People and the Sound

WATER MANAGEMENT

A Planning Report prepared for the New England River Basins Commission by the U.S. Environmental Protection Agency, and the States of New York and Connecticut

New England River Basins Commission

The Long Island Sound Regional Study is a "level B water and related land resources study." It was conducted under provisions of the federal Water Resources Planning Act of 1965. The Plan which has been developed was prepared by a team of federal, state, and regional officials, local citizens, and the scientific community, under the overall coordination of the New England River Basins Commission. It is a part of the Commission's comprehensive, coordinated joint plan for the water and related land resources of its region, which includes New England and the New York portions of Long Island Sound.

The plan for Long Island Sound recommends a program for action by federal, state, and local governments; it does not bind them to undertake specific recommended actions. To assist in the evaluation and implementation process, the following reports have been prepared:

A PLAN FOR LONG ISLAND SOUND: A SUMMARY. Highlights of the plan and a brief discussion of the rationale leading to recommendations.

A PLAN FOR LONG ISLAND SOUND: SUPPLEMENT. A more comprehensive planning document which enumerates the major alternatives considered in formulating the recommendations, together with an explanation of how the plan was prepared, who did the work, and background information organized both by subject matter and by geographical sub-regions of the Study Area.

PLANNING REPORTS. Each planning report was developed by a "Work Group," chaired by a federal agency, with the active participation of state and local agencies, other federal agencies and citizen and scientific advisors. These reports incorporate data (originally published in a series of Interim Reports) which estimate people's demands for the resources of the Sound region, the requirements needed to meet those demands, the existing capacity of the region to meet the requirements, and any deficiencies noted.

The second half of each planning report develops solutions by stating objectives in terms of satisfying defined needs, suggesting alternative ways to achieve the objective, evaluating each alternative in terms of environmental, economic, and social criteria, developing economic, environmental, and composite plans, and finally making recommendations.

The following Planning Reports were prepared:

Water Management by the U. S. Environmental Protection Agency, and the States of New York and Connecticut.

Land Use by Ralph M. Field and Associates for the U. S. Department of Housing and Urban Development.

Outdoor Recreation by the U. S. Department of the Interior, Bureau of Outdoor Recreation.

Fish and Wildlife by the U. S. Department of the Interior, Fish and Wildlife Service; and the U. S. Department of Commerce, National Marine Fisheries Service.

Shoreline Appearance and Design by the U. S. Department of the Interior, National Park Service and Roy Mann and Associates.

Marine Transportation by the U. S. Department of the Army, Corps of Engineers.

Power and the Environment by Federal Power Commission staff.

Mineral Resources and Mining by the U. S. Department of the Interior, Bureau of Mines.

Flood Damage Reduction by the U. S. Department of the Army, Corps of Engineers; and the U. S. Department of Agriculture, Soil Conservation Service.

Erosion and Sedimentation by the U. S. Department of the Army, Corps of Engineers; and the U. S. Department of Agriculture, Soil Conservation Service.

OTHER REPORTS published in conjunction with the Study are:

An Economic Perspective by the U. S. Department of Agriculture, Economic Research Service; and the U. S. Department of Commerce, Bureau of Economic Analysis. An examination of the economic and demographic trends in the region, with data for use as the basis of all projections made in the Study.

Shoreline Appearance and Design: A Planning Handbook by Roy Mann Associates, Inc., for the U. S. Department of the Interior, National Park Service. Recommended management procedures for protecting and enhancing the region's scenic resources.

Sources and Movement of Water by the U. S. Geological Survey, Water Resources Division; and the National Oceanic and Atmospheric Administration. A summary of the hydrology and climate of the region.

Soils by the U. S. Department of Agriculture, Soil Conservation Service. An inventory and analysis of soil composition in the region.

For a complete listing of reports published by or in conjunction with the Study, see Appendix A of the Supplement. Copies of these reports are available from:

New England River Basins Commission
55 Court Street
Boston, Mass. 02108

National Technical Information Service
Springfield, Va. 22151

WATER MANAGEMENT

a planning report

March, 1975

Long Island Sound Regional Study

New England River Basins Commission

270 Orange Street

New Haven, Connecticut 06511

A Staff Summary of Reports Prepared by

U.S. Environmental Protection Agency
Connecticut Dept. of Environmental Protection
New York State Dept. of Environmental Conservation

FOREWORD

Long Island Sound is one of the nation's unique and irreplaceable natural resources. An almost fully enclosed arm of the ocean, it has over 1300 square miles of water surface and over 600 miles of coastline. Spreading eastward along both shores from the great metropolitan center which lies at the Sound's western end, a growing concentration of increasingly affluent people make ever greater demands on this urban sea. At the same time, there is a growing feeling that the conflicting demands are destroying the Sound, and that the problems must be resolved if the Sound is to be preserved.

The Long Island Sound Regional Study is a comprehensive planning effort by the Federal government and New York and Connecticut, led by the New England River Basins Commission. Assisting the Commission are professionals from many disciplines representing the Federal, State and regional agencies listed on the back cover, a Citizen Advisory Committee, and a Research/Planning Adivsory Committee composed of members of the region's scientific community.

> THE GOAL OF THE STUDY IS TO PRODUCE A PLAN OF ACTION BY SPRING 1975, WHICH BALANCES THE NEEDS TO PROTECT, CONSERVE AND WISELY DEVELOP THE SOUND AND ITS RELATED SHORELANDS AS A MAJOR ECONOMIC AND LIFE-ENRICHING RESOURCE FOR THE 12 MILLION PEOPLE WHO LIVE NEAR IT.

This planning report is one of a series. The water management planning report encompasses both the water quality and water supply elements of the Long Island Sound Study. The first-half of the report examines the existing water supply situation and water quality problems and ongoing programs within the study area. The second-half of this report is solution oriented. It formulates tentative objectives and alternative measures for achieving the objectives. It develops an environmental and an economic plan. It tentatively recommends one plan. The planning reports are printed and distributed before the final version of the main report. Therefore, final recommendations are to be found only in the main report, scheduled for publication in the Spring of 1975. Planning reports in the series include:

Land Use	Fish and Wildlife
Water Management	Recreation
Flood Damage Reduction	Transportation
Erosion & Sedimentation	Minerals
Shoreline Appearance & Design	Power & the Environment

SUMMARY

INTRODUCTION

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The water management planning report encompasses both the water quality and water supply elements of the Long Island Sound Study. The first-half of the report examines the existing water supply situation and water quality problems and ongoing programs within the study area. The second-half of the report is solution oriented. It formulates tentative objectives and alternative measures for achieving the objectives. It develops an environmental and an economic plan. It tentatively recommends one plan. This initial recommended plan is then further modified to improve its relationship to all other plans and to reflect input from public meetings.

WHAT DOES THE PUBLIC WANT?

The public wants sufficient supplies of high quality water to meet future drinking water demands. Additionally, the public wants the Long Island Sound waters to be clean enough for the highest uses society wishes to make of them now and in the future.

WHAT IS THE EXISTING WATER SUPPLY SITUATION?

The water supply situation for the Long Island Sound region is best summarized on a state basis. This is preferred due to the sources of supply. The Connecticut region relies primarily on surface water sources with some ground water also utilized. The New York region, with the exception of Westchester County and the Boroughs of Bronx and Queens which rely on the New York City system, is supplied almost entirely by ground water sources.

Connecticut has water systems serving less than 100 people, as well as systems serving more than 300,000 people. Safe yields vary from 10,000 gallons of water per day to 89 million gallons per day, indicating the degree of system variability. In 1970, approximately 85 percent of the Connecticut population residing within the LIS study region, or about 1.3 million people, obtained their water from public water supply systems. The average demand for drinking water generated by this population was nearly 212 million gallons per day (MGD). The developed sources of supply have a capacity of more than 278 MGD. Many of the Connecticut water systems are under pressure to open their reservoir and watershed lands to multi-purpose use. The state has developed a general policy to protect water supply watersheds in general and water supply reservoirs in particular. One other area that warrants further evaluation is the large number of small water systems that presently exist in Connecticut and, to a lesser degree, in Nassau and Suffolk Counties in New York. Many health officials have advocated the consolidation of numerous smaller water systems into a few larger systems, and there are many reasons for this position.

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In New York, about 6.2 million people or 96 percent of the total population in and around the LIS region (Westchester County, Bronx, Queens, and all of Nassau and Suffolk Counties) consumed about 927 MGD in 1970. Developed sources of supply have a capacity of 2,320 MGD. However, this figure includes the capacity of the entire New York City system whose 1970 demand is only partially reflected in the consumption total. Approximately 900 MGD was delivered to that part of New York City and upstate areas not included in the study area. In fact, the New York City system pumped an amount greater than its safe yield in 1970.

In the New York area, there is a great variation in the water systems. Westchester County and the Boroughs of Bronx and Queens are supplied for the most part by the New York City System, whose major service area lies outside of the LIS region. Nassau and Suffolk Counties depend entirely on ground water. Probably the most critical water supply problems in the New York area are the pollution and over-development of ground water in certain parts of Long Island. This once abundant supply of good quality water is gradually showing the effects of man's activities. Numerous reports, for example, have shown increased nitrate levels at various wells throughout Long Island. An additional problem facing the Long Island water supplies is the growth of sewered areas. Previously, wastewater was discharged to the ground water through individual home septic systems, but the resulting ground water pollution brought about massive sewering programs. Replenishment of ground water sources is not as extensive if wastewater is collected by sewer systems and discharged to the Sound or the ocean.

WHAT IS THE EXISTING WATER QUALITY SITUATION WITHIN THE STUDY AREA?

The existing water quality of Long Island Sound varies considerably. The poorest quality is found at Throgs Neck in the western terminus. From Hempstead Harbor, eastward, the water quality is fairly uniform and of intermediate quality. From the Connecticut River, eastward, the water quality is good. In New York, there are water quality problems in Port Chester-Byram River and harbors and embayments of Westchester County, Upper East River, Little Neck Bay, Manhasset Bay, Hempstead Harbor, and Port Jefferson, and there is a growing concern about the quality of ground water in the Long Island aquifers. In Connecticut's portion of the study area, problems of water quality exist in the Connecticut River, Housatonic River, Stamford Harbor, Thames and Oxoboxo River, Quinnipiac River, Stonington Harbor, and the Pawcatuck River.

Major sources of pollution in the Long Island Sound include: municipal and industrial wastes, overflows from combined sewers, non-point sources, wastes from pleasure craft and other boats, oil and other hazardous materials spilled from ships and also from bulk storage areas, heated water inputs from power plants and inflows from polluted rivers.

The prevention of water pollution has traditionally been a multi-agency, multi-purpose program effort involving private citizens and industries as well as local, state, interstate, and Federal cooperation. Connecticut began its comprehensive approach towards the problems of water pollution control with the passage of the Connecticut Clean Water Act of 1967.

The basis of the New York State Water Pollution Control Program is Article 17 of the Environmental Conservation Law, which was originally enacted in 1949 and enumerates the Water Pollution Control Policy and the duties of the New York State Department of Environmental Conservation.

The 1972 Federal Water Pollution Control Act Amendments create a water pollution control program based on three major elements; uniform nationwide standards, enforceable regulations, and a permit program based on effluent limits and geared to specific goals. The Connecticut, New York, and Federal water pollution laws provide a framework in which all levels of government may act to abate water pollution.

WHAT ARE THE MAJOR UNRESOLVED PROBLEMS?

The major unresolved water management problems in the LISS area are: (1) cumulative stress of pollution on Long Island Sound; (2) protecting Long Island's ground water resources; (3) land use impact on water quality; (4) closed shellfish beds and recreational swimming areas; (5) protection of Connecticut's water supply sources; and (6) inadequate funding for water quality management.

PLANNING OBJECTIVES

There are two co-equal objectives, as established by the U.S. Water Resources Council: ENVIRONMENTAL QUALITY AND NATIONAL ECONOMIC DEVELOPMENT. The National Economic Development objectives are to meet, as a minimum, existing Federal-state water quality standards. The Environmental Quality objectives are to achieve water of suitable quality to provide for recreation "in and on" all waters throughout the study area and to provide for the propagation of fish, shellfish, and wildlife (swimmable-fishable waters). The objective of both plans is to provide sufficient supplies of potable water to meet future demands.

EVALUATION OF ALTERNATIVES

The intent of this section is to describe and evaluate alternative water management techniques. A mixture of these measures will be needed to achieve the water management objectives.

FORMULATION AND EVALUATION OF ALTERNATIVE PLANS

In this section, three plans are formulated, one emphasizing the environmental quality objective (EQ), one emphasizing the national economic development objectives (NED), and a composite plan. The short-term composite plan first responds to the NED goals. Once these goals are achieved, it recommends measures which will allow attainment of the EQ objectives.

WORK GROUP RECOMMENDATIONS

A composite plan is recommended to be implemented within the study area which will provide an adequate supply of water for drinking and swimmable-fishable water for recreation and other uses by 1990. The composite plan emphasizes "best practicable treatment" for municipalities; "best available treatment" for industries; cost-effective programs to abate combined sewer pollution; land management measures to reduce non-point pollution; no discharge areas; development of a comprehensive program to mitigate the environmental effects of dredging and disposal in the LISS area and water quality management programs for the future.

TABLE OF CONTENTS

1.0 INTRODUCTION

The water management planning report encompasses both the water quality and water supply elements of the Long Island Sound Study. The purpose of this planning report is to assemble information on (1) the sources of pollution entering the Long Island Sound region (LISS Region), (2) the potential impacts on water quality of identifiable sources of pollution, (3) the existing and proposed programs to abate or regulate sources of pollution, and (4) current and projected supplies and demands of the public water systems in the region. Additionally, the report evaluates various water quality management techniques and water supply alternatives with their associated environmental, social, and economic impacts.

To accomplish its purpose, the first half of the report examines the existing situation within the study area. It is divided into two sections. The first describes the water supply situation in the study area, and the second outlines the water quality problems and ongoing programs.

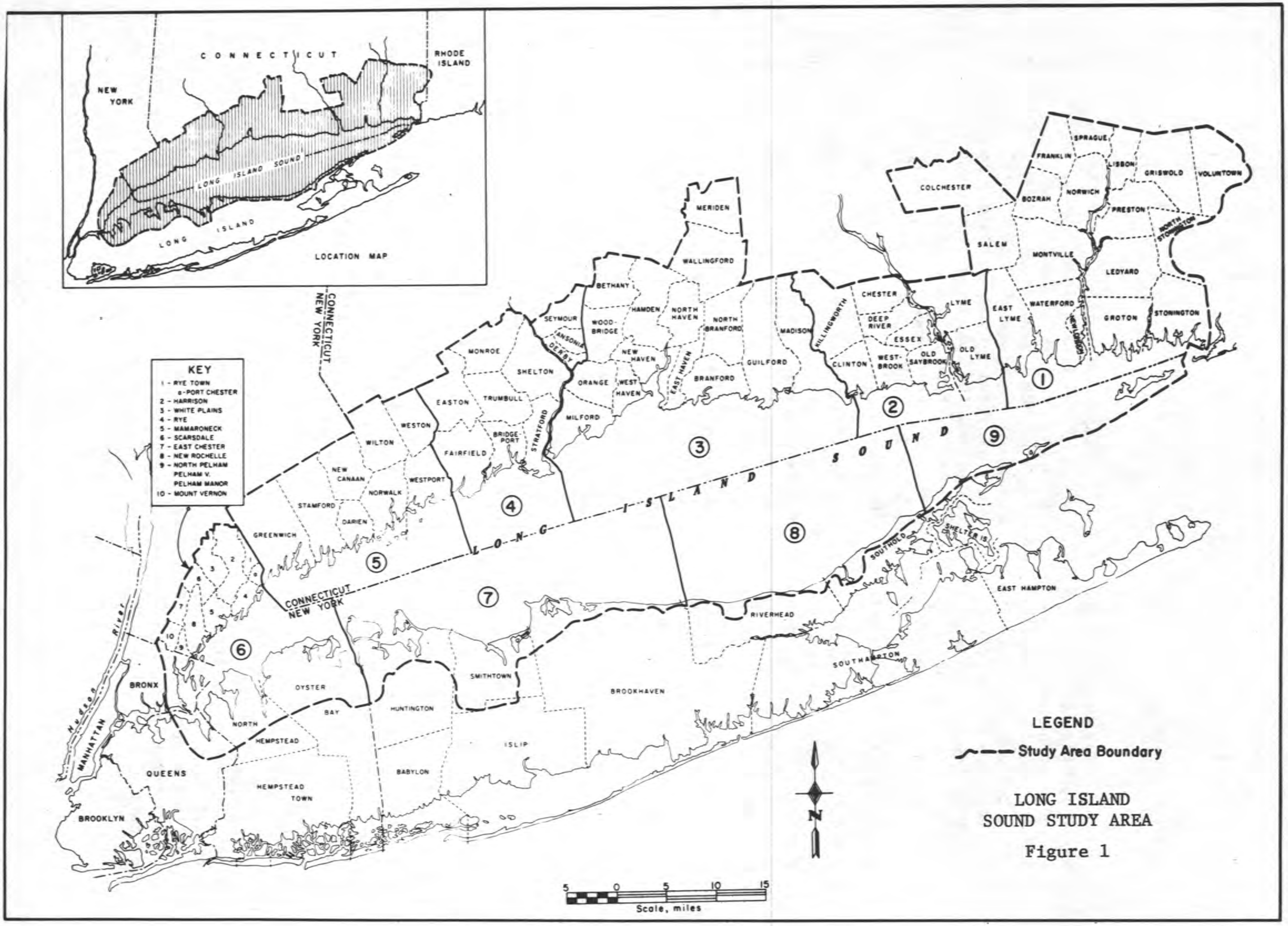
The second half of the report is solution-oriented. It:

- Formulates objectives.
- Identifies alternative measures for achieving the objectives.
- Evaluates the alternatives environmentally, economically, and socially.
- Formulates three alternative plans - stressing environmental quality, national economic development and a composite of the two, and
- Recommends a plan.

2.0 WHAT DOES THE PUBLIC WANT?

The public wants a sufficient supply of water meeting state drinking water standards available to meet both the Connecticut and New York portion of the LIS region's drinking water demands. Additionally, transmission and distribution capability to deliver the water to the point of need must be developed to accomodate both average and peak demands upon the water supply system.

Furthermore, the present day public, increasingly affluent, mobile and leisure orientated, wants the water clean enough for swimming and fishing, as well as satisfying other municipal and industrial requirements. The public has vocally expressed their concern over what they felt to be the deteriorating quality of the Sound's waters at an Enforcement Conference held on April 13 and 14, 1972.



LONG ISLAND
SOUND STUDY AREA
Figure 1

This concern over the deteriorating quality of the Sound's waters was hardly new. During the sixties, citizen activists in increasing numbers were taking their concern to county board meetings, State legislatures, enforcement conferences, Congress and the courts.

As a result of this activity, in November 1965, New York citizens went to the polls and delivered a decisive four-to-one referendum vote approving New York State's billion dollar "Pure Water Program". During the same year, a Clean Water Task Force composed of 100 Connecticut citizens was appointed to recommend means of eliminating pollution of Connecticut's waters. The recommendations of the task force were translated into Connecticut's Clean Water Act of 1967. This action strengthened Connecticut's commitment to clean the waters in and entering into Long Island Sound. On October 18, 1972, public pressure convinced the U.S. Congress to pass the Federal Water Pollution Control Act of 1972. This new law is predicated on two national goals: the elimination of discharge of pollutants into our nation's waters by 1985 and an interim attainment by July 1, 1983 of water quality which provides for protection of fish and wildlife and for recreation.

3.0 WHAT IS THE EXISTING PUBLIC WATER SUPPLY SITUATION?

Within the Long Island Study area, the sources of supply for public water systems vary greatly. Communities in Connecticut and Westchester County, New York rely extensively on surface water to meet their water supply demands. Long Island, on the other hand, relies almost exclusively on ground water sources in Nassau and Suffolk Counties.

The variations in service can best be explained on a subregional basis. The boundaries of the subregions and towns within the LIS area are shown in Figure 1. To facilitate the following discussion, brief definitions of some of the terms used are in order. In presenting water supply demands and needs, reference is made to population, population served, average day demand, estimated safe yield, needs, and per capita use. Population is simply the number of people in a community or in a water system service area. The 1970 population is based on census figures, while 1990 and 2020 population estimates are developed by the Bureau of Economic Analysis, U.S. Department of Commerce. The population served is an estimate of the number of people served by a public water supply system. This figure does not include those people having individual water supplies, i.e., private wells. The population served figure, expressed as a percentage, will increase as an area is further urbanized. The populations served estimates are calculated based on historical data for New England, and the figures refer primarily to the number of domestic customers. Self-supplied industrial users have not been considered in this part of the LIS study. Their demand includes brackish water for cooling and fresh water primarily from surface sources, used for cooling and boiler feed pruposes. The greatest industrial demand occurs in Subregions 1, 3 and 4, and sufficient sources of water are available. Consumptive uses are negligible, and discharges from these industries are generally to the approximate stream location of the water supply intake. Therefore, there is minimal impact on water resources for water supply.

The average day demand quantity is the one-year total amount of water required by a community or water system divided by the number of days in a year, thereby yielding a quantity per day figure. The safe yield figure for a water system is considered the reliable amount of water which can be provided by the system over a period of years, including drought years. In Connecticut, safe yield is generally the developed capacity of the existing water supply system. On Long Island, it is the quantity of water that can be pumped without introducing effects that are judged to be "undesirable". There is a great deal of difference among informed people as to what is undesirable and the degree of undesirability. This subject is dealt with more substantially in the interim report on water supply.

The needs estimate of a community is simply the average day demand of the community minus the safe yield of the community water system. Finally, per capita use is a measure of the average day demand divided by the population served. Large variations are common from one town to another, and the major cause is the amount of industrial water supplied by the public water system. A residential community with little demand from industrial or commercial concerns will normally have a per capita use figure ranging from 75 to 100 gallons per day. However, in larger communities where industry and business demands are met by public systems, per capita use of 200 gallons per day is not uncommon. Other factors which influence the per capita use figures are increased sewering, influx of seasonal residents, system leakage, and affluence of the consumer. It is important to remember that for the most part the usage of water is not consumptive, and water ultimately returns to ground water and surface water bodies.

Connecticut's future water supply needs are estimated using the 1970 per capita use figures for each community or system and increasing it by 1 percent per year up to 1990 and by 0.5 percent from 1990 to 2020. The values obtained are multiplied by the anticipated populations served in the target years of 1990 and 2020. The New York State Department of Environmental Conservation prepared the New York portion of the study and chose to use 1990 and 2020 water demands developed in New York State-sponsored studies.

3.1 Subregion 1

The Southeastern Connecticut Planning Agency made an extensive survey (1) of the existing water supply systems as well as compiling and proposing alternative plans for future supply for the area. (The Southeastern Connecticut Water Authority was a joint partner in the preparation of these reports.) The information supplied by this effort, as well as material developed by the State of Connecticut, has served as a basis from which this current report for the LIS study is prepared.

In Subregion 1, there are approximately 75 water systems serving the eighteen communities. In 1970, about 69 percent, or approximately

1 - Underlined numerals in parentheses are references in Appendix A.

143,000 people were served by public utilities. Four of the utilities served more than 114,000 people, but the great majority of the systems are serving less than 500 people.

Norwich has the largest single water system in the area, supplying approximately 100 percent of its residents as well as small portions of adjoining communities. Surface water reservoirs are the principal source of supply. There are additional small water systems serving other areas of the City. The other two systems serving more than 30,000 residents are the Groton and New London water systems. In each case, the sources are surface water reservoirs. The New London system supplies a large portion of the Town of Waterford's demand as well as supplying large amounts of process water for industrial use. Portions of Waterford are also served by small water systems. The major industrial demand in the Town is generated by the Millstone Nuclear Power Station, which uses a considerable amount of sea water for cooling purposes.

Groton, in addition to its surface water system, is also served by the Mystic Valley Water Company - a combined system of ground and surface water sources. This company also serves a portion of Stonington, but the major source of supply for Stonington is the Westerly, Rhode Island water system. Both Groton and Stonington have additional small water systems having limited service areas.

The Town of Colchester is partially served by three ground water systems - the Borough of Colchester system and two smaller systems. The East Lyme Water Commission has consolidated a number of smaller ground water systems and is the major supplier for that Town. The major supplier for the Town of Griswold is the Jewett City Water Company, using combined water sources. Two additional smaller systems provide service to portions of the Town. Sprague has a municipal surface water system which supplies water to the major population center around the Village of Baltic. In addition, a small, private system provides water to a limited area of the Town. Industries in the town use private sources of ground and surface water for process and cooling water.

The towns of Ledyard, Lisbon, Montville, North Stonington, and Preston are served by one or more small, privately owned water systems. Two industries in Ledyard - Dow Chemical Company and Charles Pfizer Company - supply their own industrial water needs. A small portion of Lisbon is served by the Jewett Water Company, while outlying areas of Montville are serviced by the Norwich and New London water systems. Various industries in Montville use the Thames and Oxoboxo Rivers for large amounts of process and cooling water. Preston is partially served by the Norwich system.

Four rural communities - Bozrah, Franklin, Salem and Voluntown - have no public water systems. However, some residents of Bozrah and Salem live along and are served from the transmission line of the Norwich water system.

Table 1

Water Demand - Subregion 1

Community	1970 Pop. (1000)	1970 Est. Pop. Served (1000)	1970 Ave. Day Demand (MGD)	1990 Est. Pop. (1000)	1990 Est. Pop. Served (1000)	1990 Ave. Day Demand (MGD)	2020 Est. Pop. (1000)	2020 Est. Pop. Served (1000)	2020 Ave. Day Demand (MGD)
Bozrah	2.	.4[1]		4.	1	0.09	5.4	2.7	0.29
Colchester	6.6	3.9	.35	10.4	6.8	0.74	13.2	9.9	1.25
East Lyme	11.4	5.1	.41	15.1	9.8	0.94	18.6	13.9	1.54
Franklin	1.4	0	-	2.	.5	0.05	2.5	1.3	0.14
Griswold	7.8	5.5	.78	9.2	7.4	1.29	11.0	9.4	1.90
Groton	38.2	34.9[2]	11.06[2]	37.8	36.	12.60	42.6	41.7	16.93
Ledyard	14.8	5.	.33	18.6	8.4	0.66	22.6	15.8	1.45
Lisbon	2.8	.3	.02	4.6	1.2	0.10	6.0	3.0	0.30
Montville	15.7	4.5[3]	.27[3]	20.6	9.3	0.73	25.3	17.7	1.59
New London	31.6	29.1[4]	4.5[4]	31.9	30.3	4.99	36.3	35.6	6.80
N. Stonington	3.7	1.5	.08	9.9	4.5	0.30	14.1	10.0	0.76
Norwich	41.7	41.7[5]	5.29[5]	49.5	46.	7.18	59.3	59.3	9.96
Preston	3.6	.2[6]	.02[6]	5.4	3.5	0.33	6.8	5.1	0.56
Salem	1.5	0	-	3.1	2.	0.18	4.3	3.3	0.35
Sprague	3.	2.2	.16	4.7	3.8	0.32	6.1	5.2	0.51
Stonington	15.9	3.9[7]	.64	21.7	17.4	3.48	27.1	23.0	5.34
Voluntown	1.5	0	-	1.8	.5	0.05	1.9	1.0	0.11
Waterford	17.2	5.1[8]	.07[8]	25.	11.2	0.98	31.6	22.1	2.23
TOTALS	220.4	143.3	23.98	275.3	203.1	35.01	334.7	279.9	52.01

For footnotes, see next page.

Table 1 - Water Demand - Subregion 1 Footnotes:

1. 400 people in Bozrah are served by the Norwich Water Department.

2. The Mystic Valley Water Company supplies an estimated 7,400 people; with 3,600 in Groton and 3,800 in Stonington. Average consumption for the 7,400 people was 1.23 MGD. The system's safe yield is estimated to be 2.0 MGD. The consumption and yield figures are apportioned to each community's average day demand and total safe yield figures, based on a ratio of the community population served by the system to the entire Mystic Valley Water Company service population.

3. An additional 275 people are served by the Norwich Water Department and 60 people by the New London Water Department. The estimated population served, average day demand, and safe yield figures do not reflect these additions.

4. An additional 4,164 people outside the community are served by the New London Water Department. This number is reflected in the average day demand and total safe yield figures. However, this addition is not reflected in the population served figure.

5. Same explanation as given in No. 4, but only 2,680 people are involved.

6. An additional 2,000 people are served by the Norwich Water Department. The estimated population served, average day demand, and safe yield figures do not reflect this additional number.

7. Same explanation as given in No 2. 7,000 people are supplied by the Westerly, Rhode Island Water Department. The estimated population served, average day demand, and safe yield figures do not reflect this additional number.

8. An additional 4,104 people are served by the New London Water Department. The estimated population served, average day demand, and safe yield figures do not reflect this additional number.

NOTE: References to safe yield figures are applicable to Table 2.

Table 1 presents the water supply demands for Subregion 1. As noted previously, the New London and Norwich water systems supply other communities in addition to themselves, and the approximate populations served are listed for each community. However, the water consumption and safe yield figures are listed with New London or Norwich to maintain quantities intact. The Mystic Valley Water Company supplies Groton and Stonington, and all quantities are apportioned to one community or the other, based on the percentage of population served by the company in each community.

Table 2 indicates the safe yield of the existing systems and the future needs. The needs are expressed as deficiencies to be overcome if the demands depicted in Table 1 are to be satisfied. Note that for the subregion as a whole, the capacity of the current systems (39.4 MGD) needs to be expanded by an additional 4.28 MGD by 1990 and 14.60 MGD by 2020.

Table 2

Current Yield and Future Needs for Subregion 1 (in MGD)

Community	Current Est. Safe Yield	Needs (1) 1970	1990	2020
Bozrah	-	-	0.09	0.29
Colchester	0.48	(0.13)	0.26	0.77
East Lyme	1.64	(1.23)	(0.70)	(0.10)
Franklin	-	-	0.05	0.14
Griswold	1.25	(0.47)	0.04	0.65
Groton	13.32	(2.26)	(0.72)	3.61
Ledyard	1.44	(1.11)	(0.78)	0.01
Lisbon	0.20	(0.18)	(0.10)	0.10
Montville	0.69	(0.42)	0.04	0.90
New London	6.45	(1.95)	(1.46)	(0.35)
N. Stonington	0.35	(0.27)	(0.05)	0.41
Norwich	10.45	(5.16)	(3.27)	(0.49)
Preston	.04	(0.02)	0.29	0.52
Salem	-	-	0.18	0.35
Sprague	1.91	(1.75)	(1.59)	(1.40)
Stonington	1.04	(0.40)	2.44	4.30
Voluntown	-	-	0.05	0.11
Waterford	.14	(0.07)	0.84	2.09
TOTALS	39.4		4.28(2)	14.60 (2)

(1) - Figures in parentheses denote surpluses.

(2) - Communities having estimated surpluses are not included in the calculation of this total.

3.2 Subregion 2

The Connecticut River Estuary Regional Planning Agency has evaluated existing water systems as well as potential sources that might meet future water demands in Subregion 2 (2). This information, as well as material developed by the State of Connecticut, has served as a basis from which this current report for the Long Island Sound Study is prepared.

The existing public water supply demands of the Connecticut River Estuary Region are served by a combination of surface and ground water sources. The Guilford-Chester Division of the Connecticut Water Company is the major water purveyor for the region and operates two separate distribution systems.

Presently, no interconnection exists between the two distribution systems so that water cannot flow from one to the other. The towns of Chester, Deep River, and Essex are serviced by the Chester distribution system. This system is supplied from Upper Pond, Waterhouse Pond, Turkey Hill Reservoir, Wilcox Reservoir, and Deuse Reservoir. Ground water from wells in Essex supplements the surface supplies.

The Guilford distribution system serves the towns of Clinton, Westbrook, and Old Saybrook within the Connecticut River Estuary Region as well as Madison and Guilford, which are part of the South Central Connecticut Region. Killingworth Reservoir and Kelseytown Reservoir, together with wells in Clinton and Westbrook, provide the supply to the three Estuary towns.

Old Lyme, Lyme, and Killingworth have several small, privately owned community water systems that primarily serve the shoreline communities during the summer period. These systems derive their supply from ground water sources. With small estimated safe yields, these systems are not expected to contribute significantly to future water supply development. Table 3 presents a summary of the water supply demands for the Subregion.

Table 4 indicates the safe yield of the existing systems and the future needs. The needs are expressed as deficiencies to be overcome if the demands depicted in Table 3 are to be satisfied. Note that for the Subregion as a whole, the capacity of the current systems (5.4 MGD) needs to be expanded by an additional 1.99 MGD by 1990 and 8.59 MGD by 2020.

Table 3

Water Demand - Subregion 2

Community	1970			1990			2020		
	Pop. (1000)	Est. Pop. Served (1000)	Ave. Day Demand (MGD)	Est. Pop. (1000)	Est. Pop. Served (1000)	Ave. Day Demand (MGD)	Est. Pop. (1000)	Est. Pop. Served (1000)	Ave. Day Demand (MGD)
Chester	3.0	1.1	0.12	5.8	2.6	0.36	8.8	6.2	0.99
Deep River	3.7	2.0	0.29	12.2	7.9	1.41	16.9	12.7	2.62
Essex	4.9	2.9	0.31	9.6	6.2	0.83	13.2	9.9	1.52
CHESTER DIVISION TOTALS			0.72			2.60			5.13
Clinton	10.3	5.3	0.94	13.9	9.0	1.94	19.1	14.3	3.59
Old Saybrook	8.5	7.2	0.88	12.6	11.3	1.70	15.8	14.9	2.59
Westbrook	3.8	2.4	0.32	7.4	4.8	0.77	11.2	8.4	1.56
GUILFORD DIVISION TOTALS			2.14			4.41			7.74
Killingworth	2.4	0	-	6.0	1.5	0.14	7.9	4.0	0.43
Lyme	1.5	0	-	2.6	.7	0.06	3.4	1.2	0.13
Old Lyme	4.9	0	-	7.9	2.0	0.18	10.4	5.2	0.56
TOTALS		20.9	2.86	78.	46.	7.39	106.7	76.8	13.99

Table 4

Current Yield and Future Needs for Subregion 2 (in MGD)

Community	Current Est. Safe Yield	Needs (1) 1970	1990	2020
Chester				
Deep River				
Essex				
CHESTER DIVISION TOTALS	1.8	(1.08)	0.80	3.33
Clinton				
Old Saybrook				
Westbrook				
GUILFORD DIVISION SUBTOTALS	3.6	(1.46)	0.81	4.14
Killingworth			0.14	0.43
Lyme			0.06	0.13
Old Lyme	____		0.18	0.56
TOTALS	5.4		1.99	8.59

(1) - Figures in parentheses denote surpluses.

3.3 Subregion 3

A survey developed by the Central Connecticut Regional Planning Agency (3), as well as material developed by the State of Connecticut, has served as a basis from which this current report for Subregion 3 of the Long Island Sound Study is prepared.

The present public water demands of the South Central Connecticut Region are met by four major water systems. The New Haven Water Company serves the City of New Haven, the Towns of Bethany, Branford, Cheshire (which is not within the LIS study region), North Branford, North Haven, Orange, West Haven, and Woodbridge. This inter-connected system obtains about 59 MGD from a number of surface sources, with an additional 6 MGD provided by ground water. Group operation of the reservoirs accounts for an additional 3 MGD, giving a total safe yield of 68 MGD. This is approximately 11 MGD above the 1970 average daily demand of 57 MGD.

The Guilford Division of the Connecticut Water Company serves the towns of Guilford and Madison as well as three towns in Subregion 2. This Division utilizes ground and surface sources having an estimated safe yield of 5.8 MGD. About 2.2 MGD from ground sources is available to supply Madison and Guilford, which has a present demand of about 1.0 MGD. The remaining 3.6 MGD is primarily directed for use within Subregion 2.

The Meriden Municipal Water Department supplies the City from both ground and surface sources. The 1970 demand was 6.9 MGD, from sources having an estimated safe yield of 10.7 MGD. The Wallingford Municipal Water Department provided an average of approximately 4.1 MGD in 1970 to the Town of Wallingford from a system having an estimated safe yield of nearly 5.7 MGD. Table 5 presents a summary of the water supply demands for Subregion 3.

Table 5

Water Demand - Subregion 3

System	1970 Pop. (1000)	1970 Est. Pop. Served (1000)	1970 Ave. Day Demand (MGD)	1990 Est. Pop. (1000)	1990 Est. Pop. Served (1000)	1990 Ave. Day Demand (MGD)	2020 Est. Pop. (1000)	2020 Est. Pop. Served (1000)	2020 Ave. Day Demand (MGD)
New Haven Water Co.	413.4	394.5	56.82	504.5	479.3	84.35	590.2	578.4	118.00
Connecticut Water Co.	21.8	9.6	1.10	31.8	20.7	2.86	40.6	30.5	4.88
Meriden Municipal Water Co.	55.9	55.	6.9	67.6	66.9	10.24	81.2	81.2	14.37
Wallingford Municipal Water Co.	35.7	30.	4.1	45.9	41.3	6.90	56.2	52.2	10.13
TOTALS	526.8	489.1	68.92	649.8	608.2	104.35	768.2	742.3	147.38

Table 6 shows the safe yield of the existing systems and the future needs. The needs are expressed as deficiencies to be overcome if the demands depicted in Table 5 are to be satisfied. Note that for the subregion as a whole, the capacity of the current systems (85.5 MGD) needs to be expanded by an additional 19.01 MGD by 1990 and 61.58 MGD by 2020.

Table 6

Current Yield and Future Needs for Subregion 3 (in MGD)

Community	Current Est. Safe Yield	Needs (1) 1970	1990	2020
New Haven Water Co.	67.2	(10.4)	17.15	50.8
Connecticut Water Co.	2.2	(1.1)	0.66	2.68
Meriden Municipal Water Co.	10.7	(3.8)	(0.46)	3.67
Wallingford Municipal Water Co.	5.7	(1.6)	1.20	4.43
TOTALS	85.8		19.01[2]	61.58

(1) - Figures in parentheses denote surpluses.
2 - The Meriden Water Company will have an estimated surplus of 0.46 MGD, which is not included in the calculation of this total.

3.4 Subregions 4 and 5

Reports prepared for the Greater Bridgeport Regional Planning Agency (4), the South Western Regional Planning Agency (5), and the Valley Regional Planning Agency (6), together with material developed by the State of Connecticut have served as a basis from which this current report for Subregions 4 and 5 of the Long Island Study is prepared.

The existing public water supply demands of the Greater Bridgeport Valley Regions are served by a combination of surface and ground water sources. The major supplier is the Bridgeport Hydraulic Company, which also serves some communities in the Southwestern Region. A recent estimate of the safe yield of this system is 88.7 MGD with 49 MGD supplied by surface sources. The six communities of the Greater Bridgeport Region - Bridgeport, Easton, Fairfield, Monroe, Stratford, and Trumbull - as well as Shelton and a small portion of Seymour in the Valley Region, make up the major service area of Bridgeport Hydraulic. Westport and Wilton in the South Western Region are the other communities served by Bridgeport Hydraulic. Additional yield must be developed very soon.

The remaining communities of the Valley Region - Ansonia and Derby, as well as the major portion of Seymour - are supplied by the Ansonia-Derby Water Company and the Seymour Water Company. The Derby part of the Ansonia-Derby Water Company was formerly known as the Birmingham Water Company. The safe yield of the new consolidated system is estimated to be about 8.1 MGD. This company supplies the demands of Ansonia and Derby as well as a portion of the Town of Seymour. The Seymour system, in addition to supplying the Town, delivers water to Beacon Falls and a portion of Oxford - two communities outside the LIS study area. Each of the Valley water systems has average day demands approximating their safe yields.

In the South Western Planning Region, seven major water utilities are in operation providing both ground and surface supplies. The Greenwich Water Company provides water to the Town of Greenwich as well as to the Port Chester Water Company, which serves some residents in neighboring New York. Recent demands on the system have approximated the safe yield of 17 MGD, as listed in the recent inventory compiled by the Connecticut State Department of Health, and additional sources are needed in the very near future.

The Stamford Water Company supplies the residents of Stamford as well as the Noroton Water Company which supplies the Town of Darien. Surface sources with estimated safe yields of 15.4 MGD, barely meet the demands on the system, and development of additional sources is needed immediately. The New Canaan Water Company obtains its supply from surface and ground water and serves the Town of New Canaan. Present demand on the system is nearly equal to the safe yield of the system. The existing wells are of low yield, and there appears to be little chance for the development of high-yield ground water sources. Therefore, some type of regional system is needed immediately.

The Norwalk First District Water Department utilizes both ground and surface sources supplying the northern and eastern portions of Norwalk. The present demand on the system is estimated to approximate 5.5 MGD, with a conservative estimate of safe yield at 10.0 MGD. The system has an adequate supply for the near future. The Norwalk Second District Water Department serves the southern and western portions of Norwalk using surface water sources with ground water serving as an emergency source. The average day demand of the system is approaching the estimated safe yield of 5.1 MGD. Steps have been taken to insure emergency supply with a connection made to the Bridgeport Hydraulic system, along with plans for an additional source. However, the two Norwalk water districts should be able to meet 1990 needs with the existing sources of supply.

Two other towns in the region - Westport and Wilton - obtain their water supply from Bridgeport Hydraulic Company. As plans now exist, the Town of Weston will be supplied by Bridgeport Hydraulic Company when a public water supply is required.

The reports prepared for the three regional planning agencies as well as the inventory prepared by the State of Connecticut were used to develop the information provided in Table 7.

Table 7

Water Demand - Subregions 4 and 5

System	1970			1990			2020		
	Pop. (1000)	Est. Pop. Served (1000)	Ave. Day Demand (MGD)	Est. Pop. (1000)	Est. Pop. Served (1000)	Ave. Day Demand (MGD)	Est. Pop. (1000)	Est. Pop. Served (1000)	Ave. Day Demand (MGD)
Bridgeport Hydraulic Co.	379.3	332.4	68.33	488.5	439.7	99.8	587.3	552.	145.20
Ansonia-Derby Water Co.	35.0	29.9	5.22	41.9	37.7	8.10	48.4	45.5	11.28
Seymour Water Co.	17.3	9.6	1.80	25.6	16.6	3.77	34.0	25.5	6.71
Greenwich Water Co.	114.3	106.0	15.60	138.2	131.3	23.50	155.6	152.5	31.72
Stamford Water Co.	108.8	84.0	12.20	120.7	96.6	17.10	141.1	120.	24.72
Noroton Water Co. (supplied by Stamford)	20.4	19.0	2.14	17.9	17.0	2.30	20.2	19.8	3.11
New Canaan Water Co.	17.5	9.7	1.10	26.3	17.1	2.35	32.1	24.1	3.86
Norwalk First District Water Co.	79.1	44.0	5.50	98.4	98.4	14.95	119.8	119.8	21.08
Norwalk Second District Water Co.		35.1	4.50						
TOTALS	771.7	669.7	115.89	957.5	854.4	171.87	1,138.5	1,059.2	247.68

Table 8 indicates the safe yield of the existing system and the future needs. The needs are expressed as deficiencies to be overcome if the demands depicted in Table 7 are to be satisfied. Note that for the Subregion as a whole, the capacity of the current systems (148 MGD) needs to be expanded by an additional 24.02 MGD by 1990 and 99.68 MGD by 2020.

Table 8

Current Yield and Future Needs for Subregions 4 and 5 (in MGD)

System	Current Est. Safe Yield	Needs (1) 1970	1990	2020
Bridgeport Hydraulic Co.[2]	88.7	(20.37)	11.1	56.5
Ansonia-Derby Water Co.[3]	8.1	(2.88)	0.0	3.18
Seymour Water Co.[4]	2.6	(.80)	1.17	4.11
Greenwich Water Co.[5]	17.0	(1.4)	6.50	14.72
Stamford Water Co.[6]	15.4			
Noroton Water Co. (supplied by Stamford)	supplied by Stamford	(1.06)	4.0	12.43
New Canaan Water Co.	1.1	0	1.25	2.76
Norwalk First District Water Co.	10.0	(5)		
Norwalk Second District Water Co.	5.1	(0.6)	(0.15)	5.98
TOTALS	148.0		24.02[7]	99.68

(1) - Figures in parentheses denote surpluses.
2 - The estimates for the Bridgeport Hydraulic Co. are projected only for the communities presently served. Service will probably be extended to other systems in this subregion, but the extent of additional service will be evaluated in the management phase of the study.
3 - Totals reflect service to Ansonia, Derby and portions of Seymour.
4 - Totals reflect service to major portions of Seymour and portions of Beacon Falls and Oxford.
5 - Totals reflect service to Greenwich and the Port Chester Water System.
6 - Totals reflect service to Stamford only.
7 - The Norwalk Water Districts will have an estimated surplus of 0.15 MGD, which is not included in the calculation of this total.

3.5 Subregion 6

Subregion 6 is quite diverse when considered from a water service point of view. To provide a clearer picture of the area, the subregion will be discussed in three sections.

3.5.1 Westchester County. The public water supply system for Westchester County consists of 37 municipal systems and 23 investor operator companies. Approximately 96 percent of the County population is served by public water supplies.

The New York City Croton watershed covers about 50 percent of the county and has 12 reservoirs which have a safe yield of 240 MGD. Discounting the New York City development, however, the safe yield for the remainder of the county is only 32.2 MGD with 22.4 MGD from surface water sources and 9.8 MGD from ground water sources. To meet a 1970 demand of 115.5 MGD, the Westchester County suppliers took 89.5 MGD from the New York City system.

The Westchester County area that is encompassed in the Long Island Sound Study area is served by eight major municipal suppliers, all utilizing the New York City Catskill Aqueduct-Croton system.

Table 9 lists the 1970 public water suppliers in the Long Island Sound Study area of Westchester County. Population served and the water demands of those populations are also listed as projected to 2020.

Table 9

Water Demand - Subregion 6-A

Supplier	1970 Pop. Served	1970 MGD	1990 Pop. Served	1990 MGD	2020 Pop. Served	2020 MGD
Harrison WD # 1 # 2	6,500	.88	7,800	1.05	8,700	1.35
Larchmont Village	7,200	.95	8,100	1.1	9,200	1.5
Mt. Vernon City	73,000	9.5	67,000	9.3	72,400	10.8
New Rochelle Water Co.	150,650	19.8	160,000	22.1	190,000	25.2
Pelham Village	2,050	.22	2,600	.28	3,000	.4
Scarsdale	23,800	3.3	25,000	3.7	29,000	4.1
Westchester Joint Water Works	60,000	8.6	65,000	9.2	71,600	10.2
White Plains City	50,200	7.8	48,400	7.9	52,300	9.0
TOTALS	373,400	53.07	383,900	55.55	436,200	64.3
GPCD	142.1		144.7		147.4	

It is assumed that all future demands in Westchester County will be met by the New York City Water Supply system. There are no significant surface water sources yet to be developed, and due to the geology, ground water sources would not be considered for any large system. The anticipated demands for Westchester County are considered small enough to be readily met by the New York City system.

