <0.01-0.04 mg/L. With respect to water quality standards for drinking supplies, only iron, of the metals tested for, could be significantly in violation. The recommended upper limit for iron in public water supplies is 0.3 mg/L (U.S. EPA, 1976 because of the possible formation of red oxyhydoxide precipitates that stain laundry and plumbing fixtures.

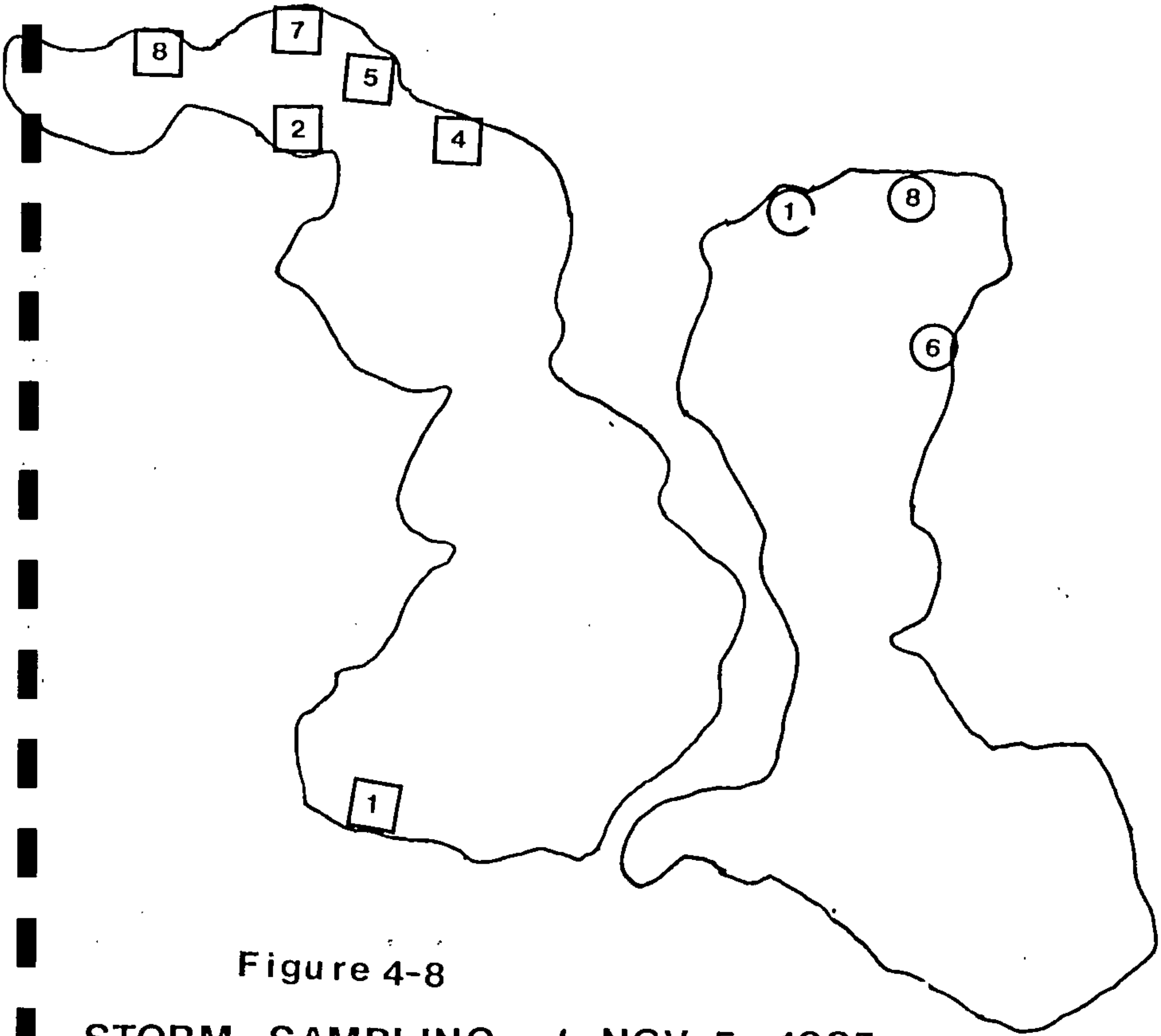

Figure 4-8

STORM SAMPLING of NOV. 5, 1985

(1) EAST MONPONSETT
[1] WEST MONPONSETT

4.8.2 Non-Metals and Bacteria

The results from the two hour time series of samples, given in Table 4-33 indicate that several important contaminants in the storm drains showed different patterns during the two storms. The average chloride concentration during the first storm event was roughly twice the concentration during the second storm.

Rainfall during the sampled storm events of April 14 and May 22, 1986 was measured in the field using a rain gage. During the April 14, 0.2 inches of rain fell from 1430 to 1630. During May 22, 0.5 inches of rain fell from 1500 to 1700. On the basis of data reported for the Brockton National Weather Service Station (NOAA, 1986), the storm of April 14 was preceded by a one day dry period and the storm of May 22 was preceded by a nine day dry period. Unfortunately, the flows in the drainage culverts could not be measured because of partial blockage by heavy debris or partial submersion of the outlet pipe below the lake surface level. It is estimated on the basis of visual observation of depths and velocities of flow that the average flows during the May 22 storm were from two to four times greater than the flows during the April 14th storm.

The decreased concentrations of chloride, and the three measured nitrogen compounds, during the second storm may be due to increased dilution. Total phosphorus concentrations were comparable during the two storms but suspended solids, total and fecal coliform bacteria levels were far greater during the May storm. A possible explanation for the May increase in suspended solids is an increased capacity of the higher flows of May to resuspend settled solids. There may also have been overland flow from failed septic systems to nearby storm drains during the May storm. Also, the longer dry period preceeding the second storm may have allowed a larger solids build-up on paved surfaces. On the basis of the fecal coliform levels, septic leachate may have infiltrated into leaky storm drains at higher rates during the May storm. The coliform counts were consistently higher at stations one and four, at the northern end of the ponds than at the other two stations. The northern end of the ponds have small lot sizes (less than or equal to 1/8 acre). The average age of the houses, and probably the average age of the septic system, is the greatest. Small lot sizes and septic system age are both factors which can be responsible for lowered ability of septic systems to remove nutrients.

On the basis of measured concentrations at the four intensively sampled storm drain outfalls, the major contaminants influencing pond water quality are total and fecal coliform bacteria, suspended solids and total phosphorus. The fecal coliform standard for primary contact (swimming) is 200 organisms per 100 milliliters for the

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TABLE 4-31

MONPONSETT PONDS STORM DRAIN SAMPLING

TOTAL METALS DATA (mg/L)
APRIL 14, 1986

METAL	STATION SD1	SD2	SD3	SD4
Cadmium	<0.01	<0.01	<0.01	<0.01
Chromium	<0.01	<0.01	<0.01	<0.01
Copper	<0.01	<0.01	<0.01	<0.01
Iron	<0.01	0.66	0.91	<0.01
Lead	<0.01	<0.01	<0.01	<0.01
Manganese	0.07	0.16	0.17	0.12
Zinc	0.07	0.16	0.35	<0.01

TABLE 4-32

MONPONSETT PONDS STORM DRAIN SAMPLING

TOTAL METALS DATA (mg/L)
MAY 22, 1986

METAL	STATION			
	SD1	SD2	SD3	SD4
Cadmium	<0.01	<0.01	<0.01	<0.01
Chromium	<0.01	<0.01	<0.01	<0.01
Copper	<0.01	<0.01	<0.01	<0.01
Iron	5.67	6.80	8.56	9.04
Lead	<0.05	0.04	<0.05	<0.05
Manganese	0.09	0.13	0.11	0.19
Zinc	<0.01	0.05	0.58	0.04

TABLE 4-33

MONPONSETT PONDS STORM SAMPLING
CHEMICAL (mg/L) and BACTERIOLOGICAL (# per 100 ml) RESULTS*

PARAMETER	MONTH	STATION SD1	SD2	SD3	SD4
Chloride	April	70.2 (27.2)	92.3 (8.9)	113.3 (9.9)	72.5 (16.9)
	May	7.1 (1.9)	10.2 (4.7)	49.1 (65.8)	15.7 (10.1)
Ammonia-Nitrogen	April	0.66 (0.12)	1.23 (0.10)	0.50 (0.13)	0.53 (0.16)
	May	0.12 (0.06)	0.22 (0.09)	0.31 (0.11)	0.42 (0.07)
Nitrate-Nitrogen	April	1.48 (1.18)	3.22 (8.34)	0.81 (0.28)	7.77 (4.24)
	May	0.29 (0.10)	0.94 (2.14)	0.93 (1.84)	0.36 (0.13)
Kjeldahl-Nitrogen	April	0.51 (0.15)	0.85 (0.06)	0.52 (0.07)	0.77 (0.07)
	May	0.31 (0.11)	0.28 (0.09)	0.20 (0.10)	0.58 (0.13)
Total Phosphorus	April	0.22 (0.06)	0.46 (0.05)	0.19 (0.04)	0.33 (0.10)
	May	0.17 (0.09)	0.35 (0.20)	0.38 (0.17)	0.48 (0.13)
Suspended Solids	April	53.5 (28.6)	123 (55.2)	21.6 (16.1)	32.4 (20.3)
	May	182 (57.1)	266 (145)	111 (77.3)	202 (207

*values in the table are the time-weighted average and standard deviation, in parenthesis, for the 2 hour time-series of samples taken during each storm event. The data used to calculate the standard deviation was not time weighted.

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TABLE 4-33 (continued)

MONPONSETT PONDS STORM SAMPLING
CHEMICAL (mg/L) and BACTERIOLOGICAL (# per 100 ml) RESULTS*

PARAMETER	MONTH	STATION			
		SD1	SD2	SD3	SD4
Dissolved Solids	April	160 (77.1)	156 (73.8)	221 (37.2)	198 (60.9)
	May	84.7 (37.8)	104 (42.9)	213 (144)	95.0 (38.5)
Total Coliform Bacteria	April	959** (1,435)	13,800 (11,920)	1,357 (3,275)	10,561 (37,610)
	May	25,176 (24,450)	11,287 (16,410)	21,077 (40,840)	37,274 (23,120)
Fecal Coliform Bacteria	April	<100	<100	<100	113 (111)
	May	5,189 (2,360)	2,642 (2,860)	600 (4,505)	4,583 (3,135)

*values in the table are the average and standard deviation, in parenthesis, for the 2 hour time-series of samples taken during each storm event.

**average values for total and fecal coliform are logarithmic means.

logarthmic mean of a set of samples. The bacterial standard was exceeded at all storm drain stations during the storm of May 22, 1986. This suggests that the primary contact bacterial standard may be periodically exceeded in the vicinity of the storm drain outfalls after rainstorms.

4.8.3 Sediment Delivery due to Stormwater

The first step in assessing the annual suspended solids discharged to the ponds by the storm drains is to estimate the quantity of water discharged into the pond through the storm drains. For the purposes of this calculation, we will assume that the storm drains carry, on an annual basis, the total amount of precipitation which falls on the paved surfaces of the adjacent roadways. Since this calculation neglects evaporation, it is probably a high estimate. The areas near the ponds covered by paved roadways which are drained by storm sewers discharging into the ponds are given in Table 4-34. The width of secondary roadways was taken to be 6.1 meters (20 feet) and the width of the major roadways (Routes 58, 106 and 36) was taken to be 9.1 meters (30 feet) on the basis of information from the Halifax Department of Public Works. Lengths of roadway were measured using the U.S.G.S. Plympton Quadrangle, 7.5 minute series, (1975); and the Hanover Quadrangles, 7.5 minute series, (1978) and cartometer. The estimated annual water flow through the storm drain systems is the product of the total paved roadway area multiplied by the annual precipitation amount, given in Table 3-1. The storm drain flow is estimated at 135,100 cubic meters for the twelve month study period.

On the basis of the measured suspended solids concentrations in the storm drains (Table 4-33) and the previously estimated annual volume of flow, the storm drains deliver 16,750 kilograms of suspended solids to the ponds on an annual basis. The annual suspended solids loading was calculated using a value of 124 milligrams per liter, the arithmetic average of the values in four storm drains sampled during two rainstorms. To assess the significance of the suspended solids load due to storm drainage, it is necessary to calculate the suspended solids load entering the Monponsett Ponds from other sources. For this purpose, the suspended sediment load carried by the perennially flowing tributaries was estimated. Sediment load delivered by the tributaries is calculated (Table 4-35) as the product of the monthly stream discharge, from Table 3-4 and the average concentrations of suspended solids in the tributaries, from Tables 4-19 and 4-20. Sediment delivery from watersheds not drained by streams or which were drained by streams never found to be flowing is neglected. The very flat topography of these watersheds was expected to result in negligible erosion and sediment delivery to the ponds. The total delivery of suspended solids to the ponds, due to tributaries is estimated at 13,000 kilograms per year.

Table 4-34

PAVED ROADWAY AREAS DRAINING INTO THE MONPONSETT PONDS

Location	Drainage System*	Roadway Main roads (meters)	Length Secondary roads (meters)	Roadway Area (square meters)
West Monponsett Northern Shore	1, 2	0	2,990	18,200
East Monponsett Northern Shore and Causeway between ponds	3,4,5, 6,7,8	1,660	1,660	25,200
West Monponsett - Southern Shore	9,10,11	440	3,420	25,000
East Monponsett- Southern and Eastern shores	12,13, 14,15 16	2,500	6,400	61,500
			Total	129,900

*refers to plate numbers in Appendix E, Storm Drainage Systems

TABLE 4-35

MONPONSETT PONDS

DISCHARGE (cfs), SUSPENDED SOLIDS (mg/L) and EXPORTED SUSPENDED SOLIDS (kg/mq) for SURFACE DRAINED SUBWATERSHEDS for MAY 1985 through APRIL 1986

SUBWATERSHED #		1985 MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	1986 JAN	FEB	MAR	APR	TOTAL EXPORT SOLIDS (kg/yr)
1	West Monponestt													
	Discharge*	0.15	0.11	0.07	0.10	0.17	0.10	0.54	0.26	0.42	0.38	0.43	0.25	
	Suspended Solids	22.2	d	14.3	d	4.5	7.2	3.2	2.7	0.7	9.4	0.2	3.7	
	Exported Solids	247	0.0	74.3	0.0	60.5	53	123	52	22	265	6	69	960
3	West Monponsett													
	Discharge	0.32	0.24	0.15	0.70	0.35	0.21	1.13	0.54	0.88	0.81	0.92	0.52	
	Suspended Solids	8.9	d	21.5	d	10.5	11.4	5.7	39.3	3.8	11.3	3.9	7.8	
	Exported Solids	211	0.0	240	0.0	421	169	479	1576	250	680	266	300	4,603
5	East Monponsett													
	Discharge	0.85	0.62	0.39	0.51	0.93	0.55	2.95	1.43	2.31	2.11	5.86	1.37	
	Suspended Solids	0.3	2.1	12.6	2.5	5.6	9.2	3.8	0.7	3.3	13.7	0.2	4.4	
	Exported Solids	19	97	365	114	494	412	783	74	566	2147	87	448	5,587
7	East Monponsett													
	Discharge	0.36	0.26	0.17	0.21	0.40	0.23	1.24	0.61	0.98	0.90	2.48	0.58	
	Suspended Solids	10.4	1.3	7.1	1.5	0.8	3.9	3.5	0.2	0.2	5.7	0.2	0.2	
	Exported Solids	278	25	90	15	17	65	315	9	14	381	37	9	1,254
	Stump Brook Outlet													
	Discharge	1.4	3.5	-1.1	-3.9	-2.4	2.2	9.2	7.3	7.5	8.2	10.0	4.4	
	Suspended Solids	0.3	2.0	d	3.0	1.6	5.7	3.4	3.9	i	6.3	4.2	12.4	
	Exported Solids	31	514	0.0	-869	285	931	2324	2115	0.0	3838	3120	4053	16,342

d - dry, not sampled; i - inaccessible due to ice

*Discharge determined using U.S.G.S. stream gaging data for the Indian Head River on the dates listed in Section 4.1 Water Quality Sampling. Values of discharge, concentration and exported solids for the months of August, September, October and November represent the average flows and concentrations for the two sampling dates in these months.

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The estimated storm drain contribution thus almost exactly equals the suspended sediment load carried by the tributaries.

The magnitude of suspended solids concentrations in the lake water result from the balance between the inputs and the losses of suspended sediments within the lake ecosystem. If the processes of sediment export and sedimentation are first-order processes, depending only on the concentration in the pond water, then the average values of suspended solids in the ponds would be decreased by nearly one half if all suspended solids could be removed from the storm drains.

Water transparency of the Monponsett Ponds is affected by many variables; however, one of the most important determinants of visibility is the suspended solids concentration. The increase in visibility due to control of the suspended solids in the stormwater could be significant. An increase in light penetration due to control of suspended solids might stimulate macrophyte growth in deeper portions of the ponds.

5.0 NUTRIENT BUDGET AND TROPHIC STATUS

5.1 Limiting Nutrient Analysis

The limitation of a specific nutrient indicates the chemical constituent which is in shortest supply relative to the nutritional needs of algae and aquatic plants. Utilizing the in-lake nutrient data available from the year-long diagnostic study, an analysis has been conducted in order to identify the balance which exists between Total Nitrogen and Total Phosphorus as an indicator of nutrient limitation in the Monponsett Ponds. Ranges of this ratio have been published (Dillon & Rigler, 1975) to provide for this analysis:

N:P	Limiting Nutrient
Greater than 17	Phosphorus
10-17	Phosphorus and/or Nitrogen
Less than 10	Nitrogen

There are conflicting reports in the literature as to when the ratio of nitrogen to phosphorus (N:P) is best measured for assessing nutrient limitation. Two periods during the year are proposed most often. The N:P ratio at the time of spring turnover provides information as to the maximum availability of these nutrients in the lake basin and is therefore a measure of the basin-wide limitation (Wetzel, 1975). On the other hand, the actual limitation of biomass productivity due to exhaustion of nutrients occurs during the summer, when biological uptake is most rapid. The value of N:P in East Monponsett Pond ranges from 12.5 to 1 during the summer to 106 to 1 at the time of spring turnover. In West Monponsett Pond, the range is from 18.8 to 1 during the summer to 20 to 1 at the time of spring turnover. On the basis of these ratios, the biological productivity in both ponds is most likely limited by phosphorus availability.

The relationship between phosphorus concentration and trophic state/recreation potential is given in Table 5-1.

TABLE 5-1
TROPHIC STATE CLASSIFICATION SCHEME
(adapted from Reckhow et al., 1980).

Phosphorus Concentration (mg/liter)	Trophic State	Lake Use
<0.010	Oligotrophic	Suitable for water based recreation and propagation of cold water fisheries, such as trout. Very high clarity and aesthetically pleasing.
0.010 - 0.020	Mesotrophic	Suitable for water-based recreation but often not for cold water fisheries. Clarity less than oligotrophic lake.
0.020 - 0.050	Eutrophic	Reduction in aesthetic properties diminishes enjoyment for body contact recreation. Generally very productive for warm water fisheries.
> 0.050	Hyper-eutrophic	A typical "old aged" lake in advanced succession. Some fisheries, but high levels of sedimentation and algae or macrophyte growth may be diminishing open water surface area.

5.2 Phosphorus Budget

5.2.1 Land-Use Associated Phosphorus Export

A phosphorus budget for a lake is a measurement of the annual inputs and outputs of phosphorus to and from the lake. The establishment of rates of input and output allows us to estimate the impact of changes and to assess which sources of input and output are of greatest significance. A water-phosphorus budget may be obtained in either of two ways. The least involved technique, as discussed by Cooke et al. (1986) is to use phosphorus export coefficients for the various land use categories. The export coefficients, together with measured lake morphometry and water outflow data are used to estimate the annual loading. The second method for obtaining the phosphorus budget involves actual measurement of all sources of water and phosphorus input and output over a year (Cooke et al., 1986). This second method is more accurate but it is also much more expensive to carry out.

Phosphorus export from tributary-drained subwatersheds was estimated from measurements of total phosphorus concentrations in the tributaries on the sampling dates listed in Section 4-1, together with estimates of the tributary flow. Phosphorus concentrations were measured once a month from April through July, 1985 and December 1985 through May 1986; the tributaries were sampled twice a month during the period August through November, 1985.

The tributary flows on the corresponding dates were estimated from daily stream gaging records from a nearby watershed, as described in Section 3.0. The product of total phosphorus concentration times the corresponding discharge equals the phosphorus export rate. This procedure was used to calculate monthly estimates of phosphorus export for the stream-drained subwatersheds (Table 5-2). This method neglects nutrients export in groundwater flow from these subwatersheds directly through the pond bottom.

Calculated phosphorus export from the Monponsett Ponds to the Stump Brook outlet and phosphorus export in water diverted to Silver Lake is also shown in Table 5-2.

The quantity of phosphorus leaving the Monponsett Ponds through the outlet, Stump Brook (Station 5) and through the diversion aqueduct to Silver Lake were calculated from the estimated hydraulic discharges (Table 3-1) and concentrations (Tables 4-9 and 4-10) measured during the study.

In assessing the phosphorus budget of the Monponsett Ponds, a lack of adequate direct measurements of concentration and flow forced us to use a phosphorus loading calculation which was based on phosphorus export coefficients from various land-use categories. This procedure is discussed briefly by Cooke et al. (1986) and in detail by Reckhow et al. (1980). The three dominant land-use types in the Monponsett watershed are residential urban, forest and agricultural land (Figure 2-1).

In calculating phosphorus loading from forest land use in the Monponsett watershed, we used a phosphorus export coefficient based on our estimate of the phosphorus export from a forested subwatershed of the Monponsett Ponds. Sub watershed #1 (Figure 3-2) is completely covered by a mixture of soft woods and hard woods, heights of 40 to 60 feet and 80 to 100 percent crown closure (McConnell, 1971). The area of the sub watershed is 67 ha (Table 3-2). The estimated phosphorus export and corresponding export coefficient were 12.2 kg P yr^{-1} and 0.18 kg P ha^{-1}. By way of comparison, 25% of 26 reported phosphorus export

TABLE 5-2

MONPONSETT PONDS

DISCHARGE (cfs), TOTAL PHOSPHORUS (mg/L) and EXPORT PHOSPHORUS (kg/mo) from SURFACE DRAINED SUBWATERSHEDS for MAY 1985 through APRIL 1986

SUB WATERSHED #		MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	TOTAL EXPORT P (KG/YR)
1	West Monponsett													
	Discharge*	0.15	0.11	0.07	0.10	0.17	0.10	0.54	0.26	0.42	0.38	0.43	0.25	
	Total P	0.14	d	0.10	d	0.09	0.01	0.05	0.04	0.05	0.05	0.03	0.02	
	Export P	1.6	1.0	0.5	0.0	1.1	0.4	1.8	1.9	1.4	1.3	1.0	0.4	12.2
3	West Monponsett													
	Discharge	0.32	0.24	0.15	0.20	0.35	0.21	1.13	0.54	0.88	0.81	0.92	0.52	
	Total P	0.18	d	0.09	d	0.05	0.19	0.05	0.04	0.10	0.01	0.05	0.03	
	Export P	4.3	0.0	1.0	0.0	2.0	2.8	4.3	1.6	6.2	0.6	3.4	1.2	27.3
5	East Monponsett													
	Discharge	0.85	0.62	0.39	0.51	0.93	0.55	2.95	1.43	2.31	2.11	5.86	1.37	
	Total P	0.08	0.06	0.05	0.04	0.05	0.04	0.08	0.02	0.05	0.11	0.03	0.03	
	Export P	5.1	2.8	1.4	1.6	3.3	1.4	16.0	2.1	7.7	16.8	14.8	3.5	76.3
7	East Monponsett													
	Discharge	0.36	0.26	0.17	0.21	0.40	0.23	1.24	0.61	0.98	0.90	2.48	0.58	
	Total P	0.02	0.03	0.02	0.03	0.04	0.04	0.02	0.02	0.01	0.01	0.03	0.01	
	Export P	0.5	0.6	0.3	0.4	0.7	0.6	2.0	0.9	0.4	0.3	5.9	0.2	12.7
	Diversion to Silver Lake													
	Discharge	4.45	0.0	0.0	3.92	4.75	0.0	7.11	1.40	6.5	8.75	6.50	2.67	
	Total P	0.01	0.02	0.02	0.01	0.02	0.01	0.04	0.02	0.02	0.01	0.01	0.01	
	Export P	3.3	0.0	0.0	2.2	5.3	0.0	18.7	2.1	7.2	3.3	3.4	0.1	44.6
	Stump Brook Outlet													
	Discharge	1.40	3.46	-1.14	-3.90	-2.4	2.2	9.2	7.3	7.5	8.2	10.0	4.4	
	Total P	0.05	0.10	d	0.15	0.06	0.05	0.02	0.04	i	0.01	0.03	0.04	
	Export P	5.2	25.7	0.0	-42.4	-11.2	7.5	16.0	21.7	0.0	6.1	20.8	11.4	60.9

d = dry, not sampled; i = inaccessible due to ice

*Discharge determined using U.S.G.S. stream gaging data for the Indian Head River on the water quality sampling dates listed in Section 4.1. Values given for the months of August, September, October and November represent the average flows and concentrations for the two sampling dates in these months.

5-4

coefficients for forested lands fall below 0.098 kg P yr^{-1} ha^{-1} and 75% of the reported export coefficients fall below 0.314 kg P ha^{-1} yr^{-1} (Reckhow et al., 1980).

The agricultural land in the Monponsett watershed is almost exclusively active cranberry bog (McConnell, 1971). Although they are quite common in southeastern Massachusetts, there are few studies of nutrient processing in cranberry bogs. McVoy et al. (1982) reported a phosphorus export of 11 kg P yr^{-1} for a 65 ha bog in the Johns Pond (Mashpee, MA) watershed. The corresponding export coefficient is 0.16 kg P ha^{-1} yr^{-1}. This value was used in calculating phosphorus export from cranberry bogs in the Monponsett watershed.

The phosphorus export coefficients describing urban land uses exhibit a high degree of variability depending on the type of urban activity (i.e., low density residential, heavy industrial) and the associated percentage of impervious surface area. Unfortunately, there are currently insufficient data reported to adequately compile phosphorus export statistics for each class of urban activity. Characteristics of residential areas important to nutrient loading include 1) housing density; 2) grass and vegetation coverage; 3) fertilizer applications; and 4) pet density, type (dogs, cats), etc. Grass and housing density affect the infiltration/runoff ratio; fertilizers and pets are additional nutrient sources. Of a sample of 31 phosphorus export coefficient studies for urban land summarized by Reckhow et al. (1980), 25% yielded less than 0.7 kg P ha^{-1} yr^{-1} while 75% yielded less than 2.7 kg P ha^{-1} yr^{-1}. These export coefficients include septic system inputs. For lack of more specific literature values for residential land use in the Monponsett watershed, we used Reckhow et al. (1980) range, given above. The residential land area in the watershed is 262 ha (Figure 3-2); the corresponding export of phosphorus is estimated to be in the range 183-707 kg P yr^{-1}. This estimate includes septic system sources.

Estimates of phosphorus export from land use types in the Monponsett watershed are given in Table 5-3.

TABLE 5-3
MONPONSETT PONDS
LAND USE ASSOCIATED PHOSPHORUS EXPORT

LAND USE	EXPORT COEFFICIENT (kg P ha^{-1} yr^{-1})	AREA IN WATERSHED (ha)	PHOSPHORUS EXPORT (kg P yr^{-1})
Forest	0.18	979	177
Cranberry Bog	0.16	131	21
Residential (includes septic systems)	0.7 - 2.7	262	183 - 707

According to Cooke et al. (1986) wetlands contribute no net annual export of phosphorus; thus we have not included wetlands as a source of phosphorus. We will now address the magnitude of phosphorus delivery to the Monponsett Ponds from precipitation, septic system effluent and storm drain inputs.

Phosphorus input due to wet and dry precipitation was estimated on the basis of a rainfall phosphorus concentration of 0.006 mg P $liter^{-1}$, a value used by McVoy (1982) for a study on East Lake Waushakum. The total volume of rain was calculated from the precipitation and lake surface area (Table 3-1). Using Uttormark et al. (1974) estimate that dry precipitation contains about three times the total phosphorus as wet precipitation, the phosphorus delivered to the lakes from wet and dry precipitation is 52.8 kg per year.

5.2.2 Septic System Phosphorus Sources

Septic tank effluents from near-shore dwellings can be high in phosphorus and can potentially be major contributors to a lake's phosphorus loading. The amount of septic effluent phosphorus which enters the lake system depends on factors such as lake shore lot sizes, soil retention coefficients, seasonal versus permanent residency and use of appliances such as garbage disposals, dishwashers and washing machines.

Several investigations indicate that groundwater can transport dissolved substances contained in septic tank effluents (Michigan DNR, 1973; Veneman, 1982). These investigations have shown that when septic tank effluents are introduced into the soil, nutrients will eventually move downward to the water table and occasionally form and move with the groundwater. The length of time before movement and the extent and rate of this movement for a specific nutrient are determined by individual soil characteristics such as permeability, porosity and adsorptive capacity.

Significant amounts of phosphorus enter the soil beneath a septic system leach field. Recent estimates of phosphorus loads to septic system leach-fields range from 2 to 4 grams P per capita-day(Rechkow et al.,1980; Otis et al., 1985). For the Monponsett Ponds Study we used a value of 3.1 grams P per capita-day following Sedlak et al.(1985).

Septic system longevity for phosphorus retention can be defined as the length of time that phosphorus in the effluent will be retained due to adsorption in the aerated soil zone, above the water table. The propensity of phosphorus to absorb on soil particles counteracts the process of downward migration of phosphorus dissolved in the infiltrating effluent.

The following formula has been proposed for estimating drainfield volume required for complete phosphorus adsorption (Michigan DNR, 1973):

$$D = \frac{YK}{S}$$

where D = Drain field size (cubic feet)
Y = operational life of system (years)
K = Annual phosphorus load per dwelling (lbs.)
S = Phosphorus adsorption capacity for an individual soil group (lbs. per cubic foot).

In the above equation, the drain field size represents the volume of soil between the pervious horizontal interface of the tile field or leaching pit and the groundwater table. Veneman (1982) states that residence time of the septic effluent within the soil environment is extremely important to phosphorus removal; i.e. the longer it takes for the wastewater to seep through the soil the more effectively phosphorus will be removed. Coarse sandy soils, in general, are rapidly permeable, which does not allow for sufficient purification time. According to Veneman, "several states have excluded or are in the process of disallowing the use of these coarse sandy soils with percolation rates in excess of 5 minutes per inch for septic tank effluent disposal".

As reported by the Michigan DNR (1973) phosphorus adsorption values for soils range from a low of about 0.003 lb P per cubic foot to a high of about 0.017 lb P per cubic foot. Because of their rapid permeabilities, the Merrimack type soils which are the most widespread soil on the shores of the Monponsett Ponds, are expected to have a low to medium capacity for phosphorus adsorption. For the purposes of estimating longevities of average septic systems near the shores of the Monponsett Ponds, a range of 0.010 -0.014 lb P per cubic foot was used.

The volume of soil between the permeable bottom of the septic system and the ground water table is a critical factor in determining the useful life of the system for phosphorus retention. On the basis of the answers to the LYCOTT Wastewater Disposal Questionnaire (Section 2.5.2.2 of this report), many of the septic systems around the ponds are within 10 vertical feet above the lake level. These systems are clearly also within 10 feet of the groundwater level since the groundwater will in general be higher than the lake level. In order to calculate phosphorus input from septic systems to the ponds, we made the following simplifying assumptions:

1. Septic systems greater than 10 feet above the lake level make no phosphorus contribution to the lakes.

2. Septic systems less than 10 feet above the lake level contribute their entire annual loading of phosphorus to the ponds, if the useful life of the system has been exceeded.

3. Useful lifetimes for systems less than 10 feet from the lake level are calculated assuming the system is exactly 10 feet above the groundwater level. Calculations of septic system phosphorus loading and useful system life are given in Appendix L.

4. The average values for number of bedrooms and distance between system and lake shore determined from responses to the questionnaire are considered to be representative of all the dwellings around the shores of the ponds. For example, the average reported septic system setback for respondents from East Monponsett Pond was 132 feet. The number of dwellings considered to be potentially contributing phosphorus to East Monponsett were all those dwellings within twice that distance (262 feet) from the shore. The total numbers of homes which fall within twice the reported setback distances are 114 on East Monponsett, 116 on West Monponsett and 41 for the causeway between the ponds. The following formula was used to calculate the loading from each of the three geographic area groupings:

   Annual Phosphorus Loading = (number of homes within twice the average distance between septic system and lake shore) x (fraction of homes where the septic system is less than 10 feet above

LYCOTT

lake level) x (annual phosphorus loading for a typical residence) x (fraction of homes which have exceeded the useful septic system life for a system at 10 feet above the water table).

The results of these calculations are given in Table 5-4.

TABLE 5-4

SEPTIC SYSTEM PHOSPHORUS LOADING BY AREA

Residential Area	Phosphorus Load (kg P/yr)
East Monponsett Pond	177
West Monponsett Pond	187
Between Lakes	14
Total Load	378

The total phosphorus load for septic systems given in Table 5-4 is already included in the estimate for residential phosphorus loads given in Table 5-3.

Internal Phosphorus Loading

Internal loading of phosphorus due to release from anoxic sediments was not included in the Monponsett nutrient budget because our profiles of dissolved oxygen at the two deep hole stations indicated that anoxic conditions do not generally occur in the ponds (Field results, Appendix A).

Stormwater Phosphorus Loading

On the basis of the high phosphorus concentrations in storm water (Table 4-33) the yearly stormwater phosphorus export to the lake could potentially be significant. Using a value of 0.21 mg/liter for a low estimate of stormwater concentration (mean minus standard deviation) and a value of 0.43 mg/liter, (mean plus standard of deviation as a high estimate) and the estimated annual discharge from all storm drains to the lakes, 135,100 m^3 (Section 4.8.1) the range for storm water contribution to the phosphorus budget is 28.3 kg/year to 58.1 kg/year. The phosphorus load from storm drains is in actuality due to the residential land use associated with the drainage system. Thus the storm drain phosphorus source is already included in our estimate of phosphorus due to residential land use (Table 5-3).

5.2.3 Phosphorus Budget Summary

Table 5-5 gives our best estimates of phosphorus loading to the Monponsett Ponds. Residential land use associated phosphorus export is estimated at 183 to 707 kg P yr^{-1} and septic system phosphorus export is estimated at 378 kg P yr^{-1}; if septic system phosphorus is subtracted from total residential phosphorus export, the resulting range in export values for general residential phosphorus export not due to septic systems is 0 to 329 kg P/yr. The average value for this category of phosphorus export would then be 168 kg P yr^{-1}. Phosphorus discharged to the ponds from storm drains could be associated either with a septic system source or with fertilizers or pet wastes.

TABLE 5-5

MONPONSETT PONDS
PHOSPHORUS BUDGET SUMMARY
May 1985 - April 1986

PHOSPHORUS SOURCE	PHOSPHORUS LOAD (kg/yr)		PERCENT OF TOTAL LOAD	
Precipitation	53		6.6	
Forest Land	177		22.3	
Agricultural Land	21		2.6	
Septic Systems - Total	378		47.7	
East Monponsett		177		22.3
West Monponsett		187		23.5
Between Lakes		14		1.7
Diffuse Residential (includes stormwater)	168		20.6	
Total Load	793		100.0	
Outputs - Total	106		13.3	
Stump Brook		61		7.6
Silver Lake		45		5.6

With respect to phosphorus loads, septic systems contributed about 48% of the total load from May 1985 through April 1986. On-site wastewater disposal is the largest single source of phosphorus to the Monponsett Ponds. The septic system load is almost equally divided between systems loading East Monponsett Pond and systems loading West Monponsett Pond. Next in importance to the phosphorus budget were forest land at 22% and diffuse residential phosphorus export at 21%. Precipitation and agricultural land use were relatively minor sources of phosphorus to the ponds.

Phosphorus output from the Monponsett Ponds is divided between export to Stump Brook, (7.6% of the total load) and diversion to Silver Lake (5.6% of the total load). The output of total phosphorus amounted to only 13% of the total input. The remaining 87% of the load during the study year was retained in the lake, primarily in the sediments. If the Monponsett Ponds are allowed to become more eutrophic, the fraction of the phosphorus load which is retained by the sediments would probably decrease. In highly eutrophic lakes, nutrients are flushed through so that output loads approximately equal input loads (Cooke et al., 1986).

From the above analysis, it is clear that lowering the septic system phosphorus load could have a major impact on the overall phosphorus budget. As will be discussed in detail in the feasibility section of this report, it is feasible to reduce septic phosphorus loads of systems located along the central and southern shores of the ponds through reconstruction and/or proper maintenance. However, the phosphorus retention capacity of systems along the northern shores of both ponds is severely limited due to the shallow depth to groundwater and also due to small lot sizes (generally one eighth acre). Consequently, in the feasibility section of this report, it is recommended that sanitary sewers be installed for wastewater disposal from the northern shores of both ponds. Using the procedure for septic load analysis given in Appendix L, we calculated that the phosphorus loads contributed by the northern shores of East Monponsett and West Monponsett were 77 kg P yr^{-1} and 99 kg P yr^{-1} respectively.

The total phosphorus loading from the two northern shore areas amounts to nearly half of the phosphorus loading from all the septic systems located near the shores of both ponds.

5.3 The Phosphorus Lake Model

In order to plan for the management of phosphorus in a lake watershed, mathematical models describing phosphorus loading and lake trophic response can be quite useful. Given the state of knowledge regarding phosphorus cycles, and the limited funds available to most planning agencies, often the most practical mathematical model for phosphorus management is the simple input/output or "black box" empirical model (Reckhow et al., 1980). This type of model contains terms for the input, the output, and the settling (to the lake bottom) of phosphorus, but it does not explicitly include any biological or chemical reactions.

The mathematical model adopted for the Monponsett Ponds was developed by Reckhow (1979) from a database of 47 north temperate lakes included in the Environmental Protection Agency's National Eutrophication Survey. This model expresses phosphorus concentration (P, in mg liter^{-1}) as a function of phosphorus loading (L, in g m^{-2} yr^{-1}), areal water loading (q_s, in m yr^{-1}) and apparent settling velocity (V_s in m yr^{-1}) in the form:

$$P = \frac{L}{V_s + q_s}$$

Using least square regression, they found that the apparent settling velocity could be fit using a weak function of q_s. This resulted in the fitted model:

$$P(\text{g m}^{-3}) = \frac{L}{11.6 + 1.2\, q_s}$$

The Monponsett Ponds are amenable to modeling using the Reckhow procedure because their values of average phosphorus concentration, areal water loading and, as will be shown in this section, phosphorus loading, fall within the ranges of those parameters which characterize the set of lakes used in the EPA's National Eutrophication Survey (Table 5-6).

TABLE 5-6

RECKHOW PHOSPHORUS MODEL: RANGE AND VALUES FOR MONPONSETT PONDS

Parameter	Range Used in Database	Monponsett Ponds
Total Phosphorus	0.005 to 0.135 mg liter^{-1}	0.021 to 0.022 mg liter^{-1} (Appendix H)
Area Phosphorus Loading	0.07 to 31.4 g m^{-2} yr^{-1}	0.373 g m^{-2} yr^{-1} (Appendix I)
Area Water Loading	0.75 to 187 m yr-1	3.32 m yr^{-1} (Appendix I)

The Reckhow Model, as applied to the Monponsett Ponds (Appendix I) predicts a mean phosphorus concentration of 0.024 g P m^{-3}. This is close to the measured volume-weighted mean concentration of 0.022 g P m^{-3} for East Monponsett Pond and 0.021 g P m^{-3} for West Monponsett Pond (Appendix H). The Ponds are close to the borderline between mesotrophic and eutrophic conditions as defined in Table 5-1. The trophic status of the ponds can be made less eutrophic by lowering the areal phosphorus loading (L) to the Ponds. Since the Monponsett Ponds are close to a borderline trophic status, any reduction in loads could result in a marked improvement in water quality. For reasons given in the feasibility section, the recommended phosphorus control for the watershed involves sewering of the northern shores of both ponds. Using the calculated phosphorus loading for these areas given in Section 5.2.2., the predicted phosphorus level after removal of phosphorus loading from these two areas would be 0.018 g P m^{-3} (Appendix I) which would correspond to a mesotrophic condition. It is likely that algal blooms would be less frequent and macrophyte growth less extensive after a new post-sewering mesotrophic state is achieved.

5.4 Conclusions of Diagnostic Study

East and West Monponsett Ponds, located in Halifax and Hanson, Massachusetts are thermally unstratified lakes of 212 hectares total area. Both lakes are classified eutrophic, near the boundary with mesotrophic using Reckhow's lake classification system and are experiencing extensive aquatic weed growth and lowered visibility typical of accelerating

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eutrophication. Since the trophic state of the Monponsett Ponds is near the borderline between mesotrophic and eutrophic, relatively small increases or decreases in phosphorus loading can have a marked effect on the lake quality. Suspended solids concentrations in the ponds are higher than optimal. This problem is exacerbated by high levels of suspended solids entering the pond in the storm drainage system.

The major sources of water to the Monponsett Ponds are surface flow from stream-drained subwatersheds, groundwater flow from subwatersheds without streams and direct precipitation on the lake surface. Based on a study period from May 1985 to April 1986, direct precipitation accounted for 28% of the hydraulic input. About 36% was via the tributaries and another 36% from non-stream subwatersheds.

Phosphorus budget estimates using literature values for land use export coefficients and phosphorus retention capacities of septic systems gave strong evidence that septic systems were the major single source of phosphorus (about 48% of the total input). Other major phosphorus sources included forest land (22% of the total), diffuse residential, which includes fertilizers and pet waste (21% of the total). Minor phosphorus sources included precipitation (7% of the total) and cranberry bogs (3% of the total).

Phosphorus output from the Monponsett Ponds to the outlet or diversion aqueduct was relatively low (about 13% of the total phosphorus input). The relatively small rate of loss of phosphorus indicates that it is largely being stored in lake sediments and that the lake has not reached an advanced stage of eutrophication.

A short response time of 0.3 to 0.55 years indicates that increases or decreases in the phosphorus load will rapidly result in degradation or improvement, respectively, in the water quality of the Monponsett Ponds.

6.0 FEASIBILITY ANALYSIS

6.1 Range of Alternatives Investigated

The following is a presentation of examples of the broad range of alternatives which were investigated during the feasibility analysis portion of the Monponsett Ponds Study. The most feasible restoration alternatives are discussed in Section 6.2.

6.1.1 Lake Bottom Sealing

In ponds which have anoxic bottom water during the summer, sediments can be an important source of phosphorus. Materials such as fly ash or plastic sheeting have been used to block the transfer of nutrients from the sediments. These materials are used in order to reduce the internal cycling of nutrients, especially phosphorus within an aquatic system. As discussed in Section 5 on the nutrient budget, internal cycling of phosphorus is minimal due to the presence of oxygen in the bottom waters. Therefore, this alternative would not address a problem in these ponds.

6.1.2 Nutrient Inactivation

This technique is designed to reduce the concentration of nutrients in the water column. It is particularly useful in helping to control phytoplankton blooms in lakes.

Alum (aluminum sulfate) is the most common chemical used for nutrient inactivation in lakes. This chemical forms a flocculant with the phosphorus in the water column, thus precipitating the nutrient out of the water to the bottom. The alum is applied from a power boat, using onboard storage tanks and a pumping system. The action of the boat and motor aids in mixing the chemical into the water column. Application of any chemical to a water body in the State of Massachusetts must be done by a licensed applicator.

The Monponsett Ponds do not exhibit levels of algae which are sufficient to require this technique.

6.1.3 Weed Control with Sterile Grass Carp

Recently, a sterile breed of weed-eating carp has been successfully used in southern states. However, the Massachusetts Board of Fisheries and Wildlife has been unwilling to test and license the introduction of this fish to the state. Indications are that a trial of this fish is still a few years away. The Board recently decided not to allow experimental use of the carp in Chebacco Lake, in the towns of Hamilton and Essex, Massachusetts. Also, grass carp show feeding preferences for certain weeds; fanwort is not among the favored foods. In view of the legal constraints and the dubious prospects for successful control of weed in the Monponsett Ponds, the use of grass carp is not recommended.

6.1.4 Flushing

Flushing is a means of reducing algae growth by reducing the nutrient levels available to these plants. This is accomplished by replacing nutrient-rich pond water with nutrient-poor influent waters. There are two methods used to supply water with a low nutrient level. The first is to have a surface water supply that is low in nutrients and can be diverted into the pond, thus over time reducing the concentration of nutrients as they are washed out the outlet. The second method is to lower the lake level to enhance groundwater flow into the pond. Again, the inflow is nutrient-poor; thus when the lake is full, the concentration of nutrients should be reduced.

There are no new surface water sources that could be diverted to the ponds, the only method available is drawdown to increase groundwater flow. There are two problems that limit *the feasibility of drawdown to induce flushing. One problem* is that the test well data has shown the quality of the groundwater entering the ponds to be poor. The groundwater sampled from these test wells and seepage samplers is nutrient-rich instead of nutrient-poor. The second problem is that drawdown is physically infeasible due to a lack of downstream grade, and the absence of a control structure. For these reasons, the management technique of flushing is not considered viable for the Monponsett ponds.

6.1.5 Water-Level Drawdown

Water-level drawdown is a well established technique of reservoir and pond management. It is used to control certain aquatic weeds, to manage fish populations, to repair structures such as dams or docks and to facilitate dredging or installation of sediment covers. (Cooke et al., 1986) The object of water level drawdown to control nuisance weeds is to expose the plant to freezing-dessication to destroy both the thallus and the roots. Success is dependent upon many factors, including luck with regard to weather. The method is species specific, in that some species are adversely affected, some enhanced and others unaffected.

Of the species identified in the Monponsett Ponds, previous drawdown studies have shown that two of these, Bulrush and Cattail usually increase as a result of drawdown. Five of the weed species found in the ponds usually decrease as a result of drawdown; these include flatleaf pondweed, fanwort, yellow water-lily, milfoil, and white water-lily. (Cooke et al., 1986)

In order for winter drawdowns to be effective, the plants must be exposed to subfreezing, dry conditions for several days to several weeks. Water level is generally drawn down by about 1.5 meters (5 feet) between mid-October and mid-November and maintained at that level until mid-March, when it is brought back to full volume.

At the present time there exists no control structure or pumping capacity which could be used to lower the water level in the Monponsett Ponds. At this time, the aqueduct used by Brockton to divert water to Silver Lake cannot draw down the Ponds below an elevation of 52 feet above mean sea level according to Chapter 237 of the Acts of 1981 of the Massachusetts Legislature. However, if the City of Brockton installed high volume, low head pumps to pump water from the Monponsett Ponds into the aqueduct, it is conceivable that the water level in the ponds could be drawn down by 1.5 meters (5 feet) and maintained at that level from mid-November to mid-March.

In conclusion, water level drawdown from the Monponsett Ponds would have a beneficial effect in controlling on the nuisance weed population, especially when used in conjunction with other weed control methods, but neither the pumping capacity nor the legal framework exists at the present time in order to carry out a drawdown.

In conclusion, pond level manipulation by control at the outlet of East or West Monponsett is not a realistic possibility at this time.

6.1.6 Dredging

Dredging of sediment from a pond or lake can enhance recreational use potential of a water body. The water depth is deepened to reduce the intensity of sunlight on the sediment thus reducing the growth potential of
sediment thus reducing the growth potential of plants. Dredging can also reduce recycling of nutrients from highly organic sediment.

Dredging can be accomplished through either mechanical or hydraulic means, depending on the physical characteristics of the material. Very fine, loose sediments such as those found in portions of the Monponsett Ponds, are not suitable for mechanical dredging, since there would be an extremely low capture rate with this method.

A hydraulic dredge works on a system similar to a vacuum, in that a suction pipe, usually with a cutter head, is used to pump a combination of water and sediment to the disposal area. The disadvantage is that this requires the pumping of

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a significant amount of dilution water, in the order of 9 to 1 water to sediment. This water and sediment must be separated in order to further work the sediment. In addition, this would be nutrient-rich water so it could not be immediately returned to the lake because of the high concentration of nutrients and suspended solids that would be introduced into the pond. Dredging is quite expensive. Costs range from $3-8 per cubic yard removed.

Because of the large expense and also because of the potential for extreme environmental impact on the pond as a whole, for the improvement of limited areas, we do not recommend dredging for weed control in the Monponsett Ponds.

6.1.7 Aeration

Aeration of the water column with oxygen or air is a management technique which is sometimes used in pond basins with poor circulation and extensive anaerobic bottom waters. Injection of compressed air into the hypolimnion develops patterns of artificial circulation which mix the bottom and top waters. This eliminates the anaerobic conditions and reduces the nutrient release from the sediments.

East and West Monponsett ponds do not stratify. Although the hypolimnion did exhibit lowered concentrations of oxygen, the bottom waters did not become anaerobic during this study (see Section 4.2.2.). Therefore, implementation of aeration would not provide any substantial change in the release and cycling of nutrients with the pond.

6.1.8 Lime Application to Lake Water and Watershed

Acidification of natural waters in Massachusetts is a problem which has recently become a priority issue for the Massachusetts Division of Fisheries and Wildlife (Cronin,1985). The loss of buffering capacity (alkalinity) and lowering of pH in ponds and lakes in Massachusetts has recently been studied by Godfrey et al. (1984). According to his criteria, lakes with a pH of <5.0 and alkalinity of zero are defined as acidified. These lakes would not support normal biological communities and would be an extreme case of acidification. Lakes with alkalinities of 0-40 microequivalents per liter are classified as critical and alkalinities of 41-100 microequivalents per liter are endangered.

Liming a watershed or lake will provide additional buffering capacity. This is a result of the breakdown of lime (CaCo3) into Ca++ and buffering carbonate. Addition of lime raises the pH of the water. Liming has been utilized in Scandinavian lakes for neutralizing acidified lake waters since the 1920's. Many lakes in the U.S. have been limed in

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the last 25 years.

There is no universally accepted management criteria for applying lime to a lake. The Monponsett Ponds are still naturally buffered, with alkalinities of greater than the endangered threshold of 100 microequivalents per liter. These ponds should be monitored consistently in the future in order to assess the desirability of liming on an ongoing basis (see Chapter 7).

6.1.9 Aquatic Weed Raking

The aquatic weed rake removes plant material and a limited amount of muck from shoreline areas. The rake itself is a paddle-wheel propelled floating backhoe which has a large rake instead of a bucket on the end of the arm. This rake is effective in excavating the plant, including the roots and small amounts of sediment. Because the hydrorake can work close to shore; it is effective in maintaining beach areas and shorelines. The aquatic weed rake is not commercially available and therefore spare parts and maintenance may be difficult. This type of work is best contracted to an appropriate firm. The cost of this operation is approximately $150 per hour, plus a mobilization fee of $300. Typically, a 50-foot frontage requires about an hour to clear. This figure depends on the density of plants, bottom composition, species, and the amount of muck to be removed. Therefore, 50 feet would cost $100 to $200. Offloading of weeds would typically be on the individual shore front lots nearest to the areas of raking.

Disadvantages of aquatic weed hydro-raking include:

- Suspension of sediments: in the process of removing weeds and roots, surface sediment is disturbed and can be suspended in the water. The resulting high turbidity makes continued hydroraking difficult and can result in patches of vegetation which are missed.

- Hydro-raking may encourage vegetative fragmentation of target and non-target plants and may encourage rapid growth or shifts in species composition if opportunistic species are given a competitive advantage.

- Raked vegetation and floating fragments must be collected and removed from the water: these steps may be energy or labor intensive and relatively costly.

- Only relatively small areas can be treated by individual machine units during the growing season, when nuisance conditions may require simultaneous treatments over large areas in a short time period.

- Favorable weather is essential to safe and effective operations.

- Hydro-raking operations must rely, at the present, on mechanical systems that usually involve high capital cost, are technically specialized, and could breakdown or require extensive maintenance.

- Hydro-raking operations are limited by access to the site, by confined spaces that limit movement and by physical factors such as submerged rocks and other bottom irregularities.

- Because of slowness, hydro-raking operations may create public dissatisfaction and disputes over which treatment areas have priority.

- Hydro-raked vegetation is usually a waste material that must be disposed of, adding to costs. Piles of decaying vegetation may produce odors. Water runoff from the piles can put nutrients back into the lake.

- Costs of hydro-raking are estimated at $800-1000 per acre, as compared to the $500. per acre cost for Sonar treatment.

Despite these numerous drawbacks, hydroraking is the only weed control technique which can be recommended for implementation during the summer of 1987.

6.1.10 Herbicide Management

Herbicide application is a common and effective method for controlling nuisance aquatic weeds. Certain chemicals and application rates selectively control only target weed species; hence the applicator has the option of treatment only specific nuisance weeds. Herbicides kill weeds either by direct contact (contact herbicides) or uptake by leaves, stems or roots (systemic herbicides).

Most herbicides are not effective in controlling Fanwort, which is the major nuisance weed in the Monponsett Ponds. However, a newly registered herbicide, fluridone, which is sold under the trade name of "Sonar" can control Fanwort. Sonar is a systemic, broad spectrum herbicide which inhibits the formation of the enzyme carotene within the leaves of the weed. The absence of carotene exposes the weed's chlorophyll to photodegradation and causes the weed to lose its characteristic green color. Generally 30 to 90 days are required for the treated weed to die and decompose.

The use of aquatic herbicides is somewhat controversial. According to Cooke et al. (1986) adverse impacts associated

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The use of aquatic herbicides is somewhat controversial. According to Cooke et al. (1986) adverse impacts associated with herbicide use include nutrient release from dead weeds, dissolved oxygen depletion from weed decomposition and toxic effects on non-target aquatic organisms. There are also unresolved issues regarding mutagenic and carcinogenic effects of some herbicides on humans.

The use of Sonar cannot be recommended for control of fanwort in the Monponsett Ponds because of the water rights of the local cranberry growers and their concerns over the use of herbicides in the lake. There are maximum "tolerance levels" or maximum allowable concentrations in the fruit for the pesticides commonly used in cranberry production. There have been no tolerance level tests performed on cranberries with Sonar and thus there is not any established tolerance level. The presence of any pesticide at levels greater than the tolerance level will preclude the marketing of the affected cranberries. Sonar, therefore, cannot be recommended for use in the Monponsett Ponds.

If, at some time in the next year or two, Sonar is tested on cranberries and a tolerance level for it is established, Sonar could be a viable tool for weed control in the Monponsett Ponds. In recognition of this possibility, we include in this report information on Sonar treatment for the Monponsett Ponds in Appendix J.

6.1.11 Wastewater Disposal Alternatives

6.1.11.1 No Action Alternative

The no action alternative would likely result in the continual deterioration of existing septic systems and an increasing number of septic system failures. Eutrophication of Monponsett Ponds would be expected to continue at an accelerated rate as long as current wastewater disposal practices are continued. It is conceivable that the occurrence of low water levels may result in the emission of foul odors from the decomposition of bacteria and other organic matter and may render the pond unacceptable for recreation. Population in Halifax increased from 3,537 in 1970 to 5,513 in 1980 (USDA, 1975, DEM, 1984). This corresponds to a per decade rate of increase of 55%. If growth continues at this rate in Halifax and in the watershed of the ponds, and assuming that phosphorus loading to the ponds from septic systems and diffuse residential sources is proportional to the population, the residential phosphorus load in 1996 would increase by about 300 kg P/yr at that time. The Reckhow model predicts that the in-lake phosphorus concentration would be 0.032 mg P/liter, well into the eutrophic range. The extent of weed coverage and the incidence of algal blooms would be considerably greater in the ponds if no corrective action is taken.

The no action alternative is considered unacceptable for water quality and health reasons.

6.1.11.2 Maintenance of Existing Septic Systems

Maintenance of existing near shore septic systems alone should not be considered as a permanent solution to the Monponsett Pond pollution problem, since even well-functioning systems would ultimately contribute to the pond's nutrient loading. Maintenance should be considered as a temporary measure for lessening the frequency of gross system failures and resultant public health hazards while a permanent solution is being implemented. Maintenance pumping of existing failing sub-surface systems may prevent sewage overflow to the environment at certain times of the year, early spring or wet seasons, but as the system fails completely total sewage flow must be pumped and homeowner costs are prohibitive.

Maintenance of the sewage disposal systems will allow the system to continue to function properly for longer periods of time with less ultimate costs. Excessive solids from garbage grinders, coffee grounds, paper goods and solids that can be otherwise disposed of, must not be discharged to the septic system because this leads to excessive solids in the septic tank. Grease, oils, waxes and other similar materials must not be discharged to the septic system to prevent the formation of an excessive scum layer and premature failure of the leaching facilities. Most importantly, solvents, industrial chemicals, and any type of harsh chemical must not be flushed down the sinks or toilets since these chemicals are virtually untreated and are quickly discharged to the groundwater.

Maintenance of the septic system should include yearly pumping of the septic tank for the removal of solids from the bottom of the septic tank, and the removal of scum floating on sewage at the top. The removal of both these layers prevents carry-over into the leaching area and early failure. At times of anticipated heavy usage, the septic tank should be pumped before the heavy use and solids carry-over.

6.1.11.3 Reconstruction of Failing On-Site Sewage Disposal Systems With Conventional Systems

The replacement/reconstruction of identified failing or substandard sewage disposal systems could be required by the Boards of Health of Halifax and Hanson as part of its Title 5 enforcement activities. The need for such reconstruction (or expansion) would be determined on an individual site-specific basis. Identification of particular problem systems could be accomplished as part of the first phase of an inspection/maintenance program.

Reconstruction/replacement of failing or substandard sewage disposal systems in the immediate shore area in accordance with Title 5 requirements would be impossible for a large number of pond area residences because of small lot size and inadequate setback distances from individual potable water supply wells and/or the lake shore. Reconstruction of failing septic systems should be considered a temporary measure in areas where eventual sewering may be implemented.

Ordinances requiring upgrading of septic systems upon sale of residences cannot be considered a viable solution to the trophic condition of Monponsett Pond, since the soil types, which generally fall under categories of Hinckley, Merrimac and Windsor soils, do not function as a good filter medium for nutrients and other contaminants (see Figure 2-3, Section 2.4.2).

6.1.11.4 "Black Water" Handling Alternatives

Black water is primarily made up of human wastes associated with the use of toilets, i.e., urine and fecal material which are characterized as the high B.O.D. components of the wastewater. Other constituents of black water include toilet paper, sanitary napkins and diapers.

Black water makes up approximately 40 percent of the wastewater from the average household. Numbers of systems for the disposal of black water are available. Some of the most widely used alternatives to conventional septic systems include compost systems, recycle systems, incinerator toilets and low flush toilets. These systems are described in Appendix K.

Title 5 presently requires that compost or humus toilets be located only on lots where a subsurface disposal system could be constructed in accordance with Title 5. Title 5 does allow for a reduction in leaching area sizing based on the assumption that up to 40 percent of the anticipated hydraulic loading is "black water". Thus, for a two-bedroom dwelling which would have a design sanitary loading of 220 gallons per day (without a garbage grinder), a grey water leaching area could be designed for approximately 140 gpd with compost toilet use. Waste residuals are required to be buried at a Board of Health-approved location with a minimum earth cover of two feet. Other innovative facilities such as recycle or incinerator systems would require a variance from Title 5 on a lot-by-lot basis.

In general, the "black water" reduction systems are not considered feasible for meeting the water quality goals for the Monponsett Ponds for the following reasons:

1. They do not handle the grey water component of sewage.

2. Most types of black water reduction systems recycle waste to the surrounding land; therefore, the problem of nutrient contamination to Monponsett Pond will not be eliminated.

3. Incineration of the black water constituents may cause significant odor problems in the Monponsett Ponds area. The incineration process is also susceptible to frequent mechanical failures.

6.1.11.5 "Grey Water" Reduction

Grey water typically originates from water used in the laundry, bathtub, kitchen, bathroom sinks, dishwashers and other appliance used for cleaning. Grey water contributes approximately 60 percent of the volume of wastewater from the average home, the remainder of the flow is classified as blackwater (310 CMR, section 15.17).

"Grey water" cannot be eliminated by incineration, recycling, or composting, as is the case with black water. However, many water conservation devices are commercially available to greatly reduce grey water generation. Flow restrictors and regulators can be placed on faucets and shower heads to reduce use. An average shower will use six gallons of water per minute for 7.5 minutes with a standard shower head. Should a three-gallon-per-minute flow reduction device be installed, an average family of four persons could save 90 gallons of water per day, assuming each person took only one shower daily.

Other water conservation methods and their associated water savings are listed below:

Method	Approximate Savings (Gallons/Use)
Five (5) minute shower instead of bath	15-20
"Navy" or "Sea" shower	5-10
Plug sink while washing or shaving	3-5
Turn off water while brushing teeth or washing hands	5-10
Remove garbage disposal	5
Flow-reduction shower head	10-30
Faucet aerators	75% Reduction
Toilet reservoir water-saver insert	3
Shallow trap toilet	3-4
Flush only when necessary (Alameda Principle)	6
Weighted bottles in toilet reservoir	2
Front-loading clotheswasher	20

Source: Warshall (1979).

Obviously, the preceding flow reduction methods cannot effectively be implemented as a mandatory requirement. However, these methods should be encouraged by the Towns of Halifax and Hanson for flow reduction on individual systems.

Although this system will conserve water use, it will not reduce the quantity of nutrients from entering the groundwater.

6.1.11.6 Non-Conventional Individual On-Site Wastewater Systems

a. Aerobic Treatment/Subsurface Disposal

Many alternative individual systems utilize an aerobic biological treatment process. The basic operating principle of aerobic treatment units is the same as that used in conventional municipal activated sludge wastewater treatment plants. In essence, these household/on-site systems are miniature models of the larger municipal plants. Some units are complex, while others are a simple aeration chamber.

The incoming wastewater is initially treated by settling heavy solids, grinding large particles or filtering. Wastewater then enters the aeration chamber where it undergoes aerobic decomposition. Solids formed by the aerobic degradation process are subsequently allowed to settle out. The effluent, although of generally higher quality than septic tank effluent, does contain substantial amounts of pollutants which must be subsequently removed by soil percolation.

The sensitive nature of the treatment process, in addition to the mechanical equipment involved, requires that it be monitored and maintained on a continual basis. A service contract may be instituted using reliable repair service with a series of scheduled maintenance calls (at least four times a year). Alarms can also be supplied which automatically activate when malfunctions occur.

Much of the soil in the Monponsett Pond area is Merrimac loamy sand, a type which is poorly suited for removing pollutants before their entry into the Pond via groundwater. Therefore, the aerobic treatment subsurface disposal system may not effectively reduce the nutrient loading to the Pond.

b. Mound or Fill Systems

A mound system is essentially an above-ground leaching bed, usually placed about three feet above the ground surface or adapted to a slope condition. A diversion ditch commonly diverts surface water away when mound systems are placed on moderate slopes. The mound system achieves wastewater degradation by percolation through soil, combined with evapotranspiration via vegetation and wind. A clay layer or other impervious barrier is commonly placed along the edge of the mound to prevent lateral seepage of untreated effluent.

The mound leachfield system is commonly used in areas where poorly drained soils, high groundwater, and shallow depth to bedrock exist. At Monponsett Ponds much of the soil is a loamy sand type and the depth to groundwater is sufficient; therefore, mound systems are generally not applicable to the Monponsett Pond area. The mound systems could, however, provide added nutrient removal in areas of peat and Scarboro soils to the northeast of East Monponsett Pond. These types of soils are severely limited for septic system service because of shallow depth to groundwater (Figure 2-3).

c. Holding Tanks

A holding tank is basically a large underground watertight storage tank used to temporarily store wastewater. The tank is pumped periodically and the contents hauled away for ultimate disposal. These tanks are usually used in remote or isolated areas where absorption fields are not feasible. Maintenance costs are high and monitoring is required on a continual basis. These systems are a sure method to eliminate contamination due to subsurface system failures. A service contract with a pumping company is recommended so that the tank can be pumped regularly. Alarms which activate when the tank is nearly full also are advisable. A holding tank is only allowed upon submission of proof to the Board of Health and DEQE by a registered professional engineer or sanitarian that a given lot cannot accept a septic system designed according to Title Five. Because of their high operational costs, holding tanks should only be considered as a last resort solution as an alternative to a formal condemnation. Based on the accepted flow of 110 gallons per bedroom it is possible to require pumping every two to three weeks at considerable costs to the homeowner.

6.1.12 Sub-Surface Disposal System Correction

On-site subsurface sewage disposal systems, designed and constructed in accordance with Title Five of the State Environmental Code are designed to prevent contamination of surface drains, brooks, streams and other bodies of water such as Monponsett Ponds. While a system is functioning properly no breakouts or overflows occur causing bacteriological contamination of the surface water source.

However, all systems in time fail and constant inspection and vigilance is necessary to detect systems that have failed, and no longer function as designed. Failed systems may or may not be capable of reconstruction or replacement in accordance with Title Five, and judicious approval of design or replacement system with some variances is required. However, variances to new construction are not allowable under Title Five.

Generally, if on-site subsurface sewage disposal systems are properly designed and constructed, bacteriological contamination of the groundwater beneath the system does not occur. But, compounds that are in solution travel downward with the water component of sewage until they meet the water table, become mixed with the groundwater and can be transported to a nearby stream or lake. These compounds include sodium chloride, nitrates, phosphates, soluble cleaners and other household compounds.

While Title Five requires the connection of the washing machine and dishwasher to the subsurface sewage disposal or catch basins may have occurred. This practice allows the entrance of contaminants directly into surface water drainage systems.

To adequately control the discharge of sewage to Monponsett Ponds, the following two step procedure is recommended to the Boards of Health of Halifax and Hanson:

Step One - Evaluation

Suggested plan of evaluation to obtain necessary information.

Review Board of Health files for following:

1. Name, address and location of lot served by system.

2. Type of system and location

    a. no disposal system

    b. septic tank to surface of ground

    c. cesspool to surface

    d. cesspool in ground water or ledge

    e. septic tank and leaching pit

    f. septic tank and leaching field

3. Verify above and fill in unknown based on field survey.

4. Prepare report on above findings.

5. Homeowners to meet with Board of Health and prepare plan of action.

Step Two - Action

Suggested plan of action to eliminate sewage discharge:

1. Knowing current difficulty of installing sewage disposal systems in complete accordance with Title Five.

a) Agree on criteria for enforcement.

b) Agree on variances for lot lines, foundations, depth to water, ledge, etc.

c) Agree on easements to be obtained from the Town, shared land.

2. Starting at water edge of Monponsett Pond area order those with no disposal system to install system.

a) Order those with surface discharge to comply with Title Five.

b) Order those contaminating drains, waterways, and ponds, etc. to cease violations.

c) List others for yearly review.

3. Look to possible interconnection of several lots into common sewage disposal systems with Town maintenance.

4. Require that the rest of lots be put on maintenance programs to prevent contamination of surface drainage systems.

6.1.14 Stormwater Treatment Alternatives

In addition to the removal of nitrogen, phosphorus, and coliform bacteria from the drainage systems following the septic system reconstruction and partial sewering recommendations in this report, it is necessary to address siltation of the ponds, and the resultant increase in turbidity and decrease in water clarity and quality.

While it does not appear that large areas of disturbed earth are to be found surrounding the ponds, significant amounts of silt and turbidity are being introduced into the lake systems from surrounding drains. The source of these inorganic sediments are from sand, applied for ice and snow control, travel debris, automobile tire wear and other debris introduced into the drains from the roadway.

Methods of removal of this debris and sediment from drainage systems are by structural means, such as:

A. Natural Sedimentation--allowing surface water to run over the surface of the ground; bacterial decomposition can occur and the frictional effect of grasses and plants allow the drainage water to be reduced in velocity, spread over wider areas and to be naturally cleansed. Wetlands, currently protected, serve this function.

B. Oil and Grit traps (so called MDC traps) placed in the discharge end of storm drains allow oil, grease, filter tips and other floating debris to rise to the surface of the manhole and be skimmed and removed, and sand and other heavy particles to settle to the bottom of the manhole to be removed and disposed of. This type of installation is sufficient to remove oil, floating debris and large heavy material but is deficient in detention time to remove suspended material, such as fine silt. A representative oil and grit trap is shown in Figure 6-1.

C. Open sand filters constructed at the discharge end of large drainage systems have been used successfully by D.E.Q.E., Division of Water Supply on water supply watershed lands in Marlboro, Westboro and Sterling, MA to protect surface water supplies. Sand beds with 24-14 inches of washed, graded sand on top of an open joint pipe collection system receiving the discharge from drains will remove debris, granular and fine materials by filtration, allowing a clarified effluent from these sand filters to be discharged to the receiving body of water. The open sand bed is periodically raked clean and the debris, along with a few inches of the filter sand is disposed of. From time to time, additional graded filter sand is added to maintain the proper depth of filter sand. A representative open sand filter is shown in Figure 6-2. Depending on design parameters, filtration rates range from 50-200 gallons per square foot of media per hour. Greatest cost effectiveness is obtained if the filters are designed for removal efficiencies of 70% for suspended solids (Wanielista et al, 1982).

To reduce the cost of the construction of sand filters, several drains can be interconnected, negating the construction of numerous sand filters, or in areas where land for construction is not available or presents difficult construction procedures.

Because the drainage systems exist the location of the filters may not be easily selected, and sufficient land may not be available in all locations for optimum filter size.

Stormwater diversion has been considered but because of the size of the lakes, the location of the drain and the flat topography it does not appear a feasible alternative at the location.