3.5.2 Bronx and Queens. Public water for the Bronx and Queens is supplied by the New York City Department of Water Resources and two privately owned suppliers: the Jamaica Water Supply Company and the Utilities and Industries Corporation. The New York City system water sources are the Croton, Catskill, and Delaware Watersheds, while the privately owned systems use ground water sources in Queens.

In 1970, the New York City system furnished 1,334 MGD to all of New York City and 90.4 MGD to various upstate utilities. This exceeded the safe yield of the system which is 1,297 MGD. A water system should not attempt to depend upon the production of a quantity of water greater than the safe yield of the supply. Such a practice, while possibly successful to a degree during wet periods, will result in inadequate supply during drought periods. The pumpages for the Jamaica Water Supply Company and the Utilities and Industries Company in 1970 were 55.6 MGD and 11.0 MGD respectively, which served an approximate population of 700,000 in Queens.

The Long Island Sound Study area encompasses a relatively small portion of the Bronx and Queens. Since the entire system is integrated, disaggregation of either water use or population is not feasible. Based on present population and population projections, water demand is summarized in Table 10.

Table 10

Water Demand - Subregion 6-B

Borough	1970		1990		2020	
	Pop. Served	MGD	Pop. Served	MGD	Pop. Served	MGD
Bronx	1,471,701	210.5	1,423,668	217.8	1,379,800	231.8
Queens	1,987,144	284.2	2,095,272	320.6	2,039,600	342.6
Totals	3,458,845	494.7	3,518,940	538.4	3,419,400	574.4
GPCD	143.0		153.0		168.0	

It should be noted that current population trends show a decreasing population in the Bronx. The decrease is anticipated to continue over the next fifty years. However, since per capita consumption will increase, overall demand will probably increase.

Shortages within the New York City System are anticipated to be met in the future through plans now being developed by the Temporary State Commission on the Water Supply Needs of Southeastern New York. In addition, the New York City Board of Water Supply is giving consideration to new sources.

Also, several proposals have been developed for the New York metropolitan area in the U.S. Army Corps of Engineers Northeastern United States Water Supply (7) issued in November, 1971.

3.5.3 Nassau County. Long Island, with a hydraulic system very different from the adjacent mainland, provides Nassau County with an excellent natural ground water resource. To date, ground water has been the sole source of public water supply and provides about 200 MGD to more than 1.4 million people. Of this 200 MGD, about 125 MGD is consumptive use with the remaining amount being discharged back to the aquifer.

Thirty-nine municipal systems and seven privately owned water companies distribute water throughout the County with less than 1 percent of the County population estimated to use private wells.

Within the Nassau County part of the Long Island Sound Study area, there are 11 municipal and 4 privately owned public water supply systems. Two of the three Nassau County townships (North Hempstead and Oyster Bay) have boundaries into the Long Island Sound Study area.

Table 11 summarizes the Nassau County water supply situation in the Long Island Sound Study area.

Table 11

Existing Water Supply Inventory (1971)

Town	Township Pop.	Percent Township Pop. Served	LISS Area Pop. Served	LISS Area Pumpage (MGD)	LISS Area GPCD	LISS Area Permissive Sust. Yield (MGD)
North Hempstead	235,500	100	121,000	18.9	136.5	20.3
Oyster Bay	363,050	99	91,550	12.5	155.9	27.6
Totals (Ave)	598,550	99.5	212,550	31.4	147.7	47.9

In the North Hempstead township, pumpage is approaching the area's permissive sustained yield, and, as indicated previously, sustained pumping greater than the safe yield can result in a decrease of the yield and inadequate supply. A study prepared for Nassau County (8) indicates that by 1980 the County water supply will be operating with net deficiencies. The County will have to provide for an additional yield of 92 MGD in 1990 and 177 MGD by 2020 to offset the deficiencies.

The overall County demands for 1990 and 2020 are illustrated in Table 12.

Table 12

Future Water Supply Demands - Nassau County

Nassau County	1990 Pop. Served	1990 MGD	2020 Pop. Served	2020 MGD
Hempstead	950,601	130.2	1,012,720	148.6
North Hempstead	269,721	57.0	288,086	58.8
Oyster Bay	429,250	69.6	466,594	82.5
Total	1,649,572	250.8	1,767,400	289.9

3.6 Subregions 7, 8 and 9: Suffolk County

The public water supply system for all of Suffolk County consists of 19 Municipal Water Districts, 58 privately owned companies, and one Water Authority. Approximately 80 percent of the county population is served by public supplies with the remainder on privately owned wells. Ground water sources are used exclusively to meet all County water demands. The public supply population within the Long Island Sound Study area of Suffolk County is served by 6 municipal suppliers, 22 private companies (including Fishers Island supplier) and 4 plant areas operated by the Suffolk County Water Authority. Five of the ten townships which make up Suffolk County have boundaries in the Long Island Sound Study area. The five townships are Huntington, Smithtown, Brookhaven, Riverhead and Southold. The major portion of the served populations in the more heavily developed western portion of the County (Huntington, Smithtown, and part of Brookhaven) are supplied by the Suffolk County Water Authority and large municipal water districts, whereas Brookhaven and the eastern townships of Riverhead and Southold have the majority of the privately owned water companies. The privately owned companies are generally small and usually have facilities capable of serving only the development within their service areas. Several near the shore line areas are seasonal or have significant demands only during the summer seasons. Table 13 summarizes the Suffolk County water supply picture with respect to the Long Island Sound Study Region.

The low per capita figure for the Town of Riverhead illustrates the seasonal usage mentioned previously. Because of the Greenport Village Water System, which serves the Greenport area in Southold year round, the per capita figures for Southold are comparable to the western townships.

The small, privately owned water supplies will most likely be acquired by the Suffolk County Water Authority as the Authority expands its services. Comprehensive water supply studies completed for Suffolk County (9) show that the County permissive sustained yield is 440 MGD. Thus, the ground water reservoir is more than adequate to meet the Suffolk County demands through 2020, and there is a surplus which could be used on a short-term basis to meet the projected deficiency in the neighboring Nassau County.

Table 13

Existing Water Supply Inventory - Subregions 7,8 and 9 (1971)

Town	Township Pop.	Township Pop. Served	Town Pop. Served LISS Area	LISS Area Pumpage (MGD)	LISS Area GPCD	Township Permissive Sust. Yield (MGD)
Huntington	204,800	196,000	86,040	8.7	101	55
Smithtown	116,000	102,000	67,470	6.5	96	32
Brookhaven	256,000	187,000	31,030	2.6	83	157
Riverhead	19,400	10,900	2,305	0.10	44	33
Southold	17,000	8,300	7,610	0.79	104	90

*CPWS - 24 Holzmacher, McLendon & Murrell (9).

Table 14

Future Water Supply Demands - Suffolk County

Suffolk County	1990 Pop. Served	1990 MGD	2020 Pop. Served	2020 MGD
Babylon	281,199	42.5	388,222	59.0
Brookhaven	625,767	83.2	945,235	128.7
East Hampton	19,802	3.5	30,945	6.5
Huntington	310,903	40.8	419,167	54.6
Islip	400,015	50.7	540,134	67.7
Riverhead	39,605	15.2	61,890	20.6
Shelter Island	3,960	0.5	8,440	1.0
Smithtown	207,928	27.6	281,320	36.2
Southampton	59,408	9.5	90,022	17.8
Southold	29,704	9.2	47,824	10.3
Totals	1,978,291	282.7	2,813,200	402.4

Table 15

Water Demand in the Connecticut Part of the LISS Area

	1970			1990			2020		
Subregion	Pop. (1000)	Est. Pop. Served (1000)	Ave. Day Demand (MGD)	Est. Pop. (1000)	Est. Pop. Served (1000)	Ave. Day Demand (MGD)	Est. Pop. (1000)	Est. Pop. Served (1000)	Ave. Day Demand (MGD)
1	220.4	143.3	23.98	275.3	203.1	35.01	334.7	279.9	52.01
2	43.0	20.9	2.86	78.0	46.0	7.39	106.7	76.8	13.99
3	526.8	489.1	68.92	649.8	608.2	104.35	768.2	742.3	147.38
4 & 5	771.7	669.7	115.89	957.5	854.4	171.87	1,138.5	1,059.2	247.68
Totals	1,561.9	1,323.0	211.65	1,960.6	1,711.7	318.62	2,348.1	2,158.2	461.06

3.7 Long Island Sound Region Summary

The water supply situation for the Long Island Sound region is best summarized on a State basis. This is preferred due to the sources of supply. The Connecticut region relies primarily on surface water sources with some ground water also utilized. The New York region, with the exception of Westchester County and the Boroughs of Bronx and Queens which rely on the New York City system, is supplied almost entirely by ground water sources. Therefore, different management considerations must be applied to each region.

Connecticut has water systems serving less than 100 people, as well as systems serving more than 300,000 people. Safe yields vary from 10,000 gallons of water per day to 89 million gallons per day, indicating the degree of system variability. The water demands for Connecticut are shown by Subregion in Table 15.

Table 16 indicates the safe yield of the existing systems and the future needs for Connecticut. The needs are expressed as deficiencies to be overcome if the demands depicted in Table 15 are to be satisfied. Note that for Connecticut as a whole, the capacity of the current systems (278.6 MGD) needs to be expanded by an additional 49 MGD by 1990 and 184 by 2020. Sufficient water resources exist to meet these needs and additional needs well beyond 2020.

Table 16

Yields and Future Needs in the Connecticut Part of the LISS Area

Subregion	Current Est. Safe Yield (MGD)	Needs 1970 (MGD)	Needs 1990 (MGD)	Needs 2020 (MGD)
1	39.4	-	4.28	14.60
2	5.4	-	1.99	8.59
3	85.8	-	19.01	61.58
4 & 5	148.0	-	24.02	99.68
Totals	278.6		49.3	184.46

Many of the Connecticut water systems are under pressure to open their reservoir and watershed lands to multi-purpose use. The State has developed a general policy to protect water supply watersheds in general and water supply reservoirs in particular. These policies are presented in the report entitled, "A Plan for Conservation and Development for Connecticut" (10) prepared by the Department of Finance and Control, Office of State Planning (now the Planning Section of the Planning and Budgeting Division). The policies are listed below so that they may be incorporated into future planning efforts.

1. The future water supply needs of the State should be met, in part, through those water supply reservoirs, diversions, and high priority underground sources (aquifers) depicted on the Water Use Policy Map.

2. As a general principle, water should be obtained from ground water resources before resorting to the creation of new impoundments.

3. The State should develop mechanisms to protect and preserve the 91 water supply sites identified. Although future studies may show some of these sites to be less desirable than others, all should be protected.

4. Until the water yield obtainable from high priority underground sources (aquifers) identified on the Water Use Policy Map is known, all uses of the land above these aquifers should be limited to present activities.

5. The watersheds tributary to the water supply reservoirs delineated on the Water Use Policy Map should be managed to ensure the quality of the impounded waters for their intended purposes.

6. Continue the practices of not permitting direct waste discharges into streams tributary to public water supplies and not constructing water supply facilities which would be fed by wastewater receiving streams.

7. Limit the discharge of liquid wastes to those "wastewater receiving streams" and "recreation and wastewater streams" identified on the Water Use Policy Map.

8. Lands which are presently maintained in an open state for the purpose of protecting a public water supply should be continued to be maintained in that state.

In addition, Public Act 73-555 states that "No person or municipality shall discharge any sewage into any waters of the state which are tributary to an existing water supply impoundment or any proposed water supply impoundment identified in the long-range plan for management of water resources, prepared and adopted pursuant to Section 25-5b." One other area that warrants further evaluation is the large number of small water systems that presently exist in Connecticut and, to a lesser degree, in Nassau and Suffolk Counties in New York. Many health officials have advocated the consolidation of numerous smaller water systems into a few larger systems, and there are many reasons for this position. Generally, the larger suppliers, because of their financial status, are able to obtain better sources, or provide better treatment for poorer sources. In addition, the larger supplies are able to provide better staffing for their laboratories and sanitary surveys. They should be better able to do the required sampling for chemical and bacteriological protection. The data on sampling verifies this. Better service and ability to expand is usually possible because of financial status.

In the New York area, there is a great variation in the water systems. Westchester County and the Boroughs of Bronx and Queens are supplied for the most part by the New York City System, whose major service area lies outside of the LIS region. Nassau and Suffolk Counties depend entirely on ground water. Probably the most critical water supply problems in the New York area are the pollution and overdevelopment of ground water in certain parts of Long Island. This abundant supply of good quality water is gradually showing the effects of man's activities. Numerous reports, for example, have shown increased nitrate levels at various wells throughout Long Island. An additional problem facing the Long Island water supplies is the growth of sewered areas. Previously, wastewater was discharged to the ground water through individual home septic systems, but the resulting ground water pollution brought about massive sewering programs. Replenishment of ground water sources is not as extensive if wastewater is collected by sewer systems and discharged to the Sound or the ocean. Table 17 presents the water demands for the New York area.

Table 17

Existing and Future Water Supply Demands in the New York Area In and Around the LIS Region

	1970		1990		2020	
Subregion	Pop. Served	MGD	Pop. Served	MGD	Pop. Served	MGD
6.1	373,400	53.07	383,900	55.55	436,200	64.3
6.2	3,458,845	494.7	3,518,940	538.4	3,419,400	574.4
6.3	1,436,750	214.1	1,649,572	250.8	1,767,400	289.9
7,8 & 9	1,164,500	165.2	1,978,291	282.7	2,813,200	402.4
Totals	6,433,495	927.07	7,530,703	1,127.45	8,436,200	1,331.0

Table 17 Notes:

Region 6.1 includes the eight major municipal water systems serving the portion of Westchester County within the LIS region.

Region 6.2 includes all of the Boroughs of Bronx and Queens, rather than the small portion of each within the LIS region. Due to system integration, disaggregation of water use or population is not feasible.

Region 6.3 includes all of Nassau County.

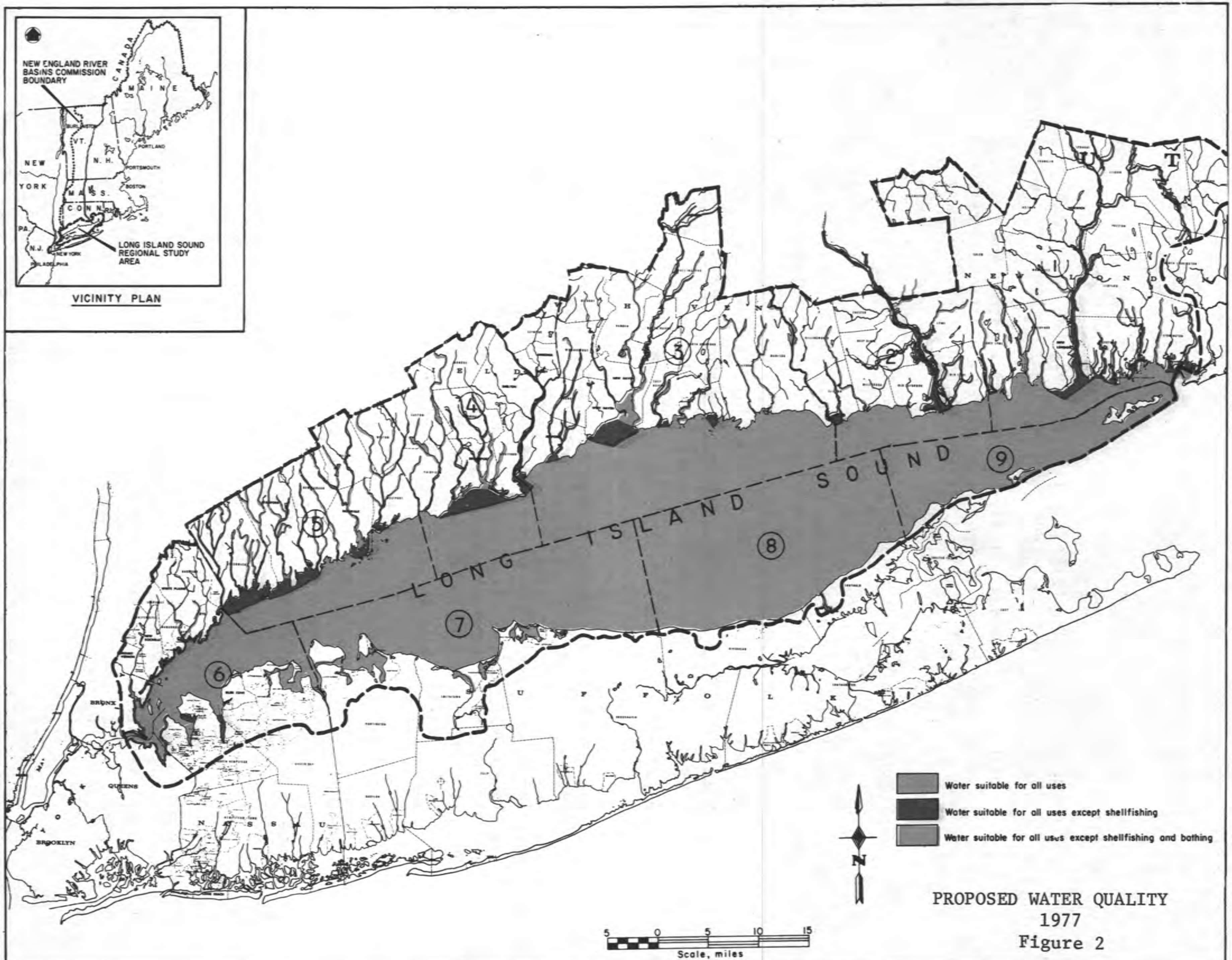
Regions 7, 8, and 9 include all of Suffolk County. Projections available to the study are made on a county basis. Also, 1971 data is used for each county, rather than 1970 information.

4.0 WHAT IS THE EXISTING WATER QUALITY SITUATION WITHIN THE STUDY AREA?

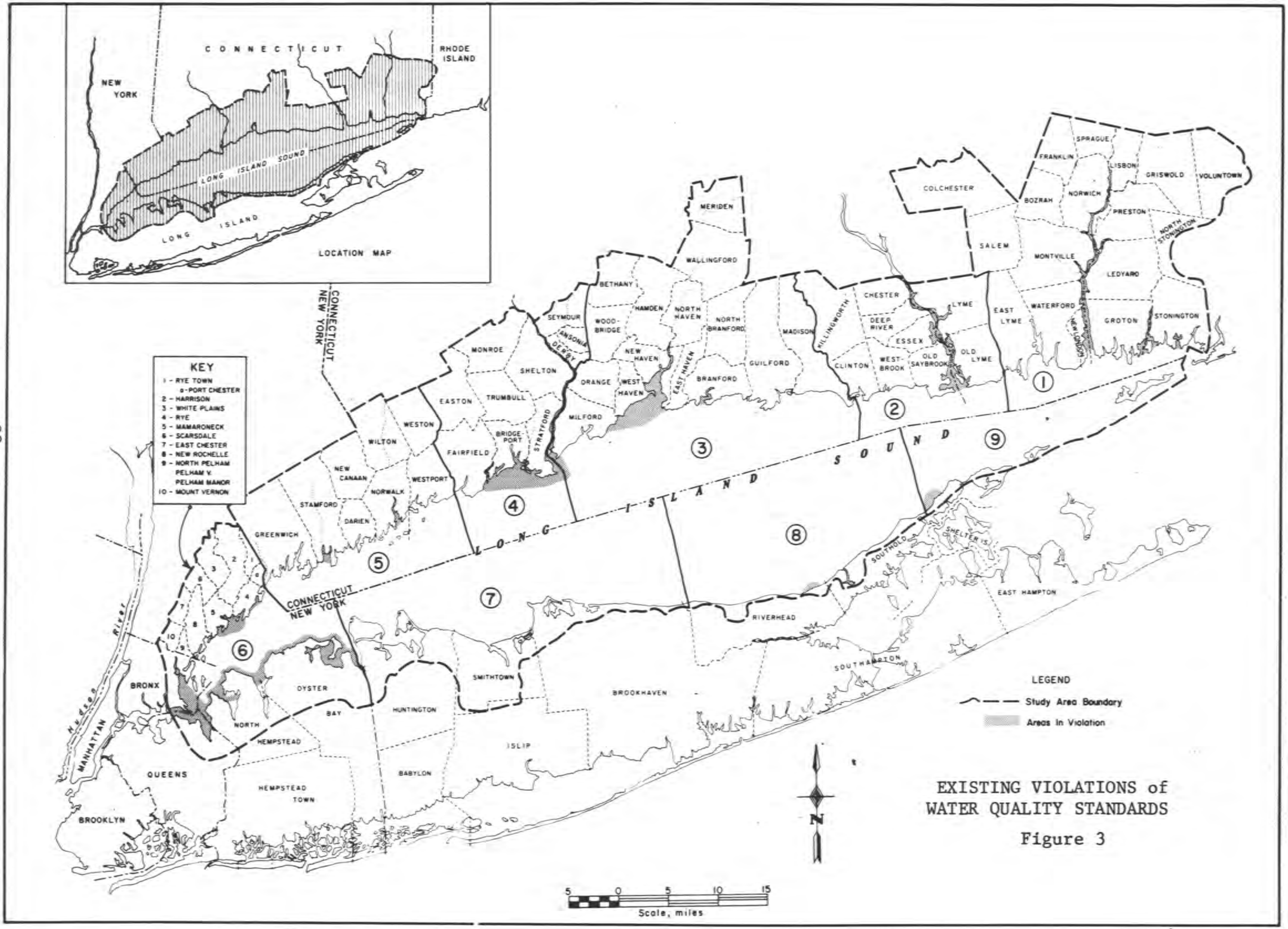
4.1 Introduction

The quality of water refers to its chemical, physical, and biological characteristics. All water contains dissolved solids, all possess physical characteristics such as temperature, taste and odor and some biological organisms such as bacteria and fish. The natural quality of water depends upon its environment, movement and source. For the purpose of this report, pollution is defined as the man-induced degradation of the natural quality of water. Several reports documenting the effect of pollution on the Sound are referenced in Appendix A -- (20), (21), (22), (23), (32), (34), (39), (40), (41), (42), (43), (44), (45), (46), (47), (50), (51), (52), (53), (54), (55), (56), (57), and (58).

The extent to which the water of Long Island Sound has been affected by various pollution sources can be shown by comparing existing water quality with approved water quality standards. These standards include criteria which define water quality -- physical, chemical, temperature and biological requirements for each major use of water. For example, a portion of an estuary designated for shellfishing, has to be "cleaner" than water designated for industrial cooling. During the sixties, each State, after holding public hearings, decided how it wanted to use portions of the waters that flow within its borders. Figure 2 shows the intended use of the waters within the Long Island Sound Study Region by 1977.



PROPOSED WATER QUALITY
1977
Figure 2



EXISTING VIOLATIONS of
WATER QUALITY STANDARDS
Figure 3

The water quality of Long Island Sound varies considerably. The poorest quality is found at Throg's Neck at the western terminus. All parameters monitored indicated that the poor water entering Throg's Neck significantly degrades the Sound's water eastward to Hempstead Harbor. From Hempstead Harbor eastward to the area opposite the Connecticut River, the water quality is fairly uniform and of intermediate quality. From the Connecticut River eastward, the water quality is good. It is important to realize that the variable conditions can produce an inaccurate over-view of water quality. At certain times and places, there may appear to be no water quality problems in the Sound, while at other times the quality may be disastrously poor. Examples of these variable water quality conditions are manifested by the increased bacterial count in the water after a rainstorm, an occasional algae bloom or fish kill, an oil spill, or the temporary water quality degradation of a harbor brought about by a dredging project. Figure 3 delineates those areas which continually cannot serve their intended use. Significant water quality problem areas are the Thames River, Quinnipiac River, New Haven Harbor, Branford Harbor, the Housatonic Estuary, Bridgeport Harbor, Norwalk Harbor, and western Long Island Sound.

4.1.1 Subregion I

On the Thames River; New London, Norwich and Groton are large urban areas. Significant quantities of storm water from city streets, with varying degrees of polluting oil, organic matter, and bacteria, run off into the Thames River. Land management practices along this river may be necessary to prevent street and parking lot runoff from polluting the Thames River. However, the major source of pollution from the Thames River is believed to be the combined sewers of the City of Norwich and the primary effluents of Norwich and New London wastewater treatment plants along with the Pfizer industrial discharge.

4.1.2 Subregion III

In Subregion III, the Quinnipiac River is a water quality limited segment where unacceptable levels of dissolved oxygen are found and coliform bacteria levels are exceeded. Currently, the secondary effluents of the municipal plants at Meriden, Wallingford, and North Haven exceed the assimilative capacity of this river which has low flow during summer months. During periods of rain, large amounts of sediments and nutrients enter the river through storm drains. The State Department of Environmental Protection has ordered the towns of North Haven, Meriden and Wallingford to provide expanded treatment for the municipal wastewater. The State envisions eventual advanced treatment at Southington and Cheshire as well. Various land management programs will also have to be initiated along the river to achieve water quality goals.

Combined sewer overflows and urban runoff prevent the achievement of the water quality goals in New Haven Harbor. These sources result in unacceptable solids and coliform levels in the harbor.

Branford Harbor is affected by eutrophication and low DO problems. The major source of nutrients for the algal blooms may be the Branford wastewater treatment plant. The State has ordered that this facility be expanded so that it may better treat its flow. Upgrading the plant to advanced treatment or relocation of the plant outfall is also being considered.

4.1.3 Subregion IV

Bridgeport Harbor is a water quality limited segment where nutrients and coliform bacteria, solids, and oxygen-demanding materials prevent achievement of water quality standards. The major sources of pollution in Bridgeport Harbor are the overflows from combined sanitary and storm sewers and urban runoff. The City of Bridgeport has considered a deep tunnel storage and auxillary treatment system to correct combined sewer overflows. This proposal and others are still under study. When there is a solution to combined sewers and land management measures have been enacted to control urban runoff, it is expected that Bridgeport Harbor will meet water quality goals. The State has conducted intensive monitoring in Bridgeport Harbor and is in the process of analyzing such data to develop input to a strategy to address Bridgeport Harbor water quality problems.

The lower Housatonic River, below the Derby Dam, is a water quality limited segment. The combined sewer systems of Derby and Shelton, in combination with runoff from streets in these urbanized areas, cause the river to exceed the acceptable limits of coliform bacteria, solids, and oxygen-consuming materials. Shelton and Derby will undertake some sewer system improvements as treatment plants are upgraded. However, when the combined sewer overflow problems are fully addressed, it is expected that the lower Housatonic will meet and maintain water quality standards.

4.1.4 Subregion V

Norwalk Harbor, like Bridgeport Harbor, is a water quality limited segment with combined sewer overflow problems. Levels of solids, oxygen-consuming materials and coliform bacteria are beyond the acceptable standards. Norwalk is currently designing a supplemental treatment plant with microstraining and chlorination process to treat sewer overflows. When construction for the supplemental plant is complete, it is expected that Norwalk Harbor will meet and maintain the water quality standards.

4.1.5 Subregion VI

Western Long Island Sound includes the open waters and embayments of Long Island Sound, bordered by Westchester County on the north, New York

City on the west, and Nassau County on the south. The Upper East River enters Long Island Sound at its western end. Water quality in the East River is very poor by all standards employed. It is directly affected by four municipal treatment plants, combined sewer overflow and urban runoff. When East River water is diluted with water from Long Island Sound, persistent algal blooms occur and reach a maximum along the line connecting City Island and Execution Rock, slightly east of the New York City line. Also affected by algal blooms are bays such as Hempstead Harbor and Oyster Bay on the north shore of Long Island.

4.2 What are the major sources of pollution?

4.2.1 Municipal and institutional waste sources

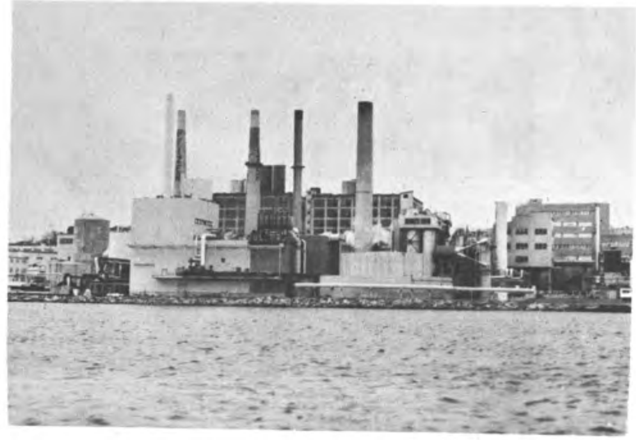
A major source of waste water in the Long Island Sound Region comes from municipal wastewater sources. The Interim Water Quality Report contains detailed information on town populations and populations served by each municipal and institutional treatment plant. For each plant, it lists the type of treatment, the design and average flow in millions of gallons/day (MGD), the receiving water body, and proposals for improvements or replacement. Table 18 is based largely upon information contained in the appendix of the Interim Report (70). Note that existing treatment systems have cut the BOD contained in waterborne discharges by about two-thirds. Raising all plants to secondary treatment at 85 percent removal efficiency would have the effect of reducing BOD discharges by an additional 20 percent.

Figure 4 locates the 50 largest systems -- all municipal -- and the areas they service. Table 19 gives the average daily flow of 50 of the plants. The 14 other municipal and institutional plants listed in the Interim Report, Appendix C, had a combined average daily flow of less than 2 MGD. Note how two of the nine sub-regions have no treatment plants and one sub-region has only one very small plant.

Municipal wastewater can also enter the Sound from four waterborne sources outside the Long Island Sound Region.

(1) The Upper East River. This is by far the most significant outside source. The 575 MGD of secondary effluent discharged there, at an assumed 70 percent average treatment efficiency, contains about 144 tons of BOD. This is about three times the total BOD exerted by all plants in the Long Island Sound Region. Unfortunately, the dispersion pattern of this effluent is currently not well known, a situation that justifies the highest research priority to resolve. Discharges into the Upper East River are expected to increase to about 715 MGD by 2020. Not included in the above data are about 350 MGD currently being discharged into the Lower (below Hell's Gate) East River. Since much of this wastewater is still raw, it exerts a high quantity of BOD, about 150 tons daily. Fortunately,

SPILLS FROM OIL TRANSFER OPERATION



INDUSTRIAL WASTEWATER

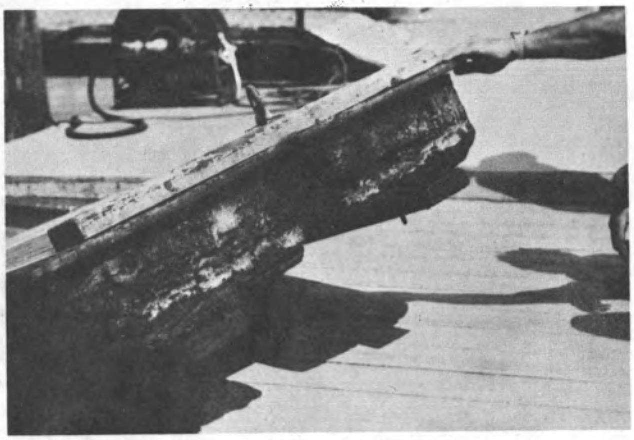
SOURCES OF POLLUTION

MUNICIPAL WASTEWATER

STORM WATER RUNOFF

CONSTRUCTION AND MINING ACTIVITIES

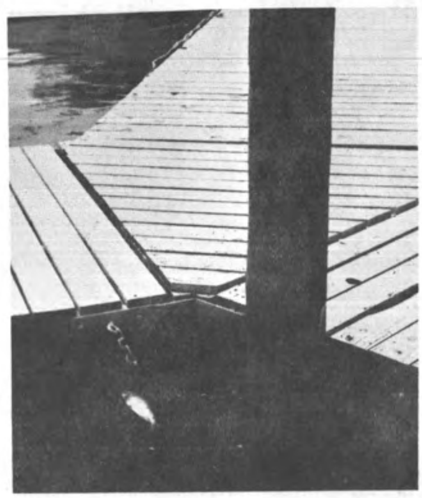
WASTE DISCHARGE FROM RECREATIONAL VESSELS



DAMAGE TO PROPERTY CAUSED BY OIL SPILLS

IMPACT OF SOURCES OF POLLUTION ON WATER QUALITY

NO SHELLFISHING



KILLS FISH

LOWERS WATER QUALITY

because net flow in the Lower East River is away from Long Island Sound, most of this discharge probably does not enter the Sound. However, when flood tide occurs in New York Harbor twice daily, the flow is toward the Sound.

(2) The Connecticut River. According to a recent comprehensive study (59), upstream cities and industries along the Connecticut River and its tributaries north of the regional boundary discharge wastewater which exerts about 100 tons of BOD daily. Its effect on the Sound, however, is probably minor for two reasons. First, BOD is a non-conservative contaminant, meaning that most of the oxygen demanding wastes are probably oxidized before they reach the Sound. Second, most of the flow of the Connecticut River appears to be swept out to the ocean rather rapidly by surface currents (58).

(3) The Housatonic, Thames and a few small rivers bring an additional pollution load into the LIS Region. The Interim Report contains water quality data for the Housatonic and Thames Rivers just before these rivers enter the study area.

(4) The Race may allow an undetermined but small quantity of Rhode Island wastewater, greatly diluted with ocean water, to enter the Sound through major deep inflowing currents.

Other municipal waste problems that will become more apparent as conventional treatment reduces the load of organic waste are those caused by storm or combined sewers and by nutrients which are not removed by conventional treatment. A discussion of combined sewers will be given later in Section 4.2.3.

A most vexing problem in water quality management in the western part of the Sound is the condition that results from the addition of excessive amounts of nutrients, principally the nitrogen compound. Although these elements are needed in small quantities to produce food for aquatic animals, excessive amounts result in over-fertilization and alteration of the aquatic system. Although some nutrients reach waters from other sources, in sub-area 6, municipal waste contributes a major load.

There are many alternative solutions to the existing and potential pollution from domestic wastewater discharges in the study area. Section 7.1 evaluates advanced wastewater treatment, relocation of outfalls and water recharge as possible alternative solutions to meet water quality goals.

Another major problem is to ensure wastewater treatment plants are operating at design effectiveness. The removal of 80-90% of organic matter in wastewater, as called for by the 1977 goal of secondary treatment, will require more effort to improve plant operation and maintenance around the region. There is a strong need to increase the technical and management assistance to operators of wastewater treatment plants in the Region.

Table 18

Municipal Wastes Discharged into Long Island Sound from Sources Located Within the Study Region

Location	Type of Treatment System	Population Served	Waterborne Discharges (MGD)	BOD Load (1) Prior to Treatment (Tons/Day)	Assumed Removal Efficiency	BOD Load Discharge into Study Region (Tons/Day)	BOD Load if all Plants are Secondary (85% removal) (Tons/Day)
Connecticut	Secondary	459,645	84.41	70.40	85%	10.56	10.56
	Primary	542,855	97.95	81.69	30%	57.18	12.25
	Ground	481,000	0	0	0	0	0
	SUBTOTAL	1,483,500	182.36	152.09		67.74	22.81
Westchester, Bronx, Queens, New York	Primary	183,500	35.7	29.77	30%	20.84	4.47
	Secondary	3,491,000 (3)	575.0	480.	70%	144.	72.00
	Ground	Unknown (2)	0	0	0	0	0
	SUBTOTAL	Unknown (2)	610.7	509.77		164.84	76.47
Nassau, Suffolk	Secondary	109,008	15.55	12.97	85%	1.95	1.95
	Primary	12,250	1.53	1.28	30%	0.9	0.19
	Ground	Unknown (2)	0	0	0	0	0
	SUBTOTAL	Unknown (2)	17.08	14.25		2.85	2.14
Totals of Above	Secondary	4,059,653	674.96	563.37		156.51	82.56
	Primary	738,605	135.18	112.74	30%	78.92	16.91
	TOTAL	4,798,258	810.14	676.11		235.43	99.47

(1) Assumed that strength of wastewater coming into municipal system exerts average BOD Load of 200 mg/l.
(2) Wastewater discharged to ground through cesspools and septic systems is rare in the Bronx and Queens, common in Nassau County and almost universal in Suffolk. Exact quantities for the LIS portion of these counties is difficult to determine because the LIS region boundary does not follow township or census tract lines.
(3) Four Municipal Treatment Plants which discharge into Upper East River outside the Study Area Proper. Two of these plants serve portions of the LISS Area.

Table 19

Major Municipal Waste Water Treatment Plants

SUBREGION	MAP LOCATION	NAME	AVG. DAILY FLOW Primary	AVG. DAILY FLOW Secondary
1	1	Jewett City		2.80
	2	Groton (Town)		0.66
	3	Groton (City)		1.81
	4	New Longon-Trumbull St	2.87	
	5	New London-Riverside Plant	0.50	
	6	Norwich - Main	4.27	
	7	Norwich - Old	0.167	
	8	Sprague		0.816
		Mystic		0.15
		SUBREGION TOTAL	7.81	6.24
2		NONE		
		SUBREGION TOTAL	0	0
3	9	Branford		1.48
	10	Wallingford		3.38
	11	Meriden		3.67
	12	North Haven		3.0
	13	New Haven-Blvd.	15.60	
	14	New Haven-East St.	15.50	
	15	New Haven-East Side	10.55	
	* 16	West Haven	7.67	
	17	Milford-Beaver Brook		0.50
	18	Milford-Gulf Pond		4.17
	19	Milford-Town Meadow		2.10
	20	Milford-Harbor	___	0.765
		SUBREGION TOTAL	49.32	19.04
4	* 21	Shelton	1.50	
	22	Seymour		0.62
	23	Derby	1.69	
	24	Ansonia		2.70
	* 25	Stratford		6.69
	26	Bridgeport-West Side		26.14
	27	Bridgeport-East Side		11.85
	28	Fairfield	___	6.67
		SUBREGION TOTAL	3.20	54.67
5	29	Westport		0.95
	30	Norwalk		13.52
	31	New Canaan		1.16
	32	Darien	1.42	
	33	Stamford	16.00	
	34	Greenwich	___	9.19
		SUBREGION TOTAL	17.42	24.82
		CONNECTICUT TOTAL	77.75	104.77
6	35	Port Chester	4.4	
	36	Blind Brook	1.9	
	37	Mamaroneck	16.9	
	38	New Rochelle	11.5	
	39	City - Hart Island	1.0	
	40	Belgrade		1.34
	41	Great Neck (V)		0.99
	42	Great Neck		2.56
	43	Port Washington		2.63
	44	Roslyn		0.42
	45	Glen Cove		5.06
	46	Oyster Bay	___	1.2
		SUBREGION TOTAL	35.70	14.2
7	47	Huntington		1.2
	48	Northport		0.15
	49	Port Jefferson	1.24	___
		SUBREGION TOTAL	1.24	1.35
8		NONE		
		SUBREGION TOTAL	0	0
9	50	Greenport	0.29	___
		SUBREGION TOTAL	0.29	0
		NEW YORK TOTAL	37.23	15.55
		LISS TOTAL	114.98	120.32

*These treatment plants presently being upgraded to secondary

Table 20

Summary of Major Thermal Electric Power Development in Long Island Sound Study Area (1972)

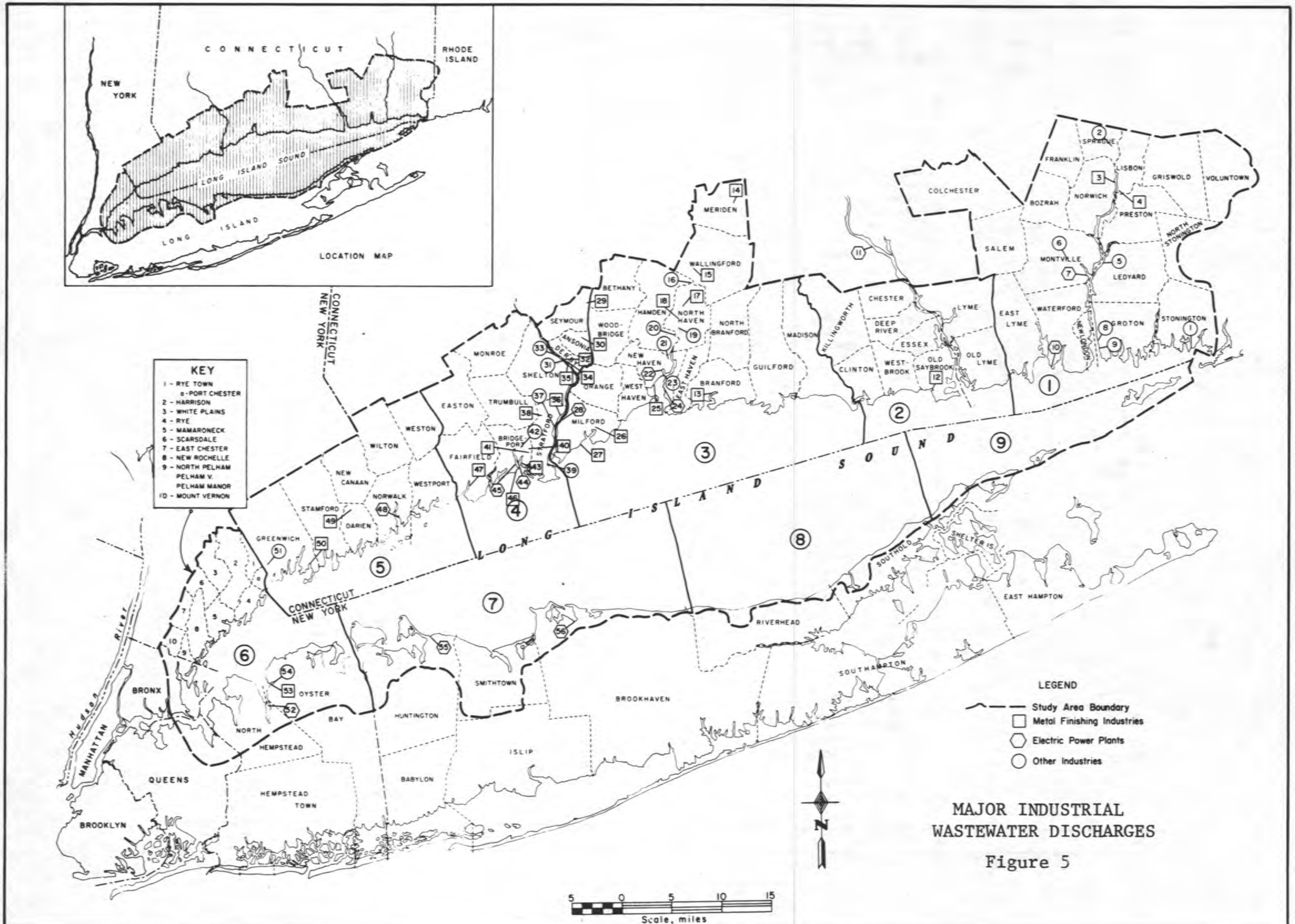
Sub-Region	Plant Name and Location	Type	Capacity (MW)	Cooling Water Requirements (MGD)	Temperature Rise in °F Cooling Water	Receiving Water	Scheduled Completion Date
1	Northeast Utilities Unit 1 Milestone Point, Conn.	Nuclear	662	605	21.3	Long Island Sound	In operation
1	Northeast Utilities Unit 2 Millstone Point, Connecticut	Nuclear	828	-	-	Long Island Sound	1974
1	Conn. Light & Power Company Montville, Conn.	Fossil	577	422	15	Thames River	In operation
1	United Illuminating Co. Coke Works	Fossil	445	-	-	New Haven Harbor	1975
2	Conn. Yankee Atomic Power Company Haddam Neck, Conn.	Nuclear	600	536	22.8	Connecticut River	In operation
3	United Illuminating Company English New Haven, Conn	Fossil	146	144	13.6	New Haven Harbor	In operation
4	United Illuminating Company Steel Point Bridgeport, Conn	Fossil	156	153	16.4	Bridgeport Harbor	In operation
4	United Illuminating Company Bridgeport Harbor, Bridgeport Connecticut	Fossil	661	642	15.8	Bridgeport Harbor	In operation
4	Connecticut Light & Power Company Devon, Connecticut	Fossil	454	472	15	Housatonic River	In operation
5	Connecticut Light & Power Company Norwalk, Conn.	Fossil	326	316	16	Norwalk Harbor	In operation
6	Long Island Lighting Company Glenwood Landing, New York	Fossil	377	382	19.2	Hempstead Harbor	In operation
6	Consolidated Edison Company Davids Island, New New Rochell,e N.Y.	Nuclear	4,000	-	-		Potential Site
7	Long Island Lighting Co. Shoreham, N.Y.	Nuclear	849	-	-	Long Island Sound	1975
7	Long Island Lighting Co. Port Jefferson, NY	Fossil	467	390	19	Port Jefferson Harbor	In operation
7	Long Island Lighting Co. Northport, Long Island	Fossil	774	360	26.5	Huntington Bay	In operation
7	Long Island Lighting Co. Lloyd Neck, NY	Nuclear	1,000	-	-	Huntington Bay	Potential Site

Table 21

Major Sources of Industrial Dischargers

SUBREGION	DISCHARGER	TYPE OF INDUSTRY	DISCHARGED TO	FLOW IN MGD
1	American Velvet Co.	Textile Mill	Little Narragansett Bay	0.21
	Federal Paper Board Co.	Paper Mill	Little River	7.9
	Artistic Wire Products Co.*	Metal services	Shetucket River	0.1
	King-Seeley Thermos	Metal plating	Shetucket River	0.09
	Dow Chemical Co.	Plastic material	Thames River	1.86
	Robertson Paper Box	Paper mill	Oxoboro River	0.60
	Connecticut Light & Power Co.	Electric power	Thames River	432.0
	General Dynamics	Shipbuilding	Thames River	1.79
	Pfizer Co.	Chemical & allied products	Thames River	115.5
	Millstone Point Co.	Electric Power	Long Island Sound	662.0
2	Connecticut Yankee Power	Electric Power	Connecticut River	545.0
	R. Donnelly & Sons	Metal plating & polishing	Oyster River	0.15
3	Atlantic Wire Co.	Steel & wire related products	Branford River	0.34
	Napier Co.	Metal plating & polishing	Quinnipiac River	0.09
	Wallingford Steel Co.	Cold finishing of steel shapes	Quinnipiac River	3.15
	American Cyanamid Co.	Plastic material	Quinnipiac River	3.58
	Pratt & Whitney	Aircraft engines	Quinnipiac River	1.39
	Marlin Firearms Co.	Metal polishing & finishing	Waterman's Brook	0.18
	Upjohn Co.	Organic chemicals	Quinnipiac River	.60
	Humphrey Chemical Co.	Organic chemicals	Quinnipiac River	0.50
	Federal Paper Board Co.	Paper board	Mill River	0.1
	United Illuminating Co.	Electric power	Mill River	356.0
	Simkins Ind.	Paper board	Mill River	1.01
	United Illuminating Co.	Electric power	New Haven Harbor	403.0
	Sargent & Co.	Metal services	New Haven Harbor	0.33
	Schick Safety Razor	Metal plating & polishing	Indian River	0.36
	Robertshaw Controls	Metal plating & polishing	Long Island Sound	0.35
	Connecticut Light & Power	Electric power	Housatonic River	373.0
4	Kerite Co.	Metal plating & polishing	Bladems Brook	0.43
	Anaconda American Brass	Metal plating & polishing	Naugatuck River	2.64
	Hull Dye & Print Works	Textile mill products	Housatonic River	1.96
	W.E. Basset Co.	Metal plating & finishing	Housatonic River	0.05
	B.F. Goodrich	Fabricated rubber products	Housatonic River	19.6
	USM Corp.	Metal polishing & plating	Housatonic River	0.16
	Chromium Process Co.	Metal plating & polishing	Housatonic River	0.32
	Dresser Industries	Metal plating & polishing	Housatonic River	0.20
	Raybestos-Manhattan	Asbestos products	Ferry Creek	1.92
	Contract Pating Co., Inc.	Metal polishing & plating	Long Brook	0.24
	Avco: Lycoming		Housatonic River	3.74
	Chemical Plating Co.	Metal plating & polishing	Bruce Brook	0.21
	Bridgeport Rolling Mills Co.	Metal plating & polishing	Bruce Brook	0.11
	General Electric	Electric houseware & fans	Stillman Pond	13.90
	Carpenter Technology Co.	Blast furnaces & steel mills	Yellow Mill Creek	3.98
	United Illuminating	Electric power	Bridgeport Harbor	163.75
	United Illuminating	Electric power	Bridgeport Harbor	560.0
	Remington Electric	Metal plating & polishing	Bridgeport Harbor	0.07
	Bullard Co.	Metal plating & polishing	Ash Creek	0.42
5	Connecticut Light & Power	Electric power	Long Island Sound	316.0
	Machlett Laboratories	Metal plating & polishing	Springdale River	1.30
	Electrolux	Metal services	Long Island Sound	0.08
	GAF Corp.	Felt goods	Byram River	2.61
6	Long Island Lighting	Electric power	Hempstead Harbor	391.0
	Long Island Tungsten	Metal	Glen Cove Creek	0.317
	Powers Chemco Inc.	Organic chemicals	Glen Cove Creek	0.190
7	Long Island Lighting	Electric power	Long Island Sound	720.0
	Long Island Lighting	Electric power	Port Jefferson	320.0

* burned down, no plans to rebuild



MAJOR INDUSTRIAL
WASTEWATER DISCHARGES
Figure 5

Industries discharging into a municipal sewage treatment plant will be required to pretreat its effluent so that it does not interfere with the operation of or pass through the plant without adequate treatment. Nationally, 85 percent of plants having municipal sewers available to them use the sewers for some portion of their wastes; however, since high water volume industries are usually located away from municipalities, industrial wastewaters make up only about 8 percent of the volume of wastewater discharged into municipal systems.