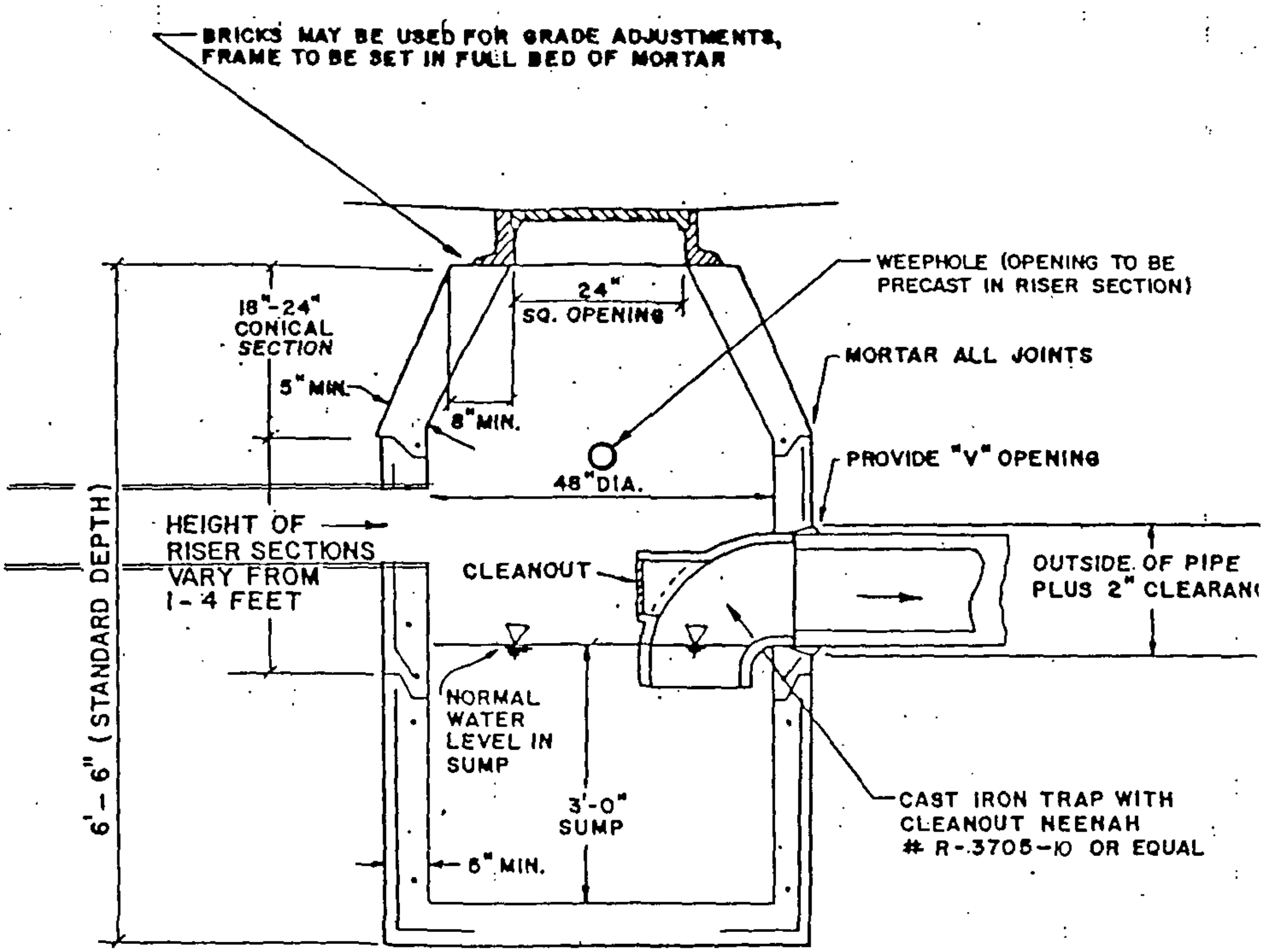

Figure 6-1 PRECAST CONCRETE MANHOLE WITH GAS TRAP AND CLEANOUT

NOT TO SCALE

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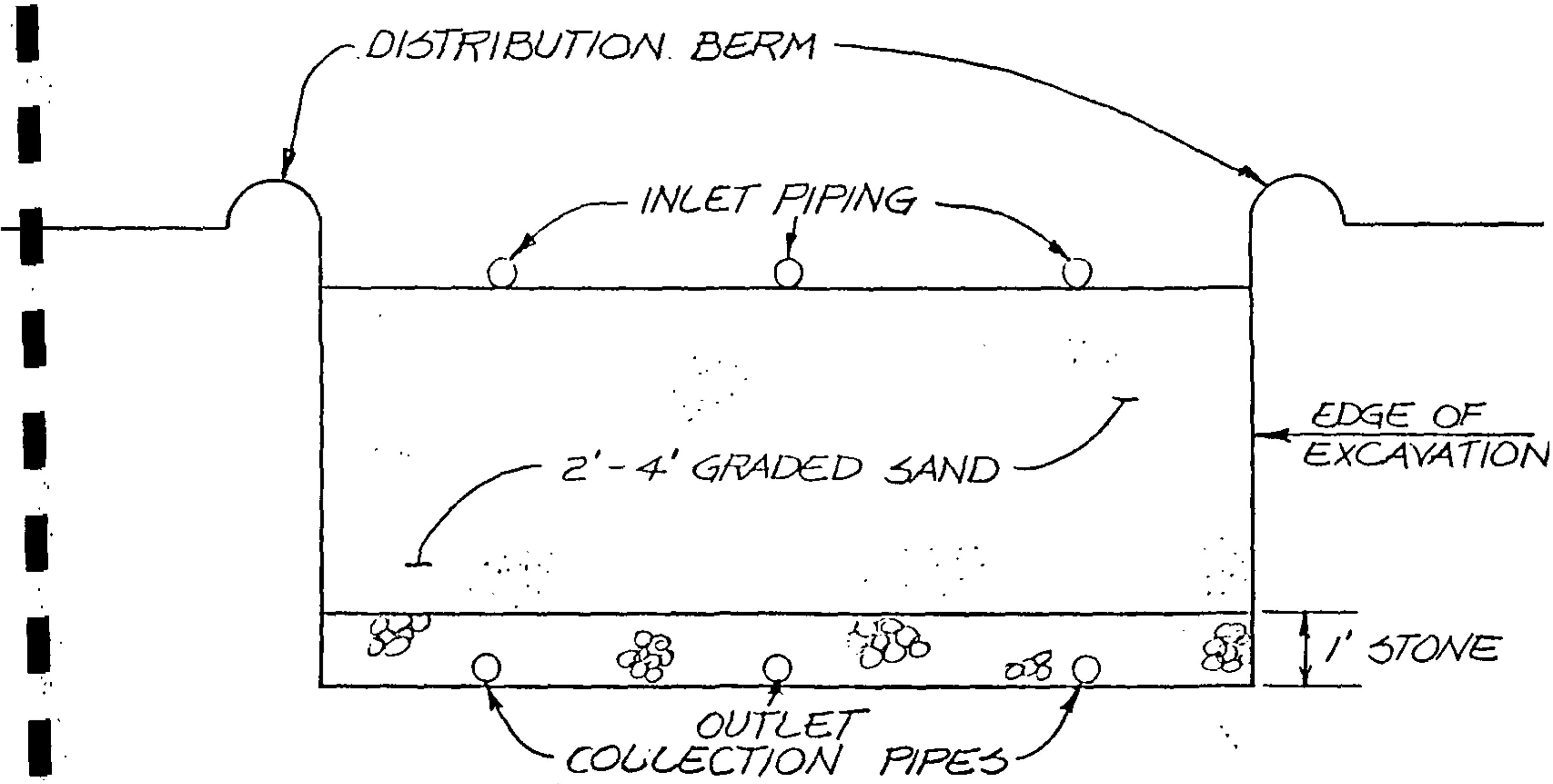


Figure 6-2 SAND FILTER
NOT TO SCALE

6.2 Evaluation of Selected Feasibility Alternatives

The following is a discussion of the most feasible alternatives for management and restoration in response to identification of the four major problems in Monponsett Ponds; aquatic weeds, high septic system phosphorus loading, siltation from solids carried in by the storm water and contamination of storm drains from failing septic systems.

6.2.1 Acidification Monitoring Program

Because of the low pH and alkalinity values measured in the Monponsett Ponds, it is recommended that an annual monitoring for pH, alkalinity and dissolved aluminum ion be carried out. Measurements should be made at the deep holes of each lake, at tributary stations 2 and 3 of East Monponsett at tributary stations 4 and 5 of West Monponsett. It is recommended that aluminum be monitored because of its extreme toxicity to many fish species. Chronic effects to fish are considered to begin in the pH range 5.5-6.0, with mortality occurring at pH 5.0 and below. With aluminum present, however, mortality can occur around pH 5.5 (Henricksen, 1980). This monitoring program should be carried out in the springtime, after snowmelt, in order to assess the situation at the most acidified, hence most critical, period of the year. The estimated cost for the program is $360/year, including the report.

6.2.2 Community Sewage Treatment Plant

In addition to the recommendations made in Section 6.1.10 to control septic tank effluents, and the improper disposal of the effluent whether over the ground through illegal pipes or storm drains, additional corrective action appears to be justified in the near future for the following reasons:

1. Lots are too small to allow reconstruction of septic systems in conformance with Chapter 5 of the Massachusetts Sanitary Code. Any zoning change made at this time will not affect existing dwellings.

2. There has been an increase in sewage flows because of conversion from summer cottages to permanent residences, sometimes accompanied by the addition of bedrooms.

3. The soils near Monponsett Ponds are generally coarse sand and gravel with limited capacity to retain phosphorus.

4. Phosphorus retention is further limited at the north ends of both ponds because of the high groundwater table.

5. The dwellings at the northern ends of the two ponds are relatively inexpensive housing; it is reasonable to assume

that frequent septic system maintenance or repair may be beyond the ability of the homeowner to pay.

6. If no action is taken, contamination of storm drains and weed growth near shore will likely worsen.

7. Coliform counts near storm drain outlets will be dramatically lowered after sewering.

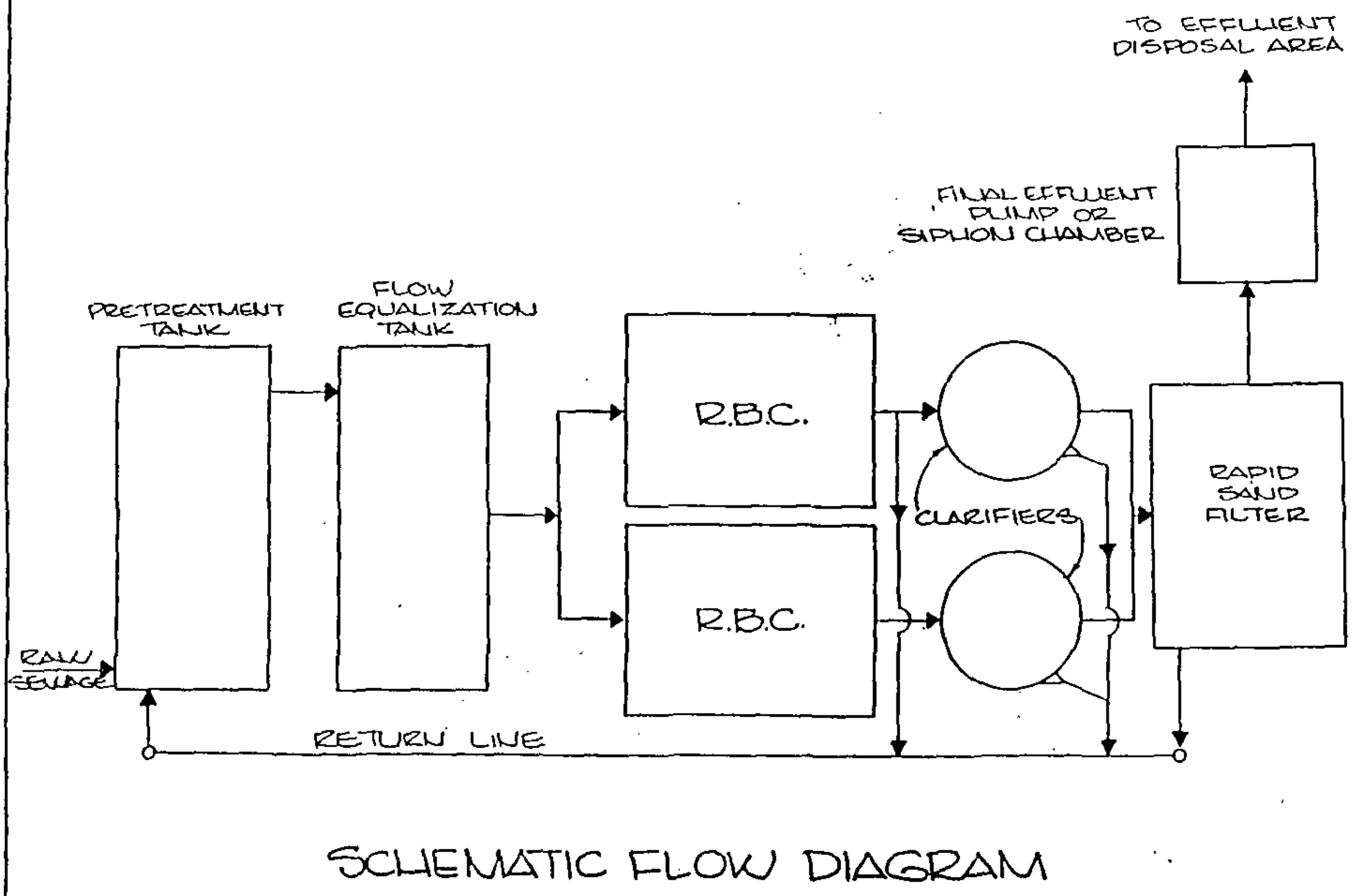
Field surveys were conducted during the summer of 1985 and 1986, complemented by a questionnaire type survey. These surveys showed that while many cottages were previously planned for summer use, year-round residence is now the rule, with many cottages being rented and expanded. The developed northern shore areas of both ponds have a high groundwater table with subsurface flow in a southward direction towards the ponds.

Assessors maps augmented by field observations, indicate that lot sizes in the two above mentioned areas are generally smaller than 1/8 acre, allow maximum density, and make construction of a proper on-site disposal system most difficult if not impossible.

A review of the results of bacterial analyses of samples collected from East and West Monponsett Pond show that on occasion fecal coliform bacteria concentrations in stormwater, testwells and seepage samplers exceed the swimming water standard of 200 organisms/100 ml (Article 8 of the State Sanitary Code, 310 CMR 17.00).

The action required is for the study, plan preparation and construction of collection and disposal facilities in the northern area of East Monponsett Pond in Halifax, and the northern area of West Monponsett Pond in Halifax and Hanson.

A rotating biological contactor (RBC) type of treatment plant is recommended because it has a number of advantages over older types of treatment systems such as the activated sludge system and the trickling filter system. The RBC system is the most economical, has fewest moving parts, produces less noise (it has no blowers) and has the lowest power costs. It can be delivered to the site largely prefabricated, which reduces construction costs. In principle the RBD is a fixed-film biochemical treatment system, like the trickling filter, but with the plastic disks that serve as the filter media alternately immersed in wastewater and exposed to the air. In the trickling filter, wastewater and air circulate while the media is immobile (Ouano, 1983). The effluent from the RBC goes through a settling tank, then through a chlorinator, a sand filter and finally activated carbon filter for phosphate removal. The polished effluent goes into open sand leaching beds and infiltrates into the ground.



TO EFFLUENT DISPOSAL AREA
FINAL EFFLUENT PUMP OR SIPHON CHAMBER
FLOW EQUALIZATION TANK
PRETREATMENT TANK
R.B.C.
R.B.C.
CLARIFIERS
RAPID SAND FILTER
RAW SEWAGE
RETURN LINE
SCHEMATIC FLOW DIAGRAM

Figure 6-3

6.2.3 Stormwater Treatment

Because of the heavy sediment load carried by the storm drains studied in the report and the resultant silting in of storm drain areas, treatment to remove sediments from the stormwater is recommended. Excessive sedimentation can interfere with fish reproduction (Muncy et al., 1979) and results in extensive shallow areas which are then colonized and eventually overgrown by aquatic weeds. It is recommended that at a minimum four and as many as seven existing storm drains, be equipped with open sand filters to trap suspended sediments. Nutrient concentrations and bacterial counts would not be significantly reduced by the sand filters; the only contaminant which these filters remove efficiently is suspended solids. At a 70% removal efficiency (Section 6.1.12), if sand filters were installed on all stormwater drainage systems that discharge to the Monponsett Ponds, delivery at suspended solids to the ponds could be reduced by nearly 12,000 kilograms per year (see Section 4.8.3) which would be 40% of the total sediment delivery to the ponds during the study year. The highest priority storm drains for construction of the sand filters are the four sites shown in Figure 2-4. Prior to construction of the sand filters it is necessary to perform a hydraulic study to size the sand filters for an expected maximum design flow (Wanielista et al., 1982). It is anticipated that the hydraulic study would be undertaken prior to preparation of engineering plans, specifications and construction bid estimates.

7.0 RECOMMENDED RESTORATION PROGRAM

The Monponsett Ponds are mesotrophic-eutrophic lakes with increasing weed problems. They are also receiving excessive sediment loads from the storm drain system. The ponds have been identified as phosphorus limited and are receiving a high level of phosphorus loading from the septic systems which surround the lake. Of the systems investigated in this study, the ones located on the northern shore of East Monponsett in Halifax and on the northern shore of West Monponsett in Halifax and Hanson are primarily responsible for the loading. The following recommended program will provide short-term relief from the weeds and long-term planning for the ultimate reduction of phosphorus loading to the lake.

7.1 In-Lake Recommendations

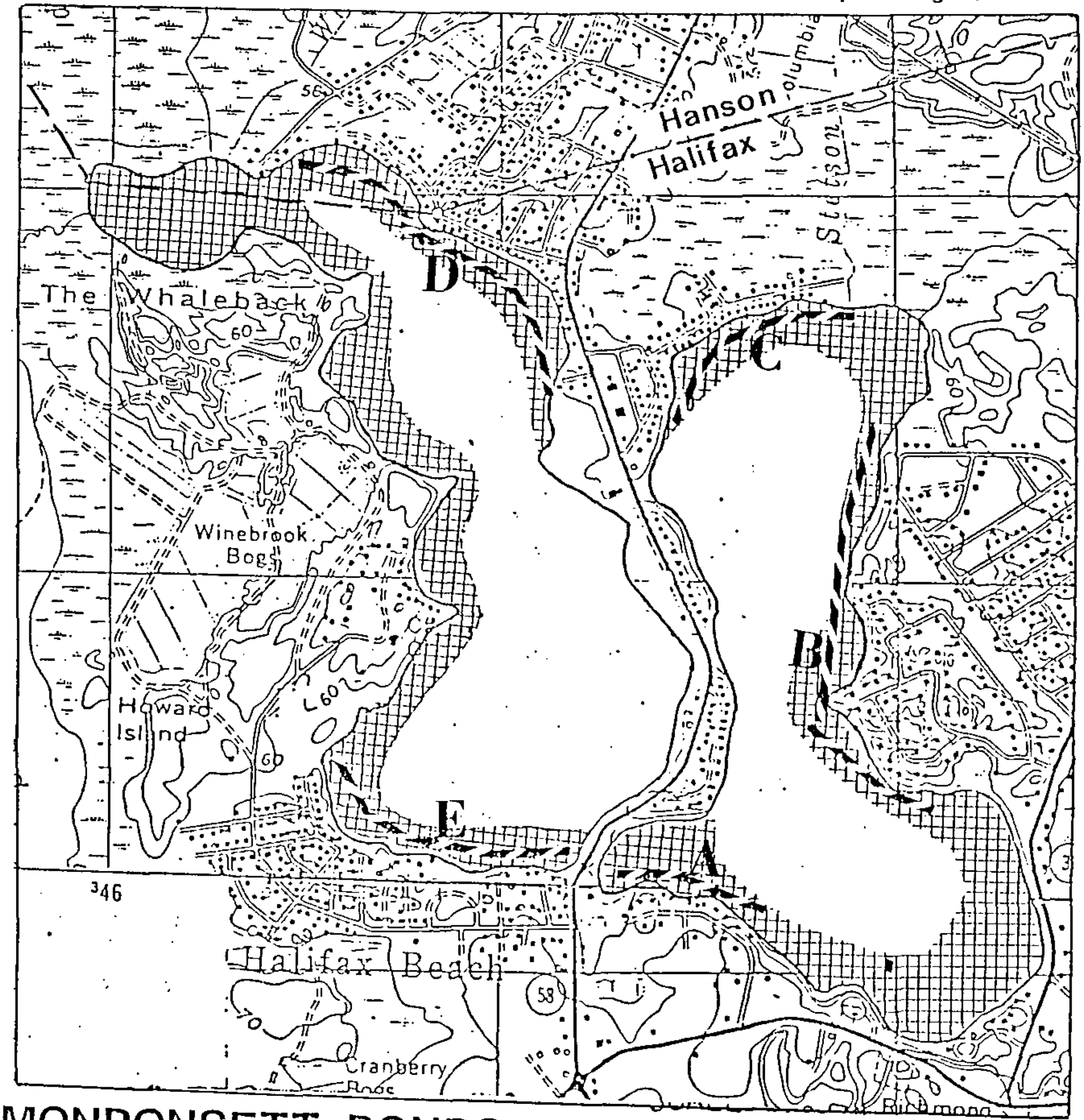
Aquatic weed raking the most dense shoreline stands of aquatic weeds in the Monponsett Ponds would provide local residents with enhanced aesthetics and increased recreational opportunities. The five recommended areas for this raking, denoted A through E, are shown in Figure 7-1. These areas represent the residentially developed portion of the shoreline which is currently suffering from dense growth of aquatic weeds. Table 7-1 gives shoreline lengths, and hours and costs for clearing these areas with a hydrorake. These costs assume that the raked weeds are deposited on individual shorefronts. Additional costs would be incurred if weeds were transported to four or five unloading sites and then trucked to the town landfill.

The total shoreline length recommended for hydroraking is 13,800 feet. At a rate of 50 feet per hour and a per hour cost of $150, the total project cost would be $41,300. The town may wish to select one of these areas as a test shoreline in order to evaluate the hydroraking process and decide whether or not to hydrorake any of the other recommended areas. Weeds can be expected to grow back after one to two years, requiring annual or biannual raking.

The raked weeds must be ultimately deposited in an area outside the watershed to prevent return of plant-stored nutrients to the lake. The weeds have some value as crop fertilizer; thus a local farmer may be willing to accept all or a portion of the cut weeds. If this is not the case, the local landfill is the likely depository for the cut weeds. Transport of weeds to the landfill could be performed by the Town's Department of Public Works.

In conclusion, by aquatic weed raking shoreline areas which are utilized for swimming and other recreation can be cleared for unimpeded use. The recommended hydroraking will provide for more open water areas and greater use of the shoreline

Base map from U.S.G.S. Plympton and Hanover 7.5 minute quadrangles.



MONPONSETT PONDS

AREAS OF AQUATIC WEEDS **AUGUST 15, 1985**
RECOMMENDED HYDRORAKING AREAS

N

aquatic weed density 〉50% **COVERAGE**

recommended hydroraking areas

KILOMETER

1 .5 0

Figure 7-1

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TABLE 7-1

Hydroraking Project Costs

Area[1]	Shoreline length (feet)	Hours of Raking	Cost
A	1,400	27.5	$4,100
B	4,000	80	12,000
C	1,900	39	5,800
D	4,000	80	12,000
E	2,500	49	7,400
Total	13,800	275.5	$41,300

[1]Letters denote areas in Figure 7-1.

areas of the Monponsett Ponds.

7.2 Watershed Recommendations

7.2.1 Sewage Treatment Plant

A community sewage treatment plant in Hanson and associated sewer system are recommended in order to reduce the influx of nutrients into the pond and to control sewage contamination of the storm drainage system. This system would serve the northern shore areas of East and West Monponsett Ponds.

Because of the previously stated house density, difficulty in constructing or reconstructing sewage systems, and the discharge of coliform and nutrients to the Ponds by both ground and surface water, a system of sewers and a sewage treatment plant is the most likely solution to the contamination of the northern sections of East and West Monponsett Pond. Such facilities can reasonably be expected to consist of sanitary sewers, pumping stations, force mains, and treatment works. The treatment works will require tertiary treatment with nutrient removal and carbon absorption and disinfection prior to discharge into the ground. The sewage treatment plant will need to have a capacity of about 65,000 gallons per day to serve an estimated 200+ homes in Hanson and Halifax (Figure 7-2).

The following table gives the project costs of constructing the recommended sewage treatment plant and associated sanitary sewer system.

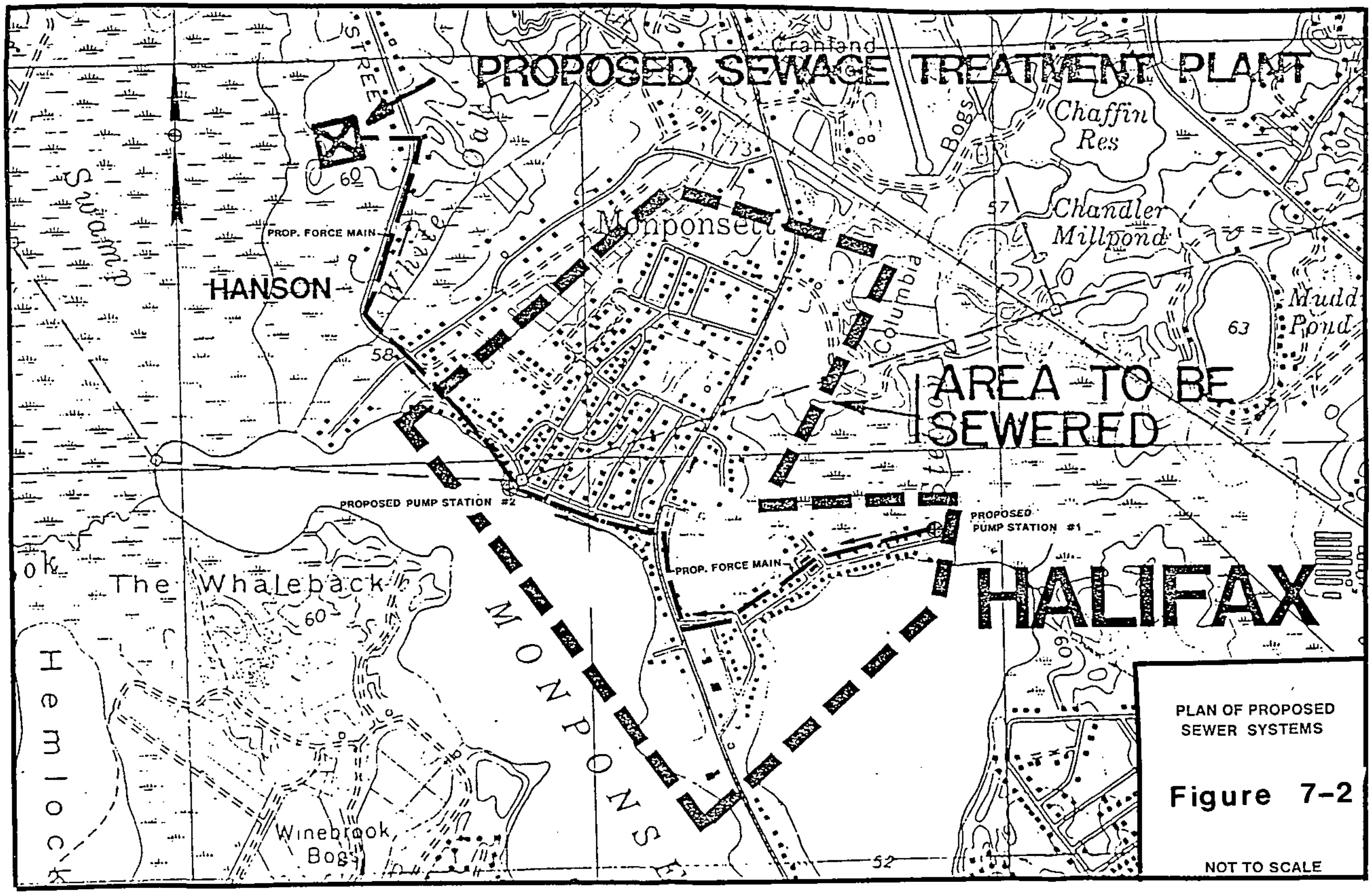
PROPOSED SEWAGE TREATMENT PLANT
Cranland
Chaffin Res
Bogs
Chandler Millpond
Mudd Pond
Monponsett
HANSON
PROP. FORCE MAIN
Swamp
White Oak
Columbia
AREA TO BE SEWERED
PROPOSED PUMP STATION #2
PROPOSED PUMP STATION #1
PROP. FORCE MAIN
HALIFAX
The Whaleback
MONPONSET
Hemlock
Winebrook Bog
PLAN OF PROPOSED SEWER SYSTEMS
Figure 7-2
NOT TO SCALE

TABLE 7-2

COSTS FOR PROPOSED SEWERS AND TREATMENT PLANT

Key Aspect	Initial Capital Cost ($)	Annual Costs for Operation & Maintenance $/year
1. Construct a Rotating Biological Disk Treatment Plant	325,000-455,000	30,000
2. Construct 5000 feet of force main sewer piping system	125,000	
3. Construct two sewage pumping stations at Broadway Road near the Town Line	100,000	1560-1680
4. Construct 20,000 feet of collecting sewers	800,000	
Construction Total	1,350,000-1,480,000	
Engineering Plans, Specifications and Estimates	140,000	

Basis of Costs:

Costs for the treatment plant and associated piping are based on the most recent project bid costs available to G.P.I. Engineering. The basis of the cost for the treatment plant is an estimate of $5.00 to $7.00 per gallon of installation. The cost of the force mains based on an estimate of $25.00 per linear foot. The sewer installation costs are based on an estimate of $40.00 per foot. At this time it is not possible to estimate the costs of acquiring the necessary land rights and utility easements which will be required for the treatment plant. The cost for engineering plans, specifications and bid estimates for the treatment plant and associated pumps and piping is roughly nine to ten percent of the construction cost estimate of $1,350,000 to

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$1,480,000. Under Operation and Maintenance costs, it is estimated that the labor of one half man-year at a wage rate of $15,000 per year and a cost to the town of $30,000/year will be required. The cost for annual operation of two pumping stations is estimated on the basis of power costs of $65.70 per month per station. The total annual cost for operation and maintenance of the sewer system and treatment plant would be roughly $32,000.

The expected nutrient removed through implementation of the community sewer system is roughly 70% of the phosphorus loading from the northern shore areas of East and West Monponsett Ponds. The remaining 30% of the loading is due to lawn fertilization, pet wastes and other diffuse sources (Table 5-5). It is expected that the installation of sanitary sewers would dramatically lower the levels of coliform bacteria contamination of storm drains. It is likely that some residual level of coliform bacteria contamination would remain due to uncontrolled deposition of pet and seagull feces.

Sewering the northern sections of East and West Monponsett Ponds is predicted to lower the in-lake phosphorus level from its current range of 0.021-0.022 g P m^{-3} to a value of 0.018 g P m^{-3} (Section 5.3). Although the reduction is only about 15%, the value of 0.018 g P m^{-3} corresponds to a high mesotrophic condition as compared with the present low eutrophic condition. It is likely that algal blooms would be less frequent and macrophyte growth less extensive after a new post-sewering equilibrium state is reached.

7.2.2 Sand Filters for Storm Drain Outfalls

Because of the high concentrations of suspended solids and coliform bacteria coming into the ponds from storm drains (Table 4-33), it is recommended that from four to a maximum of seven sand filter beds be constructed at the outlets of storm drains. The four largest storm drain outlets are indicated as stations SD1 through SD4 on Figure 2-4 .

Sand filter beds (Figure 6-1) are a proven method of control of sand, silt and larger debris in storm drains. Furthermore, they remove a large percentage of coliform bacteria. They are relatively inexpensive to construct and maintain; the cost is roughly $10 per installed square foot.

If seven filter beds are constructed, the cost could range from $50,000 to $90,000, excluding land acquisition. The lower figure corresponds to a filter size of 700 square feet (20 feet by 35 feet); the upper figure corresponds to a filter size of 1,250 square feet (25 feet by 50 feet).

The expeditious construction of the sand filter beds will improve water quality in the ponds on an interim basis, prior to sewage disposal improvements. It can be expected that the construction of a sewage treatment system to serve the northern ends of the ponds will take much longer to construct than the filter beds due to funding and jurisdictional problems. Relatively long delays are also expected before a program of septic system study and repair would have a beneficial impact on the water quality of the Monponsett Ponds.

Prior to construction of the sand filters, it will be necessary to perform a study to properly size the filters for the maximum expected flow and to draw up engineering plans, specifications and estimates. The cost for this study is expected to be roughly $30,000.

8.0 RECOMMENDED RESTORATION PROGRAM - IMPLEMENTATION INFORMATION AND WORK SCHEDULE

8.1 Sources of Funding

The primary source of funding for the proposed hydroraking for weed control will be through the Massachusetts Clean Lakes Program, Chapter 628. This program is administered by the Lakes Section of the Division of Water Pollution Control in the Massachusetts Department of Environmental Quality Engineering. Funds for implementation of acceptable recommended restoration alternatives are awarded on a 75/25 percent basis between the state and town. Requested annual funds for maintenance activities such as the herbicide treatment are only available if progress on watershed management programs can be documented.

Funding sources for the recommended program of septic system evaluation and sewage treatment plant construction can come from a combination of local, state and federal resources. The cost of the suggested evaluation of septic systems as performed by a private consultant is estimated to be roughly $30,000 on the basis of awarded consultant bids on similarly sized lakes. This contract should specify priority areas for evaluation and identification of failing, improperly designed or improperly constructed systems using colored dyes. First priority would be given evaluation of systems near the lake shore or near street side catch basins. The septic system evaluation program is fundable at the 75 percent level by the Commonwealth under the Clean Lakes Program. The remaining 25 percent must be raised by Halifax (possibly with a contribution from Hanson). All improvements to individual septic systems which are recommended by the feasibility study and adopted by the Boards of Health of Hanson and Halifax would have to be paid for by individual homeowners.

The funding for the proposed treatment plant consists of three distinct, yet intimately connected phases (314 CMR 11.00 Grants for Construction of Wastewater Treatment Facilities). This funding is available under Chapter 286 of the Acts of 1982, which is administered by the Division of Water Pollution Control, Constructions Grants Section. At each step of the application process it is suggested that the Towns of Halifax and Hanson request financial assistance from Brockton. Brockton may wish to provide such financial assistance because the treatment plant, once constructed, would be expected to result in lower water treatment costs to Brockton, for its drinking water pumped from East Monponsett Pond. The first phase, called step 1, is the feasibility study. This study is estimated to cost between $100,000 to $200,000 for a full feasibility study for the Towns of Hanson and Halifax (Al Slater, DEQE, personal communication) and is fundable at the 90% level by the Commonwealth. Prior to the awarding of the Step 1 Grant, Halifax and Hanson must sign an intermunicipal agreement to specify each town's responsibilities for funding and liability insurance. The next phase, called step 2, is for engineering plans, specifications and bid estimates and is also fundable at the 90% state level. The construction of the treatment plant, force mains and pumping stations is called a step 3 project and is also fundable at the 90% level by a combination of state and federal funds or at the 70% level under a recently adopted state program. The 70% state-only funding is available under regulation chapter number 314 CMR 14.00, Supplemental Grants for Construction of Pollution Abatement Facilities, which is administered by DWPC, Construction Grants Section. For each of the three steps it is necessary for Halifax to apply for a grant, be placed on an eligibility list and wait for the application to move into the portion of the list which is fundable under the current state budget. Waiting times on the step 1 and step 2 lists are on the order of months; unfortunately, waiting time on the joint state-federally funded step 3 list can be much longer, on the order of several years. At this time it is believed that waiting times on the 70% state-only list for step 3 funding will be significantly less, perhaps on the order of 6 months to one year.

Construction of a "lateral" collector sewer system is fundable at the 50% level by the state under Massachusetts Chapter 557 of 1979. This grant program is also administered by the DWPC, Construction Grants Section. The Construction Grants Section coordinates the award of step 1, step 2 and step 3 and lateral sewer grants so that projects do not get delayed by failure to be in the funded portion of the eligibility list.

The recommended sand filters to remove sediments from the storm drains are fundable at a state level of 75% under the Massachusetts Clean Lakes Program, Phase II grants. The town share of the study to size and design the filters would be approximately $7,500.

If the town does not appropriate funds for mechanical weed control, it would still be possible for concerned citizens to organize a lake association. The lake association could then work through Representative Charles W. Mann, to get a bill passed in the state legislature which would create a "lake protection district" or other public entity with legal authority to accept public funding through the Clean Lakes Program. This public entity, created for the purpose of lake improvement, would have to obtain liability insurance for any projects which would alter the lake or its watershed. After these steps were taken the lake protection district could apply for 75% state funding for approved lake restoration alternatives under the Clean Lakes Program (Phase II).

8.2 Milestone Work Schedule

The work schedule for the recommended restoration alternatives is given in Tables 8-1 to 8-4.

8.3 Implementation Monitoring Program

During implementation of the recommended hydroraking weed management programs, it is suggested that a program of monitoring be followed.

In order to assess any impact on plant nutrients before and after treatment, samples should be collected monthly during June through September for the following parameters: turbidity, secchi disk depth, total Kjeldahl nitrogen, nitrate nitrogen, ammonia nitrogen, total phosphorus and phytoplankton. Samples should be obtained roughly in the center of each of the five recommended treatment areas. Aquatic macrophytes should be mapped in June, before hydroraking and also post-raking, in July, August and September. The cost for the four rounds of nutrient/phytoplankton sampling at five stations would be $2000. The cost for the program of macrophyte mapping would be approximately $1200.

The documentation of water quality improvements due to stormwater treatment will require that flow-weighted composite samples for total phosphorus and suspended solids be obtained at storm drain outfalls during storm events. Samples should be collected during three storm events prior to filter construction and three storm events after filter construction. The cost for the sample analysis would be roughly $1,500. A likely cost for collection of samples and report generation would also be $1,500. It is recommended that secchi disk depths be routinely monitored at the two bathing beaches during the summer bathing season by either the park department or the Board of Health. Recent rainfall should also be noted. These data would assist in documenting improvements in water quality which could be attributed to stormwater filtration.

If the Towns of Halifax and Hanson plan to perform a septic system evaluation/remediation program and or a community sewering program for northern shore areas, a long term monitoring program should be implemented. The first step in setting up this program would be to identify typical septic system leachate plumes in each of the five proposed weed treatment areas. Selected plumes would be mapped as to width, depth and concentrations of total phosphorus, and fecal coliform bacteria at the lake shore. Groundwater gradient would also be determined from groundwater elevations in at least two wells on a perpendicular line back from the lake shore. Homeowner cooperation would be necessary, since measurements would have to be performed and samples collected on private property. This monitoring would document reductions of leachate transport of phosphorus and bacteria due to septic system corrections or a sewering project. Since the process of leachate migration is relatively slow, measurements would probably be done once a year over the course of a long time period (possibly ten years).

If 10 samples each were collected for total phosphorus and fecal coliform bacteria for each leachate plume, the cost for sample analysis would be $320 per year per leachate plume. If five plumes were monitored the annual cost would be $1,920. A report would cost roughly $500 extra.

Annual monitoring costs for the three recommended Phase II projects and for acidification monitoring are given in Table 8-1.

MILESTONE WORK SCHEDULE - HYDRORAKING

TASK	1987 F M A M J J A S O N D / 1988 J F M A M J J A S O N D	START	FINISH
- Town officials decide on priority areas; Town - submits Phase II grant application to D.E.Q.E. Clean Lakes Program	———	3/87	10/1/87
- Town raises local matching funds for Phase II grant and obtains approval from the Conservation Commission	———	10/1/87	5/1/88
- Contracted Hydroraking and monitoring	———	6/88	9/88

MILESTONE WORK SCHEDULE - STORMWATER TREATMENT

TASK	1987 M A M J J A S O N D	1988 J F M A M J J A S O N D	1989 J F M A M J J A S O N D	START	FINISH
- Town selectmen apply to the C.L.P. of D.E.Q.E. for a Phase II grant to size and design sand filters.	———			3/87	10/1/87
- Town raises local matching funds for Phase II grant.	———	———		10/1/87	5/1/88
- Contacted hydraulic study and design of sand filters.		———	———	6/1/88	7/1/89

continued on next page

MILESTONE WORK SCHEDULE - STORMWATER TREATMENT

TASK	1989 J M M A M J J A S O N D	1990 J F M A M J J A S O N D	START	FINISH
- Town selectmen apply to D.E.Q.E. C.L.P. for a Phase II grant for filter construction			5/1/89	10/1/89
- Town raises local matching funding for Phase II grant and obtains approval from the Conservation Commission			10/1/89	5/1/90
- Contracted stormwater monitoring			5/89	10/90
- Contracted construction of sand filters.			6/1/90	11/1/90

MILESTONE WORK SCHEDULE - SEPTIC SYSTEM STUDY

TASK	1987 M A M J J A S O N D	1988 J F M A M J J A S O N D	1989 J F M A M J J	START	FINISH
- Halifax Selectmen and Board of Health submit Phase II C.L.P. grant application				3/87	10/1/87
- Halifax signs inter-municipal agreement with Hanson and raises local matching funds.				10/1/87	5/1/88
- Contracted study				6/1/88	1/1/89
- Halifax Board of Health action to bring septic systems into compliance.				1/1/89	?

MILESTONE WORK SCHEDULE - SEWAGE TREATMENT PLANT

TASK	1987 M A M J J A S O N D / 1988 J F M A M J J A	START	FINISH
- Halifax and Hanson agree to pursue the construction of a treatment plant; the two towns sign an intermunicipal agreement and write a letter of application to D.E.Q.E.'s Construction Grants Section (CGS)		3/87	3/87
- Halifax hires engineering consultant; consultant meets with CGS to establish the "scope of services" for the Step I study		4/87	5/87
- Halifax raises the local matching funds for the Step I study		5/87	6/87
- Step I grant application processed by D.E.Q.E.		6/87	8/87
- Contracted Step I study		8/87	8/88

MILESTONE WORK SCHEDULE - SEWAGE TREATMENT PLANT

TASK	1988 J A S O N D	1989 J F M A M J J A S O N D	1990 J F M A M J J A S	START	FINISH
- Halifax raises the local matching funds for the Step II study.				8/88	9/88
- Step II grant application processed by D.E.Q.E.				9/88	11/88
- Contracted Step II study.				11/88	11/89
- Halifax raises the local matching funds for lateral sewer construction and for step grant.				11/89	1/90
- Step III grant application processed by D.E.Q.E.				1/90	12/90
- Construction of sewers and sewage treatment plant.				12/90	12/91

TABLE 8-1

ANNUAL MONITORING COSTS

Phase II Project	Monitoring Cost ($)
Hydroraking	3,700
Stormwater Treatment	3,000
Septic System Corrections	2,500

8.4 Public Participation Section

During the course of the diagnostic/feasibility study, three public meetings were held. The meetings were all advertised in the Halifax Reporter and were open to the interested public. During the first meeting on April 24th, 1985, Paul Sommer, the project manager for Lycott, outlined the elements of the study including an overview of the techniques for lake maintenance and restoration. The second meeting was held on August 21, 1985, after five months of data had been collected. Paul Sommer discussed the data and the preliminary assessment of the lake's trophic state.

The diagnostic study results and restoration recommendations which were included in the draft final report were presented at the public meeting held on August 26, 1986. Alexander Duran of Lycott presented the results of the diagnostic study and Roger Rondeau of G.P.I. Engineers presented the restoration recommendations for the watershed including stormwater treatment and sewering the northern shore area. At that time, hydro-raking was the recommended weed management technique. An attendance record was kept: there were 106 citizens in the audience including the DWPC project officer, Dr. Rick McVoy, E. Raymond Blood from the Halifax Board of Health, Edward O'Brien, Jr. from the Halifax Conservation Commission, William Riley of the Halifax Park Commission, Michael Paulson of the Quincy Patriot-Ledger newspaper and Ida Raduc of the Halifax Reporter newspaper. A number of people at the meeting voiced concern over the safety of swimming due to the heavy weed growth in the ponds. The general consensus appeared to be that Brockton should help defray the cost of the proposed cleanup since it would receive benefits if the water quality were improved. There was a discussion concerning the question of septic system problems in homes near the ponds. Many town residents felt there were septic system operational problems in certain areas. Some respondents suggested that Brockton draw down the water-level of the ponds over the winter months since they already owned and operated the diversion structure and aqueduct leading from East Monponsett Pond to Silver Lake.

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9.0 ENVIRONMENTAL EVALUATION AND PERMIT IDENTIFICATION

This section evaluates environmental impacts for each of the proposed implementation alternatives and describes mitigative measures for adverse impacts.

The Halifax Conservation Commission and also the Massachusetts Historic Preservation Commission have been contacted and informed of the proposed watershed projects to control pollution of the ponds. According to the Massachusetts Historic Preservation Commission, there are numerous prehistoric sites near the shores of the Monponsett Ponds. An archaeological survey would have to be completed before the commencement of any watershed project which involved construction. This would include construction of sand filters for storm drains and construction of sewers, pumping stations and a sewage treatment plant.

HYDRORAKING

The most significant impact which could result from the proposed hydroraking project include:

- short-term turbidity
- plant fragments washing onto beach areas
- removal of small fish entangled with the weeds
- insect and odor problems associated with decaying weeds

Because the hydroraking is limited to a relatively small portion of the Monponsett Ponds, negative effects on the water quality in the ponds would be expected to be minor. A certain amount of turbidity will inevitably result from the process of removal of weeds and roots but in most cases it will dissipate within a period of several hours.

Impacts to fish spawning would be minimized if operation did not start until June, after spring spawning. Turbidity could be contained within the work area by the installation of silt curtains attached to bouys, but the small magnitude of the problem doesn't justify the expense involved. The silt curtains would also serve to contain floating fragments of Cabomba which could be washed up on beach areas. We recommend that the work schedule be geared to the orientation of the prevailing wind with respect to the beach area. Hydroraking should not occur in an area where the wind will carry fragments directly towards a public beach area.

The best way to minimize insect and odor problems associated with decaying vegetation is to minimize the periods during which the piles of removed vegetation are allowed to remain on shore. This could be accomplished by using a centralized collection point, and trucking of all hydroraked material to the Halifax Landfill at the end of each working day. The use of the state boat ramp on West Monponssett and the town-owned boat ramp on East Monponssett as collection points are recommended. In order for hydroraking to proceed without interruption during the workday, two self-propelled weed transport barges should work as a team, to ferry the hydroraked material from the work site to the off-loading site at the boat ramp. At the off-loading site, a backhoe could transfer the hydroraked material from the barge to a large "dumpster" container which can then be trucked to the landfill.

Hydroraking can inadvertently remove small fish which become trapped in the weeds as they are raked up. There is no evidence that this type of problem has ever had a major negative impact on a lakes fishery. The majority of the the trapped fish are generally the slower moving sunfish, bullheads and perch; few bass are generally trapped.

Minor spillage of fuels, lubricants and hydraulic fluids can occur in any operation with mechanized equipment. Proper maintenance and inspection procedures should minimize these problems.

CONSTRUCTION

The major environmental impact associated with the construction of open-sand filter basins for storm water treatment is the erosion from the construction site during construction and assocated sedimentation in the storm-drain depositional area in the pond. Control practices for construction sites can be divided into two categories: Those that require little cost for implementation but require timing and coordination with construction activities; and those that require some financial resourses but can be implemented at some time during construction.

No-cost practices include:

Storing excavated soils at a reasonable distance from any drainage channels or structures, thereby increasing the distance that eroded soil must travel to reach the drainage channel or structure.

Use only one route (preferably the future service road) to approach the building site with trucks and heavy construction equipment. The approach road should be covered by gravel.

Rough grading the construction site as soon as possible after excavation, eliminating soil mounds that are easily eroded.

Removing excess soil from the sites as soon as possible after back filling, reducing erosion of surplus fill.

Other practices include:

Cleaning streets frequently in the construction site zone and removing the sediment from the curbs.

Vegatative measures for controlling erosion and sedimentation from construction sites include the use of cover crops, both temporary and permanent, and mulches.

a. Stabilizing moderate slopes: Areas of moderate slopes and fertile soils can be easily stabilized by establishing hardy ground cover plants. During land use changes a temporary cover is sufficient and, at the completion of the change, more permanent cover crops should be used.

b. Stabilizing critical areas: Sites that have exposed subsoil, steep slopes, shallow depth to bedrock, drought conditions, or other limiting properties require additional treatment. Special attention must be given to seed bed preparation, fertility levels,supplemental irrigation, adapted seedlings or plantings, and site protection until the vegetative cover is established.

c. Mulching: Mulch can be used to protect constructed slopes and other areas brought to final grade at an unfavorable time for seeding. The area can be seeded when the weather permits without removing the mulch. Mulch is essential in protecting bare areas and in establishing good stands of grasses and legumes on steep cut-and-fill slopes and other areas where it is difficult to establish plants. By reducing runoff, mulch allows more water to infiltrate the soil. It also reduces the loss of soil moisture by evaporation; holds seed, lime, and fertilizer in place; and reduces seedling damage from heaving of the soil caused by freezing and thawing.

The materials most widely used for mulching are small-grain straw, hay, and certain commercially processed materials.

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APPENDIX F

Septic System Phosphorus Loading and System Life Calculations

East Monponsett Pond

Assumptions:

1. 3.0 bedrooms (br) per residence (LYCOTT questionnaire)
2. 110 gallons per day (gpd)/br (Massachusetts Sanitary Code).
3. 14.6 mg/liter total phosphorus in septic effluent (U.S. EPA, 1977).
4. 10.4 month/yr average residency period (LYCOTT questionnaire)
5. 2-8 minutes per inch percolation rate for Merrimack soil (Veneman, 1982; Massachusetts Sanitary Code).
6. 1-1.6 sq ft/gpd bottom leaching area (Massachusetts Sanitary Code)
7. 0.010-0.014 lb P/ft^3 phosphorus adsorption capacity for Merrimack soil (Michigan DNR, 1973).

Phosphorus loading per residence:

(3.0 br) x (110 gpd/br) x (3.78 l/gal) x 14.6 mg P/l) X (316 day/yr)

= 5.8 kg P/yr
= 12.7 lb P/yr

Adsorption capacity for septic system located 10 feet above the water table:

(3.0 br) X (110 gpd/br) X (1-1.6 sq ft/gpd) X (10 ft) = 3300 - 5280 ft^3

(3300 - 5280 ft^3) X (0.010 - 0.014 lb P/ft^3) = 33-74 lb P

Useful lifetime of system for phosphorus adsorption:

$$\frac{33 - 74 \text{ lb P}}{12.7 \text{ lb P/yr}} = 2.6 - 5.8 \text{ yr}$$

West Monponsett Pond

Assumptions:

1. 2.5 bedrooms (br) per residence

2., 3., 5., 6., 7. same assumptions as for East Monponsett Pond.

4. 12 month per year average residency period (LYCOTT

questionnaire)

Phosphorus loading per residence:

(2.5 br) X (110 gpd/br) X 3.78 l/gal) X (14.6 mg P/liter) X (365 day/yr)

= 5.5 kg P/yr
= 12.1 lb P/yr

Adsorption capacity for septic system located 10 feet above the water table:

(2.5 br) X (110 gpd/br) X (1-1.6 sq ft/gpd) X (10 ft) = 2750 -4400 ft^3

(2750-4400 ft^3) X (0.010-0.014 lb P/ft^3) = 27.5 - 61.6 lb P

Useful lifetime of system for phosphorus adsorption

$$\frac{27.5 - 61.6 \text{ lb P}}{12.1 \text{ lb P/yr}} = 2.3 - 5.1 \text{ yr}$$

Causeway Between Lakes

Assumptions:

1. - 7. same as for West Monponsett Pond

Phosphorus loading per residence: 5.5 kg P/yr (12.1 lb P/yr)

Useful lifetime of system for phosphorus adsorption: 2.3 -5.1 yr.

LYCOTT

APPENDIX G

Phosphorus Load from Septic Systems Determination

East Monponsett Pond

1. Average distance between septic systems and lake shore is 132 ft. (LYCOTT questionnaire).
2. 114 homes within 264 ft. of shore line (U.S.G.S. Plympton and Hanover Quadrangles).
3. 28% of septic systems located within 10 ft. above the lake level (LYCOTT questionnaire).
4. Average phosphorus load per residence is 5.8 kg P/yr (Appendix L)
5. 96% of septic systems are older than 5 years (LYCOTT questionnaire).

Annual Phosphorus Load from Septic Systems:

(114 residences) X 0.28 x (5.8 kg P/residence-yr) X 0.96

= 177 kg P/yr.

LYCOTT

West Monponsett Pond

Assumptions:

1. Average distance between septic systems and lake shore is 125 ft. (LYCOTT questionnaire).
2. 116 homes within 250 ft. of shoreline (U.S.G.S. Plympton and Hanover Quadrangles).
3. 38% of septic systems located within 10 ft. above the lake level (LYCOTT questionnaire).
4. Average phosphorus load per residence is 5.5 kg P/yr. (Appendix L).
5. 77% of septic systems are older than 5 years (LYCOTT questionnaire).

Annual Phosphorus Load from Septic Systems:

(116 residences) X 0.38 X (5.5 kg P/residence-yr) X 0.77

= 187 kg P/yr

LYCOTT

Causeway Between Lakes

Assumptions:

1. Average distance between septic systems and lake shore is 146 ft. (LYCOTT questionnaire).
2. 41 homes within 292 ft. of shoreline (U.S.G.S. Plympton and Hanover Quadrangles).
3. 7% of septic systems within 10 ft. above the lake level (LYCOTT questionnaire).
4. Average phosphorus load per residence is 5.5 kg P/yr (Appendix L)
5. 89% of septic systems older than 5 years.

Annual Phosphorus Load from Septic Systems:

(41 residences) X 0.07 X (5.5 kg P/residence-yr) X 0.89

= 14 kg P/yr

APPENDIX H

Volume Weighted Mean Monthly Phosphorus Concentrations*

Month	East Monponsett Pond Station 1	West Monponsett Pond Station 1
January	0.015	0.017
February	0.0063**	0.010
March	0.0053**	0.005
April	0.013	0.012
May	0.057	0.010
June	0.025	0.03
July	0.020	0.022
August	0.0081**	0.03
September	0.033	0.04
October	0.024	0.018
November	0.039	0.021
December	0.020	0.04
Mean	0.022	0.021
Standard Deviation	0.014	0.011

*gm P m^{-3}. Surface and deep concentrations were averaged with a weighting ratio of 3 to 1 (surface to deep).

**in averaging "<" values, where a concentration was less than the method limit of detection, the assumed "true" value was taken to be one-half of the limit of detection.

APPENDIX I

Calculation of Reckhow Model Parameters

Areal Water Loading (q_s):

$$q_s(m) = \frac{V_{in}}{A}$$

where V_{in} is the water load from direct rainfall and from watershed runoff = 5.78×10^6 m^3/yr (See Table 5-3)

A is the lake area = $2.12 \times 10^6 m^2$ (See Table 3-1)

$$q_s = \frac{7.06 \times 10^6}{2.12 \times 10^6} \text{ m yr}^{-1} = 3.32 \text{ m yr}^{-1}$$

Areal Phosphorus Loading (L):

$$L \; (g\ P\ m^{-2}\ yr^{-1}) = \frac{P_{in}}{A}$$

where P_{in} is the total amount of phosphorus delivered to the lake on an annual basis = 793 kg yr^{-1} (see Table 5-7).

$L = 0.37$ g P m^{-2} yr^{-1}

Predicted Phosphorus Concentration [P]:

$$[P] \; g \; m^{-3} = \frac{L}{11.6 + 1.2\, q_s}$$

$[P]$ g m^{-3} = 0.024

Effect of sewering on Trophic State:

Amount of phosphorus loading removed by sewering the northern shores of East and West Monponsett Ponds:

$P = 76.5 + 98.6 = 175.1$ kg yr^{-1} (from Table 5-6)

Post-sewering areal phosphorus loading:

$$\frac{618 \text{ kg yr}^{-1}}{2.12 \times 10^6 \text{ m}^2} = 0.291 \text{ g P m}^{-2} \text{ yr}^{-1}$$

LYCOTT

Post sewering predicted phosphorus concentration:

$$[P]\ g\ m^{-3} = \frac{0.291\ g\ \ P\ m^{-2}\ yr^{-1}}{15.58\ m\ yr^{-1}} = 0.018$$

APPENDIX J

Sonar Treatment for the Monponsett Ponds

Sonar Management of Aquatic Weeds

Of the aquatic weeds identified in the Monponsett Ponds (Figure 4-7), SONAR is effective in controlling the following:

- Common duckweed (*Lemna minor*)
- Yellow water-lily (*Nuphar* spp.)
- White water-lily (*Nymphaea* spp.)
- Pondweed (*Potamogeton* spp.)
- Watermilfoil (*Myriophyllum* spp.)
- Fanwort (*Cabomba caroliniana*)

SONAR provides partial control of the following aquatic weeds:

- Bulrush (*Scirpus* spp.)
- Arrowhead (*Sagittarius* spp.)
- Cattail (*Typha* spp.)

Source: ELANCO (1986)

It is important to maintain the maximum concentration of SONAR in contact with the weeds as long as possible. Rapid water movement or any condition which results in rapid dilution of SONAR treated water will reduce its effectiveness. SONAR is best applied after spring runoff and prior to weed growth or when weeds begin actively growing.

The EPA has provided full labeling for "Sonar". However, approval for a secondary water supply would require a special permit from the state. "Sonar," according to the manufacturer, has been used extensively in the midwestern and southeastern United States in controlling many different types of aquatic plants, including fanwort.

Only state licensed supervisory personnel should be involved in conducting any herbicide treatments, and it is strictly illegal for anyone to introduce chemicals into the waters of Massachusetts without being licensed and without acquiring a permit from the Commonwealth.

The cost of herbicide management of the Monponsett Ponds will vary from year to year, depending on the quantities of aquatic vegetative growth and the relative species composition.

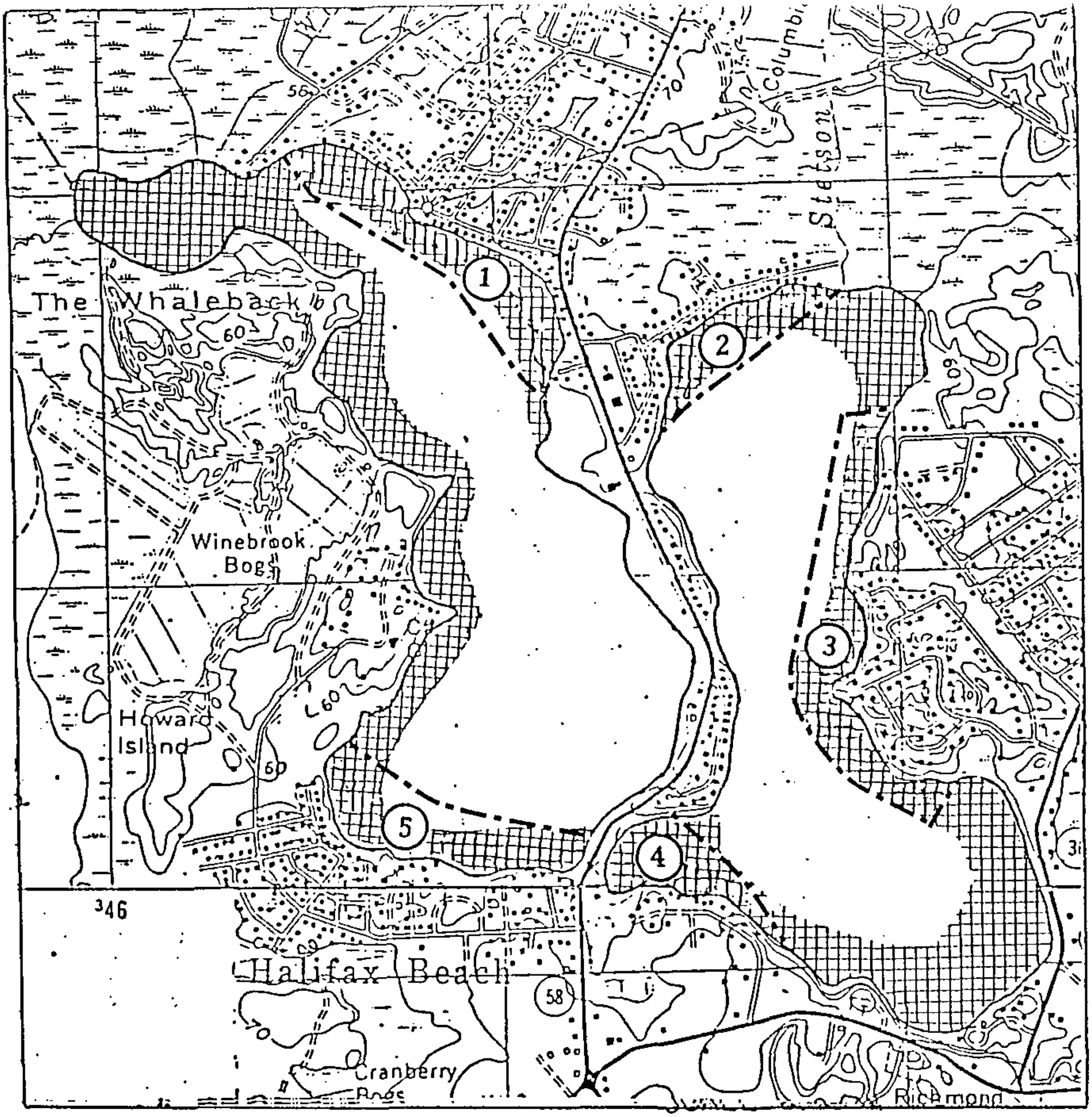
Sonar, the herbicide proposed to be used in the Monponsett Ponds, has been thoroughly tested and has a minimal effect on the aquatic environment. Tests have been conducted to assess the product's safety for use by humans, for wildlife exposure and for side effects on environmental quality. The test results indicate a very low order of toxicity to mammalian species following acute, subchronic or chronic exposure. In addition, large repeated doses of Sonar did not result in the development of tumors, impairment of reproduction or abnormal effects on the development of offspring.

Sonar has been tested in acute and chronic laboratory studies in birds, fish and invertebrates. In laboratory tests the 96 hour LC_{50} (lethal concentration) for fish such as trout, blue gills, catfish and minnows ranges from 4.2 to 22 ppm. This is approximately 42-220 times the concentration at the recommended dosage rate. Some invertebrates are more sensitive than fish. The 48 hour LC_{50} values for daphnia and midge larvae are 4.4 and 1.3 ppm respectively. By comparison the Sonar concentration after uniform distribution at the recommended dosage rate is roughly 0.08 ppm. Chronic studies were also conducted with amphipods, daphnia and midges. A concentration of 0.6 ppm had no effect on the growth or survival of amphipods or on the emergence of adult midge. Reproduction of daphnia was not affected by a concentration of 0.2 ppm.

In studies with mallards and quail, maximum concentrations of 5,000 ppm in the diet of young birds of both species caused no mortality.

Sonar treatment of developed shoreline areas should be used as a management technique for weed control until the long term plan for reduction of phosphorus loading from the watershed can be implemented. Herbicide treatment will be required every year or two but after the first treatment it is likely that subsequent treatments could be less extensive and less costly.

Five different areas of the Monponsett Ponds are recommended for treatment with SONAR (Figure 0-1). These areas were selected on the basis of the density of weed coverage and the proximity to developed shoreline areas. The total area recommended for treatment is 91 acres. Using a cost factor of $500 per acre (Lee Lyman, personal communication), the total cost would be $45,500 (Table 7-1).

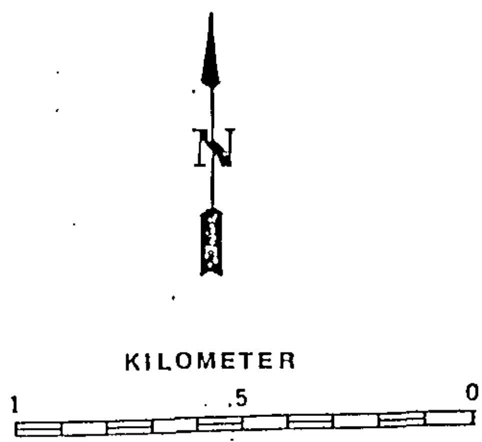


MONPONSETT PONDS

AREAS OF AQUATIC WEEDS
RECOMMENDED SONAR TREATMENT AREAS

aquatic weed density 〉50% (August 1985)

(1) recommended SONAR treatment areas



LYCOTT

Figure α-1

COSTS FOR SONAR TREATMENT OF THE MONPONSETT PONDS

Area #[1]	Description	Size (acres)	Average Depth (meters)	Cost ($)
1	N.E. shore of West Monponsett	19	1	9,500
2	N.W. shore of East Monponsett	14	0.8	7,000
3	E. shore of East Monponsett	29	1	14,500
4	S.W. shore of East Monponsett	10	2	5,000
5	S. shore of West Monponsett	19	0.8	9,500
	TOTAL	91		$45,500

[1] area #'s refer to Figure 0-1.

LYCOTT

APPENDIX K

Black-Water Handling Alternatives

a. Compost Systems

Compost toilets decompose human wastes by a natural biological process over an extended period of time. The process is identical to the composting of leaf and manure piles for garden and agricultural soil enrichment. The two (2) basic types of compost systems involve a) a large compost chamber called an external unit that must be installed in the basement or underground; and b) a smaller chamber called an internal unit completely within the bathroom. The larger external units rely on natural processes without external heat addition or composting aids. The addition of heat and compost aids (such as a starter bed or enzymes) speeds the degradation process, thereby decreasing the required volume in the smaller units. The basic treatment process is the same for each type, but occurs more quickly in the internal unit because of the external aids. Toilet wastes enter the external type through a toilet chute and accumulate in the compost chamber. The waste decomposes with air supplied through ventilation, warm temperatures and humidity. Organic material, such as food wastes, should be introduced to aid in the composting process. The process creates minor odors which must be removed by outside ventilation and evaporation. Flies and other insect production can occasionally be a problem.

Total decomposition time ranges from 1-1/2 to 2 years initially and from 3 to 12 months thereafter. The wastes will then have been reduced to a rich, odorless humus for possible use as a garden soil supplement. Periodic removal of the humus is the only required maintenance for external units. The amount of humus produced varies with the system and ranges from 15 to 60 pounds per capita per year.

Electricity is required for heating and ventilation in most internal units. Most external units utilize convection currents for ventilation. Humus toilets (so called Clivus Multrum toilets) whereby solids, and household garbage are deposited in specially designed and vented pits are allowed to decay into humus and periodically emptied and disposed of into the soil are sometimes approved by DEQE. However, grey water, from baths, cooking, washing machines, etc., need to be disposed of into a separate sub-surface sewage disposal system built in accordance with Title Five of the State Environmental Code. Thus, humus toilets cannot be considered a substitute for a properly operating sub-surface septic system (310 CMR, Section 15.17).

The main disadvantages of the compost system are that it requires nutrient cycling back onto the land and it does not handle gray water. Therefore, this type of system will not prevent nutrients from entering into the Monponsett Ponds.

b. Recycle Systems

A recycle system is a self-contained package treatment unit specifically designed to transport black water by means of vacuum, to a self-contained unit where treatment occurs by a combination of anaerobic and aerobic decomposition, settling, filtering and disinfection by ultraviolet light.

This treatment process operates efficiently at temperatures between 55 degrees F and 120 degrees F. Effluent is returned to a holding tank for reuse as flushing water. The recycle toilet consumes 300 to 500 kWh of electricity (100 volts AC) per month of operation. Regular maintenance and periodic replacement of some parts are required. Cultured bacteria must be added periodically in the form of dry packets to accelerate digestion of solids. Activated carbon in the filtering system, the ultraviolet lamp bulb used in disinfection, the air filter cartridges on the vacuum and aeration pumps and a three-way solenoid valve regulating vacuum and aeration usually require annual replacement.

This type of system is not recommended because the initial costs are high; the operation and maintenance costs are significant; the system is susceptible to treatment problems resulting from shock loads and the system will not significantly reduce the nutrient contamination of the pond.

c. Incinerator Toilets

The incinerator toilet is a waterless toilet which operates via an electric radiant or gas heater that burns wastes, leaving only an ash. Some models require that the toilet bowl be lined with a wax paper liner prior to every use. Proper venting also is necessary. A cycle time of 20 minutes per use is generally allowed for complete incineration of wastes. Operation and maintenance is minimum, unless replacement of parts, such as the radiation unit, is needed. Maintenance includes periodic emptying of the ash pan, as well as cleaning of the bowl, blower housing, ventline and interior of the housing. Electricity or gas is required to operate the heater and vent blower.

Incinerator toilets are susceptible to frequent mechanical failures and may substantially reduce the air quality if the incineration process is not controlled properly. Therefore, this system is not recommended.

d. Low-Flush Toilets

Low-flush toilets are commercially available. These units utilize from one quart to two gallons of water instead of the average 5 to 8 gallons used by a standard flush toilet. A limited capacity, self-contained tank controls the volume of flushing water. Air in the tank is compressed as it is filled with water. When flushed, the compressed air forces the water through the toilet bowl at a rapid rate, thereby requiring a low volume to empty the bowl.

Other low-water flush toilets involve mechanical equipment and use either vacuum or pressure to empty the toilet bowl. The basic components for a one-toilet vacuum system are the toilet itself, plumbing at all times. A valve separates the toilet bowl and the plumbing. When activated, the valve opens, allowing the contents of the toilet bowl to be drawn into the plumbing. These wastes remain under vacuum until they reach the holding or discharge tank. The maintenance required is minimal, but mechanical equipment is involved to maintain the pressure or vacuum. Although the water content is lowered, the amount of organics, solids and toxic constituents remain the same as with the conventional flush toilet. Therefore, contaminants are more concentrated in the lower volume of wastewater, and the net result is that the same amount of pollutants would enter the groundwater with this system, as it would with conventional flush toilets.

APPENDIX L

Public Education Materials

The following publications on lake problems and methods of restoration are written for a general audience:

"Detergents and Your Lake"
"Septic Systems and Your Lake"
"Fertilizers and Your Lake"

The three publications listed above are available from:

Lakes Section
Division of Water Pollution Control
Westview Building, Lyman School
Route 9
Westborough, MA 01581
(617) 366-9181

"Mechanical Control of Aquatic Weeds"

This report is available from:

Bureau of Preserve, Protection and Management
Room 412
New York State Department of Environmental Conservation
50 Wolf Road
Albany, New York 12233-0001

"Clean Lakes and Us"

This report is available from:

Frank Lapensee
Criteria and Standard Division
U.S.E.P.A.
401 M St. S.W.
Washington, D.C. 20460
(202) 382-7105

APPENDIX A
FIELD RESULTS

MONPONSETT PONDS
Field Results

Collection Date: 4/18/85   Weather: overcast, light wind

Secchi: 1.2 meters

East Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (^{o}C)	Dissolved Oxygen (mg/liter)
0	11.0	4.6
1	11.0	3.0
2	11.0	2.1
3	17.0	3.8

MONPONSETT PONDS
Field Results

Collection Date: 5/29/85

Weather: Clear, NW wind, 60's

Secchi: 1.6 meters (East Monponsett)
1.1 meters (West Monponsett)

East Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (°C)	Dissolved Oxygen (mg/liter)
0	20.0	6.45
1	20.0	6.25
2	19.8	1.8
3	19.8	1.9

West Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (°C)	Dissolved Oxygen (mg/liter)
0	20.2	6.7
1	20.2	2.7
2	20.1	2.15
3	19.9	1.9

MONPONSETT PONDS
Field Results

Collection Date: 6/11/85 Weather: Clear, calm, 70's

Secchi: 1.7 meters (East Monponsett)
1.6 meters (West Monponsett)

East Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (°C)	Dissolved Oxygen (mg/liter)
0	23.0	6.2
1	21.5	2.9
2	21.0	2.25
3	21.0	2.25

West Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (°C)	Dissolved Oxygen (mg/liter)
0	23.1	4.0
1	22.5	3.0
2	20.5	2.1
3	21.5	2.4

MONPONSETT PONDS
Field Results

Collection Date: 7/8/85 Weather: Partly cloudy, light wind

Secchi: 2.5 meters (East Monponsett)
2.0 meters (West Monponsett)

East Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (°C)	Dissolved Oxygen (mg/liter)
0	25.0	5.6
1	24.8	2.6
2	20.1	2.1
3	21.0	2.1

West Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (°C)	Dissolved Oxygen (mg/liter)
0	25.0	6.0
1	25.0	5.0
2	18.0	2.0
3	25.0	3.8
4	18.2	3.5

MONPONSETT PONDS
Field Results

Collection Date: 8/13/85 Weather: Fair, calm, 80°s

Secchi: 1.5 meters (East Monponsett)
1.2 meters (West Monponsett)

East Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (°C)	Dissolved Oxygen (mg/liter)
0	27.0	5.0
1	26.0	3.7
2	25.5	2.7
3	25.0	2.5

West Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (°C)	Dissolved Oxygen (mg/liter)
0	27.0	4.8
1	26.5	3.5
2	25.0	2.3
3	25.0	2.1

MONPONSETT PONDS
Field Results

Collection Date: 8/28/85

Weather: Clear, 70's, Brisk west wind

Secchi: 1.10 meters (East Monponsett)
1.22 meters (West Monponsett)

East Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (°C)	Dissolved Oxygen (mg/liter)
0	23.5	9.3
1	23.0	4.5
2	23.0	3.5
3	23.0	3.0

West Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (°C)	Dissolved Oxygen (mg/liter)
0	24.5	6.6
1	24.5	4.4
2	23.5	3.4
3	23.0	2.5

MONPONSETT PONDS
Field Results

Collection Date: 9/11/85

Weather: Mostly sunny, west wind, 65°

Secchi: None; water surface too rough to make measurement.