4.2.3 Combined sewer overflows

The multi-million dollar wastewater treatment plant upgrading and expansion program now going on in the region may not be as effective as it might be if means of mitigating the effects of combined sewer overflows are not found. Fourteen municipal collection systems (six in New York and eight in Connecticut) have combined sewers. They serve approximately 770,600 people. This is more than 50% of those currently receiving treatment.

Combined sewers have "built-in" deficiencies. They are designed to carry only specific quantities of stormwater in addition to wastewater. Such a system, therefore, of necessity incorporates planned (and unplanned) overflow points to relieve it of excess flows when runoff exceeds system design. These overflows, a mixture of wastewater and stormwater, contains pollutants such as oxygen demanding compounds, toxic substances, oil and grease which noticably reduce the receiving waters aesthetic and recreational value. These overflows are not disinfected so they produce large increases in bacterial and viral densities and pose a danger to public health.

The volume of sanitary sewage lost from a combined sewerage system by overflow is small (generally 3 to 5 percent). However, the relatively poor flow characteristics of combined sewers during dry-weather when sanitary wastes alone are carried, promotes settling and build-up of solids in the lines until a surge of flow caused by a rainstorm scours the system. Studies in Buffalo, New York have shown that 20 to 30 percent of the annual collection of domestic sewage solids are settled and eventually discharged during storms (67). Consequently, large residual sanitary pollution load, over and above that normally carried is discharged over a relatively short interval of time. This "first flush" phenomenon can produce shock loadings detrimental to receiving water life.

Often, poorly maintained combined sewer regulators permit overflows which should not occur. A recently completed study by the Interstate Sanitation Commission of portions of New York City examined combined sewer regulators (31). The report concluded that too many regulators do not work and even those that do work overwhelm the receiving waters during periods of rainfall when they by-pass. For example, during the first ten minutes of one rainfall, the study team found that one regulator discharged more solids than the whole treatment plant normally discharges in 24 hours.

In the first four hours of rain, over 24,000 gallons of oil were discharged. Combined sewer overflows of this intensity in the Upper East River would affect the water quality of western Long Island Sound.

Table 22

Combined Sewer Systems

Municipal System	Estimated Population Served	Municipal System	Estimated Population Served
Connecticut		New York	
Bridgeport	117,400	City - Hart Island	6,000
Shelton	10,000	Port Chester	23,000
Derby	12,100	Blind Brook	10,000
Seymour	10,100	Mamaroneck	80,000
New Haven	178,000	New Rochelle	64,500
Norwich	24,000	Eastchester Bay Area	180,000
Norwalk	55,000		363,500
Jewett City	3,500		
	410,100	Combined Systems	770,600

4.2.4 Watercraft waste

Vessels of all types, commercial, recreational and governmental, plying the water of Long Island Sound and its tributaries are contributors of untreated and/or inadequately treated wastes in local harbors and in the open water of the Sound.

An estimated 80,000 recreational boats navigate both the harbors and the open waters of Long Island Sound. There are nearly 500 boating facilities containing almost 44,000 berths which now serve these vessels. Many of these vessels are now discharging quantities of untreated or inadequately treated wastes into the waters of the Sound. The wastes emanating from these recreational boating activities are endangering the enjoyment that boating enthusiasts hope to derive from the Sound in future years.

Although watercraft discharges are dwarfed by industrial and municipal discharges in terms of magnitude, the adverse health and aesthetic conditions which can be caused by them, especially in narrow,

Table 23

Recreational Boating Inventory

SUBREGION	BOATING FACILITIES	SLIPS & MOORINGS	TOTAL CRAFT* BERTHED	RECREATIONAL BOATING AREAS (PRESENT AND FUTURE)
1	65	4,185	4,642	Mystic Harbor, Stonington Harbor, Niantic Bay & Harbor and Thames River
2	57	4,094	3,835	Town of Essex, Patchoque River, Menunketesuck River, Clinton Harbor, Conn. River Harbors, North Cove, Hamburg Cove
3	49	4,367	5,148	New Haven Harbor, Branford Harbor, West River, Guilford, Stony Creek, Milford Harbor
4	30	2,867	2,830	Housatonic River, Lewis Gut, Great Meadows, Yellow Mill Channel, Poquonnock River, Ash Creek, Southport
5	94	12,617	12,892	Saugutuck River, Wescott Cove, Greenwich Cove, Cos Cob Harbor, Stamford Harbor, Norwalk Harbor
6	135	11,882	13,788	Mamaroneck Harbor, New Rochelle Harbor, City Island, Manhasset Bay, Hempstead Harbor, Oyster Bay Harbor, Little Neck Bay
7	51	3,473	5,299	Cold Spring Harbor, Huntington Harbor, Northport Bay, Centerport Harbor, Port Jefferson Harbor, Mt. Sinai Harbor
8	5	263	350	Mattituck Creek
9	3	174	165	
TOTAL	489	43,922	48,949**	

*New York Figures Do Not Include Privately Berthed Boats

**Counting an additional 30,000 unberthed craft, the total estimated number of recreational boats using Long Island Sound is about 80,000.

poorly flushed harbors, are worthy of serious consideration. Also, the mobility of these crafts allows their waste to be discarded in areas that are unaffected by other sources of pollution.

Waste discharged from boats is generally clumped materials with particles of considerable mass and mixed liquids. This material, whether floating or solid in nature, requires a significant time interval for decomposition of organic material and destruction of included organisms. Numerous studies indicate that sewage organisms generally have a shorter life in salt water than in fresh water. The die-off period, however, is not exactly known.

Several studies regarding water pollution from watercraft waste discharges have been conducted in the marine waters of New York State. Results of these studies indicate that the quantities of wastes discharged at any one time into a specific boat anchorage or docking area generally were not sufficient to exert a significant oxygen demand upon the receiving waters. There was observed, however, to be a substantial increase in bacterial densities in these areas. Though these high bacteria density conditions may be intermittent and short-lived, they do, as mentioned above, merit serious considerations.

In addition to the threat that the discharge of improperly treated bodily wastes poses to the recreational boating activity itself, it also constitutes a real or potential hazard to the health and well-being of persons utilizing the same water for bathing and shellfishing.

4.2.5 Dredging and disposal

Dredging and the disposal of dredged spoils in the Sound must be considered in discussing the water quality of the Sound. Much of the recreational and commercial activity of the region is based on the navigability of its harbors. Therefore, maintenance dredging and improvement dredging to some degree are necessary for the overall welfare of the Sound.

The New Haven Harbor Maintenance Dredging Project, which involves the dredging and disposal of 800,000 cubic yards of spoil, is now being carried out under the direction of the Corps of Engineers. There has been much sampling and surveillance of this project by the Federal, State and academic community prior to start, at the present time and will continue after the completion to determine its impact on the Sound. Another project which just recently received approval is the Department of the Navy's dredging of New London Harbor. This project would involve dredging 2.65 million cubic yards of spoil to permit larger nuclear submarines to navigate the Thames River. In order to develop many of the marinas and channels for commercial activities being considered as part of this comprehensive plan, there will be a need for an increased amount of dredging and disposal.

Until recently there were 19 dredge spoil disposal sites in the Sound. These sites were selected by the U.S. Army Corps of Engineers in consultation with U.S. Fish and Wildlife Service and EPA's predecessor organizations. Although selected prior to the passage of Federal laws requiring the consideration of environmental impacts in the selection process, the site selections were made on the basis of fishery, economic and navigational considerations. Subsequent legislation prompted a reduction of the 19 sites to 4 sites. These sites are located in Figure 7.

Dredging may result in pollution at both the removal and the spoil disposal sites. The direct effects of dredging, especially those that are confined to the project area, are generally short term and include: turbidity effects, sediment build-up, removal of substrate materials and resuspension of solids. There is little undisputed information now available concerning the long term effects of dredging and dredge spoil disposal - to what extent they represent a significant problem and the magnitude of the problem. Over the last decade, the Corps has spent over $25 million dollars researching the implication of dredge spoil disposal. The Corps' Draft Environmental Statement on New Haven Harbor maintenance dredging made the following statement concerning the potential long term effects of dredging and disposal. "Accumulation of the oxygen demanding material and heavy metals may continue their adverse effects long after the disposal operations are terminated."

4.2.6 Oil and hazardous material spills

Oil and other hazardous pollutants also threaten our goal of achieving swimmable-fishable water for all of Long Island Sound. These pollutants reach the Sound through accidental spills, discharge of oily bilge water, inadequately treated municipal and industrial wastewater, overflow from combined sewers, runoff from land, discharge exhaust from two-cycle engines used on recreational boats, air pollutants and drainage entering Long Island Sound from outside the Study Area.

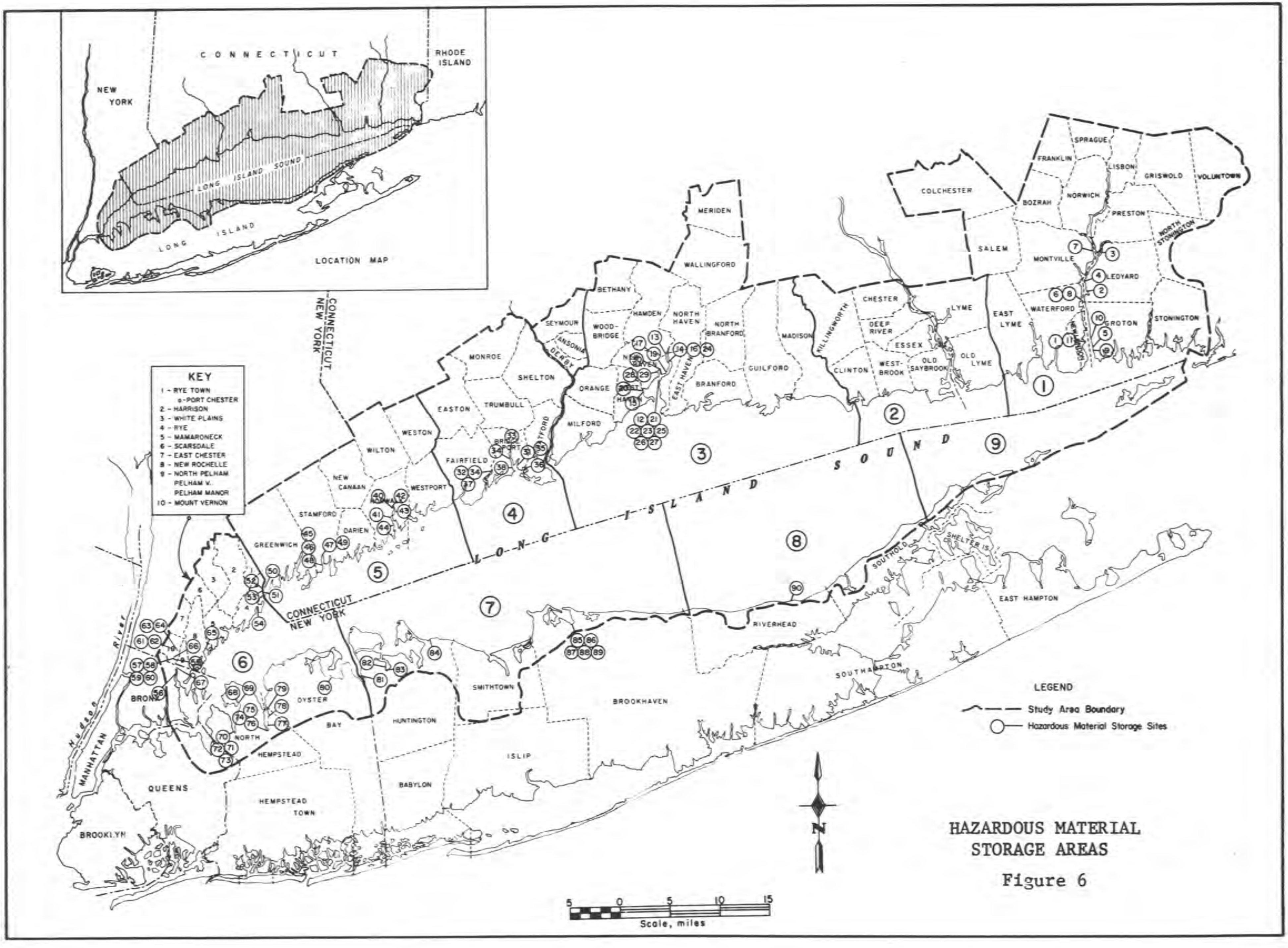
The region has no refineries, but the Sound is a major transportation route for large oil tankers and barges carrying refined petroleum products and other hazardous materials. Many oil unloading and storage facilities are located on the coastline and major tributaries to the Sound. These areas are tabulated in Table 24 and located in Figure 6. Table 25 summarizes the oil products transported into the Region from 1965 to 1970. Note how deliveries increased 50 percent in 5 years.

Oil and hazardous material spills result from many causes such as careless transfer operations, equipment failure, leaks, barge and tanker grounding and overflows. During 1971, there were 104 spills reported in the study area, followed by another 187 in 1972. A detailed breakdown of these spills is found in Table 26. Spills cause damage to boats and shorefront property and are harmful to marine life and water fowl.

Table 24

Hazardous Material Storage Area

Sub-Region	Map Location	Facility	Storage Capacity
1	1	City Coal Co. (gal)	941,200
1	2	Connecticut Light & Power	361,170
1	3	Dahl Oil Company	7,320,000
1	4	Dow Chemical	
1	5	Hess Oil Corporation	102,000,000
1	6	New London Petroleum Terminal	2,609,000
1	7	Lehigh Petroleum Co. (Norwich)	3,342,523
1	8	Norwich State Hospital "	200,000
1	9	Charles Pfizer Company	85,500
1	10	United Fuel Corporation	850,000
1	11	Central Vermont Railroad	800,000
3	12	Atlantic Richfield	33,500,000
3	13	Benedict Fuel Oil	590,000
3	14	Chevron Oil Co.	1,960,000
3	15	Connecticut Refining Co.	2,520,000
3	16	Dorch-King, Inc.	1,500,000
3	17	E.I.duPont de Nemours (sulfuric acid) (tons)	1,700
3	18	Elm City Plant No. 1 (gal)	1,260,000
3	19	Elm City Plant No. 2	13,400,000
3	20	Elm City Plant No. 3	960,000
3	21	Exxon	77,500,000
3	22	Getty Oil Co.	1,480,000
3	23	Gulf Oil Corp.	25,000,000
3	24	Jet Lines, Inc.	440,000
3	25	Mobil Oil Co.	27,800,000
3	26	New Haven Terminal	35,200,000
3	27	T.A.D. Jones & Co., Inc.	20,100,800
3	28	Texaco, Inc.	3,660,000
3	29	United Illuminating Co.	1,480,000
3	30	Wyatt, Inc.	57,000,000
4	31	Connecticut Light & Power Co.	3,235,000
4	32	Exxon Company	
4	33	Hoffman Brothers	
4	34	J.P. Crowley & Company	
4	35	Buckley Brothers, Inc.	
4	36	Sun Oil Company	
4	37	Socony Mobil Oil Co.	
4	38	United Illuminating Co.	
4	39	United Illuminating Co.	
5	40	Divine Brothers, Inc.	
5	41	Harris & Gans Co.	650,000
5	42	Home Oil Co.	
5	43	Leahy's Norwalk Oil	1,392,000
5	44	Penn. Petroleum Corporation	
5	45	Fleming Rutledge Oil Corp.	1,563,000
5	46	Hoffman Fuel Company	
5	47	Independent Oil Co. Of Connecticut	
5	48	Metropolitan Petroleum Corporation	
5	49	Stamford Oil Company	
5	50	Power Test Petroleum Corporation	
5	51	Royal Petroleum Corporation	1,200,000
6	52	Fair Chester Oil Company	
6	53	Exxon	
6	54	Mitchel Oil Corporation	
6	55	Sentinal Oil Company	
6	56	Shell Oil Company	
6	57	American Oil Company	
6	58	Mobil Oil Company	
6	59	Metropolitan Petroleum Co.	
6	60	Royal Petroleum Corp.	
6	61	Power Oil Corporation	
6	62	Crown Central Petroleum Corp.	
6	63	Cities Service Oil Co.	
6	64	Suburban Fuel Oil Service	
6	65	Sun Oil Company	
6	66	Exxon	
6	67	Sinclair Refining Co.	
6	68	Auto-Heat Corporation	
6	69	Lewis Oil Company	
6	69	Lewis Oil Company	
6	70	Universal Utilities Wharf	
6	71	Sinclair Refining Co.	
6	72	Metropolitan Petroleum Co.	1,632,000
6	73	Wells Fuel Wharf	
6	74	Lewis Oil Company	
6	75	Mobil Oil Company	
6	76	Auto Heat	
6	77	Phillips Oil Company	1,100,000
6	78	Windsor Oil Company	1,000,000
6	79	Long Island Lighting Company	
6	80	Commander Oil Company	8,000,000
7	81	Mobil Oil Company	
7	82	Huntington Utilities	
7	83	Nick Brothers	500,000
7	84	Long Island Lighting Company	
7	85	Long Island Lighting Company	
7	86	Swezy Oil Company	1,000,000
7	87	Exxon	1,080,000
7	88	Consolidated Petroleum Company	57,500,000
7	89	Mobil Oil Company	2,500,000
8	90	Northville Industries	100,000,000



HAZARDOUS MATERIAL STORAGE AREAS

Figure 6

Table 25

Oil and Petroleum Products
Total Freight Traffic for Calendar Years 1965-1970

(Short tons)

Sub-Region	Ports	1970	1969	1968	1967	1966	1965
	Connecticut						
1	New London Harbor	3,678,811	2,800,947	1,253,325	830,150	904,413	813,125
1	Thames River	372,930	222,615	258,169	262,436	234,696	266,439
2	Connecticut River (Below Hartford)	3,715,760	4,244,073	3,542,776	3,108,044	2,824,281	2,748,342
3	New Haven, Conn.	10,514,458	8,950,842	9,918,544	9,943,863	8,084,637	8,273,285
3-4	Housatonic River	312,000	251,447	116,660	99,454	30,822	14,071
4	Bridgeport Harbor	3,306,314	3,335,055	2,962,239	2,682,326	2,128,876	2,219,379
5	Norwalk Harbor	207,960	167,759	95,188	89,326	252,083	263,115
5	Stamford Harbor	592,247	601,397	467,595	574,164	521,104	435,305
5	Greenwich Harbor	23,040	29,296	28,314	32,686	28,739	26,398
5	Westport Harbor	7,139	11,069	12,542	13,271	9,684	9,995
	New York						
6	Port Chester Harbor	234,735	319,792	326,057	318,874	298,226	273,752
6	East Chester Creek	1,532,122	1,587,862	1,569,810	1,519,482	1,454,408	1,456,733
6	Westchester Creek	615,569	754,618	674,717	709,985	596,734	576,025
6	Manhasset Bay	490,635	617,894	632,208	628,472	652,969	012,457
*	Flushing Bay & Creek	570,572	726,096	817,531	766,463	778,953	799,048
*	East River	17,412,521	16,059,119	15,072,609	13,670,728	12,661,976	11,139,874
6	Hempstead Harbor	1,052,117	1,259,118	1,184,477	1,253,266	1,055,738	943,447
7	Huntington Harbor	33,509	118,535	159,584	187,495	212,264	183,362
7	Port Jefferson Harbor	3,615,275	2,187,778	1,719,602	1,554,666	1,253,651	996,409
	TOTAL	48,287,714	44,245,312	40,811,947	38,240,151	33,984,254	32,046,561

* Neither Flushing Bay or East River are in the Long Island Sound Study area. These areas were included in the tabulation because of the potential effect oil and petroleum traffic in these areas might have on the Sound.

Table 26

Oil Spill Data: 1971 - 1972

	1971	1972
I. Number of Oil Spills by Geographic Location		
a. New Haven	20	30
b. Bridgeport	19	11
c. Thames River	8	73
d. Other	57	73
	104	187
II. Cause of Oil Spill		
a. Personnel failure	20	45
b. Equipment failure	16	40
c. Leaking tank	7	6
d. Grounding	4	5
e. Normal operation	2	-
f. Sabotage	2	-
g. Collision	-	3
h. Other and unknown	53	88
	104	187
III. Quantities spilled (Gallons)		
0 - 9	5	35
10 - 99	12	53
100 - 999	14	25
1000 - 2000	5	4
3000	2	0
6000	1	0
386,000	1	0
Unknown	64	70
	104	187
IV. Total Oil Spilled - Approximate Gallons	435,000	100,000

A recent major oil spill in the study area occured on March 21, 1972 when the tanker F.L. Hayes was grounded on Bartlett's Reef near Niantic Bay, causing an estimated 80,000 gallons of oil to be spilled. A field study was undertaken by VAST, Inc. for EPA to determine the effects of a No. 2 fuel oil spill on the benthic communities of Niantic Bay, on the Northern shore of Long Island Sound. Three benthic stations were chosen within the Bay, and a control station was selected to the west of Black Point. Stations were analyzed for density and diversity of species as an indicator of stress. Sediments and selected biota were analyzed for fuel oil by gas chromatography. Results show that only the mid-bay station was definitely contaminated, which may have caused the loss of the amphipods. The hermit crab, Pagurus, may also be sensitive to the oil. Concentration of the pollutant in its tissues appears to make it a good indicator for low levels of residual oil. The bay was spared severe contamination by a storm which dissipated and weathered the oil. Ultimate disposition of residual oil was determined by currents of the area rather than movement of the surface slick immediately following the spill.

4.2.8 Non-point sources

Water quality problems and solutions are not all conveniently confined within the pipes of municipal and industrial wastewater sources. In marked contrast to these sources, non-point sources are elusive to measure and control. Prominent non-point sources include (1) stormwater runoff from urban, suburban and agricultural lands, (2) rainfall and wind borne contaminants, (3) resuspension of pollutants previously deposited in water courses, (4) seepage from contaminated ground water, and (5) leaching from dumps and landfills (36).

Although these sources are currently difficult to measure and their effects are even more difficult to assess, non-point sources must be fully integrated into any comprehensive plan that aims to improve and/or maintain water quality.

Materials which commonly reside on street surfaces have been found to contribute substantially to urban pollution when washed into receiving waters by storm runoff. In fact, runoff from street surfaces is similar in many respects to sanitary sewage. Studies (62) based on a hypothetical, but typical U.S. city indicated that runoff from the first hour of a moderate to heavy storm would contribute more pollutional load than would the same city's raw sanitary sewage during the same period of time. The hypothetical city has the following characteristics:

- population: 100,000 persons
- total land area: 14,000 acres
- land-use distribution:
  - residential: 75%
  - commercial: 5%
  - industrial: 20%
- sanitary wastewater: 12 million gallons/day

The comparison made on Table 27 is for the first hour of a moderate-to-heavy rainstorm; one which involves brief peak rates at least 1/2-in/hr. during the first hour. From Table 27, it is obvious that urban street runoff is a much greater source of short-term "slug" loadings. It should be noted

Table 27

Comparison of Pollutional Loads
from Hypothetical City* -

Street Runoff vs Raw Sanitary Wastewater

	CONTAMINANT LOADS ON RECEIVING WATERS STREET SURFACE RUNOFF (lb/hr)	RAW SANITARY WASTEWATER (mg/l)	(lb/hr)[a]	RATIO STREET TO WASTEWATER [b]
Settleable + Suspended Solids [c]	560,000	300	1,300	430
BOD[c]	5,600	250	1,100	5.1
COD^5 (c)	13,000	270	1,200	11
Total Coliform Bacteria	40×10^{12} Organisms/hr	$250 \times 10^{(6)}$ Organisms/liter	4.6×10^{14} Organisms/hr	0.0087
Kjeldahl Nitrogen[c]	880	50	210	4.2
Phophates	440	12	50	8.8
Zinc	260	0.20	0.84	310
Copper	80	0.04	0.17	470
Lead	230	0.03	.13	1,800
Nickel	20	0.01	0.042	480
Mercury	29	0.07	0.27	110
Chromium	44	0.04	0.17	260

(a) Loadings discharged to receiving waters (average hourly rate).
(b) Ratio of loadings: street runoff/sanitary discharge
(c) Weighted averages by land use, all others from numerical mean.

*This comparison is for the first hour of a moderate to heavy rainfall. The table illustrates that urban street runoff can be a greater source of short term slug loadings than raw sanitary wastewater.

The classification of New York State's 3.5 million acres of lakes and more than 70,000 miles of rivers was initiated in 1949, and officially adopted in 1967. Every stream, lake, river, bay and estuary within New York has been classified as to its best usage. Water quality standards have been established to judge the suitability of water for its best usage. Both classifications and standards are periodically reviewed and are modified to reflect changes.

In 1962, a countywide comprehensive sewerage study and planning program was initiated to provide a framework for implementation of coordinated systems of wastewater treatment facilities. The Pure Waters Bond Act of 1965 provided $1 billion in grants toward the construction of municipal and joint municipal industrial waste treatment facilities, compatible with countywide plans. These programs, along with provisions of the Clean Water Restoration Act of 1966 (PL 89-753) promoted development of 342 sewage treatment projects at an eligible project cost of $3.3 billion.

The $1.5 billion Environmental Quality Bond Act of 1972 included $650 million to supplement the 1965 Bond Act. This added grant money was needed to cover inadequate Federal funding, higher than expected inflation, and the costs of higher treatment standards and capacity requirements. There are presently 374 pending municipal projects. Of these, 168 projects at an estimated total eligible project cost of nearly $2 billion have been ranked in a priority listing. The remaining projects which are in various stages of planning have an estimated total cost of nearly $3 billion.

Control of discharges through permits was begun by New York in 1968. At present, New York operates the State Pollution Discharge Elimination system and is incorporating the National Pollution Discharge Elimination system. Water quality monitoring and surveillance, research and development, operation and maintenance, oil spill clean up, and environmental impact analysis are other areas of State activity.

In Connecticut, as of October 1971, the authority to control water pollution was transferred from the State Water Resources Commission to the newly formed Department of Environmental Protection. A Water Compliance Unit was formed within the Division of Environmental Quality of this new Department to operate the program.

The Water Pollution Control Section of the Water Compliance Unit has the overall responsibility for the water pollution control program. Its staff of engineers and inspectors are responsible for initiation of the construction of sewage and industrial wastewater discharges, assessing the discharger's ability to control pollution, issuing Orders for the control of pollution, reviewing designs of all control facilities and inspecting the operation of industrial wastewater treatment plants.

The Municipal Facility Section is responsible for insuring that all municipal, state, Federal and private sewage treatment systems are maintained and operated with maximum effectiveness. Periodic inspections and evaluations of all facilities (sewers, pumping stations, treatment plants) are carried out. The Water Compliance Unit, through this program of inspections, oversees the treatment of all domestic waterborne wastes in the state except for those wastes disposed of by household septic systems. The unit also operates training programs and certifies the sewage treatment plant operators.

The Oil & Chemical Section of the Water Compliance Unit is responsible for reacting to oil and chemical spills and insuring that containment and removal of the hazardous substance is carried out. This section strives to prevent these occurrences through regulations and issuance of appropriate licenses or permits to oil and chemical terminals served by vessels, transporters of waste oil and chemicals, and oil and chemical clean-up contractors.

The Water Quality Management Section of the Water Compliance Unit is responsible for handling of basic data on water pollution and water quality in the state and for developing planning wherein the water pollution abatement strategy for entire river basins are considered as a total problem. Continued inputs into the Statewide Long-Range Water Resources Plan, the State Plan of Conservation and Development and the Long Island Sound Study are provided by this Section.

Under Connecticut Public Act No. 57, approved May 1, 1967, public hearings have been held relative to the adoption of standards for the waters of the State and the State has adopted water quality standards for interstate, intrastate and coastal waters. These water quality standards were recently revised to reflect the interim goals and the ultimate goal of swimmable/fishable waters by 1990.

Enactment of the comprehensive Federal Water Pollution Control Act Amendments of 1972 signalled a new determination and a long-range commitment on the part of the Federal government to purify and maintain the purity of the waters. The key areas of action set forth by the new law are:

- Stringent new standards for pollution abatement.
- Increased Federal funding for construction of municipal wastewater facilities.
- Expanded pollution control planning.
- A permit program to more tightly regulate all discharges.
- A public disclosure of facts about pollution problems and greater public participation in the regulatory process.

Perhaps the predominant influence on the Act was the universal recognition that basic compliance and enforcement efforts on a case-by-case judgement of a particular facility's impacts on ambient water quality is both scientifically and administratively difficult. To minimize the difficulties in relating discharges to ambient water quality, the Act requires minimum effluent limitations for each category of discharger, based on technological and economic feasibility, regardless of receiving water requirements. When water quality standards cannot be achieved by imposition of these controls alone, receiving water conditions will be used to dictate to individual discharges more stringent limitations. The complexities of relating effluent amounts to ambient quality also led the Congress to provide that the effluent limit, not ambient quality, is the basis for enforcement actions.

The Act places heavy emphasis on planning to maximize the results of the construction grant program, to provide continuing management commensurate with the magnitude of the new program, and to assure compatibility with other environmental quality and natural resource planning. There are four major aspects in the Act.

- State Continuing Planning Process in Section 303(e) to serve as the State's overall system for coordination of all aspects of planning, programming and local implementation. The process is intended to permit the Governor and others an apportunity to participate in resolution of significant issues, while serving as the basis for the State's annual program grant application to EPA. The focus of this section is on basin plans.

- Areawide Waste Treatment Management Planning, Section 208 is a continuing management planning process focusing on areas which have substantial water quality control problems because of urban-industrial concentration or other factors. The Governor may designate locally representative planning agencies for such problem areas.

- Facilities Planning, Section 201, to provide facilities planning where 208 agencies are not designated, or to serve prior to their designation to assure cost effectiveness requirements for approval of individual treatment plant grant applications.

- Water Resources Basin Planning, Section 208, providing Level B multi-purpose water resource studies for all basins by 1980, with priority to designated problem areas under Section 208.

The Interstate Sanitation Commission was formed by the Tri-State Compact between the States of New Jersey, New York and Connecticut to have jurisdiction in the Interstate Sanitation District. This District consists of all coastal, estuarine and tidal waters within or covering the signatory states in an area which includes the New York Harbor complex and the waters of Long Island Sound from the East River to a line extending from the east side of New Haven Harbor on the Connecticut shore to the east side of Port Jefferson Harbor on the New York shore.

In its activities for water pollution abatement, the Commission provides assistance in coordinating approaches to regional problems. Priorities in this area receiving attention are: pretreatment of industrial wastes, removal of oils from the District waters, compliance monitoring, thermal pollution, enforcement, and combined sewers. It is anticipated that more than $4.69 billion will be spent in the ISC region on wastewater treatment in the next several years. During this past year, the Commission continued to operate its own automatic water quality monitors and those that it leases from the United States Environmental Protection Agency. The Commission has continued its cooperation with the States and other enforcement agencies. This has been accomplished by assisting the States in certification of discharges in District waters, providing laboratory analyses for state and Federal enforcement agencies, and by Commission personnel taking part in various actions on behalf of the States and other agencies.

One of the major problems in the Interstate Sanitation District is what to do with the present and increasing quantities of sludge produced from municipal waste treatment plants. The Commission is responsible for managing a two-year three-phase program to develop a viable and coordinated system for sewage sludge disposal in the New York-New Jersey Metropolitan Area by June 1976.

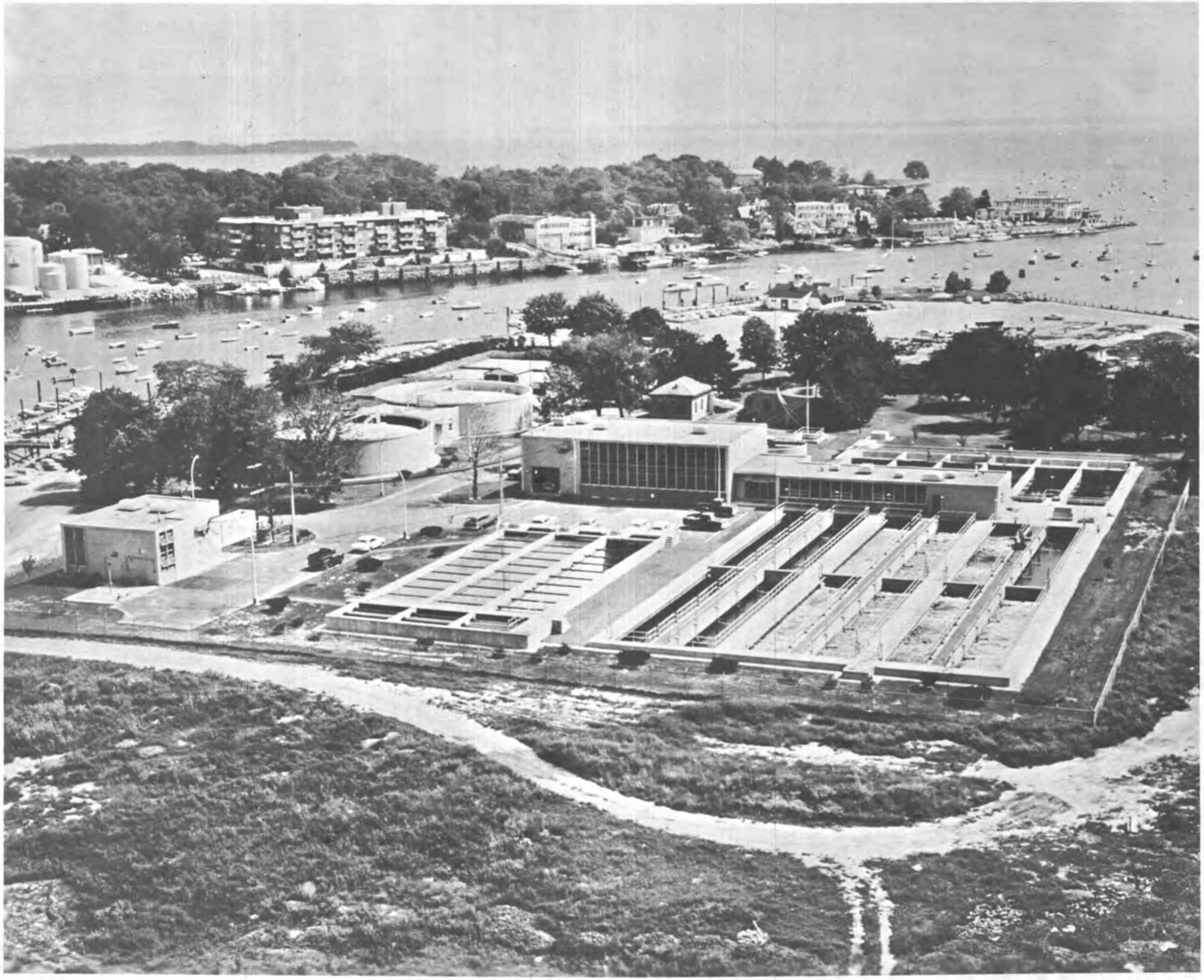
In order for the States to have an analytical basis on which to allocate wasteloads, the Commission has, at the request of and through funding provided by the U.S. Environmental Protection Agency, let a contract to model the entire New York Harbor area, including the Upper East River and Long Island Sound.

The New England Interstate Water Pollution Control Commission, representing the six New England States and the State of New York, was established by interstate compact in 1947. The Commission provides a vehicle for interstate cooperation in water pollution control through the classification of interstate streams, research on regional water pollution control problems and public information. Recently, it has directed its attention to programs providing training for waste treatment plant operators.

4.3.2 Municipal and industrial sources of pollution

The current regulatory requirements of the Federal-State Water Pollution Control Program is that "point source" discharges -- industries, municipal and other discrete sources -- must obtain permits specifying allowable amounts and constituents of effluent and a schedule for achieving compliance. States meeting requirements specified by EPA may administer the permit program. The State of Connecticut has satisfied these requirements and the State of New York is in the process of meeting them.

Permits must be consistent either with applicable effluent guidelines currently being issued by EPA for major classes and categories of industrial facilities or with EPA requirements for publicly owned waste treatment works. The technology-based effluent limitations and the water quality standards that may dictate more stringent effluent limitations are



— MUNICIPAL WASTEWATER TREATMENT PLANT AT GREENWICH —

to be applied in two phases. By 1977, municipal plants must provide "secondary treatment" -- a common level of treatment for organic wastes, usually based on bacterial decomposition and stabilization. Also by 1977, industrial facilities must comply with EPA's effluent guidelines prescribing "best practicable control technology currently available". Stricter effluent limitations for both industry and municipalities will be required in individual cases if best practicable technology or secondary treatment is not adequate to meet ambient water quality standards which are set on the basis of water uses, such as propagation of fish and wildlife and recreation.

By 1983, municipalities must provide "best practiable waste treatment technology" and industries must comply with effluent guidelines prescribing best "available technology economically achievable" which will result in "reasonable further progress" toward the goal of eliminating the discharge of pollutants. More stringent effluent limitation may be imposed for individual industries or municipalities when necessary to "contribute" to water quality needed to "assure protection of public water supplies, agricultural and industrial uses, and the protection and propagation of a balanced population of shellfish, fish and wildlife, and allow recreational activities in and on the water". The more stringent limitation will not apply, however, if the discharger demonstrates that there is "no reasonable relationship" between the economic and social costs and benefits to be obtained.

In addition to issuing effluent guidelines for existing point source, EPA is setting special effluent standards for new industrial point source, based on best available demonstrated control technology. These will apply to at least 27 categories of sources listed in the Act.

The EPA is also publishing a list of toxic pollutants and effluent limitations or prohibitions for them. Toxic pollutants are defined as those which, when assimilated either directly from the environment or indirectly by ingestion through food chains, will cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfuntions, or physical deformities in any organism or its offspring.

The EPA also issues pretreatment standards requiring an industrial facility discharging into a municipal sewage treatment plant to pretreat its effluent so that it does not interfere with the operation of or pass through the plant without adequate treatment. Nationally, 85 percent of plants having municipal sewers available to them use the sewers for some portion of their wastes; however, since high water volume industries are usually located away from municipalities, industrial wastewaters make up only about 8 percent of the volume of wastewater discharged into municipal systems.

4.3.3 On-going programs to abate combined sewer overflows

Neither the EPA nor the States have made a comprehensive effort to identify or correct combined sewer discharges. Some special studies have been conducted (Norwalk and Bridgeport). However, most of the communities within the LISS region will have to undertake in-depth sewer system evaluation to determine the most cost-effective solution to their particular problem. Until these studies are conducted, combined sewer discharges cannot be abated. The NPDES permit program will become the vehicle to produce the necessary analyses. Permits will require municipalities to monitor overflows; and within 1 to 2 years, develop a plan for their correction to meet water quality standards. New York has developed detailed permit guidelines for publicly-owned treatment works with combined sewer overflows.

The studies required by the permits can be funded through the construction grants program (Step 1 grants). Connecticut is currently planning Step 1 studies for its localities with combined sewers. The City of Norwich is expected to be the first municipality to undertake such a study. It will probably be funded in Fiscal Year 1975. Following the Step 1 studies, combined sewer projects are eligible for construction grants.

4.3.4 On-going programs to abate watercraft waste

The 1970 amendment of the water pollution control law set in motion a procedure to regulate sewage discharges from ships and boats. EPA was required to issue standards for marine sanitation devices to prevent the discharge of untreated or inadequately treated sewage from vessels.

EPA issued standards in 1972. When these go into effect, they will forbid the discharge of any sewage waste, treated or not, into the waters from toilet equipped vessels.

The Coast Guard has developed regulations consistent with the EPA's standards governing the design, construction, installation and operation of marine sanitation devices. After the Coast Guard regulations are promulgated, they and the EPA standards will take effect in two years for new vessels and in five years for existing vessels.

Existing vessels will be allowed to use treatment devices certified by the Coast Guard if installed within five years of the regulations' issuance. The treatment devices will have to reduce fecal coliform bacteria to no more than 1,000 per 100 milliliters of water and prevent the discharge of visible floating solids.

These regulations might pre-empt more stringent state laws such as the one that now exists in New York. Section 33-c of the New York State Navigation Law sets forth the prohibitions and requirements regarding liquid and solid waste discharged from watercraft. This law empowers the Department of Environmental Conservation to promulgate rules, regulations and standards regarding boat pollution control. Effluent standards have been developed for all sewage passed overboard from boats. As of now, no treatment device has been deemed capable of meeting the effluent standards. In view of this law, pollution problems associated with watercraft waste will become minimal.

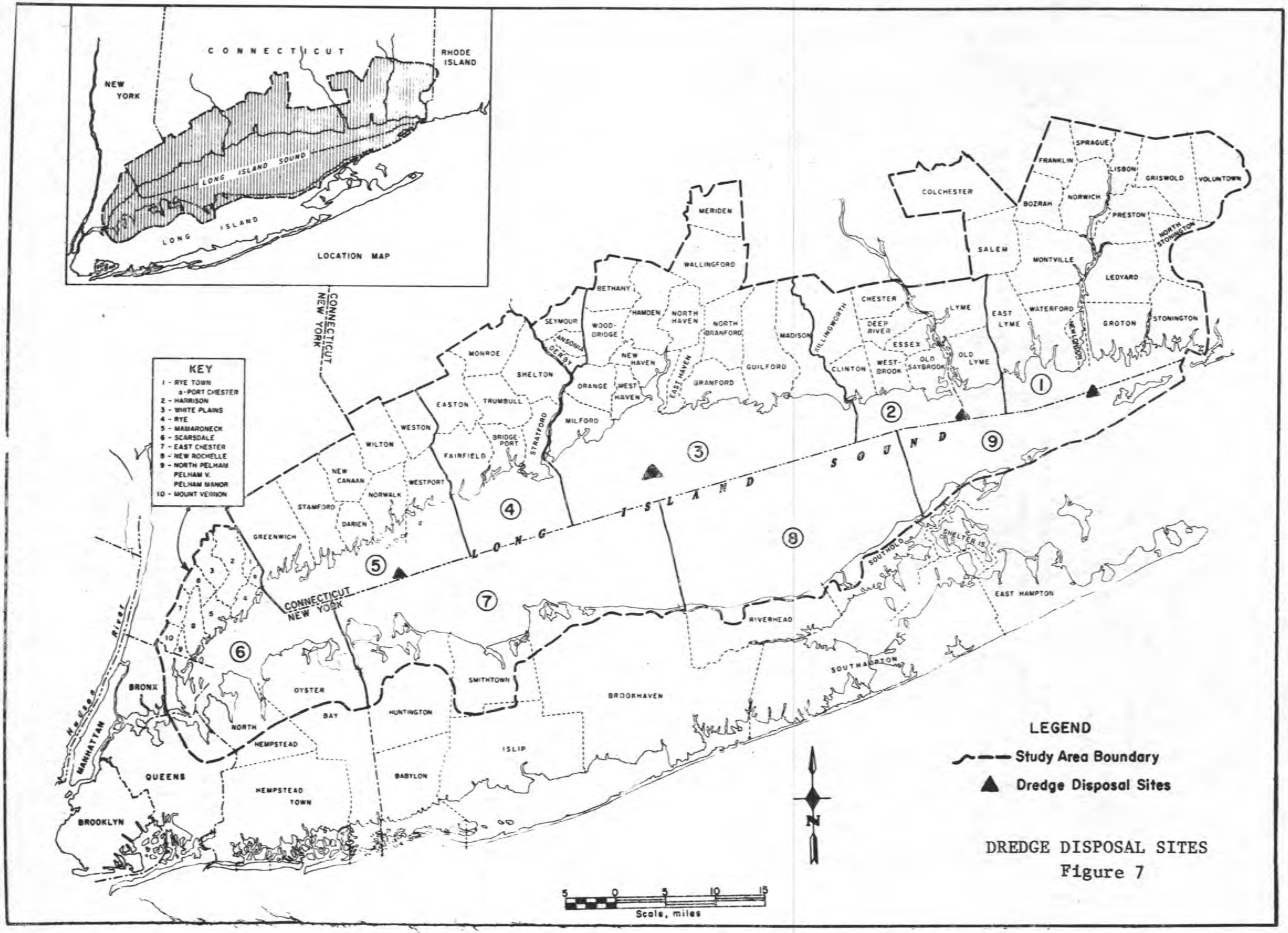
As a result of these regulations, both private and public marinas have constructed pump-out facilities to assist pleasure crafts in complying with New York State Law. As of January 1, 1973, the following private marinas provide pump-out services in the New York area:

Nichols Yacht Yards, Mamaroneck, New York
Glen Cove Yacht Service, Glen Cove, New York
Halesite Marina, Huntington, New York
Little Africa Town Park, Smithtown, New York
Municipal Marina, New Rochelle, New York
Roosevelt Memorial Park, Oyster Bay, New York
Milldam Marina, Huntington, New York
Pt. Jefferson Marina, Brookhaven, New York
Consolidated Yachts, City Island, New York
Tappen Beach Marine, Glenwood Landing, New York
Cedar Beach Marina, Brookhaven, New York
Minneford Boat Yard, City Island, New York
Knutson's Marina, Huntington, New York
Long Beach Marina, Smithtown, New York
Nissequogue Yatch Club, Smithtown, New York
Woodbine Marine, Huntington, New York

The State of Connecticut is presently developing a program for the abatement of pollution due to watercraft waste. Preliminary planning studies have tentatively called for the issuance of orders to all marinas that can be demonstrated to exist as areas of significant small craft population. The orders will require that these identified areas provide pump-out services for holding tanks of small craft and the subsequent treatment of the collected wastes by means capable of meeting defined effluent standards. Alternatives for waste treatment disposal include interceptor extension to the marina site, transport by truck to a proximate sewage treatment facility, septic tank storage and ground recharge, etc., the choice being that which is most suitable to a particular site.