East Monponsett
In-lake (Station 1)

Depth (meters)	Temperature ($^{\circ}$C)	Dissolved Oxygen (mg/liter)
0	21.0	8.0
1	21.0	4.2
2	21.0	3.1
3	21.0	3.1

West Monponsett
In-lake (Station 1)

Depth (meters)	Temperature ($^{\circ}$C)	Dissolved Oxygen (mg/liter)
0	21.0	7.5
1	20.5	4.0
2	20.5	3.0
3	20.5	2.7

MONPONSETT PONDS
Field Results

Collection Date: 9/26/85

Weather: Overcast, east wind

Secchi: 2.4 meters (East Monponsett)
1.5 meters (West Monponsett)

East Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (^{o}C)	Dissolved Oxygen (mg/liter)
0	22.0	8.3
1	*	*
2	*	*
3	*	*

West Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (^{o}C)	Dissolved Oxygen (mg/liter)
0	22.0	8.3
1	22.0	*
2	*	*
3	*	*

*Van Dorn bottle broke.

MONPONSETT PONDS
Field Results

Collection Date: 10/10/85 Weather: Overcast, NW wind, 65^{O}

Secchi: 2.29 meters(East Monponsett)

East Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (^{O}C)	Dissolved Oxygen (mg/liter)
0	18.0	8.8
1	17.0	8.7
2	17.0	8.5
3		

West Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (^{O}C)	Dissolved Oxygen (mg/liter)
0	17.0	9.3
1	17.0	9.2
2	17.0	9.0
3		

MONPONSETT PONDS
Field Results

Collection Date: 10/23/85 Weather: Fair, west wind

Secchi: 2.4 meters(East Monponsett)
2.1 meters(West Monponsett)

East Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (°C)	Dissolved Oxygen (mg/liter)
0	13.0	10.0
1	13	10
2	13	10
3	13.0	10.0

West Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (°C)	Dissolved Oxygen (mg/liter)
0	13.0	9.2
1	*	*
2	*	*
3	*	*

*YSI meter not functioning properly.

MONPONSETT PONDS
Field Results

Collection Date: 11/13/85 Weather: Overcast, west wind

Secchi: 2.4 meters (East Monponsett)
2.25 meters (West Monponsett)

East Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (°C)	Dissolved Oxygen (mg/liter)
0	10.5	12.0
1	10.5	12.0
2	10.5	12.2
3	10.5	12.8

West Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (°C)	Dissolved Oxygen (mg/liter)
0	10.0	12.2
1	10.0	11.8
2	10.0	11.6
3	10.0	11.2

MONPONSETT PONDS
Field Results

Collection Date: 11/25/85

Weather: Fair, 42°

Secchi: 2.7 meters (East Monponsett)
2.7 meters (West Monponsett)

East Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (°C)	Dissolved Oxygen (mg/liter)
0	7.0	11.6
1	7.0	11.6
2	7.0	11.6
3	7.0	12.0

West Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (°C)	Dissolved Oxygen (mg/liter)
0	7.0	11.8
1	7.0	11.6
2	7.0	11.8
3	7.0	11.8

MONPONSETT PONDS
Field Results

Collection Date: 12/20/85 Weather: Fair 20^{o}, calm

Secchi: N/A, ice cover

East Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (^{o}C)	Dissolved Oxygen (mg/liter)
0	0.5	9.9
1	*	*
2	*	*
3	*	*

West Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (^{o}C)	Dissolved Oxygen (mg/liter)
0	1.0	9.2
1	*	*
2	*	*
3	*	*

*surface sample only because of hazardous ice conditions.

MONPONSETT PONDS
Field Results

Collection Date: 1/22/86 Weather: Fair, 45°

Secchi: N/A; ice cover

East Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (°C)	Dissolved Oxygen (mg/liter)
0	1.0	9.4
1	*	*
2	*	*
3	*	*

West Monponsett
In-lake (Station 1)

Depth (meters)	Temperature (°C)	Dissolved Oxygen (mg/liter)
0	2.0	9.4
1	*	*
2	*	*
3	*	*

*surface sample only because of hazardous ice conditions.

MONPONSETT PONDS

Date of Collection: 2/13/86

Site Condition-
Weather: fair, 21° NW wind
Lake Condition:
Secchi: N/A (lake frozen)

STATION	TEMP.(C)	DISSOLVED O_2 (mg/l)	pH
EAST MONPONSETT #1 (Inlake)			
0M	2.0	10.0	5.8
1M	1.5	9.8	5.9
2M	1.5	9.8	5.8
3M	1.5	10.0	6.0
WEST MONPONSETT #1 (Inlake)			
0M	1.0	9.6	6.5
1M	1.0	9.4	6.5
2M	1.0	9.6	6.5
3M	1.0	9.6	6.6

MONPONSETT PONDS

Date of Collection: 3/19/86

Site Condition-

Weather: Rain, 56°, high wind

Lake Condition:

Secchi: N/A due to weather.

STATION	TEMP.(C)	DISSOLVED O_2 (mg/l)	pH
EAST MONPONSETT			
#1 (Inlake)			
0M	4.5	8.7	5.2
1M	4.5	8.6	5.4
2M	4.5	8.9	5.2
3M	4.5	8.7	5.3
4M	4.5	8.7	5.2

MONPONSETT PONDS

Date of Collection: 3/31/86

Site Condition-

Weather: rain, high wind

Lake Condition:

Secchi: N/A due to weather

STATION	TEMP.(C)	DISSOLVED O_2 (mg/l)	pH
WEST MONPONSETT			
#1 (Inlake)			
0	4.5	8.8	5.3
1	4.5	8.9	5.3
2	4.5	8.8	5.3
3	4.5	8.8	5.3
4	4.5	8.8	5.3

MONPONSETT PONDS

Date of Collection: 4/17/86

Site Condition-
Weather: Fair, northeast wind
Lake Condition:
Secchi:

STATION	TEMP. (^oC)	DISSOLVED O_2 (mg/l)	pH
EAST MONPONSETT			
#1 (Inlake)			
0M	13.3	3.2	5.5
1M	13.3	4.0	
2M	13.3	8.8	5.4
3M	12.2	8.7	5.5
4M	13.3	8.5	5.5
WEST MONPONSETT			
#1 (Inlake)			
0M	12.2	8.6	5.1
1M	12.2	7.7	5.4
2M	12.2	7.0	5.4
3M	13.9	2.5	5.1

MONPONSETT PONDS

Date of Collection: 5/14/86

Site Condition-

Weather: Clear, 70's

Lake Condition:

Secchi: 2.4 meters (East Monponsett)

STATION	TEMP.(C)	DISSOLVED O_2 (mg/l)	pH
EAST MONPONSETT			
#1 (Inlake)			
0M	14.5	10.8	5.4
1M	13.0	11.0	5.5
2M	13.0	10.6	5.4
3M	13.0	10.4	5.6
WEST MONPONSETT			
#1 (Inlake)			
0M	15.0	10.2	5.6
1M	15.0	10.4	5.8
2M	13.5	10.2	5.4
3M	13.5	9.4	5.6

PHYTOPLANKTON ANALYSIS

Sample From East Monponsett Sample Number #3

Date of Collection 4/18/85 Date of Examination 11/5/85 Amount Examined 10 ml

TOTAL GENERA 13
DENSITY 1385.5 organisms/ml.

CHRYSOPHYTA-Diatoms

Asterionella	4
Cyclotella	124
Cymbella	9
Melosira	23
Navicula	5
Nitzchia	4
Synedra	41
Tabellaria	51

CHLOROPHYTA-Green Algae

Chlorella	4
Scenedesmus	82

EUGLENOPHYTA-Euglenoids

Trachelomonas	27

CYANOPHYTA-Blue-green Algae

Anacystia	69
Chroococcus	18

PHYTOPLANKTON ANALYSIS

Sample From East Monponsett Sample Number #12

Date of Collection 5/29/85 Date of Examination 11/5/85 Amount Examined 10 ml

TOTAL GENERA 10
DENSITY 603.9 organisms/ml.

CHRYSOPHYTA-Diatoms

Asterionella	28
Cocconeis	4
Cyclotella	60
Eunotia	9
Melosira	37
Navicula	5
Synedra	41
Tabellaria	19

CHLOROPHYTA-Green Algae

Staurastrum	4

EUGLENOPHYTA-Euglenoids

Trachelomonas	18

PHYTOPLANKTON ANALYSIS

Sample From East Monponsett Sample Number #18

Date of Collection 6/11/85 Date of Examination 11/5/85 Amount Examined 10 ml

TOTAL GENERA 11
DENSITY 858.9 organisms/ml.

CHRYSOPHYTA-Diatoms

Achnanthes	5
Asterionella	5
Cyclotella	46
Melosira	121
Synedra	69

CHLOROPHYTA-Green Algae

Chlorella	4
Staurastrum	3

EUGLENOPHYTA-Euglenoids

Trachelomonas	18

CYANOPHYTA-Blue-green algae

Anacystis	12
Chroococcus	17

PYRROPHYTA-Dinoflagellates

Gonyalux	20

PHYTOPLANKTON ANALYSIS

Sample From East Monponsett Sample Number #20

Date of Collection 7/8/85 Date of Examination 11/5/85 Amount Examined 10 ml

TOTAL GENERA 6
DENSITY 1033.3 organisms/ml.

CHRYSOPHYTA-Diatoms		
	Cyclotella	10
	Cymbella	5
	Synedra	7
-Xanthophyceae		
	Cloeobotrys	306
CHLOROPHYTA-Green Algae		
	Pediastrum	42
CYANOPHYTA-Blue-green algae		
	Chroococcus	15

PHYTOPLANKTON ANALYSIS

Sample From East Monponsett Sample Number 36

Date of Collection 8/13/85 Date of Examination 11/19/85 Amount Examined

TOTAL GENERA 9

DENSITY 6492.54 organisms/ml.

CHRYSOPHYTA-Diatoms	
Cocconeis	5
Cyclotella	54
Cymbella	1
Synedra	28
Tabellaria	3
CHLOROPHYTA-Green Algae	
Staurastrum	3
EUGLENOPHYTA-Euglenoids	
Trachelomonas	1
CYANOPHYTA-Blue-green algae	
Chroococcus	672
Nostoc	1652

PHYTOPLANKTON ANALYSIS

Sample From East Monponsett Sample Number 39

Date of Collection 8/28/85 Date of Examination 11/19/85 Amount Examined

TOTAL GENERA 10
DENSITY 638.79 organisms/ml.

CHRYSOPHYTA-Diatoms	
Achnanthes	12
Cyclotella	28
Melosira	24
Navicula	9
Pinnularia	1
Synedra	8
Tabellaria	1
CHLOROPHYTA-Green Algae	
Chlorella	15
CYANOPHYTA-Blue-green algae	
Chroococcus	160

PHYTOPLANKTON ANALYSIS

Sample From East Monponsett Sample Number 50

Date of Collection 9/26/85 Date of Examination 11/19/85 Amount Examined

TOTAL GENERA 5
DENSITY 754.20 organisms/ml.

CHRYSOPHYTA-Diatoms	
Achnanthes	28
Synedra	11
Tabellaria	14
EUGLENOPHYTA-Euglenoids	
Trachelomonas	9
CYANOPHYTA-Blue-green algae	
Chroococcus	219

PHYTOPLANKTON ANALYSIS

Sample From East Monponsett Sample Number 59

Date of Collection 10/10/85 Date of Examination 11/19/85 Amount Examined ____

TOTAL GENERA 9
DENSITY 826.67 organisms/ml.

CHRYSOPHYTA-Diatoms	
Cocconeis	4
Cyclotella	21
Melosira	97
Synedra	16
Tabellaria	20
CHLOROPHYTA-Green Algae	
Scenedesmus	16
EUGLENOPHYTA-Euglenoids	
Trachelmonas	17
CYANOPHYTA-Blue-green algae	
Anacystis	13
Chroococcus	104

PHYTOPLANKTON ANALYSIS

Sample From East Monponsett Sample Number 69

Date of Collection 10/23/85 Date of Examination ______ Amount Examined ______

TOTAL GENERA 11
DENSITY 1199.92 organisms/ml.

CHRYSOPHYTA -	Diatoms	
	Cocconeis	5
	Cyclotella	8
	Synedra	6
CHLOROPHYTA -	Green Algae	
	Chlamydomonas	92
	Chlorella	119
	Chlorococcum	2
EUGLENOPHYTA -	Euglenoids	
	Euglena	104
	Phacus	1
	Trachelomonas	6
CYANOPHYTA -	Blue-Green Algae	
	Anabaena	80
	Chroococcus	24

PHYTOPLANKTON ANALYSIS

Sample From East Monponsett Sample Number 75

Date of Collection 11/13/85 Date of Examination ____ Amount Examined ____

TOTAL GENERA 8

DENSITY 399.9 organisms/ml.

CHRYSOPHYTA -	Diatoms	
	Achnanthes	16
	Navicula	13
	Synedra	11
	Tabellaria	32
CHLOROPHYTA -	Green Algae	
	Chlorella	81
EUGLENOPHYTA -	Eugleniods	
	Euglena	111
	Phacus	3
CYANOPHYTA -	Blue-Green Algae	
	Chroococcus	31

PHYTOPLANKTON ANALYSIS

Sample From East Monponsett Sample Number 86

Date of Collection 11/25/86 Date of Examination ________ Amount Examined ____

TOTAL GENERA 6
DENSITY 185.2 organisms/ml.

CHRYSOPHYTA -	Diatoms	
	Achnanthes	2
	Asterionella	1
	Synedra	4
EUGLENOPHYTA -	Euglenoids	
	Euglena	26
	Trachelomonas	6
CYANOPHYTA -	Blue-Green Algae	
	Chroococcus	30

PHYTOPLANKTON ANALYSIS

Sample From East Monponsett Sample Number 95

Date of Collection 1/22/86 Date of Examination ______ Amount Examined ______

TOTAL GENERA 2
DENSITY 72.4 organisms/ml.

EUGLENOPHTA -	Euglenoids	
	Trachelomonas	3
CYANOPHYTA -	Blue-Green Algae	
	Anacystis	24

Lake	Station	Date Collected	Lab No.
East Monponsett		2/13/86	EM-98

Analysis by	Vol	Count	Date Analyzed
David Gendron	10 ml	1 square	6/20/86

Class	Type	Organism	Count	Tally	Cells/ml
Bacillariophyceae (Diatoms)	Centric	cyclotella	1	1	2.7
	Pennate	tabellaria	1	1	2.7
		synedra	5	5	13
		fragilaria	5	5	13
Cyanophyceae (Blue-Greens)	Coccoid				
	Filamentous				
Chlorophyceae (Greens)	Coccoid				
	Desmids	scenedesmus	1	2.7	
	Filamentous	bulbocheate (unit count)	7	7	19
	Flagellates				
Chrysophyceae (Golden-Browns)					
Cryptophyceae (Cryptomonads)					
Dinophyceae (Dinoflagellates)					
Euglenophyceae (Euglenids)					

Chlorophyll a / in mg/m^3

Tot. live algae (c/ml) 54

Lake			Station	Date Collected	Lab No.
East Monponsett				3/19/86	EM107
Analysis by: David Gendron		Vol. 15 ml	Count 1 square	Date Analyzed 6/23/86	

Class	Type	Organism	Count	Tally	Cells/ml
Bacillariophyceae (Diatoms)	Centric	cocconeis	3	3	5.4
		cyclotella	1	1	1.8
		melosira	1	1	1.8
	Pennate	fragitaria	35	35	63
		synedra	83	83	150
		navicula	13	13	23
		diatoma	9	9	16
		meridion	1	1	1.8
		cymbella	2	2	3.6
		asterionella	87	87	160
		tabellaria	92	92	170
Cyanophyceae (Blue-Greens)	Coccoid				
	Filamentous				
Chlorophyceae (Greens)	Coccoid				
	Desmids	scenedesmus	3	3	5.4
		ankistrodesmus	3	3	5.4
	Filamentous	stigeoclonium (unit count)	1	1	1.8
		ulothrix	3	3	5.4
	Flagellates				
Chrysophyceae (Golden-Browns)					
Cryptophyceae (Cryptomonads)					
Dinophyceae (Dinoflagellates)					
Euglenophyceae (Euglenids)					

Chlorophyll a / in mg/m^3

Tot. live algae (c/ml) 600

Lake		Station	Date Collected	Lab No.
East Monponsett			4/17/86	EM-133
Analysis by: David Gendron	ml: 30 ml	Count: 1 square	Date Analyzed: 6/19/86	

Class	Type	Organism	Count	Tally	Cells/ml	T
Bacillariophyceae (Diatoms)	Centric	cyclotella	9	9	8.1	
		melosita	18	18	16	
		cocconeis	6	6	5.4	
	Pennate	navicula	9	9	8.1	
		tabellaria	10	10	9.0	
		synedra	5	5	4.5	
		asterionella	389	389	350	
		diatoma	8	8	7.2	
		fragilaria	11	11	9.8	
		stamoneis	2	2	1.8	
Cyanophyceae (Blue-Greens)	Coccoid	cymbella	1	1	0.89	
	Filamentous					
Chlorophyceae (Greens)	Coccoid	gomphosphaeria	1	1	0.89	
	Desmids					
	Filamentous	anabaena (unit count)	16	16	14	
		zygnema (unit count)	1	1	0.89	
	Flagellates					
Chrysophyceae (Golden-Browns)						
Cryptophyceae (Cryptomonads)						
Dinophyceae (Dinoflagellates)						
Euglenophyceae (Euglenids)						

Chlorophyll a / in mg/m^3

Tot. live algae (c/ml) 420

Lake	Station	Date Collected	Lab No.
East Monponsett		5/14/86	EM142

Analysis by	MI	Count	Date Analyzed
David Gendron	30 ml	1 square	6/20/86

Class	Type	Organism	Count	Tally	Cells/ml
Bacillariophyceae (Diatoms)	Centric	cyclotella	15	15	13
		melosita	23	23	21
		cocconeis	4	4	3.6
	Pennate	asterionella	21	21	19
		tabellaria	28	28	25
		synedra	2	2	1.8
		fragilaria	44	44	39
		diatoma	4	4	3.6
		navicula	3	3	2.7
Cyanophyceae (Blue-Greens)	Coccoid				
	Filamentous				
Chlorophyceae (Greens)	Coccoid	gamphosphaeria	1	1	0.89
		phytoconis	1	1	0.89
		oocystis (unit count)	1	1	0.89
		chlorococcum	24	24	21
	Desmids	ankistrodesmus	63	63	52
		scenedesmus	2	2	1.8
		tetraedron	1	1	0.89
	Filamentous	desmidium	12	12	11
		anabaena	5	5	4.5
	Flagellates				
Chrysophyceae (Golden-Browns)					
Cryptophyceae (Cryptomonads)					
Dinophyceae (Dinoflagellates)					
Euglenophyceae (Euglenids)		englena	3	3	2.7

Chlorophyll a/ in mg/m3

Tot. live algae (c/ml)

PHYTOPLANKTON ANALYSIS

Sample From West Monponsett Sample Number #3

Date of Collection 5/29/85 Date of Examination 11/5/85 Amount Examined 10 ml

TOTAL GENERA 16
DENSITY 1540.6 organisms/ml.

CHRYSOPHYTA-Diatoms

Achnanthes	28
Asterionella	92
Cocconeis	9
Cyclotella	56
Cymbella	9
Eunotia	23
Gomphonema	5
Melosira	47
Navicula	5
Nitzchia	5
Pinnularia	5
Surirella	4
Synedra	154
Tabellaria	103

CHLOROPHYTA-Green Algae

Staurastrum	65

EUGLENOPHYTA-Euglenoids

Trachelomonas	14

PHYTOPLANKTON ANALYSIS

Sample From West Monponsett Sample Number #10

Date of Collection 6/11/85 Date of Examination 11/5/85 Amount Examined 10 ml

TOTAL GENERA 16
DENSITY 1639.9 organisms/ml.

CHRYSOPHYTA-Diatoms

Achnanthes	4
Asterionella	106
Cocconeis	9
Cyclotella	33
Cymbella	14
Eunotia	51
Fragillaria	28
Melosira	103
Navicula	4
Nitzchia	18
Stauroneis	2
Synedra	87
Tabellaria	101
Gomphonema	5

EUGLENOPHYTA-Euglenoids

Trachelomonas	18

CYANOPHYTA-Blue-green algae

Gomphosphaeria	28

PHYTOPLANKTON ANALYSIS

Sample From West Monponsett Sample Number #17

Date of Collection 7/8/85 Date of Examination 11/5/85 Amount Examined 10 ml

TOTAL GENERA 13
DENSITY 1046.8 organisms/ml.

CHRYSOPHYTA-Diatoms	
Achnanthes	3
Asterionella	4
Cyclotella	15
Cymbella	5
Eunotia	5
Melosira	9
Synedra	9
Tabellaria	201
-Chrysophyceae	
Synura	47
CHLOROPHYTA-Green algae	
Chlorella	5
Scenedesmus	20
Treubaria	5
CYANOPHYTA-Blue-green algae	
Chroococcus	65

PHYTOPLANKTON ANALYSIS

Sample From West Monponsett Sample Number 24

Date of Collection 8/13/85 Date of Examination 11/19/85 Amount Examined

TOTAL GENERA 12
DENSITY 7284.37 organisms/ml.

CHRYSOPHYTA-Diatoms	
Cocconeis	1
Cyclotella	14
Melosira	13
Tabellaria	56
CHLOROPHYTA-Green Algae	
Elakatothrix	21
Excentrosphaera	2
Gonium	4
Scenedesmus	48
EUGLENOPHYTA-Euglenoids	
Euglena	7
Trachelomonas	7
CYANOPHYTA-Blue-green algae	
Chroococcus	539
Nostoc	2002

PHYTOPLANKTON ANALYSIS

Sample From West Monponsett Sample Number 27

Date of Collection 8/28/85 Date of Examination 11/19/85 Amount Examined

TOTAL GENERA 13
DENSITY 3585.82 organisms/ml.

CHRYSOPHYTA-*Diatoms*	
Cyclotella	255
Melosira	64
Navicula	9
Synedra	61
Tabellaria	73
CHLOROPHYTA-Green Algae	
Chlorella	72
Cosmarium	1
Eudorina	32
Scenedesmus	64
EUGLENOPHYTA-Euglenoids	
Trachelomonas	8
CYANOPHYTA-Blue-green algae	
Anacystis	57
Chroococcus	637
PYRROPHYTA-Dinoflagellates	
Gonyalux	1

PHYTOPLANKTON ANALYSIS

Sample From West Monponsett Sample Number 38

Date of Collection 9/11/85 Date of Examination 11/19/85 Amount Examined ___

TOTAL GENERA 16

DENSITY 2839.67 organisms/ml.

CHRYSOPHYTA-Diatoms	
Achnanthes	9
Cyclotella	28
Eunotia	1
Melosira	37
Naivcula	8
Stauroneis	1
Synedra	63
Tabellaria	108
CHLOROPHYTA-Green Algae	
Chlorella	4
Cosmarium	26
Pandorina	48
Scenedesmus	8
Staurastrum	2
EUGLENOPHYTA-Euglenoids	
Trachelomonas	12
CYANOPHYTA-Blue-green algae	
Chroococcus	65
Nostoc	52

PHYTOPLANKTON ANALYSIS

Sample From West Monponsett Sample Number 41

Date of Collection 9/26/85 Date of Examination 11/19/85 Amount Examined ___

TOTAL GENERA 9
DENSITY 1033.34 organisms/ml.

CHRYSOPHYTA-Diatoms	
Achnanthes	33
Cyclotella	32
Eunotia	3
Synedra	41
Tabellaria	43
CHLOROPHYTA-Green Algae	
Pediastrum	32
Scenedesmus	24
EUGLENOPHYTA-Euglenoids	
Trachelomonas	39
CYANOPHYTA-Blue-green algae	
Chroococcus	138

PHYTOPLANKTON ANALYSIS

Sample From West Monponsett Sample Number 52

Date of Collection 10/10/85 Date of Examination ____ Amount Examined ____

TOTAL GENERA 5

DENSITY 225.0 organisms/ml.

CHRYSOPHYTA -	Diatoms	
	Cymbella	9
	Melosira	27
	Synedra	4
	Tabellaria	38
EUGLENOPHYTA -	Euglenoids	
	Trachelomonas	7

PHYTOPLANKTON ANALYSIS

Sample From West Monponsett   Sample Number 68

Date of Collection 10/25/85   Date of Examination ______   Amount Examined ___

TOTAL GENERA 14
DENSITY 1876.11 organisms/ml.

CHRYSOPHYTA -	Diatoms	
	Achnanthes	4
	Asterionella	112
	Fragillaria	40
	Cyclotella	16
	Melosia	61
	Navicula	1
	Synedra	57
	Tabellaria	247
CHLOROPHYTA -	Green Algae	
	Chlamydomonas	32
	Chloretta	40
EUGLENOPHYTA -	Euglenoids	
	Euglena	49
	Phacus	1
	Trachelomonas	4
CYANOPHYTA -	Blue-Green Algae	
	Anacystis	35

PHYTOPLANKTON ANALYSIS

Sample From West Monponsett Sample Number 75

Date of Collection 11/13/85 Date of Examination Amount Examined

TOTAL GENERA 13
DENSITY 518.0 organisms/ml.

CHRYSOPHYTA -	Diatoms	
	Achnanthes	4
	Asterionella	15
	Cocconeis	1
	Cyclotella	3
	Navicula	2
	Tabellaria	21
CHLOROPHYTA -	Green Algae	
	Chlorella	77
	Eudorina	8
	Scenedesmus	8
	Staurastrum	1
	Tetraedron	1
EUGLENOPHYTA -	Euglenoids	
	Euglena	43
	Trachelomonos	9

PHYTOPLANKTON ANALYSIS

Sample From West Monponsett Sample Number 87

Date of Collection 11/25/85 Date of Examination ____ Amount Examined ____

TOTAL GENERA 5
DENSITY 378.4 organisms/ml.

CHRYOPHYTA - Diatoms

Achnanthes	1
Asterionella	16
Synedra	3
Tabellaria	21

CYANOPHTA - Blue-Green Algae

Chroococcus	100

PHYTOPLANKTON ANALYSIS

Sample From West Monponsett Sample Number 97

Date of Collection 1/22/86 Date of Examination ____ Amount Examined ____

TOTAL GENERA 4
DENSITY 1473.5 organisms/ml.

CHRYSOPHYTA -	Diatoms	
	Navicula	2
EUGLENOPHYTA -	Euglenoids	
	Trachelomonas	456
CYANOPHYTA -	Blue-Green Algae	
	Anacystis	81
	Chroococcus	10

Lake	Station	Date Collected	Lab No.
West Monponsett		2/15/86	WM-104

Analysis by	ML	Count	Date Analyzed
David Gendron	15 ml	1 square	6/20/86

Class	Type	Organism	Count	Tally	Cells/ml
Bacillariophyceae (Diatoms)	Centric				
	Pennate	asterionella	23	23	41
		tabellaria	76	76	140
		diatoma	10	10	18
		navicula	1	1	1.8
		synedra	7	7	13
		fragilaria	19	19	34
Cyanophyceae (Blue-Greens)	Coccoid				
	Filamentous				
Chlorophyceae (Greens)	Coccoid	anacystis (unit count)	1	1	1.8
		chlorococcum	13	13	23
	Desmids				
	Filamentous				
	Flagellates				
Chrysophyceae (Golden-Browns)					
Cryptophyceae (Cryptomonads)					
Dinophyceae (Dinoflagellates)					
Euglenophyceae (Euglenids)					

Chlorophyll a / in mg/m^3

Tot. live algae (c/ml) 270

Lake	West Monponsett	Station		Date Collected	3/31/86	Lab No.	WM106
Analysis by	David Gendron	ML 15 ml	Count 1 square	Date Analyzed	6/20/86		

Class	Type	Organism	Count	Tally	Cells/ml
Bacillariophyceae (Diatoms)	Centric	cocconeis	5	5	9.0
		cyclotella	3	3	5.4
	Pennate	fragilaria	18	18	32
		navicula	25	25	45
		diatoma	22	22	39
		synedra	23	23	41
		cymbella	1	1	1.8
		asterionella	176	176	310
		tabellaria	408	408	730
Cyanophyceae (Blue-Greens)	Coccoid				
	Filamentous				
Chlorophyceae (Greens)	Coccoid	coelastrum (unit count)	1	1	1.8
		coccochloris (unit count)	1	1	1.8
		gomphosphaeria	1	1	1.8
	Desmids	scenedesmus	3	3	5.4
		ankistrodesmus	6	6	11
	Filamentous	ulothrix	50	50	89
	Flagellates				
Chrysophyceae (Golden-Browns)					
Cryptophyceae (Cryptomonads)					
Dinophyceae (Dinoflagellates)					
Euglenophyceae (Euglenids)					

Chlorophyll a / in mg/m³

Tot. live algae (c/ml) 1300

Lake		Station	Date Collected	Lab No.
West Monponsett			4/17/86	WM132
Analysis by: David Gendron	Ml: 30 ml	Count: 1 square	Date Analyzed: 6/20/86	

Class	Type	Organism	Count	Tally	Cells/ml
Bacillariophyceae (Diatoms)	Centric	cocconeis	13	13	11.6
		cyclotella	11	11	9.8
		melosira	6	6	5.4
	Pennate	Aeterionella	661	661	590
		Tabellaria	491	491	440
		Navicula	47	47	42
		Diatoma	28	28	25
		Fragilaria	48	48	43
		synedra	7	7	6.3
		cymbella	1	1	0.89
		meridion	5	5	4.5
Cyanophyceae (Blue-Greens)	Coccoid				
	Filamentous				
Chlorophyceae (Greens)	Coccoid	gomphosphaeria	1	1	0.89
		anaceptis	1	1	0.89
		chlorococcum	1	1	0.89
	Desmids	scenedesmus	5	5	4.5
		tetraedron	2	2	1.8
	Filamentous	spyrogyra	10	10	9.0
		zygnema (unit count)	20	20	18
	Flagellates	phacotus	1	1	0.89
Chrysophyceae (Golden-Browns)					
Cryptophyceae (Cryptomonads)					
Dinophyceae (Dinoflagellates)					
Euglenophyceae (Euglenids)					

Chlorophyll a / in mg/m³

Tot. live algae (c/ml)

1209

Lake: West Monponsett			Station	Date Collected: 5/14/86	Lab No.
Analyst by: David Gendron		Ml: 30 ml	Count: 1 square	Date Analyzed: 6/20/86	WM146

Class	Type	Organism	Count	Tally	Cells/ml	Total
Bacillariophyceae (Diatoms)	Centric	cocconeis	2	2	1.8	
		cyclotella	1	1	0.89	
	Pennate	asterionella	51	51	46	
		tabellaria	40	40	36	
		diatoma	1	1	0.89	
		navicula	3	3	2.7	
		synedra	2	2	1.8	
		fragilaria	9	9	8.1	
Cyanophyceae (Blue-Greens)	Coccoid					
	Filamentous					
Chlorophyceae (Greens)	Coccoid	chlorococcum	95	95	85	
		sphaerocystis	1	1	0.89	
	Desmids	antistrodesmus	97	97	87	
		scenedesmus	1	1	0.89	
	Filamentous	oscillatoria	1	1	0.89	
		bulbochaete	14	14	13	
		anabaena (unit count)	1	1	0.89	
	Flagellates					
hrysophyceae (Golden-Browns)						
yptophyceae (Cryptomonads)						
nophyceae (Dinoflagellates)						
uglenophyceae (Euglenids)		englena	2	2	1.8	

orophyll a / in mg/m^3

Tot. live algae (c/ml) 290

APPENDIX C
TEST WELL AND SEEPAGE
SAMPLER RESULTS

East Monponsett Lake

Client: Town of Halifax
499 Plymouth Street
Halifax, MA 02338

Date of Collection:11/13/8

Sample A: Test Well 1
Sample B: Test Well 2
Sample C: Test Well 3
Sample D: Test Well 4
Sample E: Test Well 5
Sample F: Seepage Sample by Test Well 1

Sample	TW1	TW2	TW3	TW4	TW5	SS
Analysis Number	76	77	78	79	80	76A
Sodium	11.0	14.0	50.0	28.0	16.0	9.0
Nitrogen - Ammonia	1.66	1.76	< 0.1	0.85	< 0.1	< 0.1
- Nitrate	0.20	0.20	0.12	0.35	4.3	0.75
- Kjeldahl	1.84	6.50	5.25	1.92	1.10	.28
Total Phosphorous	.306	1.05	10.1	.510	.203	.032
- Ortho	.298	.880	10.9	.531	.192	.025
Total Coliform	1200/100	1000/100	7500/100	5000/100	3400/100	400/100
Fecal Coliform	< 100/100	< 100/100	< 100/100	< 100/100	< 100/100	< 100/100

Results expressed in mg/l.

< = Less Than.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

By [signature]

West Monponsett Lake

Client: Town of Halifax
499 Plymouth Street
Halifax, MA 02338

Date of Collection: 11/13/85

Sample A: Test Well 1
Sample B: Test Well 2
Sample C: Test Well 3
Sample D: Test Well 4
Sample E: Test Well 5

Sample	TW1	TW2	TW3	TW4	TW5
Analysis Number	76	77	78	79	80
Sodium	48.0	20.0	12.0	30.0	21.0
Nitrogen - Ammonia	1.05	1.02	.84	< 0.1	3.0
- Nitrate	14.6	4.7	0.75	0.20	1.33
- Kjeldahl	1.56	1.32	2.30	.28	3.0
Total Phosphorous	.132	.082	1.03	.385	.295
- Ortho	.124	.050	1.66	.395	.281
Total Coliform	32000/100	1100/100	1,550,000/100	5400/100	3300/100
Fecal Coliform	1500/100	< 100/100	250,000/100	< 100/100	< 100/100

Results expressed in mg/l.

< = Less Than.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

By ____________________

EAST MONPONSETT
TEST WELLS

Date of Collection: 4/17/86 Date of Analysis:

Sample A: TW-1
B: TW-2
C: TW-3
D: TW-4

LABORATORY ANALYSIS

SAMPLE	A	B	C	D
Analysis Number	EM-133	EM-134	EM-135	EM-136
Conductance	112.1	187.4	140.6	643.
Ammonia Nitrogen	0.026	0.025	*	4.52
Kjeldahl Nitrogen				
Nitrate Nitrogen	5.25	4.0	1.5	2.65
Total Phosphorus	0.181	0.343	*	6.14
Sodium	11.2	37.0	28.0	91.0
Total Coliform	130/100	10/100	20/100	<10/100
Fecal Coliform	<10/100	<10/100	<10/100	<10/100

All results are expressed as mg/l with the exception of bacteria which is expressed as organisms per 100 ml of sample.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY____________________

*not collected due to low water level.

WEST MONPONSETT

TEST WELLS

Date of Collection: 4/17/86 Date of Analysis:

Sample A: TW-1
B: TW- 2
C: TW- 3
D: TW- 4

LABORATORY ANALYSIS

SAMPLE	A	B	C	D
Analysis Number	WM-137	WM-137A	WM-138	WM-139
Conductance	144	77.3	112.1	162.0
Ammonia Nitrogen	0.13	0.033	0.16	0.24
Kjeldahl Nitrogen				
Nitrate Nitrogen	2.07	3.75	0.80	1.01
Total Phosphorus	0.123	0.217	1.71	0.300
Sodium	23.2	7.8	8.7	21.2
Total Coliform	20/100	< 10/100	50/100	< 10/100
Fecal Coliform	< 10/100	< 10/100	< 10/100	< 10/100

All results are expressed as mg/l with the exception of bacteria which is expressed as 100 ml of sample.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________

EAST MONPONSETT
<u>TEST WELLS</u>

Date of Collection: 5/14/86 Date of Analysis:

Sample A: TW#1
B: TW#2
C: TW#3
D: TW#4

LABORATORY ANALYSIS

SAMPLE	A	B	C	D
Analysis Number	EM-143	EM-144	EM-145	EM-146
Conductance	190.3	240.6	868.6	TEST WELL
Ammonia Nitrogen	2.50	5.60	0.24	OUT PUT
Kjeldahl Nitrogen	1.55	3.4	0.40	BACK IN NO SAMPLE
Nitrate Nitrogen				
Total Phosphorus	0.755	3.59	0.162	
Sodium	32.0	34.0	88.0	
Total Coliform	70/100	100/100	20/100	
Fecal Coliform	<10/100	<10/100	<10/100	

All results are expressed as mg/l with the exception of bacteria which is expressed as 100 ml of sample.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY______________________________

EAST MONPONSETT
SEEPAGE SAMPLES

Date of Collection: 5/14/86 Date of Analysis:

Sample A: SS#1
B: SS#2
C: SS#3
D: SS#4

LABORATORY ANALYSIS

SAMPLE	A	B	C	D
Analysis Number	EM-148	EM-149	EM-150	EM-151
Conductance	152.5		179.3	137.
Ammonia Nitrogen	0.25	NO SAMPLE	0.18	0.36
Kjeldahl Nitrogen	0.38		0.37	0.62
Nitrate Nitrogen				
Total Phosphorus	0.300		0.212	0.262
Sodium	16.4		14.1	14.6
Total Coliform	50/100		200/100	50/100
Fecal Coliform	<10/100		10/100	30/100

All results are expressed as mg/l with the exception of bacteria which is expressed as organisms per 100 ml of sample.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY______________________________

WEST MONPONSETT
TEST WELLS

Date of Collection: 5/14/86 Date of Analysis:

Sample A: TW#1
B: TW#2
C: TW#3
D: TW#5

LABORATORY ANALYSIS

SAMPLE	A	B	C	D
Analysis Number	WM-147	WM-148	WM-149	WM-150
Conductance	133.2	149.	192.5	208.4
Ammonia Nitrogen	0.09	0.66	1.66	3.44
Kjeldahl Nitrogen	0.74	0.65	0.65	1.85
Nitrate Nitrogen				
Total Phosphorus	1.31	1.24	0.735	0.075
Sodium	13.6	11.9	13.0	21.4
Total Coliform	20/100	800/100	10/100	300,000/100
Fecal Coliform	<10/100	20/100	<10/100	<10/100

All results are expressed as mg/l with the exception of bacteria which is expressed as organisms per 100 ml of sample.

WEST MONPONSETT
TEST WELL

Date of Collection: 5/14/86 Date of Analysis:

Sample E: TW#4

LABORATORY ANALYSIS

SAMPLE	E
Analysis Number	WM-151
Conductance	575.
Ammonia Nitrogen	0.18
Kjeldahl Nitrogen	0.20
Nitrate Nitrogen	*
Total Phosphorus	0.515
Sodium	95.0
Total Coliform	500/100
Fecal Coliform	10/100

All results are expressed as mg/l with the exception of bacteria which is expressed as organisms per 100 ml of sample.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________________

*sample lost in laboratory.

WEST MONPONSETT
SEEPAGE SAMPLES

Date of Collection: 5/14/86 Date of Analysis:

Sample A: SS#1
B: SS#2
C: SS#4
D: SS#3

LABORATORY ANALYSIS

SAMPLE	A	B	C	D
Analysis Number	WM-152	WM-153	WM-154	WM-154
Conductance			163.	180.
Ammonia Nitrogen			0.16	0.06
Kjeldahl Nitrogen	N O S A M P L E		0.21	0.22
Nitrate Nitrogen	Seepage samplers			
Total Phosphorus	were pulled out.		0.001	0.073
Sodium	Seepage samplers		18.5	20.5
Total Coliform	were replaced.		400/100	60/100
Fecal Coliform			90/100	30/100

All results are expressed as mg/l with the exception of bacteria which is expressed as organisms per 100 ml of sample.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY______________________________

EAST MONPONSETT

TEST WELLS

Date of Collection: 5/14/86 Date of Analysis:

Sample E: Test Well #5

LABORATORY ANALYSIS

SAMPLE	E
Analysis Number	EM-147
Conductance	179.3
Ammonia Nitrogen	3.05
Kjeldahl Nitrogen	0.34
Nitrate Nitrogen	
Total Phosphorus	0.057
Sodium	13.8
Total Coliform	20/100
Fecal Coliform	< 10/100

All results are expressed as mg/l with the exception of bacteria which is expressed as 100 ml of sample.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________________

EAST MONPONSETT
TEST WELLS

Date of Collection: 5/22/86   Date of Analysis:

Sample A: TW-1
B: TW-2
C: TW-3
D: TW-4

LABORATORY ANALYSIS

SAMPLE	A	B	C	D
Analysis Number	EM-163	EM-164	EM-166	EM-167
Conductance	191	206	787	173.5
Ammonia Nitrogen	2.12	2.33	6.74	0.26
Kjeldahl Nitrogen	0.54	0.90	1.80	0.1
Nitrate Nitrogen	0.1	0.1	1.52	0.1
Total Phosphorus	.336	0.314		0.085
Sodium	43.0	50.0	109	35.0
Total Coliform	3400/100	1800/100	2700/100	1300/100
Fecal Coliform	520/100	300/100	10/100	50/100

All results are expressed as mg/l with the exception of bacteria which is expressed as organisms per 100 ml of sample.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ____________________

EAST MONPONSETT
SEEPAGE SAMPLES

Date of Collection: 5/22/86 Date of Analysis:

Sample A: SS-1
B: SS-2
C: SS-3
D: SS-4

LABORATORY ANALYSIS

SAMPLE	A	B	C	D
Analysis Number	EM-169	EM-170	EM-171	EM-172
Conductance	132.0	257.	144.	
Ammonia Nitrogen	0.11	0.10	0.17	NOT
Kjeldahl Nitrogen	0.1	0.1	0.1	COLLECTED
Nitrate Nitrogen	0.1	0.1	0.1	SEEPAGE SAMPLER
Total Phosphorus	0.001	0.134	0.255	HAD BEEN PULLED
Sodium	38.0	45.0	39.0	OUT.
Total Coliform	110/100	40/100	900/100	
Fecal Coliform	50/100	10/100	350/100	

All results are expressed as mg/l with the exception of bacteria which is expressed as organisms per 100 ml of sample.

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BY________________________

EAST MONPONSETT
TEST WELLS

Date of Collection: 5/22/86   Date of Analysis:

Sample E: Test Well #5

LABORATORY ANALYSIS

SAMPLE	E
Analysis Number	EM-168
Conductance	231.4
Ammonia Nitrogen	0.36
Kjeldahl Nitrogen	0.11
Nitrate Nitrogen	0.1
Total Phosphorus	
Sodium	53.0
Total Coliform	50/100
Fecal Coliform	10/100

All results are expressed as mg/l with the exception of bacteria which is expressed as organisms per 100 ml of sample.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY____________________________

APPENDIX D
STORM SAMPLE RESULTS

West Monponsett Lake

Storm Analysis

Client: Town of Halifax
499 Plymouth Street
Halifax, MA 02338

Date of Collection: 11/5/85

Sample A: WM1
Sample B: WM2
Sample C: WM4
Sample D: WM5
Sample E: WM7
Sample F: WM8

Sample	A	B	C	D	E	F
Analysis Number	WM1	WM2	WM4	WM5	WM7	WM8
Iron	2.09	1.13	0.19	0.56	0.82	0.85
Manganese	.14	.09	< .01	.05	.05	.03
Nitrogen - Kjeldahl	1.56	1.36	0.38	0.58	0.56	1.0
Total Phosphorous	.364	.334	.024	.056	.072	.214
Suspended Solids	13.1	25.0	.36	17.9	7.4	83.0
Bacteria - Total Coliform	8500/100	3000/100	1000/100	3000/100	6800/100	2200/100
- Fecal Coliform	40/100	100/100	200/100	1100/100	480/100	5200/100

Results expressed in mg/l.
< = Less Than.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

By ____________________

State Certified Laboratory

East Monponsett

Storm Analysis

Client: Town of Halifax
499 Plymouth Street
Halifax, MA 02338

Date of Collection: 11/5/85

Sample A: EM1
Sample B: EM6
Sample C: EM8
Sample D:
Sample E:
Sample F:

Sample	A	B	C	D	E	F
Analysis Number	EM1	EM6	EM8			
Iron	1.25	.83	1.00			
Manganese	.10	.06	.06			
Nitrogen - Kjeldahl	0.56	0.52	0.45			
Total Phosphorous	.06	.162	.092			
Suspended Solids	< .4	.4	16.9			
Bacteria - Total Coliform	4000/100	1700/100	8000/100			
- Fecal Coliform	500/100	5800/100	2500/100			

Results expressed in mg/l.
< = Less Than.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

By [signature]

State Certified Laboratory

WEST MONPONSETT

STORM SAMPLING

STATION NO. 1

Date of Collection: 4/14/86

Sample A: First flush
B: 10 minutes
C: 20 minutes
D:
E:
F:

LABORATORY ANALYSIS

Sample	A	B	C
Analysis Number	WM-110	WM-111	WM-112
Biochemical Oxygen Demand			
Chloride	132.5	110.	90.
Ammonia-Nitrogen	0.86	0.75	0.69
Nitrate-Nitrogen	4.30	1.40	1.42
Kjeldahl-Nitrogen	0.86	0.60	0.48
Total Phosphorus	0.316	0.296	0.242
Suspended Solids	90.8	95.6	78.7
Dissolved Solids	387.2	126.4	151.3
Total Solids	64.	222.	230.
Total Coliform	2000/100	5300/100	2000/100
Fecal Coliform	< 100/100	< 100/100	< 100/100
pH			
Oil & Grease			
Chemical Oxygen Demand			

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________

STATE CERTIFIED LABORATORY

WEST MONPONSETT

STORM SAMPLING

STATION NO. 1

Date of Collection: 4/14/86

Sample A:
B:
C:
D: 30 minutes
E: 45 minutes
F: 60 minutes

LABORATORY ANALYSIS

Sample	D	E	F
Analysis Number	WM-113	WM-114	WM-115
Biochemical Oxygen Demand			
Chloride	77.5	67.5	62.5
Ammonia-Nitrogen	0.68	0.60	0.59
Nitrate-Nitrogen	3.12	1.00	0.93
Kjeldahl-Nitrogen	0.42	0.45	0.64
Total Phosphorus	0.209	0.217	0.244
Suspended Solids	58.0	21.0	33.1
Dissolved Solids	128.0	155.0	130.9
Total Solids	186	176.	164.
Total Coliform	100/100	2000/100	900/100
Fecal Coliform	$<$100/100	$<$100/100	$<$100/100
pH			
Oil & Grease			
Chemical Oxygen Demand			

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________________

STATE CERTIFIED LABORATORY

WEST MONPONSETT

STORM SAMPLING

STATION NO. 1

Date of Collection: 4/14/86

Sample A: 75 minutes
B: 90 minutes
C: 105 minutes
D: 120 minutes
E:
F:

LABORATORY ANALYSIS

Sample	A	B	C	D
Analysis Number	WM-116	WM-117	WM-118	WM-119
Biochemical Oxygen Demand				
Chloride	55.0	47.5	50.0	50.0
Ammonia-Nitrogen	0.65	0.71	0.46	0.40
Nitrate-Nitrogen	0.90	0.68	0.50	0.58
Kjeldahl-Nitrogen	0.39	0.48	0.38	0.35
Total Phosphorus	0.228	0.175	0.170	0.107
Suspended Solids	13.3	49.6	23.3	72.0
Dissolved Solids	128.7	150.4	146.7	100.0
Total Solids	142.	200.	170.	172.
Total Coliform	500/100	1500/100	100/100	1100/100
Fecal Coliform	<100/100	<100/100	<100/100	<100/100
pH				
Oil & Grease				
Chemical Oxygen Demand				

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________________

STATE CERTIFIED LABORATORY

EAST MONPONSETT

STORM SAMPLING

STATION NO. 3

Date of Collection: 4/14/86

Sample A: First flush
B: 10 minutes
C: 20 minutes
D:
E:
F:

LABORATORY ANALYSIS

Sample	A	B	C
Analysis Number	EM-108	EM-109	EM-110
Biochemical Oxygen Demand			
Chloride	125.	120.	122.
Ammonia-Nitrogen	0.353	0.360	0.640
Nitrate-Nitrogen	0.42	0.86	0.58
Kjeldahl-Nitrogen	0.50	0.51	0.40
Total Phosphorus	0.110	0.087	0.083
Suspended Solids	7.0	5.3	7.0
Dissolved Solids	191.0	222.7	259
Total Solids	198.0	228	266
Total Coliform	1000/100	1000/100	500/100
Fecal Coliform	300/100	400/100	<100/100
pH			
Oil & Grease			
Chemical Oxygen Demand			

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________________

STATE CERTIFIED LABORATORY

EAST MONPONSETT

STORM SAMPLING

STATION NO. 3

Date of Collection: 4/14/86

Sample A:
B:
C:
D: 30 minutes
E: 45 minutes
F: 60 minutes

LABORATORY ANALYSIS

Sample	D	E	F
Analysis Number	EM-111	EM-112	EM-113
Biochemical Oxygen Demand			
Chloride	127	122	135
Ammonia-Nitrogen	0.382	0.342	0.727
Nitrate-Nitrogen	0.52	0.93	0.59
Kjeldahl-Nitrogen	0.44	0.46	0.50
Total Phosphorus	0.080	0.075	0.118
Suspended Solids	1.0	14.0	25.3
Dissolved Solids	261.0	258.0	252.7
Total Solids	262.0	272.0	278.0
Total Coliform	12000/100	1000/100	2000/100
Fecal Coliform	< 100/100	<100/100	< 100/100
pH			
Oil & Grease			
Chemical Oxygen Demand			

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ____________________

STATE CERTIFIED LABORATORY

EAST MONPONSETT

STORM SAMPLING

STATION NO. 3

Date of Collection: 4/14/86

Sample A: 75 minutes
B: 90 minutes
C: 105 minutes
D: 120 minutes
E:
F:

LABORATORY ANALYSIS

Sample	A	B	C	D
Analysis Number	EM-114	EM-115	EM-116	EM-117
Biochemical Oxygen Demand				
Chloride	120	107	107	140
Ammonia-Nitrogen	0.521	0.624	0.546	0.512
Nitrate-Nitrogen	0.76	1.03	1.17	1.30
Kjeldahl-Nitrogen	0.56	0.62	0.60	0.59
Total Phosphorus	0.154	0.192	0.160	0.121
Suspended Solids	29.7	38.6	38.2	49.6
Dissolved Solids	238.3	177.4	203.8	150.4
Total Solids	268.0	216.0	242	200.0
Total Coliform	2000/100	2000/100	4000/100	5000/100
Fecal Coliform	<100/100	<100/100	<100/100	<100/100
pH				
Oil & Grease				
Chemical Oxygen Demand				

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________________

STATE CERTIFIED LABORATORY

WEST MONPONSETT

STORM SAMPLING

Station No. 2

Date of Collection: 4/14/86

Sample A: First flush
B: 10 minutes
C: 20 minutes
D:
E:
F:

LABORATORY ANALYSIS

Sample	A	B	C
Analysis Number	WM-120	WM-121	WM-122
Biochemical Oxygen Demand			
Chloride	87.5	100	87.5
Ammonia-Nitrogen	1.07	1.18	1.17
Nitrate-Nitrogen	28.1	3.17	0.18
Kjeldahl-Nitrogen	0.95	0.86	0.82
Total Phosphorus	0.372	0.419	0.429
Suspended Solids	140.8	143.2	164.0
Dissolved Solids	299.2	166.8	60.0
Total Solids	440.0	310.0	224.0
Total Coliform	< 100/100	400/100	35,000/100
Fecal Coliform	< 100/100	<100/100	100/100
pH			
Oil & Grease			
Chemical Oxygen Demand			

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________________

STATE CERTIFIED LABORATORY

WEST MONPONSETT

STORM SAMPLING

Station No. 2

Date of Collection: 4/14/86

Sample A:
B:
C:
D: 30 minutes
E: 45 minutes
F: 60 minutes

LABORATORY ANALYSIS

Sample	D	E	F
Analysis Number	WM-123	WM-124	WM-125
Biochemical Oxygen Demand			
Chloride	95.	102.5	107.5
Ammonia-Nitrogen	1.33	1.35	1.32
Nitrate-Nitrogen	0.15	0.10	0.18
Kjeldahl-Nitrogen	0.88	0.88	0.83
Total Phosphorus	0.465	0.489	0.486
Suspended Solids	260	88.9	88
Dissolved Solids	184	132.1	162
Total Solids	444	226	250
Total Coliform	13,000/100	25,000/100	12,000/100
Fecal Coliform	100/100	<100/100	100/100
pH			
Oil & Grease			
Chemical Oxygen Demand			

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________________

STATE CERTIFIED LABORATORY

WEST MONPONSETT

STORM SAMPLING

Date of Collection: 4/14/86

Sample A: 75 minutes
B: 90 minutes
C: 105 minutes
D: 120 minutes
E:
F:

LABORATORY ANALYSIS

Sample	A	B	C	D
Analysis Number	WM-126	WM-127	WM-128	WM-129
Biochemical Oxygen Demand				
Chloride	95.	82.5	87.5	77.5
Ammonia-Nitrogen	1.34	1.37	1.14	1.12
Nitrate-Nitrogen	0.10	<0.1	0.13	0.10
Kjeldahl-Nitrogen	0.82	0.90	0.76	0.76
Total Phosphorus	0.471	0.553	0.442	0.479
Suspended Solids	120	93.3	56.0	82.2
Dissolved Solids	186	122.7	160.0	199.8
Total Solids	306	216.0	216.0	282.0
Total Coliform	30,000/100	28,000/100	30,000/100	15,000/100
Fecal Coliform	<100/100	<100/100	<100/100	<100/100
pH				
Oil & Grease				
Chemical Oxygen Demand				

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________________

STATE CERTIFIED LABORATORY

EAST MONPONSETT

STORM SAMPLING

STATION NO. 4

Date of Collection: 4/14/86

Sample A: First flush
B: 10 minutes
C: 20 minutes
D:
E:
F:

LABORATORY ANALYSIS

Sample	A	B	C
Analysis Number	EM-118	EM-119	EM-120
Biochemical Oxygen Demand			
Chloride	77.5	65.	52.5
Ammonia-Nitrogen	0.544	0.512	0.607
Nitrate-Nitrogen	4.24	5.55	3.91
Kjeldahl-Nitrogen	0.76	0.76	0.77
Total Phosphorus	0.317	0.529	0.431
Suspended Solids	50.7	72.9	61.5
Dissolved Solids	181.3	153.1	108.5
Total Solids			
Total Coliform	65,000/100	2000/100	130,000/100
Fecal Coliform	< 100/100	< 100/100	< 100/100
pH			
Oil & Grease			
Chemical Oxygen Demand			

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________________

STATE CERTIFIED LABORATORY

EAST MONPONSETT

STORM SAMPLING

STATION NO. 4

Date of Collection: 4/14/86

Sample A:
B:
C:
D: 30 minutes
E: 45 minutes
F: 60 minutes

LABORATORY ANALYSIS

Sample	D	E	F
Analysis Number	EM-121	EM-122	EM-123
Biochemical Oxygen Demand			
Chloride	45.	57.5	67.5
Ammonia-Nitrogen	0.563	0.559	0.453
Nitrate-Nitrogen	4.75	4.69	5.80
Kjeldahl-Nitrogen	0.75		0.94
Total Phosphorus	0.460	0.268	0.288
Suspended Solids	29.7	19.3	25.2
Dissolved Solids	114.3	170.7	244.8
Total Solids			
Total Coliform	3000/1000	38,000/100	7000/100
Fecal Coliform	300/100	300/100	200/100
pH			
Oil & Grease			
Chemical Oxygen Demand			

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________________

STATE CERTIFIED LABORATORY

EAST MONPONSETT

STORM SAMPLING

STATION NO. 4

Date of Collection: 4/14/86

Sample A: 75 minutes
B: 90 minutes
C: 105 minutes
D: 120 minutes
E:
F:

LABORATORY ANALYSIS

Sample	A	B	C	D
Analysis Number	EM-124	EM-125	EM-126	EM-127
Biochemical Oxygen Demand				
Chloride	77.5	80.	90.	105.
Ammonia-Nitrogen	0.416	0.321	0.332	0.320
Nitrate-Nitrogen	8.21	10.0	17.2	13.4
Kjeldahl-Nitrogen	0.81	0.74	0.73	0.69
Total Phosphorus	0.295	0.290	0.218	0.239
Suspended Solids	19.2	16.4	14.0	15.2
Dissolved Solids	202.8	303.6	264.0	234.8
Total Solids				
Total Coliform	40,000/100	1000/100	4000/100	8000/100
Fecal Coliform	200/100	<100/100	300/100	<100/100
pH				
Oil & Grease				
Chemical Oxygen Demand				

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ____________________

STATE CERTIFIED LABORATORY

WEST MONPONSETT
STORM SAMPLING

STATION NO. 1

Date of Collection: 5/22/86

Sample A: First flush
B: 10 minutes
C: 20 minutes
D:
E:
F:

LABORATORY ANALYSIS

Sample	A	B	C
Analysis Number	WM-147	WM-148	WM-149
Chloride	8.8	8.8	10.0
Ammonia-Nitrogen	0.11	0.11	0.12
Nitrate-Nitrogen	0.32	0.49	0.32
Kjeldahl-Nitrogen	0.42	0.39	0.33
Total Phosphorus	0.040	0.115	0.063
Suspended Solids	183.	153.	120.
Dissolved Solids	93.	155	80
Total Solids			
Total Coliform	90,000/100	42,000/100	38,000/100
Fecal Coliform	6,800/100	6,000/100	3,500/100

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________

STATE CERTIFIED LABORATORY

WEST MONPONSETT
STORM SAMPLING

STATION NO. 1

Date of Collection:

Sample A:
B:
C:
D: 30 minutes
E: 45 minutes
F: 60 minutes

LABORATORY ANALYSIS

Sample	D	E	F
Analysis Number	WM-150	WM-151	WM-152
Chloride	8.8	8.8	6.3
Ammonia-Nitrogen	0.08	0.09	0.29
Nitrate-Nitrogen	0.33	0.30	0.20
Kjeldahl-Nitrogen	0.15	0.34	0.39
Total Phosphorus	0.175	0.185	0.038
Suspended Solids	104	181	170
Dissolved Solids	32	43	44
Total Solids			
Total Coliform	48,000/100	40,000/100	46,000/100
Fecal Coliform	6,800/100	10,500/100	8,600/100

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________________

STATE CERTIFIED LABORATORY

WEST MONPONSETT
STORM SAMPLING

STATION NO. 1

Date of Collection: 5/22/86

Sample A: First flush
B: 10 minutes
C: 20 minutes
D:
E:
F:

LABORATORY ANALYSIS

Sample	A	B	C
Analysis Number	WM-147	WM-148	WM-149
Chloride	8.8	8.8	10.0
Ammonia-Nitrogen	0.11	0.11	0.12
Nitrate-Nitrogen	0.32	0.49	0.32
Kjeldahl-Nitrogen	0.42	0.39	0.33
Total Phosphorus	0.040	0.115	0.063
Suspended Solids	183.	153.	120.
Dissolved Solids	93.	155	80
Total Solids			
Total Coliform	90,000/100	42,000/100	38,000/100
Fecal Coliform	6,800/100	6,000/100	3,500/100

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________________

STATE CERTIFIED LABORATORY

WEST MONPONSETT
STORM SAMPLING

STATION NO. 1

Date of Collection:

Sample A:
B:
C:
D: 30 minutes
E: 45 minutes
F: 60 minutes

LABORATORY ANALYSIS

Sample	D	E	F
Analysis Number	WM-150	WM-151	WM-152
Chloride	8.8	8.8	6.3
Ammonia-Nitrogen	0.08	0.09	0.29
Nitrate-Nitrogen	0.33	0.30	0.20
Kjeldahl-Nitrogen	0.15	0.34	0.39
Total Phosphorus	0.175	0.185	0.038
Suspended Solids	104	181	170
Dissolved Solids	32	43	44
Total Solids			
Total Coliform	48,000/100	40,000/100	46,000/100
Fecal Coliform	6,800/100	10,500/100	8,600/100

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY______________________________

STATE CERTIFIED LABORATORY

WEST MONPONSETT

STORM SAMPLING

STATION NO. 1

Date of Collection: 5/22/86

Sample A: 75 minutes
B: 90 minutes
C: 105 minutes
D:
E:
F:

LABORATORY ANALYSIS

Sample	A	B	C
Analysis Number	WM-153	WM-154	WM-155
Chloride	6.3	3.8	6.3
Ammonia-Nitrogen	0.17	0.11	0.08
Nitrate-Nitrogen	0.14	0.15	0.32
Kjeldahl-Nitrogen	0.44	0.15	0.34
Total Phosphorus	0.315	0.327	0.171
Suspended Solids	315	243	164
Dissolved Solids	105	119	92
Total Solids			
Total Coliform	8500/100	7500/100	11,500/100
Fecal Coliform	3500/100	4800/100	3,200/100

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________________

STATE CERTIFIED LABORATORY

WEST MONPONSETT

STORM SAMPLING

STATION NO. 1

Date of Collection:

Sample A:
B:
C:
D: 120 minutes
E:
F:

LABORATORY ANALYSIS

Sample	D
Analysis Number	WM-156
Chloride	5.0
Ammonia-Nitrogen	0.08
Nitrate-Nitrogen	0.28
Kjeldahl-Nitrogen	0.16
Total Phosphorus	0.224
Suspended Solids	190
Dissolved Solids	40
Total Solids	
Total Coliform	11,000/100
Fecal Coliform	3,000/100

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________

STATE CERTIFIED LABORATORY

WEST MONPONSETT
STORM SAMPLING

STATION NO. 2

Date of Collection: 5/22/86

Sample A: First flush
B: 10 minutes
C: 20 minutes
D:
E:
F:

LABORATORY ANALYSIS

Sample	A	B	C
Analysis Number	WM-157	WM-158	WM-159
Chloride	20.0	11.3	8.8
Ammonia-Nitrogen	0.15	0.38	0.37
Nitrate-Nitrogen	0.38	0.50	0.24
Kjeldahl-Nitrogen	0.20	0.39	0.30
Total Phosphorus	0.118	0.592	0.317
Suspended Solids	85.6	594	254
Dissolved Solids	108.4	220	84
Total Solids			
Total Coliform	13,500/100	2500/100	58,000/100
Fecal Coliform	5,600/100	230/100	4,800/100

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________

STATE CERTIFIED LABORATORY

LYCOTT

WEST MONPONSETT
STORM SAMPLING

STATION NO. 2

Date of Collection: 5/22/86

Sample A:
B:
C:
D: 30 minutes
E: 45 minutes
F: 60 minutes

LABORATORY ANALYSIS

Sample	D	E	F
Analysis Number	WM-160	WM-161	WM-162
Chloride	10.0	6.3	6.3
Ammonia-Nitrogen	0.23	0.26	0.18
Nitrate-Nitrogen	0.11	0.18	<0.1
Kjeldahl-Nitrogen	0.33		0.16
Total Phosphorus	0.137	0.519	0.631
Suspended Solids	185	281	183
Dissolved Solids	49	97	115
Total Solids			
Total Coliform	11,400/100	11,000/100	5,000/100
Fecal Coliform	4,000/100	3,200/100	670/100

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY______________________________

STATE CERTIFIED LABORATORY

LYCOTT

WEST MONPONSETT
STORM SAMPLING

STATION NO. 2

Date of Collection: 5/22/86

Sample A: 75 minutes
B: 90 minutes
C: 105 minutes
D:
E:
F:

LABORATORY ANALYSIS

Sample	A	B	C
Analysis Number	WM-163	WM-164	WM-165
Chloride	18.8	6.3	8.8
Ammonia-Nitrogen	0.24	0.18	0.15
Nitrate-Nitrogen	0.27	0.11	0.16
Kjeldahl-Nitrogen	0.39	0.38	0.18
Total Phosphorus	0.450	0.410	< 0.001
Suspended Solids	475	203	207
Dissolved Solids	85	87	79
Total Solids			
Total Coliform	26,000/100	13,500/100	19,000,100
Fecal Coliform	4,800/100	1,170/100	5,300/100

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY____________________________

STATE CERTIFIED LABORATORY

LYCOTT

WEST MONPONSETT

STORM SAMPLING

STATION NO. 2

Date of Collection: 5/22/86

Sample A:
B:
C:
D: 120 minutes
E:
F:

LABORATORY ANALYSIS

Sample	D
Analysis Number	WM-166
Chloride	8.8
Ammonia-Nitrogen	0.10
Nitrate-Nitrogen	7.36
Kjeldahl-Nitrogen	0.19
Total Phosphorus	0.324
Suspended Solids	192
Dissolved Solids	115
Total Solids	
Total Coliform	41,000/100
Fecal Coliform	10,500/100

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY_______________________________

STATE CERTIFIED LABORATORY

LYCOTT

EAST MONPONSETT
STORM SAMPLING

STATION NO. 3

Date of Collection: 5/22/86

Sample A: First flush
B: 10 minutes
C: 20 minutes
D:
E:
F:

LABORATORY ANALYSIS

Sample	A	B	C
Analysis Number	EM-153	EM-154	EM-155
Chloride	139	175	180
Ammonia-Nitrogen	0.29	0.46	0.53
Nitrate-Nitrogen	0.38	6.36	1.30
Kjeldahl-Nitrogen	0.29	0.22	0.25
Total Phosphorus	.420	.210	.176
Suspended Solids	51.7	33.3	37.1
Dissolved Solids	368.3	328.7	218.9
Total Solids			
Total Coliform	2200/100	3800/100	2900/100
Fecal Coliform	220/100	90/100	40/100

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________________

STATE CERTIFIED LABORATORY

LYCOTT

EAST MONPONSETT
STORM SAMPLING
STATION NO. 3
Date of Collection: 5/22/86

EAST MONPONSETT
STORM SAMPLING

STATION NO. 3

Date of Collection: 5/22/86

Sample A:
B:
C:
D: 30 minutes
E: 45 minutes
F: 60 minutes

LABORATORY ANALYSIS

Sample	D	E	F
Analysis Number	EM-156	EM-157	EM-158
Chloride	88.8	36.3	26.3
Ammonia-Nitrogen	0.31	0.19	0.44
Nitrate-Nitrogen	0.38	0.63	< 0.1
Kjeldahl-Nitrogen	0.18	0.10	0.15
Total Phosphorus	.380	0.600	0.501
Suspended Solids	55.	169.	46.
Dissolved Solids	175.	523.	116.
Total Solids			
Total Coliform	42000/100	4000/100	98000/100
Fecal Coliform	660/100	<10/100	1800/100

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________________

STATE CERTIFIED LABORATORY

EAST MONPONSETT

STORM SAMPLING

STATION NO. 3

Date of Collection: 5/22/86

Sample A:
B:
C:
D: 120 minutes
E:
F:

LABORATORY ANALYSIS

Sample	D
Analysis Number	EM-162
Chloride	20.0
Ammonia-Nitrogen	0.39
Nitrate-Nitrogen	< 0.1
Kjeldahl-Nitrogen	0.19
Total Phosphorus	.390
Suspended Solids	206.
Dissolved Solids	56
Total Solids	
Total Coliform	65,000/100
Fecal Coliform	3,600/100

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY________________________________

STATE CERTIFIED LABORATORY

LYCOTT

EAST MONPONSETT

STORM SAMPLING

STATION NO. 4

Date of Collection: 5/22/86

Sample A: First flush
B: 10 minutes
C: 20 minutes
D:
E:
F:

LABORATORY ANALYSIS

Sample	A	B	C
Analysis Number	EM-143	EM-144	EM-145
Chloride	12.5	13.8	43.8
Ammonia-Nitrogen	0.32	0.37	0.44
Nitrate-Nitrogen	0.52	0.12	0.35
Kjeldahl-Nitrogen	0.49	0.72	0.35
Total Phosphorus	0.565	0.488	0.582
Suspended Solids	46.4	49.3	77.5
Dissolved Solids	95.6	106.7	144.5
Total Solids			
Total Coliform	30,000/100	40,000/100	6,000/100
Fecal Coliform	9,000/100	7,800/100	110/100

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________

STATE CERTIFIED LABORATORY

LYCOTT

EAST MONPONSETT

STORM SAMPLING

STATION NO. 4

Date of Collection: 5/22/86

Sample A:
B:
C:
D: 30 minutes
E: 45 minutes
F: 60 minutes

LABORATORY ANALYSIS

Sample	D	E	F
Analysis Number	EM-146	EM-147	EM-148
Chloride	15.0	13.8	8.8
Ammonia-Nitrogen	0.46	0.35	0.56
Nitrate-Nitrogen	0.48	0.29	0.25
Kjeldahl-Nitrogen	0.49	0.58	0.82
Total Phosphorus	0.574	0.697	0.349
Suspended Solids	46.7	317	648
Dissolved Solids	111.3	47	130
Total Solids			
Total Coliform	56,000/100	70,000/100	75,000/100
Fecal Coliform	5,500/100	9,300/100	11,200/100

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________

STATE CERTIFIED LABORATORY

LYCOTT

EAST MONPONSETT

STORM SAMPLING

STATION NO. 4

Date of Collection: 5/22/86

Sample A: 75 minutes
B: 90 minutes
C: 105 minutes
D:
E:
F:

LABORATORY ANALYSIS

Sample	A	B	C
Analysis Number	EM-149	EM-150	EM-151
Chloride	10.0	11.3	20.0
Ammonia-Nitrogen	0.36	0.39	0.42
Nitrate-Nitrogen	0.34	0.34	0.53
Kjeldahl-Nitrogen	0.68	0.56	0.48
Total Phosphorus	0.417	.223	.43
Suspended Solids	227	*	*
Dissolved Solids	31	*	*
Total Solids			
Total Coliform	75,000/100	35,000/100	25,000/100
Fecal Coliform	5,400/100	8,500/100	4,400/100

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY________________________________

STATE CERTIFIED LABORATORY

*not enough sample

LYCOTT

EAST MONPONSETT

STORM SAMPLING

STATION NO. 4

Date of Collection: 5/22/86

Sample A:
B:
C:
D: 120 minutes
E:
F:

LABORATORY ANALYSIS

Sample	D
Analysis Number	EM-152
Chloride	*
Ammonia-Nitrogen	0.52
Nitrate-Nitrogen	*
Kjeldahl-Nitrogen	0.64
Total Phosphorus	*
Suspended Solids	*
Dissolved Solids	*
Total Solids	
Total Coliform	*
Fecal Coliform	*

All results are expressed in mg/l with the exception of bacteria which is org/100 ml and pH which is in pH units.