4.3.5 On-going programs to mitigate environmental effects of dredging and disposal

On October 27, 1972, the President signed into law the Marine Protection Research and Sanctuaries Act of 1972 which declared it national policy "to regulate the dumping of all types of materials into ocean waters and to prevent or strictly limit the dumping into ocean waters of any material which would adversely effect human health, welfare, or amenities of the marine environment, ecological systems or economic potentialities. In order to carry out the requirements of this law, EPA is required to promulgate regulations that will set out the procedures for permit application and issuance, and designate and evaluate disposal sites.



DREDGE DISPOSAL SITES
Figure 7

As a result of this law and a memorandum of understanding between the States of Connecticut and New York, the number of designated sites within the Sound has been reduced to the following four: Eaton's Neck dumping ground, Cornfield Shoal dumping ground, New Haven dumping ground, and New London dumping ground. These four sites are shown on Figure 7.

The 1972 Federal Water Pollution Control Act Amendments reaffirms the authority of the U.S. Army Crops of Engineers to issue permits for the disposal of dredge or fill material into the water. This is consistent with the Corps' historic role of safeguarding navigation. But to safeguard water quality, dredge or fill materials may be dumped only in specified disposal sites. EPA and the States have authority to veto the selection of disposal site to prevent adverse effects on municipal water supplies, fishery resources, wildlife or recreation.

The EPA has also issued guidelines to protect coastal and ocean waters from pollutants. Permits for ocean disposal of pollutants must comply with the guidelines. The guidelines cover the effects of pollutants on human health and welfare, on marine life, shorelines and beaches and cover alternatives to ocean disposal of pollutants. Section 4.2.5 describes the current status of dredging in Long Island Sound.

4.3.6 On-going programs to prevent oil and hazardous material spills

The Federal Government was given extensive authority in 1970 to clean up oil spills, require those responsible to pay the cost of clean up and assess fines and other penalties. It was also given authority to control pollution from hazardous substances. Connecticut handles the problem of oil and hazardous material spills under the Comprehensive State Law which includes control over terminals by licensing. This law became effective on October 1, 1969 with licensing commencing on January 1, 1970. In New York, rules and regulations to prevent spills are being developed under authority of the 1970 legislation which established the new Department of Environmental Conservation.

In order to facilitate clean up operations, regional contingency plans for the coastal and inland waters have been developed. These regional contingency plans provide the organizational and communication mechanism for welding Federal, State and local efforts into a coordinated response to oil and hazardous material incidents. The contingency plans have and are continuing to overcome the institutional shortcomings for coping with spills, and they are becoming increasingly more effective in ensuring the supply of equipment, materials and other resources, including communications and technical advice.

Another Federal-State program to control pollution from hazardous substances is the permit program. Each storage area within the study area has to apply for a permit as described in Section 4.3.2. A condition of the permit requires that the storage areas develop protective measure to ensure no runoff of harmful quantities of oil. A harmful discharge of oil is defined as an amount that violates a water quality standard or causes a "film or sheen", or "discoloration" of the water surface on adjoining shorelines or the causes a "sludge or emulsion" deposit beneath the water surface.

4.3.7 <u>On-going program to abate non-point sources of pollution</u>

Previous water pollution control legislation has stressed water pollution which has emanated from so-called "point sources". Man is also a substantial originator of non-point discharges to the environment. The effects of these discharges were generally ignored at earlier levels of pollution control. With secondary treatment currently the national minimum and advanced waste treatment increasingly required, this is no longer the case. The benefits from advanced treatment may be offset by contradictory non-point practices. If greater attention is not given to the land use function as a component of water quality management systems, it is evident that non-point sources will impose a limit to water quality which cannot be exceeded on a sustained basis through advanced waste treatment of municipal and industrial waste. Waterbodies which might not reach water quality standards because of contamination from stormwater runoff and other non-point sources include the Thames River, Lower Housatonic River, Shetucket River, Quinnipiac River, New Haven Harbor, Bridgeport Harbor and Norwalk Harbor in Connecticut. In New York, the areas affected by non-point sources include the Upper East River, the harbors and embayments of Westchester County and Nassau County and ground water aquifers of Long Island.

The dependency of water quality on air pollution and land use indicates the fallacy of attempting to provide for comprehensive water pollution control outside the context of comprehensive land-water resource planning. With various notable exceptions, government organizations of all levels have not adequately developed and carried out comprehensive plans that properly protect the environment.

Certain State and Federal programs have been instituted to control non-point sources of pollution. The U.S. Congress passed the National Environmental Policy Act of 1969 (NEPA) which laid down the environmental impact statement requirements for Federal agencies which propose to undertake activities that are likely to affect environmental quality. Federal legislation has been proposed to be implemented by the states to create sediment control programs for land development and road building activities. The Soil Conservation Service publishes standards and specifications for erosion and sedimentation control practices as outlined in Section 8.4.2.

New York State has instituted certain control procedures for those non-point source situation which have been demonstrated to impair stream quality. The State Stream Proection Law, Article 15, Title 5 of the recodified Environmental Conservation Law, requires that any construction activity which will affect a classified stream, must obtain a permit from the Department before it can proceed. A broader application of this principle is currently being applied in the environmental hearings which the Department holds on any development which can signficantly affect the environment. Rules and regulations have been drafted regarding bulk storage of substances whose spillage can affect waterways. The Pesticide Control Law, Article 33, prohibits use of certain pesticides and restricts use of others. Distributors, vendors and users are required to secure permits from the Department. Similarly, controls for solid waste disposal operations and scavenger operations have been instituted to prevent stream pollution.

Connecticut has emulated the spirit of NEPA by Connecticut's Environmental Policy Act P.A. 73-562 requiring state agencies to insure that all programs, activities and practices meet the environmental standards designed to protect the state's vital natural resources. Thus, the recognition of land-use projects which may impact adversely with the environment, is man-dated with the intent of lessening these effects by consideration of alternate schemes.

There are several units within the Connecticut Department of Environmental Protection concerned specifically with the control of potential non-point sources of pollution. The Water and Related Resources Unit is concerned with the problem of shore erosion control and has recently undertaken erosion control work in East Lyme and Fairfield. The Oil and Chemical Section of the Water Compliance Unit requires the licensing of oil and chemical storage and handling facilities with the objective of preventing contamination of the State's water resources. Among the functions of the Pesticide Compliance Unit is the regulation of the sale and use of pesticides within the State.

5.0 WHAT ARE THE MAJOR UNRESOLVED PROBLEMS?

The major unresolved water management problems in the LIS area are: (1) cumulative stress of pollution on Long Island Sound; (2) protecting Long Island's ground water resources; (3) land use impact on water quality; (4) closed shellfish beds and recreational swimming areas; (5) protection of Connecticut's water supply sources; and (6) inadequate funding for water quality management.

5.1 Cumulative stress of pollution on the Sound

Long Island Sound has long been the repository for many pollutants. It is still not possible to make quantitative predictions of the cumulative effects of pollution such as the nutrients and toxic substances which enter Long Island Sound. This is complicated particularly by our lack of understanding of the three-dimensional circulation pattern in the Sound and its variations with time.

Some scientists have voiced serious concern over the eutrophication problem caused by man-added nutrients in parts of Long Island Sound. The short-term effects of excessive enrichment are generally rapid growth or blooms of algae, resulting in large daily fluctuations in oxygen concentrations, lowered dissolved oxygen due to algae die-off and biodegradation, and possible benthic animal and fish kills because of oxygen stress. An attendant problem is a general lowering of the aesthetic and recreational values of the water. Long term effects include an increased rate of ageing of the body of water, characterized by increased plant production, shifts in species composition, and a net increase of plant and animal biomass due to increased flow of food through the food chain. Recent cruises have shown that persistent algal blooms of nuisance proportions have occurred in the western part of Long Island Sound where nutrient input is greatest and circulation restricted. An unpublished staff report (70) prepared by New York State Department of Environmental Conservation indicates:

> These effects are immediately attributed to nitrogen contributions to Long Island Sound from the New York City area... It can be assumed, however, unless denitrification occurs extensively in mud flats around the East River that all the nitrogen discharged into the East River (from municipal treatment plants) eventually finds its way into either the Sound or New York Harbor.....
>
> Using the present flows to the New York City treatment plants, existing nitrogen data for other New York State discharges, population estimates for Connecticut and for other discharges to the Connecticut River Basin, and appropriate runoff coefficients, the nitrogen loads to the Sound are estimated in the following table:

Sources of Nitrogen	# Nitrogen/Day	Percent
New York City	170,000	54.0
New York State	15,000	4.8
Runoff	50,000	15.8
Rainfall on Sound	5,000	1.6
Connecticut*	75,000	23.8
	315,000	100.0

* Including Massachusetts, Vermont and New Hampshire discharges to the Connecticut River.

Because of this nitrogen input and localized poor flushing, the eutrophication problem is not limited to western Long Island Sound, but is also evident in many of the harbors and embayments such as Branford Harbor in Connecticut and Hempstead Harbor and Oyster Bay in New York.

The discharge of toxic substances also has cumulative damaging effects on the waters and sediments of the Sound and its embayments. These toxic substances include heavy metals such as lead, mercury and cadmium, petroleum products, pesticides, cyanide, and PCB's (polychlorinated biphenyls). Often in the natural breakdown of some of these substances, other toxic compounds are formed.

5.2 Protecting Long Island's ground water resources

Another major unresolved water management problem is to provide a sufficient supply of water of suitable quality to meet the present and long-range needs of the residents of Long Island.

The wedge-shaped mass of unconsolidated sediment that forms Long Island contains its ground water supply. The reservoir can be divided into four water bearing layers called aquifers. The Island's North Shore obtains all its water supply from three of these aquifers.

Precipitation is the only fresh-water source for Long Island. Rain-water and snow melt infiltrate the ground surface and the fresh-water moving through the soil recharges the ground water supplies in various aquifers. Street paving, building construction, diversion of fresh-water to the sea as wastewater effluent and storm sewer runoff and increased water withdrawals have reduced ground water recharge and lowered the water table. In areas not completely sewered, cesspool effluents from many dwellings have resulted in widespread contamination of the upper aquifer, causing abandonment of many of the shallow wells and the creation of public supply wells tapping the deeper aquifer. A net withdrawal from the deep aquifer has caused some local salt-water intrusion in coastal areas. Increased withdrawal rates could cause serious encroachment.

Herein lies Long Island's water resources dilemma. If sewers are constructed and wastewater is discharged to the ocean or Sound, the ground water levels will decline, with the attendant salt-water intrusion. If septic tanks and cesspools continue to be the primary method of wastewater disposal, the nitrate content of the ground water will exceed drinking water standards in many parts of the Island. Evidently, any solution or combination of solutions to Long Island's water resources problem must not only re-establish a balance between fresh ground water and salt-water, but also must preserve the quality of the ground water.

5.3 Land use impact on water quality

Experience under the existing water quality programs has shown that land use significantly affects the quality of water. Present land use patterns degrade water quality in three ways: by permitting damaging and perhaps poorly distributed point sources of pollution; by generating urban and rural runoff; and by destroying natural protective mechanisms, such as wetlands, flood plains and vegetative cover, which reduce quantity of pollutants washed from the land to open waters.

A major problem facing the Long Island Sound area is the conflict between increased development requirements, recreational demand and the preservation of the Sound's natural resources. In the absence of an enforceable land use policy, development will continue with minimal regard for the environment. The water clean-up program can be self-defeating if it merely stimulates unsound shoreland development that generates another round of pollution. Further, land use controls are necessary to maintain wetland and greenspace systems.

Finally, complementary land management practices must control non-point pollution from urban and rural runoff. A key problem is how the Federal, state and local governments should use land policy as an environmental management technique, and conversely, how they should use the air, water and other environmental legislation to help guide growth and land use patterns. For example, local communities could adopt land management zoning such as green belts and minimum lot sizes to reduce the impact on water quality.

5.4 Closed shellfish beds and recreational swimming areas

The water quality problems within the study area are most vividly portrayed by the closed shellfish and swimming areas. There are over 100,000 acres of shellfish beds within the study area closed to the harvesting of shellfish due to pollution created by man. During certain periods of the summer, swimming is considered unsafe in the Thames, Connecticut, Quinnipiac, Lower Housatonic, East and Nissequoque Rivers as well as many embayment, such as Little Neck Bay and Eastchester Bay.

During the past ten years, there has been a tremendous increase in the amount of activity and money spent for water pollution abatement within the study area. Yet each year, rather than opening up new recreational and shellfishing areas, it appears that more areas are closed. For example, during the past summer, all of western Long Island Sound was closed to shellfishing.

Why is this happening? One reason is that public health regulatory agencies are increasingly concerned over the dangers of swimming in polluted waters and eating shellfish taken from polluted water. Shellfish have long been implicated as significant vectors of typhoid fever and other enteric diseases. They are also a transmitting agent for infectious hepatitis. Interpretations of shellfish harvesting standards are becoming much more rigorous because the shellfish strain bacterial and viral pathogens, radionuclides, heavy metals, pesticides, organics, metallic compounds and parasitic protozoa and worms.

For these reasons, all shellfish growing waters of the state must be classified as to their sanitary suitability. To be fully approved for commercial and recreational shellfishing, the areas must meet two requirements: (1) based on the bacteriological quality of the water, the total coliform count does not exceed 70 per 100 ml; and (2) the area is sufficiently removed from wastewater outfalls and other pollution sources so that the shellfish would not be subjected to fecal contamination which might be dangerous to public health.

Because of increased concern for public health, the interpretation of these standards is becoming increasingly stringent. If population and economic development with its associated urban and suburban sprawl continues along the shoreline, more shellfish areas will be closed due to their proximity to new sources of pollution.

Existing data are inconclusive as to the direct public health effects of swimming in polluted waters. Studies suggest that the coliform standards may have imposed an economic and social burden by denying the use of beaches to the public on the basis of an erroneous assumption. These closed areas, unfortunately, are generally close to urban centers where they are most needed. Because these areas were considered unsafe for swimming, public access has not been protected.

A major unresolved problem is how to protect the remaining shellfish and recreational areas and wherever possible to open up or develop new areas for recreational and shellfish activity. Research is also needed to determine whether the current standards are adequate or overly conservative in protecting public health.

5.5 Protection of Connecticut's water supply sources

Many of the Connecticut water systems are under intense pressure to open their reservoir and watershed lands to recreational use. The unspoiled characteristics of a protected watershed are becoming more appealing as the growing population begins to crowd existing recreational areas. The State, long aware of the potential problems associated with unlimited use of watershed lands, has taken a cautious approach to opening these lands. This has been necessary because watershed protection and chlorination were the only forms of water supply protection employed by many water systems. Filtration is now being instituted as part of the treatment process for many systems and proponents of the open watershed land use concept argue that this will provide adequate treatment to enable the water systems to deliver sufficient quantities of potable water to the consumer. Also, many water companies which are privately owned by stockholders are under pressure by these stockholders to sell portions of this valuable land for financial gain, thereby losing varying degrees of control of the activity on these lands.

Those opposed to opening the lands feel that there are sufficient alternatives for recreational use. Also, they feel that filtration is just one additional means of providing good quality water to the consumer. It should not be taken as a license to allow further pollution of a potential water supply source. These people feel that opening these watershed lands will place a greater financial strain on the water companies because of the additional forms of treatment required and the monitoring necessary to ensure that all treatment measures are working adequately. The State will also be required to place greater efforts into surveillance and technical assistance to aid the water companies.

One other area that warrants further evaluation is the large number of small water systems that presently exist in Connecticut. Many health officials have advocated the consolidation of numerous smaller water systems into a few larger systems, and there are many reasons for this position.

Generally, the larger suppliers, because of their financial status, are able to obtain better sources, or provide better treatment for poorer sources. In addition, the larger supplies are able to provide better staffing for their laboratories and sanitary surveys. They should be better able to do the required sampling for chemical and bacteriological protection. The data on sampling verifies this. Better service and ability to expand is usually possible because of financial status.

5.6 Adequate water quality management funding

The high costs of achieving water quality goals, as called for in this report, will require increased levels of funding during the next decade. On one hand, Long Island Sound is fortunate to be bordered by two of the nation's most progressive states in the water pollution control field. With their construction grant program and their strong regulatory controls over industries, it has been assured that by the end of this decade all the municipal treatment plants will be providing at least secondary treatment and the most damaging sources of industrial pollution will be abated. Eligible public costs to complete this portion of the water quality management program is approximately $280 million for Connecticut and $330 million for New York.

On the other hand, the unresolved problems mentioned on the previous pages will require increased funding even after the backlog of treatment plants are funded. Current estimates for separating the combined storm and sanitary sewer systems in Connecticut's portion of the study area is $200 million; while the Upper East River and Eastchester Bay area combined sewer correction programs could cost $2 billion. Also, any attempt to provide extensive advanced treatment facilities in western Long Island Sound an recharge projects on Long Island will not only increase construction cost substantially, but will raise operation and maintenance costs. Thus, perhaps the greatest unresolved water management problem within the study area is attaining adequate funding to pay for the required statement facilities.

6.0 TENTATIVE PLANNING OBJECTIVES

The goal of the Long Island Sound Regional Study is to produce a plan of action by January 1975, which balances the needs to protect, preserve and wisely develop the Sound and its related shorelands as a major economic and life enriching resource for the 12 million people who live near it.

The goal can be achieved by reflecting society's informed preferences for attainment of the overall co-equal study objectives, as established by the U.S. Water Resources Council.

1. Environmental Quality (EQ), which enhances the quality of the environment through the management, conservation, preservation, creation, restoration or improvement of the quality of certain natural and cultural resources and ecological systems.

2. National Economic Development (NED) which increases the value of the Nation's output of goods and services and improves national economic efficiency.

The management of the water resources to ensure good quality and adequate supply is probably the most important elements in the plan of action. Stated in its broadest terms, the objectives of the water management plan is to present programs which will satisfy requirements for water supply and which will manage the quality of water in an economically, socially and environmentally acceptable way.

No one can dictate what degree of cleanliness the environment should have. It is a matter for the informed choice of the people. Cleaning up the waters within the study area costs money. Keeping the waters clean will restrict developmental patterns. What price are we willing to pay? How many of the problems addressed in Section 5 are we willing to solve? These choices must be made on an assessment of relative values of the different uses to which we want to put the water resources within the study area. We must balance the extra costs of goods and services that our factories, power plants, cement works, oil terminals and other industries give us, against the worth of reducing the unpleasant and harmful effects we suffer from the pollution of the region's waters.

There are wide differences in desires and ambitions for the multiple uses of the region's water resources. In order to spell out what programs are necessary to achieve various desired uses, two plans will be developed. The so-called "national economic development plan" will recommend programs to:

a. Meet, as a minimum, existing Federal-state water quality standards.

b. To provide sufficient supplies of water to accomodate economic growth which will increase the output of goods and services within the region.

c. To provide sufficient supplies of potable water to meet future demands.

The "environmental quality plan" will recommend programs to:

a. Solve the problems highlighted in Section 5.

b. Achieve water of suitable quality to provide for recreation "in and on" all waters throughout the study area and to provide for the propagation of fish, shellfish and wildlife (swimmable-fishable waters).

c. To provide sufficient supplies of potable water to meet future demands.

d. To encourage the efficient use of water supply sources and the conservation of use by the consumer.

After multi-purpose plan formulation and public scrutiny, the tentative plans described above may be changed. They will also become more specific and hopefully a "composite" plan will emerge which will most fully satisfy the goals of the Long Island Sound Regional Study.

Within these plans there are a large number of alternative measures listed in Table 28. These alternatives are rather broad. This is necessitated by the vast number of water management techniques available. In the next section, most of these alternatives will be described and evaluated. The list can not be cut appreciably because the selection of an alternative depends very heavily on site-specific conditions.

7.0 EVALUATION OF ALTERNATIVE MEASURES

In appendix B, water management techniques are evaluated in terms of 48 environmental, economic, social and political-institutional criteria. These criteria are based primarily on information contained in the

Table 28

Alternative Water Management Measures

I. Municipal Point Sources
   - A. Sewering
     1. Do nothing
     2. Planned development
   - B. Treatment Measures
     1. Less than secondary treatment
     2. Secondary treatment
     3. Best practicable treatment
   - C. Wastewater Effluent Disposal
     1. Long Island Sound disposal
     2. River disposal
     3. Embayment disposal
     4. Land disposal
     5. Direct reuse
   - D. Sludge Disposal
     1. Use as soil conditioner or fertilizer
     2. Landfill
     3. Incineration
     4. Wet oxidation
     5. Long Island Sound disposal

II. Industrial Sources
   - A. Industrial Treatment
     1. Best practicable treatment
     2. Best available treatment
   - B. Joint treatment
   - C. In-process changes

III. Combined Sewer Overflows
   - A. Do nothing
   - B. Sewer separation
   - C. Control measures
     1. Regulator maintenance
     2. Use of improved regulators
     3. Control of infiltration/in-flow
     4. Computerized control
   - D. Treatment Measures
   - E. Storage

IV. Non-point Sources
   - A. Land Use Controls
     1. Guiding growth
     2. Preservation of environmentally critical areas
     3. Critical use siting
   - B. Land Management Practices
     1. Street cleaning
     2. Erosion & sedimentation controls
     3. Porous pavement
     4. Minimize use of highway salts, fertilizers & pesticides
     5. Abatement of animal waste runoff

V. Watercraft Waste
   - A. Fuel Recycling Devices
   - B. Domestic Wastes
     1. Holding tanks & pumpout facilities
     2. Flow-through devices

VI. Oil and Hazardous Materials
   - A. Establish sea lanes
   - B. Train personnel
   - C. Use containment equipment
   - D. Licensing requirements
   - E. Offshore oil transfer
   - F. Consolidation of ports

VII. Dredging & Disposal of Spoils
   - A. No dredging
   - B. Treatment of spoil
   - C. Open water disposal
   - D. Land disposal
   - E. Incineration
   - F. Creation of artificial habitats

VIII. Water Supply
   - A. Surface Water Development
     1. Expand reservoirs
     2. Develop high flow stream diversion facilities
     3. Construct water treatment facilities
   - B. Groundwater Development
     1. Develop safe yield
     2. Mine groundwater
     3. Employ recharge
   - C. Other Proposals
     1. Import water
     2. Interconnect water systems
     3. Desalination
     4. Direct reuse
   - D. Water Conservation
     1. Increased pricing
     2. Plumbing controls
     3. Zoning to limit growth
   - E. Do nothing

SWIMMING

FISHING

USES
OF
LONG
ISLAND
SOUND
WATERS

BOATING

INDUSTRIAL COOLING WATER

WILDLIFE SANCTUARY

Table 29

Summary Evaluation of Alternative Measures

ALTERNATIVE MEASURES	OVERALL EVALUATION: ENVIRONMENTAL	ECONOMIC	SOCIAL	POLITICAL, LEGAL, INST.
MUNICIPAL POINT SOURCES				
A. SEWERING				
DO NOTHING	P	F	P	F/G
PLANNED DEVELOPMENT	G	G	G	F
B. TREATMENT MEASURES				
LESS THAN SECONDARY	P	F	P	G
SECONDARY TREATMENT	G	G	G	G
BEST PRACTICABLE	G	F	G	F/P
C. WASTEWATER EFFLUENT DISPOSAL				
LONG ISLAND SOUND	F/G	F/G	F	G
RIVER DISPOSAL	F/G	G	F	G
EMBAYMENT DISPOSAL	F/G	G	F	G
LAND DISPOSAL	F/G	F	G	F
DIRECT REUSE	G	P	F	F/P
D. SLUDGE DISPOSAL				
SOIL CONDITIONER	F/G	F	F	F
LANDFILL	F	F/G	F	F
INCINERATION	F/G	F/G	F/G	F/G
WET OXIDATION	F/G	F/G	F/G	G
LONG ISLAND SOUND	P	F/G	F	F
INDUSTRIAL SOURCES				
A. INDUSTRIAL TREATMENT				
BEST PRACTICABLE	G	G	G	G
BEST AVAILABLE	G	F/P	G	F
B. JOINT TREATMENT	G	G	G	F
C. IN-PROCESS CHANGES	G	G	G	G
COMBINED SEWER OVERFLOWS				
A. DO NOTHING	P	F	P	G
B. SEWER SEPARATION	F/G	P/F	F/P	F/P
C. CONTROL MEASURES				
REGULATOR MAINTENANCE	F/G	F/G	G	F/G
IMPROVED REGULATOR	G	F/G	G	F/G
CONTROL INFILTRATION	G	F/G	G	F/G
COMPUTERIZED CONTROL	G	F	G	F
D. TREATMENT MEASURES	G	F	G	F/G
E. STORAGE	G	F	G	F/G
WATERCRAFT WASTE				
A. FUEL RECYCLING DEVICES	G	G	F	F
B. DOMESTIC WASTES				
HOLDING TANKS & PUMPOUT	G	F/G	G	F
FLOW-THROUGH DEVICES	G	G	G	F
NON-POINT SOURCES				
A. LAND USE CONTROLS				
GUIDING GROWTH	G	G	G	F/P
PRESERVATION OF ENVIRONMENTALLY CRITICAL AREAS	G	G	G	F
CRITICAL USE SITING	G	G	G	F/P
B. LAND MANAGEMENT PRACTICES				
STREET CLEANING	G	F/G	G	F/G
EROSION & SEDIMENTATION CONTROLS	G	G	F/G	F/G
POROUS PAVEMENT	G	F	F/G	F/G
MINIMIZE USE OF HIGHWAY SALTS, FERTILIZERS, ETC.	G	G	F/G	F
ABATE ANIMAL WASTE RUNOFF	G	G	F/G	F
OIL & HAZARDOUS MATERIALS				
A. ESTABLISH SEA LANES	G	G	G	F
B. TRAIN PERSONNEL	G	F	G	F
C. USE CONTAINMENT EQUIPMENT	G	F	G	G
D. LICENSING REQUIREMENTS	G	F/G	G	F/P
E. OFFSHORE OIL TRANSFER	G	F	G	F
F. CONSOLIDATION OF PORTS	G	F	G	F
DREDGING & DISPOSAL OF SPOILS				
A. NO DREDGING	G	P	F/P	F/G
B. TREATMENT OF SPOIL	G	F	F	F
C. OPEN WATER DISPOSAL	F	G	F	F
D. LAND DISPOSAL	F/G	F	F	F
E. INCINERATION	F/G	F	F	F
F. CREATION OF ARTIFICIAL HABITATS	G	F/P	F/G	F
WATER SUPPLY				
A. SURFACE WATER DEVELOPMENT				
RESERVOIRS	F/G	F/G	G	
STREAM DIVERSION	G	F/G	F	
PUMPING TO TREATMENT FACILITIES	F/G	F/G	G	
B. GROUNDWATER DEVELOPMENT				
DEVELOP SAFE YIELD	G	G	G	
MINE GROUNDWATER	P	F	P	
EMPLOY RECHARGE	G	G	G	
C. OTHER PROPOSALS				
IMPORT WATER	G	F	F	
INTERCONNECT SYSTEMS	F/G	F	F	
DESALINATION	F	P	F	
DIRECT REUSE	F	P	F	
D. WATER CONSERVATION				
INCREASED PRICING	F/G	F	G	
PLUMBING CONTROLS	F/G	F	G	
ZONING TO LIMIT GROWTH	G	F	F	
E. DO NOTHING	F	F	P	

P = POOR F = FAIR G = GOOD

Principles and Standards of the U.S. Water Resources Council. Where necessary, notes define the criteria and explain the basis for the evaluations.

In this section, highlights of the evaluations will be described. Table 29 is a summary of the matrix found in appendix B. To help clarify the role which the Long Island Sound Study will play in reaching the water management goals of the region, appendix D describes the general levels of planning of which the Long Island Sound Water Quality Management Plan is one. The intent of evaluating alternative measures is to document the best mix of workable measures which will attain the various objectives for least cost consistent with economic, environmental, social constraints. The alternative measures must abate the impact of cronic sources of pollution such as municipal, industrial, combined sewer and non-point waste, and sporatic sources, such as oil spills and dredging and disposal activities.

7.1 Municipal Point Sources

Alternative municipal wastewater treatment systems have to consider four basic factors: (1) the sewer service area, (2) the degree of treatment to be provided, (3) wastewater disposal, and (4) sludge disposal. Measures within these categories are listed in Table 28.

7.1.1 Sewering

With the possible exception of transportation facilities and highways, which have a broad overall effect on land use patterns, sewer lines are unmatched for their impact on the timing and location of urban growth. Decisions to provide sewer service to influence the timing and density of development have, until recently, been exceptions to the rule. There are presently two broad approaches for sewering within the region. They are: (1) continue with the do nothing approach, or (2) utilize the timing and placement of sewer lines to direct urban growth and promote high quality development where appropriate and in suburban and environmentally critical areas, develop and/or enforce non-structural controls such as zoning to encourage land use patterns and density that will preserve environmentally critical areas and will ensure that on-lot waste disposal sytems will function indefinitely.

7.1.1.1 Do nothing

The "do nothing" approach does not provide any guidance for what areas should be sewered and where growth should be limited. At least two negative consequences of this pattern can be cited. One is related to the practice of allowing septic tanks to be installed in developments at too high densities. Aside from precipitating the pollution of ground water and water supplies, the practice of installing septic tanks and leaching fields is particularly illogical and wasteful if sewers will be required. The increased cost for installing sewers with the necessary treatment facilities, after roads and homes are built, is substantial. Examples of this type of development are found in many communities in western Long Island as pointed out in Section 5 and environmentally acceptable solutions to the dilemma will be quite expensive. A second consequence concerns the lack of overall planning and coordination of the placement of sewer lines in accordance with the desired patterns of development. The typical practice of action and reaction, building and servicing, while possibly satisfactory in the short run, eventually leads to over-extension of service, the jeopardizing of irreplaceable resources and a complete disregard for balancing the natural and man-made environment.

7.1.1.2 Planned development

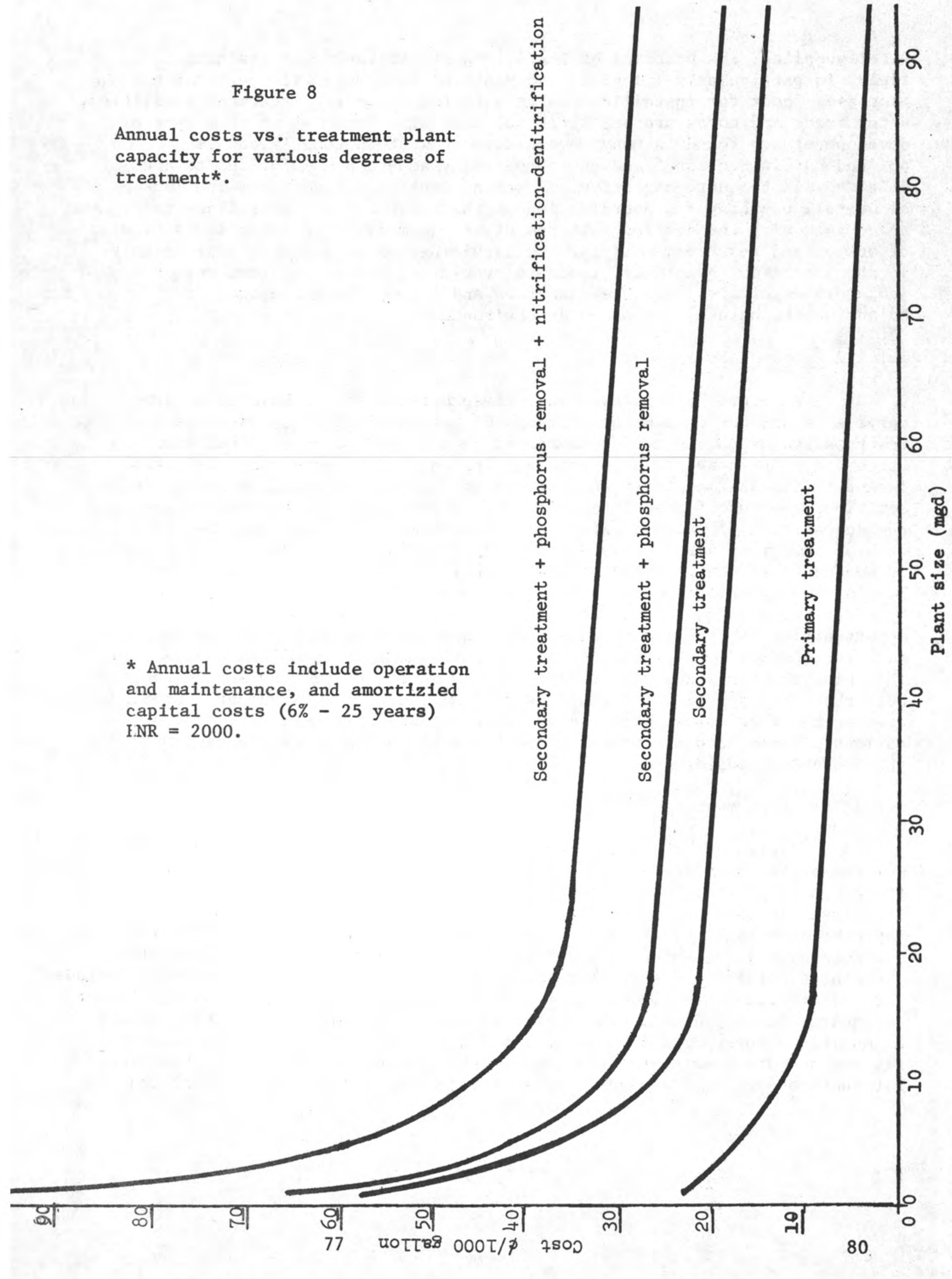
As previously pointed out, the provision or withholding of sewer service is and can be a powerful means of determining growth patterns. Sewers allow high density developments; thus it can be argued that open space can be preserved. However, this increased development necessitates larger treatment facilities and concomitant larger wastewater volume. In addition, the runoff associated with higher densities can contribute to the degradation of water quality. It is obvious that since sewering (or lack of sewering) has so many diverse ramifications, a detailed investigation is needed to effectively use planned sewering as a land use tool. "The Plan of Conservation and Development for Connecticut" made a first attempt by identifying areas throughout the State that have varying degrees of opportunities for, or limitations on, future urban development as related to water quality as well as social, economic and environmental considerations. This plan shows how sewering can be used as a tool to promote staged contiguous urban development which would rectify many of the environmental problems created by urban sprawl. The land use report will discuss the impact of various planned land use patterns and how sewering patterns can best meet the NED and EQ goals.

7.1.2 Treatment measures

Basically, there are three municipal treatment alternatives for sewered areas: provide less than secondary treatment, provide secondary treatment or provide "best practicable waste treatment technology" (BPWTT). The first alternative; that of providing less than secondary treatment, may encounter legal difficulties in view of the Water Pollution Control Act Amendments of 1972, which require secondary treatment by 1977. Other disadvantages which can result from providing less than secondary treatment include: a deterioration in receiving water quality, with the associated adverse impact on aquatic life; a diminishing of the natural beauty of the receiving water; a possible adverse impact on health; and a decrease in value of recreation, fishing and other water-related activities. The chief benefits of the first alternative over more advanced forms of treatment are the low capital and

Figure 8

Annual costs vs. treatment plant capacity for various degrees of treatment*.



* Annual costs include operation and maintenance, and amortizied capital costs (6% - 25 years) ENR = 2000.

77

80

Table 29

Summary Evaluation of Alternative Measures

ALTERNATIVE MEASURES	OVERALL EVALUATION			
	ENVIRON-MENTAL	ECONOMIC	SOCIAL	POLITICAL, LEGAL, INST.
MUNICIPAL POINT SOURCES				
A. SEWERING				
DO NOTHING	P	F	P	F/G
PLANNED DEVELOPMENT	G	G	G	F
B. TREATMENT MEASURES				
LESS THAN SECONDARY	P	F	P	G
SECONDARY TREATMENT	G	G	G	G
BEST PRACTICABLE	G	F	G	F/P
C. WASTEWATER EFFLUENT DISPOSAL				
LONG ISLAND SOUND	F/G	F/G	F	G
RIVER DISPOSAL	F/G	G	F	G
EMBAYMENT DISPOSAL	F/G	G	F	G
LAND DISPOSAL	F/G	F	G	P
DIRECT REUSE	G	P	F	F/P
D. SLUDGE DISPOSAL				
SOIL CONDITIONER	F/G	F	F	F
LANDFILL	F	F/G	F	F
INCINERATION	F/G	F/G	F/G	F/G
WET OXILATION	F/G	F/G	F/G	G
LONG ISLAND SOUND	P	F/G	F	F
INDUSTRIAL SOURCES				
A. INDUSTRIAL TREATMENT				
BEST PRACTICABLE	G	G	G	G
BEST AVAILABLE	G	F/P	G	F
B. JOINT TREATMENT	G	G	G	F
C. IN-PROCESS CHANGES	G	G	G	G
COMBINED SEWER OVERFLOWS				
A. DO NOTHING	P	F	P	G
B. SEWER SEPARATION	F/G	P/F	F/P	F/P
C. CONTROL MEASURES				
REGULATOR MAINTENANCE	F/G	F/G	G	F/G
IMPROVED REGULATOR	G	F/G	G	F/G
CONTROL INFILTRATION	G	F/G	G	F/G
COMPUTERIZED CONTROL	G	F	G	F
D. TREATMENT MEASURES	G	F	G	F/G
E. STORAGE	G	F	G	F/G
WATERCRAFT WASTE				
A. FUEL RECYCLING DEVICES	G	G	F	F
B. DOMESTIC WASTES				
HOLDING TANKS & PUMPOUT	G	F/G	G	F
FLOW-THROUGH DEVICES	G	G	G	F
NON-POINT SOURCES				
A. LAND USE CONTROLS				
GUIDING GROWTH	G	G	G	F/P
PRESERVATION OF ENVIRONMENTALLY CRITICAL AREAS	G	G	G	F
CRITICAL USE SITING	G	G	G	F/P
B. LAND MANAGEMENT PRACTICES				
STREET CLEANING	G	F/G	G	F/G
EROSION & SEDIMENTATION CONTROLS	G	G	F/G	F/G
POROUS PAVEMENT	G	F	F/G	F/G
MINIMIZE USE OF HIGHWAY SALTS, FERTILIZERS, ETC.	G	G	F/G	F
ABATE ANIMAL WASTE RUNOFF	G	G	F/G	F
OIL & HAZARDOUS MATERIALS				
A. ESTABLISH SEA LANES	G	G	G	F
B. TRAIN PERSONNEL	G	F	G	F
C. USE CONTAINMENT EQUIPMENT	G	F	G	G
D. LICENSING REQUIREMENTS	G	F/G	G	F/P
E. OFFSHORE OIL TRANSFER	G	F	G	F
F. CONSOLIDATION OF PORTS	G	F	G	F
DREDGING & DISPOSAL OF SPOILS				
A. NO DREDGING	G	P	F/P	F/G
B. TREATMENT OF SPOIL	G	F	F	F
C. OPEN WATER DISPOSAL	F	G	F	F
D. LAND DISPOSAL	F/G	F	F	F
E. INCINERATION	F/G	F	F	F
F. CREATION OF ARTIFICIAL HABITATS	G	F/P	F/G	F
WATER SUPPLY				
A. SURFACE WATER DEVELOPMENT				
RESERVOIRS	F/G	F/G	G	
STREAM DIVERSION	G	F/G	F	
PUMPING TO TREATMENT FACILITIES	F/G	F/G	G	
B. GROUNDWATER DEVELOPMENT				
DEVELOP SAFE YIELD	G	G	G	
MINE GROUNDWATER	P	F	P	
EMPLOY RECHARGE	G	G	G	
C. OTHER PROPOSALS				
IMPORT WATER	G	F	F	
INTERCONNECT SYSTEMS	F/G	F	F	
DESALINATION	F	P	F	
DIRECT REUSE	F	P	F	
D. WATER CONSERVATION				
INCREASED PRICING	F/G	F	G	
PLUMBING CONTROLS	F/G	F	G	
ZONING TO LIMIT GROWTH	G	F	F	
E. DO NOTHING	F	F	P	

[illegible] F = FAIR [illegible] = GOOD

Table 30

Comparison of Treatment Methods[1]

Treatment Method	Effluent [2] mg/l					Annual Cost ¢/1000*		
	BOD	COD	SS	P	N	1 mgd	10 mgd	100 mgd
Primary treatment	130	-	90	-	-	23	12	3
Secondary treatment (activated sludge)	20	50	20	10	20	47	26	13
Physical - chemical treatment (chemical coagulation, filtration, carbon absorption)	16	16	2	2	18	86	39	20
Secondary effluent polishing:								
micro-straining & activated sludge	4	-	5	-	-	63	31	-
sand filtration & activated sludge	2.5	-	5	-	-	69	31	-
Activated sludge & phosphorus removal	20	50	20	2	20	65	31	18
Nitrification - denitrification & A.S.+P. removal (3 stage act. sludge)	7	20	10	.5	3	100	45	27

*Annual cost includes operation and maintenance and amortized capital costs (6%-25 years). ENR = 2000

1. Cost data is taken from U.S. EPA technology transfer series and reference (1).

2. Abbreviations: BOD - biochemical oxygen demand
   COD - chemical oxygen demand
   SS - suspended solids
   P - phosphorus as P
   N - nitrogen as N

operation and maintenance costs. Annual 1971 cost for primary treatment including operation and maintenance and amortized construction costs, are approximately 17¢ per 1000 gallons treated for 1 mgd plant. Secondary treatment may cost as much as 42¢ per 1000 gallons.

Secondary treatment is generally considered adequate in most areas. Well-run plants have BOD removal efficiencies of about 90 percent. Construction costs and operation and maintenance costs for secondary treatment are substantially higher than for primary treatment. However, the improvement in water quality can be significant. Consequently, secondary treatment is, in many cases, the most cost-effective treatment technique. It offers the greatest increase in water quality, for the least incremental cost.

The final alternative is BPWTT. The 1972 Act requires "best practicable treatment" by 1983. Rather than relying strictly on one treatment technique, BPWTT is based on three alternative technologies; treatment and discharge to receiving waters, treatment and reuse, and treatment and land disposal. The selection of a particular technique is governed by cost-effectiveness, as well as general environmental considerations, such as the characteristics of the receiving waters. Therefore, secondary treatment may quality as BPWTT in areas which do not have severe water quality problems. If BPWTT is defined as advanced treatment anywhere in the LISS area, it will probably be in the water quality limited segments, western Long Island Sound and perhaps on Long Island to protect the ground water.

Since "best practicable treatment" is selected with environmental considerations in mind, the impact on water quality and aquatic life is beneficial. For example, if the receiving water is affected by algae blooms and/or severe eutrophication, BPWTT would include nutrient removal. If it is determined that nutrient removal, either phosphorus or nitrogen is necessary, costs may skyrocket. Phosphorus removal is the less expensive of the processes. Additional costs for phosphorus removal (over secondary treatment) are generally about 5¢ per 1000 gallons. In salt water environments, however, nitrogen is thought to be the limiting nutrient and nitrogen removal is extremely costly. Figure 8 and Table 30 illustrate the costs of the various treatment processes. Two possible adverse consequences of nutrient removal are increased land requirements and greater quantities of sludge. Improper disposal of this additional sludge could adversely affect terrestrial plants and animals, aquatic plants and animals, or air quality, depending upon what type of sludge disposal system is used. Sludge disposal systems, as well as effluent disposal techniques will be discussed in the next two subsections.

7.1.3 Wastewater effluent disposal

Once the wastewater is treated, there are three broad possible methods of reusing or disposing of the effluent. They are: water disposal, land disposal, or direct reuse.

7.1.3.1 Water Disposal

Water disposal is presently the most widely used form of effluent disposal. Treatment plant effluent may be discharged to the open waters of Long Island Sound, a river or a bay. The environmental impact of water disposal varies, depending primarily on the quality of the effluent, the dispersing action of the receiving water and the location of the outfall. Possible adverse impacts of water disposal include the following: Toxic substances, such as pesticides and heavy metals may be concentrated at the outfall site if they are present in the effluent. There may be an increased oxygen demand on the receiving waters due to the bio-oxidation of organic matter in the effluent and the upswelling of bottom waters normally deficient in dissolved oxygen. However, if the wastewater is adequately treated, the above impacts may be minimal.

Generally, the discharge of effluent into a river or bay will cause more degradation than its discharge farther out into the Sound. The negative impact on recreation, fish and wildlife is usually more pronounced in river and embayment disposal. There does, nevertheless, exist several potential benefits in river and bay discharge. Effluent discharge in rivers may maintain year round flow in intermittent streams. In addition, the productivity of some estuaries may increase. The chief benefit of river and embayment disposal is that their outfall construction costs are relatively inexpensive.

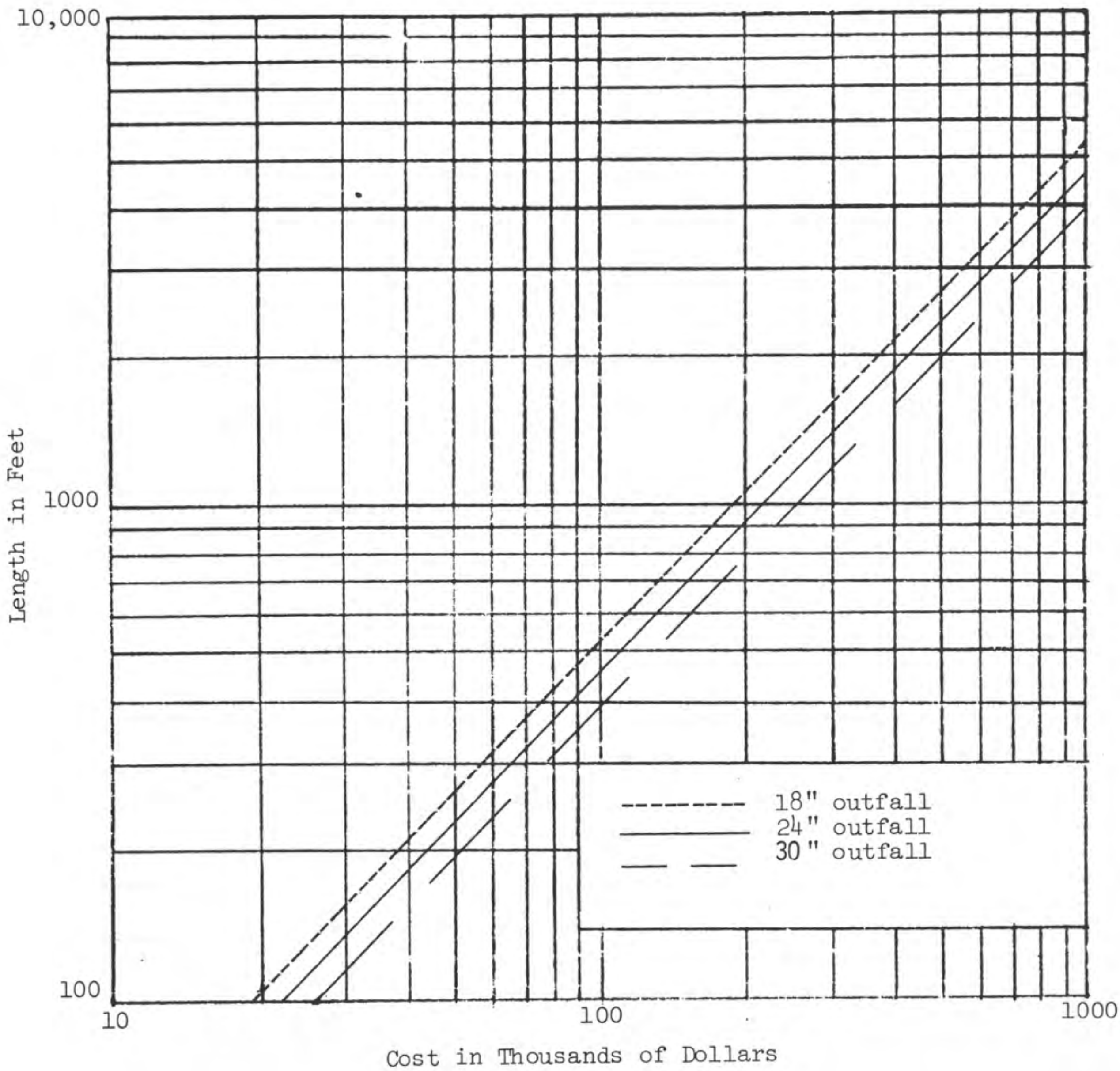
The high cost of extended outfalls must be weighed against their environmental benefits. The fast currents and greater volumes of water available for dilution in the open waters of the Sound generally reduce any local concentration of pollutants which may occur at an outfall. The result is improved harbor water quality with little degradation of Long Island Sound waters. Municipal wastes on Long Island are presently given secondary treatment with discharge to bays and harbors. These harbors are poorly flushed. With increased sewered populations, discharges must be moved out of the harbors into the Sound, or alternately must be provided treatment, such as nutrient removal.

It is possible, however, that a long outfall may adversely affect an estuary. The discharge of treated effluent, which is essentially fresh water, into Long Island Sound would prevent this fresh water from flowing into the bays of Connecticut and New York. This fresh water by-pass could change bay salinity, and thus, alter the eco-system of the bay.

The cost of outfall construction is quite expensive. An extended outfall is being evaluated for the Fort Hill plant at Mumford Cove in Groton. This outfall, which is a combination of gravity and pressure pipes, is designed to travel 3-1/2 miles overland and extend 1-1/2 miles

Figure 9

CONSTRUCTION COSTS* FOR OCEAN OUTFALLS IN DEPTHS UP TO 50 FEET ENR 1940 (MARCH 1974)



*Costs are those computed for Boston Harbor by Camp, Dresser & McKee.

out into the Sound. The land and shallow water portion is expected to cost $2,356,000 ($126 per linear foot), while the ocean portion should cost about $5,239,000 ($671 per linear foot), for a total cost of $7,590,000. The cost of the secondary treatment plant was $5,300,000. Thus, the outfall is expected to cost $2 million more than the entire cost of the plant. Figure 9 provides additional costs data for ocean outfalls.

The one great disadvantage of water disposal is the irretrievable loss of fresh water resources. Once fresh water is discharged to the Sound, it is lost to the watershed. This is particularly important on Long Island.

7.1.3.2 Land disposal

The concept of land disposal is an excellent one, especially for an area like Long Island, where there is concern about lowering water tables and salt water intrusion. Land disposal can effectively recylce treatment plant effluent. Unfortunately, the application of land disposal technology is highly dependent upon existing environmental conditions at a given location. Major factors involved in site selection include: type, drainability and depth of soil; depth, quality and use of ground water; topography, climate, and considerations of public access to the land. There are five types of land disposal: overland flow, modified streambed, irrigation, infiltration-percolation and deep well injection. Overland flow will not be evaluated for several reasons, the primary reason being that it does not recharge the ground water.

The modified streambed method utilizes existing streams to recharge the ground water. On Long Island, the streams are generally fed by ground water. If effluent was added to the heads of streams, the upper reaches would remain flowing all years and a certain amount of recharge would occur. Downstream, where the stream passes through the ground water table, the flow of ground water into the stream would be lessened. Periodic silt removal and scouring would be needed to deter clogging. Also, advanced treatment would probably be needed to prevent deterioration of water quality. This technique offers some promise on Long Island.

Irrigation is the most widely used type of land application. Generally, a cover crop is planted and effluent is either sprayed, flooded or directed through furrows on the land. In order to remove nitrogen from the wastewater, these crops should be harvested. Loading rates are low, usually around 2 inches/week. Thus, land requirements are high. This is a major disadvantage of irrigation. Table 31 lists land requirements for spray irrigation of projected 2020 wastewater flows on Long Island. A loading rate of 0.85 inches/week was used to prevent nitrate contamination of the ground water for secondary effluent. Almost 50% of the land vacant in 1968 would be needed to dispose of 2020 flows. About 20% of the land would be needed following advanced treatment. Furthermore, not all of this land is

Table 31

Land Requirements for Spray Irrigation Following Secondary Treatment and Advanced Treatment

Location (Town & Sewer District)	2020 Wastewater Flow District No.	Flow	Total	Total Available Land (includes vacent & farmland)	Land Requirement Secondary Effluent Acres	% of available lard	Land Requirements for Advanced Effluent Acres	% of available land
Nassau County:								
S.D. #3,4 (Oyster Bay and parts of Hempsted and N. Hempsted)	3 4	120 81	201	11,300	61,100	540%	26,100	230%
Suffolk County: Huntington, Smithtown Babylon (S.D. #1, 4, 5, 6, 7	1 4,5,6 7	54 12	79	50,800	24,000	47%	10,300	20%
Islip and small parts of Smithtown and Brookhaven (S.D. #2)	2	58	58	28,200	17,600	62%	7,500	27%
Southold (S.D. #13)	13	23	23	25,900	7,000	27%	3,000	12%
Riverhead, Brookhaven, Southampton, East Hampton (S.D. #3, 8, 9, 10, 11, 12, 15, 16)	3,9,10 8 11 12 15 16	60 18 61.7 16.5 32.2 5.6	194	230,900	59,000	26%	25,200	11%
TOTALS		555	555	347,100	168,700	48%	72,200	21%

NOTES:

For Secondary Effluent: Land requirements are based on maximum nitrogen loadings (200 pounds N/acre-yr.) Nitrogen concentration in effluent is assumed to be 20 mg/l. Crop harvesting is assumed. Using these values the design loading is 0.85 inches/week (304 acres/mgd).

Advanced Treatment: A design loading rate of 130 acres/mgd (2 inches/week) was used.

Available land is based on estimates for 1968.

Land Requirements do not include buffer strips.

suitable for land disposal. In view of the high cost of land on Long Island, the cost of such a system would be prohibitive. Another major disadvantage of irrigation in the study area involves the climate. Irrigation cannot be used during the winter. Consequently, large storage lagoons would be needed to store winter flows. Irrigation of either secondary or advanced effluent should not be rejected outright. It can be used on a smaller scale in parts of Suffolk County, not only to treat wastewater but also to preserve open space.

High rate recharge either infiltration-percolation or deep well injection could be an efficient means of preserving ground water quantity. On Long Island, loading rates up to 400 feet per week have been recorded in storm basins. A recharge research project in Suffolk County has been proposed in which loading rates for effluent would be up to 200 feet per week. Land costs would be relatively low but advanced treatment including nitrogen removal would be necessary.

7.1.3.3 Direct reuse

Direct reuse of properly treated wastewater can provide significant benefits. Not only does direct reuse of reclaimed effluent lessen the stress being put on diminishing fresh water supplies, but it also eliminates a source of pollution. Potential for wastewater reuse exists in municipal, industrial, agricultural, recreational and ground water recharge applications. Although direct interconnection between the water supply system and wastewater facilities is not presently recommended due to limited knowledge with respect to health hazards, municipal water supply systems can benefit from decreased industrial and agricultural water demands. Industrial use of water has been estimated to be about seven times that of municipal use nationwide. If some of this industrial demand can be met by the use of reclaimed wastewater, a significant amount of potable water can be saved for domestic consumption. The required quality of water varies widely depending upon the specific industrial use involved. In some cases, direct reuse of secondary effluent as cooling water has proven satisfactory.

Irrigation with wastewater effluent can also save large quantities of drinking water as well as decrease the need for fertilizer. The primary concern with the use of reclaimed water for irrigation has been the possibility of health hazards from effluent contact with crops directly consumed by humans. The use of advanced wastewater treatment technology offers the potential for unrestricted, direct reuse for irrigation. Finally, reclaimed water can be used for recreation. The suitability treated effluent for recreation has been demonstrated in Alpine County, California. Indian Creek Reservoir, which is filled with one billion gallons of reclaimed wastewater from the South Tahoe Public Utility District, has been stocked with rainbow trout and approved for all water contact sports.

To summarize, the benefits of direct reuse include; protection of aquatic life, improved water quality, additional recreational opportunities and increased supplies of drinking water. The primary disadvantages of direct reuse are the possibility of health hazards and the cost. The total cost of a reuse program is directly dependent upon the degree of treatment required. In most cases, advanced treatment will be necessary.

7.1.4 Sludge Disposal

Sludge is a by-product of wastewater treatment processes. It is not primarily solid, rather it is a liquid containing contaminants removed from wastewater. Most sludges are 95 to 98 percent water. A typical digested sludge contains about 20 tons of water for each ton of solids. Sludge can be disposed of in many ways: It can be used as a soil conditioner in either a dry or wet form. It can be placed in a sanitary landfill. It can be reduced in volume by incineration or wet oxidation or it can be dumped at sea. The fact that sludge handling and disposal represents 25 to 50 percent of the total treatment plant capital and operating cost suggests the importance of a thorough evaluation of sludge disposal alternatives.

If the ideal solution to the sludge disposal problem is to be found, it must meet the following criteria: (1) It must not contribute to any environmental pollution (water, land or air). (2) It must have a beneficial use. (3) It must be economical. (4) It must solve the problem. With these criteria in mind, sludge disposal alternatives will be evaluated. It must be remembered, however, that selection of specific systems to treat and dispose of sludge depends upon a number of local conditions. These conditions include: climate, availability, and cost of land, soil and ground water conditions, aesthetics, waste characteristics, and relative capital and operating costs.

The use of sludge as a soil conditioner can provide substantial environmental, economic and social benefits. It utilizes the water, nutrients and organic matter in sludge to increase the humus content, fertility and water retaining capacity of the soil. It furnishes an alternative to the more concentrated inorganic fertilizers which have recently been diminishing in supply and increasing in cost due to the petroleum shortage. Since large buffer zones are needed for land disposal sites, parks and outdoor recreational areas can be preserved. Its cost is generally competitive with other alternatives, especially if there are barren lands to be reclaimed in the area.

Unfortunately, there are several potential hazards inherent in the land spreading of sludge. Sludges from most industrial cities contain significant amounts of heavy metals. The accumulation of these toxic metals in the soil after many years of application could make the soil unfit for plant and animal life. This problem has yet to be solved. Perhaps more dangerous is the possibility of toxic metal build-up in the food chain. This could occur if crops are planted which absorb relatively high amounts of metals. There is also the possiblity of nitrate contamination of the ground water if application rates are too high. The extensive coordination of many public agencies and political subdivisions is necessary for land spreading, since the land requirements will cross the boundries of many political jurisdications. This could result in political and institutional conflicts. Finally, lack of public acceptance could cause implementation problems. Few people care to live near a sludge disposal site.

The potential danger inherent in the spreading of sludge on land is not being emphasized to reject this alternative, rather it is intended to suggest that we must proceed with caution when applying this technology. It is, therefore, recommended that demonstration projects utilizing land disposal processes be initiated in the study area to establish application rates and techniques and examine the environmental effects of land spreading.

The use of sanitary landfills for dewatered or incinerated sludge is common in the LIS region. If the landfill is well-run and carefully monitored, adverse environmental impacts will be minimal. The leachate (liquid drainage) from the landfill usually contains high concentrations of dissolved organic and inorganic contaminants. This leachate should be prevented from reaching the ground water either by trapping it with impermeable layers or by its removal through an underdrain system. Daily coverage of newly deposited wastes with soil will minimize odors and flies. Disposal sites can be landscaped after several years to provide new recreational areas. The availability of nearby suitable sites may cause some problems. The primary arguments against this type of solution to the sludge disposal problem is that it does not take advantage of the nutrients in the sludge and it is not a permanent solution. The average cost of landfill, as well as other disposal methods, is listed in Table 32. It shows that landfilling is more costly than land application of liquid sludge, but costs about the same as land spreading of dewatered sludge.

Sludge can be disposed of through incineration. Advantages of incineration include a small land requirement for both the incinerator and ash disposal site and the production of useful energy. In the future, it may be possible to economically reclaim some of the metals which remain in the ash. At present, however, no beneficial use is made of sludge constitutents when incineration is used. Another disadvantage of incineration is that it can cause air pollution, if proper safeguards are not used.

Wet oxidation is a flameless combustion process. Sludge is mixed with compressed air, heated (400°-650°F) and pressurized (1200-1800 psig). At these temperatures and pressures organics are oxidized. Gases, ash and a clear acidic liquid containing compounds of nitrogen and phosphorus are produced. Advantages of this process are that it is not necessary to dewater the sludge, a low volume of sterile end products is produced, land requirements are small and it may be possible to reclaim some of the constituents of the ash. Adverse water quality impacts may be caused by the disposal of the process effluent which is highly acidic and contains high concentrations of nutrients. Air pollution control equipment is needed to cleanse the gaseous by-products to ensure that they do not contribute to air pollution. Construction, operation and maintenance costs are high, as are power requirements. Personnel safety in handling highly pressurized reactors is also a concern. In spite of all of these problems, wet oxidation technology is improving and future process modifications may make it a much more viable alternative.

Sludge is not dumped into the Long Island Sound or any water body within the study area. The environmental hazards of this practice far outweigh its economic benefits. The toxins, pathogens and oxygen demanding wastes in sludge adversely affect water quality and aquatic life. Benthic organisms can be smothered by the solids and many fish cannot tolerate the deteriorated water quality. Several cities and other jurisdictions in Nassau and Westchester Counties are presently dumping sludge at the New York City dumping site in the Atlantic Ocean which is 10 miles south of Long Island and 12 miles east of New Jersey. There is some evidence that the sludge has crept within 2 miles of Long Island's south shore. Dr. Robert Swanson of NOAA has said that the dumping of this sludge "has resulted in degradation of the environment in the general area". In view of this evidence, programs are underway to determine better ways to handle the sludge problem.

Table 32

Overall Costs for Various Methods of Sludge Disposal (69)

Method of Sludge Disposal	Capital and Operating Costs ($/dry ton) Average	Range
Incineration		
Wet Oxidation	42	
Multiple Hearth	30	10-50
Fluidized Bed	30	10-50
Landfill (dewatered sludge)	25	10-50
Lagooning	12	7-25
Land Application(1)		
Heat Dried Sludge	50	40-55
Dewatered Sludge	25	10-50
Liquid Sludge	15	8-50
Disposal at Sea		
Barging	12	5-25
Pipeline	11	

(1) Excludes any return from sale of sludge.

7.2 Industrial sources

Three broad approaches to abate industrial pollution can be used: An industry can treat their wastes and discharge effluent to a waterbody or land disposal site; a plant can discharge its wastes to a publicly owned treatment plant; or the industrial process, itself, may be altered to reduce wastewater discharges.

7.2.1 Industrial treatment

The first approach, that of separate industrial treatment, may be divided into two categories: "best practicable control technology" (BPT) and "best available technology economically achievable" (BAT). The application of "best practicable treatment" usually results in effluent quality comparable to municipal secondary treatment. Therefore, water quality and aquatic life are, ordinarily adequately protected. BPT for any industry is determined only after the following factors are considered: the total cost of the technology in relation to the effluent quality improvement, the age of the equipment and facilities involved, the process employed and possible process changes. Since BPT (and BAT) is based on an economic evaluation of alternative control measures, adverse economic impacts are minimized. It is possible that some marginal operations already in economic jeopardy may be forced to close. However, the long run viability of the affected industries would not be seriously threatened, nationally, but may be locally.

BAT is based on the same sources as BPT. However, BAT provides a higher level of treatment. For some industries, BAT is defined as a closed loop watercycle system with no discharge. As a result, BAT can cost significantly more than BPT, and it has the attendent adverse economic impacts. The higher levels of treatment called for by BAT can further improve water quality, preserve aquatic eco-systems, and protect the life, health and safety of persons in the vicinity of the discharge. Negative aspects of BAT are related to the administrative difficulties and expected judicial involvement associated with securing full industrial compliance.

7.2.2 Joint treatment

Joint treatment of municipal and industrial wastewaters is usually a desirable practice. Such combined treatment can benefit the environment, the municipality and industry, if the system is properly designed and operated. Some advantages of joint treatment are:

1. Increased flow which can result in reduced ratios of peak to average flows.

2. Savings in capital and operating expenses due to the economics of large-scale treatment facilities.

3. Better use of manpower and land.

4. Improved operation (larger plants are potentially better operated than smaller plants).

5. Increased number of treatment modules with resultant gains in reliability and flexibility.

6. More efficient disposal of sludges resulting from treatment of wastewaters containing compatible pollutants.

In order to benefit from joint treatment, the industrial wastewater must not interfere with the workings of the municipal plant. If the two wastewater flows are incompatible, the industry must pretreat its waste. Water quality benefits are limited by the type of municipal treatment available (generally secondary). Administrative and institutional problems may result from difficulties in establishing proper user fees for each industry. Additionally, industrial costs may be high because each industry is required to pay its share of the full cost of treatment plant construction, without Government cost sharing.

7.2.3 <u>In-process changes</u>

Altering the actual industrial process, itself, to reduce pollution causing discharges can be a very attractive alternative. This alternative includes the following in-plant control techniques:

1. By-product recovery even in the absence of a feasible market for use of the recovered material.

2. Water reuse and recycling.

3. Reuse of wastewater constituents.

4. Multi-purpose operations for the primary purpose of water pollution abatement.

5. Waste stream segregation.

6. Elimination of unessential water use.

7. Water conservation (dry processes).

By utilizing any of the above control techniques, industrial pollution abatement costs can be lowered without sacrificing water quality. Frequently, these non-structural techniques are inexpensive and they offer cost-effective solutions to industrial pollution.

7.3 Combined sewer overflows

The alternative for abating combined sewer overflows are: Do not meet the needs, storm and sanitary sewer separation, control measures, treatment measures and storage measures. Categorizing abatement alternatives into discrete approaches is not meant to imply that each approach must be used independently of the others. On the contrary, many of the methods can and should be integrated to provide optimum results.

7.3.1 Do not meet the needs

"Do not meet the needs" alternative is poor from an environmental standpoint. The Thames River, New Haven Harbor, Bridgeport Harbor, the lower Housatonic River, Norwalk Harbor and much of western Long Island Sound will not attain water quality standards unless combined sewer overflows are abated. However, since the costs of all abatement measures are significant, the "do nothing" approach has a distinct economic advantage. Nevertheless, because of this alternative's negative impact on the value of recreation and fishing, it is rated only fair economically.

7.3.2 Sewer separation

For years, sewer separation had been considered to be the only real solution to the combined sewer problem. Recently, however, studies have revealed that sewer separation is not usually the best alternative. An EPA study (67) indicated that if separation were used, the reduction in wet-weather pollution would be only 50 percent. The other 50 percent would remain in the untreated urban storm runoff. Furthermore, sewer separation is an enormous project. It requires separation of all of the following structures: storm and sanitary sewers, roof drains, yard drains, air conditioning and cooling system drains, foundation drains and catch basin inlets. The cost can be astronomical. An APWA study computed the cost of separation of all of the nation's combined sewers to be $85 billion at today's cost. In the larger cities, separation is usually more expensive than other available alternatives. For example, in Bridgeport the cost of complete separation has been estimated to be $114 million, while a deep tunnel storage plan would cost only $66 million.

The State of Connecticut feels that sewer separation is a viable solution to the combined sewer problem and has indicated a number of urban areas where sewer separation is cost-effective. The State recognizes the choice between sewer separation and other alternatives is controlled by local conditions. In smaller communities with minor combined sewer problems, separation is warranted. However, once again it must be emphasized that stormwater runoff itself, can be a significant source of water pollution and in the future it may be necessary to collect and treat storm sewer discharges in certain areas.

7.3.3 Control measures

Combined sewer control measures include: regulator maintenance programs, the use of improved regulators, the control of infiltration and inflow, and computerized sewer system control. The above measures vary in cost and effectiveness. Thus, a community can choose between these measures and implement only those necessary to achieve their particular water quality goals. The first and usually least expensive step in mitigating the effects of combined sewer overflows involves a vigorous regulator maintenance program. Since malfunctioning devices are often prime sources of pollution, a maintenance program can be an effective and economical means for abating overflows. The installation of dynamic regulators, which are responsive to a variety of flow conditions and characteristics, provides even greater control over wastewater overflows. Unfortunately, many of these devices are more expensive to build and maintain and they are more apt to jam or clog, than conventional static regulators. One innovative regulator, the swirl concentrator, not only regulates overflows, but provides for sedimentation of pollutants as well. A great advantage of this device is that it has no moving parts, so maintenance and ajdustment requirements are minimal.

The infiltration of water into a sewerage system reduces the capacity of the sewer which is available to transport wastewater. The elimination of infiltration generally involves a great deal of work. Some community disruption could occur while public works crews restore the system. However, not only can elimination of infiltration reduce overflows, but it can also lower the cost of treatment by decreasing the quantity of water reaching the treatment plant.

Another effective way to upgrade a combined sewer system is to install level sensors, rain gage networks, sewage and receiving water quality monitors, overflow detectors, dynamic regulators and flow meters, and then apply computerized collection system control. Such a system is designed to make the most effective use of interceptor and line capacity by routing and storing combined sewer flows. The computer system allows an operator to divert flows to half-empty interceptors, thus utilizing all available in-system storage. This type of system is much less expensive than sewer separation. In Cleveland, such a system was estimated to cost $3,000 per acre, whereas separation would cost ten times that amount. An added advantage to this type of system is that individual components can be installed as funds become available. Such a partially completed system can still produce good results.

7.3.4 Treatment

Treatment of combined sewer overflows may be necessary to insure that the discharges does not degrade water quality. Treatment facilities may be either centralized or located at individual outfalls. Centralized facilities offer advantages in reduced plant costs. However, they inevitably

Table 33

Estimated Capital and Operation & Maintenance Costs for Various 25 mgd Treatment Alternatives[a]

Type of Treatment	Capital Cost (dollars)	Operation and Maintenance Cost (¢/1,000 gal)	Comments
Sedimentation and storage	$ 1,900,000.	2	O & M costs based on Milwaukee facility operated 300 hours/year.
Dissolved air flotation	842,000	6.64	
Microstrainers	323,000.	69	Loading rate of 25 gpm/ft^2.
Highrate, dual media filtration	1,580,000	14	O & M costs based on 300 hours of 24 gpm/ft^2, operating per year at satellite location.
Biological treatment contact stabilization	1,900,000	4.8	Based on Kenosha, Wis. plant and 250 hours operating per year.
Trickling filter	1,980,000	6.1	O & M based on dry-weather flow costs and 250 hours/year: New Providence, N.J. plant
Rotating biological contractor	750,000.	4.4	Based on Milwaukee project at 250 hours/year.
Oxidation pond	1,730,000.	2	Based on 10 day detention time operated at 250 hours/year.
Physical-chemical treatment	3,644,000	15.6	Albany pilot plant data. Capital costs include: screens, grit chamber, overflow facilities pipe reactor vessels, pumps, chemical storage, carbon slurry tanks, sludge storage, agitators, flocculators, tube settlers, filtration chlorination, carbon regeneration/sludge incineration, fluidized bed furnace, chemical make up system. 10% contingencies and land.

a. ENR = 2000. All cost figures are averages from Urban Stormwater Management and Technology: An Assessment.

require high expenditures for the installation of large conduits to transport overflows to the centralized plant. The decision to use centralized or dispersed facilities depends on local conditions. Each community must determine which type of arrangement is most beneficial.

Many different treatment techniques may be applied to combined sewer overflows. Most methods can be used effectively at either a centralized location or at individual outfalls. Biological treatment techniques, however, are an exception to this. Since these processes are particularly susceptible to the unpredictable shock loadings which prevail in combined sewers, they are generally located at a centralized site, where they can be preceded by surge chambers to equalize flow. Table 33 provides costs for various treatment methods. These costs are intended to be used only as a preliminary guide.

7.3.5 Storage

Storage is the best documented combined sewer abatement measure currently in practice. Storage facilities offer many advantages: (1) they are simple in design and operation; (2) they respond without difficulty to intermittent and random storm behavior; (3) they are capable of providing flow equalization; and (4) they can frequently be used in conjunction with regional treatment plants to offer both dry-and wet-weather benefits. Major shortcomings of such facilities are due primarily to their cost, visual impact, solids disposal problems, and large size.

Storage facilities may be either in-line or off-line. In-line storage is generally provided by restricting flow in the system. This creates additional storage by backing up water in the lines. In order for this type of project to be effective, flat sewer grades in the vicinity of the interceptor, large interceptor capacity and extensive control and monitoring networks are necessary. Off-line storage devices include: lagoons, concrete holding tanks, underground silos, void space storage, deep tunnels and mine labyrinths. In most cases, storage devices provide some sedimentation and retained flows are generally pumped to the treatment plant during low flow periods.

The management alternatives previously discussed are not singular solutions. A cost-effective solution to combined sewer overflows requires that these methods be combined to optimize results. For example, storage tanks are often combined with auxiliary treatment facilities.

It is difficult to evaluate combined sewer abatement alternatives in such a general way. The significant benefits of individual alternatives will only become apparent when they are studied with specific sites in mind. The sewer hydraulics, topography, land use patterns, availability of construction sites, rainfall and runoff characteristics, location of overflow points, capabilities of the municipal wastewater treatment facilities, water quality standards for the receiving waters, and other factors must be thoroughly evaluated before the best combination of alternatives for each city can be found.

7.4 Non-point sources

The role of land use in water quality is frequently ignored. Land use patterns can adversely affect water quality in several ways: by permitting damaging and perhaps poorly distributed point source waste discharges; by generating urban and rural runoff pollution; by destroying natural systems, such as floodplains, wetlands and vegetative covers, which reduce the impact of pollution; and finally, by obstructing public access which is as important as quality to our enjoyment of water resources. Consequently, water quality problems and solutions are not conveniently confined within streambanks. The attainment of our water quality goals requires land use policies to both protect high quality waters from future municipal and industrial pollution and to control runoff pollution.

Alternatives to abate non-point sources fall into three categories: land use controls, land management practices, and air pollution control. The effect of air pollution on water quality can be minimized by implementing the Clean Air Act of 1970. A discussion of air pollution alternatives,however, is beyond the scope of the water management report; therefore, those measures will not be described here.

7.4.1 Land use controls

The guidance and/or limitation of growth can reduce water quality degradation. The location of land uses, assignment of density levels and the timing of development must be based on water-related factors to protect water quality. These factors include: the water quality standards for potentially affected waterbodies, the waste load allocations for stream sections, the existing and planned capacity of the sewer system, and the non-point waste load potentials for each sub-area. Particular attention should be given to guiding growth through the provision of sewer services. This alternative is evaluated in the section on sewering.

In addition to having a beneficial affect on water quality and aquatic life, guiding or limiting growth based on water quality parameters can preserve unique environmental features, terrestrial plants and animals, and areas of natural beauty. Costs are low and increased recreational and cultural opportunities may ensue. Although there is a distinct possibility that judicial involvement and legal battles may follow attempts to implement growth policies, there is a legal basis for such policies. The Federal Water Pollution Control Act and State laws require protection and improvement of water quality. Further, these laws apply to both point and non-point sources. Thus, water quality protection provides a valid justification for regulating growth.

A variety of techniques can be used to preserve such areas. Outright acquisition, purchase of development rights, long term lease and land use regulations utilizing zoning, subdivision regulations or health regulations can be used. The cost of this alternative depends upon which land use control is utilized. Acquisition is the most expensive. Zoning and subdivision regulations will probably be of little cost to the community. However, their use could result in lengthy courtoom fights. Preservation of environmentally critical areas provides many benefits in addition to water quality improvement. Wildlife protection, aesthetics and improved air quality are but a few. A number of other goals can also be achieved. For example, protecting stream banks can serve both flood damage reduction and recreation goals as well as reducing water quality damages. Thus, protection of these areas is recommended not only from an environmental standpoint, but also from an economic and social point-of-view.

Land uses which generate wastewater discharges of major proportions are herein called critical uses. Examples include power plants, wastewater treatment plants, solid waste sites, agricultural feedlots, and various industries. These critical uses must be located where their affect on water quality will be minimized. Since these uses are often difficult to anticipate, they must be located on a case-by-case basis. Because of their potentially harmful impacts, critical use siting should receive extra careful assessment.

7.4.2 Land management practices

Non-point sources range from dirty city streets to wide stretches of farmland. Therefore, in order to abate runoff pollution, the breadth of land management practices must be extensive. Runoff pollution abatement measures include abatement of combined sewer overflows; street and storm drain cleaning; the use of environmental safeguards during construction; the use of erosion and sedimentation controls, such as sediment traps, catch basins, vegetative buffer strips and detention basins; the use of porous pavement; minimal use of highway salts, fertilizers and pesticides; and abatement of animal waste runoff.

A broad spectrum of pollutants accumulate in urban and suburban streets. After a storm, a large amount of this pollution load is discharged overland or through storm and combined sewers into rivers, lakes and bays. Street cleaning can reduce the magnitude of this waste load. Unfortunately, present street cleaning operations are relatively ineffective at reducing stormwater pollution. Street cleaning is done for aesthetic reasons, not for water pollution control. Thus, while street sweepers are relatively efficient removing large debris, they are inefficient at removing the fine material from which most runoff pollution results. Water quality benefits can result from improved street cleaning techniques. New vacuum cleaning equipment or more man-hours can be used to obtain better removal of fine materials. Both methods will increase street cleaning costs.

Erosion control during construction can minimize stream turbidity and changes in stream flow temperature. Pollution by oils, wastewater, aggregate washwater, pesticides and other construction wastes can be controlled by adequate erosion and sedimentation control measures. Generally, these measures will increase the cost of construction. However, the magnitude of this increase varies. An EPA report, Comparative Costs of Erosion and Sedimentation Control, Construction Activities, concluded that in many cases the hydromulching method of stabilizing disturbed soil is the most cost-effective erosion control methods. In this technique, a well-mixed slurry of wood fiber, water, seed and fertilizer is sprayed onto the soil to be stabilized. The unit cost of hydromulching ranges from less than $400 per acre for areas of 15 acres or more, to as high as $900 per acre for areas of less than an acres, (65). Nevertheless, it is believed that the economic as well as environmental benefits of erosion control far outweigh its effect of increasing construction costs. Economic benefits of erosion control include: increased value of recreation and fishing, decreased water purification costs (if surface water supplies are affected), and decreased top soil losses.

Since construction activities are not the only source of sediment, erosion and sedimentation control measures should be used at all times. These measures range from catch basins and detention tanks, which are a part of the storm sewer system to sediment traps and vegetative buffer strips, which trap sediment before it enters the sewer system. Evaluation of the many control measures is beyond the scope of this report, however, most of these measures are evaluated in a variety of recently published EPA reports on land management practices. Some of these reports are pictured in figure 10.

A promising stormwater pollution abatement measure is porous pavement. It is a type of asphaltic concrete which allows up to 60 or more inches of rainfall to penetrate through it per hour. By attenuating runoff, it reduces storm and combined sewer flows and hence, surface water pollution. Other benefits include increased ground water supplies, improved highway safety, relief of flash flooding, preservation of vegetation and prevention of puddling. However, when considering porous pavement, such local features as geographical area, temperature, subsurface conditions and possible ground water contamination may play an important role in design and site selection.

Stormwater runoff contains a variety of chemicals. The two most significant chemicals are those used for control of snow and ice, and those for control of vegetation. The widespread use of deicing chemicals could constitute a serious pollution problem. Since few highway departments are willing to prohibit the use of deicing salts, their adverse effects must be minimized by using less of these or finding new ways to keep roads clear. The following steps should be useful in reducing the rates of salt application without sacrificing highway safety: (1) no salt application on straight, flat sections; (2) better training of operators of salt-spreading equipment; and (3) keeping records of salt use. These techniques have been used successfully in Ann Arbor, Michigan. Other alternative means of reducing salt use include: thermal melting, compressed air snow plows and adhesion reducing pavement.

Abrasives may also be used to a greater extent. Sand spreading, however, contributes significantly to suspended solids. Furthermore, large quantities of sand can clog storm and combined sewers, and increase street cleaning costs. Abrasives are also more expensive (by weight) than sodium chloride. The adverse effects of salt spreading, by comparison, involve many damage, degradation of water supplies and damage to roadside vegetation. Thus, in some cases, a more complete economic comparison might fabor abrasives over salt.

The waste loads from livestock can be significant. For example, the solid waste produced by one cow is equivalent to that produced by 16 people (in terms of BOD)(66). Appropriate land and animal management practices can reduce these loads. Such practices include: (1) spreading acceptable rates of manure uniformly on land; (2) applying feed lot runoff effluent on land as recommended for specific site conditions; (3) maintaining an adequate land to livestock ratio on pastures; (4) locating feeders and waterers a reasonable distance from streams and watercourses; and (5) refraining from spreading on frozen sloping lands. Strict compliance to these practices will reduce the amount of nutrients and oxygen demanding wastes reaching nearby waterbodies. Costs for these practices are not high. At their worst, these techniques might cause some inconvenience to farmers (68).

7.5 Watercraft waste

7.5.1 Oil pollution

A large quantity of unburned fuel is discharged through the exhaust of two-cycle outboard engines on recreational boats. The effect of this fuel on the water quality and aquatic life in uncertain. Since the resultant oil concentrations are low, adverse environmental effects may be minimal. However, toxic constituents in the fuel, such as lead, may be increasing as a result of these discharges. One effect of these discharges is, nevertheless, certain; a large quantity of oil and gasoline is being wasted. Devices which eliminate these discharges and recylce unburned fuel are presently available. These devices are inexpensive to purchase and they lower fuel bills. Consequently, their use is recommended not only from an environmental standpoint, but also from an economic one.

7.5.2 Domestic wastes

There are two alternative methods to abate watercraft waste discharges: onboard treatment devices and holding tanks with onshore pumpout facilities. The use of either device poses problems. On one hand, flow-through devices will not always operate at designed levels of treatment, due to lack of proper maintenance; and there is no practical way for enforcement personnel to insure that proper maintenance will be carried out. Additionally, the treatment provided by an onboard flow-through device could be considered inadequate in certain waters. Consequently, there would

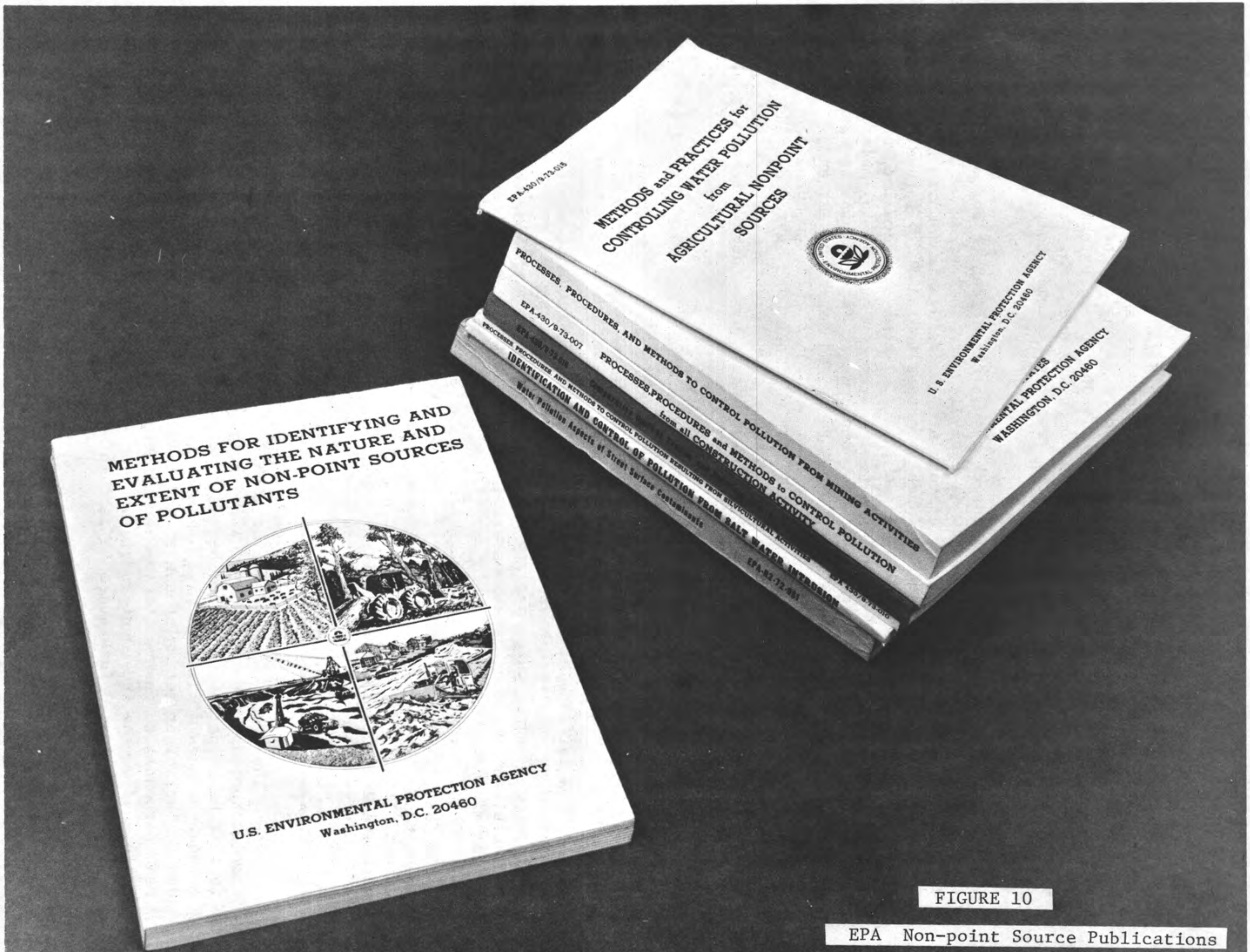


FIGURE 10

EPA Non-point Source Publications

be a demand for the creation of no discharge zones. The widespread establishment of such zones would destroy the uniformity so necessary for the success of watercraft waste abatement. One advantage of flow-through devices is that they do not limit a vessel's self-sufficiency by preventing it from going offshore for any length of time.

The second alternative; holding tanks, also poses problems. Pumpout facilities are unavailable in most docks and marinas. This is a major problem in the implementation of New York State's marine sanitation law. Additionally, in many cases, the level of treatment which the wastes receive onshore after having been pumped-out is inadequate. Furthermore, for certain types of vessels (particularly sailboats) holding tanks are not feasible. After careful consideration of these and other factors, Federal marine sanitation standards, incorporating the holding tank alternative, were promulgated. These standards address the major shortcomings of no discharge devices by permitted existing vessels to install onboard treatment devices for the next five years. Further exemptions may be permitted, if necessary.

It is believed that the holding tank onshore treatment alternative is better able to improve water quality, than the onboard treatment alternative. This is based on the supposition that onshore treatment facilities are likely to be better than any onboard treatment device that is presently available or is developed in the future -- especially in the case of onboard devices on small vessels. This is due to lack of space, cost constraints and the lack of trained personnel to operate and maintain an onborad device. Thus, once pumpout and onshore treatment facilities are constructed, the no discharge alternative will insure maximum possible pollution abatement. In the meantime, the use of flow-through devices will lead to some immediate pollution abatement.

7.6 Oil and Hazardous Material Spills

Alternatives dealing with oil spills stress prevention. Most measures involve policy reform. Oil spills occur in four ways; during normal vessel and terminal operations; (e.g. leaks), during transfer operations; deliberately, as in the discharge of oily bilge water; and accidentally as a result of collisions or running aground. Alternative means of preventing oil spills must address all spill causes.

Oil spill prevention alternatives include: the training of oil handling personnel, the use of containment equipment during all transfer operations, increased inspection of transferring procedures, the licensing of all oil terminals, stiffer licensing requirements for tanker operators, requiring tug boats to remain with oil-carrying vessels until they are completely unloaded, the establishment of restricted sea lanes, and stricter enforcement of all legislation dealing with oil and/or hazardous materials. New clean up operations must also be developed. However, since clean up operations are generally ineffective and expensive, preventative measures should be emphasized.

Besides the above alternatives, other more exotic measures can be taken to minimize the number of oil spills. Offshore oil transfer facilities which are properly designed and sited could possible prevent the possibility of oil reaching environmentally sensitive areas. The consolidation of terminals and the transportation of oil by pipe lines can also lessen the possibility of spills into waterbodies.

All of the above alternatives will improve oil handling procedures and thus, preserve water quality and protect aquatic life. The problems most likely to be encountered in implementing these programs are administration and funding difficulties. The licensing of crew members would be especially troublesome in view of the fact that many of the tankers in Long Island Sound are of foreign registry. Personnel training, increased inspection and several other programs require additional staffing. In order to strictly enforce existing and proposed oil pollution abatement programs, higher levels of funding are essential. Without more money, enforcement agencies simply will not be able to effectively prevent oil spills. Unfortunately, it is exceedingly difficult to suitably evaluate any of the alternatives individually. No one alternative can be entirely effective on its own. An integrated program comprising most of the alternatives must be developed for the Sound.

Hazardous material spills should be dealt with in the same manner as oil, but because most of these materials are transported by land, the danger of the spilled materials reaching a waterbody is somewhat lessened. The training of personnel and stiffer licensing requirements appear to be the keys to preventing major hazardous material spills.

7.7 Dredging and disposal of dredge spoils

Alternatives in this section can be divided into two categories: those which reduce or eliminate the need for dredging and those which mitigate the environmental impact of dredging. The first category includes: no dredging, offshore berths and other transportation-related alternatives. These alternatives will be discussed in the transportation element of the Long Island Sound Study. However, it must be noted that the out-right banning of dredging in Long Island Sound could produce serious economic repercussions and could make navigation unsafe in some areas.

Alternatives which mitigate the environmental impact of dredging include: treatment of dredge spoils, open water disposal, land disposal, incineration and creation of artifical habitats. Treatment alternatives are concerned primarily with oxidizing organic materials, preventing anaerobic decomposition and dewatering spoil. Aeration and chemical oxidation can be utilized to oxidize highly organic spoils. These techniques can improve the quality of the spoil, thereby minimizing the environmental risks of dredging and spoiling operations. However, some methods may create new dangers. For example, the use of chlorine as a chemical oxidizer may damage the surrounding marine life.

Very little is known about the long term effects of spoil disposal on the marine environment. Therefore, any new ocean disposal projects must be carefully monitored. Some adverse impacts of open water disposal may be: increased turbidity, lowered dissolved oxygen concentrations, burial of bottom life and the introduction of pathogenic organisms and toxic substances. Long Island Sound has been extensively used as a site for spoil disposal because it is the least expensive alternative. Disposal outside the Sound can substantially increase costs, but these increased costs could be offset by environmental benefits. However, disposal should not occur beyond the continental shelf because it is believed that life in the deep sea is extremely susceptible to environmental changes. Table 34 shows unit costs for open water disposal.

Table 34

Estimated Dredging Costs Per Cubic Yard

Method	1 Mile	3 Miles	10 Miles	20 Miles	50 Miles
	$	$	$	$	$
Hydraulic pipeline dredging	0.95	1.30	(1)	(1)	(1)
Dipper dredging & dump scows	1.10	1.25	1.50	1.80	3.60
Hopper dredging	0.28	0.34	0.54	0.81	1.66

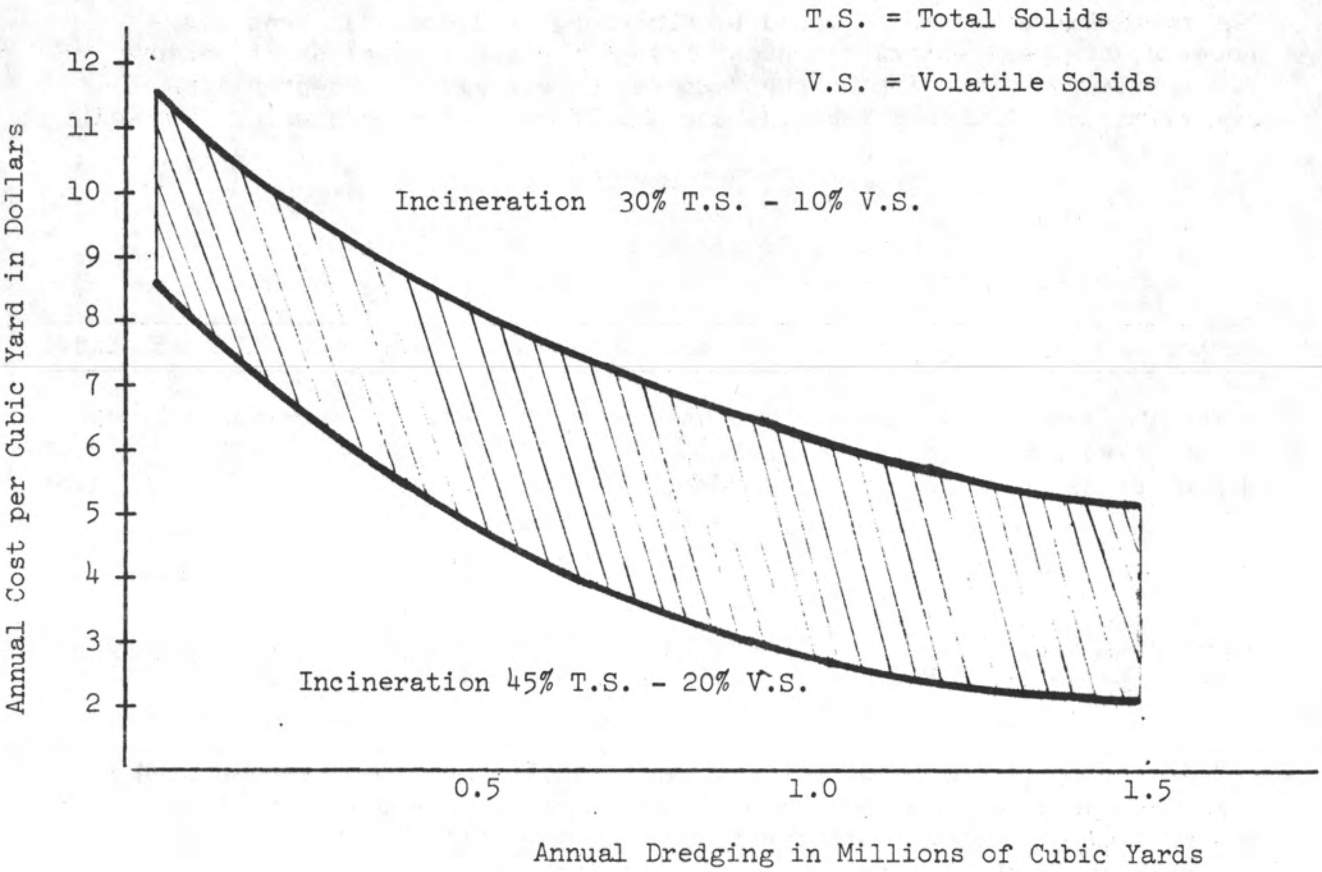
(1) Pipeline dredging operations beyond 3 miles are usually not practical because of problems in handling long floating pipelines and the extra pumping equipment involved. Chart is taken from Ocean Dumping: A National Policy, prepared by Council on Environmental Quality. Costs are for 1970.