* bottle leaked, not enough sample

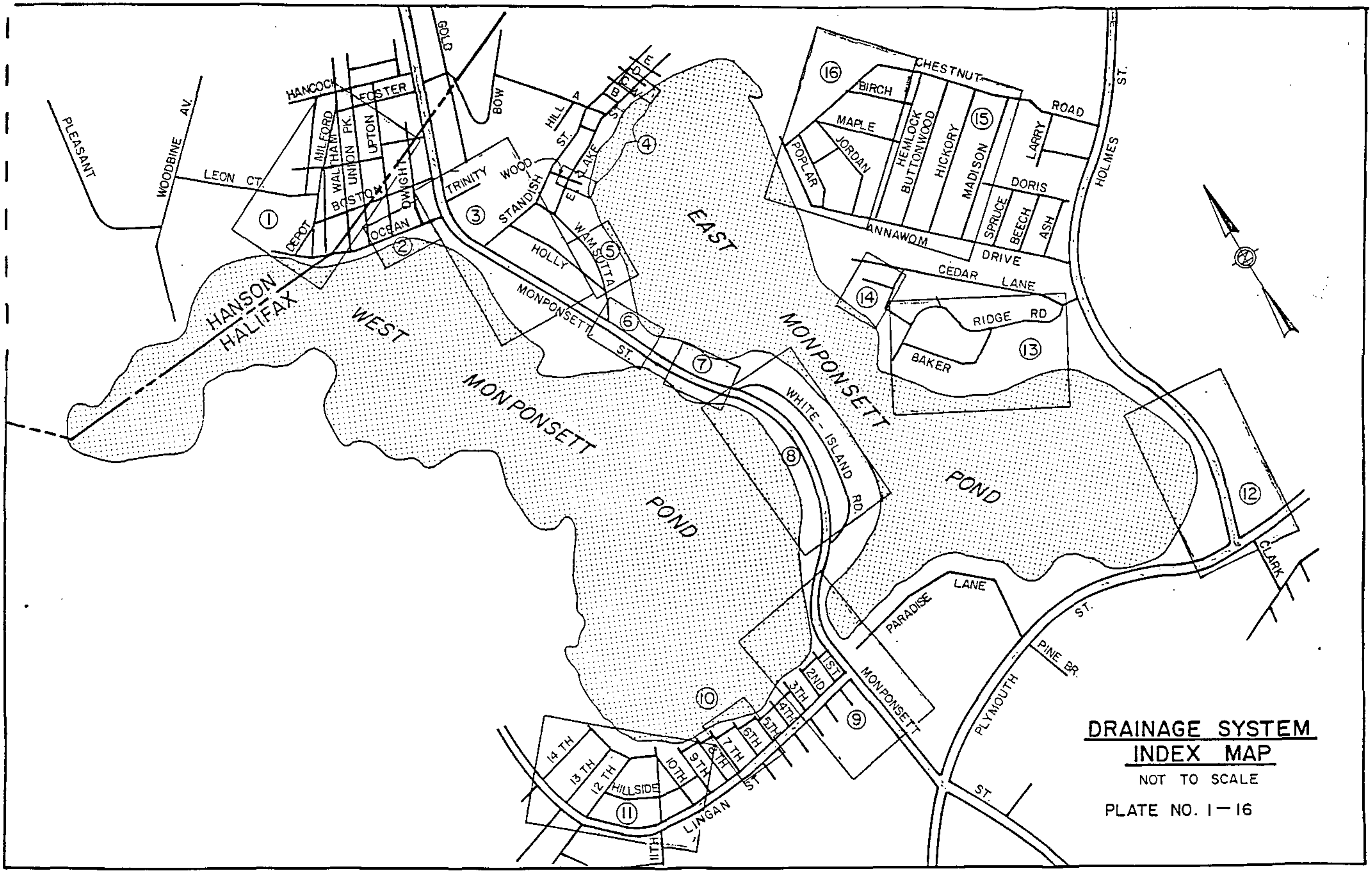
LYCOTT ENVIRONMENTAL RESEARCH, INC.

BY ______________________

STATE CERTIFIED LABORATORY

LYCOTT

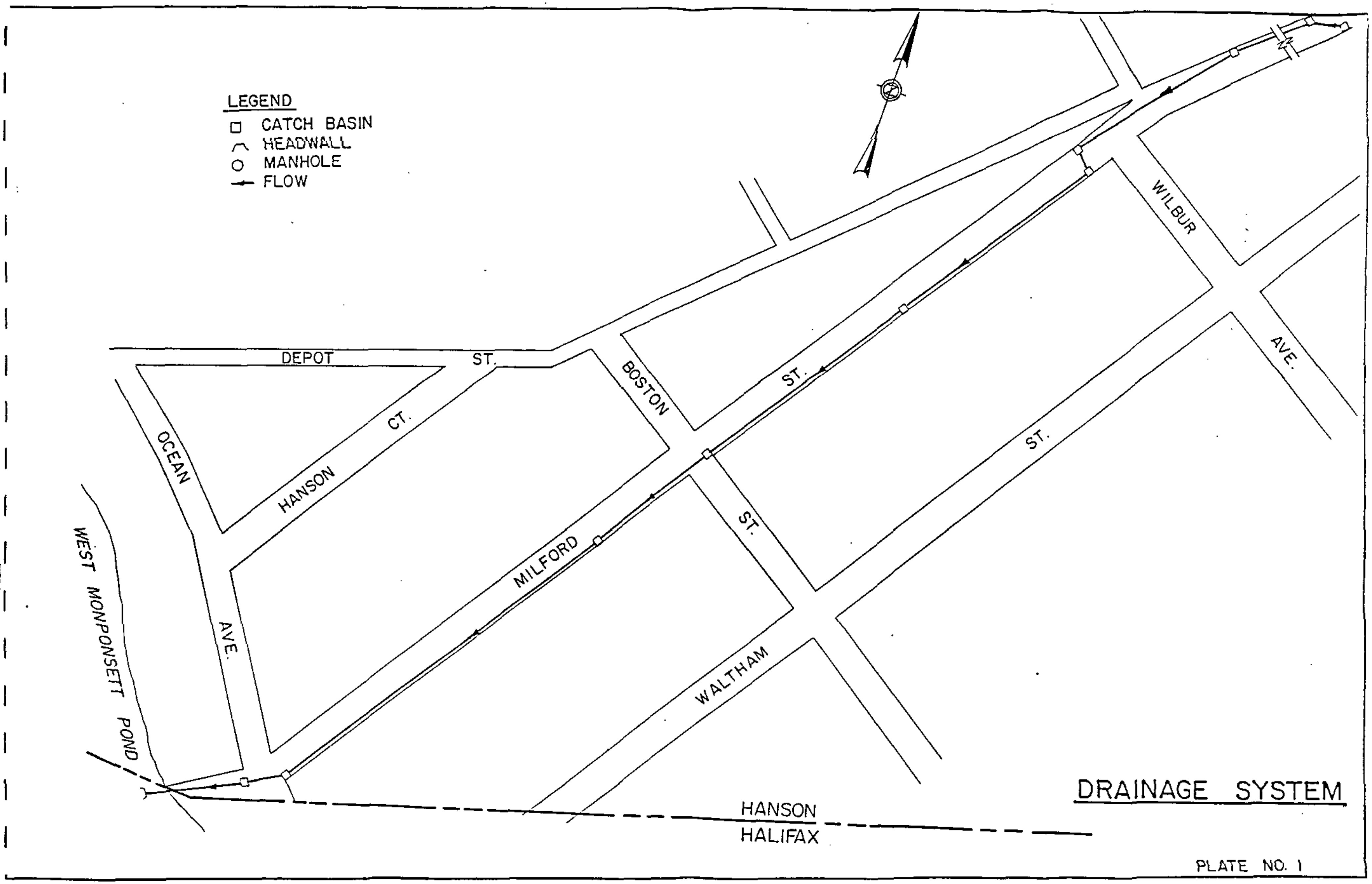
APPENDIX E
STORM DRAINAGE SYSTEM



DRAINAGE SYSTEM INDEX MAP

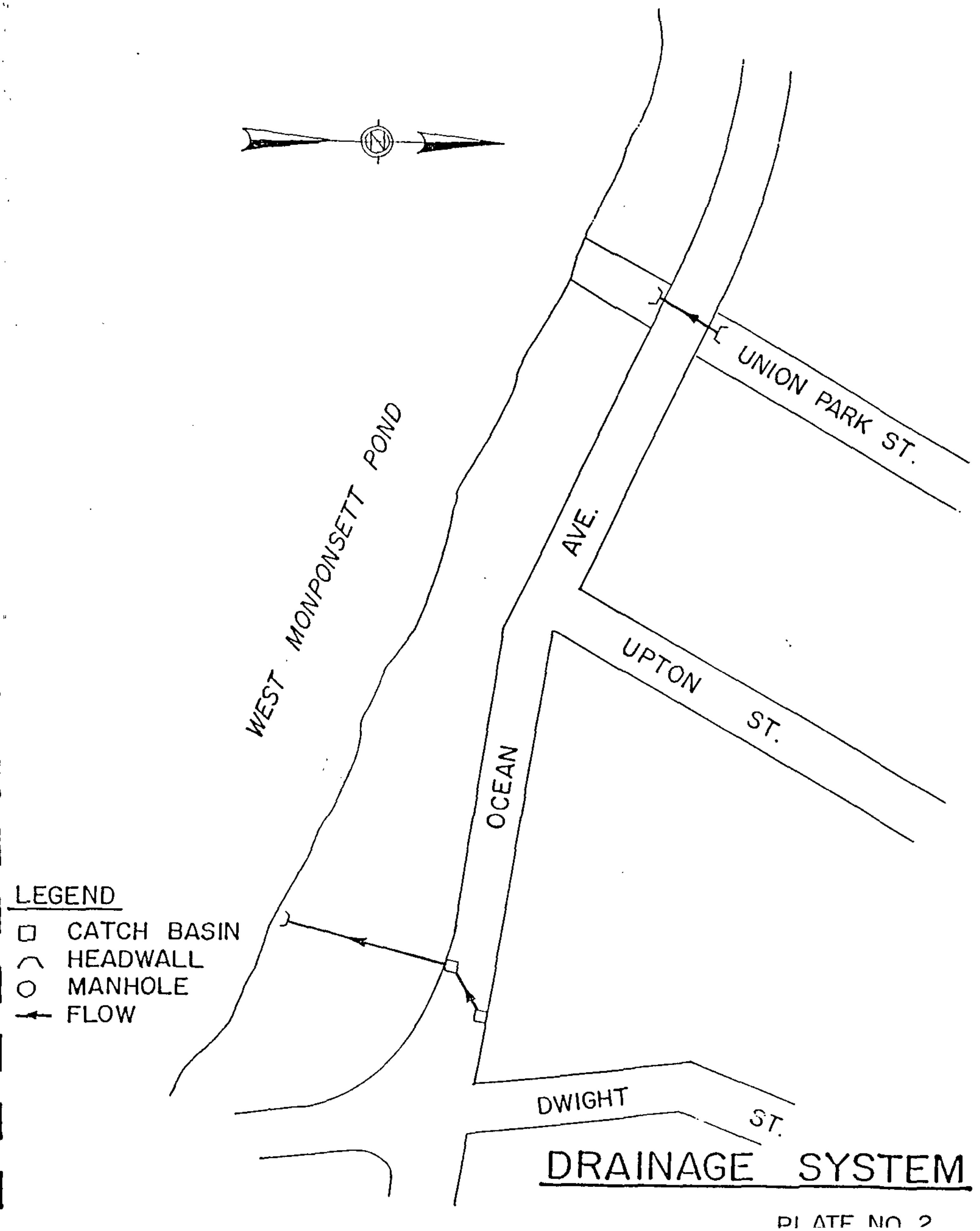
NOT TO SCALE

PLATE NO. 1 — 16



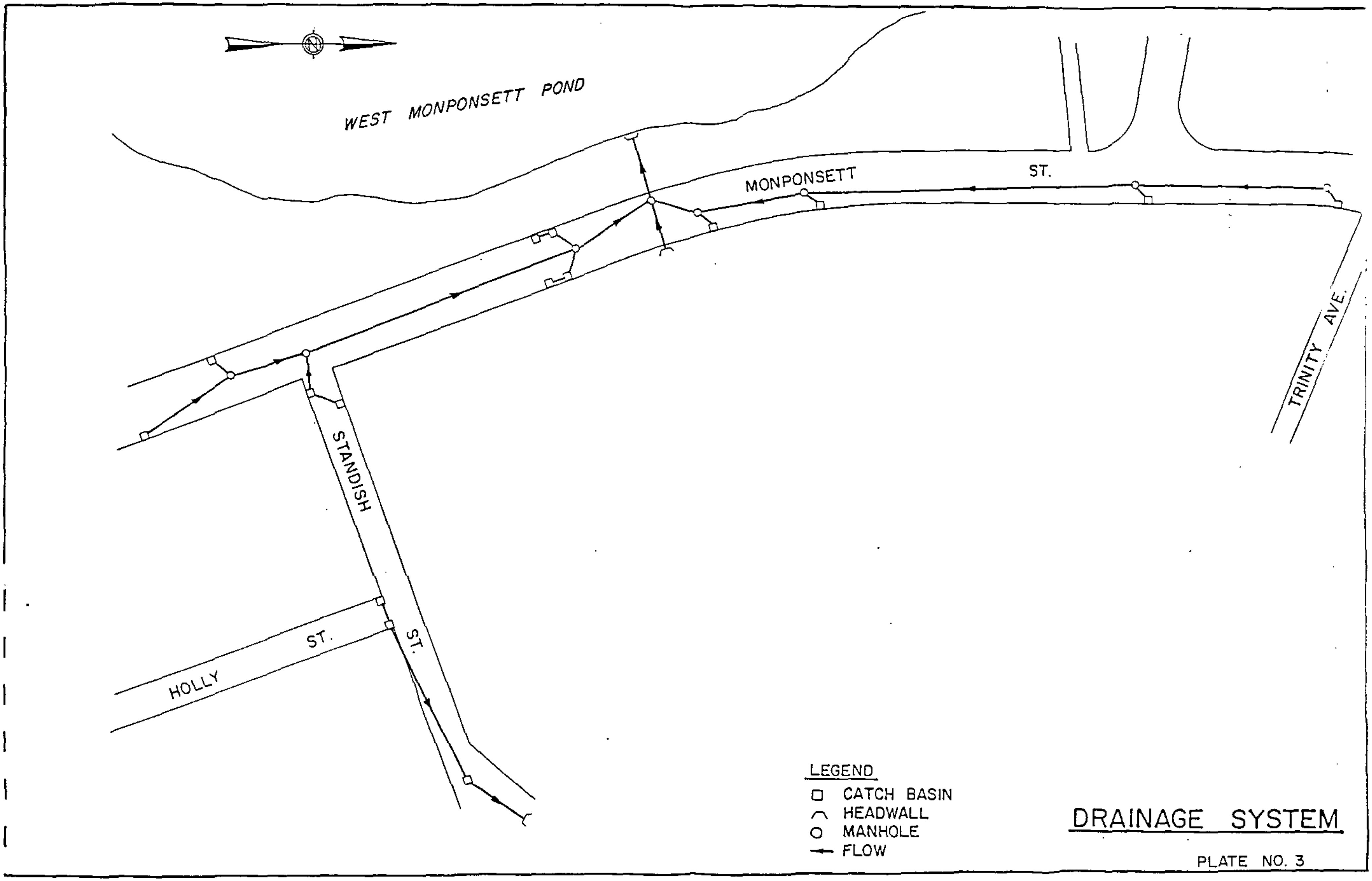
DRAINAGE SYSTEM

PLATE NO. 1



DRAINAGE SYSTEM

PLATE NO. 2



DRAINAGE SYSTEM

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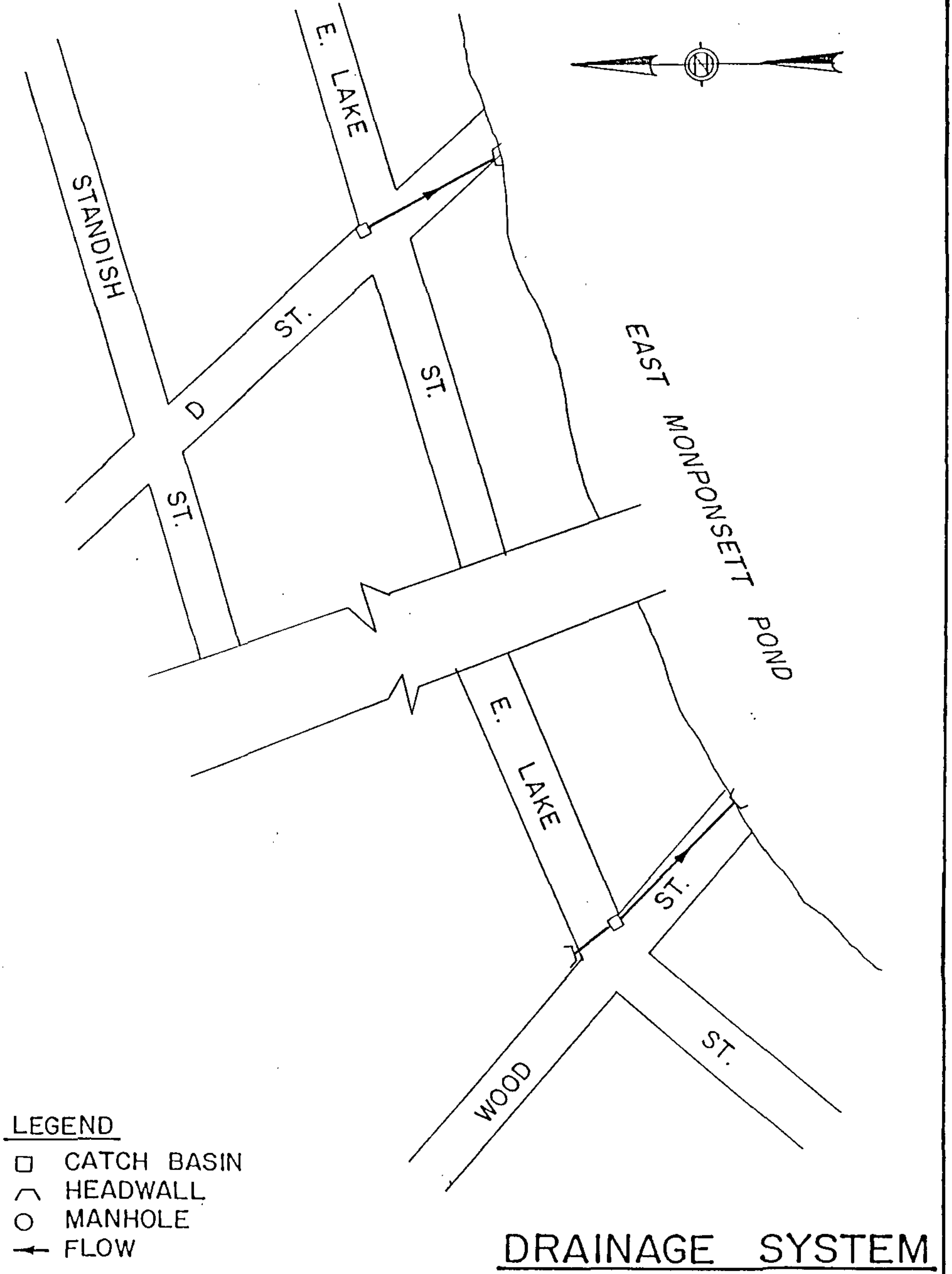
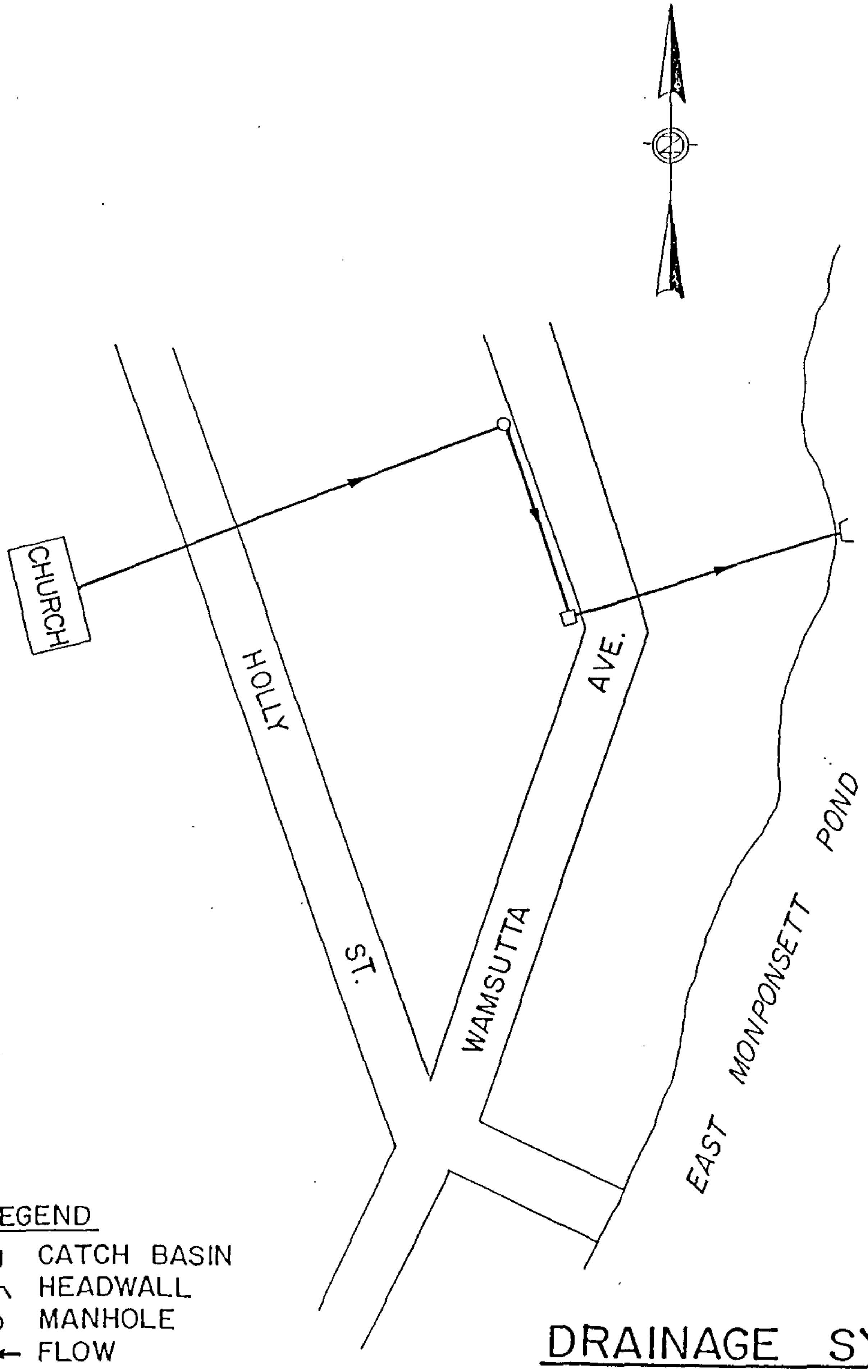