Dredge spoil may be disposed of on land. It may be confined by dikes or spread on land in a manner similar to the land spreading of sewage sludge. Either method has the potential for creating public health hazards through the presence of toxins and other pollutants. There is further danger of ground water contamination. However, this hazard may be minimized by installing impermeable linings or underdrains beneath the land disposal site. Diking has additional disadvantages. The diked area cannot be used for many years and it is very unattractives. Estimates for 35 dike projects on the Great Lakes during 1969 indicated that the costs of diking vary greatly - from $0.35 to over $6. per cubic yard. The average increased cost of diking over open-lake disposal was $1.50 per cubic yard (64).

The creation of artificial islands and marshes using dredge spoils is a promising alternative. The islands could be used for incinerators, power plants, recreational areas or wildlife habitats. Construction of artificial habitats depends primarily on the nature of spoil material. The highly organic or polluted spoil which is present in most industrial harbors would probably not be suitable for such use. Other problems with this type of project are its high cost and possible disputes over the jurisdiction of the ultimate site.

Figure 11

RANGE OF ANNUAL COST PER
CUBIC YARD FOR INCINERATION (64)



Dredging should only be considered when no other economically practical alternative is available. Until a comprehensive program for dredging and disposal is instituted in the Sound, each dredging project must be evaluated on a case-by-case basis. The alternatives for dredging and spoil disposal should be assessed and mintoring should be conducted at both the dredge and disposal sites.

7.8 Water Supply

As with sewering and transportation facilities and highways, the extension of water supply system service areas has a very broad overall effect on land use patterns and urban growth. Decisions to expand water service areas must be made only after considering the impact of additional urban growth on a region. Water may be supplied to an area through public systems (either publically or privately owned) or through individual water systems for each consumer (one well per household). There are two approaches to providing water within the region. They are (1) adopt a "do nothing" approach and thereby stop planning of all further development of public or individual water systems, or (2) utilize the timing and placement of water lines to direct urban growth and promote high quality development where appropriate, and in suburban and environmentally critical areas, develop and/or enforce non-structural controls such as zoning to encourage land use patterns and density that will preserve these areas and ensure that individual water systems will continue to produce high quality water and be protected from pollution from on-lot waste disposal systems.

7.8.1 Do nothing

The "do nothing" approach does not provide guidance for which areas should have water service and which should have limited development. In areas selected for water service, consideration also must be given to the type of wastewater disposal employed. If sewers are also planned for the area, then review is primarily directed toward insuring that sewer lines can carry the flows expected due to the water mains. If, however, on-lot disposal systems are used, the size of water lines should be consistent with the ability of the acres in size, it is generally agreed that installation of water lines is uneconomical. Where individual water systems are used (wells in nearly all cases) proper zoning is needed to protect the quality of the ground water. Sewers are a means of protection, but they also carry water away from the recharge area that could replenish the ground water source. Also, sewers often encourage increased development and density resulting in ground water degradation over the long term. Zoning is most crucial where on-lot disposal systems are employed in order to assure that soil conditions are such that the wastewater can be effectively treated before delivery to the aquifer.

7.8.2 Surface Water Development

Development of surface water sources will be a major means of supplying water to the Connecticut inhabitants of the LISS region in future years. The development within the region centers on the creation or enlargement of surface water reservoirs, the diversion of flood stage stream flow, and the installation of treatment or pumping facilities at existing surface sources.

The "Plan of Conservation and Development for Connecticut" has made a first attempt to identify areas and waterbodies throughout the State that have varying degrees of opportunities for surface water development. Many existing surface sources are not filtered before delivery to the consumer, and such a practice has been satisfactory due to the watershed protection measures. The State has many potential water supply sources and want to extend strict control of use at or around these sources. Now, with the increasing pressure of those desiring use of the watershed land and reservoirs for recreational purposes, filtration looms as a potential requirement for all surface water sources. If recreational use is allowed, the cost for such measures as filtration of the water, maintenance of the recreational facilities, additional surveillance and monitoring of the watershed, and increased sampling and analysis of the water source must be accepted by the water supplier who must reflect this cost in his bill to the consumer or in a charge to those using the recreational facilities.

Of course, portions of the watershed land may be considered for residential or industrial use. It seems reasonable that any such development should only be allowed after approval by the water supplier, the local communities involved, and the State Department of Health. It should always be kept in mind that filtration of a system is used only to enhance the quality of the water supply and not as a measure to allow additional pollution in or around the water source.

A major decision related to surface water development centers on the use of the Housatonic River as a future water source. Presently, the Connecticut State Department of Health could not certify use of the River because it receives some sewage effluent. However, the quality of the River is reasonably good, and the potential yield of the River system (160 MGD) makes it a very viable source of water supply. The U.S. Army Corps of Engineers, in their June, 1973, Northeast United States Water Supply Study, "Further Development of Regional Water Supply Alternatives: Northern New Jersey - New York City - Western Connecticut Metropolitan Area", suggests that stage development of the Housatonic River with diversions is advantageous to Connecticut, as projects would be relatively inexpensive because of existing storage available in the power reservoirs. Additional upstream storage construction would be needed at some later date.
A decision must be reached as to the future availability of this sources, as Regions IV and V are depending upon a favorable decision to meet the needs after 1990.

Various opinions have been offered as to the effect of the increased use made of Lake Whitney on the flow of the West River. The installation of a rapid sand filtration plant is projected to increase yield by 15 MGD. However, some people feel that such an increase in withdrawal will result in depletion of flow in the West River during certain periods of the summer. Resolution of the two opinions will require further study with the understanding that some minimum flow must be maintained in the River. The same principle should apply to all potential diversions. A minimum flow must be established below which no diversion of water is allowed.

A review of the various surface water development possibilities yields the following general conclusions. The creation or enlargement of surface water reservoirs appears to be fair to good both environmentally and economically and good from a social criteria standpoint. Such concerns as natural beauty, aquatic plants and animals, and water quality - as well as the potential impact on other functional areas such as recreation and power - are enhanced by surface development, while terrestrial plants and animals, legal-judicial involvement, and certain political impacts such as ease of creating institutions and legislation to manage reservoirs are negatively affected. Stream diversion, while appearing good environmentally, seems fair to good from an economic point and fair from a social point. Diversion is beneficial in protecting terrestrial plants and animals, as well as reducing erosion and sedimentation problems. First costs appear to be high and, therefore, negative, but annual and external costs seem low, and hence are positive. The other negative aspects are related to such social considerations as legal-judicial involvement, institutional administration, and political mechanisms needed to create the institutions. Treatment or pumping facilities are rated fair to good from both an environmental and economic evaluation and good from a social well-being review. The positive points of this proposal are associated with the life, health, and safety of residents, as well as the educational, cultural, and recreational considerations of the same people. Functional areas such as land use, water quality, and recreation will also be enhanced with such treatment. The major negative aspects are related to the first costs associated with the construction of these facilities.

7.8.3 Ground water development

Ground water will serve as the major source of supply for the Long Island portion of New York. To a lesser extent, ground water is and will be an important source for Connecticut. Ground water development proposals center on three areas - developing estimated safe yield, mining ground water, and utilizing recharge basins. Developing only the safe yield of ground water sources is rated as good from all three considerations - environmental, economic and social. Positive aspects are reflected in costs, water quality, and maintenance of natural beauty of areas. Mining ground water appears to be poor from an environmental and social point of view and fair from an economic standpoint. Mining water would lower water levels and negatively affect both terrestrial and aquatic plants and animals as well as the natural beauty of an area. Recreation activity and shoreline appearances would also be degraded. Utilization of ground water recharge basins appears good from all three considerations. Protection of aquatic plants and animals should result from this process whereby water table levels will be maintained. Other positive aspects are similar to those resulting from the development of the safe yield only process.

The consideration of ground water development is inadequate without an overall analysis of ground water management (water supply - wastewater disposal) from the area.

Precipitation is the only fresh water source for Long Island. Rain water and snow melt infiltrate the ground surface, and the fresh water moving through the soil recharges the ground water supplies in various aquifers. Street paving, building construction, diversion of fresh water to the sea as wastewater effluent and storm sewer runoff, and increased water withdrawals have reduced ground water recharge and lowered the water table. In areas not completely sewered, cesspool effluent from many dwellings has resulted in widespread contamination of the upper aquifer, causing abandonment of many of the shallow wells and the creation of public supply wells tapping the deeper aquifer. A large net withdrawal from the deep aquifer has caused salt water intrusion in coastal areas. Increased withdrawal rates are likely to cause serious encroachment.

Therefore, the present controversy of whether or not to construct sanitary sewers in parts of Long Island is an example of largely valid but conflicting points of view. The present method of dispersing of household waste through cesspools and septic tanks helps maintain the quantity of water in the ground water reservoir but causes deterioration of the quality of the water in shallow aquifers, which poses a health hazard. The construction of sanitary sewers will help preserve the chemical quality of the shallow aquifers, but this construction will result in an increase in the net loss of water from the ground water reservoir if other conservation procedures are not adopted.

The human impact of the ground water regime in the Little Neck Bay has been severe. There the water table in the upper glacial aquifer has been lowered 10 to 20 feet since 1900 (Soren, 1971). In other sections of Queens County, the ground water table declined 40 feet during this period. Water levels in the lower aquifers have also declined. These declines were caused by water withdrawals at a rate much greater than the rate of ground water recharge. Urbanization reduced the ground water recharge rate to about 0.5 X 10 gal/day per square mile, roughly half that of unaltered areas. Salt water intrusion is widespread in the upper glacial aquifer in urbanized sections of Long Island's Coast. The western portion of the Little Neck Bay drainage basin obtains its water supply from New York City's reservoir system. There is little ground water development in this area.

Ground water resource in the Manhasset Bay-Hempstead Harbor region have reached the second stage of development. Increased withdrawals will probably result in further salt water intrusion similar to that which has already occurred around Port Washington (Swarzenski, 1963). Sand and gravel mining has affected ground water on Manhasset Neck. For example, artificial salt water ponds were created for washing and sorting sand and gravel, and salt water from these ponds has infiltrated local ground water reservoirs.

Land excavations below the water table have reduced the storage capacity of the ground water reservoir. This reduced capacity decreases the fresh water head in the shallow aquifer, and sea water encroachment may ensue. Near most of the North Shore bays, ground water is confined by impersious clay beds. Removal of clay beds by dredging in the bays can increase fresh water discharge to the sea. The result again is landward shift of the fresh-salt water interface.

There is no evidence of major salt water encroachment of the ground water between Hempstead Harbor and Oyster Bay. The ground water withdrawal in this region can be increased without immediate, serious consequences (Isbister, 1966). Ground water resources from Huntington Bay to Port Jefferson Harbor are of good quality and occur in substantial supply (Lubke, 1964). Owing to their proximity to the sea, the ground water resources of Lloyd Neck and Eatons Neck are limited. Moderately heavy ground water withdrawal has already occurred near the southern extremities of Cold Spring, Huntington, and Northport Harbors. Assuming the data to be correct (Holzmacher et al., 1970, Vol II, p. 75), records for the periods 1907 to 1957 in the Huntington-Milville area indicate a drop in the water table of 15 feet from a maximum elevation of 95 feet. Increased rates of withdrawal will cause local salt water intrusion. Some ground water contamination in the Northport area has been caused by sand and gravel operations (Lubke, 1964).

Various proposals have been made for providing water supply to Long Island in combination with treatment and disposal of wastewater. Suffolk County would supply its own water needs and supplement those of Nassau County and each would employ advanced wastewater treatment with return of the effluent to recharge basins. Another proposal would include mining of ground water from Long Island with wastewater treatment as described above or with secondary treatment and disposal to the ocean. Ground water mining can only be considered a short-term measure if the safe yield of the system isn't sufficient to supply the average demand. The New York City source would be needed to supplement the ground water source. Such a condition would result before 2010 if ocean disposal of wastewater is employed. Ground water development without recharge basins is limited and will surely require Nassau County reliance upon the New York City system. Another proposal would build flexibility into the system by installing water lines through the Island large enough to deliver water to New York City from Long Island ground water sources (mining) during drought conditions and then providing water to Long Island from the New York City system during relatively wet years to allow the ground water reserves to build up. Waste disposal for either condition could vary from advance treatment with disposal of effluent to recharge basins or to secondary treatment with ocean disposal. The possibilities are there, and decisions must be made by the State and the Counties as to the water management policy needed for the Island.

7.8.4 Other Sources of Supply

Other means of providing water to the LIS region consist of importing water from neighboring regions, desalination, direct reuse of treated wastewater, and interconnection of water systems. Importation of water to the LISS region is particularly important to Subregions 4, 5 and 6 in the longer period.

Nassau County must consider importation of water from the New York City system now if sufficient lead time is to be available for installation of adequate transmission capabilities. Regions 4 and 5 must also begin to consider importation of water now to insure delivery later. However, the urgency is not as great as that for Nassau County.

Desalination is, at this point, a potential long-term solution, The process of desalting or "salt water purification" - the recovery of fresh water from saline water - has been the subject of intensive research and development in the United States in recent years. At present, there are basically eleven methods which may be used for desalting water:

1. Multiple effect distillation
2. Flash distillation
3. Electrodialysis
4. Vapor compression
5. Freezing
6. Solar distillation
7. Solvent extraction
8. Reverse osmosis
9. Ion exchange
10. Critical pressure
11. Osmionics

Distillation is the best-developed salt water purification method. It is estimated that 95 percent of the desalted water produced in the world is obtained by some variant of the distillation method. Large scale purification of salt water is basically not a problem of technical feasibility, but of economics. High initial costs and large energy requirements keep present desalting operations from being able to compete with other methods of providing water supply wherever such alternatives are available. It appears that this alternative, if it is to be considered further, will have primary application for Long Island only as Connecticut has sufficient supplies of fresh water sources.

The direct reuse of treated wastewater for public water supply is presently not a viable alternative for meeting the water demands of the region. This proposal does have application in certain agricultural and industrial processes and certainly has potential in recreational and ground water recharge considerations. The following four statements taken from the "EPA Policy on Water Reuse" should serve as a guide for any consideration of this alternative.

1. EPA supports and encourages the continued development and practice of successive wastewater reclamation, reuse, recycling and recharge as a major element in water resource management, providing the reclamation systems are designed and operated so as to avoid health hazards to the environment.

2. In particular, EPA recognizes and supports the potential for wastewater reuse in agriculture, industrial, municipal, recreational and ground water recharge applications.

3. EPA does not currently support the direct interconnection of waste water reclamation plants with municipal water treatment plants. The potable use of removated wastewaters blended with other acceptable supplies in reservoirs may be employed once research and demonstration has shown that it can be done without hazard to health. EPA believes that other factors must also receive consideration, such as the ecological impact of various alternatives, quality of available sources and economics.

4. EPA will continue to support reuse research and demonstration projects including procedures for the rapid identification and removal of viruses and organics, epidemiological and toxicological analyses of effects, advanced waste and drinking water treatment process design and operation, development of water quality requirements for various reuse opportunities, and cost-effectiveness studies.

The interconnection of the water systems is a means of supplying water to water-short areas from regions with an abundance of supply. While subregions 4, 5 and 6 presently place great emphasis on these interconnections, even greater reliance will be expected in the future. It is important to realize that the interconnection of water systems does not develop new sources of supply. Rather, it allows only for the sharing of water sources. Therefore, it is a temporary solution and not a true water supply alternative. Connecticut systems, for the sake of flexibility, will, in the long run, probably have interconnections between all systems in Regions 2 through 5, while New York will have connections between the major systems in its portion of the study area.

Importation is rated good from an environmental viewpoint and fair from economic and social considerations. Positive aspects relate to the fact that existing land use will not be disrupted by new reservoirs or well fields, while negative implications are more closely tied to the legal-judicial involvement and the political considerations necessary for making importation a reality. Desalination and direct reuse of wastewater are rated fair from an environmental and social point of view and poor from an economic review. Positive aspects relate to providing sufficient supplies of water, leaving existing land use or areas of natural beauty undisturbed. The negative aspects of either proposals are associated with the high costs involved and with the legal and institutional arrangements necessary for administering either proposal. Interconnection of water systems is only a very short-term approach to providing water to an area. Such an approach appears good environmentally and fair for the other two considerations. Benefits relate to preserving the natural beauty of an area and to choosing the land use desired for an area. Also annual and external costs will be low. Negative features of such a proposal relate to the legal and institutional problems encountered, as well as the first costs associated with the project.

7.8.5 Water conservation measures

Water conservation measures would make more water available by reducing the consumption totals of the individuals in the region. Possible approaches to this deal with pricing, plumbing controls, and zoning regulations. Current pricing practices of decreasing charges per unit of water consumed as total volume increases could be changed to maintaining the same charge, or in fact, increasing the change for additional units. Such an approach may encourage consumers to cut back use or, in the case of industry, to consider recycling. Of course, this approach assumes that universal metering is in effect. Metering is part of the plumbing controls along with water-saving appliances. These appliances include water-saving toilets, shower heads, and laundry equipment. Proposals recently made by the Temporary State Commission on the Water Supply Needs of Southeastern New York in the report, "Water for Tomorrow" suggests that such measures might cut per capita consumption by 15 gallons per day. If all these measures were instituted immediately, reduction of some 10 percent in water needs could be expected. However, installation of such measures will be long term, resulting in a gradual reduction. Both pricing and plumbing controls rate as fair to good environmentally, socially, and economically essentially because new resources do not have to be used in an area, and therefore, natural beauty or the ecological system would not have to be disturbed. Also, additional costs are negligible. The legal and institutional arrangements may be the major negative aspects of the proposals. The process of zoning an area to restrict or deter increases in population is rated fair both in an economic and a social sense for the same reasons as pricing and zoning. However, it is rated good from an environmental point of view.

All of the water conservation measures are dependent upon public awareness and education. It is imperative that municipalities and water supply instititions support and take part in programs that will inform the public of the value of water and the need to conserve its use. For instance, the large number of apartments in the region is of concern. While apartment buildings may be metered, the individual tenants are not, and therefore, they probably do not notice an increase in the cost or the amount of water used. As a result, public information programs should be instituted, as they are the only means of encouraging conservation of water.

8.0 FORMULATION AND EVALUATION OF ALTERNATIVE PLANS

In this section, two plans utilizing the alternatives evaluated in the previous sections are developed in order to achieve the economic development objectives and the environmental objectives within the region. To meet either the NED objective or the EQ objectives, three concurrent approaches are necessary: (1) develop cost effective programs to minimize the chronic sources of pollution emanating from municipal, combined sewer, industrial, recreational vessel, and non-point sources, (2) minimize the impact and frequency of sporadic occurrences such as oil spills and dredging and disposal activities, and (3) provide sufficient supplies of water to meet future demands.

In order to establish priorities and allow the people an opportunity to decide which goals should be met, the plans will be developed in phases. Phase I will be geared toward achieving the "national economic development" objectives, while carrying on the additional engineering, planning, and public participation programs which will be necessary to implement Phase II. Phase II will be geared towards achieving the "Environmental Quality" objectives. The distinction between Phase I and II is sometimes blurred, especially in programs that deal with sporadic occurrences. For these programs, each succeeding phase will attempt to produce additional environmental benefits. Figure 12 is a flow chart of the short-range water management programs which suggests the optimum time frame to achieve the objectives. More detailed information on specific programs is found in Appendix C.

8.1 Economic Development Plan

8.1.1 Water supply

Within the limitations of a quality environment, attention has been directed to enhancing regional income in at least two ways. In planning for future needs, consideration has been given to the selection of water supply alternatives which will realize a maximum economic return on a minimum adequate dollar investment. Factors such as the geographical proximity of existing water service lines and potential water sources have

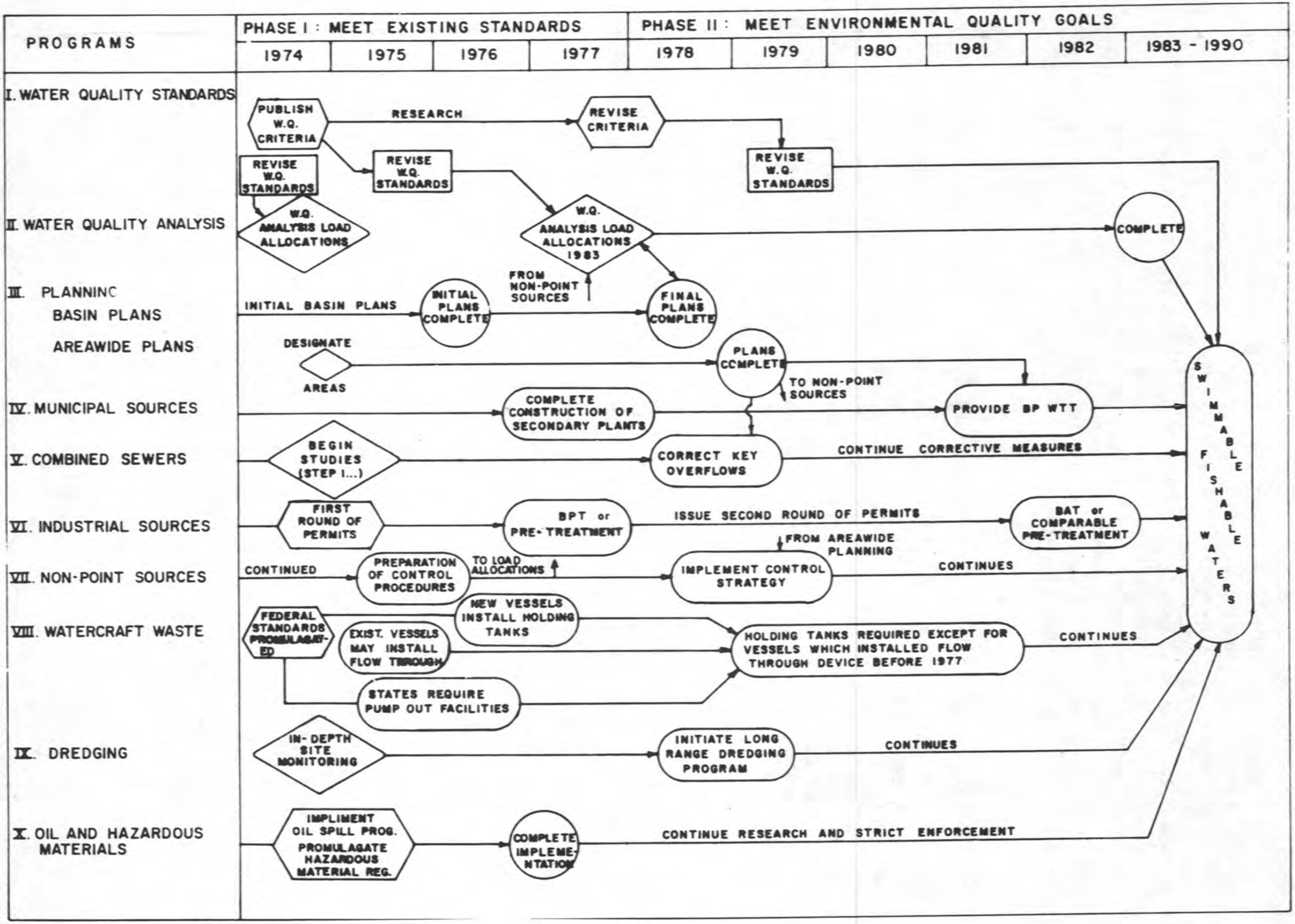


Figure 12

SHORT RANGE WATER MANAGEMENT PROGRAM FOR LONG ISLAND SOUND REGION been studied in conjunction with the anticipated distribution of direct and indirect economic benefits in an attempt to minimize an area's water development costs and maximize its benefits. Wherever possible, the development of regional water supply systems has been encouraged in order to take advantage of the substantial economies of scale and increased efficiency and reliability of water development, surveillance, treatment, and distribution which such a system offers.

Throughout the planning process, an effort has been made to achieve the most efficient allocation of water supply resources possible within the study area. The maximum prudent development of existing in-basin resources to meet future water needs has been encouraged on this ground in preference to reliance upon inter-basin transfer arrangements. Regionalization of water supply systems, in addition to enhancing economic efficiency, offers opportunities for more efficient utilization of available resources.

Although the primary focus of this work has been within the LIS study region, consideration has been given to minimizing the costs and enhancing the economic benefits of alternative regional plans for adjoining areas of Connecticut and New York. Preferential development of in-basin water supply resources is expected to contribute to the national income by leaving essential, high quality resources outside the region available for economic development in other localities, as well as by simply making better and increased use of existing natural LISS resources. It is also likely that attempts to maximize benefits to the regional income from water supply development will provide significant indirect economic benefits for must of the rest of Connecticut and New York.

Connecticut and New York have completed extensive, individual planning studies. Connecticut, in "A Plan of Conservation and Development for Connecticut" has identified potential surface water sources and diversions along with the most favorable yield aquifers, while New York has considered various proposals to providing water to New York City and Long Island. In addition, the Corps of Engineers is continuing investigations of the alternatives to meet the water needs of the New York Metropolitan area including Long Island and Southern Connecticut.

Water systems in Connecticut have developed specific plans for increasing supply. The regional planning agencies, working with these systems have compiled areawide plans which are necessary when considering the creation or enlargement of regional water systems. Most proposed sources of supply are within the LISS region, and most sources are approved by the State Department of Health. The one source in conflict with State policy is the Housatonic River which, for long-term development, has a potential yield of 160 MGD. Since this source is not needed until after 1990, Phase I will be limited to sampling and monitoring surveys, which will be undertaken as part of an EPA and state contract with Raytheon to develop a water quality model for the River. Information from the model should provide sufficient information from which to determine the suitability of the River for water supply purposes. Also, as part of Phase I, the state and the water companies should review the overall watershed development policies to determine if revision is in the best interest of the water supply consumer. Such a review is necessary because of the increasing pressure for multi-purpose use of these lands. Areas to be considered should include types of use -- residential, recreational, etc. -- and institutional mechanisms necessary for orderly transition of these lands to other uses, if such is recommended. Communities in Regions I and II should determine the feasibility of combining many of the small water systems into a few larger systems. This investigation would be carried out as part of Phase I.

New York must decide upon definite policy for water management for Long Island. This will be the most important part of Phase I, as the formal establishment of such a policy will provide the guidance as to how the Island will be supplied after 1990. The state, in the development of this policy, will have to coordinate with the local communities and the counties of Long Island, as well as New York City. Water management investigations will have to include additional pilot plants involving recharge basin receiving effluent from advanced waste treatment facilities.

Throughout the study area, measures to reduce consumption should be initiated as part of Phase I. These provisions should include universal metering, as well as the development of public education programs by water utilities. These programs should stress the true value of water as well as ways of conserving the resource. Water-saving applicances should be encouraged and water pricing policies reviewed so that over the next decade, consumers grow to appreciate the true cost of a glass of water and thereby take the necessary steps to reduce unnecessary consumption.

8.1.2 <u>Water quality</u>

Most of the pollution problems being addressed in this phase are well identified and proceed from other work of state and Federal governments in the past years. As part of Phase I, states have had underway a program of dividing all rivers and other water bodies within the study area into hydrological segments. Where the application of best practicable technology for industries and secondary treatment for municipal plants will result in meeting the existing Federal-state standards, the segment is categorized as effluent limited. Where this technological base will be insufficient for the necessary level of water quality, the segment will be classified as water quality limited. All the areas identified in Section 4.1, except the Upper East River, have been identified as water quality limited For these areas, the states must develop maximum daily loads of pollutants and establish more stringent water pollution abatement programs than are required for "effluent limited segments". As part of the Long Island Sound Study, EPA and the states have contracted with Raytheon to develop water quality models for the Housatonic, Naugatuck, and Quinnipiac Rivers, as well as Branford, New Haven, Milford and Bridgeport Harbors. Sampling and monitoring surveys have been or soon will be undertaken to provide input into these water quality models in order to develop load allocations and water quality management programs.

Phase I emphasizes the issuances of industrial and municipal discharge permits and the awards of municipal construction grants. For industrial point sources, the first round of permits will be based on the best practicable effluent guidelines developed for many major industry categories, or on the basis of water quality analyses prepared for the water quality limited stream segments.

In the municipal field, construction grant awards will continue to be concentrated on historically eligible projects such as treatment plants. However, during this same period, communities and states should develop proposals for the abatement and control of combined and storm sewer flows. As the backlog of treatment plant construction is funded and underway, it is recommended that the major focus shift to the abatement of pollution from combined and storm sewers. This will be necessary if we hope to achieve water quality goals in the urban harbor and bays.

A central element in developing controls over complex pollution sources in metropolitan areas is the designation of areawide planning and management agencies. The responsibilities of such agencies include site location of new sources or activities, non-point source control, and establishment of discharge permit conditions. Because of the comprehensiveness of these plans, including their coverage of all-point and non-point sources and their effective control of land use, they will serve as a basic structure for the implementation of the "Environmental Quality Goal".

States should continue to develop basin plans for all waters within the study area. This effort is underway, and basin plans will serve as a structure under which the more detailed facilities and areawide plans can be integrated. Most state basin plans are presently limited to segments, sub-basins, and those elements necessary to support the issuance of permits. It is recommended that an ad hoc committee with representatives from both the states and EPA coordinate and utilize the on-going development of basin plans as a systems approach to make centralized coordinated water quality management decisions for Long Island Sound.

As the abatement of point sources is achieved, the scope and nature of non-point source pollution will become increasingly obvious. During Phase I, EPA should expand its information and guidelines on non-point source control methods and techniques and the states and areawide planning agencies are expected to develop non-point source control strategies as part of their areawide and basin planning effort. Non-point source control will have to be a cooperative, intergovernmental responsibility, with authorities divided among Federal agencies and state and local units. Unlike point sources, there are currently no time requirements or levels of treatment prescribed.

During the Phase I period, a uniform procedure to regulate sewage discharge from ships and boats will become effective. In order to ensure success of this program, the state should develop procedures to ensure adequate pump-out facilities and treatment for this waste at recreational marinas.

The extent, location, and justification of harbor dredging and disposal methods are to be considered at length in the planning report on transportation. Environmentally, the long-term effects of dredging are most likely to occur at the dredge disposal sites. For this reason, the number of dredge disposal sites in Long Island Sound has been reduced to four. During Phase I, on-going major dredging projects would proceed on a case-by-case basis, subject to in-depth environmental assessments and careful monitoring at both the dredging and disposal area. During this period, the Corps of Engineers will also complete a five year dredged materials research program. With in-depth monitoring at the four designated disposal sites and input from the dredged material resource program, a long-range program by the states and Federal government can be developed as part of the coastal zone management program. This program will assign permanent dredge disposal sites, establish quantity and quality of dredge disposal materials allowed to be dumped into these sites, establish dumping procedures at these sites to mitigate environmental harm, and establish monitoring programs to determine the long-term effects (if any0 of these disposal activities.

Spills and other unique discharges of oil and hazardous substances present problems for water quality and of control that make them different from continuous or scheduled discharges. Both the economic and environmental plan of the oil and hazardous substance program is to protect water quality through the prevention of spills and minimizing the impact of spills, if and when they occur. This involves a three-fold approach: spill response, prevention and enforcement.

To provide efficient and coordinated response actions, regional contingency plans are required which delineate procedures, techniques, and responsibilities of various Federal, state and local agencies within the Long Island Sound Study area. In the Long Island Sound Region, there are various Federal, state, county, local and industrial oil spill contingency plans. At present, the contingency plans do not provide firm cooperation and coordination commitments from the different response teams. As part of the Phase I program, it is recommended that coordination commitments from the different response teams be initiated. It is the water management work group expectation that the potential spiller should develop the capacility to remove the spilled material. However, if the violator fails to do so, the Federal and state response should be to undertake the clean-up and the discharger to be charged for the cost of the removal. Since the Federal response to oil pollution will normally be instituted for major or medium spills, the state can concentrate its pollution response efforts on minor spills.

Section 7.6 defines many of the alternatives dealing with oil spill prevention and enforcement activities. Oil and other hazardous material spill should be lessened by enacting the following provisions: enact Federal legislation which would require licensing of all the boat crew members whose boat is used for hauling or pushing tank barges loaded with oil and/or hazardous materials. Enact legislation which would require a tugboat, once it picks up a barge loaded with oil and/or other hazardous material, to stay with the barge until it is completely unloaded. Enact Federal legislation to establish sea lanes to the major ports along Long Island Sound. States should provide or require that oil spill containment equipment be available in each receiving port and in use during all transfer operations. Provide funds and staffing on both the Federal and state levels in order to implement and enforce existing legislation dealing with oil and/or other hazardous materials. Such existing legislation includes: a program that calls for strict liability without fault of spiller for damages, penalties up to $5,000 for each day that a violation continues, and also to provide funds to the Coast Guard for continuous surveillance of oil spills.

8.2 Environmental Quality Plan

8.2.1. Water Supply

During Phase I, the major water management problems should be thoroughly investigated so that during the early stages of Phase II the implementation of projects researched can proceed. A firm decision on the desirability of using the Housatonic River as a water source for Regions 4 and 5 can be made with the necessary lead time available for placement of storage and transmission facilities as well as the resolution of legal, institutional, and political concerns. Also, by the beginning of Phase II, the major question of the use of watershed lands should be th thoroughly studies so as to allow formulation of policy which will guide water supply interests as well as proponents of multi-purpose use of watershed lands.

The thoughtful deliberation of a total water management policy for New York City and Long Island is the primary goal for the Phase I with development and conduct of pilot projects on ground water recharge. The information provided by such research should be used during Phase II to institute large scale projects to the effective management of water use. The local communities should be appraised of developments so that zoning regulations can be modified to accomodate the installation of recharge basins during Phase II.

As Phase I evolves, a gradual development of public awareness of the value of water should be evident with the result that during Phase II, the public as well as prive industry should be conserving water through such efforts as water-saving appliances, metering, recycling, etc. Such an attitude should prevail throughout Phase II. As with many of our resources at the present time, the consumer must be aware of the importance of conserving a limited commodity.

Table 35

Areas to be Upgraded to Meet Swimmable-Fishable Waters

Subregion I

1. Yantic River from Red Cedar Pond to mouth.
2. Little River from Peak Brook Rd. to junction with Quinebaug River.
3. Quinebaug River from Jewett City to junction of Broad Brook.
4. Oxoboxo River from outlet of Wheeler Pond to mouth.
5. Thames River and Shetucket River.
6. Prime shellfish area.

Subregion II

Connecticut River.

Subregion III

1. Quinnipiac River from tidewater to mouth.
2. Mill River from State St. to mouth.
3. New Haven Harbor inside line extending from Morse Park to Lighthouse Pt.
4. Branford River from tidewater to Branford Point.

Subregion IV

1. Ash Brook, Black Rock Harbor and Bridgeport Harbor.
2. Bruce Brook from source to tidewater.
3. Lower Housatonic River.

Subregion V

1. Bryam River from Route 1 to mouth.
2. West Branch Stamford Harbor.
3. East Branch Stamford Harbor.
4. Five Mile River from New Canaan sewage treatment plant to tidewater.
5. Norwalk River from source to tidewater.
6. Norwalk Harbor inside line extending from Keyser Pt. to Half-pasture Pt.
7. Rippowam River from Ayer Brook to tidewater.

Subregion VI

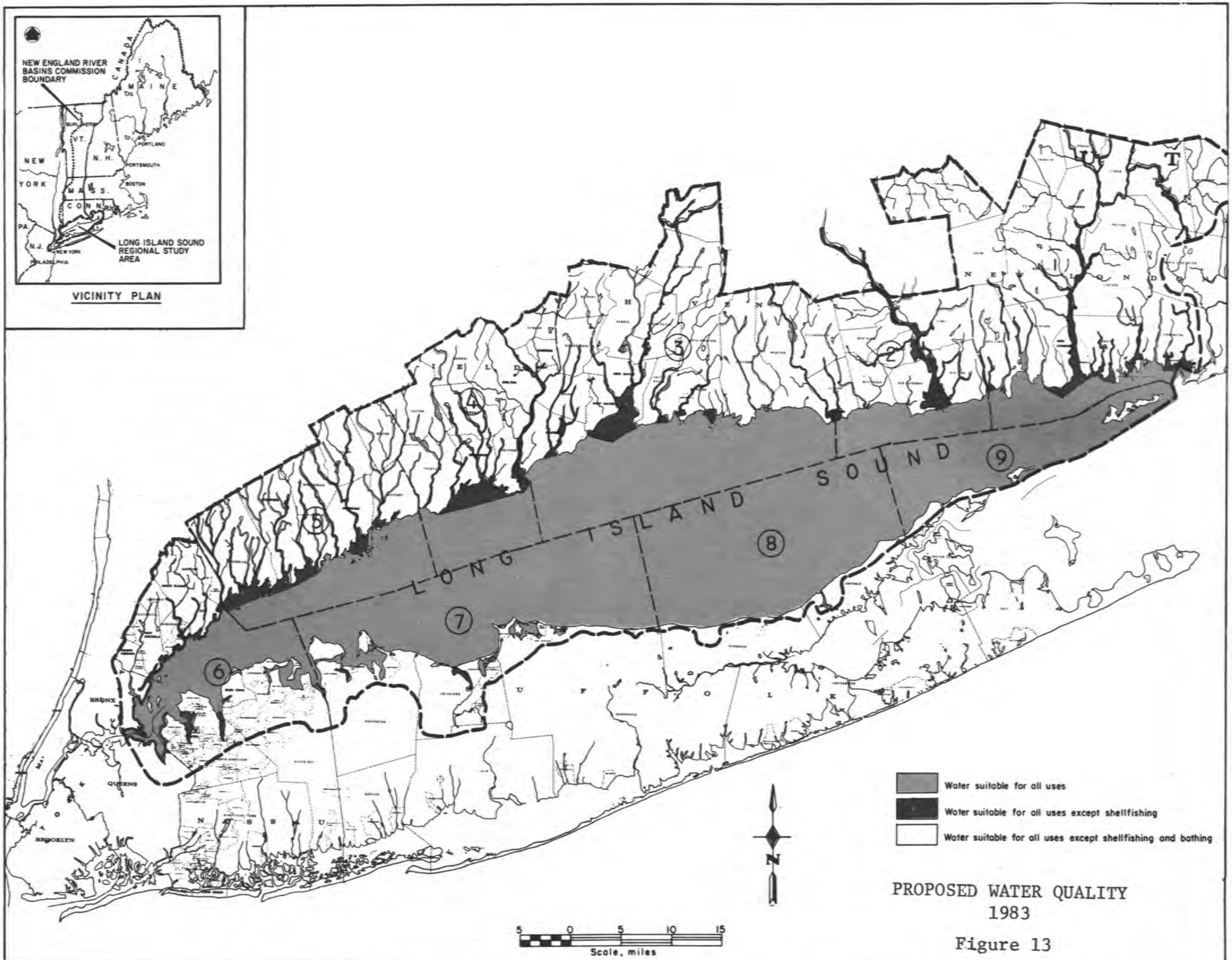
1. Beaver Swamp Brook.
2. Playland Lake.
3. Mamaroneck River.
4. East Creek.
5. Premium River.
6. Bronx River.
7. East River.
8. Inner Manhasset Bay.

Subregion VII

1. Huntington Harbor.
2. Nissequogue River.
3. Inner Port Jefferson Harbor.

Subregion VII & IX

None.



PROPOSED WATER QUALITY
1983

Figure 13

problem of identifying non-point sources of pollution, expertise with the specific types of non-point sources and local conditions should be the basis for design and appropriate controls.

Finally, preparation must be made for preventing future problems. As water conditions reach the required levels of quality increasing emphasis must be placed on maintaining and preserving these levels. Economic and social pressure to accommodate increased flows and new sources will develop and will often threaten water quality achievements. Precluding this will require an increased reliance on policies and regulations on anti-degradation, flow reductions, permits and growth, land use and land management.

9.0 WORKGROUP RECOMMENDATIONS

The workgroup recommendations for water quality would provide for swimmable-fishable waters by 1990 throughout the study area and preservation of existing high quality waters. The plan emphasizes "best practicable treatment" for municipalities; "best available treatment" for industries; abatement of combined sewer pollution; establishment of selected no discharge zones; land management measures to reduce non-point pollution, especially from urban areas, construction activities and solid waste disposal areas; development of a comprehensive program to mitigate environmental effects of dredging and disposal in the LIS study area; prevention of oil spillage; and uniform requirements for sanitation devices for watercraft.

However, a recent survey prepared by the states estimated the cost of achieving the goal of swimmable-fishable waters nationally at $350 billion by the year 1990. Anticipated levels of funding are not expected to approach this figure. Therefore, in a limited number of highly degraded urban harbors and rivers, both within and outside the study area, the goal of swimmable-fishable waters will probably not be achieved.

If funds are not sufficient to reach these goals, the limited financial resources should be invested in abatement efforts that are directed toward either providing significant short-term water quality improvements, preventing serious degradation or a public health nuisance, providing restoration of an entire riverine or estuarine system, or allowing new public uses of the water such as swimming of shellfishing. Any measures being considered would also have to be evaluated for economic acceptability, with the state probably making a decision on funding priorities.

The water supply portion of the plan emphasizes regional systems for greater flexibility and reliability; conservation of water in Nassau County until recharge on a large scale is technically feasible; and development of new and expanded supplies in keeping with land use policies to protect and conserve the water resources.

The specific recommendations are presented in the 16-point program below. Local projects are listed in Appendix C.

9.1 Water quality

Recommendation: Federal funds should be increased immediately to insure that no municipal waste water discharges reach Long Island Sound with less than secondary treatment after 1980. Costs eligible for State and Federal funds to complete this portion of the water management program are approximately $280 million for Connecticut and $340 million for New York.

Recommendation: Abatement of combined sewer pollution. Adequate Federal funds should be made available to minimize pollution from combined sewer overflows, through a phases program which should be completed by 1985. During the initial phase, improved combined sewer operation can be obtained by repair of sewers and bypass regulators and reduction of peak stormwater flows by improving waste water system usage and decreasing infiltration. Also during this phase, additional information about the combined sewer systems should be gathered.

During the next phase, further improvements can be implemented by using a combination of control, storage, relief sewers, treatment and separation. As funds become available, individual components can be selected. Probable costs to complete this program are on the order of $2 billion in New York and $200 million in Connecticut.

Recommendation: Study of nutrient enrichment in western Sound. New York State Department of Environmental Conservation should identify western Long Island Sound as water quality limited and initiate a special study of the area to determine whether nutrient removal at municipal wastewater treatment plants will be necessary to attain water quality goals. The study should also determine the relative significance of point and non-point sources of pollution coming from the Upper East River, Westchester County and Nassau County. Pollution abatement priorities after secondary treatment at municipal treatment plants should be established and a plan for financing all elements of the treatment system developed.

Recommendation: No discharge zones. States, through public hearings, should be required to designate selected streams and estuarine areas which presently have excellent water quality as no discharge zones (which prohibit both additional point and most non-point sources of pollution) in order to preserve fish, shellfish and recreational waters, and guarantee non-degradation. Examples include the Niantic River, Fisher's Island Sound and Mt. Sinai Harbor. In other high quality areas, the states may allow discharges only if the effluent is at least equal to that of the receiving water.

EPA should develop national guidelines on non-degradation to assist the states in their definitions and control strategies and to standardize the criteria for non-degradation.

Recommendation: Dredging policy. As part of their coastal zone management programs, New York and Connecticut should strengthen their present memorandum of understanding on dredging by assigning permanent dredge spoils disposal sites, establishing the quantity of dredge spoils to be dumped at these sites and, together with the Environmental Protection Agency, the U.S. Army Corps of Engineers and the National Ocean and Atmospheric Administration, establishing dumping procedures to lessen the environmental harm and monitoring programs to determine the long-term effects of these activities.

The Corps of Engineers should begin feasibility studies immediately on the use of solid waste and dredge spoils to build artificial islands in the Sound for recreation and other purposes.

Recommendation: Reduce oil pollution. To reduce the frequency and severity of spills from petroleum handling operations:

(a) Consolidate petroleum receiving facilities and operations in five ports -- New London, New Haven, Bridgeport, Port Jefferson and Northville -- to reduce the number of vessels and oil transfers and utilize improved equipment. Operations in all other locations, except for residual oil traffic would be phased out over an extended period.

(b) Develop offshore receiving terminals at New Haven and Port Jefferson by 1985 and Bridgeport by 1990, with submarine pipelines to shore.

(c) Encourage full use of existing pipelines for gasoline and distillate oil from New Haven to Chicopee, Massachusetts, and from Port Jefferson/Setauket south to Holtsville and west to Plainview. New "clean" product lines should also be built including" extension of the Holtsville-Plainview section east to Northville and west to mid-Nassau County by 1980; a second line from New Haven north to the Hartford area by 1990; and a new line from Bridgeport to the Bronx by 1995. In addition, two "hot lines" to carry residual oil from New Haven to Middletown and Bridgeport to Devon should be built by 1985.

Each of these measures should reduce the number of vessel trips and oil transfers required, particularly in the fragile enclosed bays and rivers in the region. Further details are included in Chapter 6.9, Marine Transportation.

(d) Enact Federal legislation to require licensing of all key crew members whose ships are used for hauling or pushing tank barges loaded with oil and/or other hazardous materials.

(e) Provide increased funds and staffing on both the Federal and state levels in order to implement and enforce existing legislation dealing with oil and other hazardous materials. Such legislation includes:

(1) Strict liability without fault of spiller for damages to any person and penalities up to $5,000 for each day that a violation continues;

(2) Continuous surveillance of oil spills by the Coast Guard.

(3) Coast Guard regulations which prohibit the discharge of oil bilge water from any vessel over 26 feet in length.

(f) The Coast Guard should establish sea lanes to the major ports in the Sound.

(g) States should require that spill containment equipment be available in each receiving ports.

Measures (d) through (g) should be implemented by 1977.

Recommendation: Non-point pollution control. The Environmental Protection Agency should continue to conduct research and demonstrations on non-point sources of pollution and their control. The states should identify, monitor, assess and predict the nature and extent of non-point source pollution, particularly in the most severely polluted waterbodies. By 1977, non-point source control should become a major program emphasis. The programs, using a combination of land use controls and land management practices to protect vulnerable waters and reduce runoff, erosion and sedimentation, should be tailored to local conditions.

Recommendation: Land fills and dumps. The States, through their respective ongoing solid waste recovery and management programs, should assure that the effects of dump and landfill leachates on the Sound are minimized by 1977. Open dumps and landfill operations on the shore should be terminated as soon as suitable alternative upland sites become available.

Recommendation: Vessel wastes. The Environmental Protection Agency and the Coast Guard should put into effect proposed standards and regulations require holding tanks on new vessels two years after regulations go into effect. On-board treatment devices are permitted on existing vessels if they are installed within the first three years. After five years, holding tanks will be required for all boats. Connecticut and New York must ensure that adequate pumpout and treatment facilities are available. A reasonable pumpout fee should be charged. Once implemented, The Coast Guard, states and local police patrols on the water should make spot checks in the same way they now inspect for required floatation devices.

9.2 Water Supply

Recommendation: Nassau County water needs. Nassau County should establish water conservation programs immediately, including more stringent emergency programs in case of drought. Measures such as leakage control programs, use of water saving devices, long-range and wide-spread education programs, revised water pricing with penalities for excessive consumption, and possibly an expansion of the presently practiced storm water recharge program ought to have measurable impact. During times of drought, more stringent restrictions on automobile and street washing and watering lawns could be imposed. Simultaneously, Nassau County, with State and EPA assistance, should vigorously pursue ground water recharge demonstration projects and follow-up programs to preserve both the quality and quantity of the ground water as its long-term supply source. Existing county sewering plans should be implemented as well. But importation of water from outside the county will also be required, at least during some drought years in the future.

Recommendation: Protect Upper Housatonic River. Connecticut, together with the U.S. Army Corps of Engineers and Environmental Protection Agency, working through the Corps' Urban Waters Study for the Housatonic River, should continue investigation of the feasibility of using the Housatonic River, Candlewood Lake and Lake Lillinonah complex as a major water supply source for southwestern Connecticut. Use of this project would be contrary to present State law which prohibits the taking of drinking water from any water body receiving wastes, treated or untreated. It might also conflict with intensive recreation use of these lakes and river. The potential magnitude of the project, however, necessitates an exhaustive study before dismissing the possibility. Use of this source would require: (1) a change in state law and policy; (2) improvement of water quality; and (3) resolution of legal problems in use of the reservoir and water rights for providing public water supply.

Recommendation: Regional systems. State and local governments should encourage development of regional water supply systems, where economically feasible, to provide greater flexibility and reliability in provision of water. Further interconnections between water systems should be constructed for the same reason.

Recommendation: Development of new and expanded supplies. State, regional and local planning agencies should adopt land use policies and regulations to protect and conserve potential new and expanded water supplies from unwise development.

9.3 Water quality and supply management

Recommendation: Areawide water management programs. Areawide approaches, linking groups of communities and industries, should be advanced by each state through establishment of areawide water management programs which could implement many of the recommendations in the water supply and quality program areas. Primary consideration for these districts should be given to the communities bordering the Thames River, New Haven and those communities bordering the Quinnipiac River, Greater Bridgeport area, Westchester communities, New York City, Nassau and Suffolk Counties.

Recommendation: Trend monitoring programs. The States and Interstate Sanitation Commission should initiate trend monitoring programs immediately to determine the cumulative pollution conditions throughout the Sound, stressing inorganic nutrients, organic pollutants, and trace elements, along with oceanographic factors that bear upon these. These programs would be useful to determine the flux of polluting conditions across critical boundaries of the Sound at Throg's Neck and the Race; in determining pollution abatement priorities as part of the water quality management programs; and in developing a long-range dredge and disposal program for the Sound.

Recommendation: Coordinate pollution clean-up schedule for Long Island Sound. The States and EPA, acting together and drawing on the area's professional and academic talent, should utilize the on-going "Continuing Planning Process" as a systems approach to coordinate water quality management decisions and pollution abatement priorities for Long Island Sound, and to insure the attainment of water quality objectives for the Sound.

10.0 FINAL RECOMMENDATIONS

The preceding recommendations have not necessarily been approved by the New England River Basins Commission. The FINAL RECOMMENDATIONS prepared by the New England River Basin Commission are to be found only in the final version of the Study's main report - to be published in the Spring of 1975.

APPENDIX A

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EVALUATION MATRIX

APPENDIX B

Symbols
- ++ Extremely beneficial
- + Beneficial effect
- 0 No significant effect
- − Adverse effect
- = Extremely adverse
- ← or → could be adverse or beneficial depending on other factors

	MUNICIPAL SOURCES					MUNICIPAL & INDUSTRIAL SOURCES										INDUSTRIAL SOURCES				VESSEL POLLUTION		
	SEWERING		TREATMENT PLANTS			EFFLUENT DISPOSAL					SLUDGE DISPOSAL					INDUSTRIAL TREATMENT				OIL	WASTE	
	Do nothing	Planned development	Less than secondary	Secondary	BPT	LIS disposal	River disposal	Embayment disposal	Land disposal	Direct use	Soil conditioning	Landfill	Incinerate	Wet Oxidation	LIS Disposal	BPT	BAT	Joint treatment	In-Process changes	Recycling devices on outboards	Holding tanks	Onboard treatment
1 I. ENVIRONMENTAL																						
2 A. NATURAL BEAUTY	0	+	−	+	++	+	0	0	0	+	+	−	+	+	0	+	++	+	+	+	+	+
3 B. ECOLOGICAL SYSTEMS																						
1. TERRESTRIAL																						
a. PLANTS	−	+	−	+	+	0	0	0	+	0	+	−	0	0	0	0	0	0	0	0	0	0
b. ANIMALS	−	+	−	+	+	0	0	0	−	0	+	−	0	0	0	0	0	0	0	0	0	0
2. AQUATIC																						
a. PLANTS	0	0	−	+	++	0	−	−	0	+	0	0	0	0	−	+	++	+	+	+	+	+
b. ANIMALS																						
1) ANADROMOUS	0	0	−	+	++	0	←	←	0	0	0	0	0	0	−	+	++	+	+	+	+	+
2) RESIDENT																						
a) COLD WATER	−	0	−	+	++	0	←	←	0	0	0	0	0	0	−	+	++	+	+	+	+	+
b) WARM WATER	−	0	−	+	++	0	←	←	0	0	0	0	0	0	−	+	++	+	+	+	+	+
C. VULNERABLE ENVIRONMENTAL FEATURES	−	+	−	+	+	+	+	+	0	0	0	0	0	0	−	+	+	+	+	+	+	+
4 D. SCARCE RESOURCES	−	+	−	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E. WATER QUALITY																						
1. GROUND WATER	−	+	0	+	+	+	+	+	←	++	−	−	0	0	0	0	0	0	0	0	0	0
2. SURFACE WATER	−	0	=	+	++	−	−	−	+	+	0	0	+	+	−	+	++	+	+	+	+	+
3. FLOW	0	0	0	0	0	0	+	+	0	0	0	0	0	0	0	0	0	0	+	0	0	0
4. SALINITY	0	0	0	0	0	−	←	+	+	+	0	0	0	0	0	0	0	0	0	0	0	0
F. AIR QUALITY	0	+	0	0	0	0	0	0	0	0	0	0	−	−	0	0	0	0	0	0	0	0
G. EROSION & SEDIMENT	0	+	0	0	0	0	0	0	←	+	+	0	0	0	0	0	0	0	0	0	0	0
5 H. IRREVERSIBLE COMMITMENTS	0	+	0	0	+	0	0	0	0	0	0	−	0	0	0	0	0	0	+	0	0	0
6 I. SUMMARY ENVIRONMENTAL RATING	P	G	P	G	G	FG	FG	FG	FG	G	FG	F	FG	FG	P	G	G	G	G	G	G	G
II. ECONOMIC																						
7 A. COSTS																						
1. FIRST COST	+	0	+	0	−0	−	+	+	−	−	0	+	−	−	+	+	−	+	+	+	−	−
2. ANNUAL COSTS	+	+	+	+	−0	+	+	+	0	−	0	+	0	0	+	+	0	+	+	+	+	0
8 3. EXTERNAL COSTS	−	+	−	+	+	0	−	0	+	+	+	0	+	+	−	+	+	+	+	+	+	+
9 B. VALUE OF GOODS AND SERVICES																						
1. WATER SUPPLY	−	0	−	+	+	0	0	0	+	++	←	−	+	+	0	+	+	+	+	0	0	0
2. RECREATION	−	+	−	+	+	0	0−	0−	+	+	0	0	0	0	−	+	+	+	+	+	+	+
3. NAVIGATION	0	0	0	0	0	0	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4. COMMERCIAL FISHING	0	0	−	+	+	−	→	→	0	0	0	0	0	0	−	+	+	+	0	0	+	+
C. JOBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	−	0	0	0	0	0
10 D. ECONOMIC BASE & STABILITY	−	+	0	0	0	0	0	0	0	0	0	+	0	0	0	0	−	0	+	0	0	0
11 E. RESOURCES REQUIRED OR DISPLACED BY PLAN	0	−	0	−	−	0	+	+	−	−	0	0	−	−	0	−	−	−	+	0	0	0
F. SUMMARY OF ECONOMIC RATING	F	G	F	G	F	FG	G	G	F	P	F	FG	FG	FG	FG	G	FP	G	G	G	FG	FG
12 III. SOCIAL WELL-BEING																						
A. DISLOCATIONS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B. LIFE, HEALTH AND SAFETY																						
1. DROUGHTS AND DISASTERS	0	0	0	0	0	0	+	0	+	+	0	0	0	0	0	0	0	0	+	0	0	0
2. PHYSIOLOGICAL HEALTH	−	+	−	+	+	0	0−	0−	0−	0−	0	0	0	0	−	+	+	+	0	0	+	+
3. PSYCHOLOGICAL HEALTH	0	+	−	+	+	0	0	−	−	=	−	0	0	0	−	+	+	+	0	0	+	+
C. EDUCATIONAL, CULTURAL OPPORTUNITIES	−	+	−	+	+	0	0−	0−	+	0	0	+	0	0	0	+	+	+	+	0	+	+
D. EMERGENCY PREPAREDNESS																						
1. FLEXIBLE WATER SUPPLIES	−	0	−	0	0	0	−	0	+	+	0	−	+	+	0	0	0	0	+	0	0	0
2. OTHER (POWER, WATER-TRANSPORT)	0	0	0	0	0	0	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E. SUMMARY OF SOCIAL RATING	P	G	P	G	G	F	F	F	G	F	F	F	FG	FG	F	G	G	G	G	F	G	G
IV. LEGAL, INSTITUTIONAL, POLITICAL																						
A. EASE OF ADMINISTERING	+	−	+	+	+	+	+	+	0	0	0	0	0	0	0	+	0	0	+	−	−	−
13 B. JUDICIAL INVOLVEMENT	0	−	+	+	−	+	+	+	0	−	0	0	0	+	−	0	−	−	+	0	−	−
C. INTERMUNICIPAL AGREEMENTS	+	0	+	+	0	+	+	+	−	0	0	0	+	+	+	+	+	0	+	+	+	+
D. PREFERABILITY OF NON-FEDERAL ACTION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E. YEARS TO IMPLEMENT																						
F. SUMMARY OF LEGAL, ETC. RATING	FG	F	G	G	FP	G	G	G	F	FP	F	F	FG	G	F	G	F	F	G	F	F	F
V. ABILITY TO MEET OTHER NEEDS																						
A. LAND USE	0	+	0	0	0	0	0	0	+	0	0	0	0	0	0	0	0	0	0	0	0	0
B. SHORELINE APPEARANCE AND DESIGN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C. EROSION AND SEDIMENTATION	0	+	0	0	0	0	0	0	←	0	+	0−	0	0	0	0	0	0	0	0	0	0
D. FLOOD DAMAGE REDUCTION	0	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E. RECREATION	0	+	−	+	+	0	0−	0−	+	+	0	0	0	0	0	+	+	+	0	+	+	+
F. FISH AND WILDLIFE	0	0	−	+	+	0	−0	−0	+	+	0	0	0	0	0	+	+	+	0	0	+	+
G. TRANSPORTATION	0	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H. MINERALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I. POWER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	←	0	0	0	0	0
16 VI. APPLICABILITY TO OBJECTIVES		N+E		N+E	P− EQ	P− EQ	P− ND	P− ND	P− EQ	O− EQ	P− EQ	P− ND	N+ E	N+ E	O− ND	N+E	N+E	N+E	N+E	N+E	P− EQ	P− EQ

EVALUATION MATRIX

Symbols
- ++ Extremely beneficial
- \+ Beneficial effect
- 0 No significant effect
- \- Adverse effect
- = Extremely adverse
- +- or -+ could be adverse or beneficial depending on other factors

	Notes		COMBINED SEWERS CONTROL							NON-POINT SOURCES: LAND USE CONTROLS			LAND MANAGEMENT PRACTICES					DREDGING & SPOIL DISPOSAL					
	Notes	Do nothing	Separation	Regulator Maintenance	Improved Regulators	Computerized control	Control Infil./in flow	Treatment	Storage	Guide growth	Protect critical areas	Critical use siting	Street cleaning	Erosion & Sed. controls	Porous pavement	Min. use of salts fertilizer & pest.	Abate animal waste run.	No dredging	Treatment of spoil	Open water disposal	Land disposal	Incineration	Creation of artificial habitats
I. ENVIRONMENTAL	1																						
A. NATURAL BEAUTY	2	-	0	+	+	+	+	+	+	+	++	+	+	+	+	+	+	0	0	-	-0	0	+
B. ECOLOGICAL SYSTEMS	3																						
1. TERRESTRIAL																							
a. PLANTS		0	0	0	0	0	0	0	-0	+	++	+	0	+	+	+-	+	0	0	0	-	0	+
b. ANIMALS		0	0	0	0	0	0	0	-0	+	++	+	0	0	0	0	0	0	0	0	-	0	+
2. AQUATIC																							
a. PLANTS		-	0	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+-
b. ANIMALS																							
1) ANADROMOUS		0	0	+	+	+	+	+	+	0	+	+	+	+	+	+	+	0	0	0	0	0	+
2) RESIDENT																							
a) COLD WATER		0	0	+	+	+	+	+	+	0	+	+	+	+	+	+	+	+	+	-	+	+	-+
b) WARM WATER		0	0	+	+	+	+	+	+	0	+	+	+	+	+	+	+	+	+	-	+	+	-+
C. VULNERABLE ENVIRONMENTAL FEATURES		-	+	0	+	+	+	+	+	+	+	+	0	0	0	0	0	0	0	-0	-	0	0
D. SCARCE RESOURCES	4	0	0	0	0	0	0	0	0	+	+	+	0	0	0	0	0	0	0	0	0	0	+
E. WATER QUALITY																							
1. GROUND WATER		0	0	0	0	0	+	0	0	+	+	0	0	0	+-	+	+	0	0	0	-0	0	0
2. SURFACE WATER		-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-0	+	+	+
3. FLOW		0	0	0	0	0	+	0	0	+	+	0	0	0	+	0	0	0	0	0	0	0	0
4. SALINITY		0	0	0	0	0	0	0	0	0	+	0	0	0	+	+	0	0	0	0	0	0	0
F. AIR QUALITY		0	0	0	0	0	0	0	0	+	+	0	0	0	0	0	C	0	0	0	0	-	0
G. EROSION & SEDIMENT		0	0	0	0	0	0	0	0	++	++	+	+	++	+	0	+	0	0	0	0	0	0
H. IRREVERSIBLE COMMITMENTS	5	0	-	+	0	0	0	0	0	+	++	0	0	0	0	0	0	0	0	0	-	-	0
I. SUMMARY ENVIRONMENTAL RATING	6	P	FG	FG	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	F	FG	FG	G
II. ECONOMIC																							
A. COSTS	7																						
1. FIRST COST		+	=	+	-	-	-	-	-	+	-	0	-	-	-	+	0	+	-	0	-	-	=
2. ANNUAL COSTS		+	0	0	0	-	0	-	0	+	+	0	0	0	+	+	+	+	0	0	0	-	0
3. EXTERNAL COSTS	8	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	0	-	0	0	+
B. VALUE OF GOODS AND SERVICES	9																						
1. WATER SUPPLY		-	0	+0	+0	+0	+0	+0	+0	+	+	+	+	+	+	+	+	0	0	0	0-	0	0
2. RECREATION		-	+	+	+	+	+	+	+	++	++	+	0	+	0	0	0	0	0	0	0	0	0+
3. NAVIGATION		0	0	0	0	0	0	0	0	-0	0	0	0	0	0	0	0	=	0	0	0	0	0-
4. COMMERCIAL FISHING		-	+	+	+	+	+	+	+	0	+	0	0	+	0	0	0	+	+	-	+	+	+-
C. JOBS		0	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D. ECONOMIC BASE & STABILITY	10	0	0	0	0	0	0-	0	0	+	0	0	0	0	0	0	0	=	0	+	0	0	0
E. RESOURCES REQUIRED OR DISPLACED BY PLAN	11	+	=	0	0	-	0	-	-	+	0	0	0	0	0	0	0	0	0	0	0	0	0
F. SUMMARY OF ECONOMIC RATING		F	PF	FG	FG	F	FG	F	F	G	G	FG	FG	G	F	G	G	P	F	G	F	F	FP
III. SOCIAL WELL-BEING																							
A. DISLOCATIONS	12	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B. LIFE, HEALTH AND SAFETY																							
1. DROUGHTS AND DISASTERS		0	0	0	0	0	0	0	0	+	+	0	0	0	+	0	0	0	0	0	0	0	0
2. PHYSIOLOGICAL HEALTH		-	+	+	+	+	+	+	+	0	+	0	+	0	0	+	+	0	0	0	-	0	0
3. PSYCHOLOGICAL HEALTH		-	0	0	0	0	0	0	0	0	+	+	+	0	0	0	0	0	0	0	0	0	0
C. EDUCATIONAL, CULTURAL OPPORTUNITIES		-	+	+	+	+	+	+	+	++	++	+	0	0	0	0	0	0	0	0	0	0	+
D. EMERGENCY PREPAREDNESS																							
1. FLEXIBLE WATER SUPPLIES		-	0	+	+	+	+	+	+	0	+	0	+	+	+	+	+	0	0	0	-0	0	0
2. OTHER (POWER, WATER-TRANSPORT)		0	0	0	0	0	0	0	0	+	0	0	0	0	0	0	0	=	0	0	0	0	0
E. SUMMARY OF SOCIAL RATING		P	FP	G	G	G	G	G	G	G	G	G	G	FG	FG	FG	FG	FP	F	F	F	F	FG
IV. LEGAL, INSTITUTIONAL, POLITICAL	13																						
A. EASE OF ADMINISTERING		+	=	0	0	-	0	0	0	0	0	-	0	0	0	-	-	+	0	0	0	0	0
B. JUDICIAL INVOLVEMENT		+	+	+	+	+	+	+	+	-	-	-	+	+	+	0	0	0	0	-	0	0	-
C. INTERMUNICIPAL AGREEMENTS		+	+	+	+	+	+	+	+	-	0	0	+	+	+	+	+	0	0	0	0-	0	0-
D. PREFERABILITY OF NON-FEDERAL ACTION	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E. YEARS TO IMPLEMENT																							
F. SUMMARY OF LEGAL, ETC. RATING		G	FP	FG	FG	F	FG	FG	FG	FP	F	FP	FG	FG	FG	F	F	FG	F	F	F	F	F
V. ABILITY TO MEET OTHER NEEDS	15																						
A. LAND USE		0	0	0	0	0	0	0	0	+	+	+	0	0	0	0	0	0	0	0	0	0	+
B. AESTHETIC APPEARANCE AND DESIGN		0	0	0	0	0	0	0	0	0	+	+	0	0	0	0	0	0	0	0	-0	0	+
C. EROSION AND SEDIMENTATION		0	0	0	0	0	0	0	+	+	+	0	0	+	+	0	0	0	0	0	0	0	0
D. FLOOD DAMAGE REDUCTION		0	0	0	0	+	0	0	+	+	+	0	0	0	+	0	0	0	0	0	0	0	0
E. RECREATION		-	+	+	+	+	+	+	+	+	+	+	+	+	0	+	+	0	0	0	0	0	0
F. FISH AND WILDLIFE		-	+	+	+	+	+	+	+	+	+	+	+	+	0	+	+	+	+	+	+-	+	+
G. TRANSPORTATION		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0-
H. MINERALS		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I. POWER		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VI. [illegible]	16		0- EQ	0- EQ	0- EQ	0- EQ	0- EQ	0- EQ	0- EQ	ND EQ	ND EQ	ND EQ	ND EQ	ND EQ	P- EQ	ND EQ	ND EQ	0- EQ	P- EQ	P- EQ	P- EQ	P- EQ	P- EQ

* WATER SUPPLY EVALUATION MATRIX

	LISS Region Water Development						Other Water Development				Water Conservation			Do Not Meet the Needs	Footnotes
	Surface Water			Ground Water											
	Reservoirs	Stream Diversion	Treatment or Pumping Facilities	Develop Safe Yield	Mine G. W.	Recharge	Import Water to LISS Region	Interconnection of Systems	Desalination	Direct Reuse of Treated Waste-Water	Pricing	Plumbing Controls	Zoning		
I. ENVIRONMENTAL															
A. Natural Beauty	+	0	0	+	-	+	+	+	+	+	+	+	+	0	
B. Ecological Systems															
1. Terrestrial															
a. Plants	=	+	0	0	-	0	0	0	0	0	0	0	+	+	
b. Animals	=	+	0	0	-	0	0	0	0	0	0	0	+	+	
2. Aquatic															
a. Plants	++	0	0	0	-	+	+	0	0	0	0	0	0	0	
b. Animals															
1) Anadromous	-	0	0	0	-	+	+	0	0	0	0	0	0	0	
2) Resident	+	0	0	0	-	+	+	0	0	0	0	0	0	0	
C. Unique or Vunerable Environmental Features															
D. Scarce Resources	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
E. Water Quality	+	+	++	+	-	-	0	0	0	0	+	+	+	0	
F. Air Quality	0	0	0	0	0	0	0	0	0	0*	0	0	0	0	
G. Erosion & Sediment	0	++	0	0	0	0	0	0	0	0	0	0	0	0	
H. Irreversible Commitments	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
I. Summary Env. Rating	F-G	G	F-G	G	P	G	G	F	P	F	F-G	F-G	G	G	
II. ECONOMIC															
A. Costs															
1. First Costs	-	-	-	+	+	-	-	-	=	=	+	+	+	0	
2. Annual Costs	+	+	+	+	+	+	0	+	-	-	+	+	+	0	
3. External Costs	+	+	+	+	-	+	+	+	-	-	-	-	-	-	
B. Value of Goods & Services															
1. Recreation	+	0	+	0	-	+	0	0	0	0	0	0	0	0	
2. Navigation	-	0	0	0	-	0	0	0	0	0	0	0	0	0	
C. Summary Econ. Rating	F-G	F-G	F-G	G	F	G	F	F	P	P	F-G	F-G	F-G	F	
III. SOCIAL WELL-BEING															
A. Life Health & Safety	+	+	+	+	-	+	+	+	+	+	+	+	+	-	
B. Educational, Cultural & Recreational	++	0	+	0	-	+	+	0	+	0	0	0	0	0	
C. Emergency Preparedness															
1. Energy Conservation	+	+	-	0	0	0	0	0	-	-	+	+	+	0	
2. Other	+	-	+	+	+	+	+	+	++	+	+	+	+	-	
D. Ability to Meet Other Needs															
1. Land Use	+/=	0	+	0	-	+	+	+	+	+	+	+	+	-	
2. Water Quality	+	+	++	+	-	0	+	0	0	0	0	0	0	0	
3. Shoreline Appearance	0	0	0	0	-	0	0	0	-	0	0	0	0	0	
4. Erosion & Sedimentation	0	+	0	0	0	0	0	0	0	0	0	0	0	0	
5. Flood Damage Reduction	+	+	0	0	0	0	0	0	0	0	0	0	0	0	
6. Recreation	++	0	+	0	-	+	0	0	0	0	0	0	0	0	
7. Fish & Wildlife	+	0	0	0	-	+	0	0	0	0	0	0	0	0	
8. Transportation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
9. Minerals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
10. Power	+	+	0	0	0	0	0	0	-	0	0	0	0	0	
E. Legal-Judicial Involvement	=	-	0	0	0	0	=	-	0	-	-	-	=	0	
F. Institutional															
1. Agency Primarily Responsible	V	S-L	S-L	S-L	S-L	S-L	FD-S	S-L	F-L	S-L	S-L	S-L	L	None	
2. Ease of Administrating	=	=	-	0	0	-	=	-	-	=	-	-	=	0	
G. Political															
1. Ease of Creating Institutions	-	-	0	0	0	0	=	0	0	0	0	0	0	0	
2. Ease of Passing Laws	-	-	0	0	0	0	=	0	0	0	0	0	-	0	
H. Other															
1. Environmental Attractiveness	++	0	0	0	0	-	+	0	0	0	0	0	0	0	
2. Years to Implement	5-10	0-5	0-5	0-2	0	5-10	5-10	0	>10	>10	0-2	>10	>10	0	
I. Summary Social Rating	G	F	G	G	P	G	F	F	F	F	F-G	F-G	F-G	P	

G - Good
F - Fair
P - Poor

V - Various
S - State
L - Local
FD - Federal

NOTES

1. For a clarification of alternative measures, see Table 28 in the section on Alternatives.

2. Natural beauty benefits result from the protection, enhancement, or creation of open and green space, wild and scenic rivers, lakes, beaches, shores, mountain and wilderness areas, estuaries, or other areas of natural beauty.

3. Benefits to an ecological system reflect broad judgements as to the most likely overall long-term and widespread effects on the system under consideration. For example, an entry of "+" opposite warm water resident aquatic animals (e.g., pickerel) means that (1) considering the overall consequences (in land, water and air quality; habitat; human uses; etc.), (2) the net effects (benefits less adversities) will probably be beneficial (a) over the long term once the immediate effects fade away), and (b) over all or most of the watershed. Many ecologists would understandably caution against making judgements as to net effects. They would prefer to estimate only the impacts listed elsewhere in the table (e.g., improved water quality, decreased human activities). They would refrain from estimating the effects of these impacts on any biological system as being beyond the current state of the art or as apt to mislead. To reinforce their point, they would explain for example, that what would probably be "beneficial" to one warm water species might be adverse to another. Even for the same species, they could point out that an apparently beneficial change (e.g., in deet habitat) could produce overpopulation and eventual mass starvation without management (.e.g., periodic thinning of the herds). Agreeing with these comments, we nevertheless have chosen to estimate net effects. To suspend judgements on these effects, however scientifically defensible, is not useful to those who must conscientiously weigh all major considerations before making decisions. Decisions to act or not to act can be avoided. They must be made using best available judgements on effects.

4. Scarce resources include archeological, historical, biological and geological. Any alternative which preserves these resources is considered to be beneficial.

5. Irreversible commitments of resources. Beneficial effects result from the preservation of freedom of choice to future resource users by actions that minimize or avoid irreversible or irretrievable effects.

6. Summary ratings for environmental, economical, social and legal, political, institutional criteria are expressed as GOOD, FAIR and POOR depending upon the preponderance of other relevant entries in the table. In some cases certain criteria were given more weight than others. For example, under economic factors, high costs outweighed small benefits to goods and services. It should be noted that almost every GOOD (POOR) summary rating was awarded despite one or a few adverse (beneficial) entries. Rarely is any situation all good or bad.

7. High costs are rated poorly; low costs are beneficial. Quantification of costs appears in Table 29.

8. External costs are assumed to be costs due to external diseconomies (adverse effects not reflect in market prices of project inputs). When external costs are high for a program, it gets an adverse rating.

9. Value of goods and services. An increase in the value of any goods or services is a beneficial effect.

10. Economic Base and Stability. A plan which diversified the region's economic base is beneficial. Beneficial effects include contributions to: (1) balanced local and regional economies; (2) regularizing market activity and employment fluctuations; (3) offsetting effects of climatic vagaries and accompanying uncertainties; and (4) reversal in decline of community growth.

11. Resources required or displaced. In situations where a physical structure is necessary to obtain the desired objective, the adverse effects on NED include all explicit cash expenditures for goods and services necessary to construct and operate a project throughout the period of analysis. Other adverse effects may result from certain resources being released and subsequently unemployed due to the implementation of the plan. When non-structural measures are being evaluated, adverse effects include payments to purchase easements or rights-of-ways and costs incurred for management arrangements or to implement and enforce necessary zoning.

12. Dislocations. Adverse effects in this category include any significant, but temporary disruptions in the community. Any long term disruptions or dislocations will be evaluated as extremely adverse (=).

13. Legal, Institutional, Political. A plus (+) indicates that there will probably be little or no trouble in implementing the plan. A minus (-) signifies substantial difficulties. A zero (0) indicates that there may be some minor problems.

14. If Federal action is recommended and non-Federal action is more likely and more effective, a "=" is entered. Otherwise the entry is "0".

15. Listed here are the subjects addressed in the 10 LISS planning reports. An entry reflects a judgement as to whether the net effects of an alternative program will complement (+) or conflict (-) with the listed planning report.

16. Hardly any project or program can be classified as completely oriented toward EQ or toward NED. Furthermore, almost every alternative can be adapted to minimize its adverse effects on an apparently incompatible objective. For the purpose of subsequent plan formulation, however, some meaningful categorization is very desirable here. Six entries were used to reflect this categorization:

    Only EQ - important for EQ reasons, dispite significant economic objections.

    Pref. EQ - preferable for EQ reasons, no significant economic objections or preferences.

    Pref. NED - preferable for NED reasons, no significant environmental objections.

    Only SW - Not particularly desirable or objectionable for environmental or economic reasons, preferable only for reasons of social well being.

    NED, EQ - equally important for both plans.

APPENDIX C

PLANNED PROJECTS FOR CONNECTICUT

Proposed Projects by Town and Subregion	Phase I 1974-1977 NED Goals	Cost in Millions	Phase II 1977-1990 EQ Goals	Cost in Millions
I. Water Quality	Analyses performed as part of following Basin Plans: Housatonic River Basin (9/74) Connecticut River Basin (12/74) Eastern Connecticut Coastal(3/75) (Niantic) Western Connecticut Coastal(6/75) Central Connecticut Coastal(9/75) Thames River Basin (12/75) Eastern Connecticut Coastal(2/76) (Mystic)			
II. Municipal Sources				
Subregion I				
Preston	Norwich State Hospital to tie into Norwich System			
North Stonington			Interceptor to Pawcatuck treatment plant	.5
Ledyard			Possible secondary treatment plant	1.5
New London	Upgrade to secondary	8.5	Extend sewer service area	
Waterford	Convey wastes to New London	9.1	Extend sewer service	
Montville	New secondary treatment plant already funded	7.2	Extend sewer service	

PLANNED PROJECTS FOR CONNECTICUT (Con'd)

Proposed Projects by Town and Subregion	Phase I 1974-1977 NED Goals	Cost in Millions	Phase II 1977-1990 EQ Goals	Cost in Millions
Groton (Town)			Expanded sewer service	
East Lyme			Sewer coastal area to regional treatment plant	1
Norwich	Upgrade to secondary expand sewer service - Laurel-Hill interceptor	17.5		
Colchester	Interceptors to East Hampton	5.4	Expand sewer service	
Sprague			Expand treatment plant	
Griswold			Expand Jewett City treatment plant	
Stongton	New secondary plant New secondary plant	1.86 3.7		
Subregion II				
Deep River	Interceptor to Chester	.176		
Chester	Treatment plant interceptors	1.8		
Clinton			Regional treatment plant $2 million	
Westbrook			Sewer service & connection to regional plant	1.5
Old Saybrook			Regional plant and sewers	2

APPENDIX C

PLANNED PROJECTS FOR CONNECTICUT (Con'd)

Proposed Projects by Town and Subregion	Phase I 1974-1977 NED Goals	Cost in Millions	Phase II 1977-1990 EQ Goals	Cost in Millions
Essex			Sewers & connection to regional plant	1.5
Old Lyme			Sewers and connection to regional plant	1.5
Madison			Possible joint treatment with Clinton	
<u>Subregion III</u>				
Branford			Expand treatment plant correct infiltration inflow	.8
			Sewer extension	11.1
North Branford	Interceptors to Branford, North Haven and East Haven	3.6		
Guilford	Secondary treatment plant and interceptors	3.0		
Milford			Expand treatment plant expand sewer service areas	5.5
Orange			Tie into Milford	1.28
Meriden	New interceptor	1.5	Possible upgrading to Advanced treatment	9.0
New Haven	Upgrade East Shore plant, Boulevard plant, and East Street Plant	92.9		
East Haven			Interceptor	1.8
North Haven	Interceptor to North Branford	5.6	Possible advanced treatment	2.5

APPENDIX C

PLANNED PROJECTS FOR CONNECTICUT (Con'd)

Proposed Projects by Town and Subregion	Phase I 1974-1977 NED Goals	Cost in Millions	Phase II 1977-1990 EQ Goals	Cost in Millions
Wallingford			Possible advanced treatment	2.5
West Haven			Interceptor along Oyster River $2.4 million	
Ansonia	Hilltop area. Interceptor Sludge handling facilities	.8		
Seymour			Sewer areas near Seymour Center	
Shelton	Laurel Heights Interceptors Upgrade to secondary and Sewer Routes	.8 3.6	Far Mill River interceptor	1
Derby	Upgrade to secondary		Interceptor	1.8
Subregion IV				
Trumbull	Interceptor extensions	$3.0		
Easton			Tie into Bridgeport's West Side plant	
Fairfield			Northeast section interceptor	$1.0
Stratford			Interceptors	$10.7
Subregion V				
Greenwich			Byram Shore Interceptor	$1.0
Stamford	Secondary plant already funded.			
Darien	Interceptor to Stamford	$4.4		

APPENDIX C

PLANNED PROJECTS FOR CONNECTICUT (Con'd)

Proposed Projects by Town and Subregion	Phase I 1974-1977 NED Goals	Cost in Millions	Phase II 1977-1990 EQ Goals	Cost in Millions
New Canaan			New secondary plant I/I analysis	$2.0 $0.4
Norwalk	Supplemental treatment plant interceptors	$12.4		
West_ort			Eastern sector interceptor	$4.5
Wilton	Norwalk River interceptor	$2.4		
III Combined Sewers				
Subregion I				
Norwich	Step I study		Correction of combined sewers	$40.0
Griswold - Jewett City			Separation	$0.2
Subregion III				
New Haven	Step I study		Correction of overflows	$60.0
Shelton			Separation	$ 1.0
Seymour			Separation	
Subregion IV				
Bridgeport	Step I study		Correction of overflows	$66.0
Subregion V				
Norwalk	Supplemental treatment	$12		
				$1.0

PLANNED PROJECTS FOR CONNECTICUT (Con'd)

Proposed Projects by Town and Subregion	Phase I 1974-1977 NED Goals	Cost in Millions	Phase II 1977-1990 EQ Goals	Cost in Millions
IV <u>Major Industrial Sources</u>	Major industrial dischargers not listed are in general compliance with Connecticut's industrial permits			
<u>Subregion I</u>				
Robertson Paper Box	Tie into Montville system by 12/75			
Federal Paper Board	BPT to be completed 9/75			
Pfizer - Groton	Partial BPT by 12/74		BAT	
American Velvet	Joint treatment with Stonington 9/75			
King-Sealey Thermos	Joint treatment with Norwich 12/75			
Electric Boat	Joint treatment with Groton 3/75			
<u>Subregion II</u>				
R. Donnelly & Sons	BPT by 12/75		BAT	
<u>Subregion III</u>				
Atlantic Wire Company	BPT 12/75		BAT	
Wallingford Steel	BPT 12/75		BAT	
Marlin Fire Arms Co.	NPDES permit issued			
Upjohn Co.	BPT 12/75		BAT	
Federal Paper Board	Going out of business			
United Illuminating (2 plants)	Joint treatment with New Haven			

APPENDIX C

PLANNED PROJECTS FOR CONNECTICUT (Con'd)

Proposed Projects by Town and Subregion	Phase I 1974-1977 NED Goals		Cost in Millions	Phase II 1977-1990 EQ Goals	Cost in Millions
Hull Dye and Print Works	Joint treatment with Derby	6/75			
Simkins Industries	Joint treatment with New Haven				
<u>Subregion IV</u>					
B.F. Goodrich	Joint treatment with Shelton	7/75			
Hull Dye and Print Works	Joint treatment with Derby				
USM Corporation	BPT	12/74		BAT	
Chromium Process	BPT	12/74		BAT	
Contract Plating	BPT			BAT	
AVCO Lycoming	BPT	3/74		BAT	
Chemical Plating	BPT	6/74		BAT	
Remington Electric	BPT			BAT	
Bridgeport Rolling Mills	BPT	12/74		BAT	
Subregion V					

PLANNED PROJECTS FOR CONNECTICUT (Con'd)

Proposed Projects by Town and Subregion	Phase I 1974-1977 NED Goals	Cost in Millions	Phase II 1977-1990 EQ Goals	Cost in Millions
V. Non-point Sources				
Montville	Major solid waste recovery center			
Clinton	Control leachate from landfills			
Madison Chester Essex Westbrook Old Saybrook Deep River			Abate pollution from these landfills	
North Branford			Abate runoff pollution controlled residue site	
Meriden			Controlled residue site	
North Haven			Controlled residue site	
Hamden			Abate runoff pollution	
Woodbridge			Controlled residue site	
West Haven			Abate runoff pollution	
Wallingford			" " "	
New Haven			Major solid waste recovery center	
Milford			Abate runoff pollution	
Berlin			Major solid waste recovery	
Bridgeport			Major recovery center	

APPENDIX C

PLANNED PROJECTS FOR CONNECTICUT

Proposed Projects by Town and Subregion	Phase I 1974-1977 NED Goals	Cost in Millions	Phase II 1977-1990 EQ Goals	Cost in Millions
Ansonia			Major recovery center	
Derby			Controlled residue site	
Wilton New Canaan Darien Weston Greenwich			Abate pollution from these landfills	

APPENDIX C

PROPOSED CONNECTICUT WATER SUPPLY PROJECTS

Project Location, Community	Project	Quantity of Water Provided (MGD), Period Required, and Estimated Cost (Million $)		Focal Point for Development
	Subregion 1	1974-1990	1990-2020	
Bozrah Colchester East Lyme Franklin Griswold Lisbon N. Stonington Salem Sprague Stonington Voluntown	Groundwater Development	8.5 MGD $ 5.0 MIL	10.0 MGD $ 6.0 MIL	Municipal Water Systems or Southeastern Connecticut Water Authority
Ledyard	Joe Clark Brook Reservoir and Shewville Brook Diversion	9.5 MGD $ 8.3 MIL		Southeastern Connecticut Water Authority

PROPOSED CONNECTICUT WATER SUPPLY PROJECTS

APPENDIX C

Project Location, Community	Project	Quantity of Water Provided (MGD), Period Required, and Estimated Cost (Million $)		Focal Point for Development
	Subregion 2	1974-1990	1990-2020	
Chester Clinton Deep River Essex Lyme Old Lyme	Groundwater Development	1.0 MGD $ 0.6 MIL	6.0 MGD $ 3.6 MIL	Municipal Water Systems or Regional Water System such as: Connecticut Water Company.
Killingworth	Killingworth Reservoir Enlargement	3.8 MGD $ 8.0 MIL		Regional Water System such as: Connecticut Water Company
Chester	Wilcox Reservoir Enlargement	0.8 MGD $ 2.2 MIL		
	Subregion 3			
Cheshire Guilford Meriden North Haven Wallingford	Groundwater Development	4.0 MGD $ 1.2 MIL	10.0 MGD $ 6.0 MIL	Municipal Water System or Regional Water System such as: New Haven Water Company or Connecticut Water Company

PROPOSED CONNECTICUT WATER SUPPLY PROJECTS

APPENDIX C

Project Location, Community	Project	Quantity of Water Provided (MGD), Period Required, and Estimated Cost (Million $)		Focal Point for Development
	Subregion 3 (cont.)	1974-1990	1990-2020	
Hamden	Lake Whitney Rapid Sand Filtration Plant	15.0 MGD $12.0 MIL		New Haven Water Company
North Branford	Lake Gaillard Pumping Station	6 MGD $ 0.8 MIL		New Haven Water Company
Wallingford	Coginchaug River Diversion		2.6 MGD $ 4.0 MIL	Municipal Water System
Wallingford	Parmalee Brook Reservoir		1.5 MGD $ 0.6 MIL	or
North Haven	Muddy River Diversion		4.2 MGD $ 0.35 MIL	Regional Water System such as: New Haven Water Company or Connecticut Water Company
Madison	Pond Meadow Brook Diversion		3.0 MGD $ 0.3 MIL	
	Subregion 4			
Fairfield	Groundwater Development	2.7 MGD $ 1.6 MIL		Bridgeport Hydraulic Company
Bethany	Hopp Brook Reservoir	1.6 MGD $ 0.4 MIL		Municipal Water System

PROPOSED CONNECTICUT WATER SUPPLY PROJECTS

Project Location, Community	Project	Quantity of Water Provided (MGD), Period Required, and Estimated Cost (Million $)		Focal Point for Development
	Subregion 4 (cont.)	1974-1990	1990-2020	
Trumbull	Poquonock River		9 MGD $ 10 MIL	Regional Water System such as: Bridgeport Hydraulic Company
Darien Stamford Westport	Groundwater Development	10.6 MGD $ 6.4 MIL		Municipal Water System or Regional Water System such as: Bridgeport Hydraulic Company
Wilton	Norwalk River Diversion	3.2 MGD $ 3.2 MIL		Municipal Water System or Regional Water System such as: Bridgeport Hydraulic Company
New Canaan	Siscowit Reservoir			
Wilton	Comstock Brook Reservoir			Municipal Water System or Regional Water System such as: Bridgeport Hydraulic Company
Stamford	Mianus Reservoir	5.7 MGD $ 4.5 MIL		
New Milford	West Aspetuck Reservoir		Variable	Regional Water System
Southbury	Shepaug River Diversion		Variable	Regional Water System
	Housatonic River Diversion (presently not recommended)		160 MGD 80 MIL	Regional Water System

APPENDIX C

Proposed Projects by Town and Subregion	Phase I 1974-1977 NED Goals	Cost in Millions	Phase II 1977-1990 EQ Goals	Cost in Millions
I. Water Quality Analyses				
Subregion VI	Analyses preformed as part of basin plan for Long Island Sound (10/74)		Western Long Island Sound cultural study	
Subregions VII, VIII & IX	Analyses preformed as part of basin plan for Long Island Sound (10/74)		Long Island groundwater	
II. Municipal Sources Subregion VI				
New Rochelle SD	Upgrade to secondary	$26.8		
Mamaroneck SD	Upgrade to secondary	12.1		
Blind Brook SD	Upgrade to secondary	5.4		
Portchester SD	Upgrade to secondary	15.6		
Nassau County				
Glen Cove	Treatment plant expansion & outfall	25.4		
Port Washington St.	Treatment plant expansion	6.7		
Great Neck SD			Pump station, force main, interceptors	$1.25
Nassau County #4			Treatment plant, pump stations, interceptors, force	141.0
Kings Point (Bellgrave collection district)			Interceptor	0.45
Kings Point (Great Neck collection district)			Interceptor	8.3
Roslyn Harbor			Interceptor	12.6
North Hempsted			Treatment plant expansion	1.4
Subregion VII				
Huntington			Expand treatment plant	25.0
Port Jefferson			Treatment plant, outfall & interceptors	20.2
Sewer districts #4, 4, 6			Treatment plant, outfall & interceptors	47.4

APPENDIX C

Proposed Projects by Town and Subregion	Phase I 1974-1977 NED Goals	Cost in Millions	Phase II 1977-1990 EQ Goals	Cost in Millions
Subregion VIII				
Riverhead			Expand treatment plant & interceptors	15.0
Subregion IX				
Greenport	Upgrade treatment plant	0.65		
III. Combined Sewers				
Subregion VI				
Throgs Neck			Combined waste treatment	77.3
Little Neck			Combined waste treatment	14.1
East Chester Bay			Combined waste treatment	35.2
Upper East River-Tallmans Is. area			Combined waste treatment	105.4
Upper East River - Bowery Bay Area			Combined waste treatment	112.4
Upper East River - Bronx River area			Combined waste treatment	105.5
IV. Major Industrial Sources				
Subregion VI				
Long Island Lighting, Glenwood landing				
L.I. Tungsten Glen Cove	BPT			
Powers Chemco, Glen Cove				
Sugregion VII				
Long Island Lighting Port Jefferson				

APPENDIX D

WATER QUALITY MANAGEMENT PLANNING FOR LONG ISLAND SOUND

To help clarify the role which the Long Island Sound Study will play in reaching the water quality goals of the region, it will have to be related with other water quality programs ongoing in the region. Up to the present day, planning for water quality management has generally been inadequate, fragmented, and underfunded. The 1972 Act greatly expands the emphasis given to planning and establishes a comprehensive program to improve coordination between various levels of government. This comprehensive program includes general levels of planning of which the Long Island Sound Water Quality Management Plan is one. These four areas of planning are:

1. MUNICIPAL FACILITY PLANNING is designed to provide orderly development and submission of applications for Federal funding of waste treatment plants. Administered by currently designated municipal authorities, this planning system will insure minimal interruption of facility planning until the areawide system for more complex planning areas is approved by EPA (expected between July 1975 and July 1976). At a minimum, all municipal facility plans will include:

a. A cost-effectiveness analysis comparing biological, physical-chemical and land disposal processes to select the most efficient treatment for the needs of the municipal area.

b. An evaluation of alternatives for advanced sewer system, including an analysis of possible interceptor connections to other municipal systems.

c. An evaluation of alternative sites and service areas.

d. An environmental assessment (impact statement) of the effects of the recommended treatment works on air, land, water, and other resources.

e. A complete analysis of costs of all elements in the system, (including any rainwater collection system) to meet water quality standards for a 20-year period following construction.