DRAINAGE SYSTEM

PLATE NO. 4

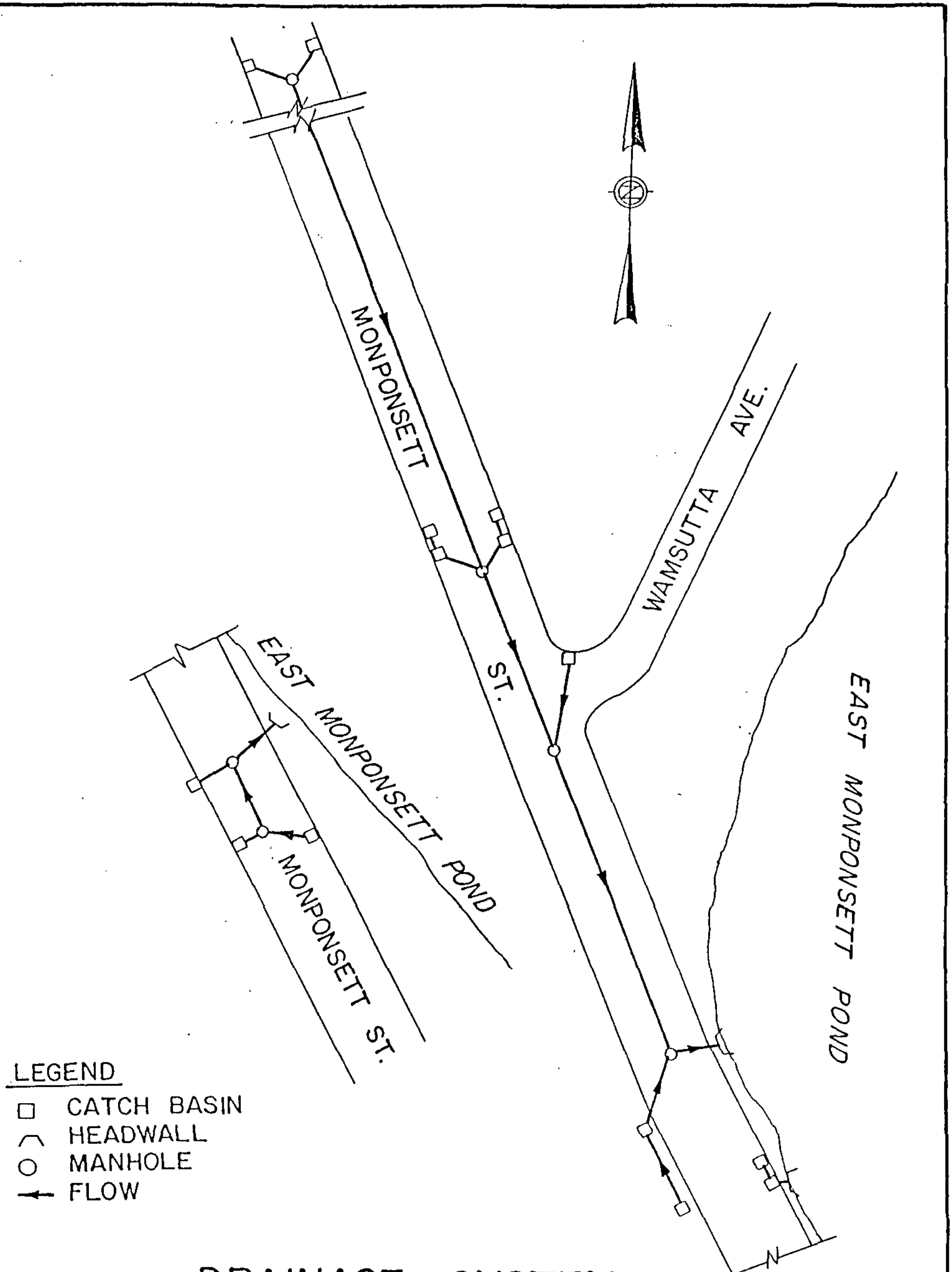


LEGEND

- □ CATCH BASIN
- ⌒ HEADWALL
- ○ MANHOLE
- ← FLOW

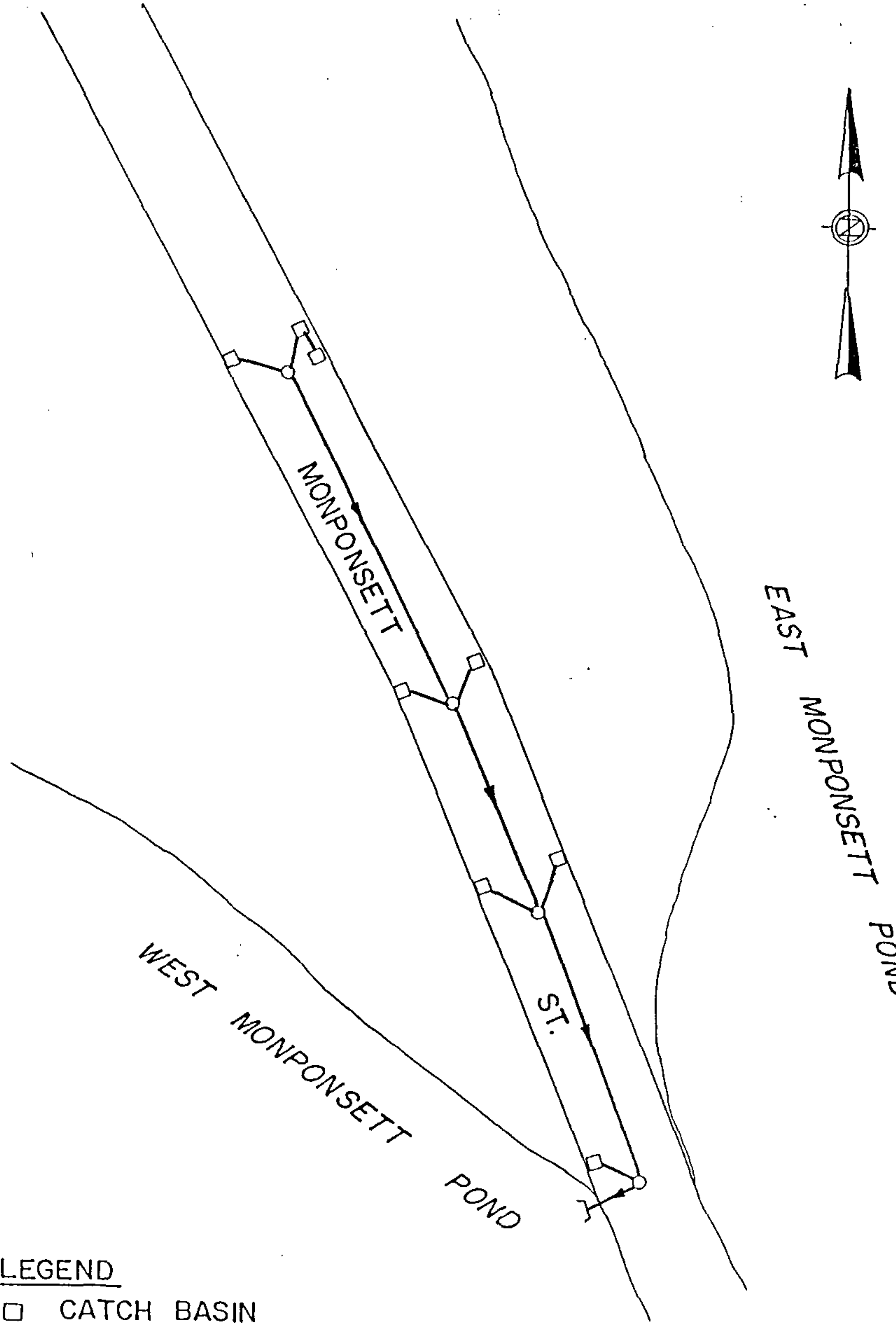
DRAINAGE SYSTEM

PLATE NO. 5



DRAINAGE SYSTEM

PLATE NO. 6

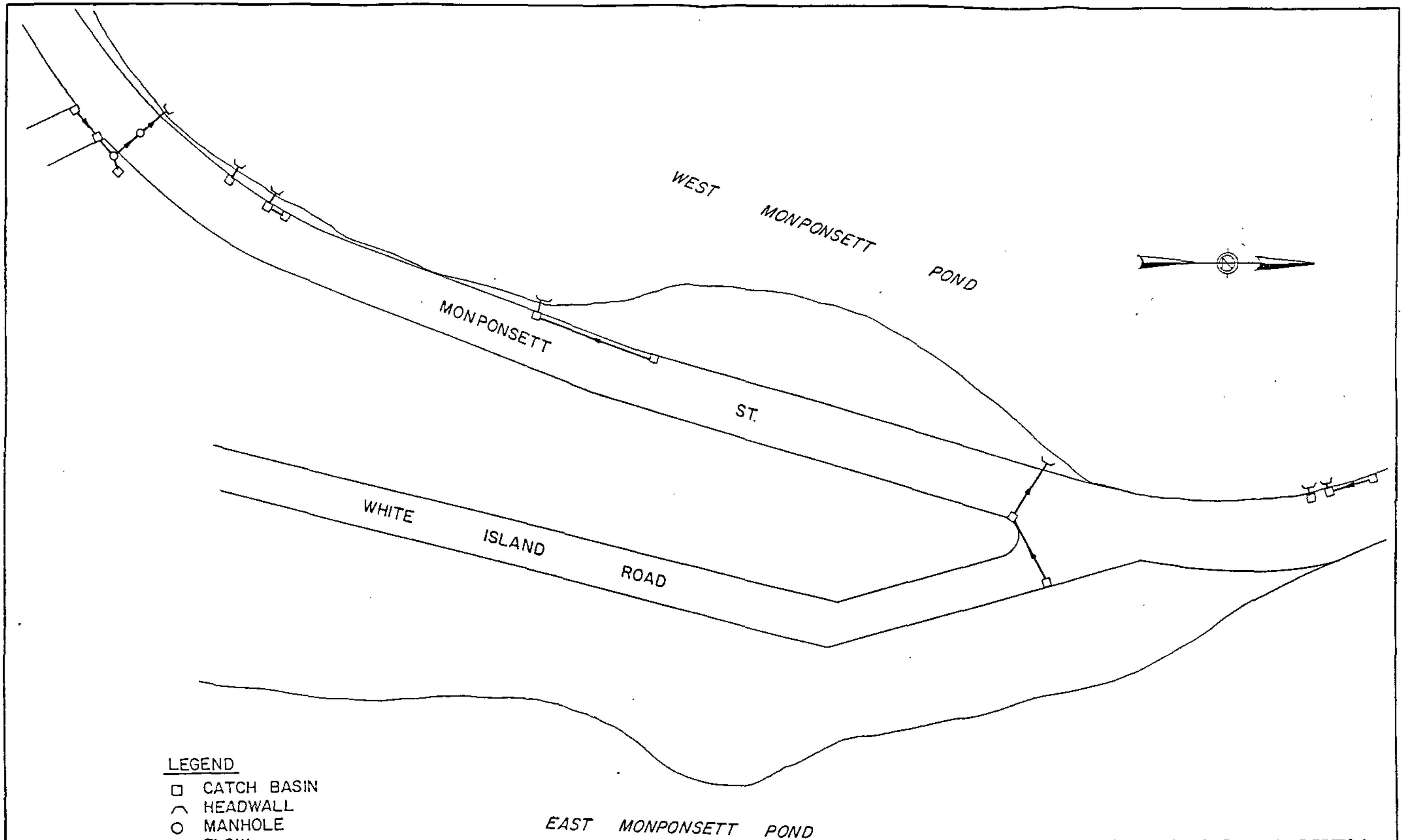


LEGEND

- □ CATCH BASIN
- ⌒ HEADWALL
- ○ MANHOLE
- ← FLOW

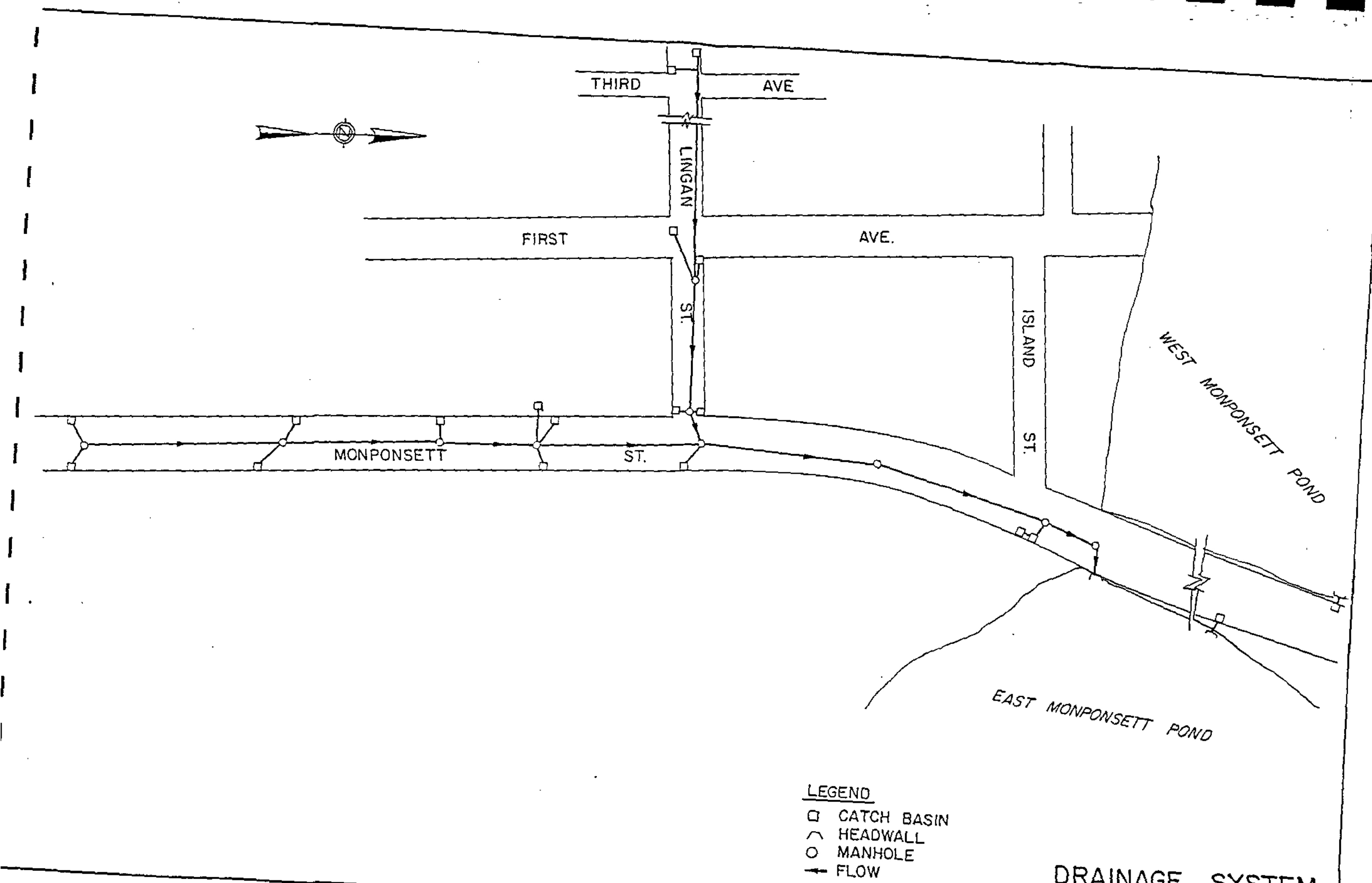
DRAINAGE SYSTEM

PLATE NO. 7



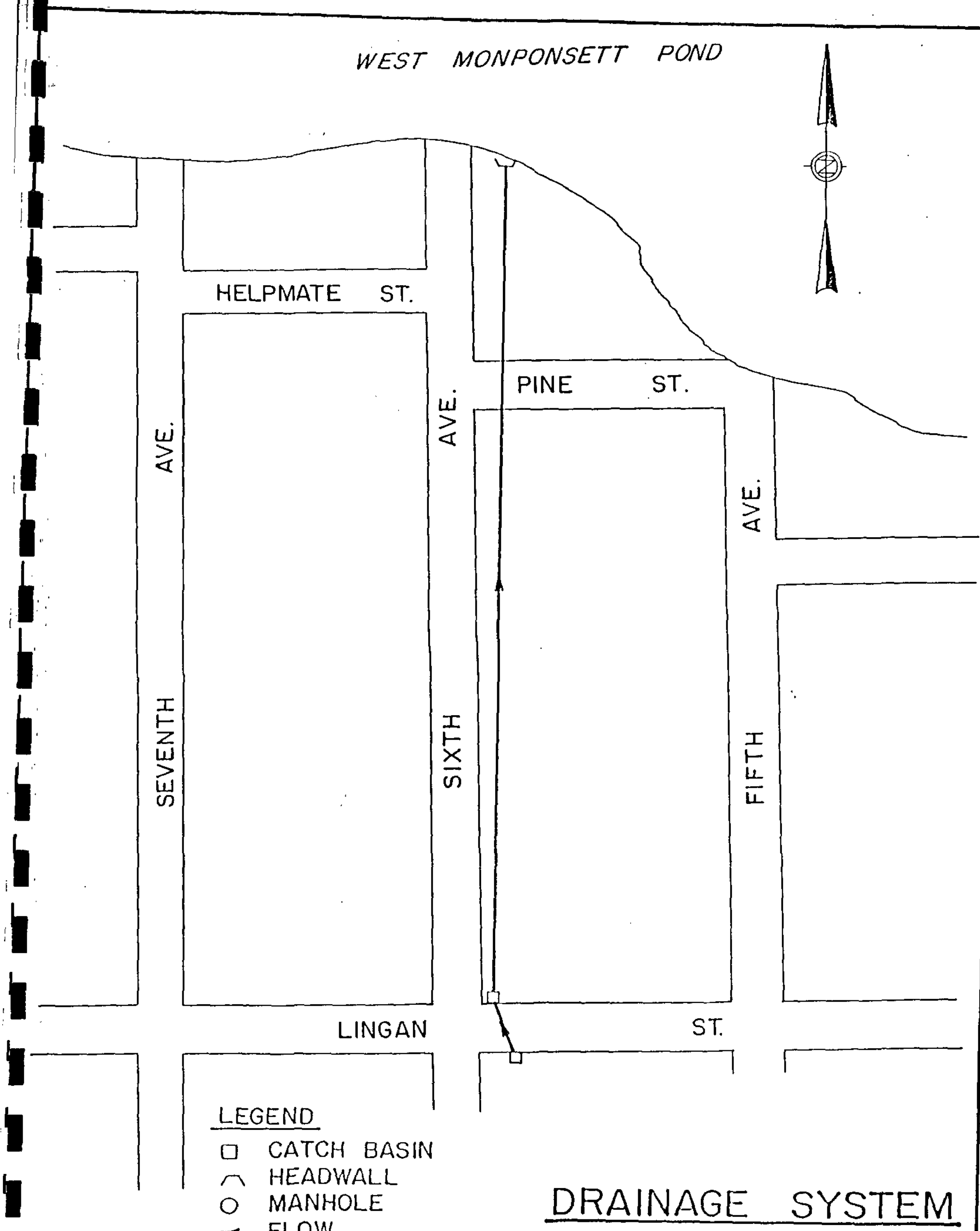
DRAINAGE SYSTEM

PLATE NO. 8



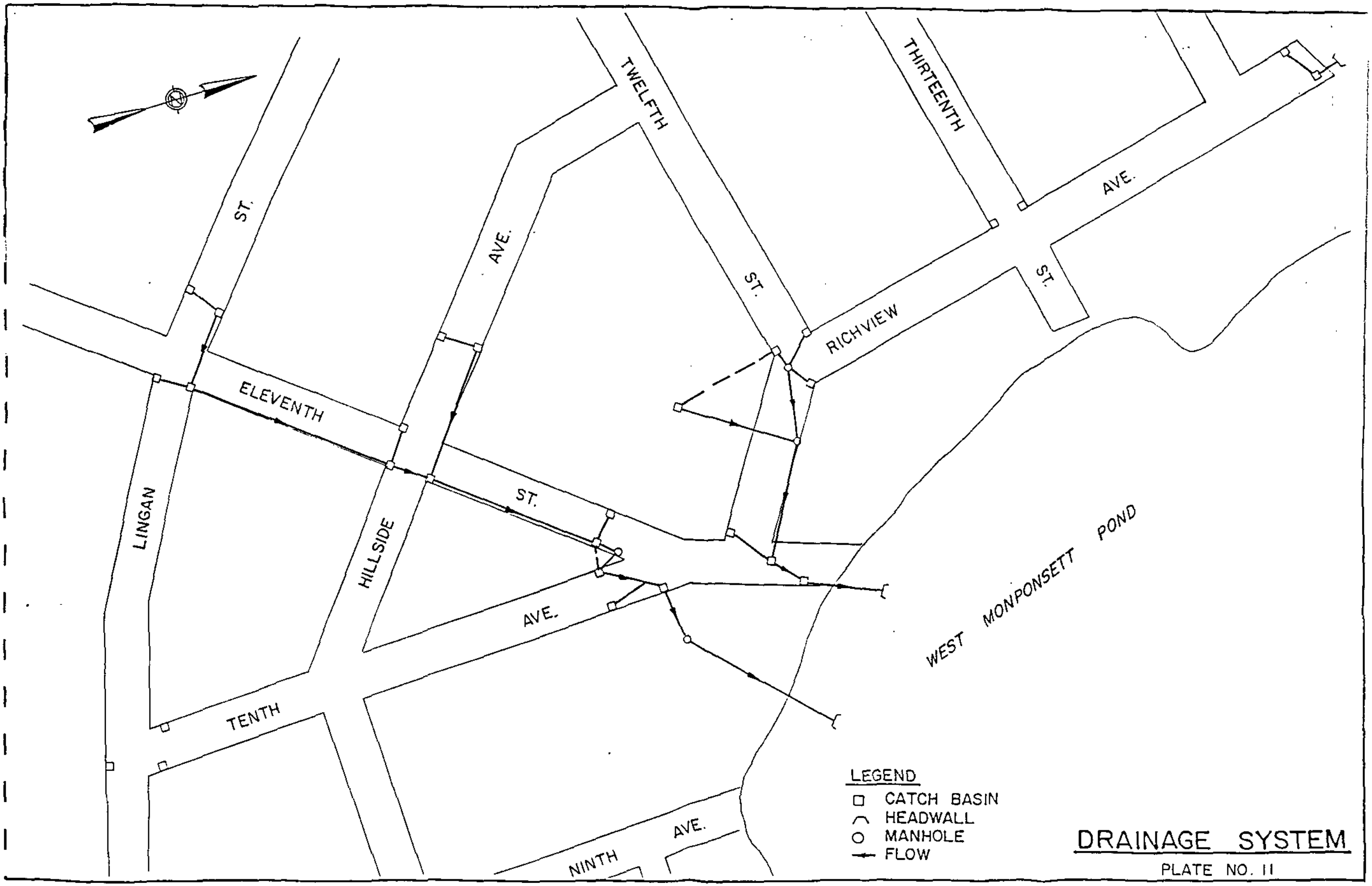
DRAINAGE SYSTEM

PLATE NO. 9



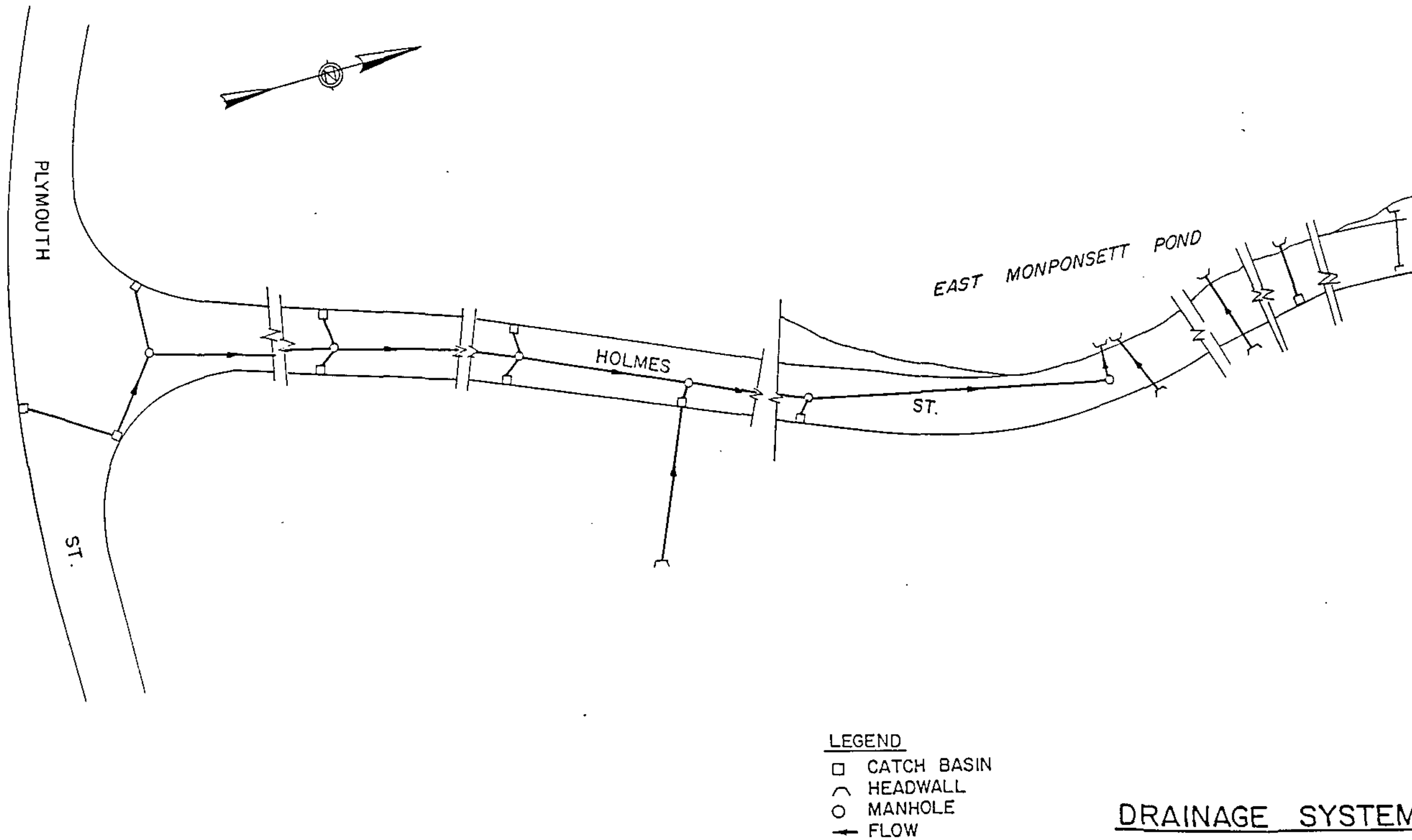
DRAINAGE SYSTEM

PLATE NO. 10



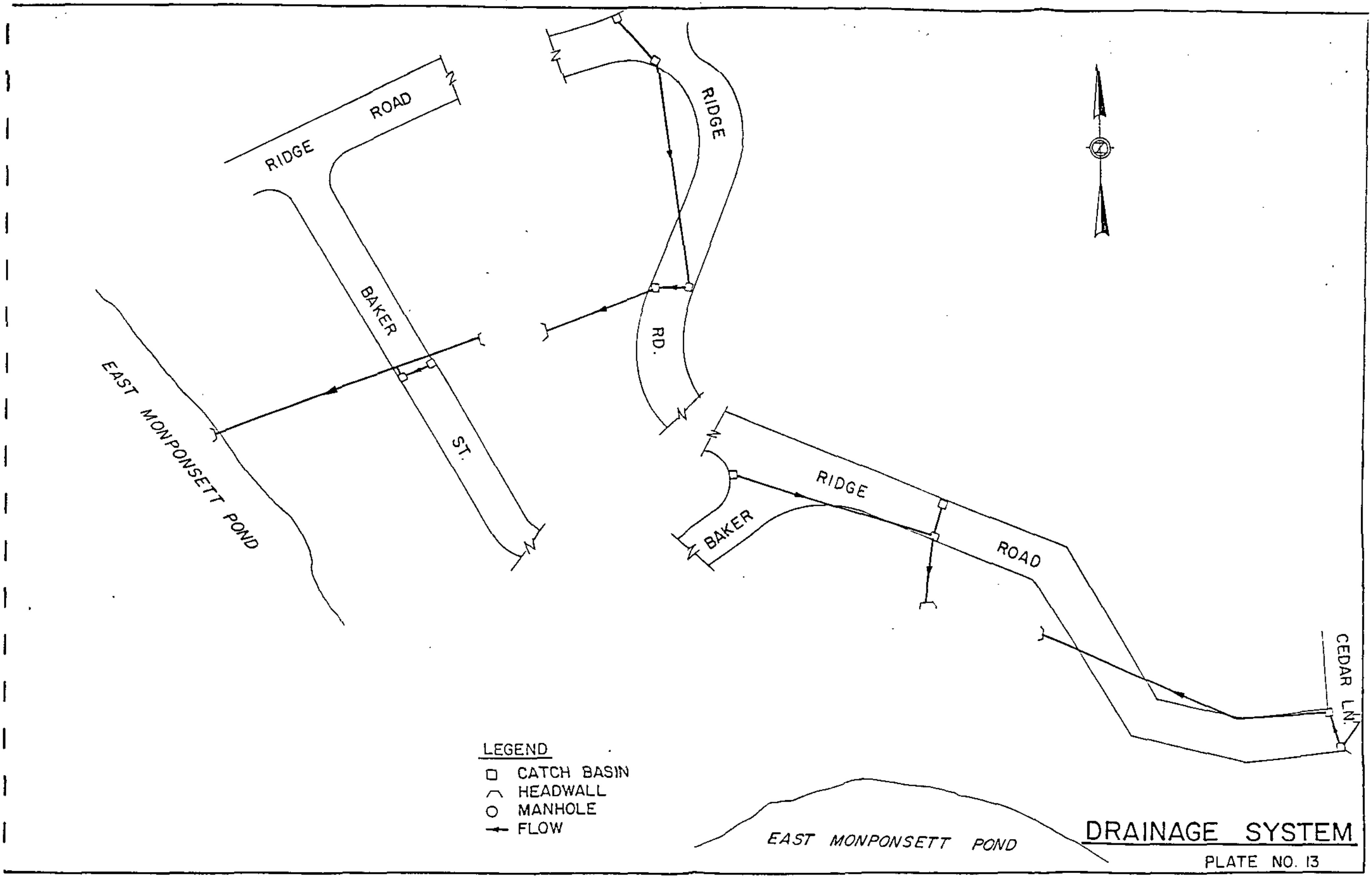
DRAINAGE SYSTEM

PLATE NO. 11



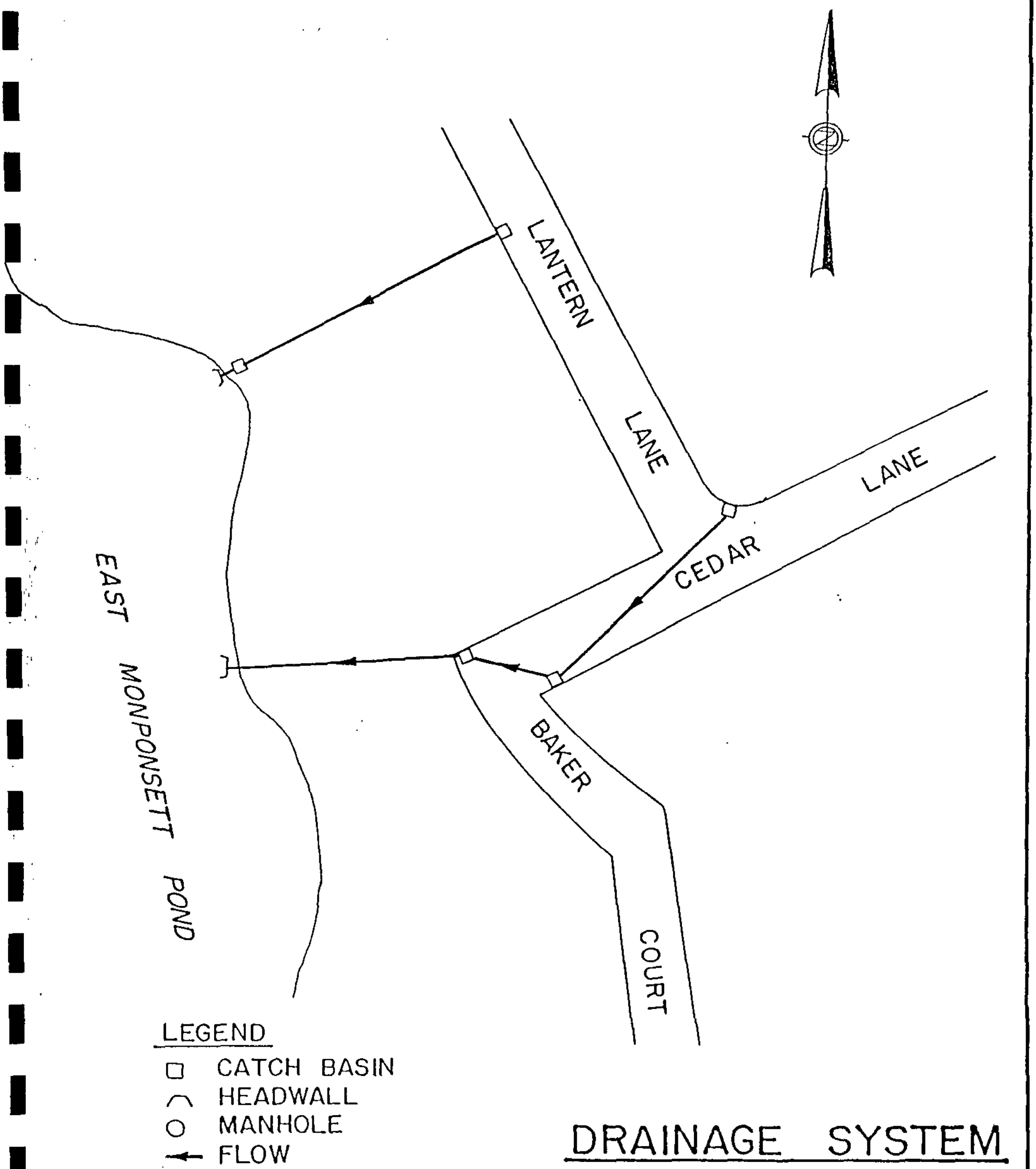
DRAINAGE SYSTEM

PLATE NO. 12



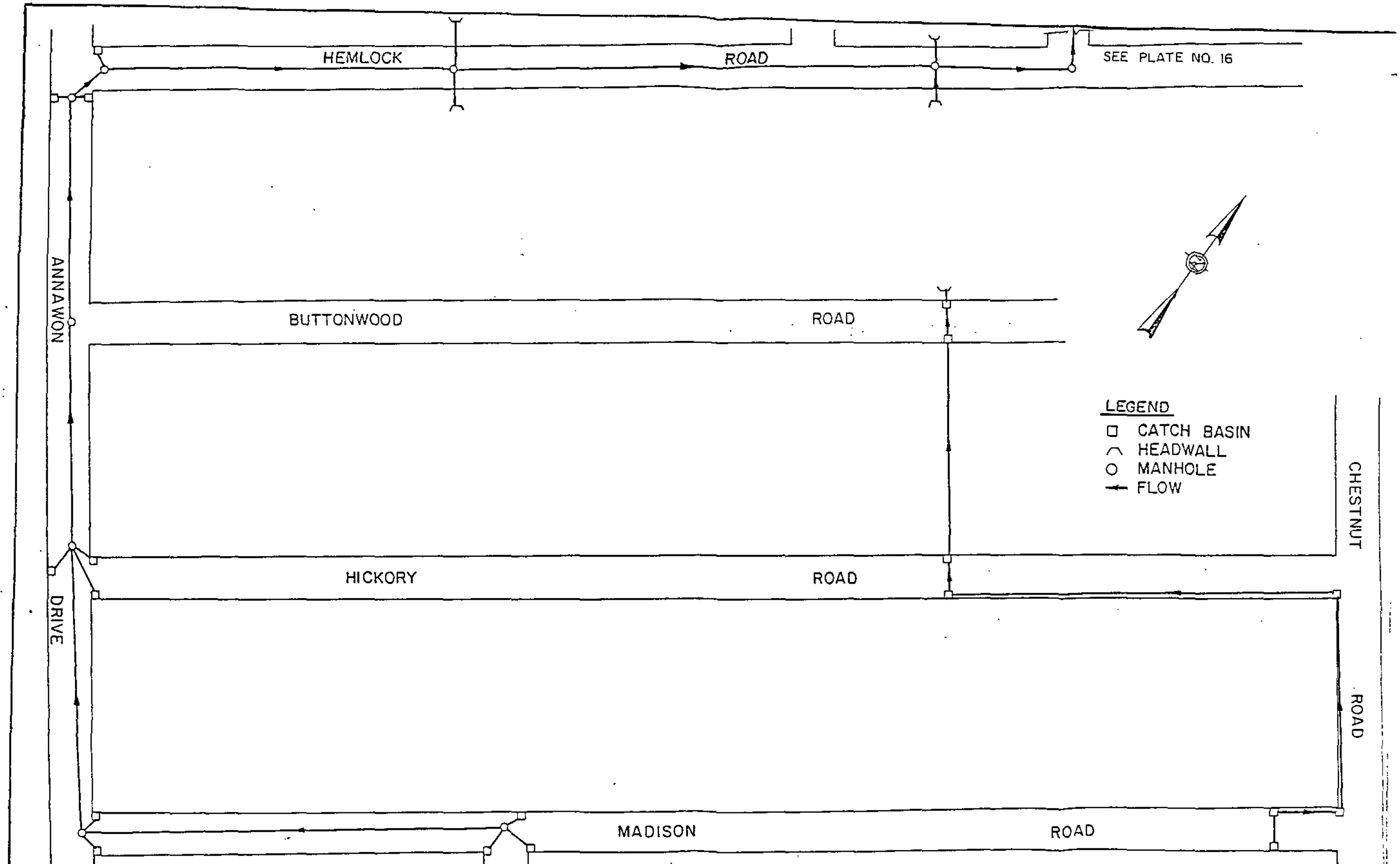
DRAINAGE SYSTEM

PLATE NO. 13



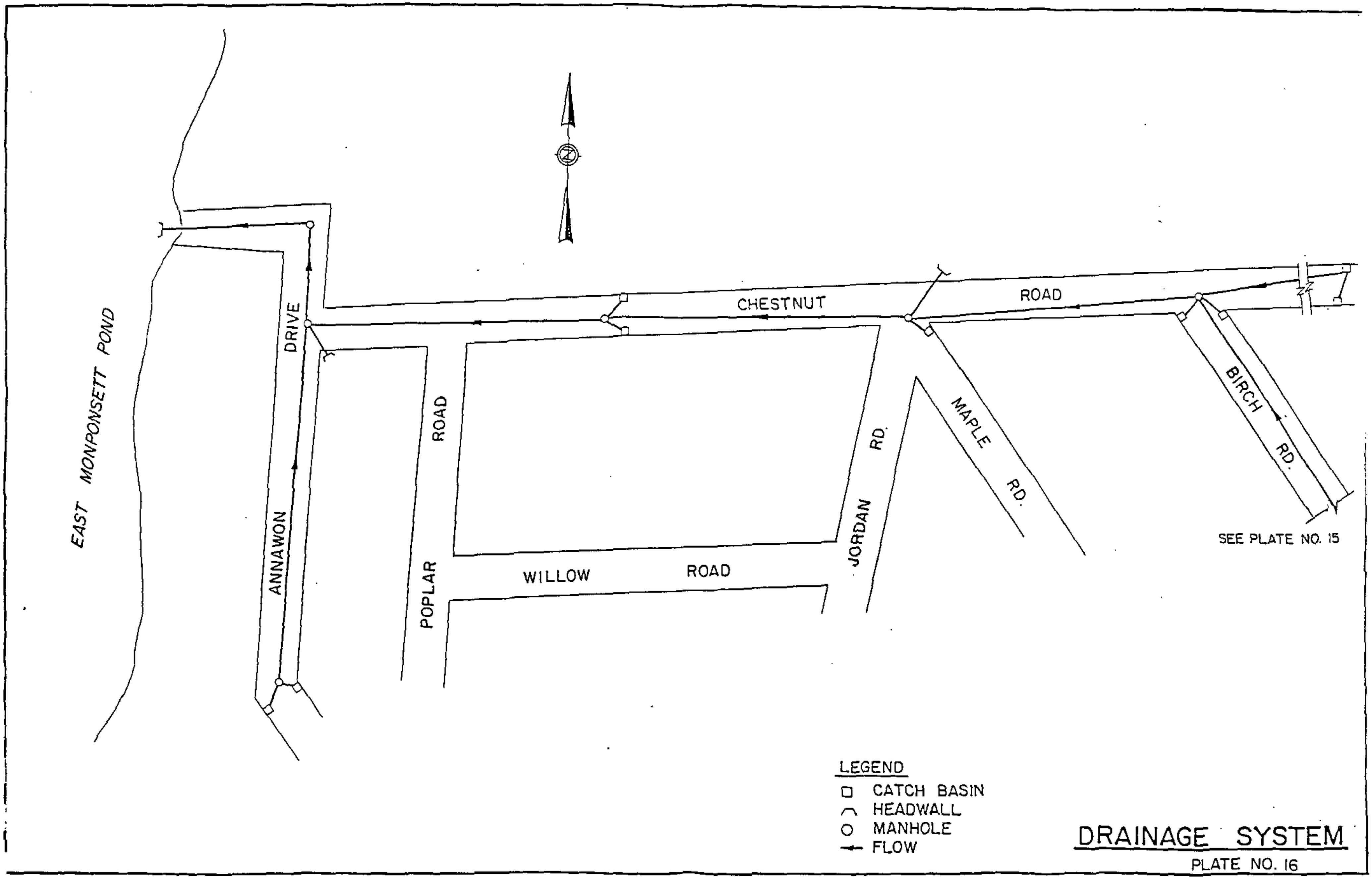
DRAINAGE SYSTEM

PLATE NO. 14



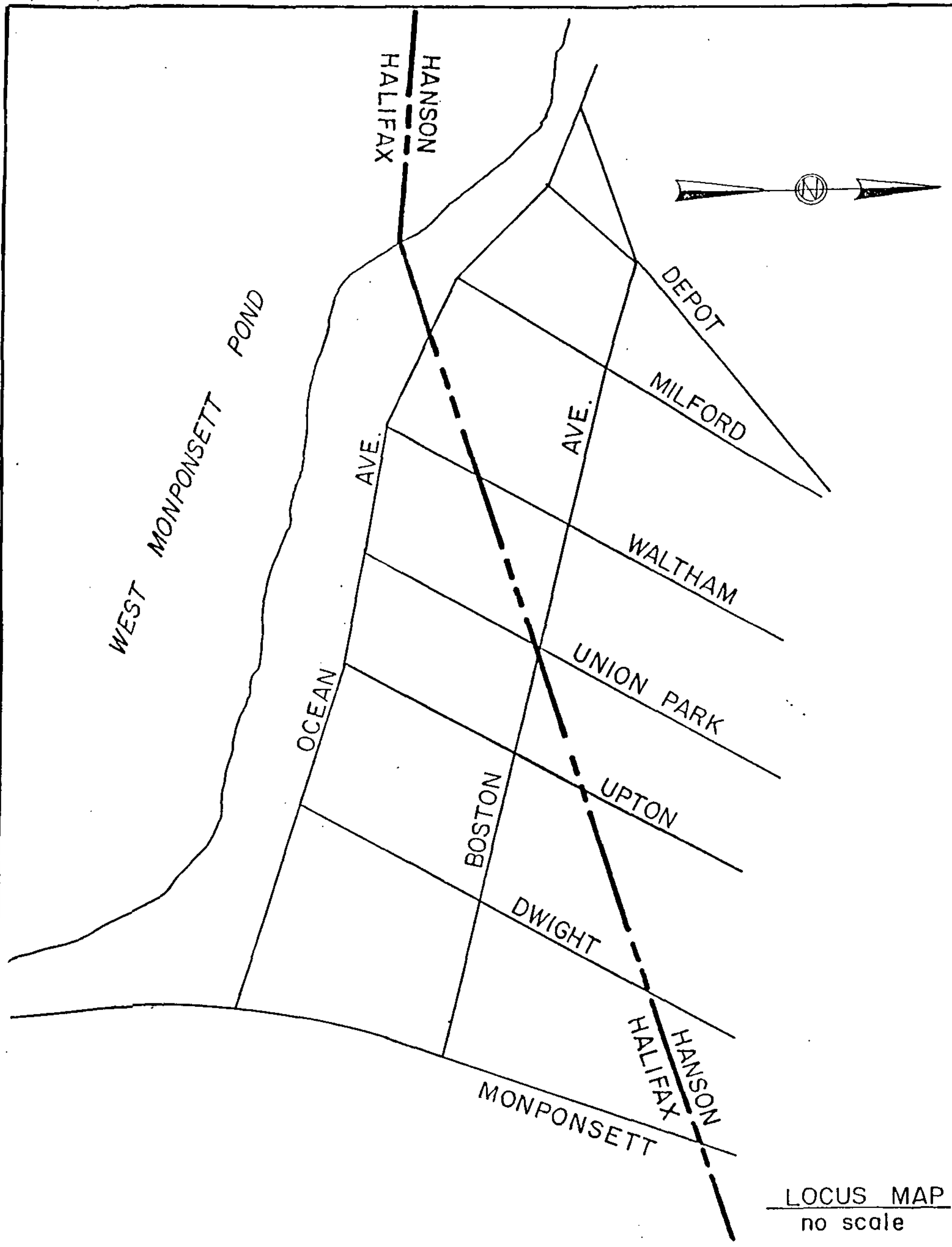
DRAINAGE SYSTEM

PLATE NO. 15

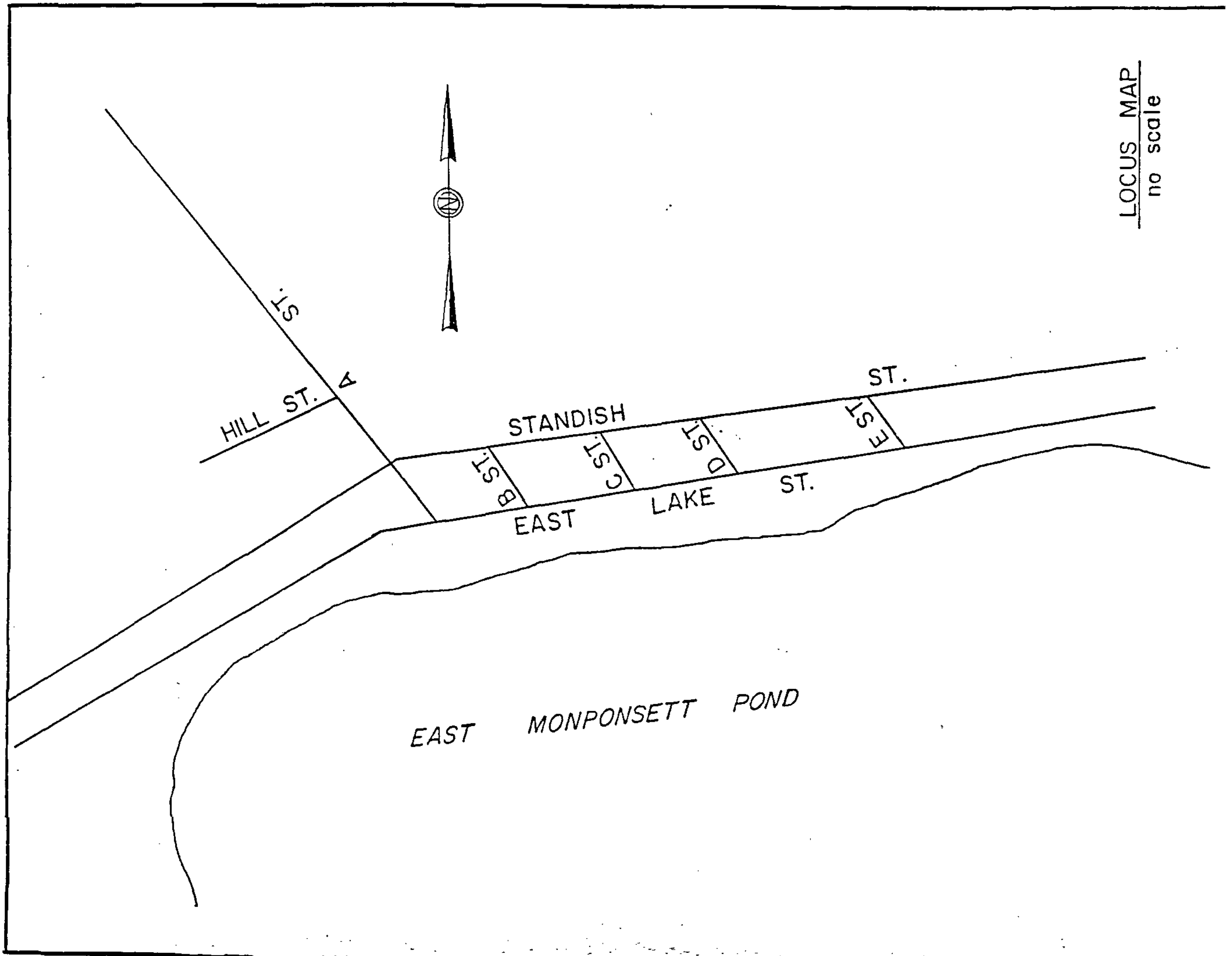


DRAINAGE SYSTEM

PLATE NO. 16



LOCUS MAP
no scale



LOCUS MAP
no scale
HILL ST.
A
ST.
STANDISH
ST.
B ST.
C ST.
D ST.
E ST.
EAST
LAKE
ST.
EAST MONPONSETT POND