If the cost of construction is estimated to be substantial over the first few years, EPA will require additional planning measures, including:

a. An analysis of the facility's compatibility with land use and transportation needs.

b. Development of maps showing all connecting interceptors, sewer lines and other treatment works and systems.

c. An areawide assessment of the nature and extent of all types of water pollution.

2. SPECIAL PLANS FOR HIGH-DENSITY AREAS: To support existing planning processes in complex metropolitan areas, such as found in subarea 6, the law calls for an integrated planning and management scheme. This "areawide" planning process will supplement information gathered by the State and will include:

a. Identification of all wastes generated in the area and all treatment works necessary to handle municipal and industrial wastes over the next 20 years.

b. Analysis of proposed alternative treatment systems, land acquisition needs and the necessary collection and storm sewer systems. Development of a plan for financing all elements of the treatment system.

c. Development of a regulatory program to control the modification and construction of all treatment works, insuring that any industrial discharges entering the facility meet pretreatment effluent standards, and identifying the regulatory agencies.

d. Identification of processes to control:

- non-point sources of pollution, including urban-agricultural runoff

- saltwater intrusion

- the disposal of all wastes (including solid wastes into landfills)

- disposal of sewage sludge

All areawide plans must be consistent with State basin plans and any other water resources plan developed for that area by other agencies. Wherever possible, the plan must provide for an integrated facility that can hook up to other operations in the region.

3. THE STATE CONTINUING PLANNING PROCESS: In past years, States had the primary role for setting and enforcing water quality standards. In the new Act, States retain this responsibility, yet have the added duty of making certain that no effluent limitation written into a permit is inadequate to protect the water quality standard. Because of the complex relationship

The details of a particular basin plan will depend upon the complexity of problems in each segment within the basin. At a minimum, however, all basin plans must include:

- Detailed and major descriptions of each body of water in the basin.
- Identification and analysis of all pollutant sources.
- A ranking of each segment of water in order of priority for improvement.
- An analysis of measures to be taken to improve or maintain water quality.
- Establishment of timetables for State actions.

At the beginning of <u>each</u> fiscal year (beginning in 1974), a State will submit its revised Planning Process to EPA for review. This report will describe all major milestones to be achieved during the year and resources available to complete these tasks.

Thereafter, States will report periodocially to EPA on their progress toward meeting the goals for the continuing planning process. These reports will reveal whether States are setting realistic timetables for their activities - a major fault under previous legislation. In addition, the State's success or failure in meeting program deadlines will enable EPA to judge whether abatement actions will be sufficient to meet the 1977 and 1983 goals. EPA will also use this data in making its annual report to Congress on the Nation's overall progress in the water clean-up effort.

To help meet the requirements of the State Continuing Planning Process, EPA, as part of the Long Island Sound Study, has initiated contracts with both States to partially fulfill the Continuing Planning Requirement for the Long Island Sound Region.

4. <u>LEVEL B PLANNING</u>: The LISS is a "Level B" plan as defined by the Water Resources Council. A WRC policy statement of July 22, 1970 describes such a plan as one which will:

1. Involve Federal, state and local interests in plan development;
2. Identify all alternative methods and programs...identify alternative projects and uses of natural and related land resources; and
3. Identify and recommend plans and programs to be pursued by individual Federal, state and local entities.

between effluent discharges and water quality, it is important that the permit issuance process be coordinated with an overall study and planning program on water quality. The State Continuing Planning Process is designed to meet this need.

Through this process the State must develop:

- a program to attack water pollution where it is most serious

- priorities for State manpower and funding

- a means for assemble and utilize data on water quality as a basis for issuing permits

Without a Federally approved State planning process, no State will be allowed to operate a permit program.

The State must undertake an adequate monitoring program to gather accurate information on water quality, and to tailor abatement programs to individual stream conditions. Each segment of every river and lake must be monitored at regular intervals to determine ambient water quality variations. Both point and non-point source discharges will be evaluated in terms of their impact on water quality. From this information, each segment will be classified into one of two categories, indicating the severity of pollution and the difficulty in achieving the desired water quality standard. These two categories are:

- Water Quality Limited -- in which the condition of the water precludes attainment of the water quality standard, even if all point sources provided the levels of treatment required under Federal guidelines.

- Effluent Limited -- in which the water quality standard is now being met by the application of Federal effluent guidelines.

Where a segment is classified as "effluent limited", the State must develop an overall management plan to maintain water quality. For any segment that is classified as "water quality limited", the State must assign maximum daily load limits restricting the introduction of pollutants into the segments as a whole. These limits, a Congressional report said, should be sufficiently stringent to insure that a balanced population of indigenous aquatic life can live in the stream. The primary functional unit under which water quality data will be gathered will be through studies of individual basins. Basin planning areas may contain both water quality and effluent limited segments.

The policy statement also notes that "beneficial and adverse effects will be determined only to the extent necessary to insure selection of the proper alternative", implying that the plan should identify those projects and program alternatives which merits further study.

COORDINATING GROUP
LONG ISLAND SOUND REGIONAL STUDY
(As of the date of this report)

New England River Basins Commission	*R. Frank Gregg
State of Connecticut	Richard Dowd
Conn. Coastal Zone Management Committee	Senator George L. Gunther
Conn. Department of Finance and Control	Horace Brown
State of New York	John A. Finck
Interstate Sanitation Commission	Thomas R. Glenn
Tri-State Regional Planning Commission	Richard DeTurk
Atomic Energy Commission	Walter Belter
Department of Agriculture	Robert G. Halstead
Dept. of the Army, Corps of Engineers	Lawrence J. Bergen
Department of Commerce	Russell T. Norris
Dept. of Housing & Urban Development	Sheldon Gilbert
Department of the Interior	William Patterson
Department of Transportation	Capt. Royal E. Grover, Jr.
U.S. Environmental Protection Agency	Walter M. Newman
Federal Power Commission	Martin Inwald
Nassau Suffolk Regional Planning Board	Lee E. Koppelman
Citizen Advisory Committee	Roger Shope
Research/Planning Advisory Committee	Lawrence E. Hinkle, Jr., MD
Study Manager	**David A. Burack

WORK GROUP ON WATER QUALITY

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State of Connecticut, Dept. of Environmental Protection	*Pam Bergman Roy Anderson
Dept. of the Interior, Geological Survey	Glen Lowderback Robert Melvin
Dept. of the Army, Corps of Engineers	Arthur Doyle Paul Pronouost
Federal Power Commission	Martin Inwald
Citizen Advisory Committee	Barbara Swartz Kevin Quinn Margaret P. Wickersham
Research/Planning Advisory Committee	Dr. J.E. Alexander Dr. Nelson Marshall Eric Mood

*Chairpersons

Primary responsibility for this planning report rests with the chair agencies indicated above. The other agencies and individuals listed participated either in an active, a review, or an advisory role, but their listing here does not necessarily imply an endorsement of the report in whole or in part.

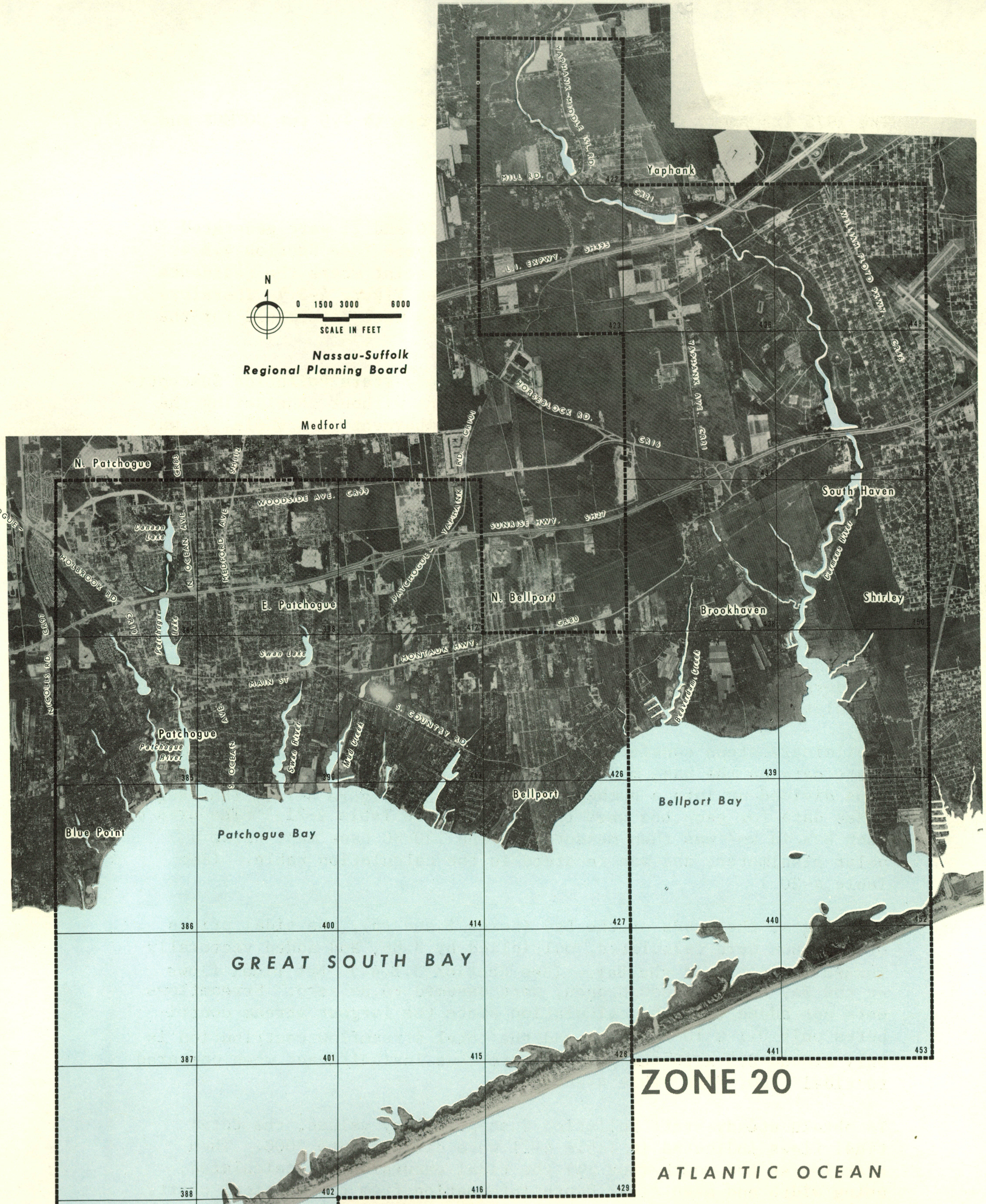


Figure 4-5

AERIAL OF ZONES 20 AND 21

The 1975 Transport Coefficient was rounded off to 1.0 for COZMOS run. (See Section 4.B.3, Table 4-4.)

4.C.4 Pollution Susceptibility

Pollution Susceptibility values for Zones 20 and 21 were generated for input to COZMOS during the region-wide analysis (See Section 4.B.4.) Both zones drain into Great South Bay at a point where the residence time is of the order of several months. (See Figure 4-5.) Therefore, steady-state Pollution Susceptibility values were determined for the zones.

Since it was not possible to calculate steady-state Pollution Susceptibility values for a portion of the embayment without considering the configuration and tidal movements of the embayment as a whole, it was necessary to do the calculations for all of Great South Bay in order to obtain the requisite information for Zones 20 and 21. The following paragraphs summarize the method requirements and procedures as they were applied to Great South Bay.

Method requirements included a base map of appropriate scale--in this case, the U.S. Coast and Geodetic Survey Small Craft Chart 120-SC with a scale of 1:40,000 was selected. Tidal range information for different sites within Great South Bay was obtained from Chart 120-SC and NOAA (National Ocean Survey) tide tables for the east coast of North America. Required equipment included a polar planimeter, proportional dividers, and tracing paper. Simple computations were made on a desk calculator.

Preliminary steps consisted of plotting and contouring tidal range and phase data on the base map. (See Figure 4-6.) Great South Bay was then divided up into a number of boxes. (See Figure 4-7.) The range/phase data for each box were tabulated. (See Table 4-21.) The area of each box in km^2 was then measured on the 120-SC base map, using a polar planimeter, and was recorded in the calculation table. (See Table 4-20.)

Starting at the heads of the Bay (boxes 1 and 15), the tidal prisms of each box were calculated, multiplied by 3.86, and added vectorally toward the mouth of the Bay. (See Section 3.B.4.) Net tidal flows at the Bay head, although open, were assumed to be zero. Streamflows were not added into the calculation since the largest stream contributes only $0.1 \times 10^{-3} km^3/day$ and the total streamflow contribution is only around $0.5 \times 10^{-3} km^3/day$ and are thus insignificant when compared to tidal flow. (See Table 4-20.)

To obtain steady-state Pollution Susceptibility values, the total tidal flows indicated in Table 4-21 were divided into 2000. Then starting at the mouth (box 29) the tidal excursion was calculated, using width and mean tidal depth information from the nautical chart. The value of 2000/x at the mouth was added to the value of 2000/x at one tidal excursion headward. This value was recorded on the chart and the process was continued, moving headward one tidal excursion at a time, and the values were added and recorded on the chart.

Figure 4-17

ENVIRONMENTAL INVENTORY

LANDFORM & WATERSHED

LEGEND:

	MAJOR WATERSHED DIVIDE
	50' CONTOURS
30	10' CONTOURS (BELOW 50')
	GENERAL DIRECTION OF STORMWATER FLOW

DESCRIPTION:

THIS MAP WAS USED TO LOCATE WATERSHED BOUNDARIES, MAJOR SWALES, THE PATH OF STORMWATER RUNOFF.

PURPOSE:

USED AS AN INPUT TO LAND USE AND LAND CAPABILITY.

THIS MAP WAS USED IN CONJUNCTION WITH THE ENVIRONMENTAL RESOURCES MAP TO DETERMINE CRITICAL WATERSHED AREAS AND WHICH OF THE CRITICAL AREAS ARE COVERED WITH NATURAL VEGETATION. THESE AREAS THEN RECEIVED HIGH PRIORITY FOR PRESERVATION AND CONSERVATION, DEPENDING UPON THEIR LOCATION.

SOURCE:

USGS 7 1/2 MINUTE TOPOGRAPHIC MAPS

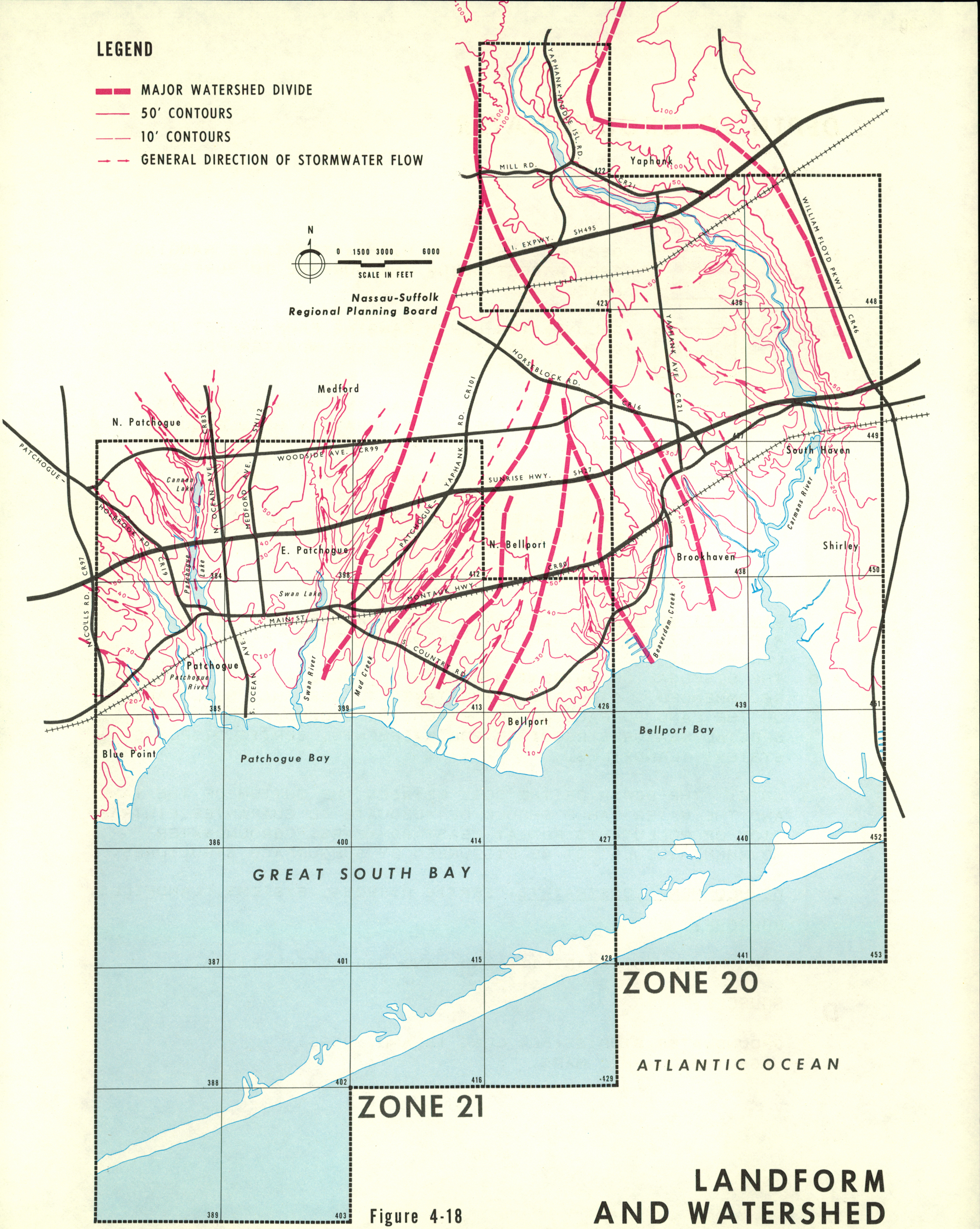


Figure 4-18

LANDFORM AND WATERSHED

DEPTH TO GROUNDWATER

LEGEND:

CONSTRAINT

A	DARK BROWN	DEPTH TO SEASONAL HIGH WATER TABLE RANGING FROM 4 FEET BELOW THE SURFACE TO SURFACE LEVEL.
B	BROWN	GROUNDWATER DEPTH RANGING FROM 4 FEET TO 9 FEET. AREA OF HIGH GROUNDWATER POLLUTION POTENTIAL.
C	LIGHT BROWN	GROUNDWATER DEPTH RANGING FROM 8 FEET TO 15 FEET. AREA OF MODERATELY HIGH GROUNDWATER POLLUTION POTENTIAL.
D	WHITE	AVERAGE GROUNDWATER DEPTHS OF GREATER THAN 15 FEET ARE NOT MAPPED BUT THE GROUNDWATER POLLUTION POTENTIAL MAY REMAIN HIGH.

DESCRIPTION:

A LIMITATIONS FOR DEVELOPMENT. UNFAVORABLE CONDITIONS FOR PIPING, UTILITIES, SEPTIC DISPOSAL SYSTEMS, BASEMENTS, LANDFILLS.

A-D THE DISPOSAL OF UNTREATED LIQUID OR SOLID WASTES IS NOT RECOMMENDED. CARE SHOULD BE TAKEN TO SEE THAT POLLUTANTS ON THE LAND SURFACE DO NOT REACH THE GROUNDWATER.

B SPECIAL MEASURES REQUIRED FOR BASEMENTS, SEPTIC DISPOSAL SYSTEMS, LANDFILLS.

NOTE: THE DEPTH OF THE SOIL BETWEEN THE BOTTOM OF THE TANK AND THE WATER TABLE SHOULD BE ADEQUATE TO GUARANTEE FILTRATION OF POLLUTANTS FOR AT LEAST 20 YEARS. GROUNDWATER MOVEMENT SHOULD NOT BE DISTURBED BY SUBSURFACE STRUCTURES.

C DEVELOPMENT CONSTRAINTS: SEPTIC DISPOSAL SYSTEMS, LANDFILLS.

PURPOSE:

INPUT TO LAND CAPABILITY AND LAND USE ALTERNATIVES.

SOURCES:

GROUNDWATER STUDIES FOR LONG ISLAND, USGS.
USGS TOPOGRAPHIC MAPS.

LEGEND

- DEPTH TO SEASONAL HIGH WATER (0 to −4 feet)
- GROUNDWATER DEPTH (−4 feet to −9 feet)
- GROUNDWATER DEPTH (−8 feet to −15 feet)

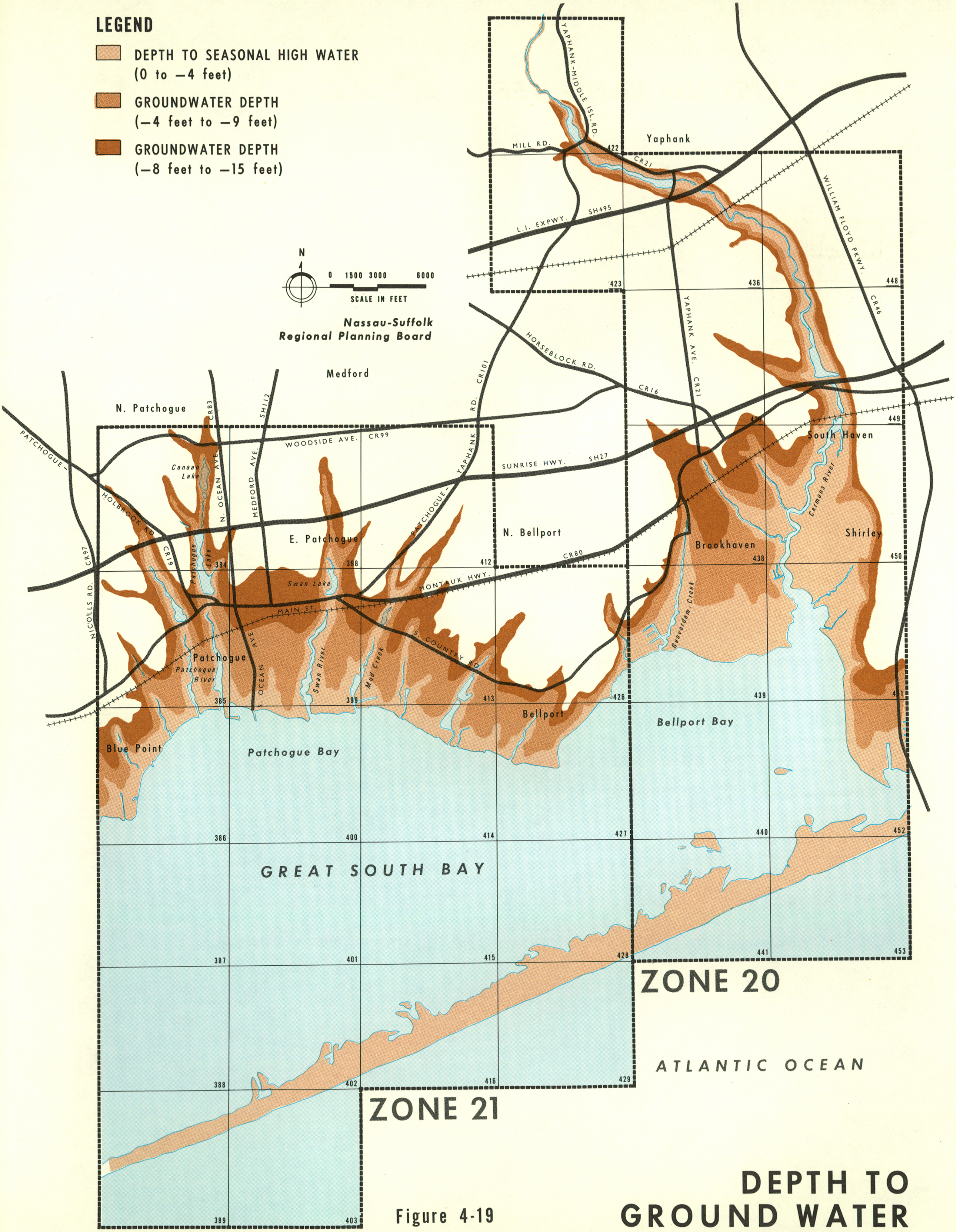


Figure 4-19

DEPTH TO GROUND WATER

1975 EXISTING LAND USE

LEGEND:	HOUSING
YELLOW ORANGE	1 D.U. & LESS/ACRE
LIGHT BROWN	2-4 D.U./ACRE
BROWN	5-10 D.U./ACRE
DARK BROWN	11 D.U. AND OVER/ACRE (HIGH DENSITY)
GREEN	OPEN SPACE
LIGHT GREEN	AGRICULTURE
RED	COMMERCIAL
PURPLE	INDUSTRIAL
BLUE	INSTITUTIONAL
GRAY	TRANSPORTATION & UTILITIES
WHITE	VACANT

SOURCES:

NASSAU-SUFFOLK REGIONAL PLANNING BOARD - 1974 AERIALS.

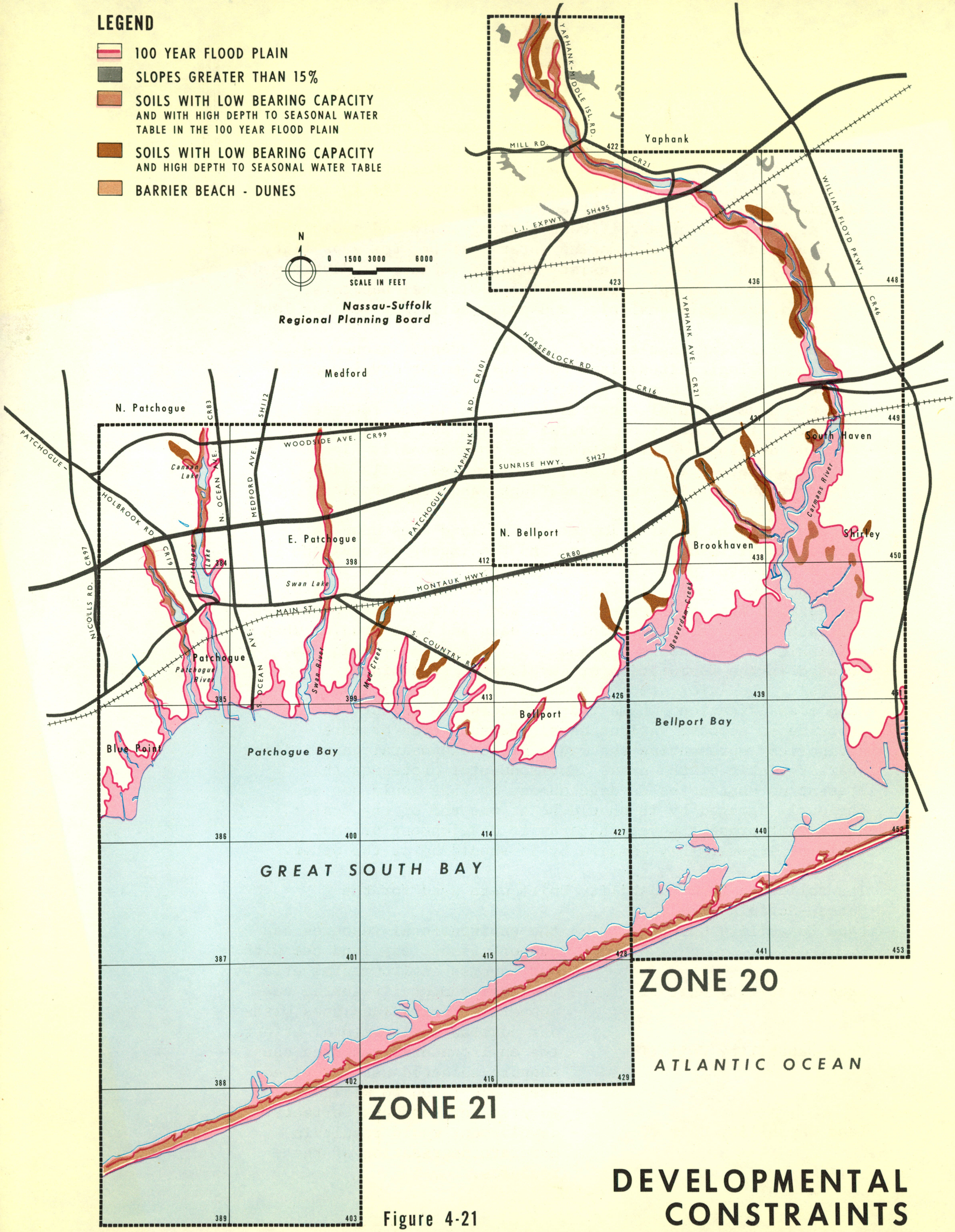


Figure 4-21

DEVELOPMENTAL CONSTRAINTS

4. Locate areas of significant hazard for development. (See Figure 4-21.)
5. Locate areas of high environmental impact potential.
6. Use the above information to prepare a series of maps for the study area, based upon an analysis of the data, inventory maps and information developed. At a minimum, the following information should be identified and mapped:
   a. Location of significant physiographic and geomorphic features, fresh and marine water quality, the capability of fresh waters to "resist" adverse impacts of development, Pollution Susceptibility, prime biological habitats, drainage basin analysis, and prime soils for various land uses.
   b. Existing significant historic, scenic, archaelogic, and geologic sites; land ownership; major developments; existing land use; transportation; and utilities.
   c. Developmental constraints including the 100 year floodplain; areas of coastal erosion and deposition; and development limitations due to seasonally high groundwater, steep slopes, major swales, soils with poor suitability for foundations, and high erosion potential.
7. Describe the general impact of CDP land uses upon each environmental resource category and the impact of environmental processes upon the CDP land uses. (See Table 3-1.)
8. Describe specific impacts of construction and phases of development upon the resource base and environmental processes for each resource. Use quantified data and case studies when available. (See Tables 3-2 and 3-3.) This information may be used in the formulation of development guidelines.
9. Using the information assembled in Steps 1-8, develop a land classification scheme that reflects the ability of the resource to support various uses. Select three or more categories representing the range of developmental capabilities characteristic of the area. Environmental processes that present no obstancles to development or that would not be seriously damaged by it should be at one end of the scale; those that present severe hazards to development or that would be irreversibly damaged by it should be at the other.

The following Land Capability Units were used for the Nassau-Suffolk area:

Land Capability Unit I	- the environmental resource can support almost any land use with out adverse environmental effects.
Land Capability Unit II	- the environmental resource can support selected land uses without adverse environmental effects.
Land Capability Unit III	- the environmental resource can support selected uses provided steps are taken to mitigate adverse environmental effects.
Land Capability Unit IV	- development would result in moderate degradation of the resource.

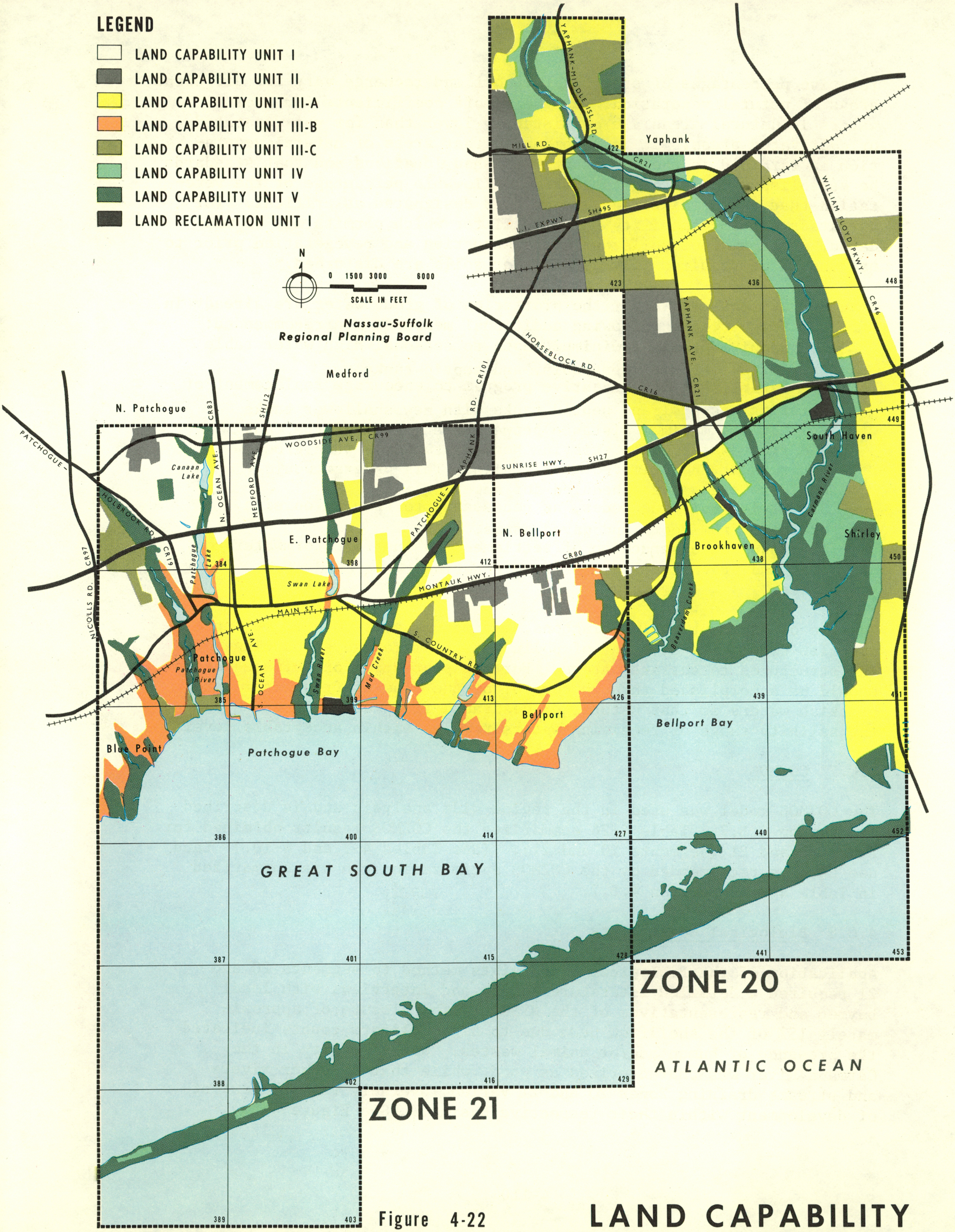


Figure 4-22 LAND CAPABILITY

relative percentages of stormwater runoff and recharge vary for different areas of natural vegetation, but the runoff coefficients for stormwaters in natural areas are consistently lower than for non-vegetated or cultivated areas. It is recommended that areas of natural vegetation be retained in the important watershed locations and that standards be established indicating the maximum allowable percentage of the vegetation that can be disturbed in any area designated as critical. For any areas within Capability Units I-III for which permits may be mandated, protection of soils during construction and revegetation prior to use should be required if vegetation or soils are disturbed.

A number of regulations for the protection of groundwater are already in effect. However, the following additional measures are recommended:

1. Require proof of minimum depth to seasonal high water table for installation of cesspools, and septic tanks.
2. Establish a tax incentive program to encourage replacement of existing cesspool and septic tanks with new shallower tanks so that the minimum distance between the bottom of the tank and groundwater meets existing health standards when groundwater is at an estimated yearly high. This program would apply to areas not scheduled for sewering.
3. Revise building codes, as necessary, to require on site drainage from roofs and paved areas.
4. Require construction of settlement basins for stormwater to trap and prevent pollutants from entering the groundwater system.

The use of sediment basins, lagoons, and man-made freshwater wetlands can also reduce the movement of pollutants from roadways, parking lots, and structures to surface waters. Further protection of surface waters should be accomplished through control of the flow of freshwater into brackish waters so that natural or desirable flows are maintained and the salinity range of receiving waters remains within acceptable levels.

4.C.7 COZMOS

The COZMOS model was used in the region-wide analysis and is described in Section 4.B.7. Table 4-26 summarizes the COZMOS results obtained for Zones 20 and 21 (segments 20 and 21). (See Tables 4-7 and 4-10.) Land use changes recommended by the COZMOS optimization run are summarized in Table 4-8 in Section 4.B.7.

4.C.8 Biological Constraints

Application of the Biological Constraints method to segments 20 and 21 required a detailed literature search and interviews with local baymen and representatives of the NYSDEC. The closure of approximately 15% of the shellfish beds due to high coliform counts indicated the presence of human and/or animal wastes. Water quality in the Carmans River was characterized as good, while that of other rivers and streams draining Zones 20 and 21 varied inversely with the extent of development within their respective basins. (See Figure 4-5.)

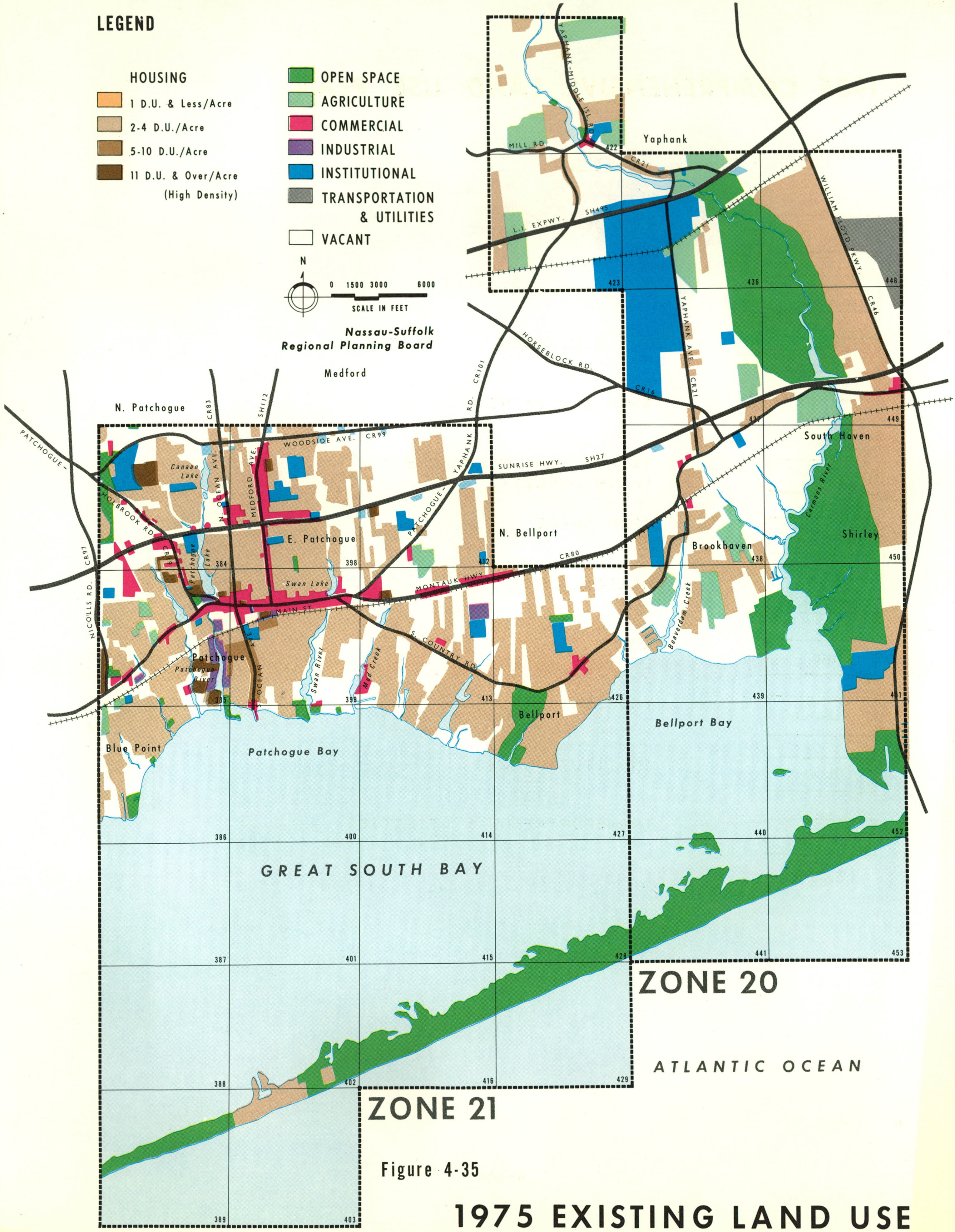
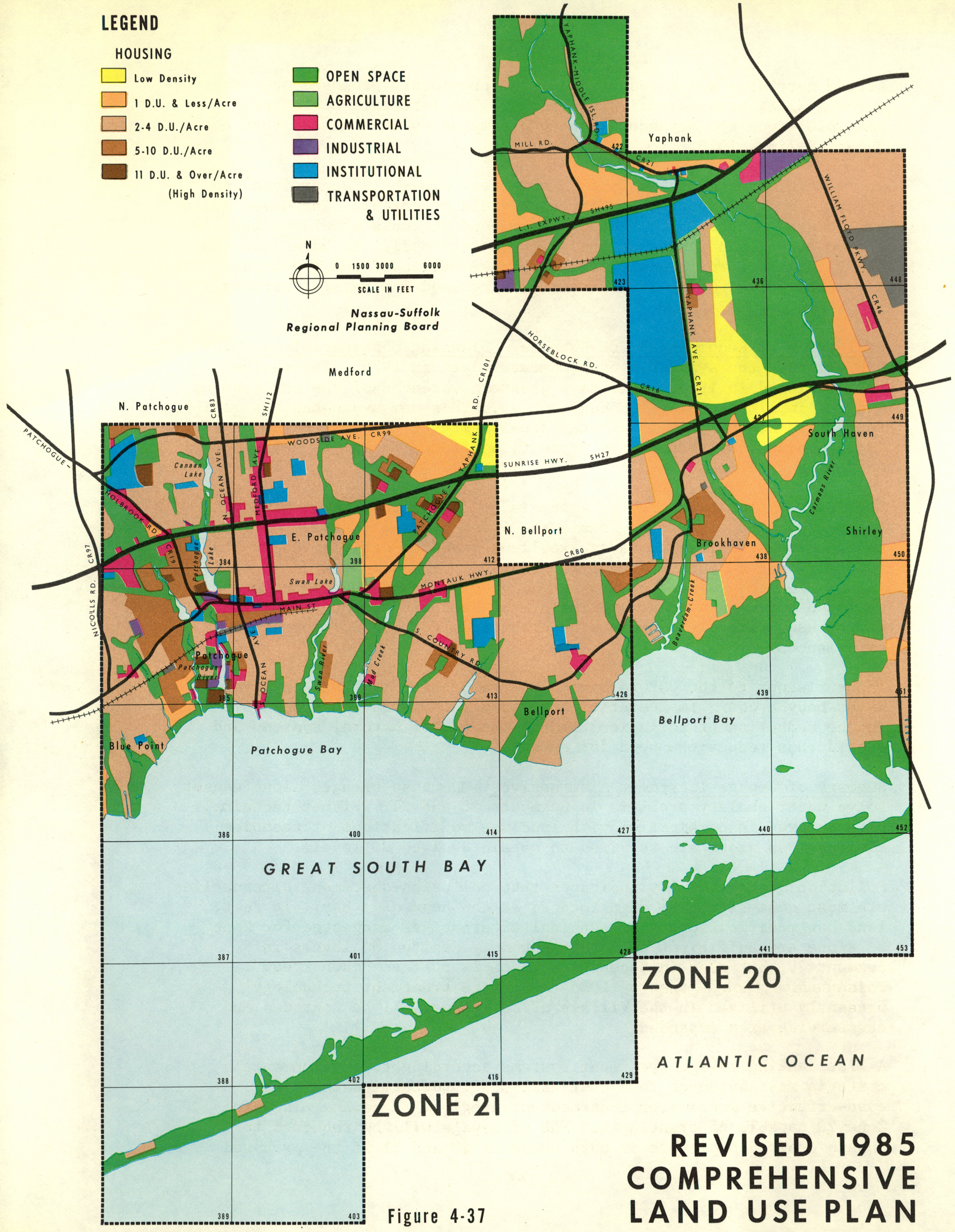


Figure 4-35

1975 EXISTING LAND USE

1985 COMPREHENSIVE LAND USE PLAN

LEGEND:	HOUSING
YELLOW	LOW DENSITY
YELLOW ORANGE	1 D.U. & LESS/ACRE
LIGHT BROWN	2-4 D.U./ACRE
BROWN	5-10 D.U./ACRE
DARK BROWN	11 D.U. AND OVER/ACRE (HIGH DENSITY)
GREEN	OPEN SPACE
LIGHT GREEN	AGRICULTURE
RED	COMMERCIAL
PURPLE	INDUSTRIAL
BLUE	INSTITUTIONAL
GRAY	TRANSPORTATION & UTILITIES



REVISED 1985 COMPREHENSIVE LAND USE PLAN

Figure 4-37

stream corridors and a reduction of the previously proposed open space acreage along transportation corridors. The latter is no longer feasible since the acreage has been preempted by development that has occurred since 1970.

The remaining farmland in Zone 20 comprises Riverhead sandy loam and Haven loam, soil types that have high yield potential. The Haven soils are located on the Suffolk County Farm, and attempts should be made to assure proper management of this high quality soil. In both Zones 20 and 21, the CDP revisions called for preservation of the remaining Riverhead soils, which are currently being used for raising nursery stock and hay.

Evaluation of Recommended CDP Changes - Planning Considerations - The CDP utilized the available environmental data in 1970. The revised CDP completed in 1976, reflects a greater awareness of the environment and the implications of its degradation. This new awareness has manifested itself not only in greater sensitivity to the environment but in the understanding that its protection affords social as well as aesthetic benefits.

The revised plan puts greater emphasis on the protection of stream corridors. These buffered corridors, which generally have a north-south orientation, serve as an excellent means of defining community identity on the south shore of Long Island. The use of stream corridors, in addition to greenbelts, provides another kind of open space component that can serve as a means of linking and buffering communities while at the same time allowing more opportunities for outdoor recreational experiences.

The revisions to the CDP recommend the relocation of PUDs away from water body areas. Implementation of this recommendation should aid in the reduction of pollution through the use of natural systems and should thus reduce the need for sewers.

Summary of Sewage Treatment Alternatives - Land use changes alone cannot solve water quality problems in Segments 20 and 21. Either technical alternatives in combination with land use modifications or technical alternatives alone are required to obtain desired DO levels.

Pollution Susceptibility indicates that pollution abatement alternatives are most cost-effective when located at the head of a bay. In fact, land use modifications and technical alternatives suggested for Zone 20 alone are sufficient to obtain not only desired DO levels in Segment 20, but also in Segment 21 which is further "downstream". This assumes, though, that by 1985 the sewage treatment technology presently utilized in the Village of Patchogue will be upgraded and the service area expanded.

A list ranking sewage treatment systems according to environmental criteria was subjected to a cost analysis to determine the most cost-effective wastewater treatment strategies. A sewage plant in Zone 20 capable of treating 1.4 MGD of sewage will be required to obtain desired DO levels in both Segments 20 and 21 if the proposed